ABUNDANCE AND DISTRIBUTION OF THE NONCONVENTIONAL DEEP-SEA FINFISH RESOURCES OFF THE SOUTH-WEST COAST OF INDIA (LAT.7^0-10^0N)

By

SAJEEVAN.M.K, B.F.Sc.

THESIS

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF FISHERIES SCIENCE

Faculty of Fisheries

Kerala Agricultural University

2005

DEPARTMENT OF FISHERY BIOLOGY

COLLEGE OF FISHERIES

PANANGAD, COCHIN

Dedicated To

My parents, wife Reena
and my two sweet little daughters,
Shilpa and Riya

DECLARATION

I hereby declare that this thesis entitled "**ABUNDANCE AND DISTRIBUTION OF THE NONCONVENTIONAL DEEP-SEA FINFISH RESOURCES OFF THE SOUTH-WEST COAST OF INDIA (LAT.7^0-10^{0}N)**" is a bonafide record of research work done by me during the course of research and that the thesis has not formed the basis for the award to me of any degree, diploma, associateship, or other similar title, of any other University or society.

Panangad,

SAJEEVAN. M.K.

27/09 /2005

2003-14-01

CERTIFICATE

Certified that this thesis entitled "**ABUNDANCE AND DISTRIBUTION OF THE NONCONVENTIONAL DEEP-SEA FINFISH RESOURCES OFF THE SOUTH-WEST COAST OF INDIA (LAT.7^0-10^0N)**" is a record of research work done independently by **Shri. SAJEEVAN. M.K.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

Panangad,
27/09/2005

Dr. J. RAJASEKHARAN NAIR
(Chairman, Advisory Committee)
Associate Professor,
Department of Fishery biology,
College of Fisheries,
Panangad, Kochi.

NAME AND DESIGNATION OF THE MEMBERS OF THE ADVISORY COMMITTEE/ EXAMINATION COMMITTEE

CHAIRMAN **Signature**

Dr. J. RAJASEKHARAN NAIR,
ASSOCIATE PROFESSOR,
DEPARTMENT OF FISHERY BIOLOGY,
COLLEGE OF FISHERIES,
PANANGAD, KOCHI.

27/09/05

MEMBER

Dr. T.M. JOSE,
ASSOCIATE PROFESSOR AND HEAD,
DEPARTMENT OF FISHERY BIOLOGY,
COLLEGE OF FISHERIES,
PANANGAD, KOCHI.

30.09.2005

MEMBER

Dr. K.G. SUNNY,
ASSOCIATE PROFESSOR,
DEPARTMENT OF FISHERY BIOLOGY,
COLLEGE OF FISHERIES,
PANANGAD, KOCHI.

30/9/2005

MEMBER

Dr. B. MANOJ KUMAR,
ASSISTANT PROFESSOR AND HEAD (i/c),
DEPARTMENT OF FISHING TECHNOLOGY,
COLLEGE OF FISHERIES,
PANANGAD, KOCHI.

30/09/05

External Examiner

DR. R. SANTHANAM
Dean
Fisheries College and Research Institute
(TANUVAS)
Thoothukudi.

5/12/05

ACKNOWLEDGEMENTS

I am deeply indebted to **Dr. J. Rajasekharan nair,** Associate Professor, Department of Fishery Biology, College of Fisheries, Panangad for his constructive guidance and prompt advice throughout the course of my study. His broadminded and careful attention, inestimable suggestions and meticulous scrutiny of the manuscript helped me a lot in the preparation of this thesis.

I am grateful to **Dr. D.D. Nambudiri,** Dean (i/c), College of Fisheries for granting permission and for providing necessary facilities for the successful conduct of the research work.

I owe a great deal to **Dr. T.M. Jose**, Associate Professor and Head, Department of Fishery Biology for all his advice, expertise, and support during the preparation of this thesis.

I am very much thankful to **Dr. K.G. Sunny**, Associate Professor, Department of Fishery Biology for his advice, support and his patience in reviewing this manuscript. With out his knowledge and experience, this thesis would not have been possible.

My sincere thanks are due to **Dr. B. Manoj Kumar**, Assistant Professor and Head (i/c), Department of Fishing Technology for his incessant source of inspiration, guidance and support during the course of this study.

The help and suggestions rendered by **Dr. K.V Jayachandran,** Associate Professor, Department of Fishery Biology **Dr. T.V Anna Mercy,** Associate Professor, Department of Fishery Biology, **Mr. S. Krishnakumar** Assistant Professor (S.G), Department of Fish Processing Technology, and **Dr. Devika pillai** Assistant Professor, Department of Aquaculture during the course of studies are gratefully acknowledged.

Faculty members of College of Fisheries provided a great learning experience and I sincerely thank them.

I wish to thank **Ms. Tessy Thomas**, Jr. Programmer, College of Fisheries for helping me in computer analysis of data.

I wish to extend my sincere thanks to all the staff members of Department of Fishery Biology, Management Studies, Fish Processing Technology, Fishing technology, and Aquaculture who directly or indirectly helped me in completing the research work.

The help and support rendered by the library staff and all the non-teaching staff of the college are gratefully acknowledged.

Thanks are also due to my batch mates, **Ms. Smita Ramakant Gawade, E.B. Beryl, Senthamil Selvi, Nisha Raj** and other friends who helped me to achieve this task.

I owe special thanks to **Mr. Jacob Cherian** for all his help, expertise and support during the preparation of this thesis.

I would like to express my deepest respect and most sincere gratitude to **Dr. V.S. Somvanshi**, Director General, Fishery Survey of India and **Dr. K.P. Philip**, former Zonal Director, Kochi base of Fishery Survey of India who granted me study leave to attend this course and allowed me to use the exploratory fishing data of M.F.V. Matsya Varshini.

My sincere thanks are due to **Dr. Santamma Varghese,** Fisheries Scientist, Fishery Survey of India, Mumbai, for her dedication and genuine concern for me.

My sincere thanks and appreciation are also due to the officers and crew of M:F.V. Matsya Varshini for their extra effort and tireless assistance in the data collection process.

My thanks are due to **Dr. K.N.V. Nair**, Zonal Director, and **Mr. P.S. Parasuraman**, Sr. Fisheries Scientist, **Dr. A. Barghava**, Sr. Fisheries Scientist, **Mr. L.K. Rao**, Sr. Administrative Officer. **Mr. P.Narayanan**, Skipper, **Mr. P. Sahadevan**, Skipper, **Mr. M.V. Ajith Kumar**, Chief Engineer. Gr.II, **Mr. C. Venugopal** former office superintendent, **Mr. Edword Karketta**, Assistant, **Dr. S. Ramachandran**, Scientific Assistant, **Ms. Santha Kuruvila**, Senior Clerk, **Mr. B. Suresh Kumar**, Junior Clerk, **Mr. K. Vijay Kumar menon,** Junior clerk and many other colleagues in Fishery Survey of India, who stood with me in times of need.

Last but not the least I would like to express my deep sense of affection and gratitude to my beloved parents, my wife, and my two sweet little daughters whose inspiration enabled me to complete this work. It was their affection and blessings that kept me in good spirits throughout my study period.

Sajeevan. M.K.

CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Figures

Plates

Introduction

1.INTRODUCTION

India is bestowed with 8129 km of coastline and has an exclusive right over 2.02 million km^2 of Exclusive Economic Zone. Fisheries sector is one of the important sectors in the socio-economic development of the country. More than six million fishermen and fish farmers depend on fisheries and aquaculture for their livelihood. Fisheries sector contributes Rs. 19555 crores to national income which is 1.4% of the total GDP. In the marine sector more than one million fishermen in 3975 fishing villages depend on fisheries for their livelihood (Planning commission, 2002)

In India fishing is an age-old occupation. From a modest 0.5 million tonnes per annum in the Nineteen fifties Indian marine fish landings have gone up to 2.7 million tonnes by the year 2000, registering a growth rate of 3.43% and thereafter stagnating at around 2.7 million tonnes (CMFRI, 2004). Bulk of the landings come from the coastal fishery, and the present trends in landings indicate that most of our coastal fishery resources are either fully exploited or over exploited.

The nineties witnessed drastic changes in the fishery sector like increase in the number of motorized craft, extension of fishing activities to deeper sector particularly along the south-west coast, and change of single-day fishing to multi-day fishing. This increased effort on the fish stocks reflected in the landings. But further increase in effort did not give the expected landings and revealed the reality that we cannot expect any further increase in the catches from our coastal waters.

Conservation and management of the conventional resources and utilization of nonconventional fishery resources are the ways now left to us to meet the growing demand of fish. Fishes that are unfamiliar to the consumer and do not immediately have demand in the market are considered as nonconventional finfishes. Lack of demand may be due to lack of awareness, poor knowledge about the quality of a particular fish, and its appearance. Fishes like *Nemipterus* spp. considered as nonconventional during the fifties fetch a good price nowadays. *Priacanthus* spp. treated as nonconventional till recently has also got a good demand in the local markets of Kerala. Further, there is a lot of regional differences in the demand status of fishes. Some fishes considered as nonconventional in some areas may have greater demand in some other localities. For eg. Balistids, which are in demand in Tamil Nadu, are still nonconventional in many parts of Kerala.

Deep-sea sector beyond 100 m depth contour is considered as an important zone for the nonconventional finfishes. Various surveys carried out by different agencies point out their presence in the above area. However, there is an urgent need for scientific knowledge about the distribution and abundance of the above resources. Conflicting reports about the diversity of deep-sea fishes further complicate the problem.

At present nonconventional finfishes caught by the trawlers as by-catch are discarded at sea. These types of by-catch and discards have been a major concern of fishery scientists and managers. According to FAO (1997) estimate the worldwide discard of fish catch amounts to an average 27 million tonnes per year. Of this amount one-third of the discard is by trawlers of the tropical fishing nations.

The working group for revalidating the potential of fishery resources in the Indian EEZ categorically stated that " An estimated 1,01,000 tonnes of deep-sea finfishes has been included, which may be an under estimate. This is a new resource and will need a considerable amount of care in handling, value addition and product development." (Ministry of Agriculture, 2000)

For the effective utilization of any resource there should be a sound knowledge about its diversity, distribution and abundance. Identification of the important components of the resources and assessing their biomass are major prerequisites to formulate future plans for tapping these resources. The knowledge about the resources helps the scientists and planners, to recommend a sustainable yield and also the effort required to exploit the above stock. As a first step towards this, an attempt has been made here to understand the diversity, distribution and abundance of the deep-sea fishes off the south-west coast of India.

The number of large trawlers (>20 m OAL) based at Visakhapatnam, which stood at around 180 in 1990 has come down to around 98 functional vessels by 2000. Total number of truly Indian larger vessels (23 –27 m OAL) at present is around 45. These are mostly engaged in coastal shrimp fishing, but are referred to as deep-sea fishing vessels. The main reason for the reduction in number of functional larger vessels and their concentration to the coastal zone is the less profitable nature of deep-sea fishing in India. Utilisation of unexploited nonconventional finfish resources will definitely make the deep-sea fishing lucrative and this will in turn help in the conservation and management of the conventional fishery resources of the coastal zone.

Review of Literature

2. REVIEW OF LITERATURE

2.1.BIODIVERSITY OF DEEP-SEA FISHES

Biodiversity of deep-sea fishes of the world has ever remained a challenge to eminent ichthyologists and taxonomists. Classical works of well-known ichthyologists and naturalists have thrown light in to the peculiarities of these fishes and these works also gave information on the deep-sea ichthyodiversity of the world. Day (1878) described the marine and fresh water fishes of India, Burma and Ceylon, which also included fishes from the deep-sea habitat. Gunther (1887) presented the systematics of deep-sea fishes based on the collection of H.M.S.Challenger during the period 1873-1876.

Alcock (1891, 1899) presented the systematics of the deep-sea fishes of India based on the collection of R.I.M.S. Investigator in the area between 5^0 and 24^0N latitudes (lat). Taxonomic characters of 169 deep-sea species were explained in the above work. The works of Goode and Bean (1895), Weber (1913) based on the materials of Siboga expedition, Norman (1939) based on John Murray expedition, Berg (1940) and Myers (1940) are considered as important scientific contributions in the systematics of deep-sea fishes. An excellent descriptive overview of the nature of many deep-sea fish groups is available in Marshall (1954,1979). Greenwood *et al.* (1966) described the relationships within and between the lines of evolution of teleosts. Cohen (1970) and Norman (1975) described the systematics of teleosts.

The general fish classification of Nelson (1976,1984,1994) remains far from perfect in providing consistently defended phylogenetic interpretations of the history of the approximately 57 orders, 484 families, 4260 genera and over 24,000 species currently suggested to be a representation of the biodiversity of fishes. In addition to the above FAO (1984) is also considered as an important work in the systematics of teleost fishes. Smith and Heemstra (1986) described 2200 species of fishes that are known or likely to occur in the seas off southern Africa. According to the authors 29% of the above fishes inhabit the deep-sea area and many of them are found in the oceans of the southern hemisphere. Helfman *et al.* (2003) described the diversity of fishes of the world Oceans.

Information on the biodiversity of nonconventional finfishes off the south-west coast of India is very limited. . Some of the notable works in the field of systematics of deep-sea fishes of India are by Samuel (1963) based on the materials collected by R.V.Conch of the Kerala University, Tholasilingam *et al.* (1964), Silas and Prasad (1966) and Oommen(1978) based on the collections of R.V Varuna of the Integrated Fisheries Project. Oomen (1980) enlisted 63 species of deep-sea fishes collected from the Quilon Bank during the period from October 1967 to May 1973 by the Integrated Fisheries Project vessels, namely R.V.Varuna, F.V.Velameen, F.V.Tuna and F.V.Klaus Sunnana.

Joseph and John (1986) have stated that the deep-sea resources in the outer shelf and slope are comprised of a few nonconventional species viz. bigeye, blackruff, greeneye, *Cubiceps* sp., *Epinnula* sp. etc in contrast to the multiplicity of species in the coastal region.

Balachandran and Nizar (1990) presented a checklist of fishes collected during the exploratory surveys of FORV *Sagar Sampada* during the period of 1985-87 along both west and east coasts of India. The list consists of 87 families, 152 genera, and 242 species, of which 87 species are nonconventional finfishes collected from the depth stratum of 100-4525m. Khan *et al.* (1996) recorded 34 deep-sea finfish species from the southeastern Arabian Sea. Venu and Kurup (2002a) identified and listed a total of 23 species from the depth stratum of 201-750 m off the west coast of India.

2.2. DISTRIBUTION AND ABUNDANCE OF DEEP-SEA FISHES

Prior to 1970 only very little study has been carried out to understand the distribution and abundance of the fishery resources beyond 100 m depth contour of the Indian EEZ. Some of the studies that enlighten us on the resources of this area are those of John (1948), Gopinath (1954), and Oommen (1974). Studies by Prasad and Nair (1973) have shown high abundance of deep-sea species like *Chlorophthalmus agassizi, Neoepinnula orientalis, Psenopsis cyanea,* and *Cubiceps natalensis* in the upper continental slope (185-450 m depth zone) of the Indian EEZ. Oommen (1980) presented the results of the exploratory fishing in Quilon bank and Gulf of Mannar, based on the data collected by Integrated Fisheries Project vessels during the period from October 1967 to May 1973. Distribution and abundance of deep-sea fishes between 175 and 370 m are covered in this literature. Joseph (1984) reported the occurrence of bullseye, Indian driftfish, and blackruff in the 200-500 m bathymetric zone along the west coast of India.

Philip *et al.* (1984) reported a gradual increase of deep-sea fish catches towards the deeper water along the coast of Kerala and Karnataka based on a systematic survey of the 200-500 m depth zone between 10^0 and 15^0N lat. Experimental fishing carried out by Integrated fisheries Project vessels during the period between October 1967 and March 1979 provides some information about the distribution pattern of the deep-sea fishes between 180 and 460 m off the south-west coast of India. Deep-sea lobster constituted 64.5% of the trawl catches between the depth zone 180 and 460 m and the share of deep-sea fishes was only 21.4% (Oommen, 1985).

Joseph (1986) opined that unexploited stocks such as bullseye and blackruff form the mainstay of the deep-sea resources in the outer continental shelf. Sivaprakasam (1986b) pointed out that major resources of deep-sea are nonconventional finfishes namely bullseye, blackruff, driftfish, and greeneye. According to him, *Chlorophthalmus agassizi* is available in plenty in the deeper waters between 200 and 600 m. Studies of Sudarsan *et al.* (1988) have shown that the most productive depth belt in the south-west coast for demersal fish is 150-200 m depth zone. Pandian and Philip (1992) studied the distribution, abundance and biology of *Ariomma indica,* a neritic deep-water fish occurring in the depth zone between 50 and 150 m.

Fishing operations conducted by FORV *Sagar Sampada* threw light on the immense potentiality of the deeper and oceanic waters beyond 50 m depth especially the abundance of fishable concentrations of exploited resources and also under-exploited deep-water resources such as bullseye, driftfish, scad, and deep-sea prawns within the Indian EEZ (James and pillai, 1990). Sivakami (1990) reported the occurrence of nonconventional finfishes like *Psenopsis* spp., *Trichiurus auriga, Chlorophthalmus agassizi, Neoepinnula orientalis,* and *Cubiceps* spp. in addition to the conventional forms especially in the deeper waters of the south-west coast. These fishes forming about 43% of the total fish caught from the area substantiate the potential stock of the above fishes

Raman and James (1990) reported the occurrence of myctophids in the DSL samples of eastern Arabian Sea and Bay of Bengal. Menon (1990) described the distribution and abundance of fish fauna in the DSL along various latitudes, depths, seasons and their diurnal vertical migration. Panicker *et al.* (1993) provided information on the availability of deep-sea fishes along the south west coast of India. Deep-sea trawling operations conducted from FORV *Sagar Sampada* during January and March-April was the basis of the above study.

Khan *et al.* (1996) based on the cruises (40&96) of FORV Sagar Sampada reported the existence of potentially rich unexploited deep-sea finfish resources in the south-eastern Arabian Sea. *Chlorophthalmus* sp., *Cubiceps natalensis, Psenopsis cyanea, Chascanopsetta lugubris, Priacanthus hamrur,* and *Chlorophthalmus bicornis* are the major resources reported by the above study. Menon *et al.* (1996) studied the distribution and abundance of the genus *Vinciguerria* in the deep scattering layer of the Indian EEZ. IFP (1997) reported that except for 1 tonne of *Emmelichthys nitidus* caught from the Quilon Bank, none of the under- exploited resources reported earlier was obtained from this region. Sivakami *et al.* (1998) presented the distribution pattern and abundance of the nonconventional finfish resources along the EEZ of India. Potential yield of major nonconventional resources along the EEZ of India is also presented in the above literature. Menon (2000) reported that finfishes form an important component of the constituents of organisms in the deep scattering layer (DSL) of Indian EEZ.

Venu and Kurup (2002a) indicated the existence of potentially rich unexploited deep-sea finfish resources along the west coast of India. Three fishing cruises of FORV *Sagar Sampada* during 1998-2000 was the basis of above study. They pointed out that the area between 7^0 and 9^0N lat. is more productive than other areas in the west coast. Panicker *et al.* (2003) studied the availability of deep-sea fish and shellfish resources off south-west coast of India. Kurup *et al.* (2004) studied the status of epifaunal component in the bottom trawl discards along the Kerala coast. Kunjipalu (2004) pointed out that the nonconventional resources like deep-sea fishes and mesopelagics like myctophids are some of the new resources for commercial exploitation.

2.3.STANDING STOCK OF DEEP-SEA FISHES

George *et al.* (1977) estimated the potential of deep-sea fishes along the Indian coast to be 0.4 million tonnes. Joseph (1984) based on the data collected by FSI vessels has estimated the potential of deep-sea fishes to be 0.27 million tonnes. Oommen (1985) has estimated the standing stock of deep-sea fishes along the south west coast (lat 7^0-13^0N) at 8,136 tonnes. Sulochanan and John (1988) reported that standing stock per unit area in the outer shelf and slope between lat 8^0 and 9^0N lat was higher than that of the inner shelf. Sudarsan *et al.* (1990) estimated the potential demersal fishery resource in the deeper waters (beyond 50 m) of the Indian EEZ at 0.65 million tonnes.

Ninan *et al.* (1992) estimated a standing stock of 30260 tonnes, and 57810 tonnes of fishery resources in the depth zone between 100 and 500 m off the south-west coast of India and Wadge Bank respectively. Sudarsan (1993) reviewing the marine fishery resources in the Indian EEZ has estimated a potential yield of 0.65 million tonnes of demersal resources from the deeper waters (50-500 m) of the entire EEZ. Khan *et al.* (1996) estimated the average biomass of deep-sea fishes in 100-450 m of southeastern Arabian Sea as 13.10tonne/nm^2. Sivakami *et al.* (1998) estimated a potential of 0.408 million tonnes of nonconventional resources in 1,58,466 km^2 area surveyed along the Indian EEZ. They have estimated the potential yield of *Chlorophthalmus* sp., *Priacanthus* spp., *Cubiceps* spp, *Ariomma indica*, *Psenopsis* spp., *Trichiurus auriga, Neoepinnula orientalis*, and other deep-sea fishes. Data collected in the depth zone between 20 and 398 m were used for the above estimation. Ministry of Agriculture (2000) revalidated the potential of fishery resources in the EEZ and estimated the potential of deep-sea finfishes in the outer continental shelf and continental slope of Indian EEZ to be 1.05 lakh tonnes.

2.4. BIOLOGY OF DEEP-SEA FISHES

Only very limited attempts have been made to study the biological aspects of deep-sea fishes, though there is some information available on their distribution. Silas and Prasad (1966) have given an account of the distribution and some aspects of the biology of *Ariomma indica.* Luther *et al.* (1988) have given some general information about this species and its fishery based on the landings during 1981-96 at Visakhapatnam. Pandian and Philip (1992) made preliminary observations on the biology of this neritic deep-water fish.

Ajiad (1987) gave an account of some morphometric and meristic properties of *Acropoma japonicum* occurring along Aqaba, Jordan. Naik and Uikey (1998) have made some preliminary studies on the biology of *Acropoma japonicum.* They observed the length weight relationship, sex ratio, and fecundity of the above species based on the collection from the central west coast of India.

Khan *et al.* (1996) made some observations on the biological aspects of the deep-sea fishes of the southeastern Arabian Sea. They have studied the length weight relationships, sex ratio, and size at first maturity of *Chlorophthalmus agassizi, Neoepinnula orientalis, Cubiceps natalensis,* *Psenopsis cyanea, Lampadena luminosa, and Priacanthus hamrur.* Venu and Kurup (2002b) gave an account of the distribution and biology of the deep-sea fish *Psenopsis cyanea* inhabiting 200 m and beyond in the south-west coast of India.

Materials and Methods

3.MATERIALS AND METHODS

3.1.EXPLORATORY SURVEYS

The Fishery Survey of India (FSI) conducts exploratory fishing surveys in the continental shelves and off shore regions of Indian EEZ. Survey and assessment of fish stocks and charting of fishing grounds in the Indian EEZ and adjoining area is an important mandate of the organization. Exploratory surveys carried out during the past provided lot of information about the characteristics of fishery resources of our country. M.F.V. Matsya Varshini, survey vessel (based at Kochi base of Fishery Survey of India) conducts demersal trawl survey in south-west coast, Wadge Bank and Gulf of Mannar. Exploratory fishing data of the above survey during the period of February 2004 to April 2005 is the base of this study.

3.2. AREA OF STUDY

As far as fishery resources are concerned south-west coast of India is considered as more productive than other sectors of Indian EEZ. Depth contours of 200 m and 1000 m are close by and almost parallel all along the main land. Hence, the wide banks in the deep-sea suitable for demersal trawling are limited. This is more evident on the east coast. Safe deep-sea demersal trawling could be conducted in well-known grounds like Quilon Bank, Wadge Bank and Ponnani Bank on the south-west coast of India. (Kunjipalu, 2004). Further any fluctuation in the fish landings of the south-west coast of India will immediately reflect on the all India landings. Considering the above factors 100-500 m depth zone off the south-west coast of India lying between 7^0 and 10^0N lat. was selected as the area of study (Plate 1) for the assessment of nonconventional finfish resources. Survey area includes Wadge Bank (7^0-8^0N lat.), Quilon Bank (8^0-9^0N lat.), and area off Aleppey & off Kochi (9^0-10^0N lat.).

3.2.1.The Wadge Bank. (7^0-8^0N)

An open sea area lying close to the southern tip of Indian continent, is situated between the latitudes 07^0.00' and 08^0.00'N. This area is generally exposed to strong wind and frequented with inclement weather conditions.

Seabed slopes vary gradually in deeper waters and results in a vast submarine plateau. Bottom is generally uneven, rocky and beset with marine growth like sea fans and sponges (Sivaprakasam, 1986a). Longitude (long.) wise up to 77^0.30'E is considered as west coast, so this point is considered as eastern border of the study area. A total of 6600 sq.km is available between 100 and 500 m depth contour of this region.

3.2.2. The Quilon Bank (8^0-9^0N)

An area of 3420 sq.km lying between Quilon and Aleppey, popularly known as Quilon Bank was considered as a rich ground for deep-sea prawn and lobsters. The bottom slope in the Quilon Bank is interrupted by a flat area of muddy and sandy bottom, and is ideal for trawling operation. Mechanisation efforts of the traditional vessels of India were initiated in this area during fifties and the location of rich prawn grounds in the Neendakara - Shakthikulangara belt changed the pattern of Indian fisheries.

3.2.3 Off Aleppey and Off Kochi (9^0 - 10^0N)

A total of 2935 sq.km area is available between 100 and 500 m depth zone of this area. Lot of flat, muddy/ sandy bottom areas ideal for trawling operation are available in this area. Fishing vessels operating from Kochi and Munambam fishing harbours exploit the deep-sea shrimp resources of this area during the period November to April.

3.3. SURVEY VESSEL

M.F.V. Matsya Varshini, a purse-seiner cum stern trawler (Plate 2) was constructed under the bilateral assistance programme between the countries of India and Denmark during 1980.It is a Fishing vessel of 36.5 m OAL fitted with 1160 HP 6 cylinder engine. The fishing winch is combination type, with net drum fitted at the mid-ship of the vessel and having a capacity of 1000 m of 20 mm dia. wire rope. Load pulling capacity of this hydraulically operated fishing winch is 10 tonnes. The major specifications of the vessel are furnished in Table 1.

