# THE SYSTEMATICS, DISTRIBUTION AND BIONOMICS OF DEEP SEA FISHES BEYOND DEPTH 200M ALONG THE SOUTH WEST COAST OF INDIA

*Thesis submitted to the*

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*In partial fulfilment of the requirements*

*for the degree of*

DOCTOR OF PHILOSOPHY

*By*

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KOCHI – 682 016

2009

*Dedicated to My Family*

## DECLARATION

I, Venu S., do hereby declare that the thesis entitled ***The Systematics, Distribution and Bionomics of Deep sea fishes beyond depth 200 m along the South west coast of India*** is a genuine record of research work carried out by me under the guidance of **Prof. (Dr.) B. Madhusoodana Kurup**, **Director**, School of Industrial Fisheries, Cochin University of Science and Technology, Kochi – 16 and no part of the work has previously formed the basis for the award of any Degree, Associateship and Fellowship or any other similar title or recognition of any University or Institution.

Venu S.

Kochi – 16

September-2009

## CERTIFICATE

This is to certify that the thesis entitled ***The Systematics, Distribution and Bionomics of Deep sea fishes beyond depth 200m along the South west coast of India*** to be submitted by Sri. Venu S., is an authentic record of research work carried out by him under my guidance and supervision in partial fulfilment of the requirement for the degree of Doctor of Philosophy of Cochin University of Science and Technology, under the faculty of Marine Sciences.

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# CONTENTS

# CHAPTER 1

# GENERAL INTRODUCTION

## Introduction

The fisheries sector has been recognised as a powerful engine for economic development and employment generation as it stimulates growth of a number of subsidiary industries. It is an important source of cheap and nutritious food, besides it provides as an instrument of livelihood for a large section of economically backward population of the country. Indian fisheries sector is an important component of the global fisheries; constituting about 4.4% of the global fish production and contributes to 1.1% of the GDP and 4.7% of the agricultural GDP According to SOFIA (2007), the amount of food fish consumed on a global scale has increased from 45 m mt in 1973 to over 90 m mt in 1997 and reached 107.2 in 2005. Over this span, world per capita food fish consumption has also risen from 12 kg/year to 16.6 kg/year (SOFIA, 2007). Growth in food fish consumption has primarily been a developing-country phenomenon. China dominated aggregate consumption of fisheries products in 1997, with over 36 percent of global consumption, rising from only 11 % in 1973. India and Southeast Asia together accounted for another 17 % in 1997, with total consumption doubling since 1973 (Delgado *et al.* 2003).

Marine fish production from the currently fishable areas of the Indian EEZ is reaching or has reached its optimum level. India is the seventh largest fishing nation of the world with an Exclusive Economic Zone (EEZ) of 2.02 million sq. km. Sudarsan *et al.* (1990) estimated a resource potential of

3.92 million tonnes from the Indian EEZ. Of this, the inshore water (0.50m), 10 % in area of the EEZ, possesses an estimated exploitable potential of 58 % (2.28 million tonnes). The rest, 1.64 million tonnes, are scattered over a very large area of (89 % of EEZ) offshore waters (50-500m). The level of exploitation in the inshore waters has already reached the Maximum Sustainable Yield (MSY) level whereas only 31.46 % of offshore waters are exploited. The 1.64 million tonnes of deep-sea fishery resources comprise 45.25 % pelagic stock, 39.8 % demersal stock and 15 % of oceanic species (Sudarsan *et al.* 1990). Demersal surveys beyond the 100 m depth have shown that unexploited species of fish, shrimps and lobsters occur in deeper waters. The major unexploited resources are fish groups are the threadfin breams, yellow fin tuna, pelagic sharks, cephalopods, carangids and shrimps in the order of abundance. In this area, the bottom trawl fishery has developed and expanded rapidly during the last couple of decades, mainly due to very favourable export markets for shrimps. Demersal fish exploited at present are components of the stocks distributed over the continental shelf, particularly within the 100 m depth zone. In view of the prevailing state of fisheries in this region and with global fish supply struggling to keep pace with demand over the next 20 years, there is scope for further exploitation of 1.25 million tonnes of deep-sea resources (D'Cruz, 2004) available in the Indian EEZ.

Recently, the depletion and increased regulation of shallow-water fishery resources have generated greater interest in the potential of deepwater fisheries. Smaller-scale fisheries for deep-sea animals have been conducted in certain locations around the world for more than a century, but large-scale commercial deepwater fisheries are a more recent phenomenon. While currently a relatively small number of countries are involved in high seas bottom trawling, and the current total value of high seas bottom trawl fisheries is estimated at well below 1% of the fish catch worldwide, fishing effort appears likely to continue to move into the deep sea as stocks closer to shore are getting depleted. When taken into consideration with the known impacts on biodiversity and the gaps in scientific knowledge, there have increasingly been demands both for reform of international governance of the high seas and for a moratorium on the practice of deep-sea bottom trawling until such a regime is put in place (http://www.savethehighseas.org). The Government of India has consistently attempted since the 1950's for the development of deep-sea fishing in the country (D'Cruz, 2004). Import of trawlers for exploitation of deep-sea resources by private fishing companies and State Government Corporations was permitted and assistance in various forms on attractive terms for deep sea fishing was extended to them. Chartering of vessels, formation of the Shipping Development Fund Committee (SDFC), which provided large number of soft loans, setting up of Foreign Investment Promotion Board to take up foreign investment in various activities including deep-sea fishing and single-window clearance of requests for permission for investments were some of the other types of major promotional incentives made in this direction. Formulation and implementation of the new deep-sea fishing policy in 1991, which envisaged by the Government during the past five decades for development of deep-sea fishing in India (D'Cruz, 2004). The present scenario suggests that the current level of marine fish production from the exploited zone has to be sustained by closely monitoring the landings and the fishing effort and also by strictly implementing the scientific management measures.

The deep-sea is the largest habitat on earth which covers more than $300 \times 10^6$ $km^2$ and constitute about 63% of the Earth's solid surface (Smith *et al.* 2008). The deep sea floor lies between the shelf break (*c.* 200m depth) and the bottom of the Challenger Deep (*c.*11000m depth). The continental slopes alone occupy 8.8 % of the world's surface, compared to 7.5 % for the continental shelf and shallow seas (Merrett and Haedrich, 1997). The distinct habitats of the deep seafloor are varied and include sediment-covered slopes, abyssal plains, and ocean trenches, the pillow basalts of mid-ocean ridges, rocky seamounts protruding above the seafloor, and submarine canyons dissecting continental slopes.

The deep-sea can be classified into four zones: the mesopelagial is uppermost and ranges from 200 to 1000m; some workers use 500m as the start of the deep water habitat. The bathypelagic occupies the 1000-4000m depth zone; the abyssopelagic goes from 4000 to 6000m and the hadal zone mentioned for completeness, is the habitat of the deep ocean trenches. For the demersal fishery, the deepwater region can be taken as the continental slopes, starting at the shelf break and corresponding to the mesopelagic and bathypelagic and, beneath, the continental rise which extends down to the abyssal planes at around 6000m. Complicating this picture are the existence of seabed features that may rises thousands of metres above the surrounding areas-seamounts, or form regions of "hills" or knolls. Gorden *et al.* (1995) are of the view that, although they comprise only something like

8.8% of the ocean bottom, the slopes are among the most complex and dynamic parts of the deep sea. Slopes are more complex topographically than are continental shelves.

The vertical zone of the oceans and seas, which extends from the shelf break *i.e.,* from the outer boundary of the shelf zone, down the slope, to the oceanic bed is called the bathyal zone. In addition to the continental slope, the slopes of islands, seamounts and rises, including the mid-oceanic ridges, are also included in the bathyal zone (Parin, 1982; 1984). The deep sea benthic zone is further divided into an upper bathyal zone, a middle abyssal zone and a lower hadal zone. The bathyal zone is the environment of the continental slope and it extends down from the continental shelf to about 3000m. It can well be defined as a broad transition zone between the sub-littoral and the true deep sea zone. It is also referred to as archibenthic zone. Historically, the bathyal zone is most important for the preservation of the marine fauna (Zezina, 1985).

With considerable changes in the ocean level (200m or more), the bathyal zone is the most accessible resting place for shallow-water and eurybathic fauna, and during the periods of substantial hydrological rearrangements related to changes in the temperature and gaseous regime in the abyssal zone, the abyssal fauna appear to find the most suitable conditions and survives in the bathyal zone. The periodic fluctuations do takes place in this zone, but not so marked as in the littoral and sub-littoral zones. The temperature of the bathyal zone in the low and middle latitudes ranges from 15-5°C and in the higher latitudes; it usually ranges from 3-1°C.

It is almost entirely aphotic and light penetration depends on the angle of the sun and transparency, owing to local factors such as salinity, sediment in suspension and plankton. The bottom waters of low and mid-latitudes are almost stagnant at about 1000m depth (Shotton, 2005).

In the marine environment, the important production of organic matter is restricted only to the illuminated surface layers of the sea. The extend of this region is known as euphotic zone. Below this lies the disphotic zone receiving scattered light. Below 200m, there is little or no light penetration which makes the zone aphotic (Nair and Thampy, 1980). In deep ocean waters, the only source of light is bioluminescence, so deep sea life must rely on alternatives to sight. Many deep sea fish have adapted large eyes to capture what little light exists. Most often, this light is blue-green, but some creatures have also developed the ability to produce red light to lure curious prey Lack of light also creates a barrier to reproduction. Bioluminescent light is also used to signal potential mates with a specific light pattern.

Deep sea creatures are also often equipped with a powerful sense of smell so that chemicals released into the water can attract potential mates. The dark, cold waters of the deep are also oxygen-poor environments. Consequently, deep sea life requires little oxygen. Oxygen is transported to the deep sea from the surface where it sinks to the bottom when surface temperatures decrease. It was observed that oxygen is never depleted in the deepest parts of the ocean because there are fewer animals to consume the available oxygen. In most parts of the deep sea, the water temperature is more uniform and constant. Pressure increases 1 atmosphere (atm) for each

10 m in depth. The deep sea varies in depth from 200m to more than 10000 m, therefore pressure ranges from 20atm to more than 1000atm. The deep sea creatures have adapted to pressure by developing bodies with no excess cavities, such as swim bladders, that would collapse under intense pressure. The flesh and bones of deep sea marine creatures are soft and flabby, which also helps them withstand the pressure. Deep sea creatures have developed some fascinating feeding mechanisms because of the lack of light and because food is scarce in these zones. Some food comes from the detritus, of decaying plants and animals from the upper zones of the ocean. The corpses of large animals that sink to the bottom provide infrequent feasts for deep sea animals and are consumed rapidly by a variety of species. The deep sea is home to jawless fish such as the lamprey and hagfish (Myxinidae), which burrow into the carcass quickly consuming it from the inside out. Deep sea fish also have large and expandable stomachs to hold large quantities of scarce food. They don't expend energy for swimming in search of food; rather they remain in one place and ambush their prey using amazing and clever adaptations. These ecological characteristics of deep sea fishes can make them vulnerable to over-exploitation, and slow to recover from it (Koslow *et al.* 1997). The species often have a slow growth rate, high longevity, low fecundity and hence low productivity (Clark *et al.* 1994; Smith *et al.* 1995; Tracey and Horn, 1999). Catches can be high initially in the fishery development and fishing – down phases, but very low on a long term sustainable basis, as with orange roughy in New Zealand and Australia (Clark, 2001). The deep sea environment, being dark and cold, has generally been regarded as a system

of low energy and low productivity (Clark, 2001). The continental slope was regarded as having little or no commercial potential (Merrett and Haedrich, 1997).

The deep sea ecology is mainly characterised by many processes different from the coastal habitats, the biomass tends to decrease as the log of the depth, growth is usually slow and life spans are long and biological communities are diverse and widespread but zoned with depth. Because no plants grow in the deep sea, there is only an indirect link to primary production through food webs and ladders of migration, and, ultimately, all deep-water production must depend on the thin photosynthetic layer at the surface. Mauchline and Gordon (1991) pointed out how important a trophic connection through pelagic animals is for deep demersal fishes and thus of course, for any fishery based on them. Many deepwater species migrate toward the surface at night returning during the day thereby forming a trophic link between surface waters and the bentho-pelagic fishes when these latter prey upon fish returning from surface layers. Other fishes make this diel migration themselves, feeding in the surface layers and then descending, presumably to avoid being eaten themselves. Some species only inhabit deep waters in their adult stage, and may be exploited during both their shallow - and deepwater phases - complicating the interpretation of whether such catches be defined as deepwater or not. The benthopelagic species live on, or close, to the bottom, a zone now known to be differentiated in its biological characteristics.

The deep sea fishes are those living at depths greater than 200m, or as described by some as greater than 500m. No rigid definition of what are deepwater fishes has been found to be always acceptable. However, deepwater fishes can be categorized into mesopelagic, bathypelagic and benthopelagic categories. Mesopelagic and bathypelagic species are true pelagic fish, generally of small adult size and unlikely to be exploited on a commercially scale. Mesopelagic fishes such as lantern fishes (Myctophidae) and cyclothonids (Gonostomatidae) live beneath the photic zone to approximately 1000m depth. Bathypelagic fishes live below 1000m and are usually highly adapted to life in a food-poor environment. Upper mesopelagic fishes are generally silvery brown, muscles well developed, gas bladder present, bones well ossified, brain large, light organs well developed and eyes normally large. Lower mesopelagic and bathypelagic fishes are dark brown or black, muscles poorly developed, no gas bladder, bones poorly ossified, brain small, light organs small or lacking and the eyes are small. Whereas, the bentho-pelagic fishes are dark brown or black, muscles well developed, gas bladder present, bones well ossified, brain large, light organs few or none and eyes large or reduced. The benthic fishes are dark brown or black, muscles poorly to well developed, no gas bladder, bones well ossified, brain variable, no light organs and eyes reduced.

The deep sea organisms are characterised by the special adaptations for their existence in the harsh environment such as large eyes, bioluminescence, strong sense of smell, body composition (absence of swim bladder), expandable stomachs, absence of jaws, and bioluminescence are common in these fishes. Deep sea fish are often transparent, black, silvery and even red in colour. The absence of red light at these depths keeps them concealed from both predators and prey. Adaptations have also evolved to capture prey. In addition to their large mouths, deep sea fish, such as the deep sea anglerfish, often have extremely long teeth that point inward. This ensures that any prey captured has little chance of escape. Deep sea species such as the gulper eel have huge hinged jaws, which enables them to swallow large prey. Some deep sea species, such as the deep sea anglerfish and the viperfish, are also equipped with a long, thin modified dorsal fin on their heads tipped with a photophore lit with bioluminescence used to lure prey.

Important species that form deepwater aggregations include orange roughy (*Hoplostethus atlanticus*) and the oreos (*Allocyttus* spp., *Neocyttus* spp. *Pseudocyttus* spp., etc), which are often fished together; alfonsinos (*Beryx* spp.) in lower latitude fisheries, Patagonian tooth fish (*Dissostichus eleginoides*) in Southern Ocean fisheries, pelagic armourhead (*Pseudopentaceros wheeleri*) and various species of Scorpaenidae found on both coasts of North America. Away from seamounts, Gadiform fishes such as the Macrouridae predominate (Shotton, 2005). These species too tend to be slow growing but are not so "extreme" in their characteristics as those species associated with seamount fisheries. Other species that may be included in this group are sablefish (*Anoplopoma fimbria*), Greenland halibut (*Reinhardtius hippoglossoides*), morids (Moridae), cusk-eels (Brotulidae) and hakes (Merlucciidae).

The declaration of EEZ gave full rights to explore, exploit, manage and conserve the living and non-living resources of nearly two million sq. km of seas around it (Joseph, 1980; Alagaraja, 1984; Sudarsan *et al.* 1990; Sudarsan, 1993; Vivekanandan, 2001). The inshore area upto 50m forms about 40% of the continental shelf and supports 63 % of the fishery potential. Over 99% of fish production is coming from this area. The shelf area forms about 1/5 of the EEZ and beyond 200m forms the rest of the area. The average landings of the country has rose from 0.8 million tonnes in 60's through 1.2 million tonnes in 70's and 1.6 million tonnes during 80's to the current production of 2.9 million tonnes (Sudarsan and Somavanshi, 1988; Sivakami, 1990). The marine fish landings consist of about 65 commercially important species or groups. Pelagic and mid-water species contributed 51.6% of the total landings. Indian oil sardine (*Sardinella longiceps*), Indian mackerel (*Rastrelliger kanagurta*) and anchovies constituted the main bulk of pelagic species caught followed by Bombay duck (*Harpodon nehereus*), Seer fish (*Scomberomorus* spp.), tunnies and cephalopods. Sciaenids, Carangids, Perches, Elasmobranchs and Marine shrimp forms main bulk of demersal resources harvested. Despite contributing only 10% of the total marine landings, commercially shrimp is still the most important variety due to its export potential (*http://www. fao.org/fishery/countrysector/ FI-CPIN/en*). When region wise comparison is made, it could be noticed that west coast dominated in the marine fish landings and more specifically south west coast of India.

It could be observed that many of the coastal resources are facing the major threat of overexploitation. The marine fish landings were in stagnation for many years in and around 2.7mt (Vivekanandan, 2001). The decrease in the catches was obvious in the case of many of the well established fishery resource landings. There had been attempts to delineate the deep-sea resources beyond the depth of 250m and indicate their scope for exploitation beyond the continental shelf edge of India during the last many decades. With this objective in view, many fishery resource surveys were conducted in the oceanic waters all along the continental slope of the Indian Coast. The investigations on deep sea fishes of Indian EEZ were carried out by Fishery Survey of India, Integrated Fisheries Project, CIFNET, UNDP/FAO Pelagic Fisheries Project and are concentrating mostly in the continental shelf or near the slope (Philip *et al.* 1984; Sudarsan and Somavanshi, 1988; Sulochanan and John, 1988; Vijayakumaran and Naik, 1988; James and Pillai, 1990; Philip and Mathew, 1996). As the demand for fish is increasing and there are diminishing returns from the coastal fishery, exploitation of the deep sea resources is found imperative to cater the increasing demand of requirements in the fisheries sector. Along with the shrimp and lobster resources such as *Heterocarpus* spp., *Parapandalus* spp., *Solenocera* spp., *Aristeus* spp., *Panilurus* sp., which are prone to varying degrees of exploitation levels, the deep sea fishes are also gaining importance for the commercial exploitation in the recent years.

As coastal fisheries and ecosystems are over-fished, the fishing and seafood industries have increasingly turned to developing new fisheries and markets for species found in deep-sea areas. The development of deep sea fishing industry is of concern to the entire marine fishery sector because it would have considerable impact on the management of near-shore fisheries, shore-based infrastructure utilisation and post-harvest activities, both for domestic marketing and export. As a result of this, a new problem has arisen in regard to fishing on the high seas, one that involves a threat to marine biodiversity on a scale as yet unknown but likely to be severe and potentially comparable to the threat to terrestrial biodiversity associated with the loss of tropical rainforests.

Many marine living resources exploited in the high seas have biological characteristics that create specific challenges for their sustainable utilization and exploitation. These include maturation at relatively old ages, slow growth, long life expectancies, low natural mortality rates, intermittent recruitment of successful year classes and spawning that may not occur every year (FAO-FIES, 2008). As a result, many deep sea living resources have low productivity and are only able to sustain very low exploitation rates. Since the deep sea living resources are becoming an alternative to the increasing demand for fish, it is important to study the composition, abundance and distribution of deep sea fishes in the EEZ. Because of the wide variability in their biological characteristics, it is also necessary to have knowledge on the life history traits and population characteristics of the resources for its sustainable exploitation. Also when these resources are depleted, recovery is expected to be long and is not assured. The recent expansion of fishing effort to the deep sea has given rise to increasing concern about the impacts of deep-sea fishing on the marine environment of the deep sea. Due to the demersal nature of most targeted deep-sea species, the extensive use of bottom trawling has had serious and probably irreversible effects on biodiversity. There is concern about the effect on the fish stocks targeted and about the impacts on the biodiversity of the deep-sea marine environment, including in particular the destructive effects of such fishing on the coral reefs, sponges and related biodiversity of seamounts. Such fishing not only adversely impacts on targeted species and on sedentary species attached to the coral reefs, but also impacts on mobile species dependent on the reefs for food and shelter. The problem has highlighted gaps in the international legal regime of such fishing on the high seas. In addition, the limited coverage and lack of management action by regional fisheries management organizations (RFMOs), compounded by illegal, unregulated and unreported (IUU) fishing, as well as the vulnerability of target species and ecosystems damaged by the fishing, has lead to serious depletion of deep-sea targeted species and damage to biodiversity. Further, finding locations at great depths from which marine living resources are caught in an economical and sustainable way, i.e., finding new fishing grounds, is a vital part in commercial fishing and requires additional scientific and technical support for management. In this context, the present study, *The Systematics, distribution and bionomics of the fishes inhabiting beyond 200m depth along the south west coast of India* has been conceptualised.

## 1.2. Review of literature

The first marine studies were closely associated with the history of voyages. The practical aims for these include mainly travel, trade, warfare, search for food and knowledge. While later in the history, it paved the basement for the Science of Navigation, Physical, Chemical, Geological and Biological Oceanography and Marine Science as a whole. The exploration of the seas started by the famous expedition of *HMS Beagle* during 1831 – 1836 and is marked by the presence of the legendary British naturalist Charles Robert Darwin (1874). The expedition covered South America and Pacific Islands and was mainly concentrated on the charting of the sea floor for the trading purposes. The outcome from the studies by Darwin were consolidated in his publications 'Structure and distribution of coral reefs' (1842), 'Monographs on Barnacle Biology' 'Volcanic islands and Fossils' and the most popular 'The origin of species' The United States Exploring Expedition during 1838 – 1841 by Lt. Charles Wilkes using Vincennes as the flag ship took 4 years for circumnavigation. The major contributions were the confirmation of Antarctica as a continent, prepared 241 maps, and could reject the hypothesis of polar hole. The *Challenger* Expedition during 1872 – 1876 by Charles Wyville Thomson and John Murray was the first oceanographic expedition to circumnavigate the world. They travelled to all the major oceans except the Arctic and is usually considered as the first "modern" oceanographic expedition. Standardized methods were used in this expedition to collect data and investigated aspects of physics, chemistry, biology and geology. This voyage revealed that life is possible in depths more than 8000m (disproving Prof. Edward Forbes's theory), discovered 4717 new species and established the existence of life at extreme depths. This has provided the foundation for the Oceanography. *Blake* Expedition (United States) in 1877-1886 by Alexander Agassiz was mainly concentrated on the distribution of manganese nodules. Collections were made in the Caribbean and Gulf of Mexico by dredging. *Princesse Alice I* and *II*, *Hirondelle I* and *II* (Monaco) Expeditions were carried out during 1886-1922.

A series of expeditions that made many deep sea collections were undertaken after these initial voyages. Other major expeditions were *Albatross* Expeditions (USA, 1887-1925; National Expedition (German, 1889); *Valdivia* expedition (German, 1898-1899); *Michael Sars* Expedition (Norway, 1904-1913); *Dana I* and *II* Expeditions (Denmark, 1921-1936); *Discovery I* and *II* Expeditions (UK, 1925-1939); *Meteor* Expeditions (Germany, 1925-1938); Bathysphere descent (USA, 1934); *Galathea* Expedition (Denmark, 1950-1952), which Made deepwater collections from around the world (up to 10 km depth); *Vitiaz* Expedition (USSR, 1957-1960) etc. The major expeditions which had been conducted in the Indian Ocean and adjacent seas were during the period 1884-1914 and 1921-1926 by *R.I.M.S. "Investigator"* which surveyed 711 stations in the Indian ocean in the rang 5°-29°N., 46°-98°E varying in depths from surface to 3652 m. During 1898-1899 the *"Valdivia"* expedition covered 271 stations in the Atlantic and the Indian Oceans in the range of 60°N 63°S and 22°W 101°E in sounding depths varying from 70-5834 m.

The *John Murray* expedition carried out during the years 1933-'34 surveyed 212 stations in the Indian Ocean within the range 29°N-7°S and 32°-73°E in sounding depths 11-5106 m and collection were made at depths from surface to 4793 m. The trawler *"Golden Crown"* (1908-1909) used in commercial fishing made many trips and the collections were complimentary to those made by the *R.I.M.S. "Investigator"* in shallow waters. The *International Indian Ocean* Expedition (1959 to 1963, peak at 1962, 1963 and 1964) explored the Indian Ocean including adjacent seas the main objectives were the complete survey of the Indian Ocean, including descriptive physical, chemical, biological oceanography, marine geology, geophysics and meteorology. The vessels participated in the expedition were *INS Kistna*, *RV Varuna*, of the Indo-Norwegian project, *RV Conch*, of the University of Kerala, and *FV Bangada*, an exploratory fishing vessel of the Ministry of Food and Agriculture, Government of India.

Till 1980, the trawling operations and exploration of the Indian EEZ were conducted by smaller vessels which can operate only in the coastal waters upto a depth of 50m. The few larger vessels of the Fishery Survey of India, Integrated Fisheries Project, Central Institute of Fisheries Nautical and Engineering Training and UNDP/FAO Pelagic Fisheries Project were also conducted exploratory surveys in the EEZ (James and Pillai, 1990). The Department of Ocean Development, Government of India acquired a 71.5m OAL modern sophisticated *Fishery Oceanographic Research Vessel*, *Sagar Sampada* in December 1984. The vessel has the capacity to explore the fishery resources using the trawling operations in the sea floor upto 1000m depth. Since then, the vessel is continuously exploring the Indian EEZ for newer resources and monitor the status of established commercial fishery.

The taxonomy of deep sea fishes in India is indebted to the outstanding work of *Lt. Col.* A. W. Alcock, *C.I.E., F.R.S.* on the samples collected during the voyage of Indian marine survey steamer, *HMS Investigator* and his contributions are included in his publications between 1889-1907 Alcock (1889) gave a list of Pleuronectidae obtained in the Bay of Bengal and neighbouring waters, with the description of new and rare species. The details of bathybial fishes of Arabian Sea and Laccadive Sea were given by Alcock (1890, 1894 & 1899). A detailed account of deep sea collection and a catalogue of Indian deep sea fishes made during the season 1892-'93 were presented by Alcock (1899). New species and genus of viviparous fishes of the family Ophidiidae were reported by Alcock, (1898). Hornel (1916) compiled many fishing grounds for future exploitation during the exploring cruises along the Indian and Ceylon coasts and in his account on the results of the systematic survey on deep sea fishing grounds by *S.T. "Lady Goschen",* Gravely (1929) gave detailed information on the various resources along the Indian coast during the period 1927-1928.

Many studies have been conducted on deep sea fishes in Atlantic and Pacific Oceans than Indian Ocean. That also restricted to the Arabian Gulf, Madagascar, Natal, Somali, Mozambique in the western side and South and West of Australia (Atkinson, 1995; Clark, 1998; Haedrich *et al.* 1998). The great deep water fisheries include the first deep water fisheries in the north Atlantic developed in the late 1960's when former USSR trawlers began to fish roundnose grenadier (*Coryphaenoides rupestris*) and Greenland halibut (*Reinhardtius hippoglossoides*) on the mid Atlantic ridge (Troyanovsky and Lisovsky, 1995). To the west of British Isles, research cruises explored new fishing grounds along the slopes of the Rockall Trough (Bridger, 1978). Extensive studies on the biology and ecology of deep water fishes were done by many researchers (Mauchline and Gordon, 1984; Gordon and Duncan, 1985, 1987; Gordon, 1986; Gordon and Mauchline, 1990; Merrett *et al.* 1991a&b; Merrett and Haedrich, 1997). Other major studies on the deep sea fishes of British Isles were from the Porcupine Sea bight (Merrett *et al.*

1991a&b) and Rockall Trough (Gordon, 1986; Gordon and Duncan, 1985, 1987).

The occurrence of a number of deep sea crustaceans in the Indian Ocean region was reported by a few workers notably by Gulland (1971) and Holthuis (1980) from the upper continental slope of Mozambique, Pakistan, Sumatra, North Western Malaysia and Burma. Studies on the deep sea crustacean resources of the south west coast of India were comparatively little, however, the work of John and Kurien (1959) and Kurien (1965) based on exploratory catches of R. V Conch and George and Rao (1966) on the basis of materials collected from *R.V. Varuna* are worth mentioning. Silas (1969), Mohamed and Suseelan (1973), Suseelan (1974), Oommen (1980) and Suseelan (1985), Radhika, *et al.* (2004) and Kurup *et al.,* (2008) have investigated the deep sea resources of Indian Sea by giving emphasis to area wise and depth wise distribution and abundance on the basis on exploratory fishery survey cruises conducted in the EEZ of India with the help of *FORV Sagar Sampada.*

Data regarding the Indian deep sea fish fauna beyond 200m depth are very scarce and the only available information is that generated from the exploratory fishing cruises conducted by Fishery Survey of India to some extend and mostly by *FORV Sagar Sampada* as part of its stock assessment programs of deep sea fin fishes. There were reports on the deep sea fishes in and around Indian waters by earlier researchers during the early sixties and seventies. The bathypelagic fish, *Epinnula orientalis* was reported from the Konkan coast by Rao (1965). Jones and Kumaran (1964, 1965) reported many new records of fish species from the seas around India. Prasad and Nair (1973) recorded high abundance of deep-sea fishes such as *Chlorophthalmus agassizi, Neoepinnula orientalis, Psenopsis cyanea, Cubiceps natalensis,* etc., in the upper continental slope (180 – 450m depth zone) in the Indian EEZ. Silas and Rajagopalan (1974) reported the occurrence of *Trichiurus auriga* in demersal deep neritic waters and from the continental slope. Joseph (1984) reported many important non-conventional and under-exploited marine fishery resources from Indian EEZ based on the results of fishery resource surveys during 1983-84. Commendable works have been done on the various biological as well as ecological aspects and stock characteristics of big eye Snappers (Priacanthidae) in the Indian seas (Joseph and John, 1986; Sivaprakasam, 1986; Vijayakumaran and Philip, 1988; Sulochanan and John, 1988; Vijayakumaran and Naik, 1988; Gopalakrishnan *et al.* 1988; Biradar, 1989). Most of the studies were mainly concentrated on the stock assessment and the pattern of abundance of these fishes from the Indian EEZ (John and Sudarsan, 1988). Bande *et al.* (1989) studied the distribution and abundance of Bull's eye (*Priacanthus* spp.) in the EEZ of India. Birader (1989) estimated the stock density, biomass and maximum sustainable yield of *Priacanthus hamrur* (Forsskal) off the north-west coast of India. James and Pillai (1990) gave a detailed account on the fishes and crustaceans in the offshore and deep sea areas of the Indian Exclusive Economic Zone based on observations made onboard *FORV Sagar Sampada* during the period 1985 to 1988. The results have shown the availability of fishable concentrations of exploited resources such as threadfin bream, ribbon fish, lizard fish, barracuda, cat fish, Indian mackerel and deep sea lobster beyond the presently exploited zone and also under-exploited deep water resources such as bull's eye, drift fish, scad and deep sea prawns within the Indian EEZ. A check list of fishes of the Indian EEZ based on the pelagic and bottom trawl collections of *FORV Sagar Sampada* was compiled by Balachandran and Nazar (1990). The exhaustive check list included 87 families and 242 species of both conventional as well as non-conventional fish fauna of the Indian EEZ. Nair and Reghu (1990) reported the distribution of *Saurida* spp. in the continental shelf and the upper continental slope from the EEZ of India. Menon (1990) recorded myctophids, gonostomatids, Bregmacros, eel larvae and juveniles of many fishes from the deep scattering layer (DSL) of Indian EEZ. Sivakami (1990) reported the occurrence of unconventional forms like *Psenopsis* sp., *Trichiurus auriga, Chlorophthalmus agassizi, Neoepinnula orientalis* and *Cubiceps* spp. In additional to the conventional forms especially in the deeper waters of the southwest region, Panicker *et al.* (1993) reported C*entrolophus* sp. and *Chlorophthalmus* spp. as dominant species in the depth zone 200 – 500m in the lat 7° to 17°N latitude, off west coast of India. Studies on the fishery and biology of the Lizardfish, *Saurida* spp. from the Karnataka coast was conducted by Muthiah (1994). Philip (1994) studied the fishes of the family Priacanthidae from the Indian waters and reported five species. Menon *et al.* (1996) reported the abundance of Priacanthids, Nemipterids and *Psenes indicus* from the depth beyond 200m from the northeast region of Indian EEZ. While Khan *et al.* (1996) observed grounds with potentially rich unexploited deep sea finfish resources from the southeastern Arabian Sea. The dominant groups included *Chlorophthalmus* sp., *Cubiceps natalensis, Neoepinnula orientalis, Psenopsis cyanea, Chascanopsetta lugubris, Priacanthus hamrur* and *Chlorophthalmus bicornis*. Similar results were also reported by Sivakami *et al.* (1996 & 1998). According to Venu and Kurup (2002a) the major species constituting the deep sea fishes were *Chlorophthalmus punctatus*, *Chlorophthalmus bicornis, Psenopsis cyanea, Neoepinnula orientalis, Hoplostethus mediterraneus, Psenes squamiceps, Nettastoma parviceps* and *Priacanthus hamrur.* The authors also were of the view that the most productive depth ranges were 201-300 and 301-400m. The recent literatures on the distribution and life history traits of deep sea fishes from the southwest coast of India are on *Psenopsis cyanea* (Venu and Kurup, 2002b), *Chlorophthalmus bicornis* (Kurup *et al.* 2005), *Hoplostethus mediterraneus,* (Venu and Kurup, 2006a) *Neoepinnula orientalis* and *Psenes squamiceps* (Venu and Kurup, 2006b). Length weight relationship of *Priacanthus hamrur* was studied by Kurup and Venu (2006). A detailed depth wise study on the length weight relationships of deep sea fishes collected from the southwest coast of Indian EEZ revealed that there exists a definite difference in the growth between the fishes inhabit in higher depths and those live in relatively shallow depths (Thomas *et al.* 2003; Kurup *et al.* 2006). *Psenopsis cyanea* was found to dominate the deep sea demersal catches in the cruise no. 241 of *FORV Sagar Sampada* (Jayaprakash *et al.* 2006). The study also gave a general idea about the length-weight relationship and various growth and population parameters such as $L_\alpha$, K, total mortality (Z), natural mortality (M), fishing mortality (F), exploitation ratio (E), recruitment pattern and length-weight relationship of some of the important species. The trawlers based at Cochin, Quilon and Munambam have been exploiting the deep-sea shrimp resources like the red-ring *Aristeus alcocki* from the Quilon Bank and other similar areas off west coast for the last ten years (Radhika, 2004). Sreedhar *et al.* (2007) reported domination of eels (21.3%) followed by the shark *Echinorhinus brucus* (13.3%) in the deep sea fish catches along the southeast coast of India. Deepu *et al.* (2007) studied the catch and biology of *Alepocephalus bicolor* from the southwest coast of India. The distribution and biology of the deep-sea eel, *Gavialiceps taeniola* along the continental slope off Indian EEZ was studied by Divya *et al.* (2007). While Hashim *et al.* (2009) reported 126 species belonging to 29 families from the Indian EEZ based on the exploratory surveys conducted by *FORV Sagar Sampada.* Karuppasamy *et al.* (2008) gave an account on the food of some deep sea fishes collected from the eastern Arabian Sea.