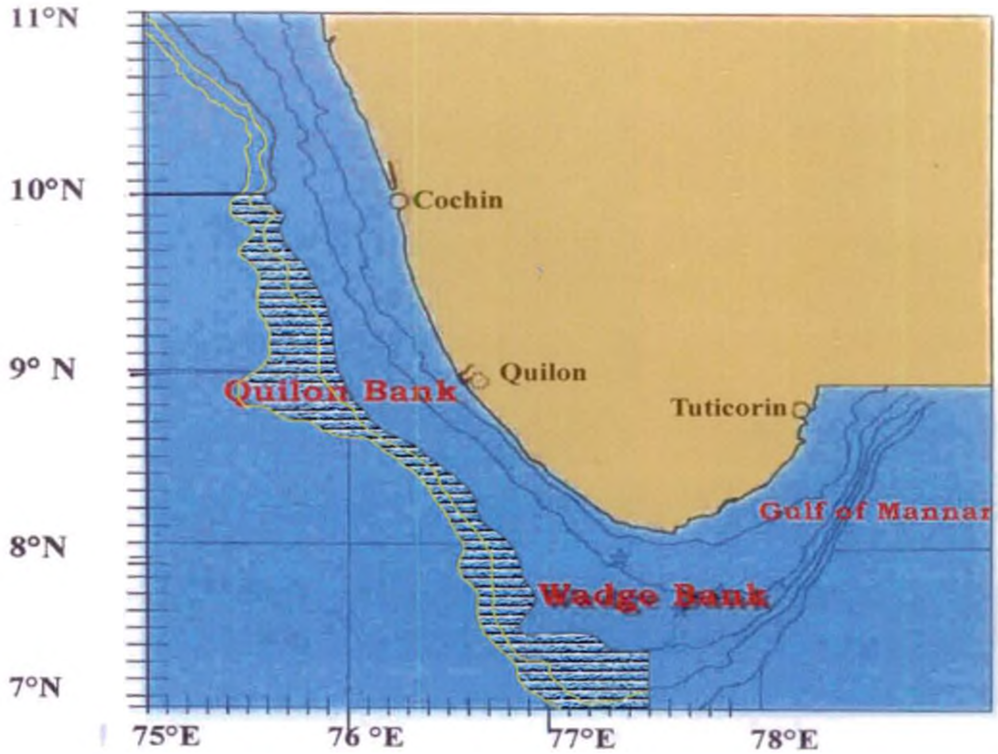

Plate 1. Area of study (Courtesy FSI)

Plate 2. M.F.V. Matsya Varshini (Courtesy FSI)

Table 1. Major specifications of the vessel

1	Name of the vessel	M.F.V. Matsya Varshini
2	Type	Purse-seiner cum stern trawler
3	Length overall	36.5 m
4	Beam	8.63 m
5	Draft	4.8 m
6	Gross registered tonnage	268.80
7	Name of the engine	B&W Alpha
7	Engine rating	1160 BHP at 1200 rpm
8	Speed	10 Knots
9	Endurance	20 days
10	Year of construction	1980
11	Navigational equipments	Satellite navigator, Radar, Radio telephone, Gyro compass
12	Fish finding equipments	Echo sounder, Fish finder
13	Fish hold capacity	209 cu. m
14	Fuel capacity	111.76 cu. m
15	Fresh water capacity	38.34 cu. m
16	Crew strength	22

3.3.1 Survey programme

Vessel conducted 13 voyages during the period between February 2004 and April 2005. A total of 54 hauls have been made in the study area spending an effort of 60.33 hours. Out of the 54 hauls 8 hauls were made at 100- 200 m depth strata and 46 hauls were made in the area between 200-500m depth zone. Distribution of hauls carried out during the period is shown in the Fig. 1. Detailed survey data during the months of March 2004, November 2004 and April 2005, during which the author has participated onboard as scientist participant and cruise leader were utilized for estimating the biomass and also to find out the distribution pattern of the finfish resources. A total of 24 hauls spending an effort of 28.58 hours have been carried out during the said period, mainly in the 200-500 m depth zone. The data from 6 hauls spending an effort of 7.83 hours in the 100-200 m depth zone during the period February 2004 to April 2005 was also utilized for analysis.

Data during the period from February 2004 to April 2005 were utilized for analyzing the group wise (deep sea finfish, prawns and lobsters, crabs, cephalopods, and elasmobranchs) percentage composition of the trawl catches of the area.

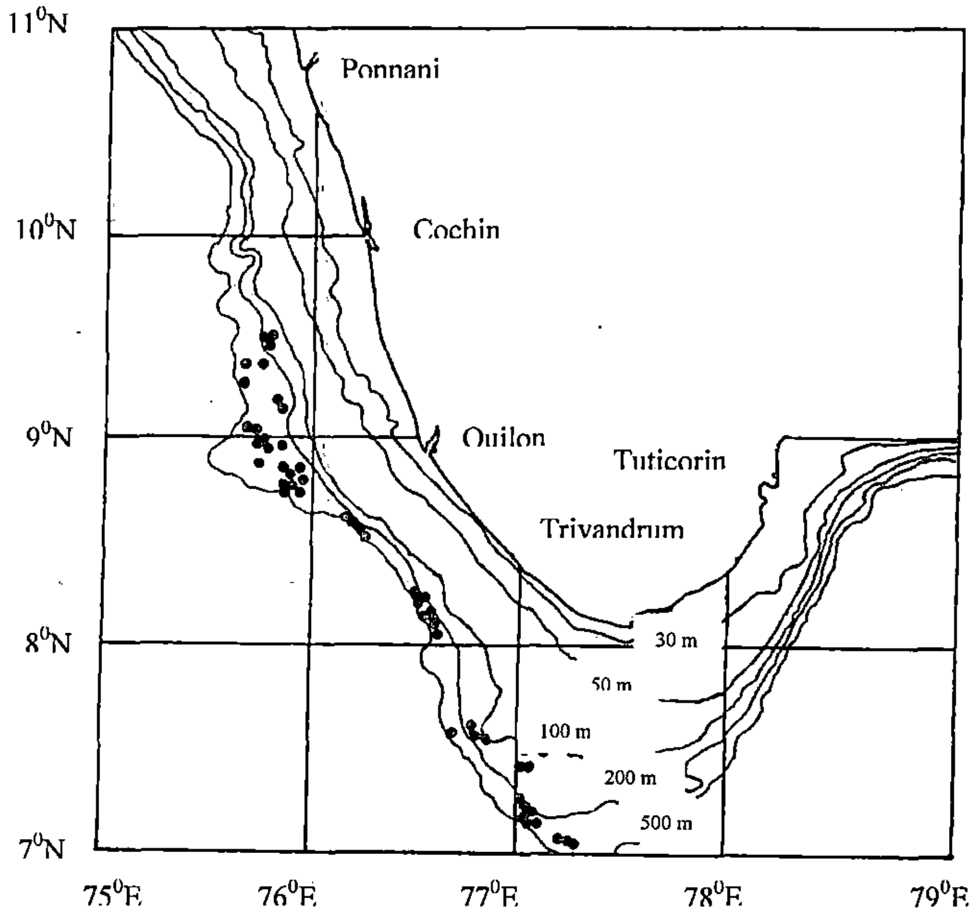

Fig.1. Distribution of effort (hauls) during the period February 2004 to April 2005.

3.3.2. Fishing gears and accessories

Two types of fishing gear were used for sampling the resources. They are i) 45.6 m Expo model fish trawl, an imported design widely used to survey the fishery resources of Indian EEZ by FSI vessels and ii) 45.12 m shrimp trawl, an important gear used to survey the shrimp resources of India. V- shaped otter boards of 3.2 sq.m, weighing 750 kg each were used for both the trawls.

3.3.2.1. 45.6 m Expo model fish trawl

It is an effective gear to sample the fishery resources, with a head rope length of 45.6m and a foot rope length of 55.8 m. Head rope is provided with 17 numbers of 270 mm dia floats. Foot rope is closely tied with link chain having a weight of 150 kg in air. The trawl, which is made of high-density polyethylene twines, with a mesh size ranging from 420 mm (wing) to 30 mm nylon mesh at codend was used. Net was constructed with 4 panels and has 37 numbers of panel sections (Fig.2).

3.3.2.2. 45.12 m Shrimp trawl

Head rope length of trawl is 45.12 m, which is provided with 270 mm dia floats. Trawl was made of high density polyethylene twines.120 mm mesh size at wing side is decreased through 100 mm, 50mm, 40mm, and 30 mm nylon mesh at codend. Trawl net was constructed with two panels and has 17 panel sections. Foot rope length of net is 49.88 m, which is provided with link chain, for the effective vertical opening of the net (fig.3).

3.4. SAMPLING METHOD

Area under study i.e. between latitude 7^0 and 10^0N from 100 to 500 m depth zone was divided into 6 strata based on the latitude and depth contours of 100 m, 200 m, and 500 m. Each 1^0 lat. x 1^0 long. was further divided in to 100 squares of 6'x 6'area. Hauls are allocated to these 6'x 6' squares following the stratified random sampling procedure. Previous exploratory data and area available for trawling were considered for allocation of hauls. Haul duration of 90 minutes per haul as per the programme could not be followed in all the hauls due to practical reasons.

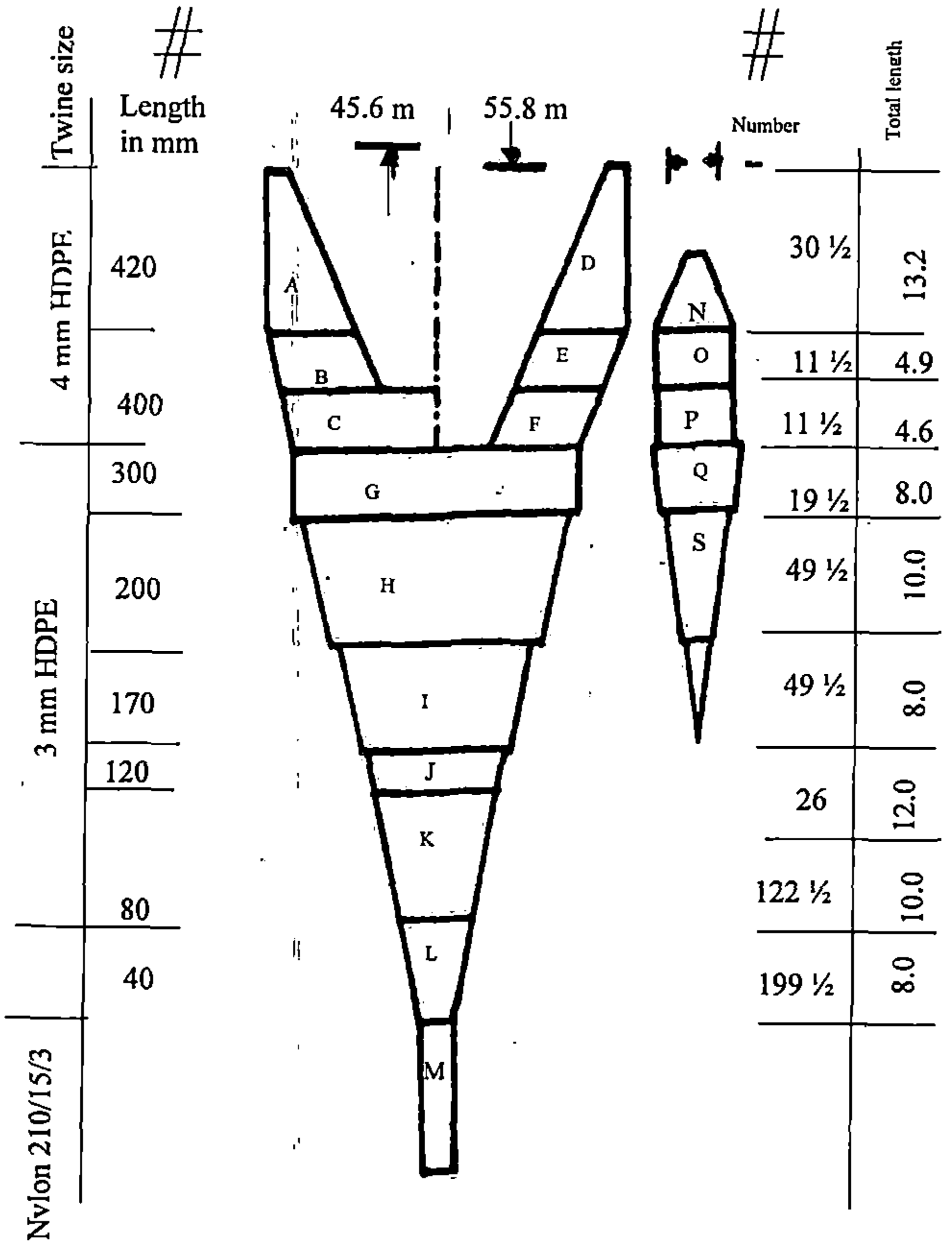

Fig.2. 45.6 m Expo model fish trawl

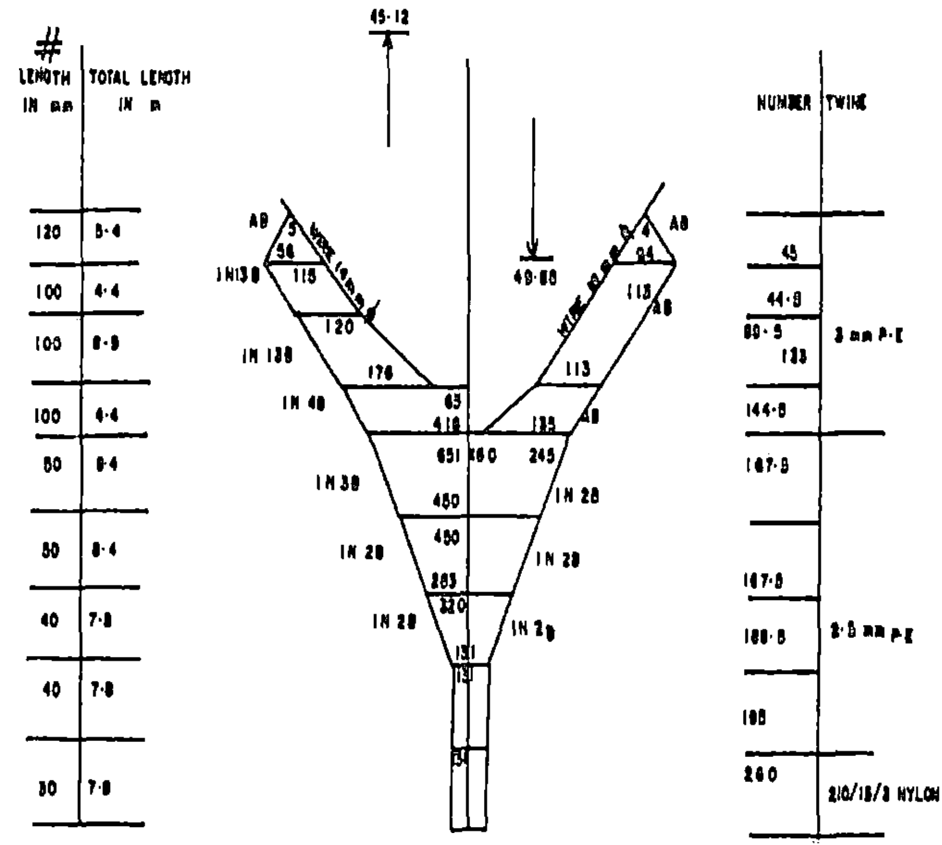

Fig.3. 45.12 m Shrimp trawl (Ninan *et al.*, 1992)

3.4.1.Deck sampling.

The catches were sorted out group-wise / species-wise immediately after each haul. The weight of each group/species were recorded to find out the group/species composition of trawl catches in each haul. For the convenience of further analysis the entire catch of nonconventional finfishes were divided in to 8 species/species-groups and the restwereput together as other deep-sea fishes. Deck sampling procedures outlined by Pauly (1980) was followed to record the catches. Necessary entries were made in the catch data sheets for further analysis. Specimens collected from the haul were immediately photographed by using a digital camera. Specimens were identified up to species level by using standard references (Day, 1878; Goode & Bean, 1895; Alcock, 1899; Munro, 1955; FAO, 1984; Smith and Heemstra, 1986). Specimens identified on board and the unidentified specimens were preserved onboard and brought to the shore laboratory for further identification. Specimens thus identified were preserved in formalin and kept in the museum of the College of Fisheries, Panangad for further studies. Identified specimens were taxonomically arranged by following Nelson (1984) to prepare the check list of the species collected during the study.

3.4.2. Length frequency studies

Specimens of major varieties collected from the haul were subjected to length frequency studies. Total lengths of identified specimens from snout to upper lobe of caudal fin were measured with an accuracy of 1mm. Lengths measured as above were recorded and pooled in to length classes of 10 mm class interval. Most of the length frequency measurements were carried out in fresh condition using the onboard facilities of the vessel. However specimens preserved onboard and brought to shore were also subjected to length frequency studies at shore laboratory. Such measurements were also added to the respective classes pooled onboard the vessel.

3.4.3.Biomass estimation

Catch recorded onboard the vessel were converted to catch per unit effort by dividing the quantity in kg with effort in hours (actual haul duration). Catch/effort data thus obtained was recorded and average catch per unit effort of major varieties thus obtained from each stratum is presented in table form. Species composition of trawl catches in different strata; latitude-wise and depth-wise are presented as pie diagrams. Biomass of the nonconventional finfish resources of the study area was estimated by using the 'swept area method' (Gulland, 1975). 'Swept area' or the 'effective path swept' by the trawl net during the haul was calculated by using the formula

a = D * h * x 2, **D = V * t**

$$a = D * h * x_2, \qquad D = V * t$$

Where a is the swept area, V is the velocity of the trawl over the ground when trawling, h is the length of the head rope, t is the time spent for trawling, x_2 is that fraction of the head rope which is equal to the width of the path swept by the trawl, (the 'wing spread', h * x_2).

In south -east Asian waters, values for x_2 ranging from 0.4 (Shindo, 1973) to 0.66 (SCSP, 1978) have been used. Pauly (1980) suggests $x_2 = 0.5$ as the best compromise. Somvanshi *et al.* (2004) based on some experiments have arrived at the value of $x_2 = 0.4$ to be the best compromise for FSI vessels, and has been used for the present study. Velocity of the trawl over the ground when trawling was 3 knots. Catch per unit area is obtained by dividing the catch per hour by the area swept per hour by trawl. Based on this, the average catch per unit area (ACPUA) in sq.km is worked out for each stratum and biomass of demersal stocks in each stratum is estimated from the relationship.

$$B = (cpua) * A / x_1$$

Where B is the Biomass, A is the area of the stratum and x_1 is the fraction of the biomass in the effective path swept, which is actually caught. The value of x_1 is actually chosen between 0.5 and 1. For trawlers used in south-east Asia a value of $x_1 = 0.5$ is commonly used in survey work (Isarankura, 1971; Saeger *et al.* 1976). Dickson (1974), on the other hand, suggests $x_1 = 1$. There is some evidence that $x_1 = 0.5$ might in fact be realistic (Pauly, 1979). In the present study also the value of x_1 is considered as 0.5. Biomass for each stratum was separately estimated for both shrimp and fish trawls and average was found out for each stratum. Biomass estimated for each stratum was then summed up to find out the total biomass of the area (Sparre *et al.*1989)

Results

4.RESULTS

4.1.BIODIVERSITY

Global fish fauna comprise something over 25000 species, of which 10-15% are found in the deep-sea environment. 1010 species of deep demersal fish and 1280 species of deep pelagic fishes are represented in the world oceans (Cohen, 1970). Deep-sea fishes are highly and quite specifically evolved and adapted to the particular environment and ecological conditions of the deep-sea, in fact they have finely tuned adaptations. Important among them are specialized eyes, highly complex bioluminescent organs, elaborate gas glands, swim bladder constructions, remarkable jaws, teeth, and colour.

During the period under study a total of 97 species belonging to 16 orders, 51 families and 78 genera are recorded from the area. Out of the 97 species recorded from the area 63 belongs to pre-perciform orders. Except for the four species recorded from 100- 200 m depth zone; all others are true deep-sea fishes. Fishes belonging to the family Cepolidae (1 Species), Uranoscopidae (2 Species), and Ariommatidae (1 Species) are recorded from the 100-200 m depth zone.

Global deep-sea demersal fish fauna is represented by species from 22 orders. The present study recorded fishes from 16 orders; this indicates the species diversity of the off shore region as already evident in the case of inshore fishes. Fishes coming under the order Perciformes dominated in diversity with 28 numbers of species, followed by order Lophiformes with 10 species and order Scorpaeniformes with 9 species. Out of the 51 families, 21 are represented by single species. Family Myctophidae and Macrouridae with 5 species each dominated over others in species diversity. Check list of finfishes collected during the study is classified following Nelson (1984). Area of specimen collection, depth of collection and total length of specimen used for the identification are given in the check list (Table 2).

Table 2. CHECK LIST OF NONCONVENTIONAL FINFISHES COLLECTED (PLATES 3 TO 14)

S.No	Species name	Common name	Area* Lat (N)/ long (E)	Depth (m)	TL** (cm)	Plate No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
INFRADIVISION ELOPOMORPHA ORDER ANGUILLIFORMES SUBORDER ANGUILLOIDEI						
I	**FAMILY: CONGRIDAE**	Conger eels				
1	*Ariosoma* sp.	Conger	$08^0$52.5' $75^0$45.0'	340	29.3	3. A
2	*Bathycongrus guttatus* (Gunther, 1887)		$09^0$20.2' $75^0$44.4'	357	30.0	3 .B
3	*Coloconger raniceps* Alcock, 1889	Frog head conger	$09^0$20.2' $75^0$44.4'	357	24.5	3 .C
II	**FAMILY: MURAENESOCIDAE**	Pike congers				
4	*Gavialiceps taeniola* (Woodmason, in Alcock, 1889)		$08^0$15.7' $76^0$30.7'	455	39.9	3. D
III	**FAMILY: NEMICHTHYIDAE**	Snipe eels				
5	*Nemichthys acanthonotus* Alcock, 1894	Slender snipe eel	$08^0$34.5' $76^0$13.1'	282	57.0	3.E

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	INFRADIVISION EUTELEOSTEI SUPERORDER PROTOCANTHOPTERYGII ORDER SALMONIFORMES SUBORDER ARGENTINOIDEI					
IV	**FAMILY: ALEPOCEPHALIDAE**	Slickheads				
6	*Rouleina squamilatera* (Alcock, 1898)	Blunt snout slickhead	$08^0$06.8' $76^0$39.9'	461	22.0	3.F
	SUPERORDER STERNOPTERYGII ORDER STOMIIFORMES SUBORDER GONOSTOMATOIDEI					
V	**FAMILY: STERNOPTYCHIDAE**	Hatchetfishes				
7	*Polyipnus spinosus* Gunther, 1891		$09^0$20.2' $75^0$44.4'	357	6.4	3.G
VI	**FAMILY: PHOTICHTHYIDAE**	Lightfishes				
8	*Vinciguerria* sp.	Lightfish	$08^0$59.6' $75^0$46.3'	334	11.3	3.H
VII	**FAMILY: CHAULIODONTIDAE**	Viperfishes				
9	*Chauliodus sloani* Schneider, 1801	Sloan's viperfish	$08^0$59.6' $75^0$46.3'	334	16.3	4.A

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
VIII	**FAMILY: ASTRONESTHIDAE**	Snaggletooths				
10	*Astronesthes martensii* Kluzinger, 1871	Astronesthid fish	$09^0$20.2' $75^0$44.4'	357	11.9	4.B
11	*Astronesthes trifibulatus* Gibbs, Amaoka &Haruta, 1984		$08^0$15.7' $76^0$30.7'	455	12.9	4.C
IX	**FAMILY: MALACOSTEIDAE**	Loosejaws				
12	*Photostomias* sp.		$08^0$15.7' $76^0$30.7'	455	17.8	4.D
SUPERORDER SCOPELOMORPHA						
ORDER ALULOPIFORMES						
SUBORDER AULOPOIDEI						
X	**FAMILY: CHLOROPHTHALMIDAE**	Greeneyes				
13	*Chlorophthalmus agassizi* Bonaparte, 1840	Short nose greeneye	$09^0$20.2' $75^0$44.4'	357	19.2	4.E
14	*Chlorphthalmus bicornis* Norman, 1934	Spiny jaw greeneye	$09^0$20.2' $75^0$44.4'	357	10.4	4.F
15	*Chlorophthalmus punctatus* Gilchrist, 1904	Spotted greeneye	$08^0$52.5' $75^0$49.1'	336	9.1	4.G
SUBORDER ALEPISAUROIDEI						
XI	**FAMILY: PARALEPIDIDAE**	Barracudinas				
16	*Stemonosudis rothschildi* Richards, 1967		$09^0$20.2' $75^0$44.4'	357	26.7	4.H

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
17	*Lestrolepis intermedia* (Poey, 1868)		$09^0$20.2' $75^0$44.4'	357	16.5	5.A
ORDER MYCTOPHIFORMES						
XII	**FAMILY: NEOSCOPELIDAE**	Blackchins				
18	*Neoscopelus macrolepidotus* Johnson, 1863	Large scaled lanternfish	$09^0$11.5' $75^0$48.4'	372	17.2	5.B
XIII	**FAMILY: MYCTOPHIDAE**	Lanternfishes				
19	*Diaphus splendidus* (Brauer, 1904)		$09^0$20.2' $75^0$44.4'	357	16.5	5.C
20	*Diaphus antonbruuni* Nafpaktitis, 1978		$08^0$14.2' $76^0$32.4'	435	15.3	5.D
21	*Diaphus* sp.		$08^0$45.0' $75^0$53.0'	410	7.8	5.E
22	*Diaphus* sp.		$08^0$08.4' $76^0$36.4'	418	6.6	5.F
23	*Lampadena luminosa* (Garman, 1899)		$08^0$15.7' $76^0$30.7'	455	12.1	5.G
SUPERORDER PARACANTHOPTERYGII						
ORDER GADIFORMES						
SUBORDER GADOIDEI						
XIV	**FAMILY: MORIDAE**	Deep-sea cods				

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
24	*Physiculus argyropastus* Alcock, 1894		$09^0$20.2' $75^0$44.4'	357	26.5	5.H
25	*Gadella* sp.		$08^0$52.5' $75^0$45.0'	340	22.7	6.A
SUBORDER MACROUROIDEI						
XV	**FAMILY: MACROURIDAE**	Grenadiers				
26	*Malacocephalus laevis* (Lowe, 1843)	Soft-head grenadier	$09^0$20.2' $75^0$44.4'	357	27.8	6.B
27	*Malacocephalus* sp.		$08^0$14.2' $76^0$32.2'	435	37.8	6.C
28	*Mesobius* sp.		$08^0$15.7' $76^0$30.7'	455	13.2	6.D
29	*Coelorhinchus quadricristatus* (Alcock, 1894)		$08^0$06.8' $76^0$39.9'	461	21.0	6.E
30	*Coryphaenoides macrolophus* (Alcock, 1889)		$08^0$06.8' $76^0$39.9'	461	15.3	6.F
ORDER OPHIDIFORMES SUBORDER OPHIDIOIDEI						
XVI	**FAMILY: OPHIDIIDAE**	Cusk-eels				
31	*Neobythites macrops* (Gunther, 1889)		$08^0$15.7' $76^0$30.7'	455	25.9	6.G

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
32	*Neobythites* sp.		$08^0$34.5' $76^0$13.0'	340	14.3	6.H
33	*Hypopleuron caninum* Smith &Radcliffe, 1913		$08^0$34.5' $76^0$13.0'	340	40.5	7.A
	ORDER LOPHIIFORMES SUBORDER LOPHIOIDEI					
XVII	**FAMILY: LOPHIIDAE**	Monks/Angler				
34	*Lophiodes mutilus* (Alcock, 1893)	Smooth angler	$09^0$11.5' $75^0$48.4'	372	23.1	7.B
35	*Lophiodes* sp.	Angler	$08^0$52.5' $75^0$45.0'	340	7.0	7.C
	SUBORDER ANTENNAROIDEI					
XVIII	**FAMILY: CHAUNACIDAE**	Sea toads				
36	*Chaunax pictus* Lowe, 1846	Pink frog-mouth	$09^0$15.0' $75^0$42.6'	369	18.7	7.D
37	*Chaunax endeavouri* Whitley, 1929	Coffinfish	$08^0$14.2' $76^0$32.2'	435	21.1	7.E
38	*Bathychaunax melanostomus* Caruso, 1989		$08^0$14.2' $76^0$32.2'	435	5.1	7.F

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
XIX	**FAMILY: OGCOCEPHALIDAE**	Sea bats				
39	*Halieutaea coccinea* Alcock, 1889	Spiny sea bat	$09^0$20.2' $75^0$44.4'	357	20.6	7.G
40	*Halieutaea nigra* Alcock, 1891		$08^0$50.2' $75^0$56.8'	330	7.0	7.H
41	*Halieutaea stellata* (Vahl, 1797)	Starry hand fish	$08^0$50.2' $75^0$56.8'	330	11.5	8.A
SUBORDER CERATIOIDEI						
XX	**FAMILY: DICERATIIDAE**	Horned anglers				
42	*Ceratius (Diceratias) bispinosus* (Gunther, 1887)	Two rod anglerfish	$08^0$14.2' $76^0$32.2'	435	11.4	8.B
43	*Phrynichthys wedli* Pietschman, 1926		$08^0$11.6' $76^0$32.2'	490	10.7	8.C
SUPERORDER ACANTHOPTERYGII SERIES PERCOMORPHA ORDER LAMPRIFORMES SUBORDER ATELEOPODOIDEI						
XXI	**FAMILY: ATELEOPODIDAE**	Tadpole fishes				
44	*Ateleopus indicus* Alcock, 1891		$08^0$14.2' $76^0$32.2'	435	34.2	8.D

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
ORDER BERYCIFORMES						
SUBORDER BERYCOIDEI						
XXII	**FAMILY: TRACHICHTHYIDAE**	Slimeheads				
45	*Gephyroberyx darwini* (Johnson, 1866)	Darwin's slimehead	$08^0$14.2' $76^0$32.2'	435	9.3	8.E
46	*Hoplostethus mediterraneus* Cuvier, 1829	Mediterranian slimehead	$08^0$14.2' $76^0$32.2'	435	6.5	8.F
XXIII	**FAMILY: BERYCIDAE**	Berycids				
47	*Beryx splendens* Lowe, 1834	Slender beryx	$09^0$20.2' $75^0$44.4'	357	15.2	8.G
XXIV	**FAMILY: HOLOCENTRIDAE**	Squirrelfishes				
48	*Ostichthys acanthorhinus* Randal, Shimizu& Yamakava, 1982	Soldier fish	$08^0$50.2' $75^0$56.8'	330	13.5	8.H
SUBORDER POLYMIXIOIDEI						
XXV	**FAMILY: POLYMIXIIDAE**	Beardfishes				
49	*Polymixia japonicus* Gunther, 1877	Silver eye	$07^0$08.2' $77^0$04.8'	226	11.2	9.A
50	*Polymixia fusca* Kotthaus, 1970		$07^0$08.2' $77^0$04.8'	226	10.3	9.B

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
ORDER ZEIFORMES						
XXVI	**FAMILY: ZEIDAE**	Dories				
51	*Zenopsis conchifer* (Lowe, 1850)	Silver John dory	$09^0 20.2'$ $75^0 44.4'$	357	36.1	9.C
52	*Cyttopsis roseus* (Lowe, 1843)	Rosy dory	$09^0 20.2'$ $75^0 44.4'$	357	16.4	9.D
ORDER SYNGNATHIFORMES SUBORDER AULOSTOMOIDEI						
XXVII	**FAMILY: MACRORAMPHOSIDAE**	Snipefishes				
53	*Macroramphosus* sp.		$07^0 08.2'$ $77^0 04.8'$	226	8.7	9.E
SUBORDER SYNGNATHOIDEI						
XXVIII	**FAMILY: SYNGNATHIDAE**	Pipefishes				
54	*Syngnathus acus* Linnaeus, 1758	Long snout pipefish	$08^0 50.2'$ $75^0 56.8'$	330	20.2	9.F

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ORDER SCORPAENIFORMES					
	SUBORDER SCORPAENOIDEI					
XXIX	**FAMILY: SCORPAENIDAE**	Scorpionfishes				
55	*Setarches quentheri* Johnson, 1862	Deep-water scorpion	$08^0 34.5'$ $76^0 13.1'$	282	10.2	9.G
56	*Setarches longimanus* (Alcock, 1894)		$09^0 15.2'$ $75^0 42.6'$	369	10.6	9.H
57	*Ectroposebastes imus* Garman, 1899	Mid-water scorpion	$08^0 15.7'$ $76^0 30.7'$	455	11.2	10.A.
XXX	**FAMILY: TRIGLIDAE**	Gurnards				
	SUBFAMILY: TRIGLINAE					
58	*Lepidotrigla* sp.		$08^0 59.6'$ $75^0 46.3'$	330	13.5	10.B
59	*Pterygotrigla hemisticta* (Temminck &Schlegel, 1842)	Black spotted gurnard	$08^0 59.6'$ $75^0 46.3'$	330	15.1	10.C
	SUBFAMILY: PERISTEDIINAE	Armoured gurnards				
60	*Satyrichthys adeni* (Lloyd, 1907)		$08^0 34.5'$ $76^0 13.1'$	282	29.9	10.D
61	*Satyrichthys* sp.		$09^0 15.2'$ $75^0 42.6'$	369	22.0	10.E
62	*Peristedion investigatoris* (Alcock, 1898)		$09^0 15.2'$ $75^0 42.6'$	369	12.4	10.F
63	*Peristedion halei* (Day, 1878)		$08^0 34.5'$ $76^0 13.1'$	282	7.9	10.G

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
ORDER PERCIFORMES						
SUBORDER PERCOIDEI						
XXXI	**FAMILY: PERCICHTHYIDAE**	Acropomatids				
64	*Acropoma japonicum* Gunther, 1859	Glowbelly	$08^0$59.6' $75^0$46.3'	334	14.7	10.H
65	*Synagrops japonicus* (D`Oderelein, 1884)	Japanese splitfin	$08^0$06.8' $76^0$39.9'	461	15.2	11.A
66	*Synagrops pellucidus* (Alcock, 1889)		$07^0$08.2' $77^0$04.8'	226	10.2	11.B
67	*Neoscombrops annectens* Gilchrist, 1922	Scomber splitfin	$08^0$59.6' $75^0$46.3'	334	12.3	11.C
XXXII	**FAMILY: SERRANIDAE**	Rock cods				
68	*Chelidoperca investigatoris* (Alcock, 1895)		$07^0$08.2' $77^0$04.8'	226	11.2	11.D
XXXIII	**FAMILY: EMMELICHTHYIDAE**	Rovers				
69	*Emmelichthys nitidus* Richardson, 1845	Bonnet- mouth	$08^0$50.2' $75^0$56.8'	330	20.5	11.E
XXXIV	**FAMILY: BATHYCLUPEIDAE**	Bathyclupeids				
70	*Bathyclupea hoskynii* (Alcock, 1899)		$09^0$20.2' $75^0$44.4'	357	12.9	11.F
XXXV	**FAMILY: OWSTONIIDAE**					
71	*Owstonia totomiensis* Taneka, 1908		$07^0$08.2' $77^0$04.8'	226	36.8	11.G

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
XXXVI	**FAMILY: CEPOLIDAE**	Bandfishes				
72	*Acanthocepola limbata* (Valenciennes, 1835)	Bandfish	$07^0 33.8'$ $76^0 50.3'$	121	57.2	11.H
SUBORDER TRACHINOIDEI						
XXXVII	**FAMILY:CHAMPSODONTIDAE**	Gapers				
73	*Champsodon vorax* Gunther, 1867		$08^0 59.6'$ $75^0 46.3'$	330	5.9	12.A
XXXVIII	**FAMILY: URANOSCOPIDAE**	Stargazers				
74	*Ichthyoscopus inermis* (Cuvier, 1829)		$07^0 33.8'$ $76^0 50.3'$	121	24.3	12.B
75	*Uranoscopus* sp.	Stargazer	$07^0 33.8'$ $76^0 50.3'$	121	19.7	12.C
76	*Xenocephalus elongatus elongates* (Temminck &Schlegel, 1843)		$07^0 08.8'$ $77^0 04.3'$	226	27.2	12.D
XXXIX	**FAMILY: PERCOPHIDAE**	Duckbills				
77	*Bemprops caudimacula* Steindachner, 1877		$09^0 20.2'$ $75^0 44.4'$	357	15.2	12.E
XL	**FAMILY: MUGILOIDIDAE**	Sandsmelts				
78	*Parapercis* sp.		$07^0 08.2'$ $77^0 04.8'$	226	20.1	12.F

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
SUBORDER CALLIONYMOIDEI						
XLI	**FAMILY: CALLYONYMIDAE**	Dragonets				
79	*Callionymus carebares* Alcock, 1890	Deep- water dragonet	$09^0 19.2'$ $75^0 49.7'$	249	12.8	12.G
SUBORDER GOBIOIDEI						
XLII	**FAMILY: GOBIIDAE**	Gobies				
80	*Gobius cometes* Alcock, 1899		$08^0 34.5'$ $76^0 13.1'$	282	10.1	12.H
SUBORDER SCOMBROIDEI						
XLIII	**FAMILY: GEMPYLIDAE**	Snake mackerels				
81	*Neoepinnula orientalis (Gilchrist & Von Bonde, 1924)*	Sackfish	$09^0 20.2'$ $75^0 44.4'$	357	17.4	13.A
82	*Ruvttes pretiosus* (Cocco, 1829)	Oilfish	$09^0 11.5'$ $75^0 48.4'$	372	33.9	13.B
83	*Promethichthys promètheus* (Cuvier, 1832)	Promethean escolar	$09^0 20.2'$ $75^0 44.4'$	357	16.8	13.C
84	*Rexea prometheoides* (Bleeker, 1856)	Royal escolar	$08^0 14.2'$ $76^0 32.2'$	435	17.3	13.D

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
XLIV	**FAMILY: TRICHIURIDAE**	Ribbon fishes				
85	*Benthodesmus elongatus* (Clarke, 1879)	Elongate frost fish	$09^0$15.2' $75^0$42.6'	369	33.1	13.E
86	*Benthodesmus tenuis* (Gunther, 1877)	Slender frost fish	$08^0$43.2' $75^0$58.4'	401	54.8	13.F
87	*Benthodesmus tuckeri* Parin & Becker, 1970	Tucker's frost fish	$08^0$43.2' $75^0$58.4'	401	53.8	13.G
88	*Trichiurus auriga* Klunzinger, 1884	Pearly hair tail	$08^0$06.8' $76^0$39.9'	461	30.1	13.H
SUBORDER STROMATEOIDEI						
XLV	**FAMILY: CENTROLOPHIDAE**	Ruffs /Medusafishes				
89	*Psenopsis cyanea* (Alcock, 1890)	Indian ruff	$09^0$20.2' $75^0$44.4'	357	19.2	14.A
XLVI	**FAMILY: NOMEIDAE**	Drift fishes				
90	*Psenes squamiceps* (Lloyd, 1909)	Indian driftfish	$08^0$59.6' $75^0$46.3'	334	18.1	14.B
XLVII	**FAMILY: ARIOMMATIDAE**	Ariommatids				
91	*Ariomma indica (Day, 1870)*	Indian ariomma	$07^0$33.8' $76^0$50.3'	121	14.6	14.C
ORDER PLEURONECTIFORMES						
SUBORDER PLEURONECTOIDEI						
XLVIII	**FAMILY: BOTHIDAE**	Lefteye flounders				

Table 2. Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)
92	*Citharichthys* sp.		$09^{0}20.2'$ $75^{0}44.4'$	357	14.9	14.D
93	*Chascanopsetta lugubris* Alcock, 1899	Pelican flounder	$09^{0}15.2'$ $75^{0}42.6'$	369	25.7	14.E
94	*Laeops macrophthalmus* (Alcock, 1889)		$09^{0}11.5'$ $75^{0}48.4'$	372	14.0	14.F
SUBORDER SOLEOIDEI						
XLIX	**FAMILY: CYNOGLOSSIDAE**	Tonguesoles				
95	*Symphurus* sp.		$08^{0}34.5'$ $76^{0}13.1'$	282	9.7	14.G
ORDER TETRAODONTIFORMES						
SUBORDER BALISTOIDEI						
L	**FAMILY: BALISTIDAE**	Triggerfishes				
	SUBFAMILY-MONOCANTHINAE	Filefishes				
96	*Alutera scripta* Berry &Vogele, 1961	Scrawled filefish	$08^{0}14.2'$ $76^{0}32.2'$	435	45.4	14.H
SUBORDER TETRAODONTOIDEI						
LI	**FAMILY: TETRAODONTIDAE**	Puffers				
97	*Amblyrhynchotes spinosissimus*(Regan, 1908)	Spiny blassops	$07^{0}33.8'$ $76^{0}50.3'$	121	12.0	14.I

* Area of collection. ** Total length of specimen used for identification

A

B

C

D

E

F

G

H

Plate 3. Photographs of the nonconventional finfishes:
FAMILY: CONGRIDAE to FAMILY: PHOTICHTHYIDAE

A. Ariosoma sp. | *B. Bathycongrus guttatus*
C. Coloconger raniceps | *D. Gavialiceps taeniola*
E. Nemichthys acanthonotus | *F. Rouleina squamilatera*
G. Polyipnus spinosus | *H. Vinciguerria sp.*

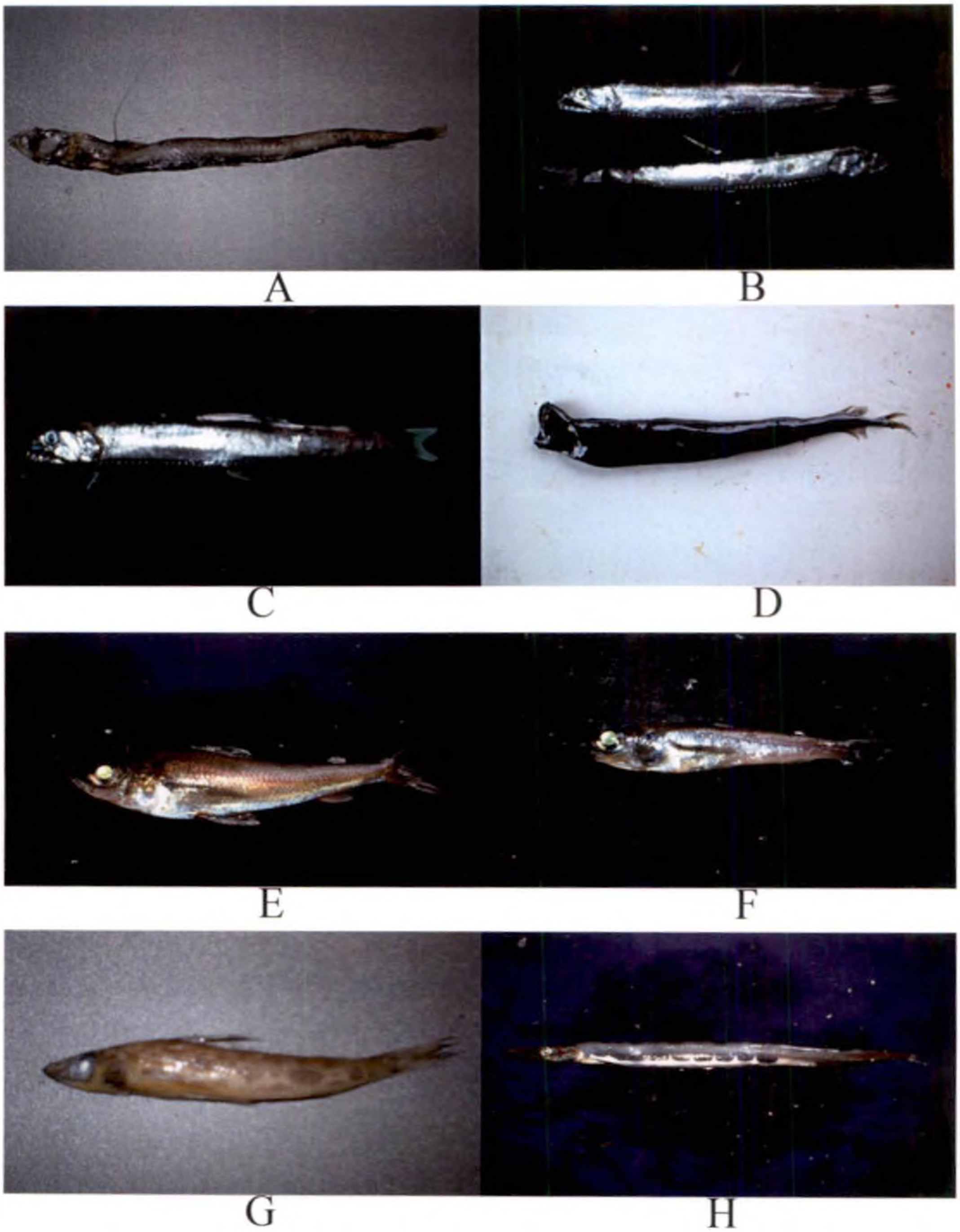

Plate 4. Photographs of the nonconventional finfishes
FAMILY: CHAULIODONTIDAE to FAMILY: PARALEPIDIDAE

A. Chauliodus sloani. *B. Astronesthes martensii*
C. Astronesthes trifibulatus. *D. Photostomias sp.*
E. Chlorophthalmus agassizi *F. Chlorphthalmus bicornis*
G. Chlorophthalmus punctatus *H. Stemonosudis rothschildi*

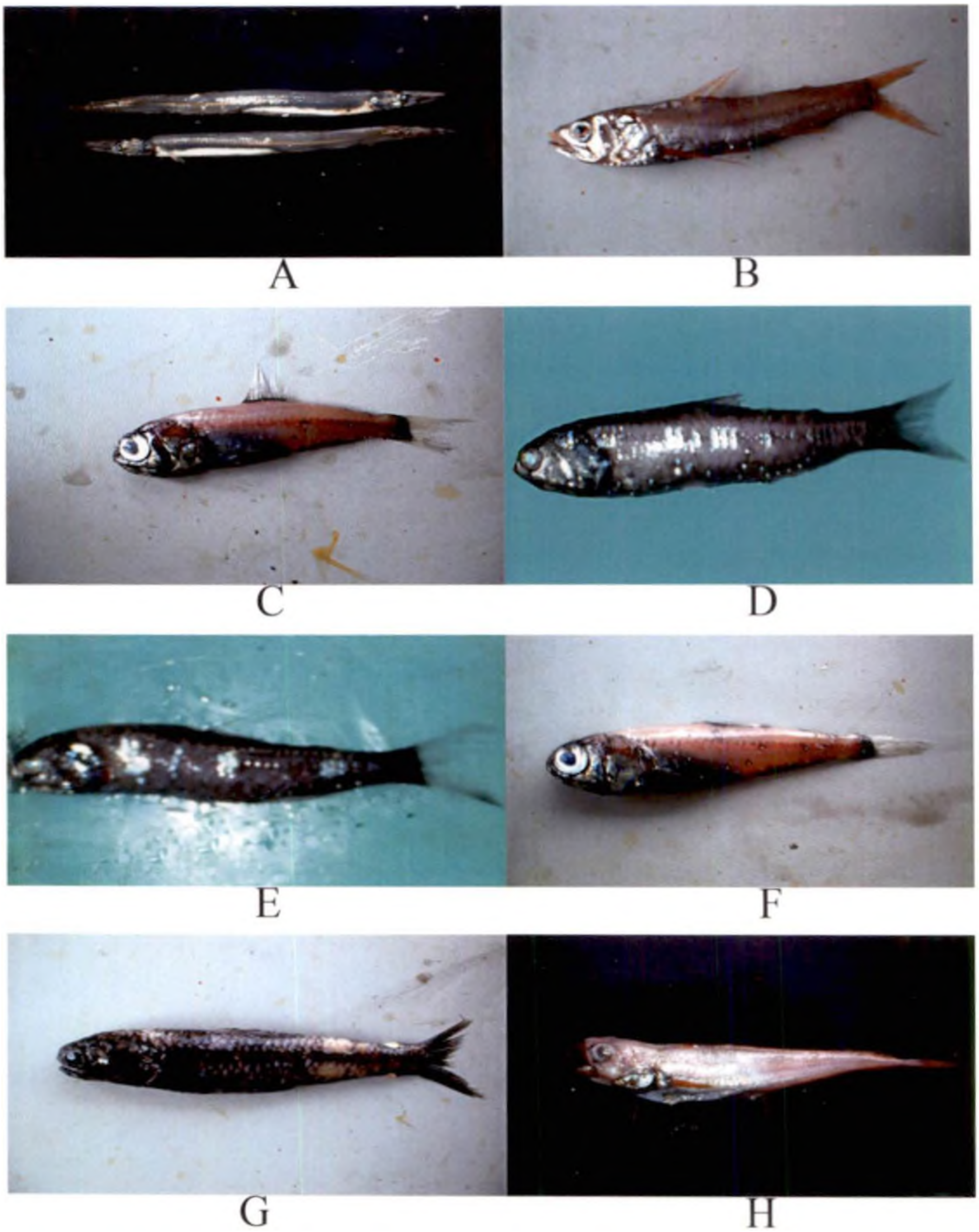

Plate 5. Photographs of the nonconventional finfishes
FAMILY: PARALEPIDIDAE to FAMILY: MORIDAE

A. Lestrolepis intermedia *B. Neoscopelus macrolepidotus*
C. Diaphus splendidus *D. Diaphus antonbruuni*
E. Diaphus sp. *F. Diaphus sp.*
G. Lampadena luminosa *H. Physiculus argyropastus*

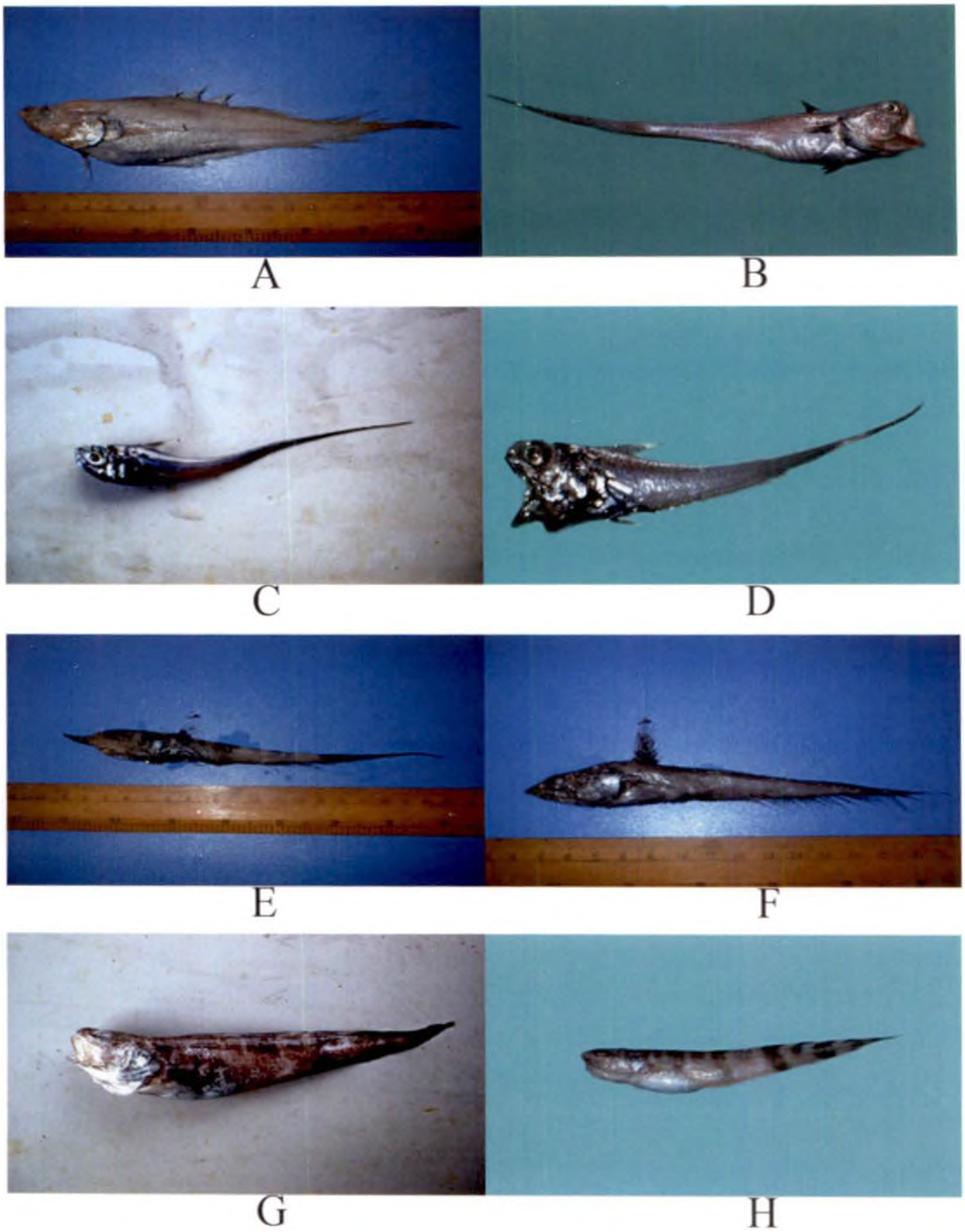

Plate 6 Photographs of the nonconventional finfishes
FAMILY: MORIDAE to FAMILY: OPHIDIIDAE

A. *Gadella sp.*	B. *Malacocephalus laevis*
C. *Malacocephalus sp.*	D. *Mesobius sp.*
E. *Coelorhinchus quadricristatus.*	F. *Coryphaenoides macrolophus*
G. *Neobythites macrops*	H. *Neobythites sp.*

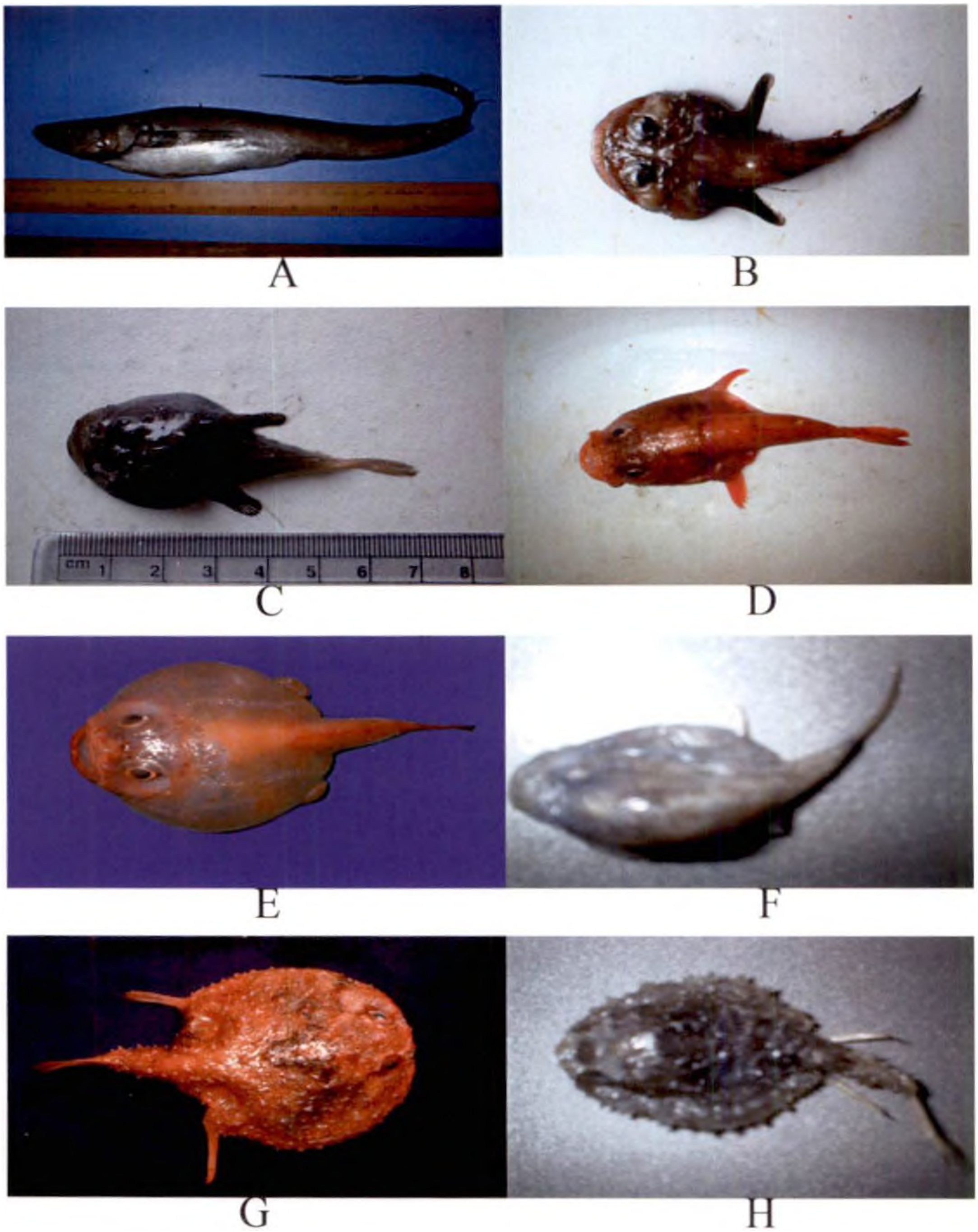

Plate 7. Photographs of the nonconventional finfishes
FAMILY: OPHIDIIDAE to FAMILY: OGCOCEPHALIDAE

A. Hypopleuron caninum
B. Lophiodes mutilus
C. Lophiodes sp.
D. Chaunax pictus.
E. Chaunax endeavouri
F. Bathychaunax melanostomus
G. Halieutaea coccinea
H. Halieutaea nigra