**1.3. Objectives**

A thorough perusal of the available information on the fish fauna and their distribution in the depth beyond 200 m in the EEZ of south western region of India showed that no detailed and comprehensive studies have so far been done on the systematics, distribution and bionomics of deep sea fishes. So in order to fill up the lacunae, the present study was undertaken with the following objectives.

1. To prepare a pioneer account on the taxonomy and systematised account of deep sea fishes inhabiting depth beyond 200m along the southwest region of Indian EEZ between the lat. 7° and 15° N.

2. To bring out the bathymetrical and spatial distribution of deep sea fishes in the study area with a view to delineate the potential species, which can become commercial fishery and the potential fishing grounds.

3. To bring out the species having commercial importance and the feasibility of their commercial exploitation.

4. To generate a data base on some of the life history trait parameters of deep sea fishes required for managing the fishery such as food and feeding habits, maturity and spawning, spawning season, sex ratio, length weight relationships and age and growth.

### 1.4. Organisation of Chapters

The thesis is presented in eight well defined chapters. The subject is effectively introduced in Chapter 1. The thesis is then apportioned into two sections, having two chapters in section I and four chapters in section II. Chapter I, titled as *General Introduction,* highlights the importance of the present study, besides reviewing various studies carried out on the deep sea fishes of Indian EEZ. The scope and objectives of present study are emphasized and a brief account of the organization of thesis is also described. Chapter 2 deals with the taxonomy and systematics of deep sea fishes of south west region of Indian EEZ. A detailed description on the study area and methods employed for sample collection are given. A systematic tree is worked out on the basis of the results obtained during the present study. Then, the families, subfamilies and genera were briefly introduced. The keys and descriptions were prepared user friendly. Except for monotypic taxa, all other taxa are following dichotomous keys. The different species under a genus are arranged and presented based on the order they appear in the key. But the sequence of suborders, families, sub families and genera are arranged and described according to their known phylogenetic and inter-generic affinities. Description of individual species is followed by a remarks section which deals mainly with its latitude and depth-wise distribution. A colour photograph of the species is also provided. Chapter 3 analyses the bathymetric and spatial distribution and abundance based on CPUE of the deep-sea finfish resources off southwest region of Indian EEZ beyond 200 m depth and results are reported. Details of the grounds where the bottom trawls were operated continuously for 1 hour or more are also given.

Section II deals with the bionomics of five deep sea fish species, *Psenopsis cyanea* (Family: Centrolophidae), *Neoepinnula orientalis* (Family: Gempylidae), *Psenes squamiceps* (Family: Nomeidae), *Hoplostethus mediterraneus* (Trachychthyidae) and *Chlorophthalmus bicornis* (Chlorophthalmidae) in chapters 4 to 7 The food and feeding habits of these fishes are described in Chapter 5. The seasonal feeding intensity and occurrence of food items expressed as percentage of total number of stomachs examined. Chapter 5 discusses the maturity and spawning. The season wise and length wise sex ratio was tested using $\chi^2$ method and the maturity stages were described in detail. The depth wise and season wise length weight relationships for males and females were worked out separately and discussed in Chapter 6. The Chapter 7 analyses the results of age and growth of the deep sea fishes. This is followed by Chapter 8, which summarises the results. Based on results of the present study, some recommendations the sustainable exploitation and utilization of deep sea finfish resources from continental slope region of Indian EEZ are proposed. A list of references is given at the end.

# SECTION I

# CHAPTER 2

# SYSTEMATICS OF DEEP SEA FISHES OF SOUTHWEST COAST OF INDIAN EEZ

## 2.1 Introduction

Pisces constitute more than half of the vertebrates (Eschmeyer, 2003). The number of valid species of fishes is nearing 31,000, with over 500 new species added in 2008 and it is expected that the final number will most likely exceed 35,000. The increase in the number of fish species during recent years can be attributed to the revitalising effect seen in fish taxonomy by more workers with more fundings support, along with increased exploration in many countries. The number of available names for use at the species level at the end of 2008 is around 55,851 while the number of valid species at the end of 2008 is about 30,959 (Eschmeyer and Fong, 2009). Fish species new to science continued to describe at a rate of over 250 per year. New taxa are primarily coming from freshwaters of South America (especially Brazil), southeastern Asia, deep reef areas and also from deep sea regions (www.calacademy.org/research/ichthyology).

The history of ichthyology have its roots starting from Aristotle (384-322 BC), the father of Zoology, who had a profound knowledge on fishes and has described the characters of fishes based on the specimens collected from Aegean Sea close to Greece. Several initial workers have contributed to the growth of the subject. Pierra Belon (1517-1575) who described around 110 fish from the Eastern part of Mediterranean in Europe in the publication entitled *'De aquatilibus libri duo'* and classified them according to their size, shape and whether they are marine or freshwater. H. Salviani (1514-1572) in his book *'Aqatilium animalium historia'* had described 92 fish species and emphasized mainly on the economy and usefulness of many species. G. Rondlet (1507-1557) had described about 197 marine and 47 freshwater fish species from Mediterranean in *'Libri de Piscibus marinis'* and *'Universae aquatilim historiae pars altera'* W. Piso and G. Margrav (1611-1678) described about 100 fish species from Brazil in the IV volume of *'Historia naturalis Braziliae'* J. Ray (1628-1705) edited F Willughby's (1635-1672) work into *'Historia Piscium'* arranging and describing about 420 species from Great Britain and Germany. They arranged fishes on the basis of cartilaginous or osseus nature of their endoskeleton and also based on the general form of body, presence or absence of ventral fins, soft and spinous nature of dorsal fins. Peter Artidi (1705-1734) who have been aptly known as 'Father of Ichthyology' contributed many valuable findings towards laying down the firm foundation of the science of Ichthyology His works were edited and published by Linnaeus as *'Bibliotheca Ichthyologica', Philosophica Ichthyologica, Genera Piscium, Species Piscium and Synonymia Piscium.* He had divided the fishes into 4 orders, *viz.*, Malacopterygii, Acanthopterygii, Branchiosterygii and Chondropterygii.

Carl Linnaeus (Carols Von Linnae, 1707-1778), who is the 'Father of Taxonomy' accomplished Artidi's unfinished task in a book form entitled *'Artidi Ichthyologica'* Besides separating Cetaceans from the class of fishes, Linnaeus reported on classification and in general of fishes in his most acclaimed publication – the $12^{th}$ edition of *'Systema Naturae'* He presented the first character-based classification of fishes as *Pisces Apodes, Pisces Jugulares, Pisces Thoracici and Pisces Abdominates.* Lorenz Theodor Gronow (1754 -1780) and Jakob Theodor Klein (1685 -1759) were the two contemporaries of Linnaeus and had developed a system of classification of fishes. In Gronow's work *'Zoophylaceum'* (1763), the genera of fishes are well defined in a system, which runs parallel to the system adopted by Artidi. *'Systema Ichthyologicum'* written in 1780 by Gronow and published posthumously by Jhon Edward Gray in 1854, embarking upon numerous excellent descriptions of new forms but unfortunately, exactly hundred years after Gronow's first paper *'Museum Ichthyologicum'* in 1774, nearly all his new taxons became synonyms. Also much less important was *'Historia Piscium Naturalis'* (1740-1744), the ichthyological work of Klein, because of naming the species polynomially. Mark Eliezer Bloch (1723-1797), a German Physician, prepared a unique, general system of fishes in which he arranged not only those described in his great works on the fishes of Germany (*viz. Oeconomische natrgeschichte der Fishe Deutschlands*, 1782) but also included Indian Fishes (*viz., Naturgeschichte dr Austaendischen Fishe*). Bloch's ichthyological works were edited by J. G. Schneider in the form of a book entitled *'M.E. Blochii Systema ichthyologiae iconibus x. Illustratum'*, in which as many as 1519 fish species were listed. B. G. E. de Lac'ep'ed (1756-11826) has compiled his studies in *'Histoire des Poissons'* (1798-1803).

During the $19^{th}$ century, G. Cuvier and A. Valenciennes contributed much to the ichthyology by their publication *'Histoire naturelles des poissons'* (1828-1848). Ahannes Muller (1801-1858) gave a more complete description to the Teleost fishes and re-examined and redefined many of the families established by Cuvier. Louis Agassiz (1807-1873) explained the system of classification in a manner to include fossil forms also. Albert Guenther (1830-1914) published his work "*Catalogue of fishes of British Museum*" during 1859-1870, which contains description of about 6847 fish species together with another 1682 doubtful species. David Starr Jordan (1851-1931) published his masterpiece *'Guide to the study of fishes'* in 1905. Then he compiled *'Genera of Fishes'* (1917-1920) in order to bring the acceptance and application of generic names of fishes in accordance with the 'RULES' or 'CODE' laid down by the International Commission on Zoological Nomenclature, a judicial body set up by International Congress of Zoology.

Throghout the history of ichthyology numerous classifications of fishes have ben proposed. Recent one has been built on the studies of many past biologists G. Cuvier, A. Valenciennes, T.N. Gill, B. S. Boulenger, A. Gunther, D. S. Jordan and C.T Regan while, contemporary ichthyologists, such as P.H. Green wood and D.E. Rosen, continued to make important contributions (Gupta and Gupta, 2006). The major approaches to classification *viz.* cladistic, synthetic and numerical were by Nelson and Platnick (1981) and Wiley (1981).

Among the Indian works on fishes, Kautilya's *'Arthashasthra'* (300 B.C); *Abhilashitarthachintamani* or *Manasollasa* by the Western Chalukya King Someshvardeva during 1126–1138 AD (Sadhale and Nene, 2005) were the earliest. Henceforth Hamilton-Buchanan's account on the fishes of Ganges a spurt of contributions were made to the systematic ichthyology of Indian region by a dedicated group of taxonomists like McClelland (1839), Sykes (1839), Jerdon (1849) and Blyth (1858,1860). The monumental treatise *"Fishes of India"* by Day (1875-1878) included 1418 species found within the boundaries of India, Pakistan (including Afganistan), Bengladesh, Myanmar and Sri Lanka. Gunther's (1864, 1868) catalogue of the fishes in the British Museum includes a number of taxa of this region.

It is Hora (1921-1949) who placed Indian Ichthyology on a universal pedestal in the 20th century with his indomitable researches on modern ichthyology and zoogeography of fishes. Hora, in his lifetime established 3 families, 28 genera and 139 species (Hora, 1951) many of them are still considered as valid. Hora's associate Dev Dev Mukherji also made several noteworthy contributions to Indian Ichthyology. Misra (1947, 1952 and 1953) published a series of checklists and manuals for the identification of the fish fauna of Indian region and its adjacent countries. In 1962, Misra published *"An aid to the identification of the common commercial fishes of India and Pakistan"* dealing with 402 marine, brackish and freshwater fish species belonging to 205 genera under selected families. In *"Fauna of India"* the author made an attempt to cover different families of fishes. Misra's (1969) volume on Elasmobranchii and Holocephali was first in this series on Pisces, followed by a volume on Cluepiformes, Bathycluepiformes, Galaxiformes, Scopeliformes and Atelopiformes (Misra, 1976a). The third volume was on the Siluroids (Misra, 1976b).

The first authentic record of the deep-sea fishes from India was made with the help of fishes collected during the explorations made by R.I.M.S. "Investigator" in the book "A Descriptive Catalogue of the Indian deep sea fishes in the Indian mseum" by Alcock in 1889. The R.I.M.S. "Investigator" had surveyed 711 stations in the Indian Ocean coverning the range 5°-29° N., 46°-98° E during 1884-1914 and collected specimens upto a depth of 3652m. "Valdivia" expedition (1898-1899) covered 12 stations in the Bay of Bangal in the geographical range 0°2'S-6°N, 73°-93°E and sampled between the sounding depths of 296-2500m. The John Murray expedition (1933-1934) surveyed 212 stations in the Indian Ocan within the range 29° N-7° S, 32°-73° E in the Arabian Sea in the depth 27-4793m (Misra, 1962). Tholasilingam *et al.* (1964) gave some insight to the bathypelagic fishes from the continental slope of southwest coast of India. Jones and Kumaran (1964, 1965a&b) described many new records from the seas around India. Other major studies during this period included those by Jones (1965a), Silas and Prasad (1966) and Silas and Rajagopalan (1974).

Recently, the investigations on deep sea fishes of Indian EEZ carried out by Fishery Survey of India are concentrating mostly in the continental shelf and slope (Philip *et al.* 1984; Joseph, 1984; Oommen, 1985; John and Sudarsan, 1988; Sudarsan and Somavanshi, 1988; Sulochanan and John, 1988; Vijayakumaran and Naik, 1988; Philip and Mathew, 1996). Data regarding the Indian deep sea fish fauna are scarce and only available information is that generated from the fishing cruises of *FORV Sagar Sampada* as part of its stock assessment programs of deep sea finfishes. Recently, the exploratory fishing cruises onboard *FORV Sagar Sampada* have brought out many little known deep sea fishes from the Indian EEZ beyond 200m depth. The major studies are those of James and Pillai (1989); Reuben, *et al.* (1989); Sivakami (1989); Sudarsan (1993); Panicker *et al.* (1993); Khan *et al.* (1996); Sivakami *et al.* (1998); Venu and Kurup (2002a, b & c; 2006a,b); Thomas *et al.* (2003); Kurup *et al.* (2005, 2008); Jayaprakash *et al.* (2006); Deepu *et al.* (2007); Divya *et al.* (2007) and Venu *et al.* (2009). The recent studies on deep sea fish taxonomy from Indian EEZ include the documentation and redescription of *Glyptophidium oceanium* from the west coast (Kurup *et al.* 2008), deep sea eel *Bassozetus robustus* (Cubelio *et al.* 2009a). *Dicrolene nigricaudis* (Cubelio *et al.* 2008).

It is against this background that the present study was conceptualized and undertaken to generate an authentic database on the systematics of deep sea fishes beyond the depth of 200m by fulfilling the above gaps, descriptions with user friendly taxonomic keys, revalidation of the new species and new distributional records.

## 2.2 Material and methods

Materials for the present study were collected from the exploratory demersal trawling operations conducted onboard *FORV Sagar Sampada* (Fig. 2.1) along the southwest region of Indian EEZ during the periods 1998–2002 and 2005–2007 (Fig. 2.2). The data were also collected from the commercial boats operated beyond 200m along south west coast of India from Cochin, Munambam and Sakthikulangara fishing harbours of Kerala during November 2000 - February 2002. The upper continental slope region of 7°–15° N was surveyed as part of Cruise Nos. 174, 183, 189, 196, 197, 238 and 241 of *FORV Sagar Sampada.*

38m High Speed Demersal Trawl II (HSDT) and 45.6m Expo- model Demersal Trawls were used for fishing in the above cruises in the depth from 200 to 1100 m. Fish samplings were done at 164 stations. The catch composition and species wise catch in kg at each fishing station were recorded and the specimens were taken to the laboratory for detailed identification. The entire study area was divided into four transects based on the latitude and were each transect was divided into three depth zones. The transects so arrived at are 7°–9° N, 9°–11° N, 11°–13° N and 13°–15°N and depth zones were 201–500 m, 501–800 m and 801–1100 m (Panicker *et al.* 1993; Khan *et al.* 1996 and Venu and Kurup, 2002b).

The fishes were identified up to species level with the help of authentic keys (Goode and Bean, 1895; Alcock, 1899; Fischer and Bianchi, 1984; Smith and Heemstra, 1986; *www.fishbase.org*).

The characters used for identification were morphology, morphometry and meristic counts (Fischer and Bianchi, 1984; Smith and Heemstra, 1986). The fin ray counts such as dorsal, pectoral, pelvic, anal, caudal and scale counts such as lateral line scales, transverse rows of scales between dorsal and lateral line, those between lateral line and pelvic fin *etc.* were done following Fischer and Bianchi (1984), Smith and Heemsta (1986) and Jayaram (1999) and the results are given in the meristic formulae of the respective species. Morphometric measurements were recorded with a dial-reading caliper of accuracy 0.02 mm and data was presented as ratios with the range. The number of morpho-meristic characters studied varied from Family to Family and in some cases between different genera of the same Family.

Most of the references to genera and species have checked with the original publications. In cases where this was not possible, www.fishbase.org, the Catalogue of Fishes database, Smith's Sea fishes, FAO species catalogues and field guides were used for verification.

The species under each genus have been arranged according the the order they occur in the keys. In the synonyms the first is the original reference with the type locality and as far as possible the name of the institution where the type is deposited is given. All localities are included if many in the original reference, but only the first mentioned is taken as the type locality. A selection of other references which are important is also given. Descriptions of the species are based mostly on those by Alcock (1889), Smith and Heemsta (1986), Goode and Bean (1896), Fischer and Bianchi (1984), www.fishbase.org, Nelson (1984) and Misra (1969, 1976a,b). The photos given are original and illustrations taken from appropriate publications and are acknowledged in the legends of the figures. Vernacular names of the species are given wherever available.

List of morphometric measurements observed and abbreviations used in the thesis are given below:

| Morphometric measurement | Abbreviation used |
|---|---|
| 1. Adipose fin base | ADB |
| 2. Anal fin base | AFB |
| 3. Anal fin height | AFH |
| 4. Barbell length | BL |
| 5. Body depth | BD |
| 6. Caudal fin height | CFH |
| 7 Caudal peduncle length | LCPD |
| 8. Depth at anus | DA |
| 9. Depth at dorsal fin | DDF |
| 10. Distance between pectoral and ventral | |
| 11. Distance between ventral and anal | |
| 12. Dorsal fin base | DFB |
| 13. Dorsal fin height | DFH |

| | |
|---|---|
| 14. Eye diameter | ED |
| 15. Fork length | FL |
| 16. Greatest body depth | BD |
| 17. Head depth | HD |
| 18. Head length | HL |
| 19. Interorbital width | IOW |
| 20. Least depth of caudal peduncle | LHCP |
| 21. Length of caudal peduncle | LCP |
| 22. Lower jaw length | LJL |
| 23. Pectoral base | PFB |
| 24. Pectoral length | PFL |
| 25. Post orbital length | PoOL |
| 26. Pre anal length | PrAL |
| 27 Pre dorsal length | PrDL |
| 28. Pre orbital length | PrOL |
| 29. Pre pectoral length | PrPL |
| 30. Pre ventral length | PrVL |
| 31. Snout length | SnL |
| 32. Standard length | SL |
| 33. Total length | TL |
| 34. Upper jaw length | UJL |
| 35. Vent to anal fin distance | Vt -AF |
| 36. Ventral base | VFB |
| 37 Ventral fin height | VFH |
| 38. Ventral fin to anal fin distance | VF-AF |

The number of specimens used for various morphometric measurements and meristic counts ranged from 1-20, depending on the availability of specimens for various species. The number of specimens observed and its size ranges are shown under the taxonomic description of each species. The different sexes of a species were not treated separately for taking the measurements unless they exhibit any clear-cut sexual dimorphism.

The scheme of classification followed in this study is those of Nelson (1984) as given in the Catalogue of Fishes. The families, Sub Families and genera were provided with concise introduction to provide a concept of each group. As far as possible, the keys and descriptions are made user friendly. Except for monotypic taxa, all other taxa are provided with dichotomous keys. All keys are prepared based on morphological appearance and they do not portray any phylogenic arrangement or affinity. The various species belonging to a genus are arranged and presented based on the sequence of their appearance in the key. But the sequence of sub orders, families, sub families and genera are arranged and described according to their known phylogenic and inter-generic affinities. A more or less uniform pattern of citation and description of species have been adopted. Synonyms were greatly limited to a few monumental works. Vernacular names are provided for each species. Among the various morphometric ratios worked out, those essential ratios required for the identification of the species are only given and so is the description. The geographical distribution of the species in general as well as in the study area in particular is presented. The information on the depth range at which the species inhabits and the most common fishing methods are provided. A photograph of the species follows each description.

In this chapter, 152 species of deep sea fishes which are collected from the demersal trawl operations in the depth beyond 200m from the continental slope region of south west coast of India are described. Altogether 123 Genera, 19 Sub families, 70 Families, 4 Super families, 26 Sub Orders, 24 Orders, 11 Super Orders, 1 Infra class, 3 Sub classes, 3 Classes and 2 Super classes are described under the Sub Phylum Vertebrata.

## 2.3 Results

### 2.3.1 Taxonomic tree of deep sea fishes

**Kingdom** : **Animalia**

**Phylum** : **Chordata**

**Sub Phylum** : **Vertebrata**

**Super Class** : **Agnatha** (Jawless fishes)

**Class** : **Myxini** (Hagfishes)

**Order: Myxiniformes**

**Family: Myxinidae** (Hagfishes, Myxines)

**Sub Family: Eptatretinae** Nelson, 1976

**Genus:** ***Eptatretus*** Cloquet, 1819

*Eptatretus hexatrema* (Müller 1836)

**Class** : **Chondrichthyes** (Cartilaginous fishes, raies, rays)

**SubClass** : **Elasmobranchii** (Cartilaginous fishes)

**Super Order** : **Euselachii**

**Order: Carcharhiniformes** (Ground sharks)

**Family: Scyliorhinidae** Gill, 1862 (Cat sharks, Catsharks)

**Genus:** ***Cephaloscyllium*** Gill, 1862 (Swell sharks)

*Cephaloscyllium sufflans* (Regan 1921) (Balloon shark)

**Genus:** ***Apristurus*** Garman, 1913 (Demon cat sharks, Ghost cat sharks)

*Apristurus saldanha* (Barnard 1925) (Saldanha catshark)

*Apristurus indicus* (Brauer 1906) (Smallbelly cat shark)

**Genus:** ***Bythaelurus*** Compagno 1988 (Tiger cat sharks)

*Bythaelurus hispidus* (Alcock 1891) (Bristly catshark)

*Bythaelurus lutarius* (Springer & D'Aubrey 1972) (Mud catshark)

**Family:** Proscylliidae Fowler, 1941 (Finback catsharks)

**Genus:** ***Eridacnis*** Smith, 1913 (Ribbontail cat sharks)

*Eridacnis sinuans* (Smith 1957) (African ribbontail catshark)

*Eridacnis radcliffei* Smith, 1913 (Pygmy ribbontail catshark)

**Order: Squaliformes** Compagno, 1973 (Dogfish)

**Family: Echinorhinidae** Gill, 1862 (Sharks)

**Genus:** ***Echinorhinus*** Blainville 1816

*Echinorhinus brucus* Bonnaterre, 1788 (Bramble shark)

**Family: Somniosidae** Jordan, 1888 (Sleeper sharks)

**Genus:** ***Centroscymnus*** Barbosa du Bocage & Brito Capello, 1864 (Velvet dogfish)

*Centroscymnus crepidater* Barbosa du Bocage & Brito Capello, 1864 (Longnose velvet dogfish)

**Family:** Etmopteridae Fowler, 1934 (Lantern sharks, Requins-lanternes)

**Genus:** ***Etmopterus*** Rafinesque, 1810 (Lantern sharks)

*Etmopterus pusillus* Lowe, 1839 (Smooth lantern shark)

*Etmopterus granulosus* (Günther 1880) (New Zealand lanternshark)

**Family:** Centrophoridae Bleeker, 1859 (Gulper sharks)

**Genus: *Centrophorus*** Müller and Henle, 1837 (Gulper sharks)

*Centrophorus lusitanicus* Barbosa du Bocage & Brito Capello, 1864 (Lowfin gulper shark)

*Centrophorus granulosus* Bloch and Schneider, 1801 (Gulper shark)

*Centrophorus uyato* Rafinesque, 1810 (Little gulper shark)

**Order: Rajiformes** (Rays, Sawfishes, Skates)

**Family:** Rajidae Blainville, 1816 (Rays, Skates)

**Genus: *Raja*** Linnaeus, 1758 (Ocellate skates)

*Raja miraletus* Linnaeus, 1758 (Brown ray, Twineye skate)

**Genus: *Leucoraja*** Malm 1877 (Rough skates)

*Leucoraja circularis* (Couch 1838) (Cuckoo ray, Sandy ray)

**Genus: *Dipturus*** Rafinesque, 1810 (Longnosed skates)

*Dipturus johannisdavisi* Alcock, 1899

**Order: Torpediniformes**

**Family:** Narcinidae Gill, 1862 (Electric rays, narcinidés, numbfishes)

**Genus: *Benthobatis*** Alcock, 1898 (Blind rays)

*Benthobatis moresbyi* Alcock, 1898

**SubClass : Holocephali** (Cartilaginous fishes, Chimaeras)

**Super Order : Holocephalimorpha**

**Order: Chimaeriformes** (Chimaeras)

**Sub Order: Chimaeroidei**

**Family:** Rhinochimaeridae Garman, 1901 (Longnosed chimaeras, Ratfishes)

**Genus: *Neoharriotta*** Bigelow and Schroeder, 1950

*Neoharriotta pinnata* (Schnakenbeck, 1931)

**Genus: *Rhinochimaera*** Garman, 1901

*Rhinochimaera atlantica* Holt and Byrne, 1909

(Knife-nosed chimaera)

**Genus:** ***Harriotta*** Goode and Bean, 1895

*Harriotta raleighana* Goode and Bean, 1895 (Long-nosed chimaera)

**SuperClass** : **Osteichthyes** (Bony fishes)

**Class** : **Actinopterygii** (Ray-finned fishes, Spiny rayed fishes)

**SubClass** **Neopterygii** (Neopterygians)

**InfraClass** : **Teleostei**

**Super Order** : **Elopomorpha**

**Order:** Albuliformes

**Suborder:** Notacanthoidei

**Family: Halosauridae** (Halosaurs)

**Genus:** *Halosaurus* Johnson, 1864

*Halosaurus carinicauda* Alcock, 1889

**Family:** Notacanthidae (Spiny eels)

**Genus:** ***Notacanthus*** Bloch, 1788

*Notacanthus indicus* Lloyd, 1909

**Order:** Anguilliformes (Anguilles, Eels)

**Sub Order:** Congroidei

**Family:** Colocongridae (Colocongrids)

**Genus:** ***Coloconger*** Alcock, 1889

*Coloconger raniceps* Alcock, 1889

**Family:** Synaphobranchidae (Cutthroat eels, Deepsea eels)

**Sub Family:** Synaphobranchinae (Cutthroat eels)

**Genus:** ***Histiobranchus*** Gill, 1883

*Histiobranchus bathybius* (Günther, 1877)
(Deepwater cutthroat eel)

**Genus:** ***Synaphobranchus*** Johnson, 1862

*Synaphobranchus kaupii* Johnson, 1862 (Longnosed eel)

**Family:** Congridae (Conger eels)

**Sub Family:** Congrinae

**Genus:** ***Bathycongrus*** Ogilby, 1898

*Bathycongrus wallacei* (Castle, 1968)

**Genus:** ***Bathyuroconger*** Fowler, 1934

*Bathyuroconger vicinus* (Vaillant, 1888) (Large-toothed conger)

**Genus:** ***Rhynchoconger*** Jordan and Hubbs, 1925

*Rhynchoconger ectenurus* (Jordan and Richardson, 1909)

**Genus:** ***Promyllantor*** Alcock, 1890

*Promyllantor purpureus* Alcock, 1890

**Family:** Muraenesocidae (False conger eels, Pike congers)

**Genus:** ***Sauromuraenesox*** Alcock, 1889

*Sauromuraenesox vorax* Alcock, 1889

**Genus:** ***Xenomystax*** Gilbert, 1891

*Xenomystax trucidans* Alcock, 1894

**Genus:** ***Gavialiceps*** Alcock, 1889

*Gavialiceps taeniola* Alcock, 1889

**Family:** Nemichthyidae (Snipe eels)

**Genus:** ***Nemichthys*** Richardson, 1848

*Nemichthys scolopaceus* Richardson, 1848 (Slender snipe eel)

**Genus:** ***Avocettina*** Jordan & Davis, 1891

*Avocettina paucipora* Nielsen & Smith, 1978

**Super Order : Protacanthopterygii**

**Order:** Osmeriformes (Argentines, smelts)

**Sub Order:** Argentinoidei

**Super Family:** Alepocephaloidea

**Family:** Alepocephalidae (Slickheads, smoothheads)

**Genus: *Rouleina*** Jordan, 1923

*Rouleina nuda* (Brauer, 1906)

**Genus: *Alepocephalus*** Risso, 1820

*Alepocephalus bicolor* Alcock, 1891

*Alepocephalus blanfordii* Alcock, 1892

**Genus: *Talismania*** Goode and Bean, 1896

*Talismania longifilis* (Brauer, 1902)

**Genus: *Narcetes*** Alcock, 1890

*Narcetes lloydi* Fowler, 1934

**Genus: *Bajacalifornia*** Townsend and Nichols, 1925

*Bajacalifornia calcarata* (Weber, 1913)

**Family:** Platytroctidae

**Genus: *Platytroctes*** Günther, 1878

*Platytroctes mirus* (Lloyd 1909)

**Super Order : Stenopterygii**

**Order:** Ateleopodiformes

**Family:** Ateleopodidae (Jellynose fishes, Tadpole fishes)

**Genus: *Ateleopus*** Temminck and Schlegel, 1846

*Ateleopus indicus* Alcock, 1891

**Order:** Stomiiformes

**Sub Order:** Gonostomatoidei

**Family:** Sternoptychidae (Deepsea hatchetfishes)

**Sub Family:** Sternoptychinae (Marine hatchetfishes)

**Genus: *Argyropelecus*** Cocco, 1829 (Hatchetfishes)

*Argyropelecus hemigymnus* Cocco, 1829 (Half-naked hatchetfish, Short silver hatchetfish)