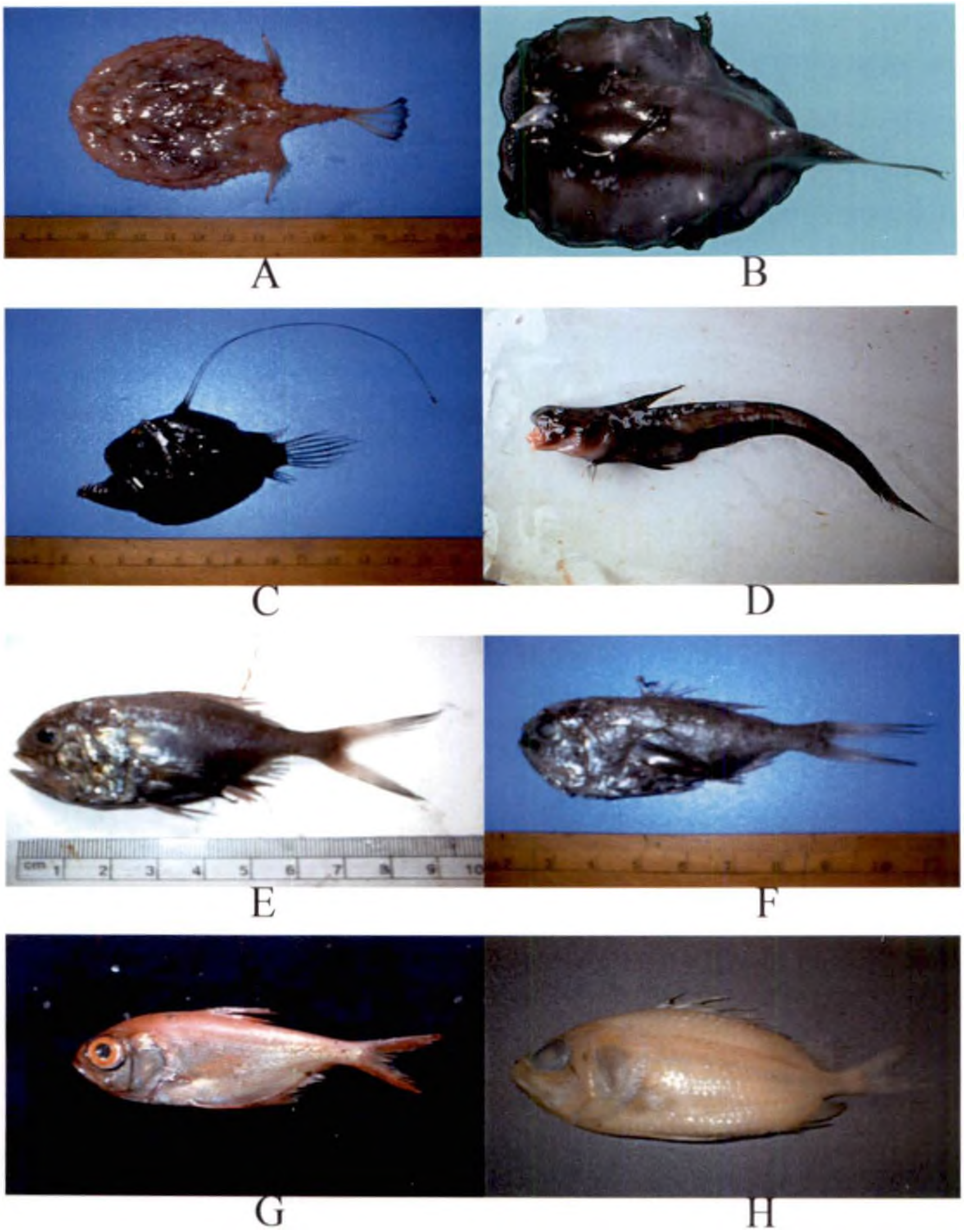

Plate 8. Photographs of the nonconventional finfishes
FAMILY: OGCOCEPHALIDAE to FAMILY: HOLOCENTRIDAE

A. Halieutaea stellata — *B. Ceratius (Diceratias) bispinosus*
C. Phrynichthys wedli — *D. Ateleopus indicus*
E. Gephyroberyx darwini — *F. Hoplostethus mediterraneus*
G. Beryx splendens — *H. Ostichthys acanthorhinus*

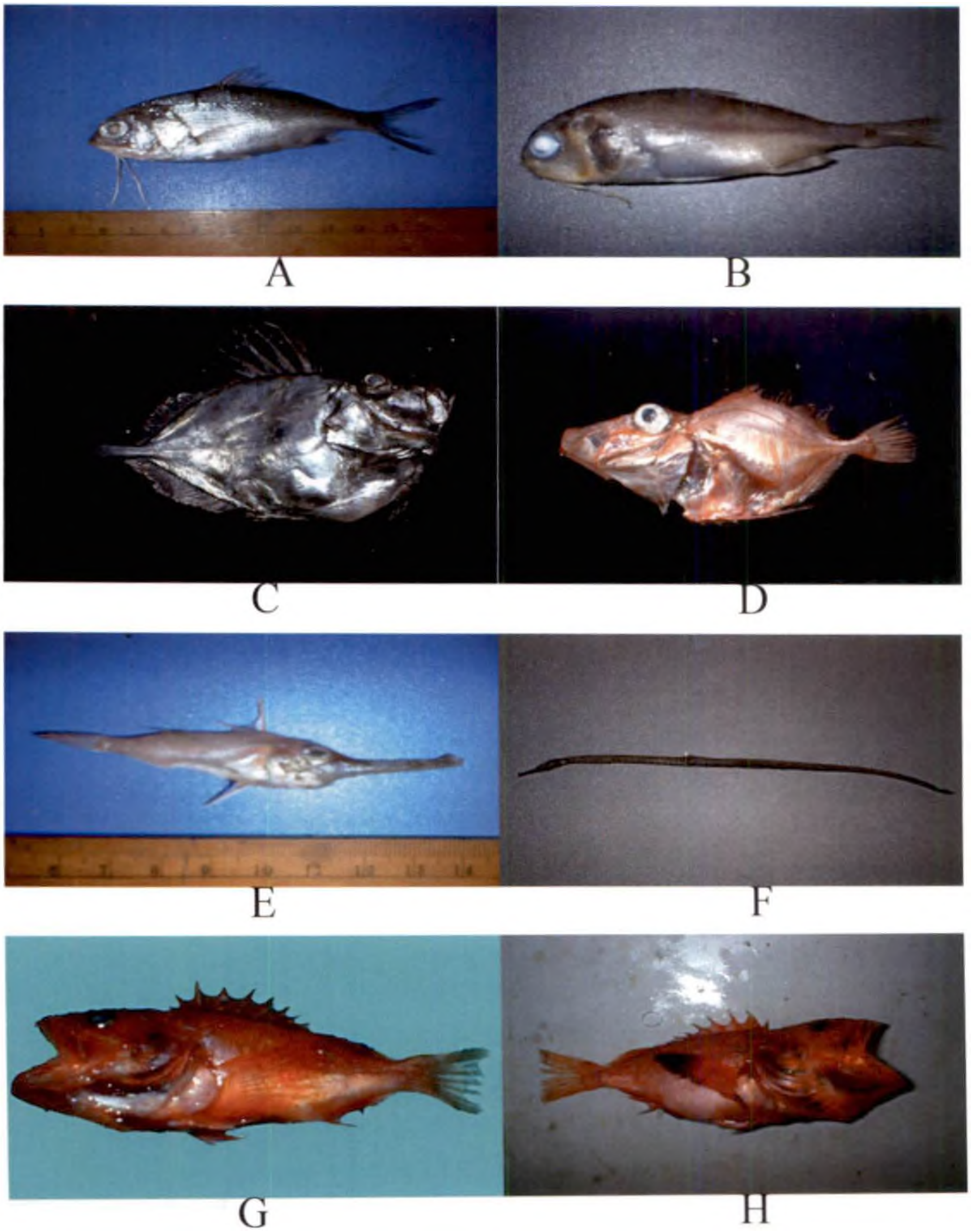

Plate 9. Photographs of the nonconventional finfishes
FAMILY: POLYMIXIIDAE to FAMILY: SCORPAENIDAE

A. Polymixia japonicus *B. Polymixia fusca*
C. Zenopsis conchifer *D. Cyttopsis roseus*
E. Macroramphosus sp. *F. Syngnathus acus*
G. Setarches quentheri *H. Setarches longimanus*

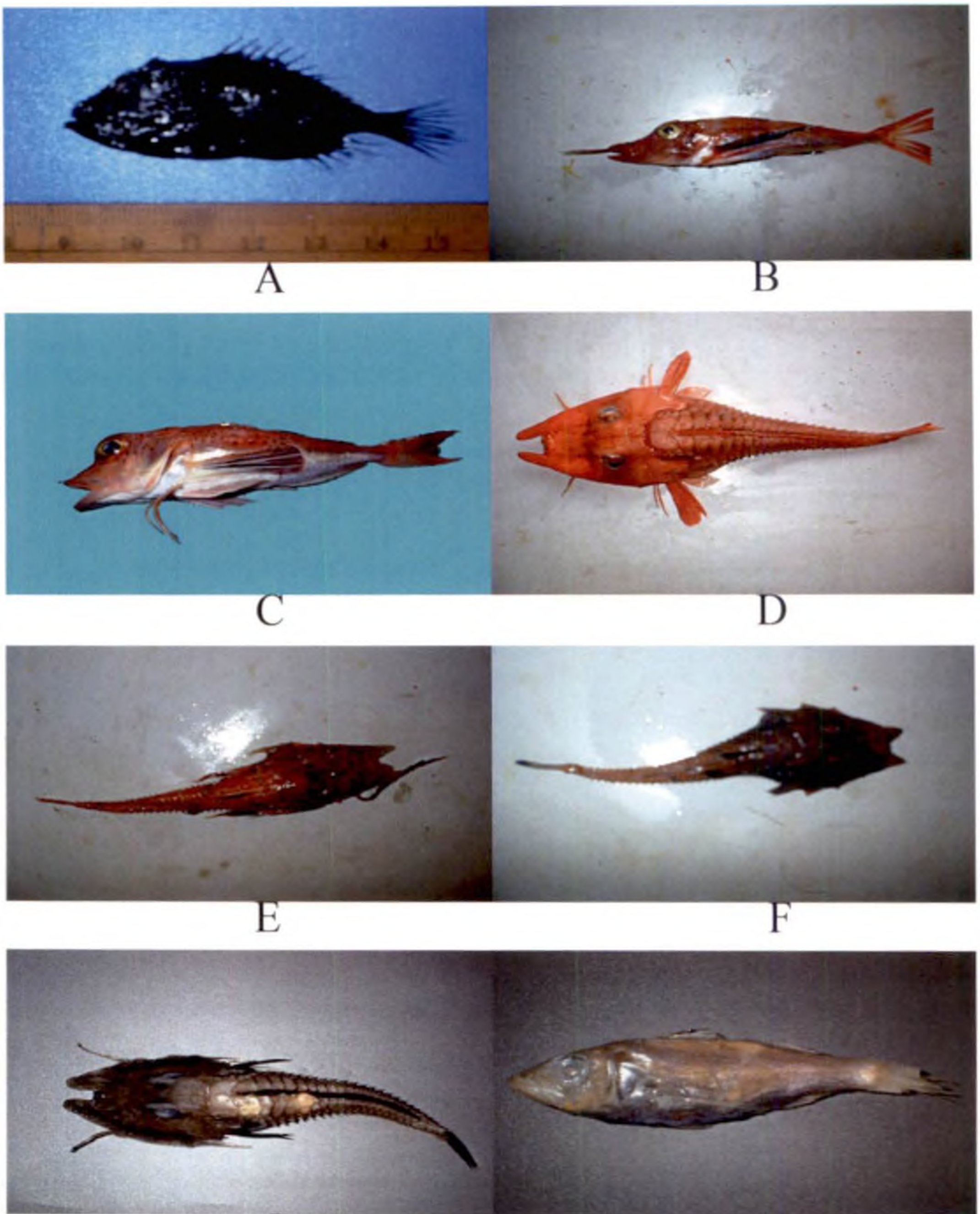

Plate10. Photographs of the nonconventional finfishes
FAMILY: SCORPAENIDAE to FAMILY: PERCICHTHYIDAE

A. Ectroposebastes imus   *B. Lepidotrigla sp.*
C. Pterygotrigla hemisticta   *D. Satyrichthys adeni*
E. Satyrichthys sp.   *F. Peristedion investigatoris*
G. Peristedion halei   *H. Acropoma japonicum*

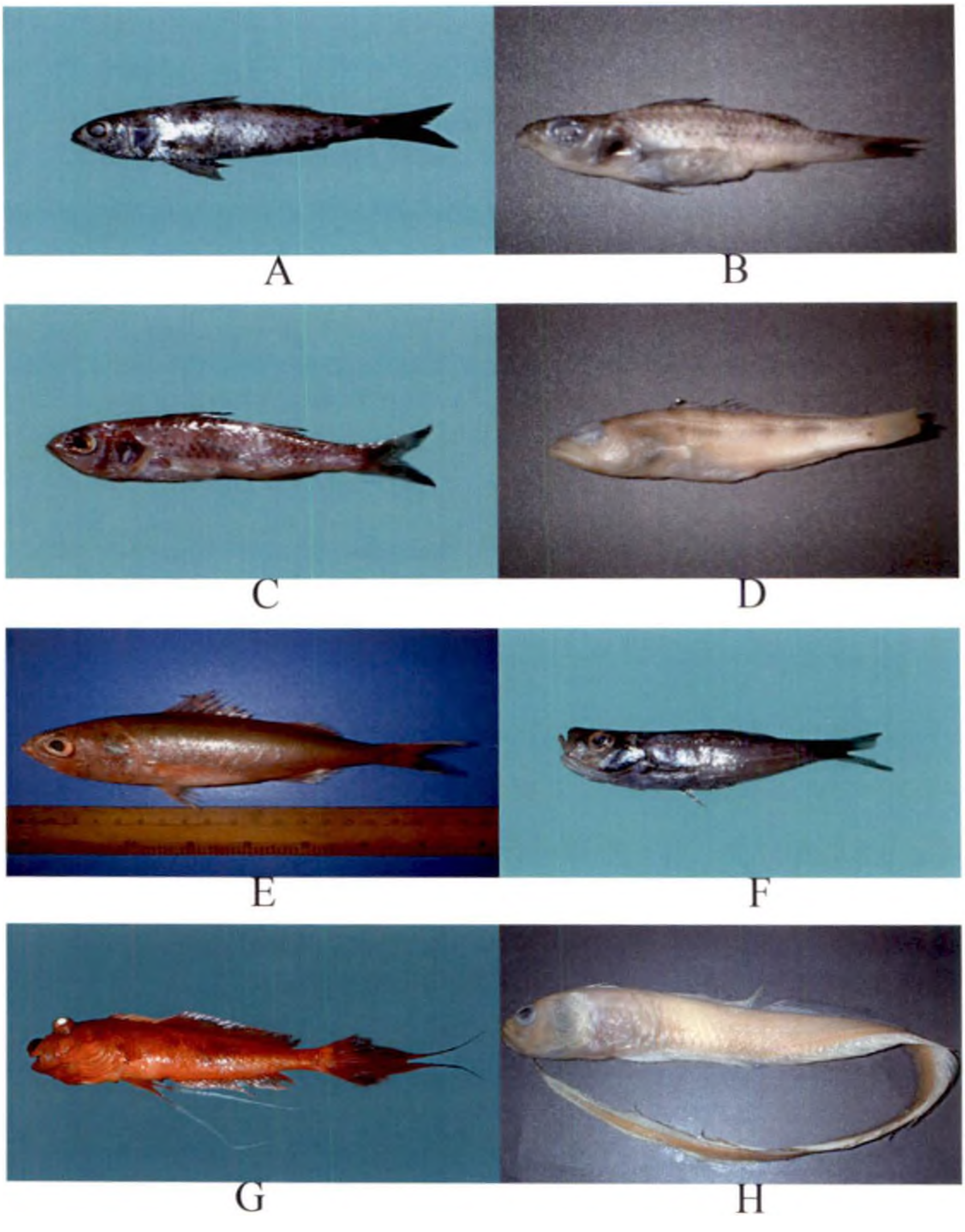

Plate11. Photographs of the nonconventional finfishes
FAMILY: PERCICHTHYIDAE to FAMILY: CEPOLIDAE

A. Synagrops japonicus *B. Synagrops pellucidus*
C. Neoscombrops annectens *D. Chelidoperca investigatoris*
E. Emmelichthys nitidus *F. Bathyclupea hoskynii*
G Owstonia totomiensis *H. Acanthocepola limbata*

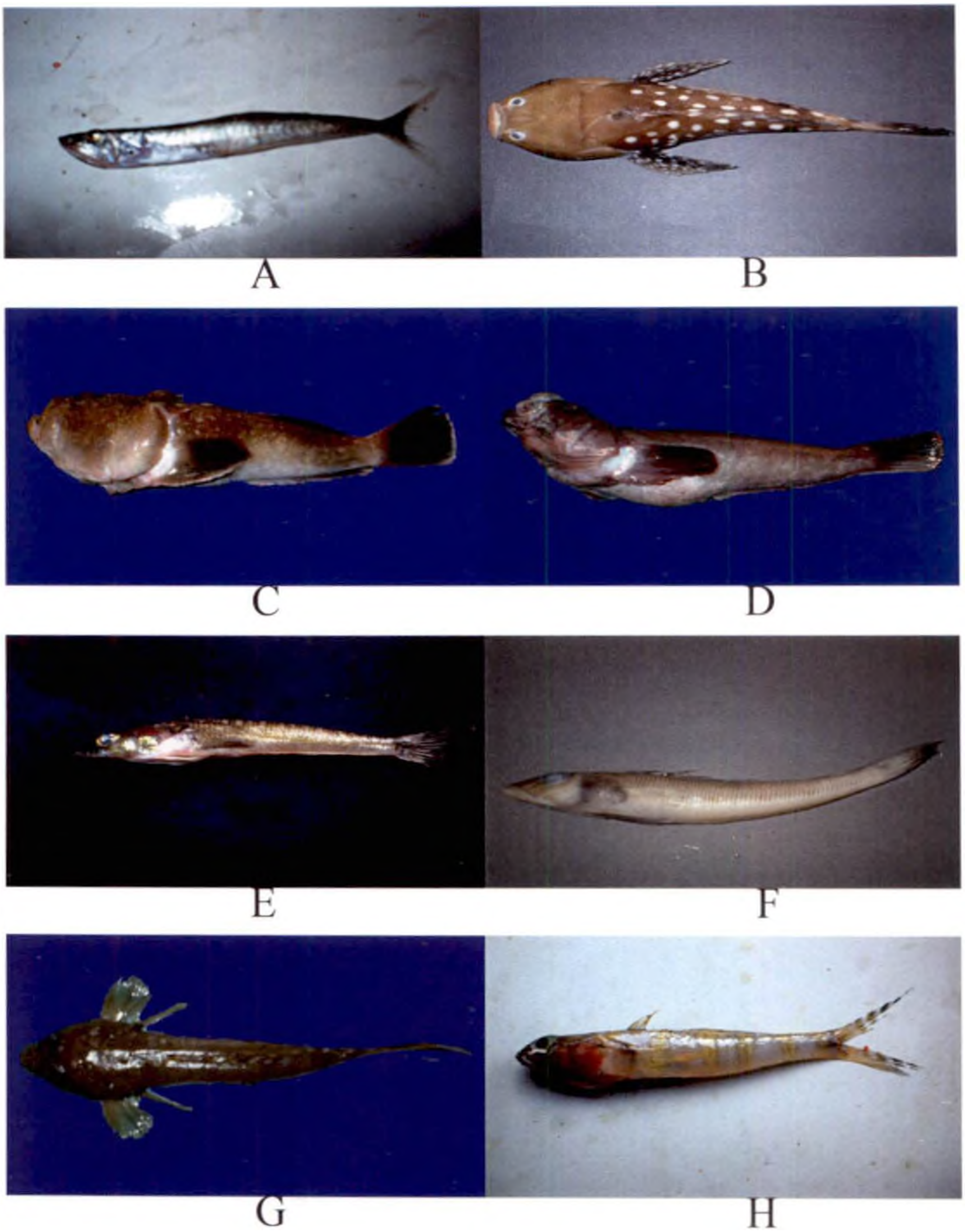

Plate12. Photographs of the nonconventional finfishes
FAMILY: CHAMPSODONTIDAE to FAMILY: GOBIIDAE

A. Champsodon vorax *B. Ichthyoscopus inermis.*
C. Uranoscopus sp. *D. Xenocephalus elongatus elongates*
E. Bemprops caudimacula *F. Parapercis sp.*
G. Callionymus carebares *H. Gobius cometes*

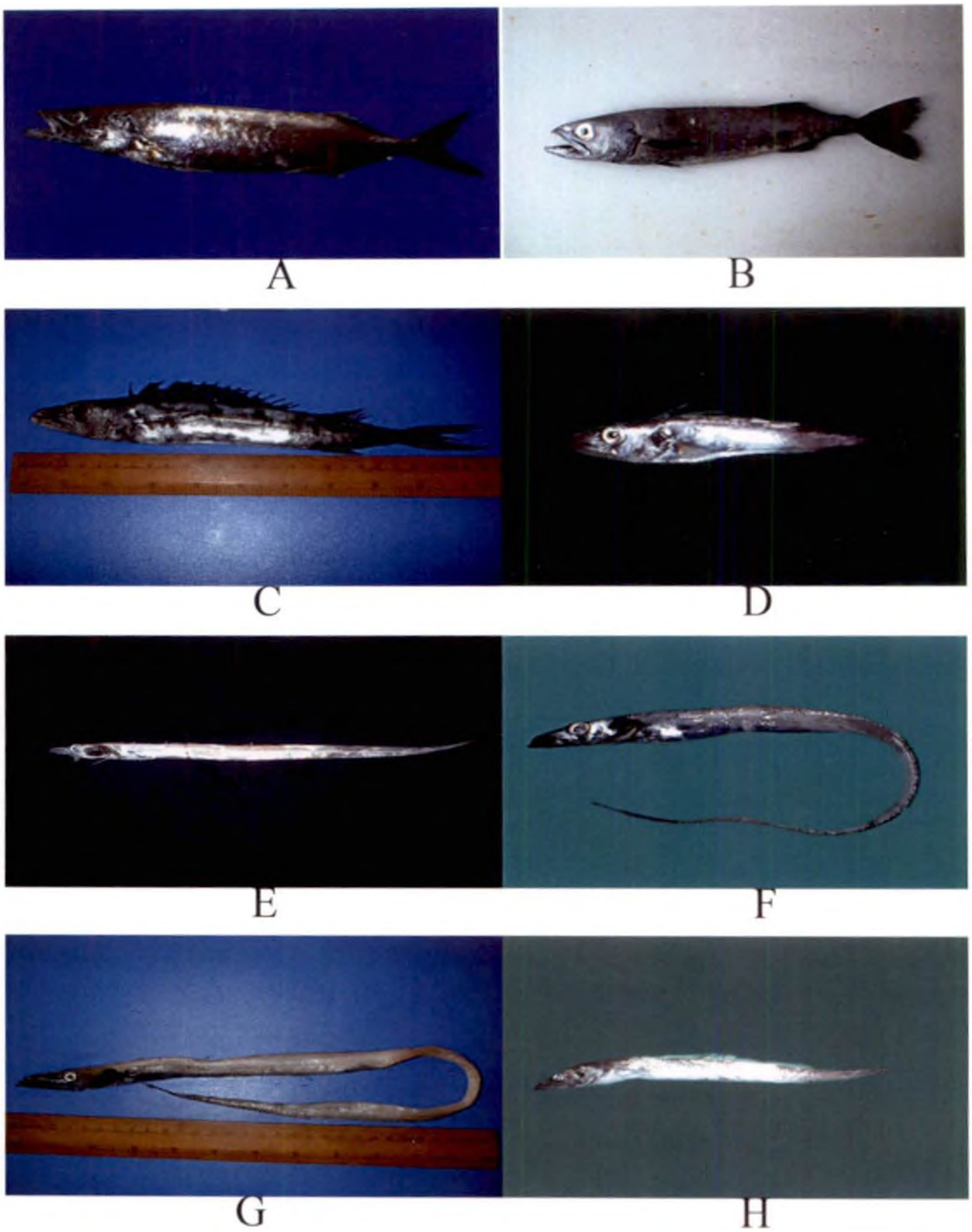

Plate13. Photographs of the nonconventional finfishes
FAMILY: GEMPYLIDAE to FAMILY: TRICHIURIDAE

A. Neoepinnula orientalis *B. Ruvttes pretiosus*
C. Promethichthys prometheus *D. Rexea prometheoides*
E. Benthodesmus elongatus *F. Benthodesmus tenuis*
G. Benthodesmus tuckeri *H. Trichiurus auriga*

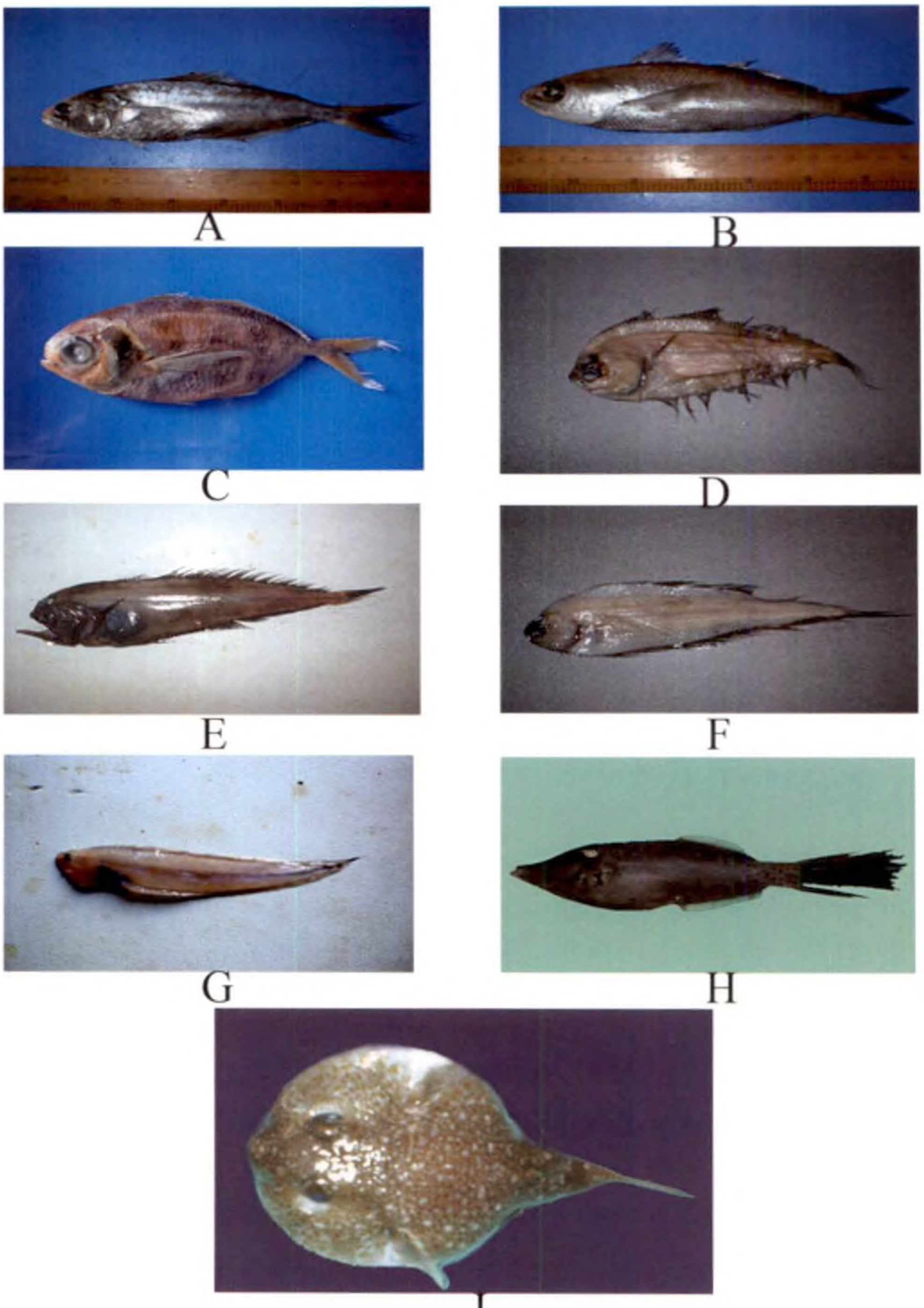

Plate14. Photographs of the nonconventional finfishes
FAMILY: CENTROLOPHIDAE to FAMILY: TETRAODONTIDAE

A. Psenopsis cyanea
B. Psenes squamiceps
C. Ariomma indica
D. Citharichthys sp.
E. Chascanopsetta lugubris
F. Laeops macrophthalmus
G. Symphurus sp.
H. Alutera scripta
I. Amblyrhynchotes spinosissimus

4.2 DISTRIBUTION OF NONCONVENTIONAL FINFISHES

Latitude-wise abundance of trawl catches recorded during the period February 2004 to April 2005 is furnished in Table 3. In the total catch of 23.5 tonnes obtained from all stations put together, nonconventional finfishes were most dominant forming 72% of the total catches recorded during the period followed by crabs 18% and prawns and lobsters 4% (Fig.4). Dominance of deep-sea fishes was more predominant in the 200-500 m depth zone. Fishes dominated with 86%, followed by crabs 6% and prawns and lobsters 5% (Fig.5). Area-wise, 7^0-8^0N lat., in the depth zone 200-500 m with an average catch per hour of 453.02 $kg.h^{-1}$ for deep-sea fishes was found to be the most productive. The second best average catch per hour of 351.59 $kg.h^{-1}$ was recorded from the area 8^0-9^0N in the depth zone 200-500 m.

4.2.1 Area-wise abundance

Area-wise and depth-wise abundance of finfishes obtained during March 2004, November 2004 and April 2005 voyages are furnished in Table 4. Out of the 97 species recorded during the study 23 species were found to be important. The highest catch rate of 933.33 $kg.h^{-1}$was of *Trichiurus auriga* recorded from 7^0-8^0N (between 200 and 500 m depth zone), followed by 356.30 $kg.h^{-1}$of *Psenopsis cyanea* recorded from 8^0-9^0N (between 200 and 500 m depth zone).

Table 3. Latitude-wise and depth-wise relative abundance (Catch/ effort in $kg.h^{-1}$) of major groups recorded during the period February 2004 to April 2005

Area (latitude)	7^0-8^0N		8^0-9^0N		9^0-10^0N		7^0-10^0N
Depth (m)	100-200	200-500	100-200	200-500	100-200	200-500	100-500
Effort (hrs)	7.33	10.75	1.0	29.5	2.5	9.25	60.33
Nonconventional finfishes	15.01	453.0	200.0	351.6	98.00	142.5	283.71
Conventional finfishes	49.93	5.77	10.00	00	8	00	7.59
Deep-sea prawn and lobsters	1.50	14.88	00	18.24	00	36.65	17.37
Deep-sea crabs	178.7	13.48	00	4.03	800	86.05	72.44
Deep-sea elasmobranchs	0.68	6.05	00	5.05	00	17.51	6.32
Deep-sea cephalopods	1.36	5.11	00	1.93	00	3.35	2.54
Total	247.2	498.3	210.0	380.9	906.0	286.1	389.95

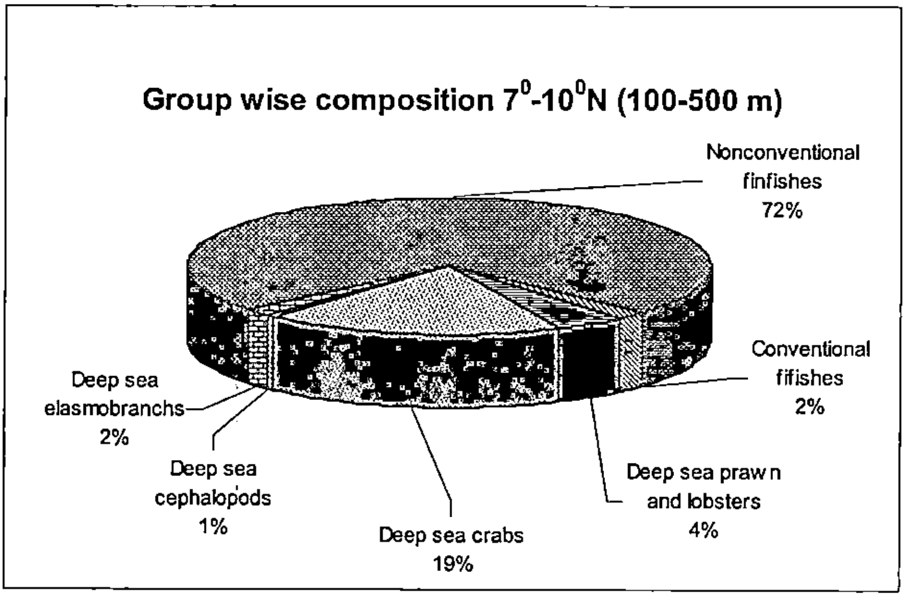

Fig.4. Group-wise composition during the period February 2004 to April 2005 (between 100 and 500 m depth zone)

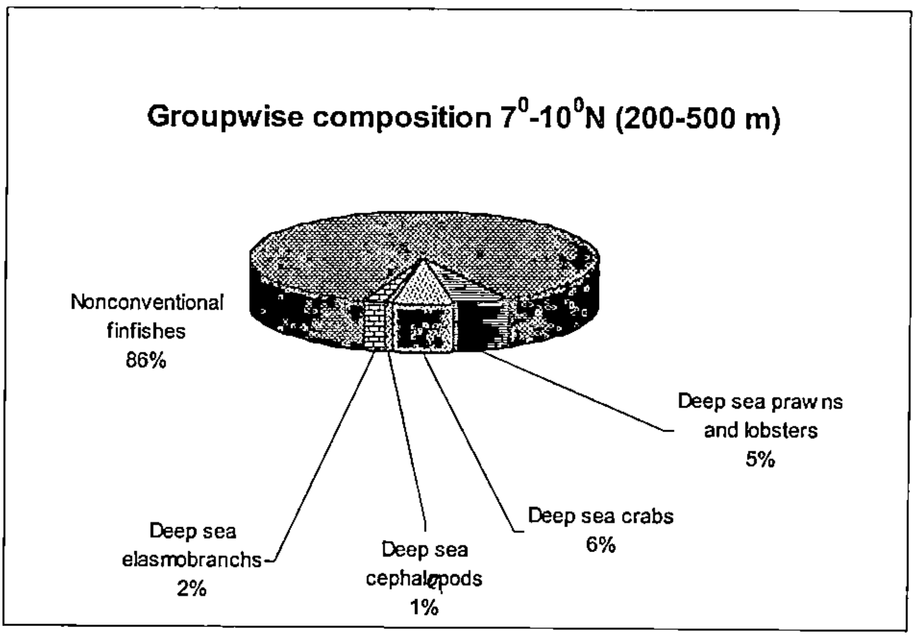

Fig.5. Group-wise composition during the period February 2004 to April 2005 (between 200 and 500 m depth zone)

Table 4. Area-wise and depth-wise abundance of nonconventional finfish resources (CPUE- $kg.h^{-1}$)

Area	7^0-8^0N		8-9^0N		9^0-10^0N	
Depth (m)	100-200	200-500	100-200	200-500	100-200	200-500
Effort (hrs)	7.33	3.0	1.0	13.33	2.5	9.25
Chlorophthalmus spp.	00	00	00	8.10	4.00	30.90
Psenes squamiceps	00	00	00	2.80	00	19.00
Psenopsis cyanea	00	40.00	150	356.30	68.00	7.40
Neoepinnula orientalis	00	00	00	12.00	00	8.00
Diaphus spp.	00	00	00	20.20	00	3.50
Neoscopelus macrolepidotus	00	00	00	11.90	00	0.80
Trichiurus auriga	00	933.33	00	190.80	00	0.10
Triglids	14.32	60.00	20.00	16.30	4.00	00
Other deep-sea fishes	0.68	36.70	30.00	46.80	22.00	73.00
Nonconventional finfishes (Total)	**15.01**	**1070.00**	**200.0**	**665.12**	**98.00**	**142.70**
Conventional finfishes	49.93	00	10.00	00	8.00	00
Others	182.26	13.30	00	17.48	800.00	143.50
Total	247.20	1083.33	210	682.60	906.00	286.20

4.2.2 Depth-wise abundance

Depth-wise abundance of nonconventional finfishes obtained during the study is furnished in Table 5. Among the deep sea fishes *Trichiurus auriga* with a relative abundance of 146.78 kg.h^{-1} dominated over other fishes, followed by *Psenopsis cyanea* with an average relative abundance of 144.38 kg.h^{-1}. The 200-300 m depth zone was found to be more productive with a relative abundance of 1829.7 kg.h^{-1} of deep-sea fishes. Crabs with a relative abundance of 305.63 kg.h^{-1} were the dominant variety in the 100-200 m depth zone. Among fishes conventional finfishes like *Nemipterus* spp., *Saurida* spp. and *Priacanthus* spp. were dominant in this depth zone. *Psenopsis cyanea* (58%), Triglids (24%), other deep-sea fishes (16%) *and Chlorophthalmus* spp. (2%) were the major varieties of nonconventional finfishes obtained from the 100-200 m depth zone (Fig. 6). *Trichiurus auriga* (44%), *Psenopsis cyanea* (41%), Other deep-sea fishes (7%) and *Chlorophthalmus* spp. (3%) were the major varieties recorded from the 200-300 m depth zone. *Psenes squamiceps* and *Neoepinnula orientalis* also were recorded from this productive depth zone (Fig.7).

All the 9-species/ species-groups including other deep-sea fishes were reported from the 300- 400 m depth zone. Other deep-sea fishes constituted 37%, *Psenes squamiceps* formed 18%, and *Psenopsis cyanea* formed 17%. These were the major varieties recorded from this depth zone (Fig.8). The 400 –500 m depth zone was characterised by the absence of *Chlorophthalmus* spp., *Psenes squamiceps*, *Psenopsis cyanea*, and Triglids. Other deep-sea fishes (42%), *Diaphus* spp. (28%), *Neoscopelus macrolepidotus* (18%) and *Neoepinnula orientalis* (8%) were the major varieties recorded from this deeper zone (Fig.9). Obviously the poorly lit condition of this depth zone has resulted in the dominance of the photophore- bearing fishes.

Table No.5. Depth-wise abundance of nonconventional finfish resources (CPUE- $kg.h^{-1}$)

Depth (m)	100-200	200-300	300-400	400-500	100-500
Effort (hrs)	10.83	6.5	12.83	6.25	36.41
Chlorophthalmus spp.	0.92	50.92	4.9	00	11.10
Psenes squamiceps	00	14.77	9.16	00	5.86
Psenopsis cyanea	29.55	742.92	8.42	00	144.38
Neoepinnula orientalis	00	16.92	4.15	11.31	6.43
Diaphus spp.	00	00	4.3	39.30	8.26
Neoscopelus macrolepidotus	00	00	0.58	25.33	4.55
Trichiurus auriga	00	817.38	0.08	4.84	146.78
Triglids	12.47	60.92	0.08	00	14.61
Other deep sea fishes	8.31	125.54	18.39	57.15	41.18
Nonconventional finfishes (Total)	**51.25**	**1829.37**	**50.07**	**137.93**	**383.15**
Conventional fishes	36.57	00	00	00	10.88
Others	308.03	174.01	34.61	4.01	135.57
Total	395.85	2003.38	84.68	141.94	529.60

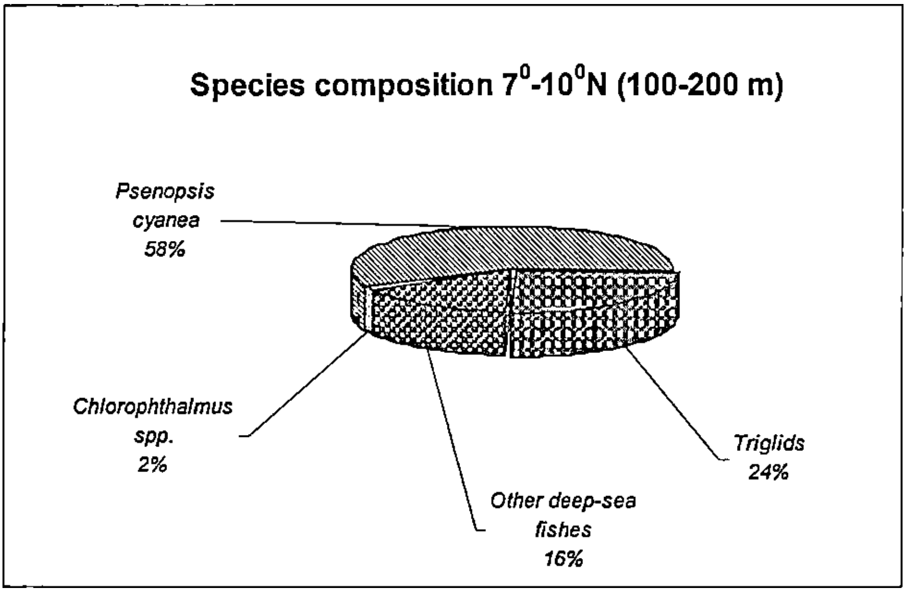

Fig.6. Species composition of nonconventional finfishes between 100 and 200 m depth zone

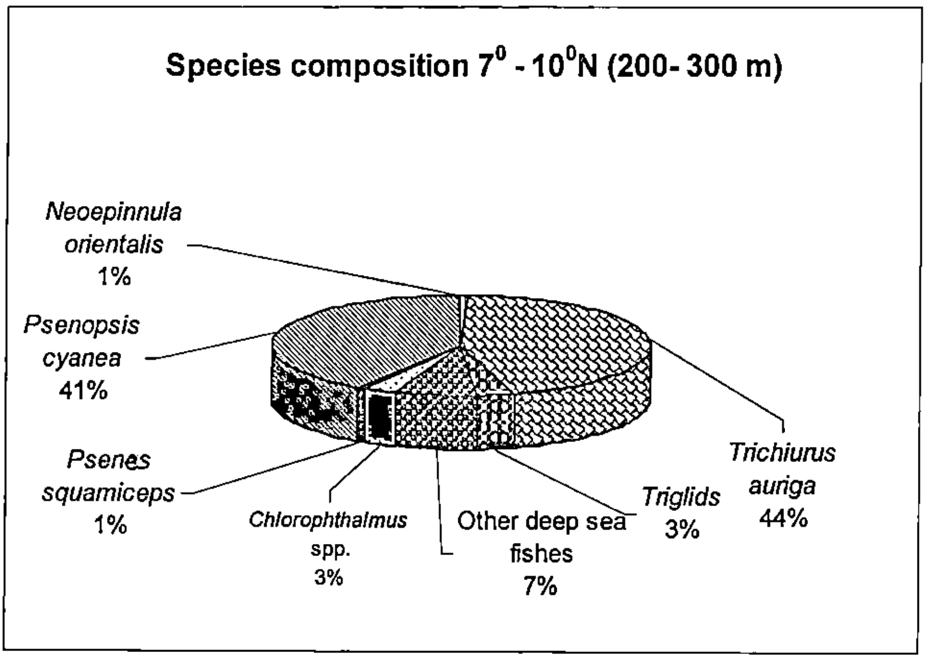

Fig. 7. Species composition of nonconventional finfishes between 200 and 300 m depth zone

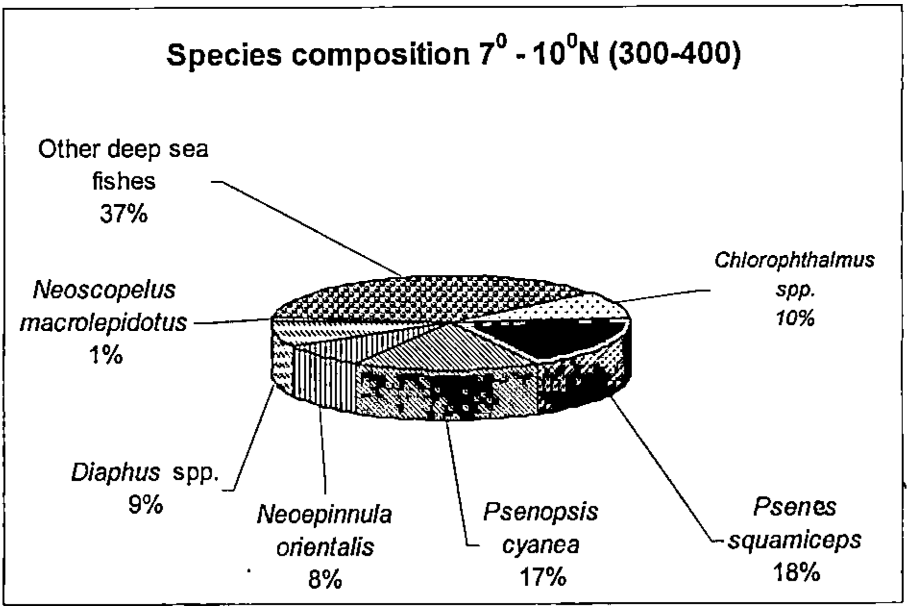

Fig. 8. Species composition of nonconventional finfishes between 300 and 400 m depth zone

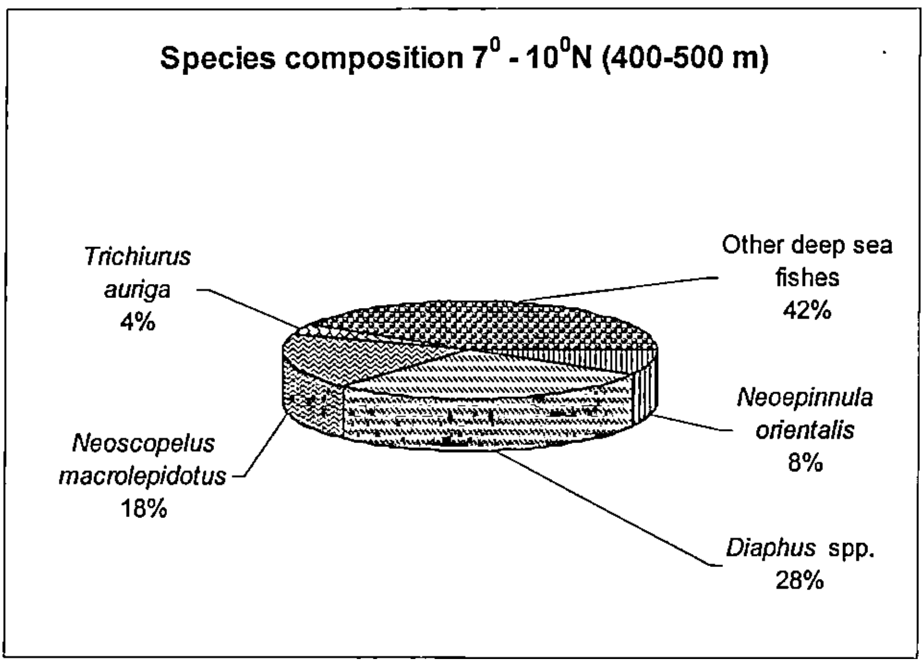

Fig. 9. Species composition of nonconventional finfishes between 400 and 500 m depth zone

4.2.3 Seasonal variation

Species composition of deep-sea finfishes obtained from the 7^0N during April 2005 is presented in the Fig.10. *Trichiurus auriga* with 87% dominated the catch followed by Triglids (6%) and *Psenopsis cyanea* (4%). Other deep-sea fishes formed 3%. Species composition of unconventional finfishes obtained during March (Fig.11), November (Fig.12) and April (Fig.13) from the latitude 8^0N indicates that seasonal variation in abundance exists in the case of these fishes. *Psenopsis cyanea* dominant during March and November was completely absent during the month of April. Similar trends could be seen in the case of *Chlorophthalmus* spp. and *Neoepinnula orientalis* both of which dominated during March and were completely absent during the months of November and April.

Species composition of deep-sea fishes obtained from the area between 9^0 and 10^0N during the month of March (Fig.14) and November (Fig.15) indicates that seasonal variation exists in the case of *Diaphus* spp. and *Neoscopelus* spp. Changes in the operational depth during the surveys and also the different gears engaged in different months may have also contributed to the seasonal variation noticed in these species. Therefore an in-depth study is required to establish the seasonal variations of the above resources.

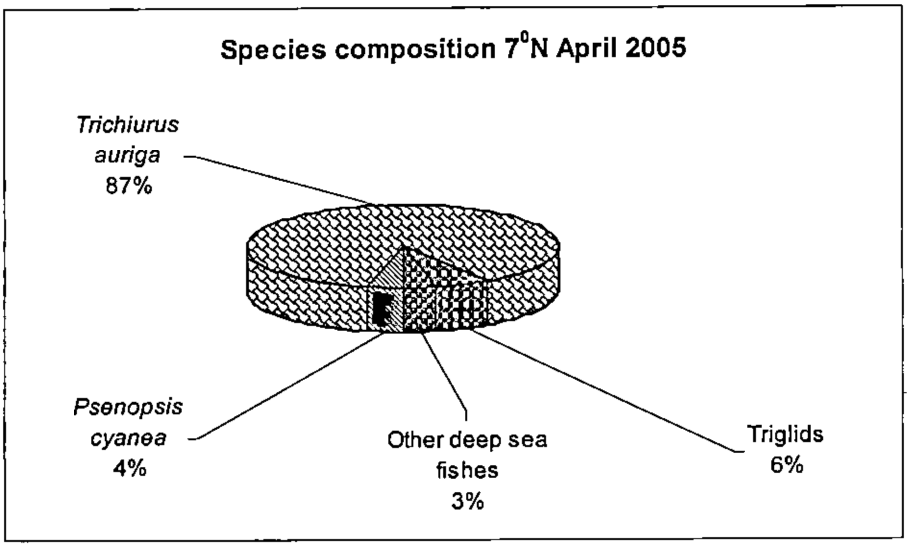

Fig. 10. Species composition of nonconventional finfishes between 7^{0} and 8^{0}N during April 2005

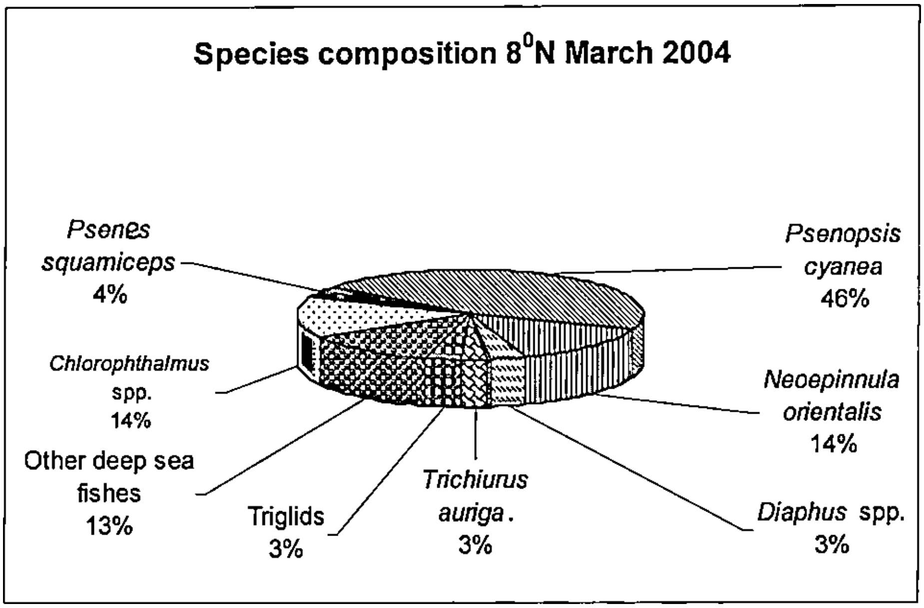

Fig. 11. Species composition of nonconventional finfishes between 8^{0} and 9^{0}N during March 2004

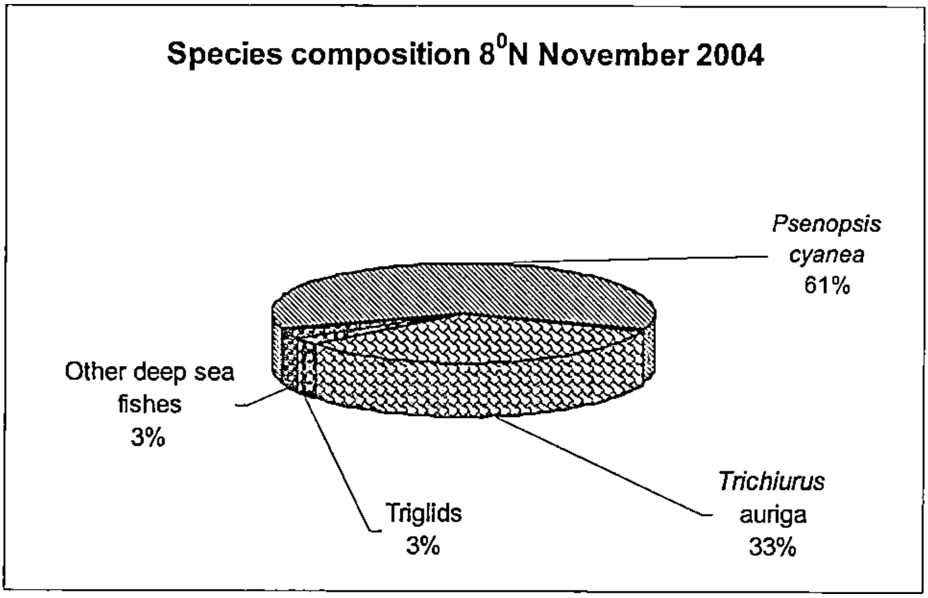

Fig. 12. Species composition of nonconventional finfishes between 8^0 and 9^{0}N during November 2004

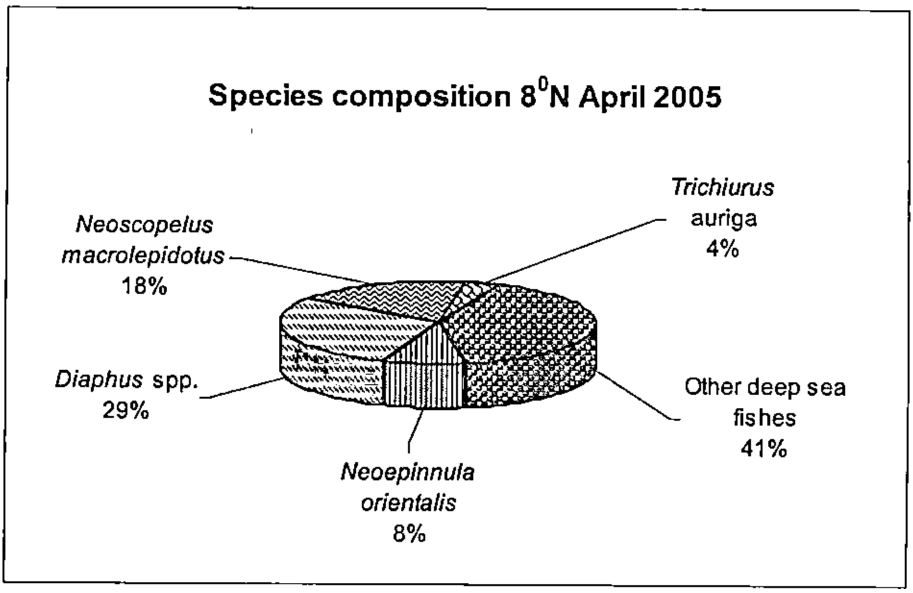

Fig.13. Species composition of nonconventional finfishes between 8^0 and 9^{0}N during April 2005

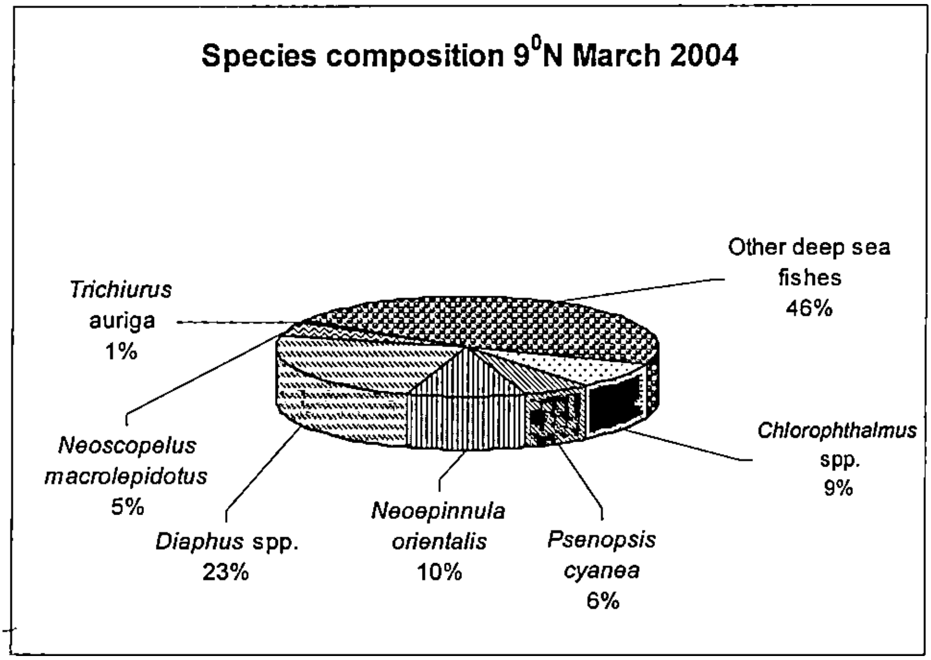

Fig.14. Species composition of nonconventional finfishes between 9^0 and 10^0N during March 2004

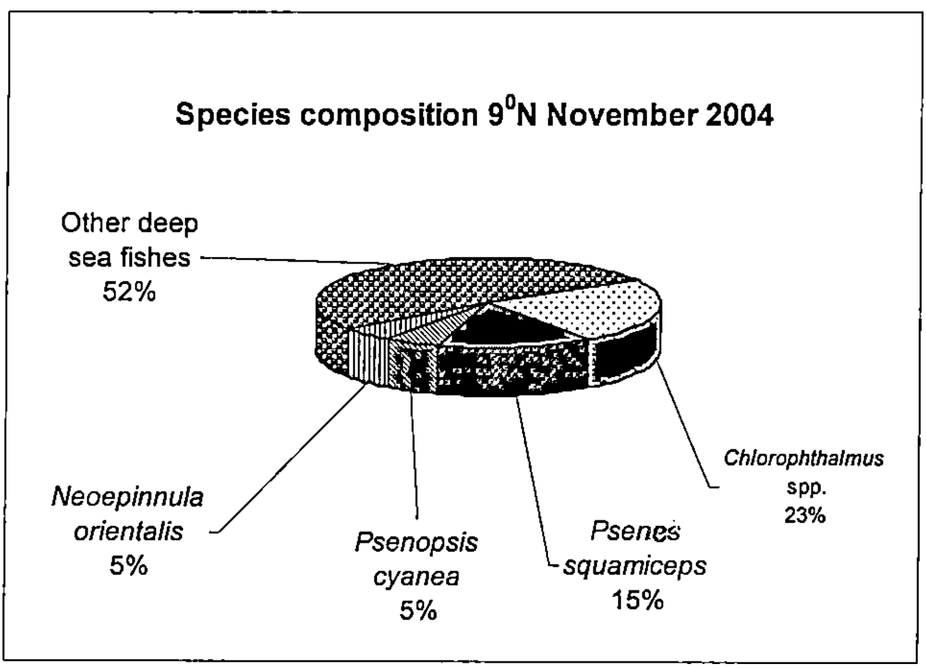

Fig.15. Species composition of nonconventional finfishes between 9^0 and 10^0N during November 2004

4.3. MAJOR VARIETIES OF NONCONVENTIONAL FINFISH RESOURCES

4.3.1. *Chlorophtlialmus* spp.