**Sub Order:** Photichthyoidei

**Family:** Stomiidae (Barbeled dragonfishes, Scaly dragonfishes)

**Sub Family:** Astronesthinae (Snaggletooths, Stareaters)

**Genus: *Astronesthes*** Richardson, 1845

*Astronesthes martensii* Klunzinger, 1871

**Super Order: Cyclosquamata**

**Order:** Aulopiformes (Aulopiforms, Salmons)

**Sub Order:** Alepisauroidei

**Family:** Evermannellidae (Sabertooth fishes)

**Genus: *Evermannella*** Fowler, 1901

*Evermannella indica* Brauer, 1906 (Indian sabretooth)

**Genus: *Coccorella*** Roule, 1929

*Coccorella atrata* (Alcock, 1894)

**Family:** Paralepididae (Barracudinas)

**Genus: *Lestidium*** Gilbert, 1905

*Lestidium nudum* Gilbert, 1905

**Genus: *Stemonosudis*** Harry, 1951

*Stemonosudis rothschildi* Richards, 1967

**Genus: *Magnisudis*** Harry, 1953

*Magnisudis indica* (Ege, 1953)

**Sub Order:** Chlorophthalmoidei

**Family:** Chlorophthalmidae (Greeneyes)

**Genus:** ***Chlorophthalmus*** Bonaparte, 1840

*Chlorophthalmus bicornis* Norman, 1939

*Chlorophthalmus nigromarginatus* Kamohara, 1953

*Chlorophthalmus agassizi* Bonaparte, 1840 (Shortnose greeneye)

**Family:** Ipnopidae

**Genus:** ***Bathypterois*** Günther, 1878

*Bathypterois atricolor* Alcock, 1896

**Sub Order:** Synodontoidei

**Family:** Paraulopidae

**Genus:** ***Paraulopus*** Sato and Nakabo, 2002

*Paraulopus maculatus* (Kotthaus 1967)

**Family:** Synodontidae

**Genus:** ***Saurida*** Valenciennes, 1850

*Saurida longimanus* Norman, 1939 (Longfin lizardfish)

*Saurida undosquamis* (Richardson, 1848) (Brushtooth lizardfish)

**Super Order: Scopelomorpha**

**Order:** Myctophiformes

**Family:** Neoscopelidae

**Genus:** ***Neoscopelus*** Johnson, 1863

*Neoscopelus microchir* Matsubara, 1943

**Genus:** ***Scopelengys*** Alcock, 1890

*Scopelengys tristis* Alcock, 1890

**Super Order: Polymixiomorpha**

**Order: Polymixiiformes**

**Family: Polymixiidae** (Barbudos, Beardfishes)

**Genus: *Polymixia*** Lowe 1838 (barbudo)

*Polymixia nobilis* Lowe 1838 (Atlantic beardfish, Stout beardfish)

*Polymixia japonica* Günther 1877 (Japanese beardfish, Silver eyes)

**Super Order: Paracanthopterygii**

**Order:** Gadiformes (Cods, Grenadiers)

**Family:** Moridae Moreau, 1881 (Deepsea codfishes, Morid cods)

**Genus: *Physiculus*** Kaup, 1858

*Physiculus roseus* Alcock, 1891

**Family:** Macrouridae Gilbert and Hubbs, 1916 (Grenadiers, Rattails)

**Sub Family:** Bathygadinae

**Genus: *Bathygadus*** Günther, 1878

*Bathygadus melanobranchus* Vaillant, 1888 (Vaillant's grenadier)

**Genus: Gadomus** Regan, 1903

*Gadomus capensis* (Gilchrist & von Bonde, 1924)

**Sub Family:** Macrourinae

**Genus: *Coelorinchus*** Giorna, 1809

*Coelorinchus braueri* Barnard 1925 (Shovelnose grenadier)

*Coelorinchus quadricristatus* (Alcock, 1891)

*Coelorinchus flabellispinnis* (Alcock, 1894)

**Genus: *Coryphaenoides*** Gunner, 1765

*Coryphaenoides macrolophus* (Alcock, 1889)

**Genus: *Malacocephalus*** Günther, 1862

*Malacocephalus laevis* Lowe, 1843 (Softhead grenadier)

**Genus: *Nezumia*** Jordan, 1904

*Nezumia investigatorisl* (Alcock, 1889)

**Order:** Ophidiiformes (Ophidiiforms)

**Sub Order:** Ophidioidei

**Family:** Ophidiidae (Cusk eels)

**Sub Family:** Brotulotaeniinae

**Genus: *Brotulotaenia*** Parr, 1933

*Brotulotaenia crassa* Parr, 1934

**Sub Family:** Neobythitinae

**Genus: *Lamprogrammus*** Alcock, 1891

*Lamprogrammus exutus* Nybelin and Poll, 1958

*Lamprogrammus niger* Alcock, 1891

**Genus: *Spectrunculus*** Jordan & Thompson, 1914

*Spectrunculus grandis* (Günther, 1877) (Giant cusk-eel)

**Genus: *Luciobrotula*** Smith & Radcliffe, 1913

*Luciobrotula bartschi* Smith & Radcliffe, 1913

**Genus: *Hypopleuron*** Smith & Radcliffe, 1913

*Hypopleuron caninum* Smith & Radcliffe, 1913

**Genus: *Glyptophidium*** Alcock 1889

*Glyptophidium lucidum* Smith & Radcliffe, 1913

*Glyptophidium argenteum* Alcock, 1889

*Glyptophidium oceanium* Smith & Radcliffe, 1913

*Glyptophidium macropus* Alcock, 1894

**Genus:** ***Bassozetus*** Gill, 1884

*Bassozetus robustus* Smith and Radcliffe, 1913

**Genus:** ***Dicrolene*** Goode & Bean, 1883

*Dicrolene multifilis* (Alcock, 1889)

*Dicrolene nigricaudis* (Alcock, 1899)

*Dicrolene tristis* Smith & Radcliffe, 1913

**Genus:** ***Monomitopus*** Alcock, 1890

*Monomitopus conjugator* (Alcock, 1896) (Scaly-headed blindfish)

**Genus:** ***Neobythites*** Goode & Bean, 1885

*Neobythites multistriatus* Nielsen and Quéro, 1991

*Neobythites steatiticus* Alcock, 1894

*Neobythites macrops* Günther, 1887

**Sub Order:** Bythitoidei

**Family:** Bythitidae (Brotulas, Viviparous brotulas)

**Sub Family:** Bythitinae

**Genus:** ***Grammonus*** Gill, 1896

*Grammonus ater* (Risso, 1810)

**Genus:** ***Hephthocara*** Alcock, 1892

*Hephthocara simum* Alcock, 1892 (Snubnosed blindfish)

**Order:** Lophiiformes (Anglerfishes)

**Sub Order:** Lophioidei

**Family:** Lophiidae (Anglerfishes, Goosefishes, Monkfishes)

**Genus:** ***Lophiodes*** Goode and Bean, 1896

*Lophiodes mutilus* (Alcock, 1894) (Smooth angler)

**Genus:** ***Lophiomus*** Gill, 1883

*Lophiomus setigerus* (Vahl, 1797) (Blackmouth angler)

**Sub Order:** Ogcocephalioidei

**Super Family:** Chaunacioidea

**Family:** Chaunacidae (Coffinfishes, Sea toads)

**Genus:** ***Chaunax*** Lowe, 1846

*Chaunax pictus* Lowe, 1846 (Painted anglerfish, Redeye)

**Super Family:** Ceratioidea (Deep sea angler fishes)

**Family:** Melanocetidae

**Genus:** ***Melanocetus*** Günther, 1864

*Melanocetus murrayi* Günther, 1887

**Family:** Ceratiidae (seadevils)

**Genus:** ***Ceratias*** Krøyer, 1845

*Ceratias uranoscopus* Murray, 1877

**Family:** Diceratiidae (Double anglers)

**Genus:** **Diceratias** Gunther, 1887

*Diceratias trilobus* Balushkin and Fedorov, 1986

**Genus :** ***Bufoceratias*** Whitley, 1931

*Bufoceratias wedli* (Pitschmann, 1926)

**Super Family:** Ogcocephalioidea

**Family:** Ogcocephalidae Jordan, 1895 (batfishes)

**Genus:** ***Halieutaea*** Valenciennes, 1837

*Halieutaea stellata* (Vahl, 1797)

*Halieutaea coccinea* Alcock, 1889

**Genus: *Halieutopsis*** Garman, 1899

*Halieutopsis micropa* (Alcock, 1891) (Lesser handfish)

**Superorder: Lampridiomorpha**

**Order:** Lampridiformes (Opahs, Ribbonfishes)

**Family:** Trachipteridae (Ribbonfishes, Trachiptères)

**Genus: *Zu*** Walters & Fitch, 1960

*Zu elongatus* Heemstra & Kannemeyer, 1984

**Super Order: Acanthopterygii**

**Order:** Beryciformes

**Family:** Anoplogastridae Gill, 1893 (Fangtooths, Sabretooth fishes)

**Genus: *Anoplogaster*** Günther, 1859

*Anoplogaster cornuta* (Valenciennes, 1833) (Common Fangtooth)

**Family:** Diretmidae (spinyfins)

**Genus: *Diretmichthys*** Kotlyar, 1990 (Spinyfins)

*Diretmichthys parini* (Post & Quéro, 1981) (Black discfish, Greater diretmid)

**Family:** Berycidae (Alfonsinos, Berycids)

**Genus: *Beryx*** Cuvier, 1829 (Alfonsinos)

*Beryx decadactylus* Cuvier, 1829 (Broad alfonsino, Red bream)

*Beryx splendens* Lowe, 1834 (Alfonsino, Slender alfonsinos)

**Family:** Trachichthyidae (Hoplites, Redfishes, Roughies, Slime heads)

**Genus: *Gephyroberyx*** Boulenger, 1902

*Gephyroberyx darwinii* (Johnson, 1866) (Big roughy)

**Genus: *Hoplostethus*** Cuvier, 1829

*Hoplostethus melanopus* (Weber, 1913)

*Hoplostethus mediterraneus* Cuvier, 1829
(Mediterranean redfish)

**Order:** Zeiformes (Boarfishes, Dories, John dories)

**Sub Order:** Zeioidei

**Family:** Parazenidae Greenwood *et al.*, 1966 (Slender dories, Smooth dories)

**Sub Family:** Cyttopsinae Greenwood *et al.*, 1966 (Smooth dories)

**Genus:** ***Cyttopsis*** Gill, 1862

*Cyttopsis rosea* Lowe, 1843 (Red dory)

**Family:** Zeidae Latreille, 1825 (Buckler dories, Dories, John dories)

**Genus:** ***Zenopsis*** Gill, 1862

*Zenopsis conchifer* (Lowe, 1852) (American John Dory, Buckler dory)

**Order:** Scorpaeniformes (Mail-cheeked fishes, Rascasses, Scorpion fishes, Sculpins)

**Sub Order:** Scorpaenoidei

**Family:** Scorpaenidae (Firefishes, Goblinfishes, Rascasses, Rockfishes)

**Genus:** ***Setarches*** Johnson, 1862

*Setarches longimanus* (Alcock, 1894) (Deepwater scorpionfish)

**Genus:** ***Ectreposebastes*** Garman, 1899

*Ectreposebastes imus* Garman, 1899

**Subfamily:** Pteroninae

**Genus:** ***Pterois*** Oken, 1817
(Butterfly-cods, Lionfishes, Turkeyfishes, Zebrafishes)

*Pterois russelii* Bennett, 1831 (Planetail firefish, Spotless butterfly-cod)

**Subfamily:** Scorpaeninae

**Genus:** ***Scorpaena*** Linnaeus, 1758 (Scorpionfishes)

*Scorpaena scrofa* Linnaeus, 1758
(Bigscale scorpionfish, Orange scorpionfish)

**Family :** Peristediidae

**Genus:** ***Peristedion*** Lacepède, 1801

*Peristedion weberi* Smith, 1934 (Crocodilefish)

**Sub Order:** Dactylopteroidei

**Family:** Dactylopteridae (Fying gurnards, Grondins volants)

**Genus:** ***Dactyloptena*** Jordan & Richardson, 1908

*Dactyloptena macracantha* (Bleeker, 1854)

*Dactyloptena orientalis* (Cuvier, 1829) (Purple flying gurnard)

**Family:** Triglidae (Gurnards, Searobins)

**Genus:** ***Lepidotrigla*** Günther, 1860

*Lepidotrigla spiloptera* Günther, 1880

**Genus:** ***Pterygotrigla*** Waite, 1899

*Pterygotrigla hemisticta* (Temminck & Schlegel, 1843)

**Order:** Perciformes (Perch-like fishes)

**Sub Order:** Percoidei

**Family:** Serranidae (Groupers, Sea basses)

**Sub Family:** Serraninae

**Genus:** ***Chelidoperca*** Boulenger, 1895

*Chelidoperca investigatoris* (Alcock, 1890)

**Family:** Priacanthidae (Bigeyes)

**Genus:** ***Heteropriacanthus*** Fitch & Crooke, 1984

*Heteropriacanthus cruentatus* (Lacepede, 1801) (Glasseye snapper)

**Genus:** ***Priacanthus*** Oken, 1817

*Priacanthus hamrur* (Forsskål, 1775) (Duskyfin bulleye, scad)

**Family:** Nemipteridae (False snappers, Threadfin breams)

**Genus:** ***Parascolopsis*** Boulenger, 1901

*Parascolopsis aspinosa* (Rao & Rao, 1981)
(Redfin dwarf monocle bream)

**Family:** Bathyclupeidae (Deepsea herrings)

**Genus:** ***Bathyclupea*** Alcock, 1891

*Bathyclupea hoskynii* Alcock, 1891

**Family:** Epigonidae (Deepwater cardinalfishes)

**Genus:** ***Epigonus*** Rafinesque, 1810

*Epigonus pandionis* (Goode & Bean, 1881)

**Family:** Pentacerotidae (Armorheads, Boarfishes)

**Genus:** ***Histiopterus*** Temminck and Schlegel, 1844

*Histiopterus typus* Temminck and Schlegel, 1844

**Family:** Cepolidae (Red bandfishes)

**Sub Family:** Owstoniinae

**Genus:** ***Owstonia*** Tanaka, 1908

*Owstonia simoterus* (Smith, 1968)

**Family:** Acropomatidae (Lanternbellies, Temperate ocean-basses)

**Genus:** ***Acropoma*** Temminck & Schlegel, 1843

*Acropoma japonicum* Günther, 1859 (Glowbelly, Laternbelly)

**Genus: *Synagrops*** Günther, 1887

*Synagrops philippinensis* (Günther, 1880)

*Synagrops japonicus* (Döderlein, 1883) (Blackmouth cardinalfish)

**Sub Order:** Stromateoidei (Butterfishes, Harvestfishes)

**Family:** Centrolophidae (Medusafishes, Pompiles, Rudderfishes)

**Genus: *Psenopsis*** Gill, 1862

*Psenopsis cyanea* Alcock, 1890

**Family:** Nomeidae (Driftfishes, Man-of-war fishes, Shepherdfishes)

**Genus: *Cubiceps*** Lowe 1843

*Cubiceps pauciradiatus* Günther, 1872
(Bigeye cigarfish, Longfin fathead)

*Cubiceps squamiceps* (Lloyd, 1909) (Chunky fathead)

**Genus: *Psenes*** Valenciennes, 1833

*Psenes cyanophrys* Valenciennes, 1833

**Sub Order:** Trachinoidei (Stargazers, Vives, Weevers)

**Family:** Percophidae (Flatheads, Flatnoses)

**Subfamily:** Bembropinae

**Genus: *Bembrops*** Steindachner, 1876

*Bembrops caudimacula* Steindachner, 1876 (Opal fish)

**Family:** Uranoscopidae (Stargazers, Uranoscopes)

**Genus: *Uranoscopus*** Linnaeus, 1758

*Uranoscopus crassiceps* Alcock, 1890

**Genus: *Xenocephalus*** Kaup, 1858

*Xenocephalus australiensis* (Kishimoto, 1989)

**Sub Order:** Callionymoidei (dragonets)

**Family:** Callionymidae (Dragonnets, scotter blennies)

**Genus:** ***Callionymus*** Linnaeus, 1758

*Callionymus sagitta* Pallas, 1770 (Arrowheaded dragonet)

**Sub Order:** Scombroidei (Albacores, Bonites, Mackerels, Ribbonfishes, Tunas)

**Family:** Gempylidae (Escolares, Snake mackerels)

**Genus:** ***Ruvettus*** Cocco, 1833 (Escolars)

*Ruvettus pretiosus* Cocco, 1833 (Escolar, Oilfish)

**Genus:** ***Neoepinnula*** Matsubara & Iwai, 1952

*Neoepinnula orientalis* (Gilchrist & von Bonde, 1924) (Sackfish)

**Genus:** ***Rexea*** Waite, 1911

*Rexea prometheoides* (Bleeker, 1856) (Prometheus gemfish, Royal escolar)

**Genus:** ***Nealotus*** Johnson, 1865

*Nealotus tripes* Johnson, 1865 (Black snake mackerel)

**Genus:** ***Promethichthys*** Gill, 1893

*Promethichthys prometheus* (Cuvier, 1832) (Purple snake mackerel, Single-line gemfish)

**Family:** Trichiuridae (Cutlassfishes, Hairtails, Ribbonfishes)

**Sub Family:** Trichiurinae

**Genus:** ***Trichiurus*** Linnaeus, 1758 (cutlassfishes, hairtails)

*Trichiurus auriga* Klunzinger, 1884 (Pearly hairtail)

**Order:** Pleuronectiformes (Flatfishes, Flounders, Limandes, Plies, Soles)

**Sub Order:** Pleuronectoidei

**Family:** Bothidae (Lefteye flounders, Lefteyed flounders, Turbots)

**Genus:** ***Chascanopsetta*** Alcock, 1894

*Chascanopsetta lugubris* Alcock 1894 (pelican flounder)

**Genus:** ***Psettina*** Hubbs 1915

*Psettina brevirictis* Alcock, 1890

**Family:** Cynoglossidae (Soles-langues, Tongue soles, Tonguefishes)

**Sub Family:** Cynoglossinae

**Genus:** ***Cynoglossus*** Hamilton, 1822

*Cynoglossus acutirostris* Norman, 1939

*Cynoglossus carpenteri* Alcock, 1889

**Family:** Soleidae (Soles)

**Genus:** ***Aesopia*** Kaup 1858

*Aesopia cornuta* Kaup, 1858 (Horned sole)

**Order:** Tetraodontiformes

(Balistes, Cowfishes, Filefishes, Leatherjackets, Puffers, Triggerfishes, Trunkfishes)

**Sub Order:** Triacanthoidei

**Family:** Triacanthodidae (Spikefishes, Triacanthodidés)

**Genus:** ***Macrorhamphosodes*** Fowler, 1934

*Macrorhamphosodes uradoi* (Kamohara, 1933)

## 2.3.2 Species description

**Kingdom** : **Animalia**

**Phylum** : **Chordata**

**Sub Phylum** : **Vertebrata**

**Super Class** : **Agnatha** (Jawless fishes)

**Class** : **Myxini** (Hagfishes)

**Order** : **Myxiniformes**

**Family** : **Myxinidae** (hagfishes, myxines)

**Sub Family** : **Eptatretinae** Nelson, 1976

**Genus** : ***Eptatretus*** Cloquet, 1819

***Eptatretus*** Cloquet (ex Duméril), In: Dictionnaire des sciences naturelles. Volumes 1-60. Dictionnaire des Sciences Naturelles. [Dates for volumes are given by Cassini 1834, Opuscles Phytologiques, p. 47.].
Fernholm & Quattrini 2008: Copeia 2008 (no. 1): 126-132.

*Eptatretus hexatrema* (Müller 1836)

(Plate I, Fig.1)

**Vernacular Name: Sixgill hagfish**

***Bdellostoma hexatrema,*** Müller 1836:79 [15] [Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin 1834. Table Bay, Cape of Good Hope, South Africa. Holotype (unique): ZMB 4698.
Type catalog: Paepke & Schmidt 1988: Mitteilungen aus dem Zoologischen Museum in Berlin v 64 (no. 1): 155-189
Bianchi & Carpenter in Bianchi et al. 1993. FAO, Rome. I-viii + 1-250, I-VII.
Fernholm 1998:34 Hagfish systematics. Pp. 33-44. In: J. M. Jørgensen, J. P Lomholt, R. E. Weber, H. Malte (eds.), The Biology of Hagfishes. Chapman & Hall, London. The biology of hagfishes.. 1-578.
McMillan 1999: Fishery Bulletin No. 97: 110-117

**Diagnostic characters (Based on 6 specimens 19.0–26.6 cm TL):**

Body elongated and cylindrical without dermal ossification of any sort; pre-branchial length about 0.31-0.36 in TL, 90-103 pairs of slime pores; eyes developed; mouth modified into six pairs of gill openings; total cusp count of teeth 40-48 with anterior 3 in outer row, and anterior 2 in inner row fused at bases; pectoral appendages absent; tail more or less diphycercal. Colour metallic black.

**Geographical distribution (Previous records):** Cape of Good Hope; Arabian sea.

**Distribution in the Southwest coast (Present study):** Between 9° and 11° N Latitudes.

**Depth:** Previous records from 20-400 m. In present study, 201-500 m.

**Class** : **Chondrichthyes** (Cartilaginous fishes, rays)

**Sub Class** : **Elasmobranchii** (Cartilaginous fishes)

**Super Order** : **Euselachii**

**Order** : **Carcharhiniformes** (Ground sharks)

Two dorsal fins, without spines; anal fin present; five gill slits, with last one to three over pectoral fin; gill rakers absent; eyes with nictitating fold or membrane; spiracles present or absent; intestinal value of spiral or scroll type.

**Key to Families**

**1a**. First dorsal fin base opposite or behind pelvic bases........ **Scyliorhinidae**

**1b**. First dorsal base in front of pelvic bases **Proscylliidae**

**Family** : **Scyliorhinidae** Gill, 1862 (Cat sharks)

Family Scylliorhinoidae Gill, 1862, Ann.Lyceum Nat.Hist.N.Y 7(32):393; emended to Family Scyliorhinidae by Jordan & Fowler (1903).

Usually elongated, catlike eyes with nictitating eyelids. Lower eyelid usually with longitudinal fold. Gill openings 5, fifth over origin of pectoral fin. Two small, spineless dorsal fins. One of largest family of sharks, occurring from intertidal zone to edges of continental and insular shelves and down slopes to depths greater than 2000 m. Spawns large eggs in tough egg-cases with tendrils. Some species are ovoviviparous. Feed mainly on invertebrates and small fishes.

## Key to Genera

**1a**. Supraorbital crests present on cranium ***Cephaloscyllium***

**1b**. Supraorbital crests absent from cranium **2**

**2a**. Head broadly flattened and spatulate, snout elongated and usually longer than mouth width. Labial furrows very long, uppers reaching upper symphysis underside of head. ***Apristurus***

**2b**. Head moderately or little-flattened, not spatulate, snout equal or usually shorter than mouth width. Labial furrows shorter or absent, when present not reaching upper symphysis ***Bythaelurus***

### Genus: *Cephaloscyllium* Gill, 1862 (Swell sharks)

***Cephaloscyllium*** Gill 1862: Annals of the Lycium of Natural History of New York v. 7: 367*-370*, 371-408.
Neut. *Scyllium laticeps* Duméril 1853. Type by original designation (also monotypic).
Compagno et al. 2005: CSIRO Marine Laboratories Report No. 243: 103 pp.
Schaaf-Da Silva & Ebert 2008. Zootaxa No. 1872: 59-68.

*Cephaloscyllium sufflans* (Regan 1921)

(Plate I, Fig. 2)

**Vernacular Name:** Balloon shark

***Scyliorhinus (Cephaloscyllium) sufflans***, Regan 1921:413 [Annals and Magazine of Natural History (Series 9) v. 7 (no. 41); off Umvoti River, Natal, South Africa, depth 220-238 meters. Holotype (unique): BMNH 1921.3.1.2.
Compagno 1984. FAO (Food and Agriculture Organization of the United Nations) Fisheries Synopsis No. 125, v. 4 (pt 2): 251-655.
Manilo & Bogorodsky 2003. Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
Inoue & Nakaya 2006: Species Diversity v. 11: 77-92.
**Synonymy:** *Scyliorhinus sufflans* Regan, 1921

### Diagnostic characters (Based on 1 specimen 49.8 cm TL):

A moderately large, stout catshark, snout broadly rounded-angular in dorsoventral view, broad and short. Anterior nasal flaps fairly elongate and lobate, not overlapping mouth posteriorly, no labial furrows. Supraorbital crests present on cranium, above eyes. Second dorsal much smaller than first. Claspers moderately short and stout. A simple colour pattern of obscure dark saddles, often obsolete Colour pattern of 7 light grey-brown saddles on a lighter, pale-grey brown background, these underside of head saddles obscure or absent in adults, pectorals dusky above, underside unspotted; fins without conspicuous light margins. A large species. Maximum 106 cm.

**Geographical distribution (Previous records):** Western Indian Ocean: South Africa and Mozambique, doubtfully from Gulf of Aden.

**Distribution in the Southwest coast (Present study):** Between 9° and 11° N latitude.

**Depth:** A common warm-temperate and subtropical offshore catshark on continental shelf and uppermost slope at depths from 40 to 440 m, commonly on sand and mud bottom. In present study, 500-800 m.

**Genus : *Apristurus* Garman, 1913**
(Demon cat sharks, Ghost cat sharks)

Garman, 1913, Mem.Mus.Comp.Zool.Harv.Coll., 36:96. Type Species *Scylliorhinus indicus* Brauer, 1906, by original designation.

Long laterally expanded snout and head, enlarged nostrils with reduced anterior nasal flaps, very long labial furrows, small rear-sited, spineless dorsal fins, very large, elongated anal fin separated from elongated caudal by a notch only, and uniform coloration.

**Key to Species**

**1a**. Interdorsal space very long, about equal to prespiracular head **_A. saldanha_**

**1b**. Interdorsal space shorter, less than prespiracular head **_A. indicus_**

*Apristurus saldanha* (Barnard 1925)

(Plate I, Fig. 3)

**Vernacular Name:** Saldanha catshark

*Scylliorhinus saldanha* Barnard, 1925, Ann.S.Afr.Mus., 21(1):44. Type Locality: Off Saldanha Bay, South Africa, 915 m depth. Holotype (unique): SAM (apparently lost).
Compagno 1984. FAO (Food and Agriculture Organization of the United Nations) Fisheries Synopsis No. 125, v. 4 (pt 2): 251-655.
Nakaya & Sato 1999:316 In: Proc. 5th Indo-Pac. Fish Conf., Noumea, 1997 [Séret B. & J.-Y Sire, eds] pp. 307-320.
Sato et al. 1999. Journal of the Royal Society of New Zealand v. 29 (no. 4): 325-335.
Nakaya et al. 2008. CSIRO Marine and Atmospheric Research Paper No. 022: 61-74.
**Synonymy:**

**Diagnostic characters (Based on 5 specimens, 29.8-34.9cm TL):**

Snout moderately long, preoral snout 0.06 – 0.07 in TL, gill slits small, 0.89-0.97 in eye length; gill septa without projecting medial lobes; ED 0.02-0.03 of TL. Mouth short and broadly arched, dental bands not prominently expanded, with lower ones falling well behind uppers; labial furrows possibly not expanded. Interdorsal space considerably greater than first dorsal base, about equal to prespiracular space; first dorsal fin slightly smaller in area than second; origin of first dorsal about over pelvic midbases; insertion of second dorsal opposite anal insertion; anal fin long, its base about equal to prebranchial space. Lateral trunk denticles flat. Colour slate-grey. Adults large, grow upto a length of 81cm.

**Geographical distribution (Previous records):** Eastern South Atlantic: Southwestern Cape Province, South Africa.

**Distribution in the Southwest coast (Present study):** 11°-13°N.

**Depth:** Known from 402 to 1000 m. In present study, 500-800 m.

*Apristurus indicus* (Brauer 1906)

(Plate I, Fig. 4)

**Vernacular Name:** Smallbelly catshark

*Scylliorhinus indicus* Brauer, 1906, *Deutsch.Tiefs.Exped. 'Valdivia', Tiefs.Fisch.*, 15:8, pl. 14, fig. 1. Lectotype: Zoolgisches Museum an der Humboldt-universität zu Berlin, ZMB 22424, 336 mm female, designated by Springer (1979:19). Type Locality: 02 59'N, 4706'E, off coast of Somalia, Indian Ocean.

Brauer, A. 1906. Die Tiefsee-Fische. I. Systematischer Teil. In: C. Chun. Wissenschaftl. Ergebnisse der deutschen Tiefsee-Expedition "Valdivia," 1898-99. Jena. Tiefsee-Fische v. 15: 1-432, Pls. 1-18.
Nakaya, *et al.* 2008. CSIRO Marine and Atmospheric Research Paper No. 022: 61-74.
**Synonymy:** *Scylliorhinus indicus* Brauer, 1906

**Diagnostic characters (Based on 5 specimens, 38.8-46.7 cm TL):**

Body relatively slender, trunk slightly tapering toward head. Snout rather long, very broad, and bell-shaped, preoral snout about 0.09 to 0.1 in TL, gill slits moderately small 0.5 to 0.68 of eye length; eye 0.02-0.3 in TL. mouth large and very broadly arched, with dental bands hardly expanded and with lower ones falling just behind uppers; Interdorsal space about 2/3 of first dorsal base and preorbital snout; first dorsal fin 0.67 of area of second, origin of first dorsal extending slightly anterior to pelvic midbases; second dorsal insertion slightly in front of anal insertion; anterior margins of pectoral fins 0.13 of TL, interspace between pectoral and pelvic bases 0.61-0.69 of preorbital snout and about 0.07 in TL, pelvic fin base about equal to prebranchial space and 0.16 to 0.20 in TL, caudal fin very long and narrow, without a crest of enlarged denticles on dorsal margin. Lateral trunk denticles with crowns close-set and fairly flat, body surface smooth and not with a felt like or fuzzy texture. Colour brownish or blackish.

**Geographical Distribution:** Western Indian Ocean: Somalia, Gulf of Aden, Oman; possibly also eastern South Atlantic off Namibia and South Africa.

**Distribution in the Southwest coast (Present study):** Distributed all along the coast from 7° to 15° N.

**Depth:** Previous records from continental slopes at 1289 to 1840 m depth. In present study, 201-800 m.

## Genus: *Bythaelurus* Compagno 1988

*Bythaelurus* (subgenus of *Halaelurus*) Compagno 1988: Sharks of the order Carcharhiniformes. Princeton Univiversity Press, Princeton, N. J. Sharks of the order Carcharhiniformes.. i-xxii + 1-486 + separate figs., Pls. 1-35.
Masc. *Scyllium canescens* Günther 1878. Type by original designation. •Synonym of *Halaelurus* Gill 1862, but a valid subgenus as described
Compagno 1999. Checklist of living elasmobranchs, pp. 471-498. In: Hamlett, W. C. [Ed.]. Sharks, skates, and rays: the biology of elasmobranch fishes.: i-x, 1-515.
•Valid as *Bythaelurus* Compagno 1988
White et al. 2007 Zootaxa No. 1639: 1-21.

### Key to species

**1a.** Roof of mouth with numerous small papillae. Eye length less than 14 times in predorsal distance in adults. Adults 24 to 29 cm ***B. hispidus***

**1b.** Roof of mouth without papillae. Eye length 14 or more times in predorsal distance in adults. Adults 30 to 35 cm ***B. lutarius***

*Bythaelurus hispidus* (Alcock 1891)

(Plate I, Fig. 5)

**Vernacular Name:** Bristly catshark

***Scyllium hispidum,*** Alcock 1891:21 [Annals and Magazine of Natural History (Series 6) v 8 (no. 43/44); Andaman Sea, 11°31'40"N, 92°46'40"E, Investigator station 115, depth 188-220 fathoms. Holotype (unique): ZSI F13120.
Figured in Alcock 1894: Pl. 8 (figs. 3, 3a) Illustrations of the zoology of the Royal Indian marine surveying steamer Investigator,...Fishes. Part 2: no p., Pls. 8-13.
•Valid as *Halaelurus hispidus* (Alcock 1891)
Compagno 1984. FAO (Food and Agriculture Organization of the United Nations) Fisheries Synopsis No. 125, v. 4 (pt 2): 251-655.
•Valid as *Bythaelurus hispidus* (ALcock 1891)
White et al. 2007 Zootaxa No. 1639: 1-21
Last & Stevens 2008:123 CSIRO Marine and Atmospheric Research Paper No. 022: 123-128.
**Synonymy:** *Scyllium hispidum, Bythaelurus hispidus*

### Diagnostic characters (Based on 3 specimens, 39.2-43.6 cm TL):

Snout broadly parabolic; eyes in adults less than 14 times in distance from snout to first dorsal origin; mouth moderately large, its width 8 to 10% of total length, its length 4 to 5% of total length; papillae present in pharynx; First dorsal origin over last third of pelvic bases; second dorsal slightly smaller than first, its origin over or slightly in front of anal midbase; abdomen moderately long in adults, distance between pectoral and pelvic bases 1.3 to 1.4 times pectoral anterior margin; length of anal base about 1.5 to 1.7 times second dorsal base, slightly shorter than distance between dorsal bases. Colour pale brown or whitish, sometimes with obscure grey cross bands, white spots, or dusky spots. Maximum 29 cm.

**Geographical distribution (Previous records):** Indian Ocean: Southeastern India, Andaman Islands.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** A common deepwater bottom dwelling catshark of the upper continental slopes at depths of 293 to 766 m. In present study,500-800 m.

*Bythaelurus lutarius* (Springer & D'Aubrey 1972)

**Vernacular Name:** Mud catshark

***Halaelurus lutarius,*** Springer & D'Aubrey 1972:6, Figs. 1A [Investigational Report. Oceanographic Research Institute Durban No. 29; Off Delagoa Bay, Mozambique basin, 25°32'S, 33°24'E, South Africa, Anton Bruun cruise 8, station 396B, depth 450-455 meters. Holotype: USNM 205135. Paratypes: USNM 221660 (16).
Type catalog: Howe & Springer 1993: Smithsonian Contributions to Zoology No. 540: i-iii + 1-19.
•Valid as *Halaelurus lutarius* Springer & D'Aubrey 1972; Compagno 1984. FAO (Food and Agriculture Organization of the United Nations) Fisheries Synopsis No. 125, v 4 (pt 2): 251-655.
Manilo & Bogorodsky 2003:S91). Journal of Ichthyology v 43 (suppl. 1): S75-S149.
•Valid as *Bythaelurus lutarius* (Springer & D'Aubrey 1972)
Last & Stevens 2008: CSIRO Marine and Atmospheric Research Paper No. 022: 123-128.
**Synonymy:** *Halaelurus lutarius*

**Diagnostic characters (Based on 2 specimens, 32.1-34.6 cm TL):**

Snout narrowly rounded; eyes in adults 14 or more times in distance from snout to first dorsal origin; mouth moderately large, its width 6 to 8% and length 4% of total length; papillae absent from pharynx. Origin of first dorsal fin over or slightly in front of pelvic insertions; second dorsal somewhat smaller than first, its origin about over anal midbase; abdomen moderately long in adults, distance between pectoral and pelvic bases 1.3 to 1.6 times pectoral anterior margin; length of anal base about 1.5 times second dorsal base, slightly shorter than distance between dorsal bases. Colour grey-brown above and light below, sometimes with obscure saddle bands. Maximum 39 cm.

**Geographical Distribution:** Western Indian Ocean: Mozambique and Somalia.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** A deepwater tropical catshark of the continental slope of the western Indian Ocean, on or just above muddy bottom, at 338 to 766 m depth. In present study, 500-800 m.

**Family : Proscylliidae** Fowler, 1941 (finback catsharks)

**Genus : *Eridacnis*** Smith 1913. (ribbontail cat sharks)

*Eridacnis* Smith, 1913, Proc.U.S.Natl.Mus.. 45(2003):599. **Type Species:** Eridacnis radcliffei Smith, 1913, by original designation.
Bass & Compagno 1986. Odontaspididae (pp. 104-105). In: Smiths' Sea Fishes (Smith & Heemstra 1986.
Compagno 2003. Sharks (Pp. 357-505). In: Carpenter 2003 [ref. 26982]. The living marine resources of the Western Central Atlantic. v. 1
Compagno et al. 2005. CSIRO Marine Laboratories Report No. 243: 103 pp.

Dwarf, slender sharklets with an anal fin and two equal-sized, spineless dorsal fins, first dorsal fin over abdomen slightly closer to pelvic fins than pectorals, preoral snout over two times mouth length, nictitating eyelids, a triangular mouth, very short labial furrows, comb like posterior teeth, short anterior nasal flaps that do not reach mouth, no nasoral grooves or barbells, a long, narrow, ribbon like caudal fin with faint dark banding.

**Key to species**

**1a.** Preoral snout over twice mouth length. Lateral dermal denticles broad and with short, wide cusps....................................................... ***E. sinuans***

**1b.** Preoral snout less than 1.5 times mouth length. Lateral dermal denticles narrow and with narrow, long cusps........................................ ***E. radcliffei***

*Eridacnis sinuans* (Smith 1957)

(Plate I, Fig. 6)

**Vernacular Name:** African ribbontail catshark

*Neotriakis sinuans* Smith, 1957, S.Afr.J.Sci., 53(10):262, fig. 2. Holotype: J.L.B. Smith Institute of Ichthyology, Grahamstown, South Africa, RUSI 31, 331 mm adult male. Type Locality: Off Durban, South Africa, at 329 m depth.
Manilo & Bogorodsky 2003. Journal of Ichthyology v. 43 (suppl.1): S75-S149.
**Synonymy:** *Neotriakis sinuans* Smith, 1957

**Diagnostic characters (Based on 6 specimens, 22.4-25.3 cm TL):**

Preoral snout over two times mouth length; labial furrows very short. Dorsal fins moderately large and high, with anterior margin of first dorsal at a high angle to body axis; anal fin height less than half dorsal heights; junction of preventral and postventral caudal margins broadly rounded. Lateral trunk denticles broad-crowned and with short, broad cusps. Colour brownish grey, with dark banding on caudal fin and light margins on dorsal fins. Maximum 37 cm, males maturing at about 29 or 30 cm and reaching at least 30 cm, females mature at 37 cm; size at birth between 15 and 17 cm.

**Geographical distribution (Previous records):** Confined to the southwestern Indian Ocean off South Africa, Mozambique and Tanzania.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** A deepwater warm-temperate and tropical bottom-dwelling shark of the upper continental slope and outer shelf of east and southern Africa at depths of 180 to 480 m. In present study, 200-800 m.

*Eridacnis radcliffei* Smith, 1913

(Plate I, Fig. 7)

**Vernacular Name:** Pygmy ribbontail catshark

*Eridacnis radcliffei* Smith, 1913, Proc.U.S.Natl.Mus., 45(2003):599, figs 1-3, pl. 47 Holotype: U.S. National Museum of Natural History, USNM-74604, 230 mm adult female. Type Locality: Off Jolo Light, Jolo Island, Sulu Archipelago, The Philippines, 6°11.8'N, 121°08.3'E, 295 m depth.
Type catalog: Howe & Springer 1993. Smithsonian Contributions to Zoology No. 540: i-iii + 1-19.
•Valid as *Eridacnis radcliffei* Smith 1913
Bass & Compagno 1986. Family No. 6: Echinorhinidae (p. 63), Family No. 10: Proscylliidae (pp. 87-88), Family No. 17· Mitsukurinidae (p. 103), Family No. 19: Odontaspididae (pp. 104-105). In: Smiths' Sea Fishes (Smith & Heemstra 1986.
Compagno et al. 2005. CSIRO Marine Laboratories Report No. 243: 103 pp.
**Synonymy:** *Proscyllium alcocki* Misra, 1950

**Diagnostic characters (Based on 8 specimens, 26.1-29.3 cm TL):**

One of smallest living sharks. Preoral snout less than 1.5 times mouth length; labial furrows rudimentary or absent. Anal fin height less than half dorsal heights; junction of preventral and postventral caudal margins broadly rounded. Lateral trunk denticles narrow-crowned and with long, narrow cusps. A long, narrow, ribbon like caudal fin with prominent dark banding, and brown coloration. Colour brown, with prominent dark banding on tail and dark markings on dorsal fins. Maximum 24 cm.

**Geographical Distribution** Wide ranging in the Indo-West Pacific, but with spotty records from Tanzania, the Gulf of Aden, India (Gulf of Mannar, Bay of Bengal), the Andaman Islands, Viet Nam, and the Philippines.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** A deepwater tropical benthic shark that often occurs on mud bottoms, on the upper continental and insular slopes and the outer shelves at depths from 71 to 766 m. In present study, 200-800 m.

## Order: **Squaliformes** Compagno, 1973 (dogfish)

Two dorsal fins, with or without spines; anal fin absent; five gill slits; spiracles present; nictitating lower eyelid absent. Many species are known from deep water.

**Key to Families**

**1a**. First dorsal fin originating behind pelvic fin origins.................................. 2

**1b**. First dorsal fin originating in front of pelvic fin origins 3

**2a**. Body with large dermal denticles **Echinorhinidae**

**2b**. Body without large dermal denticles **Somniosidae**

**3a**. Upper teeth with cusplets in addition to a cusp ***Etmopteridae***

**3b**. Upper teeth without cusplets...... ***Centrophoridae***

### Family: Echinorhinidae Gill, 1862

### Genus: *Echinorhinus* Blainville 1816

***Echinorhinus*** (subgenus of *Squalus*) Blainville 1816: Bulletin de la Société Philomathique de Paris v. 8: 105-112 [sic for 113-120] +121-124 Masc. *Squalus spinosus* Gmelin 1789. Type by monotypy.
McEachran & Branstetter in Whitehead et al. 1984 Fishes of the North-eastern Atlantic and the Mediterranean.p. 138.
Compagno et al. 2005. CSIRO Marine Laboratories Report No. 243: 103 pp.
Hoese et al. 2006. Echinorhinidae (138-139). In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Echinorhinus brucus* (Bonnaterre, 1788)

(Plate I, Fig. 8)

**Vernacular Name**: Bramble shark

*Squalus brucus* Bonnaterre, 1788, Tabl.encyclop.method.trois reg. Nat., Ichthyol., Paris, 11
Holotype: lost. Type Locality: "L'Océan" (eastern North Atlantic).
Mundy, 2005. Bishop Museum Bulletin in Zoology No. 6: 1-704.
Hoese et al., 2006. Echinorhinidae (138-139). In: Zoological Catalogue of Australia. Volume 35. Fishes.
Fricke et al. 2007 Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie). No. 706: 1-174.
**Synonymy:** *Squalus spinosus* Gmelin, 1789; *Echinorhinus obesus* Smith, 1849; *Echinorhinus* (*Rubusqualus*) mccoyi Whitley, 1931

**Diagnostic characters (Based on 5 specimens 63.2-235.3 cm TL):**

Body elongated without anal fin; dorsals without spines and far back, PrDL 0.59 – 0.63 in TL and 1.91 in HL, first behind pelvic origins. ED 0.15, IOW 0.12, BD 0.16 and PL 0.11 in TL. Dermal denticles on body and fins varying from small to very large, with many large, widely spaced, thorn or buckler-like denticles with bases not stellate and over a centimeter wide; some of these large denticles are fused in groups of 2 to 10 and may form large plates over 25 mm across. Maximum total length recorded 3.1 m.

**Geographical distribution (Previous records):** Western Atlantic: Virginia, Massachusetts, USA; Argentina. Eastern Atlantic: North Sea to Mediterranean, Morocco to Cape of Good Hope, South Africa. Western Indian Ocean: India, Mozambique, South Africa. Western Pacific: Japan, southern Australia, New Zealand. Records from Oman and Kiribati uncertain. Apparently absent in the Eastern Pacific.

**Distribution in the southwest coast of India:** Between 11° and 15° N Latitude from four stations.

**Depth:** Primarily a deepwater species, occurring on the continental and insular shelves and upper slopes at depths from 18 to 900 m. In present study,from 201–800 m.

**Family : Somniosidae** Jordan, 1888 (sleeper sharks)

**Genus** ***Centroscymnus*** Barbosa du Bocage & Brito Capello 1864

***Centroscymnus*** Barbosa du Bocage & Brito Capello 1864. Sur quelque espèces inédites de Squalidae de la tribu Acanthiana, Gray, qui fréquentent les côtes du Portugal. Proc. Zool. Soc. Lond. 1864 (pt 2): 260-263.

McEachran & Branstetter in Whitehead et al. 1984. Fishes of the North-eastern Atlantic and the Mediterranean.. 1-510.

Taniuchi & Garrick 1986. Japanese Journal of Ichthyology v. 33 (no. 2): 119-134.

Compagno, 2003. Sharks (Pp. 357-505). In: Carpenter 2003. The living marine resources of the Western Central Atlantic. v 1

*Centroscymnus crepidater* (Barbosa du Bocage & de Brito Capello 1864)

(Plate I, Fig. 9)

**Vernacular Name:** Longnose velvet dogfish

***Centrophorus crepidater***, Barbosa du Bocage & de Brito Capello 1864:262, Fig. 3 [Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1864 (pt 2); Coast of Portugal. Holotype (unique): MB T 112(49) (destroyed in fire in 1978). Denticles from holotype in MCZ 89511.
Krefft & Tortonese 1973. Oxynotidae (pp. 35-36), Squalidae (pp. 37-48). In: Hureau & Monod 1973. Check-list of the fishes of the north-eastern Atlantic and of the Mediterranean. CLOFNAM.
Springer 1990. In: Quéro et al. 1990. Check-list of the fishes of the eastern tropical Atlantic. CLOFETA v. 1.
Hutchins 2001. Records of the Western Australian Museum Supplement No. 63: 9-50.
Hoese & Gates 2006: In: Zoological Catalogue of Australia. Volume 35. Fishes. 141
**Synonymy:** *Centrophorus crepidater* Barbosa du Bocage and Brito Capello, 1864; *Centrophorus jonssonii* Saemundsson, 1922; *Centrophorus rossi* Alcock, 1898; *Centroscymnus furvescens* de Buen, 1960

**Diagnostic characters (Based on 2 specimens, 59.2-68.3 cm TL):**

Body moderately slender and compressed, dermal denticles of back with cusps and ridges. The medial ridge not extending full length of crown. Snout narrowly rounded and long, equal to distance from mouth to pectoral fin origins. Upper labial grooves extremely long, distance between their anterior ends less than their lengths, teeth differing in upper and lower jaws, uppers much smaller, with slender erect cusps and no cusplets, but broadening out near mouth angles, lowers larger, compressed, bladelike, unserrated, with a single erect to obliqe cusp, no cusplets and a deeply notched outer edge. A very small spine with lateral grooves on anterior edges of both dorsal fins, first dorsal fin very long and low, its base longer, but its hight less than second dorsal, its origin about over posterior ends of pectoral fin bases, pectoral fins shorter than upper margin of caudal fin, their inner corners broadly rounded, caudal fin with a well-developed subterminal notch and a weak lower lobe. Caudal peduncle without dermal keels or precaudal pits. Uniform brownish black. Maximum 90 cm.

**Geographical distribution (Previous records):** Aldabra island group and Laccadive Sea, Eastern Atlantic from Iceland to Namibia, New Zealand, Australia and Central Chile.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Deepwater, upper continental slope from 270 to 1070 m. 500-800 m.

**Family: Etmopteridae** Fowler, 1934 (lantern sharks, requins-lanternes)

**Genus : *Etmopterus*** Rafinesque, 1810 (lantern sharks)

*Etmopterus* Rafinesque, 1810, Caratt.gen.sp.anim.piant., Sicilia, Palermo, Pt. 1:14. Type Species: *Etmopterus aculeatus* Rafinesque, 1810, by monotypy, equals *Squalus spinax* Linnaeus, 1758.

Spinacoid sharks, with two dorsal fins, each with a spine, no anal fin. Mouth little arched, a long deep straight oblique groove on each side of mouth. Teeth of lower jaw with the point so much turned aside that inner margin of tooth forms a cutting edge. Upper teeth errect, each with a long pointed cusp and one or two small ones on each side. No nictitating membrane. Spiracles wide, superior, behind eye. Gill openings narrow.

**Key to species**

**1a**. Denticles with low, flat, concave, sessile crowns atop low bases **_E. pusillus_**

**1b**. Denticles with erect, thorn like, cuspidate crowns, more or less elevated from bases **_E. granulosus_**

*Etmopterus pusillus* (Lowe 1839)

(Plate I, Fig. 10)

**Vernacular Name**: Smooth lanternshark

*Acanthidium pusillum* Lowe, 1839, Trans.Zool.Soc.Lond., 3(1):19. Holotype: British Museum (Natural History ). Type Locality Madeira, eastern Atlantic.
Nakaya in Okamura et al. 1982, Fishes of the Kyushu-Palau Ridge and Tosa Bay.. 1-435.
Springer 1990, In: Quéro et al. 1990 [ref. 15946]. Check-list of the fishes of the eastern tropical Atlantic. CLOFETA v. 1.
Shinohara et al. 2001, Memoirs of the National Science Musuem Tokyo No. 20: 283-343.
Mundy 2005, Bishop Museum Bulletin in Zoology No. 6: 1-704.
Hoese & Gates 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy**: *Centrina nigra* Lowe, 1839; *Etmopterus frontimaculatus* Pietschmann, 1907

**Diagnostic characters (Based on 3 specimens, 28.3- 32.1 cm TL):**

Body smooth, scales very small, without spines, fairly slender with a moderately short tail, gill openings rather long, much wider than spiracle, ED 0.5 or less; Pre dorsal equal to distance between first dorsal spine to second dorsal insertion. First dorsal origin about opposite or slightly behind free rear tips of pectoral fins; second dorsal fin much larger than first, but with area less than twice that of first; distance from pelvic insertions to ventral caudal origin between 1.6 to 2 times in distance between pectoral and pelvic bases, and about 1.5 in interdorsal space; distance between pectoral and pelvic bases moderately long in adults, dermal denticles about 1.3 times head length. Lateral trunk denticles with truncated, hollow, sessile, low crowns, not thorn or bristle-like, wide-spaced; snout covered with denticles. Blackish-brown above, with an obscure broad black mark running above, in front and behind pelvic fins. Maximum total length at least 47 cm.

**Geographical distribution (Previous records):** Western Atlantic: Northern Gulf of Mexico and southern Brazil to Argentina. Central South Atlantic (oceanic), between Argentina and South Africa. Eastern Atlantic: Portugal, Madeira, Azores, Canaries, Liberia, Ivory Coast to Gabon, Zaire, Angola and Namibia. Western Indian Ocean: South Africa. Western Pacific: Japan (southeastern Honshu).

**Distribution in the southwest coast of India:** Between 11° and 15° N latitude.

**Depth:** Mostly seen at depths from 274 to 1000 m or more. In present study, 800 – 1100 m.

*Etmopterus granulosus* (Günther 1880)

(Plate II, Fig. 11)

**Vernacular Name:** lantern shark

***Spinax granulosus***, Günther 1880, Pl. 2 (fig. C) [Report on the shore fishes procured during the voyage of H. M. S. Challenger in the years 1873-1876. v. 1 (pt 6); Southwestern coast of South America, Challenger station 305, depth 120 fathoms. Holotype (unique): BMNH 1879.5.14.460. Valid as *Etmopterus granulosus* (Günther 1880)

Nakaya in Okamura et al. 1982, Fishes of the Kyushu-Palau Ridge and Tosa Bay.. 1-435.

Soto 2001, Mare Magnum v. 1 (no. 1): 51-120.

Hoese & Gates 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

**Synonymy**: *Spinax granulosus*, Günther 1880; *Etmopterus baxteri* Garrick, 1957

**Diagnostic characters (Based on 1 specimen, 58.7 cm TL):**

Stout-bodied with a short tail, distance from pelvic insertions to lower caudal origins 1.92 in distance between pectoral and pelvic bases and 1.96 in interdorsal space; distance between pectoral and pelvic bases 1.5 times head length; second dorsal fin much larger than first and 1.89 its area; gill openings much greater than spiracle width with 0.5 ED. Origin of first dorsal fin well behind free rear tips of pectoral fins; Pre-dorsal length 1 12 to distance from first dorsal spine to second dorsal midbase. interdorsal space 1.2 in distance from snout tip to pectoral insertions; second dorsal fin much larger than first (2.3 its area); distance between second dorsal base and upper caudal origin 3.1 times in interdorsal space; Lateral trunk denticles with hooked conical underside of head crowns; snout covered with denticles. Colour dark above and below, with vague blackish markings on underside of snout and abdomen, with an elongated narrow black mark running above and behind pelvic fins, and other elongated black marks at caudal fin base and along its axis. Maximum total length 75 cm, adult males at 66 cm, females at 75 cm.

**Geographical distribution (Previous records):** North Atlantic Mediterranean, Southeastern and Western South Pacific: New Zealand.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude (Single specimen).

**Depth:** Found on or near the bottom at depths of 878 to 1427 m. In present study, 800-1100 m.

**Family : Centrophoridae** Bleeker, 1859 (gulper sharks)

**Genus *Centrophorus*** Müller & Henle 1837

*Centrophorus* Müller & Henle, 1837 Ber.K.Preuss.Akad.Wiss.Berl., 2:115. (Type Species: *Squalus granulosus* Bloch & Schroeder, 1801, by monotypy.)

Spinacoid sharks with two dorsal fins, each with a spine, which is sometimes hidden under skin, no anal fin. Trunk elongate, without lateral folds. Mouth wide, but slightly arched, a long, straight, oblique groove on each side of mouth. Teeth of lower jaw with point more or less inclined backward or outward. Upper teeth erect, triangular, or narrow lanceolate, with a single cusp. No nictitating membrane. Spiracles wide, behind eye. Gill openings narrow.

**Key to species**

**1a**. First dorsal fin long and low, second dorsal higher than first, but its base only half length of first dorsal fin base ***C. lusitanicus***

**1b.** First dorsal higher and shorter, second dorsal fin lower than first but its base about 0.67-0.75 of length of first **2**

**2a.** Teeth with erect cusps on upper jaw extending well lateral to symphysis; denticles on sides of body without cusps in adults, broadly rounded, and with ridges confined to rear edges of crowns; oral cavity white; snout less pointed **C. granulose**

**2b.** Teeth on upper jaw with oblique cusps except for a few rows with erect cusps close to symphysis; denticles on sides of body with cusps and wih ridges in adults; oral cavity blackish; snout more pointed **C. uyato**

*Centrophorus lusitanicus* Barbosa du Bocage & Brito Capello 1864

(Plate II, Fig. 12)

**Vernacular Name:** Lowfin gulper shark

*Centrophorus lusitanicus* Bocage & Capello, Proc.Zool.Soc.Lond., 24:260, fig. 1 Holotype A possible syntype in British Museum Natural History), BMNH 1667.7.23.2, 75 cm immature male; other type material probably lost. Type Locality Portugal, Atlantic Ocean.
Compagno et al., 2005, CSIRO Marine Laboratories Report No. 243: 103 pp.
**Synonymy :** *Centrophorus ferrugineus* Chu et at., 1982.

**Diagnostic characters (Based on 2 specimens, 43.2-49.8 cm TL):**

Snout moderately long,broadly parabolic, preoral snout 1.0 1.13 in mouth width, 0.88-0.9 in distance from mouth to pectoral origins. First dorsal fin very low and long; second dorsal high, with base 0.5 to 0.6 of first dorsal base, and spine origin over inner margins of pelvic fins; distance from first dorsal insertion to origin of second dorsal spine about as long as tip of snout to pectoral midbases (0.94–0.99), inner margins slightly shorter than distance from second dorsal spine to caudal origin; caudal fin with a shallowly concave to weakly notched posterior margin. Lateral trunk denticles not overlapping with crowns elongated and longitudinally rhomboidal, with a strong main cusp and no lateral cusps on their posterior edges.

**Geographical distribution (Previous records):** South Africa and the Mozambique Channel, Eastern Atlantic from Off the coast of Portugal to Nigeria and the Wstern Pacific off Taiwan Island.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Deepwater shark living along the edge of the continental shelves and upper slopes at depths between 300 and 1000 m. In present study, 500-800 m.

*Centrophorus granulosus* (Bloch & Schneider 1801)

**Vernacular Name:** Gulper shark

*Squalus granulosus*, Bloch & Schneider 1801:135 [M. E. Blochii, Systema Ichthyologiae., No locality No types known. Type catalog: Paepke & Schmidt 1988:160. •Valid as *Centrophorus granulosus* (Bloch & Schneider 1801)

Bianchi & Carpenter in Bianchi *et al.* 1993, The Living Marine Resources of Namibia. FAO, Rome. I-viii + 1-250, I-VII.

Bañón *et al.* 2008, Journal of the Marine Biological Association of the United Kingdom v. 88 (no. 2): 411-414.

**Synonymy:** *Squalus granulosus*, Bloch & Schneider 1801

**Diagnostic characters (Based on 2 specimens, 59.2-68.3 cm TL):**

Body elongate and slightly compressed, dermal denticles of back widely separated and not overlapping, low crowned, thorn like in young but broad and rounded in adults, without cusps and with low ridges confined to their posterior edges. Snout pointed and longer than mouth width but shorter than distance from mouth to pectoral fin origins. Teeth differing in upper and lower jaws, upper much smaller, relatively broad and blade like, with high mostly erect cusps and no cusplets. Lower large compressed, bladelike with a single oblique cusp, no cusplets a deeply notched outer edge and serrations in adults. A short strong spine with lateral grooves on anterior edges of both dorsal fins.first dorsal relatively high and short, scond dorsal lower than first, its base 0.75-0.78 in first dorsal base, inner corners of pectoral fins greatly elongated, produced as narrow, pointed lobes that extend to behind level of first dorsal spine and with inner margins longer than distance from second dorsal spine to caudal origin. Caudal fin with a strong subterminal notch.

Caudal peduncle without dermal keels or precaudal pits.Grey above lighter below. Maximum 150 cm.

**Geographical distribution (Previous records):** Aldabra Island, Western North Atlantic, Eastern Atlantic from Morocco to Zaire and the Mediterranean Sea and Western Pacific.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Deepwater, found upto 1200 m. 500-800 m.

*Centrophorus uyato (*Rafinesque 1810)

**Vernacular Name:** Little gulper shark

*Squalus uyato* Rafinesque, 1810, known. Type Locality Sicily, Mediterranean Sea.Caratt.gen.sp.anim.piant.Sicilia, Palermo, Pt. 1:12, pl. 14, fig. 2.
Kiraly et al., 2003, Marine Fisheries Review v 65 (no. 4): 1-63.
**Synonymy** *Squalus infernus* Blainville, 1825; *Acanthias nigrescens* Nardo, 1860; *Centrophorus armatus barbatus* Teng, 1962.

**Diagnostic characters (Based on 3 specimens, 61.4-76.2 cm TL):**

Snout rather long, narrowly parabolic, preoral snout 1.3-1.6 of mouth width and 0.9-0.1.2 in distance from mouth to pectoral origins. First dorsal fin moderately high and short, second dorsal moderately large, nearly as high as first, with base 0.72 0.78 length of first dorsal base, and spine origin over rear tips or inner margins of pelvic fins; distance from first dorsal insertion to origin of second dorsal spine about as long as tip of snout to pectoral insertions (1.0-1.14), inner margins about equal to distance from second dorsal spine to caudal origin; caudal-fin with a strongly notched posterior margin. Lateral trunk denticles not overlapping with crowns broad and transversaly rhomboidal, with very short cusps on their posterior edges.

**Geographical distribution (Previous records):** Off South Africa and southern Mozambique, Western North Atlantic, Eastern Atlantic and Mediterranean Sea and Off Taiwan island in the Western Pacific.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Deepwater shark found along the outer continental shelf and uppermost slope from 250 to 1400m. In present study,501-800 m.

**Order: Torpediniformes**

**Family: Narcinidae** Gill 1862 (electric rays, narcinidés, numbfishes)

**Genus: *Benthobatis*** Alcock 1898 (blind rays)

***Benthobatis*** Alcock 1898, Annals and Magazine of Natural History (Series 7) v 2 (no. 8): 136-156. Fem. *Benthobatis moresbyi* Alcock 1898. Type by monotypy. Valid as *Benthobatis* Alcock 1898.
Rincon et al. 2001, Archive of Fishery and Marine Research v. 49 (no. 1): 45-60.
Carvalho et al. 2003, Bulletin of Marine Science v. 72 (no. 3): 923-939.

*Benthobatis moresbyi* Alcock 1898

(Plate II, Fig. 13)

**Vernacular Name:** Dark blind ray

*Benthobatis moresbyi* Alcock, 1898, Natural history notes from H. M. Indian marine survey ship 'Investigator,' Commander T H. Heming, R. N., commanding.--Series II., No. 25. A note on the deep-sea fishes, with descriptions of some new genera and species, including another probably viviparous ophidioid. Ann. Mag. Nat. Hist. (Ser. 7) v. 2 (no. 8): 136-156.
Compagno & Heemstra 2007, Publications in Aquatic Biodiversity, Bulletin No. 7: 15-49.
**Synonymy:** Nil

**Diagnostic characters (Based on 6 Specimens 22.1- 31.2 cm TL):**

Disc length 0.55, Pre Orbital 0.18, AL 0.58, Pre Oral 0.14 in TL, Disc width 0.8, Pre Orbital 0.33, Pre Oral 0.27 in Disc width; Disc length 0.95, Pre Orbital 0.18, Disc width 0.76 and Pre Oral 0.15 in AL. Snout elongated, oval, longer than wide. Dorsal fins with long, fleshy bases which are much longer than height of fin length (0.5-0.55). Origin of first dorsal well anterior to posterior tip of pelvic fins, close to mid pelvic length; dorsal fins close together, interdorsal space less than dorsal bases. Distance between second dorsal and caudal fins much smaller than length of base of second dorsal fin. Caudal fin extremely elongated, reaching almost 1/2 tail length as measured from posterior tips of pelvic fins. Dark brown dorsal and ventral surfaces; ventral entirely dark. 22.1 cm - 31.2cm TL.

**Geographical distribution (Previous records):** Western Indian Ocean: Arabian and Laccadive seas (off Travancore coast).

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** Bathydemersal; depth range 787–1071m. In present study, 500-800 m.

**Order** : **Rajiformes** (rays, sawfishes, skates)

**Family** : **Rajidae** Blainville, 1816 (rays, skates)

**Genus** : ***Dipturus*** Rafinesque 1810 (longnosed skates)

Caratteri di alcuni nuovi generi e nuove specie di animali e piante della sicilia, con varie osservazioni sopra i medisimi. pp. [i-iv] 3-69
Díaz de Astarloa *et al.* 2008, Zootaxa No. 1921: 35-46

*Dipturus johannisdavisi* (Alcock 1899)

(Plate II, Fig. 14)

**Vernacular Name:** Travancore skate

*Raja johannis-Davisi*, Alcock, 1899. Illustrations of the Zoology of the Investigator, pl., XXVII. Fig. 2. Laccadive Sea, off Travancore coast, 11°14'30"N, 74°57'15"E, Investigator station 246, depth 410-520 meters. Holotype (unique): ZSI F477/1. Type catalog: Menon & Yazdani 1968. Records of the Zoological Survey of India v. 61 (pts 1-2) [1963]: 91-190.
Manilo & Bogorodsky 2003. Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** *Raja johannisdavisi*

**Diagnostic characters (Based on 1 specimen 31.3 cm DW):**

The disc without ventral fins 0.47-0.49, Sn L 0.12, IOW 0.03, ED 0.04 and PRDL 0.9 in TL. SnL 0.39, IOW 0.11, ED 0.14 and PRDL 2.89 in disc width without ventral fins. The disc is rhomboidal with angles and its breadth is much more than its length with ventrals. Both surfaces of disc smooth, except for some star-shaped prickles on ventral surface of rostral cartilage and of edges of snout and adjacent part of pectoral fins. The anterior margin of pectroral fin is broadly sinuous. Snout slender, mouth straight. Two strong spines on anterior margin and one at posterior angle of either orbit. A very strong spine in middle of nape. An eminence but not a distinct spine on either side of shoulder and pelvic girdles. Tail smooth except for a mid-dorsal row of large spines which extend from its base to second dorsal fin. Distance between two dorsal fins rather more than half length of base of either; two fins are of about equal size and second is confluent with caudal. Smoky black above, black mottled with white below.