Chlorophthalmus spp. popularly called as greeneyes are considered as an important resource. A catch per effort of 11.10 kg.h^{-1} was recorded during the period of study. Greeneyes were represented by 3 species namely *Chlorophthalmus agassizi, Chlorophthalmus bicornis,* and *Chlorophthalmus punctatus.* Nearly 75% of the catches of greeneyes were constituted by *Chloropthalmus agassizi.* It was observed that greeneyes were distributed within 100-400 m depth zone and the maximum abundance of the group was in the 200-300 m depth zone. Area-wise they were present in the area between latitudes 8^0 and10^0N and the maximum abundance was between latitudes 9^0 and 10^0 N.

4.3.2. *Psenes squamiceps*

Psenes squamiceps commonly known as Indian driftfish was observed to be distributed between 8^0 and 10^0N lat. The distribution of this species is similar to that of the greeneyes. Depth-wise they were restricted to 200-400 m depth zone. The 200-300 m depth zone was found to be more productive zone with an average catch rate of 14.77 kg.h^{-1}. Area-wise from 9^0-10^0N lat. with an average catch rate of 19 kg.h^{-1} was found to be more productive.

4.3.3. *Psenopsis cyanea*

Psenopsis cyanea popularly known as Indian ruff is a major constituent of the nonconventional finfish resource. A catch rate of 144.38 kg.h^{-1} obtained during the study stands second next to that of *Trichiurus auriga*. Indian ruff was found to be distributed in all the three latitudinal areas studied. Depth-wise they were distributed between 100 and 400 m depth zone. An average catch rate of 742.92 kg.h^{-1} was obtained from 200-300 m depth zone, which indicated the abundance of the above species at these depths. Latitude wise 8^0- 9^0N was found to be more productive area.

4.3.4. *Neoepinnula orientalis*

Neoepinnula orientalis commonly called sackfish is a prominent deep-sea fish having the potential of commercial exploitation. Sackfish occupy a wide distribution within the depth zone 200-500 m. Area-wise they were obtained from 8^0 to 10^0N lat. An average catch rate of 16.92 kg.h^{-1} was recorded from the depth zone 200-300 m, which is the best.

4.3.5. *Diaphus* spp.

Four species of the genus *Diaphus* were recorded during the study. These are *Diaphus splendidus*, *Diaphus antonbruuni*, and *Diaphus* spp. (two species). Distribution of these was found to be restricted to 300-500 m depth zone. Area-wise they were recorded from 8^0 to 10^0N lat. An average catch per unit effort of 39.30 kg.h^{-1} obtained from the 400-500 m depth zone indicates that above species prefer deeper waters.

4.3.6 *Neoscopelus macrolepidotus*

Neoscopelus macrolepidotus popularly called as large scaled lanternfish follows a similar distribution pattern as that of *Diaphus* spp. They are restricted to the 300-500 m depth zone. Area-wise they were found between 8^0 and 10^0N lat. The 400- 500 m depth zone, with an average catch rate of 25.33 kg.h^{-1} was found to be the most abundant zone. This indicates that the above species prefer deeper waters. The area between 8^0 and 9^0N was found to be more productive.

4.3.7. *Trichiurus auriga*

Among the nonconventional finfish resources *Trichiurus auriga* popularly called as pearly hairtail is the most dominant species. An average catch per unit effort of 146.78 kg.h^{-1} was obtained from the area during the study and is the highest catch per unit effort recorded for a single species. Pearly hairtail occupies a wide distribution with in the 200-500 m depth zone. Area-wise they were obtained from all the three latitudinal zones under study. An average catch per unit effort of 817.38 kg.h^{-1} obtained from the 200-300 m depth zone indicated that their abundance was in this zone. Area-wise 7^0-8^0N lat. was found to be the most abundant with an average catch per unit effort of 933.33 $kg.h^{-1}$ obtained, which is highly encouraging.

4.3.8. Triglids

Triglids commonly called as gurnards were represented by one species of *Lepidotrigla*, one species of *Pterygotrigla*, two species of *Satyrichthys* and two species of *Peristedion*. Gurnards are obtained from all the three latitudinal areas under study. Bathymetrically their distribution was found to be restricted up to 400 m depth zone. An average catch per unit effort of 60.92 $kg.h^{-1}$ obtained from 200-300 m depth zone indicated their abundance in the above zone. Latitude-wise 7^0N was found to be more productive. Total absence of the above fishes in the area 09^0-10^0N lat. between 200 and 500 m depth zone was noticed during the study.

4.3.9.Other deep-sea fishes

All other nonconventional deep-sea fishes not included in the above-mentioned 8 categories are included in this category. Eels, hatchetfishes, lightfishes, snaggletooths, barracudinas, deep-sea cods, grenadiers, cusk-eels, slimeheads, berycids, dories, acropomatids, rovers, bathyclupeids, duckbills, dragonets, snake mackerels (except sackfish) lefteye flounders, tonguesoles, frostfish etc are the major varieties included in this group. An average catch per unit effort of 41.18 $kg.h^{-1}$ was recorded during the study. Eels were recorded from all the depth zones. Hatchetfishes, snaggletooths, lightfishes, granadiers, deep-sea codes, cusk-eels, dories, snake mackerels, frostfishes, etc prefer deeper waters. Flatfishes, berycids, barracudinas and duckbills were mainly obtained from 100-300 m depth zone. Acropomatids and bathyclupeids were mainly caught from the 200-400 m depth zone.

4.4 GEAR-WISE CATCHES

Species composition of nonconventional finfishes obtained from fish trawl and shrimp trawl are shown in Fig.16 and 17 respectively. As evident from the figures fish trawl catches are dominated by *Trichiurus auriga* (50%) followed by *Psenopsis cyanea* (43%), Triglids (4%), and other deep-sea fishes (3%). Other deep-sea fishes dominated among the shrimp trawl catches with 40%, followed by *Chlorophthalmus* spp. (14%) *Psenopsis cyanea* (11%) and *Diaphus* spp. (11%) and the rest by others. Dominance of *Trichiurus auriga* and *Psenopsis cyanea* in the fish trawl catches and minor occurrence of them in the shrimp trawl catches indicate that the above fishes inhabit the water column, being more pelagic in distribution. *Chlorophthalmus* spp., *Diaphus* spp., *Psenes squamiceps,* and *Neoepinnula orientalis* were available in the shrimp catches in significant quantity, but their presence in the fish trawl catches was very meagre, indicating that the above fishes may be more benthopelagic in distribution.

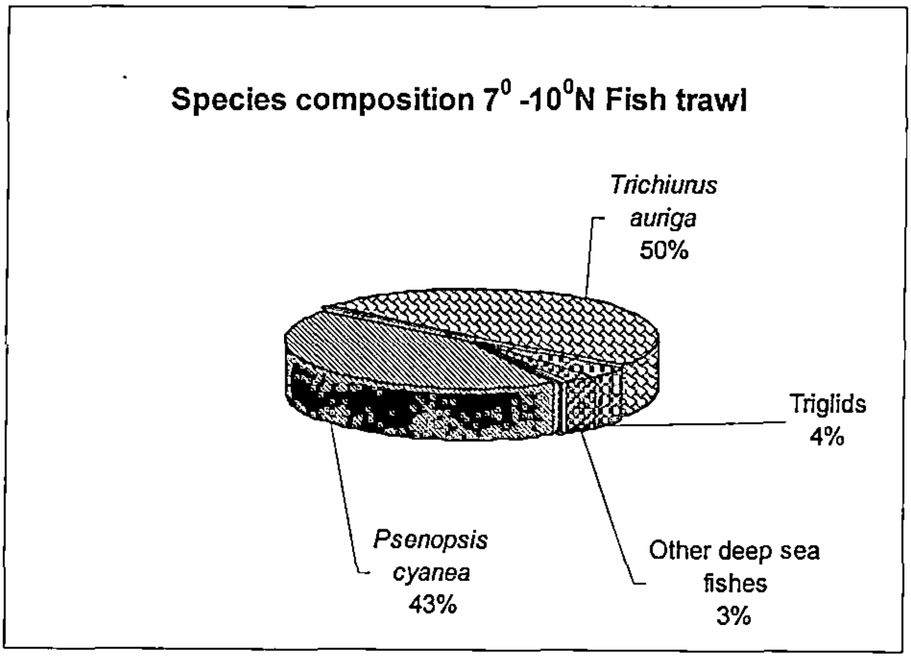

Fig.16. Species composition of nonconventional finfishes caught by 45.6 m Expo model fish trawl

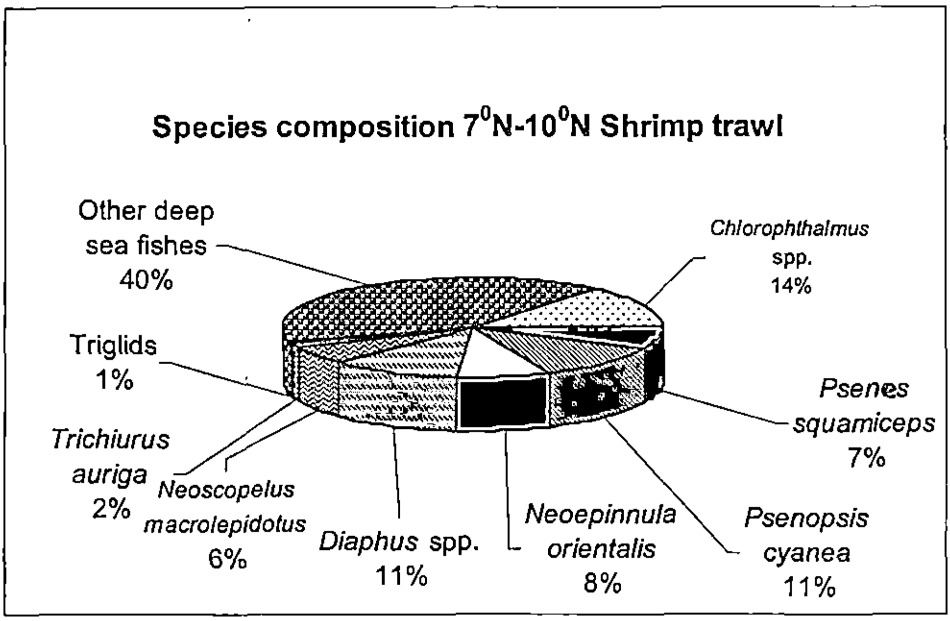

Fig.17. Species composition of nonconventional finfishes caught by 45.12 m Shrimp trawl

4.5.LENGTH FREQUENCY DISTRIBUTION

4.5.1. *Chlorophthalmus agassizi*

Length frequency distribution of *chlorophthalmus agassizi* during the months of February 2004, march2004, and November2004 are shown in Fig.18, 19 and 20 respectively. A total of 383 numbers of specimens collected during the above months were subjected to length frequency studies. As evident from the Fig.18, during February 2004 specimens with a length range of 8- 17 cm were obtained from the catches. Specimens with a length range of 9-23 cm were obtained during the month of March 2004. Length range of the specimens obtained during the month of November was 14-22 cm. The catch during March 2004 indicates the presence of two year classes in the trawl landings. Mean length of specimens obtained during February was 11.5 cm and during the month of March, two year classes with mean lengths of 12.5 cm and 20.5 cm were recorded. Mean length of the specimens obtained during the month of November was 17.5 cm. Year class with a mean length of 11.5 cm obtained during the month of

February 2004 might have grown to 17.5 cm and were caught during the month of November 2004.

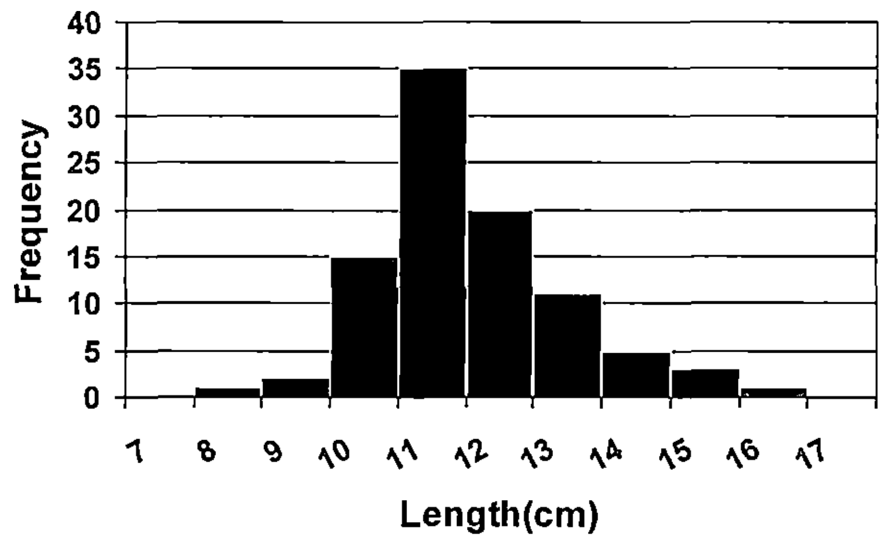

Fig. 18. Length frequency distribution of *Chlorophthalmus agassizi* during the month of February 2004

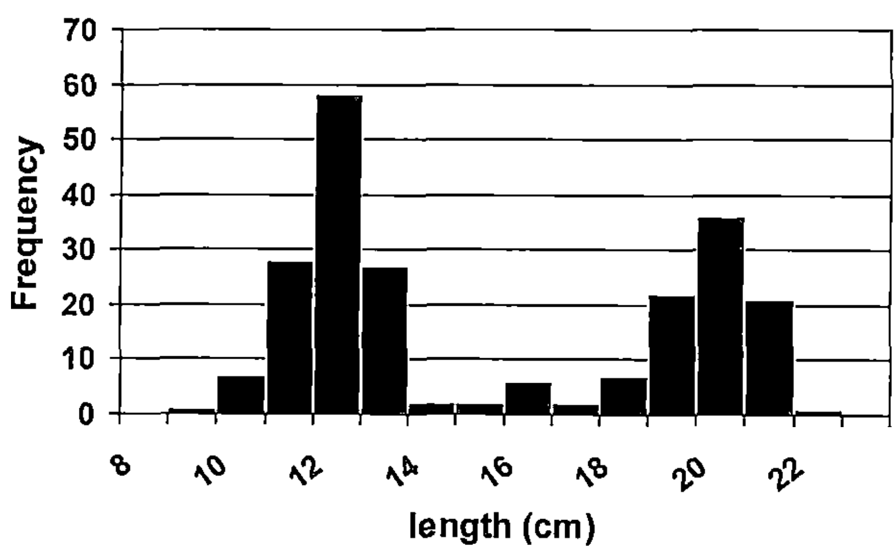

Fig. 19. Length frequency distribution of *Chlorophthalmus agassizi* during the month of March 2004

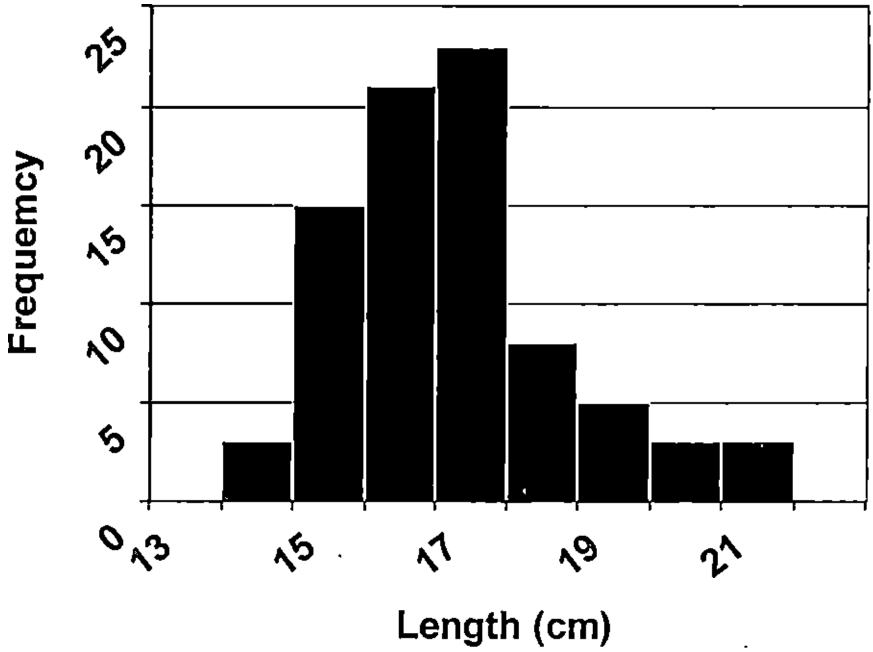

Fig. 20. Length frequency distribution of *Chlorophthalmus agassizi* during the month of November 2004

4.5.2 *Psenes squamiceps*

A total of 287 numbers of specimens collected during the months of March 2004 and November 2004 were subjected to length frequency studies. Length frequency distributions of the above fish are presented in the Fig. 21 and 22. Specimens with a length range of 12 – 20 cm and a mean length of about 18.5 cm were recorded during the month of March 2004. Length range of specimens collected during the month of November was 11- 21 cm and a mean length of about18.5 cm. Only a single year class was dominant in the trawl catches of the same months.

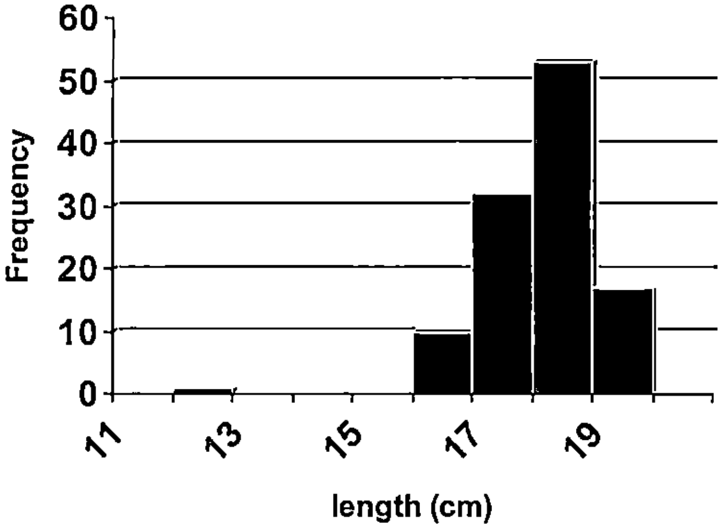

Fig. 21. Length frequency distribution of *Psenes squamiceps* during the month of March 2004

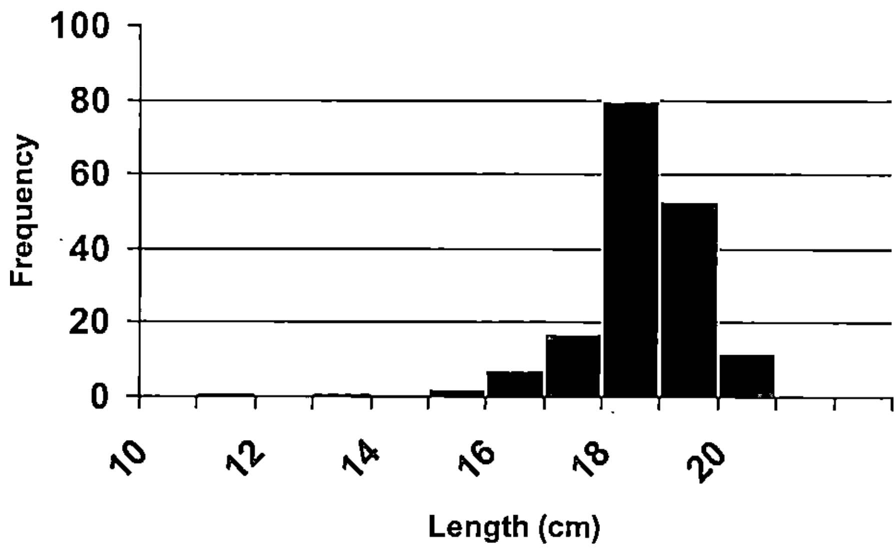

Fig. 22. Length frequency distribution of *Psenes squamiceps* during the month of November 2004

4.5.3. *Psenopsis cyanea*

Length frequency distributions of Psenopsis cyanea are shown in the Fig. 23 and 24. A total of 485 numbers of specimens were subjected to the length frequency studies. Length range of specimens collected during the month of March 2004 was 14-21 cm. During the month of November 2004, specimens with a length range of 13-20 cm were recorded. Mean lengths of specimens collected during the month of March and November are about 18.5 cm and 16.5 cm respectively. Only a single year class was caught during the above months.

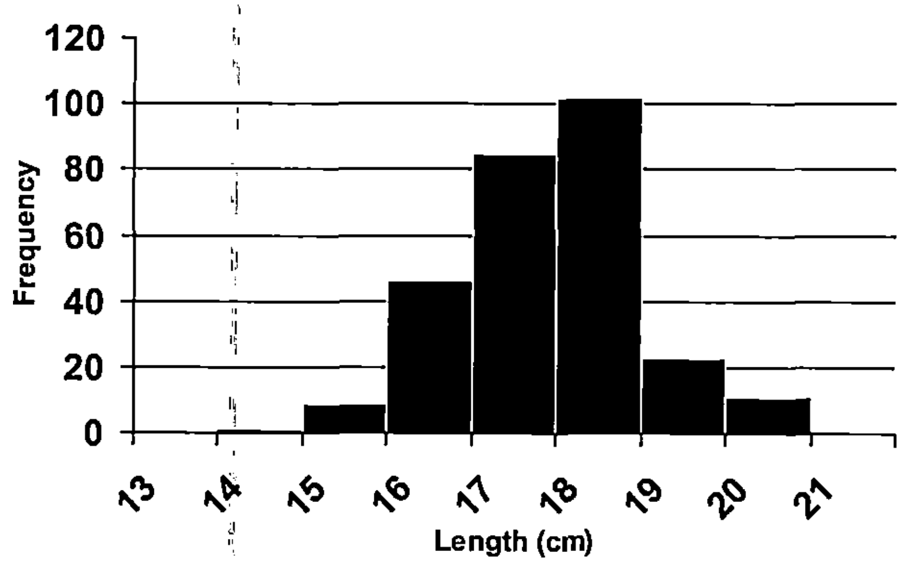

Fig. 23. Length frequency distribution of *Psenopsis cyanea* during the month of March 2004

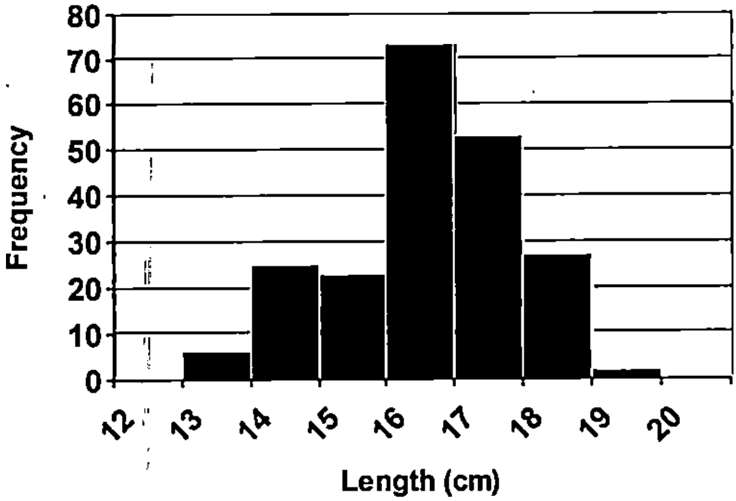

Fig. 24. Length frequency distribution of *Psenopsis cyanea* during the month of November 2004

4.5.4. Neoepinnula orientalis

A total of 288 numbers of specimens collected during the months of March 2004 and November 2004 were subjected to length frequency studies. As evident from the Fig. 25 and 26 *Neoepinnula orientalis* have a wide length range between 10 cm to 25 cm. Mean lengths obtained during the months of March and November are 17.5 cm and 16.5 cm respectively.