**Geographical distribution (Previous records):** Western Indian Ocean: Gulf of Aden and Travancore coast in India. Questionably from near Zanzibar, Tanzania.

**Distribution in the Southwest coast (Present study):** Between 13$^{o}$ and 15$^{o}$ N latitude.

**Depth:** Bathydemersal; marine, deep-water; depth range 457–549 m. In present study, 500-800 m.

## Genus: *Raja* Linnaeus 1758 (ocellate skates)

***Raja*** Linnaeus 1758, Systema Naturae, Ed. X. v. 1: i-ii + 1-824.
Genz et al. 2007, Zootaxa No. 1440: 1-19.

### *Raja miraletus* Linnaeus 1758

**Vernacular Name:** brown ray, twineye skate

*Raja miraletus* Linnaeus, 1758, Systema Naturae, Ed. X. v. 1 (Mediterranean).
*Raia ocellifera* Regan, 1906: 2, pl.2 (Algoa Bay). Smith, SFSA No. 69; 1964· *Raja (Raja) miraletus*: Hulley, 1972: 77

Bianchi & Carpenter in Bianchi et al. 1993, FAO Species Identification Field Guide for Fisheries Purposes. FAO, Rome. I-viii + 1-250, I-VII.
Heemstra & Heemstra 2004, Coastal Fishes of Southern Africa.. i-xxiv + 1-488.
**Synonymy:** *Raia ocellifera, Raia quadrimaculata, Raja quadrimaculat*

**Diagnostic characters (Based on 1 specimen 28.9 cm DW):**

The disc without ventral fins 0.47, Sn L 0.12, IOW 0.03, ED 0.04 and PRDL 0.9 in TL. SnL 0.39, IOW 0.11, ED 0.14 and PRDL 2.89 in disc width without ventral fins. 46 rows of teeth in upper jaw. 6 thorns on inner orbital margin, 2 median nuchal thorns, 12 thorns in semi-lateral and 7 thorns in lateral row on each side of tail; spinules on snout; front margins of disc, midline of back and sometimes on posterior pectoral angle; ventral surface with spinules on snout, front margins of disc and internasal region. Dorsally brownish, without small darker spots; a large blue-black ocellus at each pectoral base, consisting of 3 definite rings of colour; ventrally pale, without a small dark spot on tip of snout. Attains 50cm TL, 35 cm disc width.

**Geographical distribution (Previous records):** Eastern Atlantic: northern Portugal and throughout Mediterranean to Madeira and South Africa. Also in southwestern part of the Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** Previous records from depths 20-440 m. In present study, 500-800 m.

**Genus :** ***Leucoraja*** Malm 1877 (rough skates)

***Leucoraja*** Malm 1877:121, 609, Göteborgs och Bohusläns fauna, Ryggradsdjuren. 1-674, Pls. 1-9.
Last et al. 2008:145, CSIRO Marine and Atmospheric Research Paper No. 021 145-154.

*Leucoraja circularis* (Couch 1838)

**Vernacular Name:** Sandy ray, cuckoo ray

Raja circularis, COUCH, Charlesworth's Mag. Nat. Hist., 1838, II, 71, Cornish Fanu., p.53; Fish. Brit. Isl., i. 115, pl. 28.—GONTHER, Cat. Fish. Brit. Mus., VIII, 162; Challenger Report, XXII. 8.—Day, Fish. G. B. and Ireland. II. 348, pi. CLXXIV

Last et al. 2008:145, CSIRO Marine and Atmospheric Research Paper No. 021: 145-154.
**Synoymy:** *Raja circularis, Raja falsavela, Raja falsavela intermedia*

**Diagnostic characters (Based on 2 specimens 65.3-73.8 cm TL):**

Snout short, its tip somewhat pronounced; upper surface entirely spinulose, about 8 thorns generally in a complete row around inner margin of eye and a triangle of thorns on nape or shoulder region; underside with prickles only on snout, between gill-slits, along abdomen, and at anterior margins of disc; tail only slightly longer than body; upper surface reddish-brown to dark brown with 4-6 creamy spots on each wing, underside white. Maximum length (TL) for males 120 cm and female is 117 cm.

**Geographical distribution (Previous records):** Eastern Atlantic: Iceland, southern Norway, Skagerrak and Morocco, including western Mediterranean.

**Distribution in the Southwest coast (Present study):** Between 13° and 15° N latitude.

**Depth:** Demersal, depth range 70 – 676 m. In present study, 500-800 m.

**SubClass** : **Holocephali** (Cartilaginous fishes, chimaeras)

**Super Order** : **Holocephalimorpha**

**Order** : **Chimaeriformes** (chimaeras)

**Sub Order** : **Chimaeroidei**

**Family** : **Rhinochimaeridae** Garman, 1901
(longnosed chimaeras, ratfishes)

Long and pointed snout, lacking a hooklike process. First dorsal fin erectile, with a strong, mildly toxic spine; second dorsal fin long, low and not falcate. Diphycercal tail, i.e., the vertebral column is extending to the tip and divides the caudal fin symmetrically; caudal fin may be confluent with or separate from anal fin.

## Key to Genera

**1a.** Anal fin present ***Neoharriotta***

**1b.** No anal fin **2**

**2a.** Dorsal profile of head nearly straight; mouth in front of eye; tooth plates narrow; sharp-edged and smooth ***Rhinochimaera***

**2b.** Dorsal profile of head arched; mouth below eyes; tooth plates broad; blunt-edged and ridges ***Harriotta***

### Genus: *Neoharriotta* Bigelow and Schroeder, 1950

***Neoharriotta*** Bigelow & Schroeder 1950:406, Bulletin of the Museum of Comparative Zoology v. 103 (no. 7): 385-408, Pls. 1-7
Didier 2003:595, The living marine resources of the Western Central Atlantic. v. 1.

*Neoharriotta pinnata* (Schnakenbeck, 1931)

(Plate II, Fig. 15)

**Vernacular Name:** Sicklefin chimaera

*Harriotta pinnata* Schnakenbeck, 1931 309, Figs. 6,7 and 8 (Walvis Bay); Poll, 1951 144.
*Neoharriotta pinnata:* Bigelow and Schroeder, 1953: 550; Smith, 1953: 78, No. 97 1965: 14; Karrer, 1973: 217
Manilo & Bogorodsky 2003:S94, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** *Harriotta pinnata*

**Diagnostic characters (Based on 1 specimen 79.3 cm TL):**

Narrow, slightly flattened snout, blunt-edged, ridged tooth plates; pectoral fins short and broad, anal fin large and curved, and caudal fin with no tubercles on upper edge but with a short terminal filament. Pectoral short and broad; Dorsal spine serrated. Snout moderately slender in adults, not tuberculate. No denticles on caudal of adult males. Frontal clasper very large in males. Colour uniform chocolate brown. Attains about 128 cm.

**Geographical distribution (Previous records):** Eastern Atlantic: Cape Blanc, Mauritania to Walvis Bay, Namibia. Western Indian Ocean: Arabian Sea. Gulf of Guinea to Walvis Bay

**Distribution in the Southwest coast (Present study):** Between 11° to 13° N Latitude.

**Depth:** Bathydemersal; marine; depth range 150 - 500 m. Present studies 500 – 800 m.

**Genus : *Rhinochimaera* Garman, 1901**

***Rhinochimaera*** Garman 1901:75, Proceedings of the New England Zoölogical Club v. 2: 75-77
Paxton et al. 2006:54, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Rhinochimaera atlantica* Holt and Byrne, 1909

(Plate II, Fig. 16)

**Vernacular Name:** Knife-nosed chimaera

*Rhinochimaera atlantica* Holt and Byrne, 1909; 279 (Ireland); Bigelow and Schroeder, 1954; 72; Penrith, 1969: 66; Scherbachev, 1978:8.
Holt, E. W. L. & L. W. Byrne. 1909. Preliminary note on some fishes from the Irish Atlantic slope. Ann. Mag. Nat. Hist. (Ser 8) v 3 (no. 15): 279-280.
Møller et al. 2004:59, Cybium v 28 (no. 1): 55-60.
**Synonymy:** *Harriotta atlantica*

**Diagnostic characters (Based on 3 specimens 68.3–74.1 cm TL):**

**D. I, 0**

A longnose chimaera with a narrow, moderately flattened, pointed snout and smooth, sharp-edged tooth plates.Dorsal profile of head nearly straight; mouth in front of eye. Pectoral fins long and narrow. Dorsal spine smooth and caudal fin with very short terminal filament and wide-spaced tubercles on upper edge. Dorsal margin of caudal thickened in adults, with series of enlarged denticles in males. Adult males with small frontal clasper Whitish to uniform chocolate brown. Attains about 140 cm TL.

**Geographical distribution (Previous records):** Northwest to Northeast Atlantic, and Southeast Atlantic: Antitropical. Eastern Atlantic: northern Bay of Biscay northward to Iceland, including the Iceland-Faroes Rise; off Cayar and

Cape Barbas in Western Sahara, off Namibia and South Africa. Western Atlantic: off Nova Scotia, Canada and New England, USA

**Distribution in the Southwest coast (Present study):** Between 09° and 13° N Latitude

**Depth:** Bathydemersal; marine; depth range 500  1500 m. In present study,500 – 800 m.

**Genus : *Harriotta*** Goode and Bean, 1895

***Harriotta*** Goode & Bean 1895:471, Proceedings of the United States National Museum v. 17 (no. 1014): 471-473, Pl. 19.
Paxton et al. 2006:54, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Harriotta raleighana* Goode and Bean, 1895

(Plate II, Fig. 17)

**Vernacular Name:** Narrownose chimaera

*Harriotta raleighana* Goode and Bean, 1895; 472, pl. 19 (Atlantic coast of U.S.A.), Proc. U. S. Natl. Mus. v. 17 (no. 1014). 471-473.
Bigelow and Schroeder, 1953:551; Smith, SFSA No. 96; Karrer, 1973: 217; Shcherbachev, 1978:8.
Paxton et al. 2006:54, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonyms:** *Anteliochimaera chaetirhamphus, Harriotta curtissjamesi, Harriotta opisthoptera.*

**Diagnostic characters (Based on 1 specimen 557.7 cm TL):**

**D. I,0**

A longnose chimaera with a rather long, narrow, depressed snout, a small eye situated above or behind mouth, a rather long first dorsal fin and spine, knobby tooth plates, and caudal fin lanceolate with no tubercles on upper edge but with a long terminal filament. Dark brown or blackish in colour. Snout slender and tuberculate in adults. Pectoral short and broad; dorsal spine serrate. No separate anal fin. No denticles on caudal of adult males. Claspers are rod like, rather slender, unbranched, with tip somewhat swollen. Frontal clasper small in males. Jugular and oral canals arising separately from orbital, with a short interspace; angular (maxillary) canal joining suborbital about 2/7 of distance from front level of eye towards tip of snout. Colour uniform chocolate brown. Attain 1 m.

**Geographical distribution (Previous records):** Eastern Atlantic: Iceland, Faeroe Islands, Rockall Trough along Ireland to northern France; Canary Islands and off Cape Blanc, Mauritania; Namibia and South Africa. Western Atlantic: Nova Scotia, Canada to Chesapeake Bay in USA; southern Brazil. North Pacific: off Japan and California, USA; off southern Baja California. South Pacific: off New Zealand and Australia off western Cape, Brazil, North Atlantic, eastern and western Pacific.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N Latitude.

**Depth:** Bathydemersal; marine; depth range 200 - 2600 m. In present study, 500 – 1100 m.

| | |
|---|---|
| **SuperClass** | : **Osteichthyes** (bony fishes) |
| **Class** | : **Actinopterygii** (ray-finned fishes, spiny rayed fishes) |
| **SubClass** | **Neopterygii** (neopterygians) |
| **InfraClass** | : **Teleostei** |
| **Super Order** | : **Elopomorpha** |
| **Order** | : **Albuliformes** |
| **Sub Order** | **Notacanthoidei** |

Body eel-like; posteriorly directed spine on dorsal edge of rear of maxilla; premaxilla and maxilla bordering upper jaw; gill membranes separate; pectoral fins relatively high on body; pelvic fins abdominal, with 7-11 rays ( two fins are usually connected by a membrane); anal fin base long and merged with what remains of caudal fin; caudal fin skeleton reduced or absent; tail easily regenerated when lost; branchiostegal rays 5-23; swim bladder present. Some have photophores.

**Family : Halosauridae** (halosaurs)

Teeth present in premaxilla and maxilla. Branchiostegal membranes not united; rays 9-23. Dorsal fin far anterior to anus, with 9-13 soft rays and spineless. Cavernous lateral line stretches over entire body length lateroventrally. Relatively large scales; less than 30 lateral series of scales on each side.

**Genus : *Halosaurus*** Johnson, 1864

*Halosaurus*, Johnson, Proc. Zool. Soc. 1863, p.406: Gunther, Cat. Fishes, VII. P 482, and Challengr Deep-Sea Fishes, p. 232.
Pais et al. 2009:33, Acta Ichthyologica et Piscatoria v. 39 (no. 1): 33-37

*Halosaurus carinicauda* Alcock, 1889

(Plate II, Fig. 18)

**Vernacular Name:** Nil

*Halosaurus parvipennis* Alcock, 1889. ann. Mag.Nat. Hist., p.362: Illustrations of the Zoology of the Investigator, Fishes, pl. XXXIII, fig. 1
Menon & Rama-Rao 1975:37, Matsya No. 1 31-48.
Synonym of *Halosaurus carinicauda* Alcock 1889 - McDowell 1973:57, Memoirs of the Sears Foundation of Marine Research No. 1 (Pt 6): 1-228.
**Synonymy:** *Halosaurus parvipennis*

**Diagnostic characters (Based on 1 specimen 21.2 cm TL):**

**B. 13; D. 10; P. 12; V. I,9; Lat. 15 (pre-anal)**

Head and snout scaly. HL 0.13 of TL, less than distance between gill-opening and base of ventral fin. SnL 0.33 of HL, preoral 0.5 SnL. ED 2.15 in IOW. The maxilla does not quite reach vertical through anterior margin of orbit. The gill-rakers on outer side of first branchial arch are short and distant. The dorsal fin begins about an eye-length behind insertion of outer most ventral ray. Ventral fins not united. The pectorals are narrow and as long as post-orbital portion of head. Opercles silvery, throat and edge of opercles black.

**Geographical distribution (Previous records):** Arabian Sea, off Malabar Coast.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** 459 to 880 fathoms. In present study, 501-800 m.

**Family : Notacanthidae** (spiny eels)

Branchiostegal membranes at least partly joined; at least part of dorsal fin posterior to anus; lateral line not cavernous and well up on side; scales relatively small, more than 50 longitudinal rows occur on each side. Some species with 3 spinelike rays in each pelvic fin.

**Genus *Notacanthus*** Bloch, 1788

***Notacanthus*** Bloch 1788:278, Abhandlungen der Böhmischen Gesellschaft der Wissenschaften v. 3 [for 1787]: 278-282, 2 pls.
Paxton et al. 2006:233, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Notacanthus indicus* Lloyd, 1909

(Plate II, Fig. 19)

**Vernacular Name:** Deep-sea spiny eel

*Notacanthus indicus,* Lloyd, 1909. Weitkamp, D.E. and R.D. Sullivan 1939. Fishes. The John Murray Expedition 1933-34. Sci. Reports, John Murray Exped., 25 Nov v. 7 (no. 1): 1-116
McDowell 1973:186, Memoirs of the Sears Foundation of Marine Research No. 1 (Pt 6): 1-228.

**Synonymy:** Nil

**Diagnostic characters (Based on 1 specimens 24.4 cm TL):**

**D. XIV, 0; A. XXXII, 85; V. IV, 7; P. 11**

Body and head stouter, laterally compressed, tapouring posteriorly. HL 0.19, Pre Ventral 0.36 and Pre Anal 0.45 in TL. Mouth subterminal, reaching up to middle of eye. PrOL 0.17 and ED 0.15 in HL. Pectorals small, PL 0.15 in TL. Dorsal originate above ventrals, anal from middle of body. Lateral line extends upto caudal, runs through upper 0.67 of body. Greatest body depth 2.98 in pre-anal length. DPF 0.13 and DVF 0.14 in TL. Anal fin confluent with caudal. Mouth cleft, opercular margins, all fins black in colour. Body with dark colouration in trunk portion and whitish in all other parts.

**Geographical distribution (Previous records):** Western Indian Ocean: Arabian Sea.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude

**Depth:** Bathypelagic; depth range 960 – 1046 m. In present study, 501-800 m.

**Order: Anguilliformes** (anguilles, eels)

Pelvic fins and skeleton absent; pectoral fins and girdle absent in some; pectoral fins, when present, at least midlateral in position or higher and skeleton lacking bony connection to skull (post-temporal absent); dorsal and anal fins confluent with caudal fin (caudal fin rayless or lost in some); scales usually absent or, if present, cycloid and embedded; body very elongate (eel-like); gill openings usually narrow; gill region elongate and gills displaced posteriorly; gill rakers absent; pyloric caeca absent; maxilla toothed, bordering mouth; two pre-maxillae (rarely absent), vomer (usually), and ethmoid united into a single bone; branchiostegal rays 6-49; swim bladder present, duct usually present; oviducts absent; opisthotic, orbitosphenoid, mesocoracoid, gular plate, post-temporal, postcleithra, supramaxilla, and extrascapular bones absent; ossified symplectic absent (cartilaginous one present in Synaphobranchidae); hyomandibular united with quadrate; ribs present or absent.

**Key to Family**

**1a.** Tail shorter than head and trunk combined **Colocongidae**

**1b.** Tail longer than head and trunk combined **2**

**2a.** Rear nostrils on midlateral part of snout just before eye; pectoral present; gill openings ventrolateral and oblique, ventral and horizontal, or confluent midventrally **Synaphobranchidae**

**2b.** Rear nostrils not close to eye; gill openings lateral, wide or restricted (if gill openings are ventral, then perctoral and caudal absent) **3**

**3a.** Snout not much longer than eye diameter **Congridae**

**3b.** snout length much greater than eye diameter **Nemichthyidae**

**Sub Order : Congroidei**

**Family : Colocongridae** (colocongrids)

Body stubby and snout blunt (least elongate anguilliform); lateral line complete, most pores in short tubes; anus well behind midlength; pectoral fin well developed; vomerine teeth absent.

**Genus : *Coloconger*** Alcock, 1889

***Coloconger*** Alcock 1889:456, Annals and Magazine of Natural History (Series 6) v 4 (no. 24): 450-461.
López et al. 2007:959, Copeia 2007 (no. 4): 959-966.

*Coloconger raniceps* Alcock, 1889

(Plate II, Fig. 20)

**Vernacular Name:** Froghead eel

*Coloconger raniceps*, Alcock, Ann. Mag. Nat. Hist., Dec. 1889, p.456.
Manilo & Bogorodsky 2003:S95, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** Nil

**Diagnostic characters (Based on 10 specimens 14.2–28.1 cm TL):**

Head frog-like, 0.49-0.57 in distance between gill-opening and vent, and 0.2-0.31 in TL. Snout blunt, 0.89-0.12 ED. ED 0.24-0.26 HL and 0.97-1 1

IOW. Nostrils large, anterior sub-tubular, posterior above angle of eye. Mouth cavernous, its cleft extending to hinder edge of pupil. Jaws slender, equal with a row of small uniform teeth in continuous contact, except at their extreme tips. A large, oval horny, granular plate behind superior pharyngeal bones. A mucous channel with numerous pores along lower jaw beneath. No scales. Head with numerous black tubular papillae. Lateral line a salient tube, with upwards of a hundred similar papillae. Vertical fins confluent. Body uniformely black.

**Geographical distribution (Previous records):** Indo-West Pacific: East Africa and Madagascar to the western Pacific, north to southern Japan. Andaman Sea; Bay of Bengal; Arabian Sea, off Malabar Coast.

**Distribution in the Southwest coast (Present study):** Between 7° and 15° N Latitude.

**Depth:** Bathydemersal; marine; depth range 300 - 1134 m. In present study, 201-800 m.

**Family Synaphobranchidae** (cutthroat eels, deepsea eels)

**Sub Family: Synaphobranchinae** (cutthroat eels)

Body stout to elongate, anus usually well in front of midbody. Snout may be short and blunt or moderately elongate. Mouth usually large, gape extending behind rear margin of eye; lips without a fleshy flange; jaws nearly equal, sometimes snout projects slightly beyond lower jaw and sometimes vice versa. Teeth usually small and conical, in 1 to several rows on jaws and vomer; large fangs never present. Anterior nostril tubular, near tip of snout; posterior nostril on side of snout, at or below mideye level. Gill opening low on body; sometimes gill openings of 2 sides united in a ventral slit. Dorsal and anal fins well developed, confluent with caudal fin. Lateral line variable, often complete, sometimes reduced to a few pores at anterior end and sometimes no pores at all.

**Key to genera**

**1a.** Dorsal origin over P base; anus in about middle of TL ***Histiobranchus***

**1b.** Dorsal origin over or behind anus; anus in anterior third of TL ***Synaphobranchus***

### Genus : *Histiobranchus* Gill, 1883

***Histiobranchus*** Gill 1883:255, Proceedings of the United States National Museum v. 6 (no. 380): 253-260.
Paxton et al. 2006:262, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Histiobranchus bathybius* (Günther, 1877)

(Plate III, Fig. 21)

**Vernacular Name:** Deepwater arrowtooth eel

*Synaphobranchus bathybius* Gunther, 1877· 445 (North Pacific); 1887· 254. *Synaphobranchus australis* Regan, 1913: 235, pl.8, Fig. 5 (Indian Ocean, ca. 46oS, 45oE; 2525m).
Smith 2003:723, The living marine resources of the Western Central Atlantic. v. 2.
**Synonymy:** *Synaphobranchus bathybius,* Histiobranchus infernalis, Synaphobranchus infernalis

**Diagnostic characters (Based on 3 specimens 38.7-42.9cm TL):**

D.0, 312-354; A. 0,199-245. Dorsal fin rays anterior to anus 98-139; lateral line pores before anus 50-56. HL 0.06-0.07, BD 0.10-0.12 in TL. Pectorals small. D origin over P base. Teeth small, sharp, in bands on jaws, in a distinct inter-maxillary patch and in an irregularly biserial row on vomer. Plain brown to black. Attains 65 cm.

**Geographical distribution (Previous records):** North Atlantic and North Pacific. Durban, South Africa and Indo-Pacific. Off Durban; also in Atlantic and Indo-Pacific.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Benthopelagic; marine; depth range 295 - 5440 m. In present study, 500 – 800m.

### Genus : *Synaphobranchus* Johnson, 1862

***Synaphobranchus*** Johnson 1862:169, Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1862 (pt 2): 167-180, Pls. 22-23.
Paxton et al. 2006:263, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Synaphobranchus kaupii* Johnson, 1862

**Vernacular Name:** Grey cutthroat

***Synaphobranchus kaupii***, Johnson 1862:169, Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1862 (pt 2); Atlantic off Madeira. Syntypes: BMNH 1862.11.9.49 (1). Valid as *Synaphobranchus kaupii* Johnson 1862.
Melo 2007:315, Copeia 2007 (no. 2): 315-323.
**Synonymy:** *Nettophichthys retropinnatus*

**Diagnostic characters (Based on 5 specimens 41.1-43.8 cm TL):**

Body moderately elongated, HL 0.13-0.14 in TL and 0.95-1 12 of distance between gill-opening and vent; Tail 0.56-0.62 of TL. SnL 0.31-0.38 HL and 1.98-2.34 ED. Mouth-cleft rather over half length of head. Teeth in jaws in a narrow band with some enlarged ones anteriorly: a single short row of large teeth on premaxillary, and a single row of small teeth on vomer. Scales rudimentary, forming a diagonal pattern. Lateral line distinct. Cheeks and occiput scaly. Dorsal fin arises about a head-length and a third behind gill-opening, and therefore a short distance behind anal: both fins low. Pectorals half as long as head. Colour purple-black or brown.

**Geographical distribution (Previous records):** Circumglobal, except the northeast Pacific. Eastern Atlantic: Liberia to northern Angola; Arabian Sea.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** Benthopelagic; marine; depth range 290 - 2400 m. In present study, 201 – 800 m.

**Family : Congridae** (conger eels)

**Sub Family : Congrinae**

Body moderately elongate to extremely elongate; anus usually located at anterior half to third of total length. Eyewell (Eye well) developed, sometimes very large. Tip of snout usually extends at least slightly beyond tip of lower jaw. Anterior nostril tubular, near tip of snout; posterior nostril usually located on side of head in front of eye. In most species tip of lower jaw fits into space behind intermaxillary tooth patch. In many species, intermaxillary teeth visible when mouth closed. Branchiostegal rays long but not overlapping ventrally, usually about 8 to 12. Gill opening a crescentic slit, just in front of pectoral fins. Dorsal and anal fins always present, confluent around tail; dorsal fin always closer to pectoral fins than to anus; caudal fin sometimes reduced; pectoral fins well developed in most species, but reduced or absent in heterocongrines and *Gavialiceps*. Scales absent. Lateral line complete.

**Key to Genera**

**1a.** Vomerine teeth in a small cluster of sharp teeth anteriorly, usually with 1 or 2 enlarged and in tandem, and a few smaller ones flanking them; pores along upper lip enlarged **2**

**1b.** Vomerine teeth forming a multiserial band on roof of mouth, none enlarged or fang-like; pores along upper lip usually not enlarged **3**

**2a.** The posterior nostril is in front of upper part of eye ***Bathycongrus***

**2b.** Posterior nostril at or above mideye level ***Bathyuroconger***

**3a.** Vomerine tooth patch very short, its length little if any greater than its width **_Rhynchoconger_**

**3b.** Vomerine tooth patch more elongate, its length substantially greater than its width........................................................................... **_Promyllantor_**

## Genus: *Bathycongrus* Ogilby, 1898

***Bathycongrus*** Ogilby 1898:292, Proceedings of the Linnean Society of New South Wales v. 23 (pt 3): 280-299.
Karmovskaya & Smith 2008:26, Zootaxa No. 1643: 26-36.

### *Bathycongrus wallacei* (Castle, 1968)

(Plate III, Fig. 22)

**Vernacular Name:** Longnose conger

***Congrina wallacei***, Castle 1968:709, Pl. 107 B; Fig. 1 (a-b) [Ichthyological Bulletin of the J. L. B. Smith Institute of Ichthyology No. 33; Off the mouth of Limpopo River, Mozambique, depth 480-500 meters. Holotype: SAIAB [formerly RUSI] 620 [=8074]. Paratypes: SAIAB [formerly RUSI] 8075 (1), 8076 [ex 621] (1). Additional material (2). Valid as *Rhechias wallacei* (Castle 1968).
Karmovskaya & Smith 2008:35, Zootaxa No. 1643: 26-36.
**Synonymy:** *Congrina wallacei, Rhechias wallacei, Bathycongrus baranesi*

**Diagnostic characters (Based on 4 specimens 38.6–46.1 cm TL):**

Body elongated, moderately compressed, snout sharply pointed. Dorsal fin origin above first quarter up to first third of length of pectorals. Head 0.24 in TL, PrOL 0.17 and ED 0.08 in HL. 2 enlarged vomerine teeth on elevated base; largest vomerine tooth larger than intermaxillary teeth. The posterior nostril is in front of upper part of eye. Pre-anal pores 37-43. Dorsal rays before anus 59-67 Overall black, grey dorsally, lighter ventrally, median fins black posteriorly. Attains 55 cm TL.

**Geographical distribution (Previous records):** Indo-West Pacific: southern Mozambique to Natal, South Africa; Japan, Philippines and Indonesia.

**Distribution in Southwest coast (Present study):** Between 09° and 13° N latitude.

**Depth:** Bathydemersal, depth range recorded 250-500 m. In present study,501-800 m.

### Genus : *Bathyuroconger* Fowler, 1934

***Bathyuroconger*** (subgenus of *Uroconger*) Fowler 1934:273, Proceedings of the Academy of Natural Sciences of Philadelphia v 85 (for 1933): 233-367
Hoese & Gates 2006:290, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Bathyuroconger vicinus* (Vaillant, 1888)

(Plate III, Fig. 23)

**Vernacular Name:** Large-toothed conger

***Uroconger vicinus***, Vaillant 1888:86, Pl. 6 (figs. 1, 1a-b). Expéditions scientifiques du "Travailleur" et du "Talisman" pendant les années 1880, 1881, 1882, 1883. Poissons. Coasts of Soudan (depth 932 meters); Argnin Bank (depth 1495 meters); Cape Verde Islands (depth 1633 meters). Syntypes: MNHN 1884-0433 (1), 1884-0434 (1), 1884-0436 (1), 1884-0437 (1). Type catalog: Bauchot et al. 1993:117 with 1884-436 as holotype. Valid as *Bathyuroconger vicinus* (Vaillant 1888).
Hoese & Gates 2006:290, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Uroconger vicinus, Uroconger braueri, Bathyuroconger braueri*

**Diagnostic characters (Based on 4 specimens 41.1–49.7 cm TL):**

Body moderately elongate, HL 0.12, Depth at Eye 0.06 in TL, mouth horizontal or slightly oblique; anterior nostrils free; posterior nostril at or above mideye level. Snout equal to eye, 0.01 in TL. Jaws nearly equal; anterior teeth very strong, fang-like vomerine tooth patch with some enlarged teeth, forming a short row posteriorly. Upper labial flange absent; pores along upper jaw enlarged. Inner row of maxillary and mandibular teeth not separated from outer rows by an edentulous groove. Maxillary and mandibular teeth concealed when mouth closed. Preanal length 0.37-0.39 in TL, dorsal- and anal-fin rays segmented. Tip of tail soft and flexible, caudal fin not reduced;

pectoral fin well developed; caudal fin present though reduced. Dark brownish black.

**Geographical distribution (Previous records):** Eastern Atlantic: Cape Verde, Gulf of Guinea, Namibia and off Cape Point, South Africa. Western Atlantic: eastern Gulf of Mexico southward along coast of Central and South America to the Guianas. Indo-Pacific: eastern Africa to Hawaii.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Benthopelagic; 120 – 1318 m. Present stdy 501-1100 m.

### Genus : *Rhynchoconger* Jordan and Hubbs, 1925

***Rhynchoconger*** Jordan & Hubbs 1925.192, 196, Memoirs of the Carnegie Museum v 10 (no. 2): 93-346, Pls. 5-12.
Hoese & Gates 2006:296, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Rhynchoconger ectenurus* (Jordan and Richardson, 1909)

(Plate III, Fig. 24)

**Vernacular Name:** Longnose conger

***Leptocephalus ectenurus,*** Jordan & Richardson 1909:171, Pl. 66 (lower fig.), Memoirs of the Carnegie Museum v. 4 (no. 4); Kao-Hsiung (Takao), Taiwan. Holotype: FMNH 52117 [ex CM 245]. Paratypes: SU 21259 (1).
Hoese & Gates 2006:296, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Leptocephalus ectenurus, Rhynchocymba ectenura*

**Diagnostic characters (Based on 3 specimens 28.3–34.2 cm TL):**

Body moderately elongate, HL 0.14 – 0.15 in TL, mouth slightly oblique; flange on upper lip present or absent. Aanterior nostrils free, posterior nostril at or above mideye level. Snout short, PrOL 0.02 in TL. ED 0.01 and Depth at Eye 0.04 in TL. Teeth small; maxillary and mandibular teeth in bands or in 2 rows, not forming a cutting edge. Vomerine teeth in 2 or more rows, at least anteriorly, ending before posterior end of maxillary tooth patch; upper labial flange rudimentary. Inner row of maxillary and mandibular teeth not separated from outer rows by an edentulous groove; maxillary and mandibular teeth concealed when mouth closed. Preanal length 0.39- 0.41 in TL. Dorsal- and anal-fin rays segmented. Pectoral fin well developed, 0.07 in TL; tip of tail soft and flexible, caudal fin not reduced.

**Geographical distribution (Previous records):** Western Pacific: Japan, Korean Peninsula, East China Sea and northern Australia.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** In present study, 201-500 m.

### Genus : *Promyllantor* Alcock, 1890

***Promyllantor*** Alcock 1890:310, Annals and Magazine of Natural History (Series 6) v. 6 (no. 34): 295-311
Smith 1999:1685, In: Carpenter and Niem 1999

*Promyllantor purpureus* Alcock, 1890

(Plate III, Fig. 25)

**Vernacular Name:** NIL

*Promyllantor purpureus* Alcock, Ann. Mag. Nat. Hist., 1890, p. 310
Karmovskaya 2006:566, Journal of Ichthyology v. 46 (no. 8): 566-569.
**Synonymy:** *Ariosoma purpureus*

**Diagnostic characters (Based on 2 specimens 43.1-48.9 cm TL):**

Head with its muciferous cavities highly developed, low with a broad, swollened snout. HL 0.17 in TL, PrOL 0.21-0.29 in HL. Mouth-cleft reaching slightly behind vertical through anterior border of orbit. Eyes small, ED 0.11 in HL. Gill-openings small; 4 gills with narrow laminae and coarse lamellae and wide clefts; no gill-rakers. Integument thick, coriaceous, scaleless, investing vertical fins and completely conceiling their rays. The lateral line transverses middle of body. Vertical fins confluent; dorsal begins a distance behind occiput. The anal begins immediately behind vent, AL 0.36 in TL. Pectorals small, pointed, equal in length to postorbital portion of head PL 0.08 in TL. Body and fins in purple-black.

**Geographical distribution (Previous records):** Indo-West Pacific: off southwest Indian coast and from Sulawesi, Indonesia. Arabian sea, off the Laccadives Islands.

**Distribution in the Southwest coast (Present study):** Between 13° and 15° N latitude.

**Depth:** Bathydemersal; marine; depth range 1120 - 2250 m. In present study, 501-800 m.

### Family Muraenesocidae (false conger eels, pike congers)

Well developed teeth, especially on vomer. Pectorals well developed. Large eyes covered with skin. Origin of dorsal fin over or slightly before pectoral base. Conspicuous lateral line.

**Key to Genera**

| | |
|---|---|
| **1a.** No conspicuous sensory pores on head | ***Sauromuraenesox*** |
| **1b.** Sensory pores on head conspicuous | **2** |
| **2a.** Pectoral fins present | ***Xenomystax*** |
| **2b.** No pectoral fins | ***Gavialiceps*** |

### Genus : *Sauromuraenesox* Alcock, 1889

***Sauromuraenesox*** Alcock 1889:457, Annals and Magazine of Natural History (Series 6) v. 4 (no. 24): 450-461.
Smith 1999:1673, In: Carpenter and Niem 1999

## *Sauromuraenesox vorax* Alcock, 1889

**Vernacular Name:** Nil

*Sauromuraenesox vorax* Alcock, Ann. Mag. Nat. Hist., 1889, p. 458.
Manilo & Bogorodsky 2003:S96, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.

**Synonymy:** Nil

**Diagnostic characters (Based on 3 specimens 36.5-41.1 cm TL):**

Lizard-like body, body being high with an arched back, and tail being low, even at its junction with trunk, and tapering. Maximum depth of head almost twice depth of body at anus. HL 0.61-0.69 distance between gill-opening and vent and 0.2-0.25 TL. SnL 1.97-2.31 IOW and 2.01-2.03 ED; tapers to a slightly hooked fine point. Cleft of mouth wide, extending an eye-length behind posterior border of orbit; upper jaw overlapping lower. In maxillae and mandibles a single row of close-set, equal, acute teeth of moderate size. Vomer with a median series of enlarged fangs. Premaxillae with three smaller canines, which project when mouth is closed. Gill-openings wide, extending obliquely from upper border of base of pectoral fins to near middle line of abdomen; a broad flap of skin connects their anterior margin with base of pectoral fin; gill-laminae broad. The lateral line follows dorsal curve and ends in posterior half of tail. Vertical fins, especially anal, feebly developed, confluent; dorsal begins considerably in advance of gill-opening, anal behind a very large abdominal pore. Pectoral longer than snout. Caudal fin not reduced, tip of tail soft and flexible; anus at or before midlength. Chocolate above, whitish or silvery below; vertical fins whitish, pectorals dark brown edged with grey.

**Geographical distribution (Previous records):** Eastern Indian Ocean: Bay of Bengal.

**Distribution in the Southwest coast (Present study):** Between 13° and 15° N latitude.

**Depth:** In present study, 201-500 m.

**Genus : *Xenomystax* Gilbert, 1891**

***Xenomystax*** Gilbert 1891:348, Proceedings of the United States National Museum v. 14 (no. 856): 347-352.
Smith 2003:746, In: Carpenter 2003. The living marine resources of the Western Central Atlantic. v. 2.

*Xenomystax trucidans* Alcock, 1894

(Plate III, Fig. 26)

**Vernacular Name:** Nil

Xenomystax trucidans, Alcock, Journ. As. Soc. Bengal, Vol. LXIII., pt. 2, 1894, p. 134: Illustrations of the Zoology of the Investigator, Fishes, pl. XVI., fig. 5.
Adam et al. 1998:8, Ichthyological Bulletin of the J. L. B. Smith Institute of Ichthyology No. 67: 1-19.
**Synonymy:** Nil

**Diagnostic characters (Based on 7 specimens 49.3-65.2 cm TL):**

HL 0.98-1.12 distance between gill-opening and vent, 0.16-0.18 in TL. The snout is depressed and sharply pointed, 0.3-0.38 of HL, 3.7-4.2 ED. The mouth-cleft is wide, extending an eye-length behind posterior border of orbit, or more than half way along head. The teeth are in broad crowded bands, acicular or canine form, and for most part depressible: those in upper jaw are in two bands – an outer very broad band of large depressible teeth in four series which increase in size from without inwards, and an inner narrow band or very close-set row of small rigid teeth – two bands being separated throughout their whole extent by a broad groove. The pre-maxillary teeth are in a broad patch standing outside closed mouth: The mandibular teeth increasing in size inwards and at symphysis, form a patch which fits into a wide notch in upper jaw: vomerine teeth form a short row of fangs. Skin scaleless, glandular. Lateral line formed by a row of large brilliant close-set pores. Gill-openings wide, crescentic, separated by a very narrow interspace. Vertical (ventral) fins well developed dorsal beginning just in advance of gill-opening. Pectorals narrow, pointed, more than half snout in length. Body and fins blue-black; pectorals with narrow whitish edge and tip: margin of gill-opening and of all mucous pores of head and lateral line brilliant white.

**Geographical distribution (Previous records):** Western Indian Ocean: Maldives, the Laccadives and the Malabar Coast.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** Bathydemersal; marine; depth range 1316 - 1316 m. In present study, 201-800 m.

### Genus : *Gavialiceps* Alcock, 1889

***Gavialiceps*** Alcock (ex Wood-Mason) 1889:460, Annals and Magazine of Natural History (Series 6) v. 4 (no. 24): 450-461.
Hoese & Gates 2006:293, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Gavialiceps taeniola* (Alcock, 1889)

(Plate III, Fig. 27)

**Vernacular Name:** Nil

*Saurenchelys taeniola*, Alcock, 1889. Ann. Mag. Nat. Hist., p. 460.
*Nettastoma taeniola*, Alcock, Ann. Mag. Nat. Hist., 1891, p. 135 and 1892, p. 364.
Shinohara et al. 2005:400, Deep-sea fauna and pollutants in the Nansei Islands. Memoirs of the National Science Musuem Tokyo No. 29: 385-452.
**Synonymy:** *Nettastoma taeniola, Saurenchelys taeniola*

**Diagnostic characters (Based on 10 specimens 62.7-72 cm TL):**

**D. 0, 256-300; A. 0,183–280.**

Body elongated and slender, snout long, about 1.2-1.4 in HL. HL 0.60-0.65 of distance from gill-opening to vent, and 0.14-0.15 of total. ED 0.2-0.26 in SnL. The mouth-cleft extends to, or beyond, after limit of eye, and upper jaw projects well beyond lower. Broadish bands of small sharp teeth in both jaws, band in upper jaw subdivided by a median longitudinal toothless space. A patch of somewhat enlarged teeth on Premaxillary, separated from maxillary by a notch into which a patch of similarly enlarged teeth on mandibular symphysis fits. Gill-openings of moderate size, close together. No scales: lateral line is very distinct and consists of a row of large pores which is continued right across gill-cover to occiput. Vertical fins confluent; dorsal begins above gill-opening; No pectoral fins. No air-bladder. Black. Maximum 72cm (Male) and 83cm (Female) TL.

**Geographical distribution (Previous records):** Indian Ocean: Arabian Sea, Oman, and Bay of Bengal.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Bathydemersal. Depth range 350 – 1046 m. In present study,201-1100 m.

**Family: Nemichthyidae** (snipe eels)

Body elongate to very elongate, moderately to strongly compressed; tail moderately attenuate with a small caudal fin, or greatly attenuate and filiform; anus far forward. Jaws and snout produced into a long, non-occlusible beak in females and immatures, short in males; cleft of mouth ends under or slightly behind eye; teeth small with recurved tips, close-set in diagonal rows. Anterior and posterior nostrils located on side of head, just in front of eye; anterior nostril without a tube in females and immatures, strongly tubular and forwardly directed in mature males. Gill opening crescentic, located in front of and below pectoral fins. Dorsal and anal fins long and confluent with caudal fin when latter is present, anal fin higher than dorsal; dorsal fin begins over or slightly in front of pectoral fins; anal fin begins just behind anus; pectoral fins present. Scales absent. Lateral line complete, either as a single row of pores or 3 parallel rows of pores; pores on head well developed.

**Key to Genera**

**1a.** Caudal region extremely elongated and thread-like, a distinct caudal fin absent; 3 rows of pores in lateral line; no dermal ridges on head ***Nemichthys***

**1b.** Caudal region not thread-like, a small caudal fin present; 1 row of pores in lateral line; small, longitudinal dermal ridges on head ***Avocettina***

**Genus : *Nemichthys*** Richardson, 1848

***Nemichthys*** Richardson 1848:25, The zoology of the voyage of H. M. S. Samarang; under the command of Captain Sir Edward Belcher, during the years 1843-1846.
Paxton et al. 2006:285, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Nemichthys scolopaceus* Richardson, 1848 (Slender snipe eel)

(Plate III, Fig. 28)

**Vernacular Name:** Slender snipe eel

***Nemichthys scolopacea,*** Richardson 1848:25, Pl. 10 (figs. 1-3); The zoology of the voyage of H. M. S. Samarang; under the command of Captain Sir Edward Belcher, during the years 1843-1846. South Atlantic off Brazil. Holotype (unique): BMNH 1871 7 16.1 •Valid as *Nemichthys scolopaceus* Richardson 1848.
Fricke et al. 2007:25, Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie). No. 706: 1-174.
**Synonymy:** *Cercomitus flagellifer, Leptocephalus andreae, Leptocephalus canaricus*

**Diagnostic characters (Based on 2 specimens 48.6-51.2cm TL):**

**D. 0, 330-350; A. 0.320**

Body thin and elongated, HD 0.28-0.30 and BD 0.30-0.33 in HL. HL 0.13-0.14 in TL. Jaws elongated and snout forms 0.55 – 0.57 in HL. Caudal region extremely elongated and thread-like, a distinct caudal fin absent; 3 rows of pores in lateral line; no dermal ridges on head. Jaws long. Posterior end of body narrow, ending as a long filament. caudal fin not recognizable;. Dark brown or grey in colour, often darker below; anal fin and tips of pectoral fins almost black. Attains 130 cm.

**Geographical distribution (Previous records):** Worldwide in tropical and temperate seas. Western Atlantic: Nova Scotia, Canada and northern Gulf of Mexico to Brazil. Eastern Atlantic: Spain to South Africa, including western Mediterranean; reported from Iceland. Regularly found in the Skagerrak. Northwest Pacific: Japan and Arafura Sea. Eastern Pacific: Alaska to Chile, including the Gulf of California.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** bathypelagic; depth range 91 – 2000 m. In present study, 501-800 m.

### Genus : *Avocettina* Jordan & Davis, 1891

***Avocettina*** Jordan & Davis 1891:655, Report of the United States Fish Commission v. 16 [1888]: 581-677, Pls. 73-80.
Paxton et al. 2006:285, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Avocettina paucipora* Nielsen & Smith, 1978

**Vernacular Name:** Nil

***Avocettina paucipora*,** Nielsen & Smith 1978:33, Fig. 19, Dana Report No. 88; South Pacific, 41°47'S, 176°65'E, 3000 meters wire. Holotype: ZMUC P311128. Paratypes: ISH 1225-1968 (1), 2194-1968 (1), 2195-1968 (1), 768-1976 (1), 453a-1976 (1); LACM 10672 (1), 11451 (1); NMNZ P.2498 (1), P.2499 (2 or 1), P.3981 (1), P.3982 (1), P 10429 (1); ZMUC P311129 (1), P311131-34 (1 ea.). Type catalog: Hardy 1990:7 Valid as *Avocettina paucipora* Nielsen & Smith 1978.
Shinohara et al. 2005:401, Memoirs of the National Science Musuem Tokyo No. 29: 385-452.

**Synonymy:** Nil

**Diagnostic characters (Based on 3 specimens 49.1-58.9 cm TL):**

**D.0, 254-297, A.0, 218-257**

Body elongated and thin, head including snout 0.21-0.24 in TL, HD 0.33 in HL, snout longer than rest of head, PrOL 0.67 in HL. Caudal region not thread-like, a small caudal fin present; 1 row of pores in lateral line small, longitudinal dermal ridges on head Anus located behind pectoral fins. Dark brown to black in colour.

**Geographical distribution (Previous records):** Southwest Atlantic and southern Indian and Pacific.

**Distribution in the Southwest coast (Present study):** Between 09° and 13° N latitude.

**Depth:** In present study, 501-800 m.

**Super Order : Protacanthopterygii**

**Order : Osmeriformes** (argentines, smelts)

**Sub Order : Argentinoidei**

**Super Family : Alepocephaloidea**

**Family : Alepocephalidae** (slickheads, smoothheads)

Body shape variable, from moderately deep to elongate and eel-like. Head compressed and slightly rounded, to elongate and tube-like. Head generally without scales; papillae and raised sensory pores frequently present on head and opercles; roof and floor of mouth usually with papillae; premaxilla and mandible usually toothed. No spinous finrays; single dorsal and anal fins usually placed far back and frequently opposite each other; no adipose fin; pectoral fins, if present, moderately high on body; pelvic fins abdominal, outer ray sometimes with supporting splint bone. Scales on body present or absent, if present always cycloid smooth to touch), easily abraded.

**Key to Genera**

**1a.** Body completely scaleless ***Rouleina***

**1b.** Body covered with scales **2**

**2a.** Maxilla toothless. Pectoral fins narrow ***Alepocephalus***

**2b.** Maxilla with teeth. Pectoral fins from moderately long to very long **3**

**3a.** Dorsal origin approximately opposite anal origin; pectoral with produced rays; a black wart like spot near base of sixth dorsal fin ray ***Talismania***

**3b.** Dorsal-fin origin well in advance of anal fin, no produced pectoral rays, no spots on dorsal **4**

**4a.** Teeth in jaws multiserial, none modified ***Narcetes***

**4b.** Teeth on maxilla and dentary uniserial ***Bajacalifornia***

## Genus : *Rouleina* Jordan, 1923

***Rouleina*** Jordan 1923:122, Biological Sciences v 3 (no. 2): 77-243 + i-x.
Kenaley & Orr 2006:200, Zoological Research v 53 (no. 2) 200-202.

### *Rouleina nuda* (Brauer, 1906)

(Plate III, Fig. 29)

**Vernacular Name:** Nil

***Aleposomus nudus,*** Brauer 1906:22, Pl. 2 (fig. 2), Die Tiefsee-Fische. I. Systematischer Teil. v. 15; Off Sumatra, Indonesia, 0°39'02"S, 98°52'03"E, Valdivia station 191, depth 750 meters. Syntypes: (2) ZMB 17426 (1). •Valid as *Rouleina nuda* (Brauer 1906).
Sazonov & Williams 2001:S18, Journal of Ichthyology v 41 (Suppl. 1): S1-S36.
**Synonymy**: *Aleposomus nudus* Brauer, 1906

**Diagnostic characters (Based on 1 specimen 14.9 cm TL):**

**D.0, 18, A. 0, 17, V. 6**

A soft bodied, less elongate and not eel-like small alepocephalid fish. Head large with convex upper profile; HL 0.24 and BD 0.16 in TL, HD 0.63 in HL. Eyes well developed and its diameter more than snout. PreOL 0.29 and ED 0.31 in HL. Two supramaxillae; maxilla with teeth. Head depth more than depth at dorsal fin. Pectoral fins well developed and narrow. Anus close to anal-fin origin. Anal-fin base shorter than dorsal-fin base, dorsal-fin origin well in advance of anal-fin origin. Caudal forked. Black in colour.

**Geographical distribution (Previous records):** Western Indian Ocean: off Sumatra, Indonesia.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** Benthopelagic recorded from 750 m. In present study, 501-800 m.

### **Genus : *Alepocephalus*** Risso, 1820

*Alepocephalus* Risso, 1820. *Mem. De L Acad.Sci.Torlino*, 25, p.270 (type, *A. rostratus* Risso) Carter & Hartel 2003:876, In: Carpenter 2003. The living marine resources of the Western Central Atlantic. v. 2.

Body elongate, compressed, scales moderate, cycloid, deciduous. Eyes prominent. Snout short, blunt or long, pointed. One or two supermaxillaries. Premaxillary, palatine and sometimes vomer toothed. Maxillary toothless. 6 branchiostegals. Close set long, numerous gill rakers. Gill openings wide, surpassing level of pectorals, covered by free over lapping gill membrane and by skin of head. Pseudobranchiae. Dorsal and anal fins short; their origins nearly opposite to each other. Pelvic origin in advance of dorsal origin. Adipose fin absent. Caudal forked.

**Key to Species**

**1a.** Dorsal origin before anal origin... ***A. bicolor***

**1b.** Dorsal origin opposite to or a little behind anal origin ***A. blanfordii***

*Alepocephalus bicolor* Alcock, 1891

(Plate III, Fig. 30)

**Vernacular Name:** Bicolor slickhead

*Alepocephalus bicolor* Alcock, *Ann. Mag. Nat. Hist., (*6) 8, p. 33, 1891 (type locality: Bay of Bangal, off Ganjam coast 15o56'50" N., 81o20'20" E., 240-276fms., 11-1 C., type is in the Zoological Survey of India); *Alepocephalus bicolor* Alcock, *Ill. Zool. Invest., Fish., 1892.* Pl. 4 fig.2., *Alepocephalus bicolor* Alcock, Cat. Ind. Deep sea Fish., p.169, 1899 (Bay of Bengal, off Ganjam coast, 240-276fms., Arabian Sea, off Malabar Coast, 360fms.); *Alepocephalus bicolor* Misra, *Rec. Indian Mus.*, 1949. 45, p.406; *Alepocephalus bicolor* Misra, *Rec. Indian Mus.*, 1953. 50, p.390.
Hoese et al. 2006:385, In: Zoological Catalogue of Australia. Volume 35. Fishes.

**Diagnostic characters: (Based on 10 specimens, 18.2 – 27.8 cm TL)**

**B. 6; D. 20-21; P. 10-11; V. 8; A. 26-28; L.1.62-63; Ltr. 18**

Body elongate, compressed; abdomen non-keeled, non-serrated. Dorsal and ventral profiles gradiently equal, convex. Head 4.3, depth 5.8 in total length (3.3 – 3.8 and 4.7 – 4.9 in standard length). Eyes moderate, without adipose lid, converging anteriorly, 5.0 – 6.0 in head, 1.1 in snout and more than an eye diameter apart. Nostrils close together, immediately before eye. Snout obtusely pointed, depressed, 3.5 in head. Cleft of mouth slightly oblique; maxilla reaching just behind anterior border of eye. A row of small teeth on both jaws and on palatines. A single dorsal fin; origin just in advance of posterior third of standard length opposite vent, and much behind pelvic origin. Pectorals low, broad, inserted just behind head, reaching pelvic origin, a little longer than postorbital part of head. Pelvics moderate; 2.1-2.6 ED, reaching more than half way to anal origin; anal base 1.2-1.6 times longer than dorsal base. Caudal deeply forked, 1.1 in head with numerous rudimentary rays at its base. Head including sclerotic and eye black; body uniform dull state blue.

**Geographical distribution (Previous records):** Bay of Bengal, Arabian Sea, off Malabar Coast

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude

**Depth:** Bathypelagic, 438–1080 m. In present study, 501-800 m.

*Alepocephalus blanfordii* Alcock, 1892

(Plate IV, Fig. 31)

**Vernacular Name:** Nil

*Alepocephalus blanfordi* Alcock, Ann. Mag. nat. Hist., 1892. (6) **10**, p. 357 (type locality: S of Cape Comorin, 6o58' N., 77o26'50" E., 902 fms., 5oC.); Alepocephalus blanfordi Alcock, Ill Zool. Investig. Fish., 1894. Pl. 9, Fig. 1, Alepocephalus blanfordi Alcock, Cat. Ind. Deep Sea Fish., p. 171 (Arabian Sea, off Cape Comorin, 902 fms.).
Misra, 1949. Rec. Indian Mus., 45, p.407 Alepocephalus blanfordi Parr, 1952. Bull. Harv. Mus. Comp. Zool., 107, p.258.
Mundy 2005:160, Bishop Museum Bulletin in Zoology No. 6: 1-704.
**Synonymy:** Nil

**Diagnostic characters (Based on 6 specimens 17.4–18.9 cm TL):**

**B. 6; D. 0,16; P. 11-12; V. 6-7; A. 0,17; L.70-72.**

Body elongate, compressed; abdomen non-keeled, non-serrated. Dorsal and ventral profiles gradiently convex. HL and BD 3.1-3.5 and 5.5-6.4 in TL, 2.8-3.2 and 5.2-5.9 in SL. Eyes large, with adipose lid, 3.2-3.5 in head, 0.96-1.1 in snout. Cleft of mouth is almost horizontal; maxilla reaching just beyond anterior border of eye. Upper jaw reaching just beyond and rests upon anterior border of orbit completely enclosing mandible on all sides. A row of fine teeth in both jaws and on each prominent palatine. Gill openings very wide. Dorsal fin origin just behind vent. Pectorals low, not reaching pelvic origin. Pelvic origin almost in middle of TL, nearer to anal origin than to pectoral. Anal origin slightly behind dorsal origin. Anal base equal to dorsal base. Caudal deeply forked, 2.1-2.4 in head. Body lavender grey, head and fins black. Attains 35.9 cm in length.

**Geographical distribution (Previous records):** India: south of Cape Comorin, Arabian Sea, Flores Sea. 6° N.–8° S., 77°–21° E in the Indo-Pacific, 6° N. 77° E. in the Indian Ocean and 8° S. 121° E in the Pacific Ocean.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** Bathypelagic, 694-1650 m. In present study, 501-1100 m.

## **Genus *Talismania*** Goode and Bean, 1896

***Talismania*** (subgenus of *Bathytroctes*) Goode & Bean 1896:41, 43. Fem. *Bathytroctes homopterus* Vaillant 1888. Type by subsequent designation. Type designated by Jordan 1920:467 Valid as *Talismania* Goode & Bean 1896
Carter & Hartel 2003:877, In: Carpenter 2003 [ref. 27006]. The living marine resources of the Western Central Atlantic. v 2.

### *Talismania longifilis* (Brauer, 1902)

(Plate IV, Fig. 32)

**Vernacular Name:** Longtail slickhead

*Bathytroctes longifilis* Brauer, 1902. 277 (13°02'08" N., 46o 41'06" E); *Talismania longifilis* Parr, 1952: 269; Sazonov and Ivanov, 1980: 46
Savinykh & Savin 2001:846, Voprosy Ikhtiologii v. 41 (no. 6): 846-848. [In Russian. English translation in Journal of Ichthyology v. 41 (no. 9):807-809.]
**Synonymy:** *Bathytroctes longifilis, Nemabathytroctes longifilis*

**Diagnostic characters (Based on 3 specimens 27.1–32.8 cm TL):**

**Br. 8; D. 20-25; A. 19-25; P. 11-14; V. 7-9; Gr. (6-9)+ (13-17).**

Body moderately elongated and compressed HL 0.30-0.34, DDF 0.19-0.22 and BD 0.19-0.2 in SL. Snout pointed, longer than eye PrOL 0.3-0.34 and ED 0.12-0.15 in HL. Maxilla not reaching beyond eye, teeth small, densely set. Pectoral fins moderately long with extremely elongate thread-like first ray. Dorsal and anal fin origin far back, subequal and opposite. PrDL 0.58-0.63, DFB 0.21-0.23 and AFB 0.20-0.22 in SL. Body dark grey, head and fins black. Attains 46 cm SL.

**Geographical distribution** (Previous records): Mozambique ridge; Eastern Atlantic, Indian Ocean and Western tropical Pacific.

**Distribution in the Southwest coast** (Present study): Between 9° and 15° N latitude.

**Depth:** Benthopelagic. In present study, 501-1100 m.

### Genus : *Narcetes* Alcock, 1890

***Narcetes*** Alcock 1890:305, Annals and Magazine of Natural History (Series 6) v. 6 (no. 34): 295-311.
Hoese et al. 2006:390, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Narcetes lloydi* Fowler, 1934

(Plate IV, Fig. 33)

**Vernacular Name:** Lloyd's slickhead

***Narcetes lloydi***, Fowler 1934:253, Fig. 16, Proceedings of the Academy of Natural Sciences of Philadelphia v. 85 (for 1933); East coast of Luzon Island, Philippines, Albatross station 5460, 13°32'30"N, 123°58'06"E, depth 565 fathoms. Holotype: USNM 92335. Valid as *Narcetes lloydi* Fowler 1934.
Hoese et al. 2006:390, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** Nil

**Diagnostic characters (Based on 1 specimen 17.5 cm TL):**

**D. 0, 20; A. 0, 17**

Body not much deep and compressed; head taporing anteriorly, BD 0.2 and HD 0.15 in SL. Snout longer than orbit (PrOL 0.19 and ED 0.16 in HL), pointed. Premaxillae long and deep forming beak-like snout tip; supraorbital reduced, restricted to anterodorsal part of orbit. Premaxilla and maxilla toothed. Lower jaw with normal conical teeth in more than one series; teeth on premaxilla and maxilla multiserial; suprapreopercle completely absent; 2 supramaxillae. Upper jaw extends notably behind posterior margin of orbit. Dorsal-fin origin well in advance of anal fin, PrDL 0.57 and PrAL 0.65 in SL. Dorsal-fin base longer than anal-fin base (DFB 0.22 and AFB 0.19 in SL). Body black in colour.

**Geographical distribution (Previous records):** Indian and Pacific Oceans.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** In present study, 801-1100 m.

## Genus: *Bajacalifornia* Townsend and Nichols, 1925

***Bajacalifornia*** Townsend & Nichols 1925:8, Bulletin of the American Museum of Natural History v. 52 (art. 1): 1-20, Pls. 1-4, map.
Hoese et al. 2006:387, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Bajacalifornia calcarata* (Weber, 1913)

(Plate IV, Fig. 34)

**Vernacular Name:** Brown slickhead

***Bathytroctes calcaratus,*** Weber 1913:11, Pl. 4 (figs. 5-5a), Die Fische der Siboga-Expedition., Makasar Strait, Sulawesi, 0°36.5'S, 119°29.5'E, depth 724 meters; Ceram Sea 3°27.0'S, 131°0.5'E, depth 567 meters, Siboga station 85 and 173.
Hoese et al. 2006:387, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Bathytroctes calcaratus*

**Diagnostic characters (Based on 1 specimens 16.3 cm TL):**

**D. 0,19, A. 0,15, V. 19**

HL 9.4, DB 7.9, TL 42.5,SnL 3.0, ED 1.3. Body elongate, compressed, scales cycloid, moderate, deciduous, present or absent on head. Eyes prominent. Snout moderate, not produced into a long tube. A single series of teeth on pre-maxilla and maxilla. Gill openings wide, surpassing level of pectorals. Branchiostegals 7 Dorsal and anal fins short; dorsal origin in advance of anal origin. Pelvic origin in advance of dorsal origin. Adipose fin absent caudal forked.

**Geographical distribution (Previous records):** Indian and Pacific Oceans.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** In present study, 501-1100 m.

## Family : Platytroctidae

Many with light organs; in adults directed ventrally. Canal system subcutaneous, often connected to scale pockets by pores. Pectoral fin 14-28 rays. Pelvic fin 6-10 rays; fins absent in *Platroctes apus*. Swim bladder absent. Branchiostegal 4-8 rays. Vertebrae 40-52. Blue-green luminous fluid coming from a conspicuous opening through tubular papilla just below lateral line is produced by the black shoulder sac apparatus located under the shoulder girdle.

### Genus : *Platytroctes* Günther, 1878

***Platytroctes*** Günther 1878:249, Annals and Magazine of Natural History (Series 5) v. 2 (nos. 7/8/9): 17-28, 179-187, 248-251
Paxton et al. 2006:382, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Platytroctes mirus* (Lloyd 1909)

(Plate IV, Fig. 35)

**Vernacular Name:** Leaf searsid

***Platytroctegen mirus,*** Lloyd 1909:145, Memoirs of the Indian Museum v 2 (no. 3); Laccadive Sea, Bay of Bengal, 12°18'46"N, 74°05'29"E, Investigator station 371, depth 500 fathoms. Holotype (unique): ZSI F2382/1.
Sazonov & Merrett 2001:S38, Journal of Ichthyology v 41 (suppl. 1): S37-S50.
**Synonymy:** *Platytroctegen mirus*

**Diagnostic characters (Based on 4 specimens 14.3–18.6cm TL):**

Body deep, strongly compressed, HL 0.26 and BD 0.33 in TL. Snout shorter than eye, PrOL 0.27, ED 0.34 in HL. About half of dorsal and ventral profiles developed as nonmuscular keels. PrDL 0.56 and AL 0.62 in TL. Predorsal margin sharp, 1 scale wide. DFH 0.17, DFB 0.32 in PrDL. Pelvic fins present; scales without a median ridge. AL 1.1, AFB 0.34, AFH 0.16 and BD 0.59 in

PrDL. Caudal peduncle normal; mid-dentary teeth absent; tooth row of dentary short, ending at maxillo-mandibular ligament. Attains 18.6 cm TL.

**Geographical distribution (Previous records):** Northeast Atlantic, Persian Gulf and Bay of Bengal.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Bathypelagic, maximum depth of occurrence reported 915 m. In present study, 801-1100 m.

**Super Order : Stenopterygii**

**Order : Ateleopodiformes**

**Family : Ateleopodidae** (jellynose fishes, tadpole fishes)

Caudal fin very small and confluent with long anal fin. Adults with pelvic fin reduced to a single ray in jugular position, except for *Guentherus* with several pelvic rays behind pectorals. Dorsal fin rays 3-13. Largely cartilaginous skeleton. Bulbous snout. Branchiostegal 7 rays.

**Genus : *Ateleopus*** Temminck and Schlegel, 1846

***Ateleopus*** Temminck & Schlegel 1846:255, Fauna Japonica, sive descriptio animalium quae in itinere per Japoniam Parts 10-14. 173-269.
Senou et al. 2008:13, Bulletin of the National Museum of Nature and Science (Ser A) Suppl. 2: 13-19.

*Ateleopus indicus* Alcock, 1891

(Plate IV, Fig. 36)

**Vernacular Name:** Nil

*Ateleopus indicus,* Alcock 1891:123, Fig. 3, Annals and Magazine of Natural History (Series 6) v. 8 (no. 43/44) Andaman Sea, 11°31'40"N, 92°46'40"E, Investigator station 115, depth 188-220 fathoms. Holotype (unique): ZSI F13069.
*Podateles indicus* Misra, 1949. *Rec. Indian Mus.*, 45, p. 431
Manilo & Bogorodsky 2003:S97, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** Nil

**Diagnostic characters (Based on 6 specimens 21.3-29.7 cm TL):**

**B. 8; D. 8-10; P. 12; V. 2; A+C. 76-85**

Body elongate, compressed, naked gradually tapering to pointed tail. Depth equal to HL, behind middle of snout, 8.0 in TL. Head large, with muciferous cavities, 5.0-7.0 in TL. ED 5.5-6.7 in HL, 1.3-1.8 in IOW, 1.8 in PrOL. Snout broadly pointed, depressed, projecting, marginally inflated, 3.0 in head, 1.8 times eye. Maxilla reaching mid-orbit and slightly protractile downwards. A short band of very minute teeth in inner aspects of upper jaw; lower jaw toothless. A single, short, rayed dorsal fin; origin midway between snout end and vent, above pectoral base, DFB 0.75 in snout. Pectorals long, reaching vent, 1.1 in head, equal to longest dorsal ray. Pelvics jugular consisting of 2 stiff coherent cartilaginous rods, nearly half as long as head. Anal long, confluent with caudal, its base 1.5 times trunk. Lateral line following dorsal curve of trunk runs along middle of tail. Head, body and fins covered with thick gelatinous, scaleless skin. Gill rakers short, coarse, cartilaginous. Purple black; all fins except pelvics black. It attains 38 cm in length.