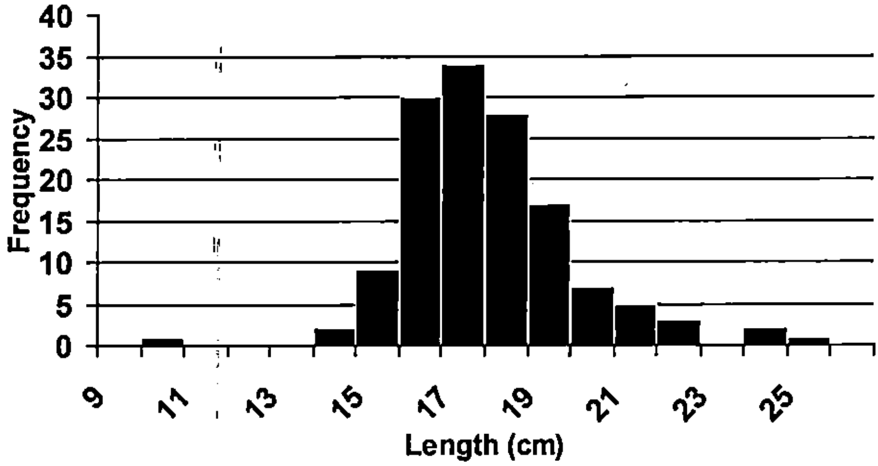

Fig. 25. Length frequency distribution of *Neoepinnula orientalis* during the month of March 2004

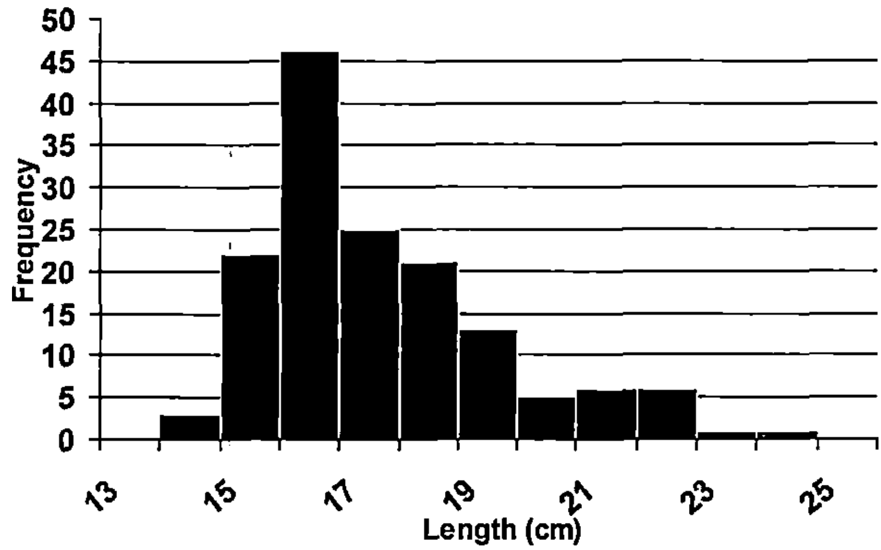

Fig. 26. Length frequency distribution of *Neoepinnula orientalis* during the month of November 2004

4.5.5 *Trichiurus auriga*

Length frequency distribution of *Trichiurus auriga* caught during the months of November 2004 and April 2005 are shown in the Fig. 27 and 28. A total of 360 numbers of specimens were subjected to length frequency studies. Length range of specimens caught during the month of November 2004 was 22- 38 cm. Specimens with a length range of 22 – 40 cm were obtained during the month of April 2005. Though a single year class is prominent in the figures, occurrence of other length groups indicates the presence of another year class in the trawl catches.

4.5.6 *Diaphus splendidus*

A total of 165 numbers of specimens were subjected to length frequency distribution studies. Length frequency distribution of *Diaphus splendidus* caught during November 2004 and April 2005 are shown in the Fig. 29 and 30. Specimens with a length range of 10-17 cm were caught during the month of November 2004. Length range of specimens obtained during the month of April 2005 was 9- 17 cm. Mean length of 14.5 cm was recorded during both months.

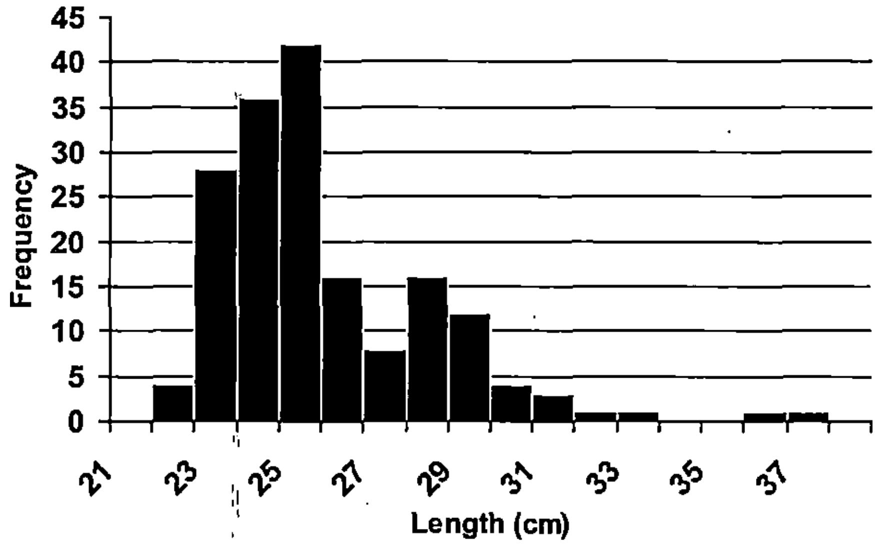

Fig. 27. Length frequency distribution of *Trichiurus auriga* during the month of November 2004

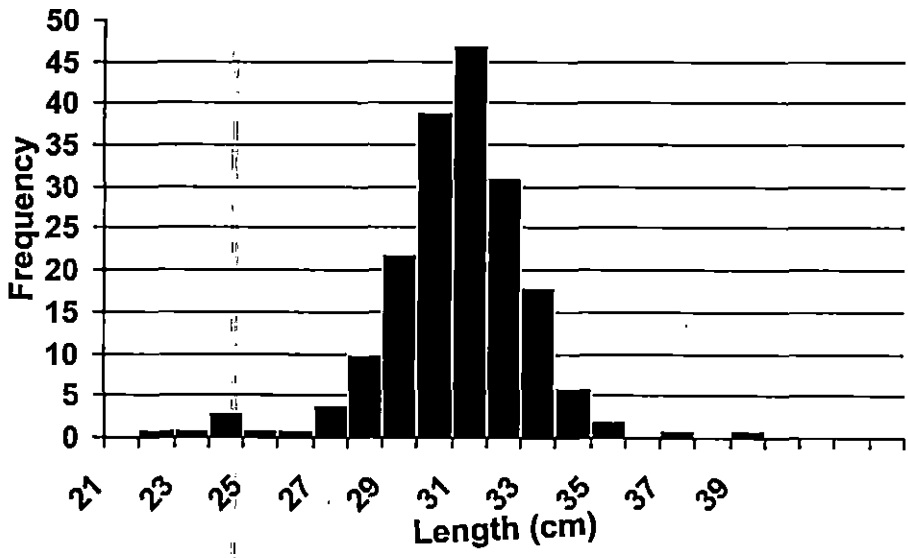

Fig. 28. Length frequency distribution of *Trichiurus auriga* during the month of April 2005

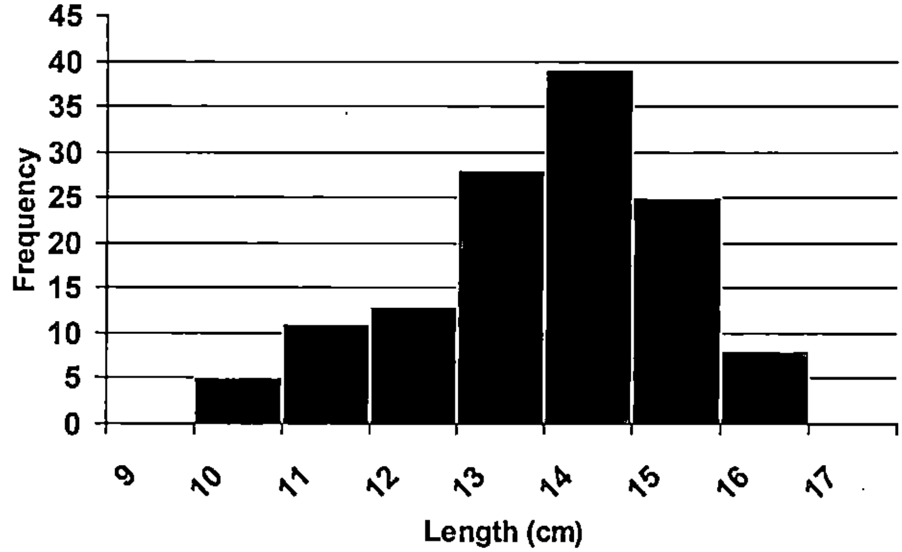

Fig. 29. Length frequency distribution of *Diaphus splendidus* during the month of November 2004

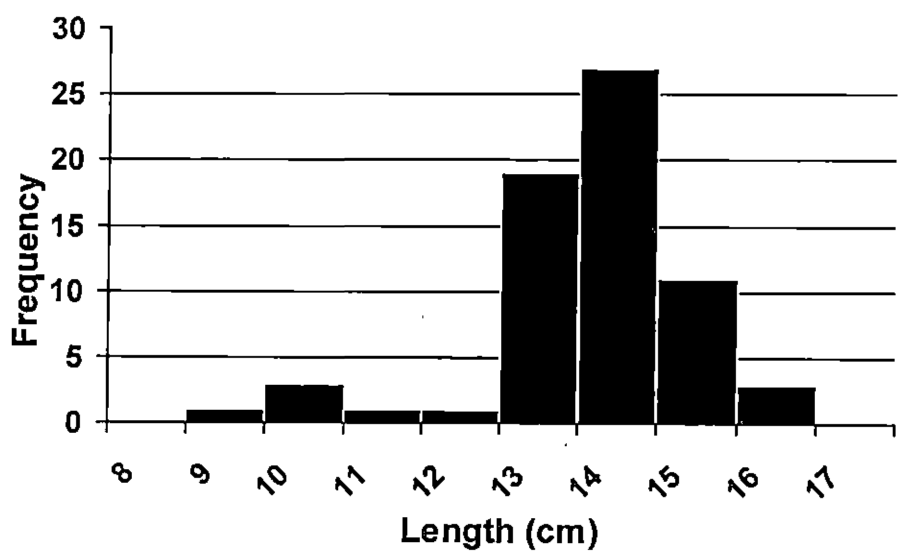

Fig. 30. Length frequency distribution of *Diaphus splendidus* during the month of April 2005

4.5.7. *Neoscopelus macrolepidotus*

A total of 318 specimens caught during the months of February 2004, November 2004 and April 2005 were subjected to length frequency studies. Length frequency distributions during the above months are shown in Fig. 31, 32 and 33. Specimens with a length range of 12 –22 cm and a mean length of 18.5 cm were caught during the month of February 2004. Length range of specimens caught during the month of November was 8-21 cm. Two year classes with mean lengths of 12.5 cm and 18.5 cm were recorded during the above month. Specimens with a length range of 11-20 cm and a mean length of 13.5 cm were caught during the month of April 2005. Length frequency distribution of *Neoscopelus macrolepidotus* recorded during the study indicates the occurrence of two year classes in the trawl catches and also a slow growth rate for the above species.

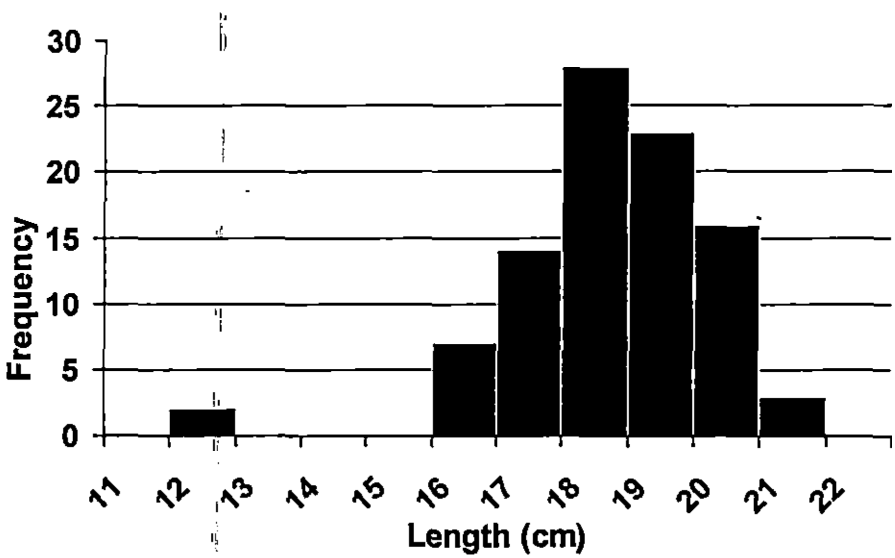

Fig. 31. Length frequency distribution of *Neoscopelus macrolepidotus* during the month of February 2004

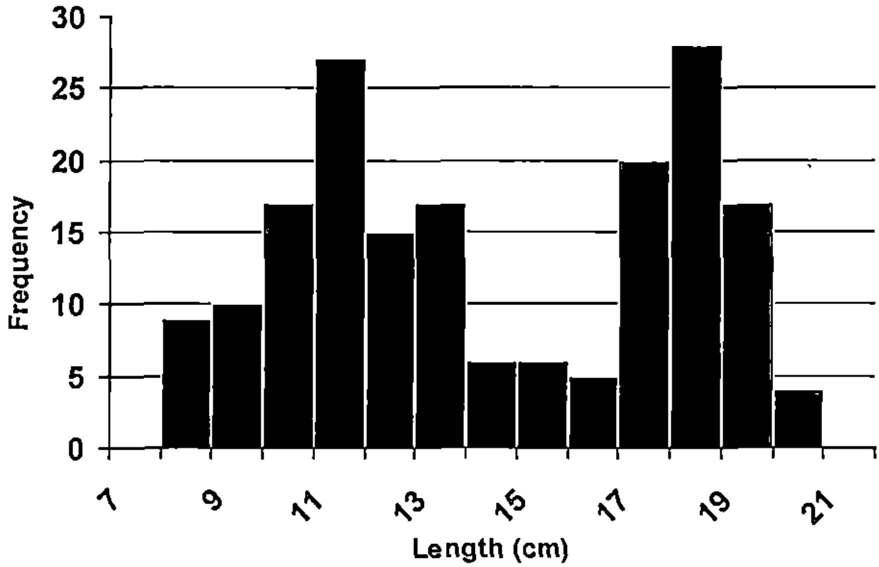

Fig. 32. Length frequency distribution of *Neoscopelus macrolepidotus* during the month of November 2004

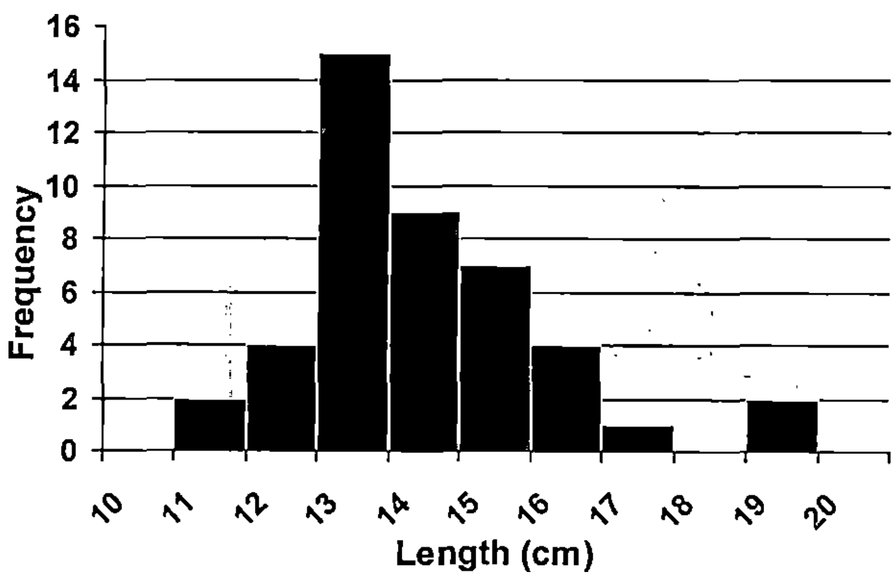

Fig. 33. Length frequency distribution of *Neoscopelus macrolepidotus* during the month of April 2005

4.6. BIOMASS OF NONCONVENTIONAL FINFISH RESOURCES

Biomass of fishery resources of the area 7^0-10^0N lat. between 100 and 500 m depth zone is furnished in the Table 6. A standing stock of 98442.17 tonnes estimated for the nonconventional finfish resources indicates the abundance of the above resources. They form 68.88% of he total fishery resources of the area. Among the deep-sea fishes *Trichiurus auriga* with a standing stock of 54724.913 tonnes dominated over the others, followed by *Psenopsis cyanea* with 24578.860 tonnes and the other deep-sea fishes with 8253.639 tonnes. The standing stocks of nonconventional finfish resources are nearly 11.3 times of the conventional finfish resources in the 100-500 m depth zone. Standing stock of deep- sea prawns and lobsters, deep- sea crabs, deep -sea cephalopods and deep -sea elasmobranchs together was estimated to be 35794.574 tonnes, which constitute 25.05% of the total fishery resources of the area.

Table 6. Biomass of fishery resources off the south-west coast of India (7^0- 10^0N lat.) between 100 and 500 m depth.

Resource	Biomass (Tonnes)
Chlorophthalmus spp.	1807.433
Psenes squamiceps	957.353
Psenopsis cyanea	24578.860
Neoepinnula orientalis	968.404
Diaphus spp.	1202.311
Neoscopelus macrolepidotus	654.865
Trichiurus auriga	54724.913
Triglids	5294.392
Other deep-sea fishes	8253.639
Nonconventional finfishes (Deep-sea fishes) -Total	**98442.170**
Conventional fishes*	8679.694
Others**	35794.574
Total	142916.438

- * Conventional fishes include *Nemipterus* spp. *Saurida* spp., and *Priacanthus* spp.

  ** Others include Deep-sea prawns and lobsters, Deep-sea crab, Deep-sea cephalopods and deep-sea elasmobranchs

Discussion

5.DISCUSSION

5.1 BIODIVERSITY

Myers (1940) observed that Indo-Pacific fish fauna is the richest among the four tropical fish fauna. Practically Indo-Pacific fish fauna contain almost all families and a considerable number of the genera that make up the fauna of the other three; in addition to many families and genera not found elsewhere. This is evident from the richness of the inshore fish fauna of the area. Only very little knowledge is available regarding the diversity of offshore fishes. Joseph and John (1986) reported that in contrast to the inshore region, the offshore region is poor in diversity represented by only a few species. Results of the present study, which recorded 97 species of nonconventional finfishes belonging to 16 orders, point out the richness of the offshore finfish diversity. This richness of the fauna becomes more clear when we consider the fact that there are only 22orders of deep demersal fish fauna distributed all over the world (Helfman *et al.*2003).

A comparative statement of the number of species recorded by the different authors during the past is furnished in the Table 7. Oommen (1980) reported 63 species of fishes from the deep waters of the Quilon Bank. Bottom trawls were used for the above survey. Balachandran and Nizar (1990) reported 87 species of nonconventional finfishes from the Indian EEZ. Both bottom and pelagic trawls were used for this study. Khan *et al.* (1996) reported 34 species from the south-eastern Arabian Sea. Demersal trawl nets were used for the above survey. Venu and Kurup (2002a) reported 23 species from the west coast of India. Bottom trawl nets were used for the survey. Major objective of the above surveys was the study of distribution and abundance of the deep-sea finfishes. Perhaps not much attention was paid to study the species diversity.

Table 7. Comparative statement of number of species of nonconventional deep-sea finfishes recorded by different authors.

Authors	Area	Depth (m)	Number of species reported
Oommen (1980)	Quilon Bank (8^0-9^0N lat.)	175-370	63*
Balachandran and Nizar (1990)	Indian EEZ	100-4524	87**
Khan *et al.* (1996)	South-eastern Arabian Sea (8^0-13^0N lat.)	170-777	34
Venu and Kurup (2002a)	West coast of India (7^0-21^0N lat.)	201-750	23
Present study	South-west coast of India (7-10^0 N lat.)	100-500	97

* Include 5 species of Elasmobranchs ** Include both pelagic and demersal deep-sea finfishes

The total number of species recorded by the above studies from waters deeper than 100 m is 151. Out of the 97 species of nonconventional finfishes recorded during the present study, 56 species were not reported by the above authors. Hence,the total number of nonconventional finfishes from the deeper waters of our country reported by the above surveys and the present study together come to 207. Certainly there could be many more species, which have not been represented in the samples. Alcock (1899) reported 169 deep-sea finfish species from the continental slopes of the India. Further studies of deep-sea finfishes by using different types of gears, covering the entire Indian EEZ are needed for a better understanding of the diversity of the deep-sea finfish resources.

5.2. DISTRIBUTION OF NONCONVENTIONAL FINFISHES

Nonconventional finfishes which formed 72% of the trawl catches (100-500 m) obtained during the study period indicates the abundance of the same in the area under study. This result matches with the findings of Khan *et al.* (1996) who reported that the deep-sea fishes formed 79.86 % of the trawl catches in the deeper waters of the southeastern Arabian Sea. Dominance of the deep-sea fishes was more predominant in the 200-500 m depth zone (continental slope), where they formed 84 % of the total catch. This finding supports the observations of Philip *et al.* (1984) that the abundance of the deep-sea fishes increases towards the deeper waters.

5.2.1 Area-wise abundance

Results obtained during the study indicate that the nonconventional finfishes are abundant (1070 $kg.h^{-1}$) in the area between 7^0 and 8^0N lat. (200-500 m depth zone) and this abundance reduces towards the northern latitudes. Khan *et al.* (1996) stated that area between 8^0 and 9^0N is the abundant zone in the southeastern Arabian Sea. This too supports the above observation of decrease in abundance of the deep-sea finfishes towards the northern latitudes. Oommen (1985) and Venu and Kurup (2002a) recorded catch rates of 59.60 $kg.h^{-1}$ and 606.48 $kg.h^{-1}$ respectively for the deep-sea finfishes from the 7^0-8^0N lat indicating the abundance of the finfishes in the above area.

5.2.2 Depth-wise abundance

Depth-wise analysis of the catches indicates that 200-300 m zone is the abundant depth zone for these fishes. *Trichiurus auriga* and *Psenopsis cyanea* domoinated among the finfishes caught from the area. According to Khan *et al.* (1996) and Venu and Kurup (2002a) 301-400 m depth zone off the south-west coast of India has more abundance of finfishes than any other depth zone. Variations in the effort spent in different latitudes and depth zones may be the reason for the above disparity.

Depth-wise and area-wise analysis of the catches point out that bathymetric difference is the key factor for the distribution and abundance of deep-sea finfishes. This is more evident from the depth-wise analysis, which shows that conventional finfishes, which are dominant in the 100- 200 m depth zone, are practically absent in the 200- 300m depth zone. This deeper area has nonconventional finfishes like *Trichiurus auriga* and *Psenopsis cyanea* in abundance. The 300-400 m depth zone is found to be rich in diversity where all the 8 species/species-groups and other deep-sea finfishes are recorded. *Psenes squamiceps* and *Psenopsis cyanea* are the dominant species recorded from this zone. The 400-500 m depth zone was dominated by the photophore-bearing fishes. The above mentioned distribution pattern has been observed throughout the area under study.

5.3. MAJOR VARIETIES OF NONCONVENTIONAL FINFISH RESOURCES

In the order of abundance *Trichiurus auriga* (38%) and *Psenopsis cyanea* (37%) are found to be the major finfish species in the area. Other species/specie-groups together formed 25% of the total catch. An average catch rate of 817.38 $kg.h^{-1}$ recorded for *Trichiurus auriga* from the 200-300 m zone is promising. Similar encouraging catch rate was obtained for *Psenopsis cyanea* (749.92 $kg.h^{-1}$) from the same depth zone. Good catch rates (50.92 $kg.h^{-1}$) are recorded for greeneye in the 200- 300 m depth zone and other deep-sea fishes in the 200-500 m depth. These catch rates are also encouraging and make them potential species/species-groups for commercial exploitation.

Catch per unit effort of dominant species reported by different authors from the respective area of study is furnished in Table 8. According to the results of present study *Trichiurus auriga* is the dominant nonconventional finfish species in the south-west zone. Though Venu and Kurup (2002a) reported that *Trichiurus* sp. as the dominant (600.60 $kg.h^{-1}$) nonconventional finfish species in the area between $7^0$and 8^0N lat., a catch rate of 1114.7 $kg.h^{-1}$ recorded for *Chlorophthalmus punctatus* from the 8^0-

9^0N lat. during their survey makes the above species as the most dominant one. Except for Panicker *et al.* (1993) and Venu and Kurup (2002a), all other authors reported that *Psenopsis cyanea* is the most dominant species. The present study recorded the above species as the second most abundant, however difference in the catch rate between the two dominant species is found to be very little.

According to Panicker *et al.* (1993) *Chlorophthalmus* spp. is the dominant nonconventional species of the south-west coast. The present study also recorded the above species in significant quantities from the 200-300 m depth zone.

5.4. GEAR-WISE CATCHES

45.6 m Expo model fish trawl and 47.12 m Shrimp trawl were the gears used for the survey. Variation in the species composition of nonconventional finfishes caught by the above gears indicates the difference in habits of the deep-sea finfishes. Fish trawl was found to be more effective in catching *Trichiurus auriga* and *Psenopsis cyanea*. *Chlorophthalmus* spp. *Psenes squamiceps and Neoepinnula orientalis* dominated in the shrimp trawl catches. This pattern of catches was evident in all the hauls made during the survey. An organised survey covering the entire EEZ of India using various types of gears will be useful to streamline the exploitation of nonconventional finfishes.

Table 8. Catch per unit effort of dominant species of deep- sea nonconventional finfishes by different authors

Author	Area of study (Latitude)	Dominant species	Catch per unit effort ($kg.h^{-1}$)
Philip *et al.* (1984)	11^0-12^0N	1.*Psenopsis cyanea* 2.*Psenes indicus*	52.8 30.0
Joseph (1986)	8^0-11^0N	1.*Psenopsis cyanea* 2.*Psenes indicus*	53.0 3.0
Sivakami (1990)	4^0-10^0N	1.*Psenopsis* spp. 2.*Chlorophthalmus* spp.	383.6 369.8
Ninan *et al.* (1992)	7^0-11^0N	1.*Psenopsis cyanea* 2.*Chlorophthalmus* spp	68.1 49.1
Panicker *et al.* (1993)	7^0-9^0N	1.*Chlorophthalmus* spp 2.*Psenopsis* spp	453.3 400.0
Sivakami *et al.* (1998)	7^0-15^0N	1.*Psenopsis* spp. 2.*Chlorophthalmus* spp.	493.5 422.6
Venu and Kurup (2002 a)	7^0-8^0N 8^0-9^0N	1.*Trichiurus* sp. 1.*Chlorophthalmus* sp.	600.6 1114.7
Present study	**7^0-10^0N**	**1.*Trichiurus auriga*** **2. *Psenopsis cyanea***	**146.78** **144.38**

5.5.LENGTH FREQUENCY STUDIES

Length frequency study of major species caught during the period gives some idea about the size groups available in the trawl catch. Results obtained during the study were compared with the findings of Khan *et al.* (1996) (Table 9.)

As evident from the Table, length ranges of finfish species recorded during both the studies are almost the same. The present study indicates the occurrence of two year classes of *Chlorophthalmus agassizi, Trichiurus auriga,* and *Neoscopelus macrolepidotus* in the trawl catches. Maximum length of *Trichiurus auriga* caught during the study was 39 cm. Most of the specimens caught during April 2005 are found to be mature. This indicates that in contrast to the ribbonfish species of inshore waters, deep-sea ribbonfishes are smaller in size. Specimens larger than 40 cm were not observed during the entire period.

Only very little information is available about the biology of deep-sea finfishes. Information regarding growth, maturity, and reproduction are essential to know the effect of fishing on the stock. An in-depth study is required to collect above information and to formulate the exploitation strategies of this virgin stock.

Table 9. Length range of important nonconventional finfishes

Name of the species	Length range (Total length in cm)	
	Khan *et al.* (1996)	Present study
Chlorophthalmus agassizi	11.0-29.9	8.0-23.0
Psenes squamiceps	11.0-20.9	11.0-21.0
Psenopsis cyanea	10.0-18.9	13.0-21.0
Neoepinnula orientalis	13.0-29.9	10.0-25.0
Trichiurus auriga	Not reported	22.0-40.0
Diaphus splendidus	Not reported	9.0-17.0
Neoscopelus macrolepidotus	Not reported	8.0-22.0

5.6 BIOMASS ESTIMATION

Estimates of the standing stock of the nonconventional finfishes carried out by different authors are furnished in Table 10. As evident from the table the estimation of Oommen (1985) can be considered as a case of under estimation, as further studies in the area showed a standing stock which is at least five times that of the above estimate. The biomass estimated during the present study is more than double that of Ninan *et al.* (1992). Use of shrimp trawl alone for the estimation of the finfishes during their survey may be the reason for the difference.

Table 10.Comparative statement of estimates of biomass of nonconventional deep-sea finfishes

Author	Area of study	Biomass (tonnes)/ Biomass per unit area (tonnes/nm^2)/ Potential (tonnes)
Oommen (1985)	7^0-13^0N	8,136
Ninan *et al.* (1992)	7^0-10^0N	40,620
Khan *et al.* (1996)	8^0-13^0N	13.1*
Sivakami *et al.* (1998)	7^0-15^0N	4,19,682
Ministry of Agriculture (2000)	Indian EEZ	1,05,345**
Present study	**7^0-10^0N**	**98,442.1**

* Biomass per unit area in tonnes/nm^2 ** Estimated potential in tonnes

The present study estimated a standing stock of 54724.9 tonnes of *Trichiurus auriga* in the deeper waters of the area 7^0-10^0N lat. Most of the earlier studies did not record this resource. However, Venu and Kurup (2002a) pointed out the abundance of *Trichiurus* sp. in the 200-300 m depth zone of 7^0-8^0N lat. Khan *et al.* (1996) estimated the biomass per unit area as 13.1 tonnes/nm^2, which includes the density of *Priacanthus* spp. too. The present study has not considered bullseye as a nonconventional finfish as this fish arrive regularly and has a good demand in local fish markets. Biomass per unit area recorded during the present study is 7.51 tonnes/nm^2. Sivakami *et al.* (1998) gives a much larger biomass in comparison to the estimate made by this study.

The working group for revalidating the potential of fishery resources in the Indian EEZ estimated a potential of 1.05 lakh tonnes of nonconventional finfishes in the Indian EEZ. Other deep-sea fishes (*Cubiceps* spp., Myctophids, *Neoepinnula* sp., and *Emmelichthys* sp.) – 65,526 tonnes, blackruff – 27,176 tonnes, Indian driftfish – 7947 tonnes, and greeneye- 4696 tonnes are the major constituents of the nonconventional finfishes of India (Ministry of Agriculture, 2000). In contrast to the potential estimation of four species- groups from the deeper waters of Indian EEZ, the present study estimated the biomass of 9 species/ species-groups of deep-sea nonconventional finfishes off the south-west coast of India. Biomass estimation of the present study from the area from 7^0-10^0N lat. supports the views of the revalidation committee that the potential estimate of 1.05 lakh tonnes of nonconventional finfishes in the deeper waters of Indian EEZ may be an under estimate.

5.6. UTILIZATION OF NONCONVENTIONAL FINFISH RESOURCES

The exploited marine fisheries of India have been stagnating at around 2.7 million tonnes (CMFRI, 2004) against the total potential marine wealth of 3.93 million tonnes (Ministry of Agriculture, 2000). Further improvement in the landings can only be possible by targeting the harvest of under and unexploited resources especially in depths beyond 100 m. The present study confirms the richness of diversity and abundance of deep-sea nonconventional finfishes off the south-west coast of India (7^0-10^0N lat.).

Studies of Philip *et al.* (1984) confirmed that deep-sea fishes are comparable in nutritive value to the commonly available conventional finfishes. The proximate composition indicated that deep-sea fishes are rich in protein (value ranges from 14.4- 17.5%). The experiments conducted by CIFT (1990); Nair *et al.* (1990) and Muraleedharan *et al.* (1996) have indicated that deep-sea fish resources could be utilized as a raw material for a variety of fishery products. Important among them are canned products, minced meat (yield 21- 30%), fish wafers, fish cutlets, fish patties, breaded fish sticks, texturised meat, fish soup powder, and fish meal.

Exploitation of the virgin deep-sea finfish resources in an organized manner from the Indian E.E.Z will give a boost to the deep-sea fishing industry, which is at present solely dependent on the deep-sea prawns and lobster resources. Further, this will result in a reduction of fishing pressure on our conventional coastal fishery resources. Therefore, popularisation of nonconventional finfishes and their commercial exploitation are urgently called for.

Summary

6. SUMMARY

1.The objectives of the study are to understand the diversity, distribution, and abundance of nonconventional finfishes in the 100-500 m depth zone off the south-west coast of India (7^0-10^0N lat.).

2. Exploratory fishing data of M.F.V Matsya Varshini (A purse-seiner cum stern trawler attached to the Kochi base of Fishery Survey of India) collected during the period February 2004 to April 2005 have been utilized for the study.

3. Study area has been divided in to six strata based on latitude and 100, 200, and 500 m depth contours.

4.Each 1^0 lat. x 1^0 long. area has been further divided in to 6' x 6' squares and hauls have been allocated to these squares by following the stratified random sampling method.

5. 45.6 m Expo model fish trawl and 45.12 m Shrimp trawl were the gears used for the study.

6. 54 hauls spending a total effort of 60.33 hrs were made in the study area during the period of study.

7. Fish catches were sorted out group-wise, namely conventional finfishes, nonconventional finfishes, prawns and lobsters, crabs, elasmobranchs, and cephalopods.

8. Nonconventional finfishes were sorted into 8 species/species-groups and the remaining were taken together as other deep-sea fishes.

9 Survey data during the period of February 2004 to April 2005 were used for analyzing the group-wise percentage composition of trawl catches of the area. Data collected during the months of March 2004, November 2004, and April 2005 were used to analyse the nonconventional finfish diversity, distribution and abundance.

10. Swept area method was used to estimate the biomass of the important constituents of the nonconventional finfishes.

11. A total of 97 species belonging to 16 orders, 51 families and 78 genera of nonconventional deep-sea finfishes are recorded from the area. This shows the richness of finfish diversity of the area.

12.A check list with photographs of the nonconventional finfishes collected during the study is presented in the text. The area of collection and the size of the specimen have also been added in the check list.

13.A catch composition of 72% of nonconventional finfishes obtained from the trawl catches of the area shows their abundance. Dominance of deep-sea fishes (86%) was more predominant in the 200-500 m depth zone.

14.Out of the 97 species recorded 23 species are found to be significant in their abundance.

15.Area-wise latitude between 7^0 and 8^0N (200-500 m depth zone) was found to be the most productive, followed by 8^0-9^0N. A decreasing trend of abundance of nonconventional finfishes towards the northern latitudes has also been observed during the study period. .

16. Depth-wise and area-wise analyses of the catches point out that bathymetric difference is the key factor for the distribution and abundance of deep-sea finfishes.

17. The 200-300 m depth zone has been found to be more productive with a relative abundance of 1829.7 $kg.h^{-1}$ of deep-sea fishes.

18. Among the deep-sea fishes *Trichiurus auriga* with a relative abundance of 146.78 $kg.h^{-1}$ dominated over other finfishes, followed by *Psenopsis cyanea* with an average relative abundance of 144.38 $kg.h^{-1}$

19. Species composition of nonconventional finfishes obtained during different months of the study indicates that seasonal variation in abundance exists in the case of these fishes.

20.Distribution pattern and abundance of the major constituents of the nonconventional finfishes have been analysed and discussed in the text.

21. Variation in the species composition of gear-wise catches indicates the difference in habits of the deep-sea finfishes.

22.Biomass of the nonconventional finfishes of the area has been estimated by using catch per unit effort data. A standing stock of 98442.17 tonnes estimated for the nonconventional finfish resources (7^0-10^0N lat.) indicates the abundance of these resources.

23. Standing stock of the 8 species/species-groups and other deep-sea fishes has been estimated and presented in the text. *Trichiurus auriga* with a biomass of 54724.9 tonnes and *Psenopsis cyanea* with 24578.9 tonnes formed the major constituents of the nonconventional finfish resources.

24. Length frequency distributions of 7 species of nonconventional deep-sea finfishes have also been carried out.

25. Length frequency studies indicated the presence of two year classes in the trawl landings of *Chlorophthalmus agassizi, Trichiurus auriga*, and *Neoscopelus macrolepidotus*

26. Findings during the study confirm the diversity and abundance of nonconventional finfishes along the offshore regions off the south-west coast of India. .

27. Results of the study point out to the need for an organized study of the nonconventional finfish resources of the Indian EEZ, and to evolve exploitation and utilization strategies for these resources.

References

7. REFERENCES

*Ajiad, A.M.1987. First record of *Aulacocephalus temmincki* Bleeker, 1857 from the Red Sea and four rare species from Aqaba, Jordan. *Cybium-3- Ser.*11 (1): 104-105

*Alcock, A.W. 1891. On the deep-sea fishes collected by the 'Investigator' in 1890-1891. *Ann. Mag. Nat. Hist.* 6(8): 119-138

Alcock, A.W. 1899. *A descriptive catalogue of the Indian deep-sea fishes in the Indian museum, collected by Royal Indian marine survey ship "Investigator".* Indian reprint 1994. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, p.211

Balachandran, K. and Nizar, A.M. 1990. A check list of fishes of the Exclusive Economic Zone of India collected during the research cruises of FORV Sagar Sampada. *Proc. First workshop Scient. Resul. FORV Sagar Sampada, June 5-7, 1989* (ed. Mathew, K.J.). CMFRI, Kochi, pp. 305-324

Berg, L.S. 1940. Classification of fishes both recent and fossil. *Trav. Inst. Zool. Acad. Sci. USSR.* 5: 87-517

CIFT. 1990. Studies on processing of deep-sea fish caught onboard FORV Sagar Sampada. *Proc. First workshop Scient. Resul. FORV Sagar Sampada, June 5-7, 1989* (ed. Mathew, K.J.). CMFRI, Kochi, pp. 457-465

CMFRI. 2004. *Annual report 2003-2004.* Central Marine Fisheries Research Institute, Cochin, p.139

Cohen, D.M. 1970. How many recent fishes are there? *Proc. Calif. Acad. Sci. 4 th ser.* 38: 341-346

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.* Bernard Quaritech, London, p.778

*Dickson, W. 1974. *A review of the efficiency of bottom trawls.* Institute of Fisheries Technology and Research, Bergen, Norway, p.44

FAO.1984. *FAO species identification sheets for fishery purposes, Western Indian Ocean (fishing area 51)*(eds Fisher. W. and Bianchi. G.). Food and Agriculture Organisation of the United Nations, Rome, Vol.1-5

FAO.1997. *The state of world fisheries and aquaculture. 1996.* FAO fisheries department, Food and Agriculture Organisation of the United Nations, Rome, p.125

George, P.C., Antony Raja, B.T. and George, K.C. 1977. Fishery Resources of the Indian Economic Zone. *Souv. Integrated Fisheries Project Silver Jubilee Celebration.* IFP, Kochi, pp.70-120

Goode, G.B. and Bean, T.H. 1895. Oceanic Ichthyology. Indian Reprint 1984. Narendra Publishing House, Delhi, p.553

Gopinath, K. 1954. A note on some deep sea fishing experiment off the south-western coast of India. *Indian J. Fish.* 1 (1&2): 163-216

Greenwood, P.H., Rosen, D.E., Weitzman, S.H. and Myers, G.S. 1966. Phyletic studies of teleostean fishes, with a provisional classification of living forms. *Bull. Amer. Mus. Nat. Hist.* 131:339-456

Gulland, J.A. 1975. Manual of method for fisheries resource survey and appraisal. Part 5. Objectives and basic methods. *FAO Fisheries Technical Paper No.* 145. Food and Agriculture Organisation of the United Nations, Rome, p.29

Gunther, A. 1887 Report on the deep-sea fishes collected by 'H.M.S. Challenger' during the year 1873-1876. *Rept. Sci. Res. Voy. "Challenger" Zool.* 12: 16-192

Helfman, G.S., Collette, B.B. and Facey, D.E. 2003. *The diversity of fishes.* Blackwell Science Inc., Malden, p.582

IFP. 1997. Results of exploration of unexploited and other exploitable marine resources of the west coast of India by MFV. Samudrika and MFV. Sagarika. *Bull. IFP.* 14: 1-35

*Isarankura, A.P. 1971. Assessment of stocks of demersal fish off the west coast of Thailand and Malaysia. *IOC/DEV/71/20.* FAO/UNDP, Indian Ocean Programme, Rome, p.20

James, P.S.B.R. and Pillai, V.N. 1990. Fishable concentration of fishes and crustacean in the off shore and deep sea areas of Indian Exclusive Economic Zone based on observation made onboard FORV Sagar Sampada. . *Proc. First workshop Scient. Resul. FORV Sagar Sampada, June 5-7, 1989* (ed. Mathew, K.J.). CMFRI, Kochi, pp. 201-213

John, C.C. 1948. Fishes and fisheries of the Cape Comerin Bank. *Bull. Res. Inst. Univ. Kerala Ser.C.*7 (1): 65-145

Joseph, K.M. 1984. Salient observations on the results of fishery resources survey during 1983-1984. *Bull. Fish. Surv. India.* 13: 1-13

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

Joseph, K.M. and John, M.E. 1986. Potential Marine Resources in Indian EEZ. *Seminar on Potential marine Resources, CMFRI, spl.Publ.* 30: 18-43

Khan, F. M.; Zacharia, P.U., Nandakumaran, K., Mohan, S., Arputharaj, M.R., Nagaraja, D. and Ramakrishnan, P. 1996. Catch, abundance and some aspects of biology of deep-sea fish in the southeastern Arabian Sea. *Proc. Second workshop Scient. Resul. FORV Sagar Sampada, February 15-17, 1994* (eds. Pillai, V.K., Abidi, S.A.H., Ravindran, V., Balachandran, K.K. and Agadi, V.V.). Department of Ocean Development, New Delhi, pp.331-346

Kunjipalu, K.K. 2004. Deep-sea fishing and new fishery resources of India. *Large marine Ecosystems: Exploration and Exploitation for Sustainable Development and Conservation of Fish stocks.* (ed. Somvanshi, V.S.). Proceedings of the International Symposium on Large Marine Ecosystems: Exploration and Exploitation for Sustainable Development and Conservation of Fish stocks, 1998. Fishery Survey of India, Mumbai, pp.206-215

Kurup, B.M., Premlal., Joice, V.T. and Anand, V. 2004. Status of epifaunal component in the bottom trawl discards along Kerala coast. (South India). *Fish. Technol. 41(2)*: 101-108

Luther, G., Rao, T.A., Ruben, S., Sastry, Y.A., Somaraju, M.V., Gopal, C. and Radhakrishnan, K. 1988. Marine Fish Calendar. 2. Visakhapatnam. *Mar. Fish. Infor. Serv. T&E Ser.* 80:1-21

*Marshall, N.B. 1954. *Aspects of Deep- sea Biology*. Hutchinson, London, p.380

Marshall, N.B. 1979. *Deep-sea Biology, Developments and Prospectives*. Blandford, London, p.566

Menon, N.G. 1990. Preliminary investigation of the fish biomass in the deep scattering layers of the EEZ of India. *Proc. First workshop Scient. Resul. FORV Sagar Sampada, June 5-7, 1989* (ed. Mathew, K.J.). CMFRI, Kochi, pp. 273-280

Menon, N.G. 2000. The deep scattering layer (DSL) of Indian EEZ. *Marine fisheries research and management* (eds. Pillai, V.N. and Menon, N.G.). Central Marine Fisheries Research Institute, Kochi, pp. 656-668

Menon, N.G., Pillai, N.G.K., Raghu, R. and Balachandran, K. 1996. Distribution and abundance of the genus *Vinciguerria* (Gonostomatidae) in the DSL of the Indian EEZ with a note on the biology of *Vinciguerria nimbaria. Proc. Second workshop Scient. Resul. FORV Sagar Sampada, February 15-17, 1994* (eds. Pillai, V.K., Abidi, S.A.H., Ravindran, V., Balachandran, K.K. and Agadi, V.V.). Department of Ocean Development, New Delhi, pp. 271-284

Ministry of Agriculture. 2000. *Report of the working group for revalidating the potential fishery resources in the Indian EEZ.* Department of Animal husbandry and dairying, Ministry of Agriculture, Government of India, New Delhi, p.66

Munro, I.S.R. 1955. The marine and fresh water fishes of Ceylon. Indian reprint 1982.Narendra Publishing House, Delhi, p.351

Muraleedharan, V., Antony, K.P., Perigreen, P.A.and Gopakumar, K. 1996. Utilisation of unconventional fish resources for surimi preparation. *Proc. Second workshop Scient. Resul. FORV Sagar Sampada, February 15-17, 1994* (eds. Pillai, V.K., Abidi, S.A.H., Ravindran, V., Balachandran, K.K. and Agadi, V.V.). Department of Ocean Development, New Delhi, pp. 539-544

*Myers. G.S.1940. The fish fauna of the Pacific Ocean, with special reference to zoogeographical regions and distribution as they affect the international aspects of fisheries. *Sixth Pacific Sci. Cong.* 3: 201-210

Naik, S.K. and Uikey, D.E. 1998. Preliminary studies on biology of *Acropoma japonicum* (Gunther, 1859): (Pisces, Perciformes, Acropomatidae). *Bull. Fish. Surv. India.* 26: 55-58

Nair, A.L., Shenoy, V. and Thankamma, R .1990. Value added products from *Chlorophthalmus agassizi* (greeneye) an unexploited fish from Exclusive Economic Zone of India. *Proc. First workshop Scient. Resul. FORV Sagar Sampada, June 5-7, 1989* (ed. Mathew, K.J.). CMFRI, Kochi, pp. 453-456

Ninan, T.V., Sivaji, V., Jagannadh, N. and Ramalingam, N. 1992. Observations on demersal resources survey between Lat. 7^0N and 11^0N along south-west coast, Wadge Bank and Gulf of Mannar during 1988-90. *Bull. Fish. Surv. India.* 24: 14-39

*Norman, J.R. 1939. Fishes, Scientific Report 1933-1934. *John Murray Exp. Sci. Rep.* 8(1): 1-116

Norman, J.R. 1975. *A History of Fishes*. Earnest Benn Ltd., London, p.463

Nelson, J.S. 1976. *Fishes of the world.* Wiley Interscience Publication (John Wiley& Sons), New York, p.416

Nelson, J.S. 1984. *Fishes of the world.* Second edition. Wiley Interscience Publication (John Wiley& Sons), New York, p.523

*Nelson, J.S. 1994. *Fishes of the world.* Third edition. Wiley Interscience Publication (John Wiley& Sons), New York, p.600

Oommen, V. P. 1974. A brief account of the topography and fishery potential on the south-west coast of India. *Mahasagar. Bull. nat. Inst. Oceanogr.* 7: 33-39

Oommen, V.P. 1978. New records of bathypelagic fishes from the Arabian Sea with description of a new species. *J. Bombay Nat. Hist. Soc.* 74(2): 282-287

Oommen, V. P.1980. Results of the exploratory fishing in Quilon Bank and Gulf of Mannar. *Bull. IFP.* 4: 1-49

Oommen, V. P. 1985. Deep-sea resources of the southwest coast of India. *Bull. IFP.* 11: 1-45

Pandian, P.P. and Philip, K.P.1992. Observations on the distribution and biology of Indian drift fish, *Ariomma indica* (Day) along the north-east coast of India. *Bull. Fish. Surv. India.* 24: 1-9

Panicker, P.A., Bhoopendranath, M.R. and Abbas, M.S. 1993. Observations on deep-sea demersal resources in Exclusive Economic Zone of India. *Fish Technol.* 30: 102-108

*Pauly, D. 1979. Theory and management of tropical multispecies stocks: a review with emphasis on the south-east Asian demersal fisheries. *ICLARM Stud. Rev.*1: 1-35

Pauly, D.1980. A selection of simple methods for the assessment of tropical fish stocks. *FAO Fisheries Circular No.*729. Food and Agriculture Organisation of the United Nations, Rome, p.54

Philip, K.P., Premchand, B., Avhad, G.K., and Joseph, P.J. 1984. A note on the deep-sea demersal resources of Karnataka and North Kerala coast. *Bull. Fish. Surv. India.* 13: 23-29

Planning Commission. 2002. Tenth Five year Plan 2002-2007: Vol.2. Planning Commission, Govt. of India, New Delhi, p.1116

Prasad, R.R and Nair, P.V.R. 1973. India and Indian Ocean Fisheries. *J. Mar. Biol. Ass. India.* 15(1): 1-19

Raman, M. and James, P.S.B.R. 1990. Distribution and abundance of lantern fishes of the family Myctophidae in the EEZ of India. . *Proc. First workshop Scient. Resul. FORV Sagar Sampada, June 5-7, 1989* (ed. Mathew, K.J.). CMFRI, Kochi, pp. 285-290

*Saeger, J., Martosubroto, P. and Pauly, D. 1976. First report of the Indonesian-German demersal fisheries project (Result of a trawl survey in the Sunda Shelf area). Marine Fisheries Research Report (Special report). *Contribution of the Demersal Fisheries Project No.1.* Indonesian-German Demersal Fisheries Project, Jakarta, p.46

Samuel, C.T. 1963. Bottom fishes collected by R.V. Conch off Kerala coast. *Bull. Dept. Mar. Biol. Oceanogr. Univ. Kerala.* 1: 97-121

*SCSP. 1978. Report on the workshop on the demersal resources of the Sunda Shelf, Part 1. *SCS/GEN/77/12.*South China Sea Fisheries Development and Coordinating Programme, Manila, p.44

*Shindo, S. 1973. General review of the trawl fishery and the demersal fish stocks of the South China Sea. *FAO Fisheries Technical Paper No.*120. Food and Agriculture Organisation of the United Nations, Rome, p.49

Silas, E.G. and Prasad, N.K. 1966. Studies on demersal fishes of the deep neretic waters and the continental slope. On the stromatoid fish *Psenes indicus* (Day) from the Indian seas, with comments on the genus and related species and notes on its biology. *Indian J. Fish.* 13: 183-218

Sivakami, S. 1990. Observation on the demersal fishery resource of the coastal and deep-sea areas of the Exclusive Economic Zone of India. *Proc. First workshop Scient. Resul. FORV Sagar Sampada, June 5-7, 1989* (ed. Mathew, K.J.). CMFRI, Kochi, pp. 215-231

Sivakami, S., Vivekanandan, E., Nammalwar, P., Khan, F. M., Zacharia, P.V., Mohanraj, G., Mathew, G. and Jayasankar, P. 1998. The nonconventional finfish resources of the Indian Exclusive Economic Zone. *Technological Advancement in Fisheries.* (eds. Hameed, M.S. and Kurup, B.M.). Proceedings of the National Symposium on Technological Advancement in Fisheries and its Impact on Rural Development, 1995. Cochin University of Science and Technology, Kochi, pp. 243-255

Sivaprakasam, T.E. 1986a. A study of the demersal resources of the wadge bank and Gulf of Mannar. *Bull. Fish. Surv. India.* 15: 1-37

Sivaprakasam, T.E. 1986b. What is in store in deep sea? Results of exploration of the demersal fishery resources of the Indian EEZ. Occ. *Pap. Fish. Surv. India.* 3: 1-23

Smith, M.M. and Heemstra, P.C. 1986. *Smith's sea fishes.* J.L.B.Smith Institute of Ichthyology, Grahamstown, p.1047

Somvanshi, V.S., Gulati, D.K., John, M.E. and Vargese, S. 2004. Stock recruitment relationship of *Nemipterus japonicus* along north-west coast of India. *Large marine Ecosystems: Exploration and Exploitation for Sustainable Development and Conservation of Fish stocks.* (ed. Somvanshi, V.S.). Proceedings of the International Symposium on Large Marine Ecosystems: Exploration and Exploitation for Sustainable Development and Conservation of Fish stocks, 1998. Fishery Survey of India, Mumbai, pp.59-68

Sparre, P., Ursin, E. and Venema, S.C. 1989. Introduction to tropical fish stock assessment. Part 1. Manual. *FAO Fisheries Technical Paper No.*306. Food and Agriculture Organisation of the United Nations, Rome, p.337

Sudarsan, D. 1993. Marine Fishery Resources in the EEZ of India. *Proc. Nat. Workshop Low Energy Fishing*, August 8-9, 1991 (eds. George, V.C., Vijayan, V., Varghese, M.D., Radhalakshmi, K., Thomas, S.L. and Joseph, J.). Soc. Fish. Technol., Cochin, pp.3-11

Sudarsan, D., Sivaprakasam, T.E., Somvanshi, V.S., John, M.E., Nair, K.N.V. and Joseph, A. 1988. An appraisal of the marine fishery resources of the Indian Exclusive Economic Zone. *Bull. Fish. Surv. India.* 18: 18-25

Sudarsan, D., John, M.E. and Somvanshi, V.S. 1990. Marine fishery resources potential in the Indian Exclusive Economic Zone- An update. *Bull. Fish. Surv. India.* 20: 1-27

Sulochanan, P. and John, M.E. 1988. Off shore deep-sea and oceanic fishery resources of Kerala coast. *Bull. Fish. Surv. India.* 16: 27-48

Tholasilingam, T., Venkayaraman, G. and Kartha, K.N.K. 1964. On some bathypelagic fishes taken from the continental slope off the south-west coast of India. *J. Mar. Biol. Ass. India.* 6(2): 268-284

Venu, S. and Kurup, M.B. 2002a. Distribution and abundance of deep-sea fishes along the west coast of India. *Fish. Technol.* 39(1): 20-26

Venu, S. and Kurup, M.B. 2002b. Distribution and biology of the deep sea fish *Psenopsis cyanea* (Alcock) inhabiting continental slope of the west coast of India. *J. Mar. Biol. Ass. India.* 44(1&2): 176-186

*Weber, M. 1913. Dic Fische der Siboga Expedition. *Siboga Exped.*57: 1-710

* Not referred in original.

ABUNDANCE AND DISTRIBUTION OF THE NONCONVENTIONAL DEEP-SEA FINFISH RESOURCES OFF THE SOUTH-WEST COAST OF INDIA (LAT.7^0-10^0N)

By

SAJEEVAN.M.K, B.F.Sc.

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF FISHERIES SCIENCE

Faculty of Fisheries

Kerala Agricultural University

2005

DEPARTMENT OF FISHERY BIOLOGY

COLLEGE OF FISHERIES

PANANGAD, COCHIN

Abstract

ABSTRACT

Most of the conventional fishery resources of the continental shelves of the Indian EEZ are either optimally exploited or over exploited. Exploitation of the unexploited nonconventional finfishes will be a solution to meet the growing demand for fish in the country. The present study based on the exploratory fishing data of M.F.V. Matsya Varshini during the period of February 2004 to April 2005 indicates the presence of nonconventional finfish resources along the deeper waters (100-500 m) off the south west coast of India (7^0-10^0N lat.). 97 species belonging to 16 orders, 51 families, and 78 genera recorded during the study points to the rich diversity of nonconventional finfishes in the study area. Nonconventional finfishes formed 72% of the trawl catches obtained during the period under study. Distribution pattern and abundance of the nine species/species-groups are presented and discussed. Area-wise 7^0-8^0N lat. (200-500 m depth zone) has been found to be more productive and the abundance has shown a decreasing trend towards the northern latitudes. Results of the study confirm that bathymetric difference is the key factor for the distribution and abundance of deep-sea finfishes. Depth wise, the 200-300 m zone has been found to be more productive with a relative abundance of 1829.7 $kg.h^{-1}$ of deep-sea finfishes. *Trichiurus auriga* with a relative abundance of 146.78 $kg.h^{-1}$ dominated among finfishes, followed by *Psenopsis cyanea* with an average relative abundance of 144.38 $kg.h^{-1}$. Existence of seasonal variation and difference of habits of the nonconventional finfishes have been observed during the study. Results of the length frequency studies carried out for seven important nonconventional finfish species are discussed. A standing stock of 98442.17 tonnes estimated for the nonconventional finfishes from the study area makes them a potential resource for commercial exploitation. Biomasses of the 9 species/species-groups of nonconventional finfishes estimated separately are also presented. Need of an organized survey of nonconventional deep sea finfishes covering the entire Indian EEZ by using different types of gears has been highlighted.