**Geographical distribution (Previous records):** Western Indian Ocean: Arabian Sea. Andaman Sea.

**Distribution in the Southwest coast (Present study):** Between 07° and 13° N latitude.

**Depth:** Bathypelagic, 260-370 m. In present study, 201-800 m.

**Order : Stomiiformes**

**Sub Order : Gonostomatoidei**

**Family : Sternoptychidae** (deepsea hatchetfishes)

Branchiostegal rays 10, except Sternoptyx with 6; 3 on epihyal. Branchiostegal photophores 3-7 (mode 6). Branchiostegal pseudobranch present.

**Sub Family: Sternoptychinae** (marine hatchetfishes)

**Genus : *Argyropelecus*** Cocco, 1829 (hatchetfishes)

***Argyropelecus*** Cocco 1829:146, Giornale di Scienze Lettere e Arti per La Sicilia Anno 7, v 26 (no. 77): 138-147
Paxton et al. 2006:424, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Argyropelecus hemigymnus* Cocco, 1829

(Plate IV, Fig. 37)

**Vernacular Name:** short silver hatchetfish

*Argyropelecus hemigymnus* Cocco, 1829. Giorn. Sci.Sic., 77, p.146 (type locality: Mediterranean).
Alcock, 1896. J. As. Soc. Bengal, 65, p. 331 (Bay of Bengal, 12o20' N., 85o8' E., 1803 fms., 1.7o C).
Misra, 1953. Rec. Indian Mus., 50, p.401
Fricke et al. 2007:57 Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie). No. 706: 1-174.
**Synonymy:** *Argyripnus hemigymnus, Argyropelecus durvillei, Argyropelecus heathi*

**Diagnostic characters (Based on 3 specimens 8.1-10.3 cm TL):**

**B-9; D. vii – viii + 7-8/0; P. 9-11; V. 5-6; A. vi + 5**

Body scaleless, short, elevated, compressed; abdomen keeled, non-serrated; dorsal profile convex; abdominal edge straight, passing abruptly into short, compressed tail. Head naked, short, depth 2.2 in TL. Eyes large, close together, telescopic, vertical, 2.2 in head, 0.5 in snout. Cleft of mouth wide, sub-vertical; maxilla reaching behind anterior margin of eye. Two spines on pre-opercle, one directed downwards, other backwards; one on shoulder; a single backwardly directed, serrated spine posteriorly at hind end of ventral keel. Dorsal fin origin immediately behind head, before pelvics. A low, long adipose dorsal at a short distance behind last dorsal ray. Pectorals low, reaching beond pelvics, 1.1 in head. Pelvics small, almost reaching anal, 3.3

in head; origin below middle of rayed portion of dorsal. Anal divided; origin just behind last dorsal ray and nearer to pelvic origin than to caudal. Caudal forked, with rudimentary rays. No lateral line. No scales; body covered with a brilliant skin. Luminous organs: an antorbital below nostril; one suborbital behind end of maxillary; 2 opercula, upper on a level with lower margin of eye, lower one behind preopercular spine; a group of 6 branchiostegals; a group of 6 behind isthmus; in abdominal series, 3 rows, lower of a group of 12, middle of a group of 6, upper above pectoral base of a group of 2; in postabdominal series, a group of 4 preanals, a group of 6 supra-anals and a group of 4 caudals. Silvery grey.

**Geographical distribution (Previous records):** Mediterranean sea, Bay of Bengal, South Africa, off the cape.

**Distribution in the Southwest coast (Present study):** Between 09° and 13° N latitude.

**Depth:** Benthopelagic and abyssal, 1500–3297 m., In present study, 501-800 m.

**Sub Order : Photichthyoidei**

**Family : Stomiidae** (barbeled dragonfishes, scaly dragonfishes)

No true gill rakers in adults; one infraorbital bone; one or no supramaxillaries; mesopterygoid reduced in size or absent; photophores without ducts or lumen; mental barbel in most, associated with hyoid apparatus; pectoral fin rays absent in *Tactostoma, Idiacanthus*, and *Photostomias*

**Sub Family: Astronesthinae** (snaggletooths, stareaters)

**Genus : *Astronesthes*** Richardson, 1845

***Astronesthes*** Richardson 1845:97, The zoology of the voyage of H. M. S. Sulphur 71-98, Pls. 45-54
Paxton et al. 2006:435, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Astronesthes martensii* Klunzinger, 1871

(Plate IV, Fig. 38)

**Vernacular Name:** Nil

*Astronesthes martensii* Klunzinger, 1871. Verh. Zool-bot. Ges. Widnn, 21, p.594 (type locality: Red sea); *Astronesthes martensi* Brauer, 1906. "Valdivia" Tiefsee Fische, 15, pp. 32, 372, pl. 2, fig. 4 (South of Ceylone, 4o56' N., 78o 58'3" E., 2000m.); *Astronesthes martensii* Regan and Trewavas, 1929. Ocean. Rep. Danish "Dana" Rep. (1920 – 22). 2, 5, (p.) 17, fig. Red Sea; *Astronesthes martensii* Misra, 1949. Rec. Indian Mus., 45, p. 419., *Astronesthes martensii* Misra, 1953. Rec. Indian Mus., 50, p. 405.
**Synonymy:** Nil

**Diagnostic characters (Based on 4 specimens 8.1–11.3 cm TL):**

**B. 23; D. 0, 11-12; P. 6-8; V. 7; A. 0, 18-22**

Body naked, elongate, compressed; abdomen non-keeled, non-serrated. Dorsal profile gradiently convex, ventral profile straight. Head naked, 4.8-5.0, depth 7 1-8.0 in TL (4.1-4.4 and 6.4-7.2in SL). ED 4.3-4.9 in HL, equal to PrOL. Cleft of mouth wide, maxilla extending to pre-opercular angle. Lower jaw prominent. Teeth on intermaxilla and mandible unequal, widely set, a few of them long, curved canines; those on maxilla much smaller; close-set, directed backwards. A barbel at mandibular symphysis, 1.1-1.5 of head. Dorsal base equal to anal base, entirely before anal origin. A small adipose dorsal nearly midway between last dorsal ray and rudimentary caudal rays. Pectorals low, almost reaching pelvic base, 1.1-1.8 in head. Pelvics 1.1-1.7 in head. Caudal forked, with rudimentary rays at its base, 1.1 to 1.4 in head. Luminous organs: an antorbital; a large suborbital; 2 small opercula; 2 branchiostegals; 8 on isthmus; in ventral series, 2 between isthmus and pectoral base, 17-18 between pectoral and pelvic, 18-20 between pelvic and rayed anal, 12-14 between anal origin and caudal base, last 5 to 6 being beyond last anal ray; in lateral series, 11-17 between operculum and pelvic origin, 17-20 between pelvic and anal origins, 3-4 between anal origin and caudal base. Besides these, numerous, in conspicuous photophores along longitudinal series of scales and scattered all over body. Bronze grey fins lighter. Attains 15 cm.

**Geographical distribution (Previous records):** Red sea, South of Ceylone.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude

**Depth:** Bathypelagic, up to 2000m. In present study, 501-800 m.

**Super Order : Cyclosquamata**

**Order : Aulopiformes** (aulopiforms, salmons)

**Sub Order : Alepisauroidei**

**Family : Evermannellidae** (sabertooth fishes)

Mesopelagic; chiefly tropical and subtropical. Head and body without normal scales. Tail showing three distinct bands of muscle tissue (epaxial, midlateral, and hypaxial). Tongue toothless. Frontmost palatine tooth much elongated. Size of eye ranging from small to large; mostly tubular. Dorsal fin 10-13 rays. Anal fin 26-37 rays. Pectoral fin 11-13 rays. Swim bladder absent.

**Key to genera**

**1a.** Eyes tubular, directed dorsally; aperture in adipose eyelid greatly exceeds lens diameter; at least some jaw teeth with barbed tips **Evernmannella**

**1b.** Eyes semi-tubular, directed dorsolaterally; aperture in adipose eyelid slightly larger than lens diameter; jaw teeth without barbed tips **Coccorella**

## Genus : *Evermannella* Fowler, 1901

***Evermannella*** Fowler 1901:211, Proceedings of the Academy of Natural Sciences of Philadelphia v. 53: 211-212.
Castellanos-Galindo et al. 2006:260, Biota Colombiana v. 7 (no. 2): 245-262.

### *Evermannella indica* Brauer, 1906

(Plate IV, Fig. 39)

**Vernacular Name:** Indian sabretooth

***Evermannella indica***, Brauer 1906:135 [Die Tiefsee-Fische. I. Systematischer Teil. v. 15;] Three localities, Indian Ocean. Syntypes: (3) ZMB 17458 (1) Valdivia station 231 Valid as *Evermannella indica* Brauer 1906
Paxton et al. 2006:496, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Odontostomus balbo atlanticus*

**Diagnostic characters (Based on 3 specimens 8.1-11.4cm TL):**

**B. 8; D. 0, 12-13; A. 0, 27–31**

Body compressed, moderately elongated, pre-dorsal profile convex, snout blunt and short. HL 0.24-0.26, PrDL 0.32-0.34, AL 0.5 and DDF 0.20-0.21 in TL. Mouth cleft horizontal, wide and maxilla reaching far behind eye. PrOL 0.04-0.05, ED 0.07-0.09 and DDF 0.81 in HL. Dirsal fin origin near to ventral origin. HL 0.79-0.8, DFH 0.47-0.5 and DFB 0.76 in PrDL. Pectorals short, reaching to dorsal origin. Anal fin origin near to posterior end of dorsal base. Caudal forked. Colour in alcohol light brown with numerous melanophores on head and body. Pigmentation varies from pale-colored pigmentation to a brownish-black pigmentation.

**Geographical distribution (Previous records):** Indo-Pacific: in tropical and subtropical waters.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude

**Depth:** Bathypelagic, depth range 500-800 m.

## Genus : *Coccorella* Roule, 1929

***Coccorella*** Roule 1929:8, 11, Bulletin de l'Institut Oceanographique (Monaco) No. 546: 1-18.
Paxton et al. 2006:495, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Coccorella atrata* (Alcock, 1894)

(Plate IV, Fig. 40)

**Vernacular Name:** Nil

*Odontostomus atratus*, Alcock, 1893. Journal and Proceedings of the Asiatic Society of Bengal v. 62 (pt 2, No. 4): 169-184, Pls. 8-9.
Roule, L. 1929. Bulletin de l'Institut Oceanographique (Monaco) No. 546: 1-18.
Mundy 2005:208, Bishop Museum Bulletin in Zoology No. 6: 1-704.
**Synonymy:** *Odontostomus atratus*

**Diagnostic characters (Based on 1 specimen 11.8 cm TL):**

**B. 8; D. 12; A. 26; P. 12; V. 8**

Body moderately elongate, deep and strongly compressed. Body and head naked. Skin smooth, delicate and easily torn. HL 0.28, PrDL 0.30 and BD 0.22 in TL. ED 0.23 and SnL 0.16 in HL. The snout has form of a pointed wart beyond which upper jaw slightly projects, lower jaw again projecting a little beyond upper The cleft of mouth extends almost to posterior edge of pre-operculum: Gill-cleft extremely wide and high: four gills with wide laminae and gill rakers inconspicuous or absent: Pseudobranchiae large. Rows of white dots exist along free border of preoperculum and inner border of broad boat-shaped mandible. The dorsal fin lies altogether within anterior half of body: anal begins about half a head length behind vertical through last dorsal ray, and extends to rudimentary basal rays of forked caudal. The large pectorals arise close to ventral profile, almost in same plane with ventrals, bases of which they touch when laid back. The ventrals arise under middle of dorsal. Head and body black in colour

**Geographical distribution (Previous records):** Indo-West Pacific: Bay of Bengal, Solomon Sea, New Zealand, and Japan. Southeast Pacific: Chile. South China Sea

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** bathypelagic, 300–2626 m. In present study, 501-800 m.

## Family Paralepididae (barracudinas)

Body elongate and slender, subcylindrical to laterally compressed. Snout pointed, mouth terminal, the lower jaw projecting by a non-ossified process. Alternatively fixed and depressible fang like teeth on dentary (lower jaw) and palatines (roof of mouth) premaxilla of uppr jaw with fange at tip followed by small saw-lik canines, gill rakers reduced to teeth or spines in multiple series on bony shields. No spiny rays in fins, single short dorsal fin set behind midpoint of body, a dorsal adipose fin always present above last anal fin rays, a ventral adipose fin also present in some gerera, anal fin long with 20 to 50 rays, its origin well behind dorsal fin except for one species, pectoral fins short, set low on body, lateral line conspicuous. Scales when present cycloid and very easily shed.

**Key to Genera**

**1a.** One band of luminous tissue on ventral midline between ventral fins to isthmus ***Lestidium***

**1b.** No luminous tissue **2**

**2a.** Dorsal and ventral saddle like blotches on trunk, confluent on tail ***Stemonosudis***

**2b.** No blotches on trunk ***Magnisudis***

## Genus : *Lestidium*

***Lestidium*** Gilbert 1905:607, Bulletin of the U. S. Fish Commission v. 23 (pt 2) [for 1903]: 577-713, Pls. 66-101.
Thompson 2003:934, In: Carpenter. The living marine resources of the Western Central Atlantic. v. 2.

### *Lestidium nudum* Gilbert, 1905

(Plate V, Fig. 41)

**Vernacular Name:** Deep water pike smelt

***Lestidium nudum,*** Gilbert 1905:607, Fig. 236 [Bulletin of the U. S. Fish Commission v. 23 (pt 2) [for 1903]; Pailolo Channel, between Molokai Island and Maui Island, Hawaiian Islands, U.S.A., Albatross station 3899, depth 0 to 283-284 fathoms. Holotype (unique): USNM 51615. Type catalog: Post 1972:149. •Valid as *Lestidium nudum* Gilbert 1905
Mundy 2005:205, Bishop Museum Bulletin in Zoology No. 6: 1-704.
**Synonymy:** Nil

**Diagnostic characters (Based on 2 specimens 26.9–30.2 cm TL):**

Body elongated and compressed, BD 0.08-0.09, DA 0.07 and HD 0.07-0.08 in SL. Head with a long snout, PrOL 0.32-0.36 in HL. Mouth terminal, upper and lower jaws elongated. Eyes comparatively large, 0.2-0.23 in HL. Dorsal, anal and ventral insertion far behind in posterior half of body, PrV 0.62-0.64 and AL 0.75-0.76 in SL. One band of luminous tissue on ventral midline between ventral fins to isthmus. Body transparent like, little dark colouration on caudal peduncle.

**Geographical distribution (Previous records):** Indian Ocean and West Pacific.

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** Bathypelagic, 183-700 m. In present study, 201-500 m.

### Genus : ***Stemonosudis*** Harry, 1951

*Stemonosudis rothschildi* Richards, 1967

(Plate V, Fig. 42)

**Vernacular Name:** Rothschild's barracudina

***Stemonosudis rothschildi,*** Richards 1967:35, Fig. 1 [California Fish and Game v. 53 (no. 1); Central Pacific, 22°47'N, 150°09'W (stomach content). Holotype (unique): USNM 199087
•Valid as *Stemonosudis rothschildi* Richards 1967
Paxton *et al.* 2006:494, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** Nil

**Diagnostic characters (Based on 3 specimens 26.9–30.2cm TL):**

**D. 8; A. 32–34**

Body elongated, with terminal mouth; head 4.7 in TL, predorsal 2.54 in TL, BD 2.7 in HL. Body transparent with 5 blotches in advance of dorsal fin; 7 blotches in advance of anal fin. Luminous organs absent on body. Pelvic origin well in front of a vertical from first dorsal fin ray (by at least one length of dorsal fin base. Dorsal set far behind body, last fin ray above or slightly before a vertical from first anal fin ray.

**Geographical distribution (Previous records):** Atlantic and Indo-West Pacific. Pacific Ocean: Kyushu-Palau Ridge to the Indo-Australian Archipelago and off the Hawaiian Islands. Reported to occur in the Western Atlantic.

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** In present study, 201-500 m

### Genus: ***Magnisudis*** Harry, 1953

***Magnisudis*** Harry 1953:234, Pacific Science v 7 (no. 2): 219-249.
Paxton et al. 2006:493, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Magnisudis indica* (Ege 1953)

(Plate V, Fig. 43)

**Vernacular Name:** Nil

***Paralepis brevis indicus*,** Ege 1953:5, Fig. 1 [Dana Report No. 40; Indian Ocean, 11°18'S, 50°03'E, about 2000 meters (4000 meters wire out). Holotype: ZMUC P2318755. Paratypes: ZMUC P236935 (1), P236941 (1), P236949-50 (2); more types at ZMUC but not identifiable. Type catalog: Post 1972:139, Nielsen 1974:33. •Synonym of *Paralepis atlantica* Krøyer 1868, but a valid subspecies as described -- (Yamakawa in Okamura *et al.* 1982:103, 337, Post in Whitehead *et al.* 1984:503, Fujii in Masuda *et al.* 1984:76, Okamura & Machida 1986:41, Scott & Scott 1988:196). •Valid as *Magnisudis indica* (Ege 1953)
Paxton in Randall & Lim 2000:592, The Raffles Bulletin of Zoology Supplement No. 8: 569-667
**Synonymy:** *Paralepis brevis indicus, Paralepis atlantica indica*

**Diagnostic characters (Based on 2 specimens 19.6-21.0 cm TL):**

**D. 0, 9; A. 0, 22; P. 17; V. 9; Gr. 8+26**

Body elongated, slender and compressed, BD 0.13-0.15 and DA 0.08-0.11 in SL. Head with pointed snout, which is longer than eye diameter and more or less equal to depth at anus. Eyes larger, 0.24-0.26 in HL. Terminal mouth cleft wide, posterior margin reaching middle of eye. Dorsal fin origin more or less at middle of body, PrDL 0.64-0.67 in SL. Pectoral short in length, subequal to greatest body depth. Ventrals originate at same line vertical of dorsal fin origin. Anal fin originate at far behind body, PrAL 0.75-0.78 in SL. Adipose dorsal fin present. Caudal fin forked.

**Geographical distribution (Previous records):** Indo-Pacific.

**Distribution in the Southwest coast (Present study):** Between 09° and 13° N latitude.

**Depth:** In present study, 201-800 m.

**Sub Order : Chlorophthalmoidei**

**Family : Chlorophthalmidae** (greeneyes)

**Genus** ***Chlorophthalmus*** Bonaparte, 1840

*Chlorophthalmus* Bonaparte, 1832-41. *Icongr. Fauna Ital., 3,* fasc. 28, p.144 (type, *C. agassizi* Bonaparte).
Paxton et al. 2006:480, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Scales cycloid, ctenoid or pectinated, without photophores. Tail about equal to trunk. Snout pointed. Cleft of mouth moderately wide. Gills 4. Branchiostegals 8-10. Dorsal fin with 11 rays, in anterior half of body; origin far in advance of anal origin. Pectorals large, inserted about middle of height. Pelvic origin slightly behind dorsal origin, nearer to pectoral base than to anal origin. Anal fin with 9-10 rays, in posterior part of tail; origin behind dorsal origin. Adipose dorsal present. Caudal fin deeply forked.

**Key to species**

**1a.** The lower jaw with a projecting denticulate plate ***C. bicornis***

**1b.** Lower jaw without a projecting denticulate plate **2**

**2a.** Eye smaller, its diameter shorter than or equal to snout length ***C. nigromarginatus***

**2b.** Eye large, its diameter longer than snout length; body square in middle or cylindrical anteriorly; back not elevated at insertion of dorsal fin ***C. agassizi***

*Chlorophthalmus bicornis* Norman, 1939

(Plate V, Fig. 44)

**Vernacular Name:** Spinyjaw greeneye

***Chlorophthalmus bicornis***, Norman 1939:25, Fig. 6, Scientific Reports, John Murray Expedition v. 7 (no. 1); Gulf of Aden, station 177, depth 274-366 meters. Holotype (unique): BMNH 1939.5.24.457 •Valid as *Chlorophthalmus bicornis* Norman 1939.
Manilo & Bogorodsky 2003:S98, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** Nil

**Diagnostic characters (Based on 17 specimens 08.2-16.3 cm TL):**

**D. 0, 12; A. 0, 9-11; P. 16-17; V. 10; Br. 8; Lat. 47-48**

HL 0.28, PrDL 0.33, AL 0.41, BD 0.19 in TL. Body slender and moderately elongated, BD 0.24-0.25, DA 0.21-0.23 in SL and 0.7-0.71 and 0.65-0.66 in

HL respectively. Head moderate, HD 0.15-0.16 and HL 0.33-0.35 in SL. Snout shorter than eye, 0.8-0.82 in ED and 0.22-0.25 in HL. lower jaw terminating in a strongly projecting transverse horizontal plate, corners of which are produced to form strong, tooth-like processes; no other denticulation at edge of lower jaw. Origin of dorsal fin close to adipose fin than to tip of snout, PrDL 0.38-0.4 in SL and 1.14-1.18 in HL. Dorsal fin longer than anal, DFB 0.12-0.14 and AFB 0.1-0.12 in SL. Pectorals not reaching anal origin, PL 0.55-0.57 in HL, ventrals as long as pectorals, 0.56-0.57 in HL. Caudal forked, its length 0.18-0.19 in SL. Silvery grey, with numerous minute black spots and traces of broad darker crossbars; bases and inner parts of pelvic fins black; eyes green. Maximum recorded total length 15 cm.

**Geographical distribution (Previous records):** Western Indian Ocean: Gulf of Aden and Kerala coast of India. Western Central Pacific: Philippines.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Bathydemersal, 270-370 m. In present study, 201-500 m.

*Chlorophthalmus nigromarginatus* Kamohara, 1953

(Plate V, Fig. 45)

**Vernacular Name:** Blackedge greeneye

***Chlorophthalmus acutifrons nigromarginatus***, Kamohara 1953:5, Figs. 3A, 4 [Japanese Journal of Ichthyology v 3 (no. 1); Mimase fish market, Kochi Prefecture, Japan. Holotype: BSKU 1541 Paratypes and non-types: BSKU 1653-59 (7), 1707-12 (6), 7218 (1). Type catalog: Kamohara 1961:2. Valid as *Chlorophthalmus nigromarginatus* Kamohara 1953 Paxton *et al.* 2006:480, In: Zoological Catalogue of Australia. Volume 35. Fishes.

**Synonymy:** *Chlorophthalmus acutifrons nigromarginatus*

**Diagnostic characters (Based on 15 specimens 11.5–23cm TL):**

**B. 8; D. 11-12; P. 15-16; V. 9; A. 9; L. l. *ca* 51-53; L.tr. 6½.**

Body slender, moderately elongated, both head and body distinctly compressed. DDF 0.18-0.19 and DAF 0.1-0.12 in SL, 0.58-0.6 and 0.35-0.36

in HL respectively. Head moderate, 0.32-0.33 in SL and 0.26-0.27 in TL. Eye smaller, its diameter shorter than snout length, ED 0.22-0.23 and PrOL 0.35-0.36 in HL, front back more or less elevated at insertion of dorsal fin. Dorsal origin in between origins of pectoral and ventral fins, PrPL 0.32-0.33, PrDL 0.4-0.41 and PrVL 0.43-0.44 in SL. Dorsal fin height and its base are equal in length. Anal fin far behind body and nearer to bifurcated caudal fin, 0.74-0.77 in SL. Anterior margin of dorsal fin and posterior margin of caudal fin black; middle portion of ventral fin with a transverse black band. Maximum recorded size 23.0 cm SL.

**Geographical distribution (Previous records):** Indo-West Pacific: Indonesia and northwestern Australia. Also from southern Japan to the East China Sea.

**Distribution in the Southwest coast (Present study):** Between 07° and 13° N latitude.

**Depth:** Demersal, depth range 184–285 m. In present study, 201-500 m.

*Chlorophthalmus agassizi* Bonaparte, 1840

(Plate V, Fig. 46)

**Vernacular Name:** Shortnose greeneye

*Chlorophthalmus agassizi* Bonaparte, 1832-41 *Icongr. Fauna Ital., 3,* fasc. 28, p.144 (type locality: Mediterranean); *Chlorophthalmus agassizi* Gunther, Cat. Fish. Brit. Mus., 5, p. 404 (Messina, 2-2.5 inches in length); *Chlorophthalmus corniger* Alcock, 1894. *J. As. Soc. Bengal,* 63 (2) p.133, pl. 6, fig. 5 (type locality: Bay of Bengal; 1.5 miles S. 83o W., off Colombo Lt., 26.5-250 fms.).

*Chlorophthalmus agassizi* Misra, 1953. *Rec. Indian Mus.,* 50, p. 415.

Fricke et al. 2007:59, Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie). No. 706: 1-174.

**Synonymy:** *Chlorophthalmus corniger*

**Diagnostic characters (Based on 20 specimens 12.1–18.9 cm TL):**

**B. 8; D. 11; P. 14-16; V. 9; A. 9-10; L. l. *ca* 52-55; L.tr. 8-9**

Body moderately elongate, compressed, scaly; abdomen smooth, non-keeled. BD 7.3-7.6 in TL, about 2.2-2.4 in HL. Head compressed, naked, 3.2 in TL. Eyes large, 3.0-3.3 in HL, 2.8-3.0 in IOW, 0.6-0.7 in PrOL. Cleft of mouth oblique, maxilla reaching beyond front border of eye. Lower jaw prominent forming a projecting, transverse, horizontal plate anterior margin of which strongly denticulated and superiorly covered by small teeth. Dorsal origin midway between snout end and adipose dorsal origin, slightly before pelvic origin. Pectorals 1.2-1.4 in head, almost reaching tips of pelvics or slightly beyond. Pelvics moderate, 1.5-1.9 in head. Anal origin nearer to caudal origin than to pelvic origin. Caudal forked, 1.3-1.4 in head. Many broad, ill defined, dusky, cross bands; fins hyaline; top of caudal and base and top of dorsal black; numerous parallel oblique rows, very consicuous on thorax and belly of tiny black specks with a silvery centre resembling incipient luminous spots. Attains 20 cm.

**Geographical distribution (Previous records):** Off Madras coast, 13°51'12" N., 80°28'12" E., 265-457m., 10°C. Sri Lanka: Off Colombo; East coast of America; Coast of Africa; Messina, Mediterranean; Zanzibar area; Fiji Is., Hawai.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Bathypelagic. In present study, 201-500 m.

**Family : Ipnopidae**

Eyes minute or large (*Bathysauropsis*), or plate-like and lensless (*Ipnops*); pseudobranch absent in adults; tip of upper jaw extending past orbit; pyloric caeca absent; dorsal fin rays 8-16; anal fin rays 7-19; pectoral rays 9-24; branchiostegal rays 8-17; vertebrae 44-80; 18 species of Bathypterois have elongated pectoral, pelvic and caudal rays.

**Genus : *Bathypterois*** Günther, 1878

***Bathypterois*** Günther 1878:183, Annals and Magazine of Natural History (Series 5) v. 2 (nos. 7/8/9): 17-28, 179-187, 248-251.
Paxton et al. 2006:485, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Bathypterois atricolor* Alcock, 1896

(Plate V, Fig. 47)

**Vernacular Name:** Attenuated spider fish

*Bathypterois atricolor* Alcock, 1896. J. As. Soc. Bengal, 65, p. 306 (type-locality: Laccadive sea, 3o47' N., 72o34'45" E., 891 fms. 5oC,, type in the Zoological Survey of India).
*Bathypterois atricolor* Alcock, 1897 Ill. Zool. Investig. Fish., pl.17, fig.6.
Castellanos-Galindo et al. 2006:252, Biota Colombiana v. 7 (no. 2): 245-262.
**Synonymy:** *Bathypterois atricolor atricolor, Bathypterois antennatus, Bathypterois atricolor indicus*

**Diagnostic characters (Based on 2 specimens 15.2–16.8cm SL):**

**B. 12; D. 15/0; P.2/12; V.9; A.10; L. 1.52; L.tr. 15.**

Body elongate, compressed, scaly; abdomen smooth, non-keeled. Head depressed, naked, BD 8.9-9.1, HD 5.8-6.2in TL, 7.8-8.0 and 4.9-5.0 in SL. Eyes small, ED 5.0 in PrOL. PrOL 3.3 in HL, equal to IOW. Cleft of mouth oblique, maxilla reaching 3 eye diameters behind eye. Lower jaw prominent. Villiform teeth in narrow band in jaws palatine edentulous. A single rayed dorsal; origin nearer to snout end than to caudal origin. Adipose dorsal far behind anal origin on caudal peduncle, nearer to caudal origin than to dorsal origin and midway between last dorsal ray and first caudal ray. Two upper pectoral rays prolonged, at least as far as end of caudal fin, coherent in basal part but not fused. Pelvic abdominal; origin nearer to pectoral base than to anal origin; 2 outer pelvic rays thickened, branched, prolonged as far as 7$^{th}$ or 8$^{th}$ anal ray, not quite as long as head. Anal shorter than dorsal; nearer to pelvic origin than to caudal origin. Caudal lobed, lower lobe longer, 1.1-1.2 in head. ventral edge of caudal peduncle notched; length 3.2 in standard length; least height 4.0 in its length. Uniform black except pectoral filaments. Attains 20.3 cm.

**Geographical distribution (Previous records):** Western Indian Ocean: Laccadive sea.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Bathypelagic. 801-1100 m.

**Sub Order : Synodontoidei**

**Family : Paraulopidae**

Dorsal fin ray 10 or 11; anal fin rays 8-11; pectoral fin rays 13-20; pelvic fin ray 9; pored lateral line scales 40-52; vertebrae usually 39-46. This clade was recognised based on six apomorphies, primarily characters in branchial arches, intermuscular bones, caudal skeleton, and pelvic girdle.

**Genus : *Paraulopus*** Sato and Nakabo, 2002

***Paraulopus*** Sato & Nakabo 2002:27, Ichthyological Research v. 49 (no. 1): 25-46.
Gomon et al. 2006:461, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Paraulopus maculatus* (Kotthaus 1967)

(Plate V, Fig. 48)

**Vernacular Name:** Cucumber fish

***Chlorophthalmus maculatus,*** Kotthaus 1967:77 Figs. 76-81 [Meteor Forschungsergebnisse. Reihe D, Biologie No. 1;] Off Mombasa, 1°18'S, 41°56'E to 1°19.8'S, 41°53'E, depth 178-220 meters. Holotype: ZMH 4926 [ex IOES 35a]. Paratypes: ZMH 494927 [ex IOES 35b] (1), 4928 [ex IOES 35c] (4).
Manilo & Bogorodsky 2003:S98, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** *Chlorophthalmus maculatus*

**Diagnostic characters (Based on 10 specimens 10.3–16.9 cm TL):**

**D. 0, 10-11; A. 0, 10; V. 10; P. 20; C. 19; Br. 5; Lat. 40.**

HL 3.2, HD 7.6, PrDL 2.2, PL 11.3, VL 8.5 and BD 5.9 in TL. PrOL 3.2, ED 4.2 and IOW 8.4 in HL. Body moderately elongate, more or less cylindrical, snout pointed. Eyes large 0.77 in PrOL. Dorsal origin around middle of body, before pelvic fin origin. Maximum depth of body at dorsal fin origin. Lower jaw prominent than upper jaw, maxilla reaching to middle of eye. Pectoral small, near to head, anal fin origin far behind dorsal origin. Caudal forked. Body light coloured, tip of fins black no prominent blotches or bars on body. Maximum length observed 16.9cm.

**Geographical distribution (Previous records):** Western Indian Ocean: off Mombassa, Kenya.

**Distribution in the Southwest coast (Present study):** Between 07° and 09° N latitude.

**Depth:** Bathydemersal, 178–290 m. In present study, 201-500 m.

## Family: Synodontidae

Supramaxilla small, if present. Branchiostegal rays 8-26. Vertebrae 39-67 Non-hermaphroditic, except in monoecious Bathysaurus. Small cylindrical fishes with spineless fins and large mouth full of slender sharp teeth, even on tongue.

### Genus : *Saurida* Valenciennes, 1850

***Saurida*** Valenciennes in Cuvier & Valenciennes 1850:499, Histoire naturelle des poissons. v. 22: i-xx + 1 p. + 1-532 + 1-91, Pls. 634-650.
Inoue & Nakabo 2006:379, Ichthyological Research v. 53 (no. 4): 379-397

Lateral-line scales not enlarged, not extending beyond base of caudal fin, procurrent and primary caudal-fin rays with scales; body cylindrical. Pelvic fin rays 9, inner rays subequal or slightly longer than outer rays.

**Key to Species**

**1a.** Pectoral reaching beyond middle of dorsal fin base ***S. longimanus***

**1b.** Pectoral reaching till anterior insertion of dorsal fin ***S. undosquamis***

*Saurida longimanus* Norman, 1939

(Plate V, Fig. 49)

**Vernacular Name:** Longfin lizardfish

***Saurida longimanus,*** Norman 1939:23, Fig. 5 [Scientific Reports, John Murray Expedition v. 7 (no. 1); Gulf of Oman, station 75, depth 201 meters. Holotype: BMNH 1939.5.24.441. Paratypes: BMNH 1939.5.24.440 (1), 1939.5.24.442-444 (3). Valid as *Saurida longimanus* Norman 1939

Inoue & Nakabo 2006:393, Ichthyological Research v. 53 (no. 4): 379-397

**Synonymy:** Nil

**Diagnostic characters (Based on 2 specimens 19.9–20.8 cm TL):**

Body elongate and tubular, HD 0.11-0.12, DDF 0.16 and DA 0.1-0.11 in SL. Head moderate, 0.21-0.23 in SL. Snout not elongated, more sub equal to eye diameter. Several rows of teeth inside in both jaws even when mouth is closed; 2 series of teeth on palatine; outer series in 2 rows anteriorly, inner sires well separated from outer and in 2-3 narrow rows. Vomer toothless. Dorsal originate in anterior half of body, PrDL 0.43-0.44 in SL. Longest ray of dorsal fin more than 3 times as long as last ray; scale in axil of pectoral fins long and pointed; fins (except first dorsal- and caudal-fin rays in some species) without dark bars or spots. Pectoral fins long, extending beyond insertion of first dorsal-fin ray, 0.29-0.31 in SL. Ventrals rays sub equal. Brownish above, silvery white below. Upper half of pectoral and distal parts of dorsal fin and lower caudal lobe dusky. Sometimes a faint series of dark spots on upper caudal.

**Geographical distribution (Previous records):** Indo-West Pacific: Gulf of Oman, southern Indonesia, and northern and northwestern Australia.

**Distribution in the Southwest coast (Present study):** Between 07° and 09° N latitude.

**Depth:** Demersal, 100-280 m In present study, 201-500 m.

*Saurida undosquamis* (Richardson, 1848)

(Plate V, Fig. 50)

**Vernacular Name:** Brushtooth lizardfish

***Saurus undosquamis,*** Richardson 1848:138, Pl. 51 (figs. 1-6), Ichthyology of the voyage of H. M. S. Erebus & Terror,... v. 2 (2); Coast of northwestern Australia. Holotype (unique): BMNH 1977.4.22.1. •Valid as *Saurida undosquamis* (Richardson 1848)
Misra, 1949. Rec. Indian Mus., 45, p. 424.
Fricke et al. 2007:58, Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie). No. 706: 1-174.

**Synonymy:** *Saurus undosquamis*

**Diagnostic characters: (Based on 10 specimens, 18.2–27.8 cm TL)**

**D. 11-12/0; P. 14-15; V. 9; A. 10-12; L. 1.45-52.**

Body elongate, more or less sub cylindrical, scaly; abdomen rounded, smooth, non-keeled. BD 6.0-8.0 in TL and 5.5-6.5 in SL. Head scaly, 5.0-5.3 in TL and 4.4 in SL. Eyes with adipose lids, 4.1-4.3 in HL, nearly equal to snout. Cleft of mouth oblique, very wide, maxilla extending to about an eye diameter behind orbit. A single dorsal fin; origin nearer to snout end than to caudal origin and midway between snout end and adipose dorsal origin. Adipose dorsal behind middle of anal base. Pectorals short, 1.4-1.5 in head. Pelvics moderate, 1.2 in head; origin much nearer to pectoral base than to anal origin and about an eye diameter before dorsal origin. Anal moderate; origin much nearer to caudal origin than to pelvic origin. Caudal bilobed, 1.2 in head. Brownish grey above, lighter below. Attains 45.7 cm.

**Geographical distribution (Previous records):** Indian Ocean; N.W. Australia, Louisiade Is., Maldives.

**Distribution in the Southwest coast (Present study):** Between 07° and 13° N latitude.

**Depth:** In present study, 201-500 m.

**Super Order : Scopelomorpha**

**Order : Myctophiformes**

**Family : Neoscopelidae**

Entirely compressed. Supramaxilla long and slender, trilobate rostral cartilage. No subocular shelf. Anal fin origin far posterior to dorsal fin. Some with photophores. Scales cycloid (ctenoid scales present in *Solivomer*). Swim bladder present in all but *Scopelengys*.

**Key to Genera**

**1a.** Photophores present; eye large, about 1 in snout; upper jaw extending to about posterior margin of eye ***Neoscopelus***

**1b.** Photophores absent; eye small, about 3 in snout; upper jaw extending at least 1 eye diameter beyond eye ***Scopelengys***

**Genus** ***Neoscopelus*** Johnson, 1863

***Neoscopelus*** Johnson 1863:44, Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1863 (pt 1): 36-46, Pl. 7
Paxton & Gates 2006:506, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Neoscopelus microchir* Matsubara, 1943

(Plate VI, Fig. 51)

**Vernacular Name:** Shortfin neoscopelid

*Neoscopelus microchir* Matsubara, 1943: 59, fig. 13 (off Heta, Japan); Maul, 1951 57; Nielsen, 1973: 170; Nafpaktitis, 1977· 9
Paxton & Gates 2006:507, In: Zoological Catalogue of Australia. Volume 35. Fishes.

**Synonymy:** Nil

**Distinctive characters (Based on 4 specimens 8.4–16.2 cm TL):**

**D.0, 12-13; A. 0, 10-12; P. 16-17; V. 8; Gr. (3-4) + (11-12).**

Head moderate, HL 0.26 in TL. PrDL 0.35, PrV 0.33, AL 0.56 in TL, Snout short, PrOL 0.25 and ED 0.21 in HL. Depth 3.9 to 4.5, Head 2.9 to 3.1 in SL. Laterally compressed body; mouth oblique and snout pointed. Dorsal and ventral origin in same line; pectoral reaching anal origin. Generally dark red on head and sides of body, silvery white below; fins pink. Attains 30 cm.

**Geographical distribution (Previous records):** Off Natal, both sides of Atlantic and from western Pacific.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** Benthopelagic over slope region in 250-700 m. In present study, 201-500 m.

### Genus : *Scopelengys* Alcock, 1890

***Scopelengys*** Alcock 1890:302, Annals and Magazine of Natural History (Series 6) v. 6 (no. 34): 295-311
Hartel & Craddock 2003:943, The living marine resources of the Western Central Atlantic. v. 2.

*Scopelengys tristis* Alcock, 1890

(Plate VI, Fig. 52)

**Vernacular Name:** Pacific blackchin

***Scopelengys tristis,*** Alcock 1890:303 [Annals and Magazine of Natural History (Series 6) v. 6 (no. 34); Off Elicapeni Bank, Laccadive Sea, 11°12'47"N, 74°25'30"E, Investigator station 104, depth 1000 fathoms. Holotype (unique): ZSI F12873. Type catalog: Menon & Yazdani 1968:104; Menon & Rama-Rao 1975:35. Figured in Alcock 1892: Pl. 7 (fig. 7). Valid as *Scopelengys tristis* Alcock 1890.
Castellanos-Galindo *et al.* 2006:254, Biota Colombiana v. 7 (no. 2): 245-262.
**Synonymy:** Nil
**Distinctive characters (Based on 2 specimens 11.4–13.2 cm TL):**

**D.0, 11; A. 0, 13-14; P. 14; V. 8; Gr. (4 + 10).**

Head 0.27-0.28, PrDL 0.0.39-0.40, AL 0.0.66-0.67, BD 0.23, PrOL 0.07-0.08, ED 0.03-0.04, IOW 0.054-0.055, PL 0.26-0.27 in SL. Body compressed, moderately long, head large, eyes small, mouth oblique and snout pointed. Dorsal fin originates at insertion of ventral. Adepose fin located at end of anal fin. Vomer has two oval patches of villiform teeth with naked median line. No tooth patches on pterygoids. Uniform brown in color, mouth and belly darker. Attains 20 cm.

**Geographical distribution (Previous records):** Arabian sea, North Madeira in Atlantic, eastern and middle Pacific and Indonesia and Philippines.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** Benthopelagic over slope region in 250-700 m. In present study, 201-500 m.

**Super Order : Polymixiomorpha**

**Order : Polymixiiformes**

**Family : Polymixiidae** (barbudos, beardfishes)

Moderately elongate and compressed. A pair of barbels on hyoid. Continuous dorsal fin; 4-6 spines, 26-38 soft rays. Anal fin 4 short spines, 13-17 soft rays. Subabdominal pelvic fin; 1 spinelike ray, 6 soft rays. Caudal fin 16 branched rays. Scales in lateral line about 33-38. Banchiostegal 4 rays. Gillrakers 11-21. Supramaxillae 2. Epurals 3. Subocular shelf, ortbitosphenoid, and basisphenoid present.

**Genus : *Polymixia*** Lowe 1838 (barbudo)

***Polymixia*** Lowe 1838:198, Transactions of the Cambridge Philosophical Society v.6:195-202, 5 col. pls.
**Heemstra** 1986: 432, In: Smiths' Sea Fishes (Smith & Heemstra 1986.
Paxton et al. 2006:548, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### Key to Species

**1a.** D. V, 35-37 (last ray double) ***P. nobilis***

**1b.** D. IV – V, 28-35 (last ray double) ***P. japonicus***

*Polymixia nobilis* Lowe 1838

(Plate VI, Fig. 53)

**Vernacular Name:** Atlantic beardfish, stout beardfish

*Polymixia nobilis* Lowe, 1836: 198, pl. 4 (Madeira): Smith, 1968: 8; Woods and Sonoda, 1973: 270.
Lowe, R. T 1838. Piscium Maderensium species quaedam novae, vel minus rite cognitae breviter descriptae, etc. Transactions of the Cambridge Philosophical Society v. 6: 195-202, 5 col. pls.
Menezes & Figueiredo in Menezes et al. 2003:58, Catálogo das espécies de peixes marinhos do Brasil. 2003: 1-160.
Moore et al. 2003:205, Northeastern Naturalist v. 10 (no. 2): 159-248.
**Synonymy:** *Dinemus venustus, Nemobrama webbii, Polymixia nobilis virginica*

**Diagnostic characters (Based on 8 specimens 11.9–16.3cm TL):**

**B. 5; D. V, 35-37; A. IV, 15-16; P. 14-15; V. 7; Gr.4+10-11; Lat.38**

HL 0.4, PrDL 0.54, AL 0.6, PL 0.3 and VL 0.12 in SL, PrOL 0.21, ED 0.28, AL 1.6, PrDL 1.41, PL 0.6, VL 0.33, DFB 1.2 and IOW 0.21 in HL. Height of body about equal to length of head, body compressed. All parts of head, except snout, suborbital space, upper jaw, middle line of chin, and border of angle of pre-operculum, are scaly. Snout not much more than half length of eye, which is about one third that of head, interorbital space about a fourth of a head-length in width. Mouth-cleft large, upper jaw reaches behind posterior border of orbit and so overhangs lower that its teeth are quite outside than mouth when closed. Barbells about as long as head without operculum. Gill-opening very wide, gill-rakers on outer side of 1$^{st}$ arch nearly half length of eye. Dorsal spines gradually increase in length posteriorly. Head and body dark brownish grey, silvery below; black blotch on distal part of anterior D rays. Attains 40 cm.

**Geographical distribution (Previous records):** West Indies: Madeira, Canaries and S. Atlantic: Mauritius: Andaman Sea: Japan.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Bathydemersal, depth range 100 - 770 m. In present study, 201-500 m.

*Polymixia japonica* Günther 1877

(Plate VI, Fig. 54)

**Vernacular Name:** Japanese beardfish, silver eyes

***Polymixia japonica***, Günther 1877:436 [Annals and Magazine of Natural History (Series 4) v 20 (no. 119). Off Inoshima, Japan. Holotype (unique): BMNH 1880.5.1.3. •Valid as *Polymixia japonica* Günther 1877
Mundy 2005:239, Bishop Museum Bulletin in Zoology No. 6: 1-704.
**Synonymy:** Nil

**Diagnostic characters (Based on 12 specimens 11.2-15.9 cm TL):**

**B. 5. D. V, 32-33; A. IV, 14-15; P. 14-15; V. i, 6-7; Gr. 4 + (10-11); Lat. 33; 8 scales from D origin to LL.**

HL 0.35, PrDL 0.42, AL 0.68, DFB 0.51, PL 0.2 and VL 0.13 in SL, PrOL 0.23, ED 0.36, AL 1.99, PrDL 1.23, PL 0.59, VL 0.35, DFB 1.49 and IOW 0.29 in HL. Moderately elongate and compressed. A pair of barbells on hyoid. Continuous dorsal fin; Sub ocular shelf, ortbitosphenoid, and basisphenoid present. Silvery on sides and belly, distinct black blotch on distal part of anterior D rays. Attains 38 cm TL.

**Geographical distribution (Previous records):** Tropical and subtropical. Atlantic, Indian, and Western Pacific.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Bathypelagic, Usually found in depths between 180 and 640 m. In present study, 201-500 m.

**Super Order : Paracanthopterygii**

**Order : Gadiformes** (cods, grenadiers)

## Family : **Moridae** Moreau, 1881 (deep sea codfishes, morid cods)

### Genus : *Physiculus* Kaup, 1858

***Physiculus*** Kaup 1858:88, Archiv für Naturgeschichte v. 24 (no. 1): 85-93.
Paxton et al. 2006:614, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Physiculus roseus* Alcock, 1891

(Plate VI, Fig. 55)

**Vernacular Name:** Rosy cod

*Physiculus roseus* Alcock, 1891. Ann. Mag. Nat. Hist., p.28; Illustrations of the Zoology of the Investigator Fishes, pl. XI. Fig.2; Journ. As. Soc.Bengal, Vol.LXIII. pt.2, 1984, p.122
Paxton et al. 2006:615, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** Nil

**Diagnostic characters (Based on 6 specimens 13.1–28.9 cm TL):**

**B. 7; D. VI-VII, 57; A.0, 55; V. 7.**

Head and trunk broad; tail compressed, higher than trunk anteriorly. Head 0.2-0.3 and greatest height of body, just behind origin of dorsal fin, 0.17-0.19 in TL. Snout depressed, broader than long, obtusely rounded and 0.96-1.0 in ED and 1.2-1.3 in IOW. Mouth wide, oblique, with upper jaw overlapping lower; maxilla reaches beyond vertical through middle of orbit. Body and head covered with a thick mucilaginous skin, six rows between first dorsal fin and lateral line. Dorsal and anal fins with a fold of thick scaleless skin, extend to within an eye-length of caudal. First dorsal, is separated from second only by a notch and its first ray is prolonged and nearly equals postrostral portion of head. Outer ray of ventrals is prolonged beyond origin of anal. Pectorals are pointed, 0.98-1.1 POL. Vent is situated well in advance of origin of anal fin, with a small post anal papilla. Uniform rose-red.

**Geographical distribution (Previous records):** Andaman Sea.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** Recorded previously from 185-220 fathoms. In present study, 201-800 m.

**Family : Macrouridae** Gilbert and Hubbs, 1916 (grenadiers, rattails)

Body attenuated posteriorly. Anal fin and second dorsal confluent with tail, which tapers to a sharp point. True fin spines lacking. Leading dorsal fin ray may be spinous. Usually with chin barbel. Pelvic fin insertion more or less thoracic. Pelvic fin rays 5-17; lacking in Macrouroides. No caudal fin, except in one species. Scales small. Light organ, if present, underneath skin along midline of abdomen with opening just before anus.

**Sub Family: Bathygadinae**

**Key to Genera**

**1a.** Elongated rays in dorsal and pectoral fins; chin barbell long, well developed ***Gadomus***

**1b.** No Elongated rays in dorsal and pectoral fins; chin barbell rudimentary, or absent ***Bathygadus***

**Genus : *Bathygadus*** Günther, 1878

***Bathygadus*** Günther 1878:23, Annals and Magazine of Natural History (Series 5) v 2 (nos. 7/8/9): 17-28, 179-187, 248-251
Bray et al. 2006:583, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Bathygadus melanobranchus* Vaillant, 1888

(Plate VI, Fig. 56)

**Vernacular Name:** Vaillant's grenadier

*Bathygadus melanobranchus* Vaillant, 1888: 206. pl. 18Fig. 1 (northeastern Atlantic); Gilchrist and von Bonde, 1924: 12; Barnard, 1925: 334; Smith, SFSA No. 249; Ivamoto, 1970: 336; Marshall, 1973:527

**Synonymy:** *Melanobranchus melanobranchus, Bathygadus vaillanti*

**Diagnostic characters (Based on 3 specimens 33.1–35.9 cm TL):**

**D. II, 9-11; P. 16-20; V. 8; Gr. (6-7) + (21-24).**

Body tapouring towards tail, highest depth is near pectoral insertions. Head bones and integument fragile, easily torn. Teeth villiform, narrow, in wide bands on upper jaw, in a narrow band on lower jaw. Maxilla extended to below rear edge of eye, about 1.7-2.0 in head. ED 3.2 to 4.0 HL, 0.97-1.1 in interorbital space. Outer gillrakers on first arch long and slender, but on second tubercular Overall flesh-coloured; linings of mouth, gill, and abdominal cavities black; fins dusky; Attains 40 cm.

**Geographical distribution (Previous records):** Table Bay and Natal coast, western north Atlantic and eastern Atlantic Ireland to South Africa and western Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Previous records from 400-2560 m. In present study, 501-1100 m.

### Genus : *Gadomus* Regan, 1903

***Gadomus*** Regan 1903:459. Masc. *Bathygadus longifilis* Goode & Bean 1885. Type by original designation (also monotypic). Valid as *Gadomus* Regan 1903.
Bray et al. 2006:594, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Gadomus capensis* (Gilchrist & von Bonde 1924)

(Plate VI, Fig. 57)

**Vernacular Name:** Nil

*Bathygadus capensis* Gilchrist and von Bonde, 1924: 13. fig. 2 (Table Bay); Smith, SFSA No. 248; Wintrbottom, 1974: 3. *Gadomus capensis* Marshall, 1973: 519. *Bathygadus fumosus* Burnard, 1925: 500 (Cape Point); 1925: 333; Smith, SFSA No. 247
Iwamoto et al. 2004:192, Proceedings of the California Academy of Sciences v 55 (no. 10): 190-207

**Synonymy:** *Bathygadus capensis, Bathygadus fumosus*

**Diagnostic characters (Based on 7 specimens 16.4–37.2cm TL):**

**D II, 9-10. 160; A. 0, 150; P. 16-19; V. 8**

Trunk short; tail compressed and greatly elongated, tapering to a slender point without a caudal fin. Head moderate, compressed and somewhat pointed snout; mouth large and inferior. Barbell rudimentary to short, more than 1.6 in eye diameter. Teeth minute, in long narrow bands in both jaws. Upper jaw band wider. One or more greatly elongated rays in first dorsal, pectoral or pelvic fins. Upper jaw extends beyond eye, about 1.6 in head. ED 0.91-0.98 in snout, 1.2 IOW, and 4.0-4.2 in head. Overall colour pale, flesh-coloured; blackish over gill covers; fins dusky to black. Attains 46 cm.

**Geographical distribution (Previous records):** Table Bay to Mozambique, Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 09° and 13° N latitude.

**Depth:** Previously recorded from 850-1480 m. In present study, 501-800 m.

**Sub Family: Macrourinae**

**Key to Genera**

| | |
|---|---|
| **1a.** Six branchiostegal rays | **2** |
| **1b.** Seven or eight branchiostegal rays | **3** |
| **2a.** Rakers absent on lateral side of first gill arch | ***Caelorinchus*** |
| **2b.** Rakers present on lateral side of first gill arch | ***Coryphaenoides*** |
| **3a.** Lower jaw teeth large, widely spaced, in 1 row | ***Malacocephalus*** |
| **3b.** Lower jaw teeth small to moderate-sized, closely spaced, in 1 or more rows | ***Nezumia*** |

## Genus *Coelorinchus* Giorna, 1809

***Coelorinchus*** Giorna 1809:179, Mémoire. Académie impériale des sciences, littérature et beaux-arts, Turin v. 9 (pt 1): 1-19, 177-180, Pls. 1-2.
Iwamoto & Graham 2008:133, Proceedings of the California Academy of Sciences (Series 4) v. 59 (no. 5): 133-146.

Macrourinae with 6 branchiostegal rays. Outer gill slit greatly restricted; no gill rakers on outer side of first arch; a stout suborbital ridge consisting of enlarged strengthened scales running from snout tip to near posteroventral angle of preopercle. Snout variously developed, from short and blunt to elongated and sharply pointed; mouth inferior; ridges of head usually rather strong, stout, scutelike, and spiny. Second spinous ray of first dorsal fin usually rounded and smooth along leading edge. Ventral light organ variously developed.

**Key to Species**

**1a.** Upper jaw tooth band much shorter than that of lower jaw; second spinous ray of first D filamentous, longer than post orbital length of head; barbell more than 3 in eye pyloric cneca 8-11 in number seven branchiostegals ***C. braueri***

**1b.** Upper jaw tooth band as long as or longer than that of lower jaw; second spinous ray of first D shorter than postorbital length of head; barbell 2.5 or less in eye; pyloric caeca 40-53 **2**

**2a.** Body-scales with 5 spiny ridges: 6 to 6½ series of scnles between first dorsal fin and lateral line ***C. quadricristatus***

**2b.** Body-scales with 8 or 9 spiny ridges: 4 to 5 series of scales between first dorsal fin and lateral line ***C. flabellispinis***

*Coelorinchus braueri* Barnard, 1925

(Plate VI, Fig. 58)

**Vernacular Name:** Shovelnose grenadier

Coelorhynchus (Oxygadus) braueri, Barnard, 1925: 501 (Saldanha and Table Bay, Cape point, East London); 1925: 342; Smith, 1968: 6. Macrurus parallelus (non Gunther): Gilchrist, 1904: 137; Brauer, 1906: 257 Coelorhynchus parallelus (non Gunther): Smith, SFSA No. 232. Coelorhynchus braueri: Karrer, 1973: 219.
Bianchi & Carpenter in Bianchi et al. 1993:142, The Living Marine Resources of Namibia. FAO, Rome. I-viii + 1-250, I-VII.
**Synonymy:** Nil

**Diagnostic characters (Based on 2 specimens 26.3-28.9 cm TL):**

**D. II, vii-ix+ ca. 105; A. 105; P. 18-20; Gr. 7-9; 4 ½ to 5 ½** scales below second D origin. Snout elongated, sharply pointed and 0.32-0.36 in HL, 1.21-1.29 of ED. Body tapering towards tail region. Head 0.93, VL 0.20, PL 0.35 in PrDL and ED 0.29 in HL. Spinules on body scales shaped like recurved, overlapping blades; blades increase in height posteriorly and form as many as 5-8 ridge like rows. Light organ shorter than rear nostril. Interspace between dorsal fins 0.96-0.99 in 1$^{st}$ D base. Body uniformly brownish. Attain 40 cm.

**Geographical distribution (Previous records):** Saldanha and Table Bay, Cape point, East London, south of Angola and north to Mozambique.

**Distribution in the Southwest coast (Present study):** Between 9° and 11° N latitude.

**Depth:** In present study, 501-800 m.

*Coelorinchus quadricristatus* (Alcock, 1891)

(Plate VI, Fig. 59)

**Vernacular Name:** Nil

***Macrurus quadricristatus***, Alcock 1891:119, Annals and Magazine of Natural History (Series 6) v. 8 (no. 43/44); Andaman Sea, 11°31'40"N, 92°46'40"E, Investigator station 115, depth 188-220 fathoms; 11°25'5"N, 92°47'6"E, station 116, depth 405 fathoms. Syntypes: ZSI F13070-71 (2) station 115, F13072 (1) station 116.
Iwamoto & Anderson 1999:1081, Copeia 1999 (no. 4): 1079-1083.
**Synonymy:** *Macrurus quadricristatus*

**Diagnostic characters (Based on 2 specimens 16.3–22.8 cm TL):**

**B. 6; D. 11; A. ca. 90; P.16; V. 7**

Head much exceeding trunk in all three dimensions: tail low, compressed, tapering. HL 0.31-0.36 of TL. BD 0.98-1.12 of PrOL, which is 0.49-0.53 of HL, 2.11-2.19 ED and IOW. Posterior half of head is longitudinally traversed on each side by two strongly serrated ridges, one extends from interorbital space to occiput, other from supra-orbital ridge to shoulder. Villiform teeth in bands in jaws, outer row in upper jaw slightly enlarged. Barbell slender, less than half eye in length. Gill-rakers in form of tubercles. Scales of head with about 3, scales of body with about 5, thin salient slightly-divergent serrated crests. First spine of first dorsal fin is very small, second is smooth throughout. Interval between first and very inconspicuous second dorsal is hardly half extent of base of first. Pectorals narrow and pointed, their length slightly exceeds that of postorbital portion of head. Ventrals with outer ray prolonged well beyond origin of anal. Chocolate; body and tail with numerous broad black cross bands, which do not reach mid-abdominal line.

**Geographical distribution (Previous records):** Andaman Sea.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** Previous reports from 185-405 fathoms. In present study, 501-800 m.

*Coelorinchus flabellispinnis* (Alcock, 1894)

(Plate VI, Fig. 60)

**Vernacular Name:** Nil

***Macrurus flabellispinnis***, Alcock 1894:123 [9], Journal and Proceedings of the Asiatic Society of Bengal v 63 (pt 2), Laccadive Sea, Investigator station 150, 719 fathoms or 13.5

miles north 64° west of Colombo, Sri Lanka, station 151, depth 142-400 fathoms. Holotype: ZSI F13472. Non-type: BMNH 1898.7 13.12 [ex ZSI] (1) Off Malabar.
Manilo & Bogorodsky 2003:S98, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** *Coelorhynchus flabellispinis, Coelorhynchus japonicus*

**Diagnostic characters (Based on 3 specimens 29.6–45.9 cm TL):**

**D. II, viii-ix + ca, 115; A. ca, 115; P. 17-19; V. 7; Gr. 2+6; 4 ½** Scales below **2nd D.**

Snout long and sharply pointed. PrOL 1.46-1.51 times of ED and 0.35 in head. ED 0.23, UJL 0.20 and LJL 0.15 in HL. Head 0.97, VL 0.22 and PL 0.33 in PrDL. Anterolateral snout margins incompletely supported by bones. Posteroventral angle of suboperculum produced into a narrow flap. Upper jaw longer than orbit diameter; scales on top of head with small spinules closely compressed and imbricate so as to form a long, serrated median longitudinal ridge and 0 to 2 shorter divergent ridges on either side of median ridge. Upper jaw tooth band as long as that of lower jaw; second spinous ray of first D shorter than postorbital length of head. Spinules on body scales sharp and keel like. Light organ extends past mid way between anal origin and ventral insertion. Interspace between dorsal fins sub equal to or shorter than first D base. Body uniformly brownish; no bold markings on body or fins. Mouth and gill cavity mostly dusky. Attains 47 cm.

**Geographical distribution (Previous records):** Indian Ocean: Laccadive Sea.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** In present study, 501-800 m.

## Genus : *Coryphaenoides* Gunner, 1765

***Coryphaenoides*** Gunner 1765:50, Det Trondhiemske Selskabs Skrifter [= Drontheim. Gesell. Schrift.] v. 3: 50-58, Pl. 3.
Bray et al. 2006:591, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Coryphaenoides macrolophus* (Alcock, 1889)

(Plate VII, Fig. 61)

**Vernacular Name:** Nil

***Macrurus macrolophus***, Alcock 1889:394 [20] [Annals and Magazine of Natural History (Series 6) v. 4 (no. 23);] 7 miles southeast by south of Ross Island, Port Blair, Andaman Islands, Investigator station 13, depth 265 fathoms. Holotype (unique): ZSI F11776.
Manilo & Bogorodsky 2003:S98, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** *Macrurus macrolophus, Macrurus lophotes, Coryphaenoides lophotes*

**Diagnostic characters (Based on 5 specimens 10.2–11.0 cm TL):**

**B. 6; D. II, 9; P. 19-21; V.8; Gr. 7; 11; 6 scales below 2$^{nd}$ D.**

HL 0.22, PrDL 0.24 and PL 0.12 in TL. Snout blunt, 0.94-1.04 in ED. Most ventral surfaces of snout, suborbital region and mandible naked; pores large and permanent in these areas. Eye diameter 0.31-0.4 in head; greater than inter orbital width. Barbell extends to end of maxillary, about 3 in head. Mouth inferior, upper jaw falls short of reaching below posterior 1/3 of orbits. Preopercle margin acutely angulated at posteroventral corner An extremely long dorsal spine, 1.3-1.5 times head length. Scales with closely set parallel rows of long, needle-like spinules. Distance from isthmus to anal less than head length. Dark brownish.

**Geographical distribution (Previous records):** Western Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 9$^{o}$ and 13$^{o}$ N latitude.

**Depth:** In present study, 501-1100 m.

## Genus : ***Malacocephalus*** Günther, 1862

***Malacocephalus*** Günther 1862:396, Catalogue of the fishes in the British Museum. v. 4: i-xxi + 1-534.
Bray et al. 2006:599, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Malacocephalus laevis* (Lowe, 1843)

(Plate VII, Fig. 62)

**Vernacular Name:** Softhead grenadier

*Macrurus laevis* Lowe, 1843: 92 (Madeira). *Malacocephalus laevis* Barnard, 1925: 344; Smith, SFSA No. 239; 1968: 6; Marshall and Iwamoto, in Marshall, 1973: 651.
Bray et al. 2006:599, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Macrourus laevis*

**Diagnostic characters (Based on 11 specimens 32.8-42.6 cm TL):**

**D. II, 9-13 + >220; A. >210; P. 16-22; V. 9; Gr. 11-14; 11-13 scale rows below 2$^{nd}$ D.**

HL 0.17-0.19, PrDL 0.21-0.22 and PrV 0.18-0.2 in TL. Elongated body tapering towards tail. PrOL 0.15 and ED 0.28 in HL. Body elongated, tapering towards caudal. Mouth inferior, upper jaw not reaching to posterior half of eye. Snout short, less than ED. Upper jaw 0.4-0.5 length of head. Upper jaw teeth in 2 series, outer series enlarged and widely spaced. Scale patches on lowermost branchiostegal rays and often on gular membrane. Ventral light organ well developed, with a bean-shaped fossa between V and a smaller circular fossa in front of anus. Anus remote from anal fin. Attains 60 cm.

**Geographical distribution (Previous records):** widespread in Atlantic and Indian Oceans

**Distribution in the Southwest coast (Present study):** Between 9° and 15° N latitude.

**Depth:** Previous records from 200–750 m. In present study, 201-800 m.

## Genus : *Nezumia* Jordan, 1904

***Nezumia*** Jordan in Jordan & Starks 1904:620, Bulletin of the U. S. Fish Commission v. 22 [1902]: 577-630, Pls. 1-8.
Bray et al. 2006:601, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Nezumia investigatoris* (Alcock, 1889)

(Plate VII, Fig. 63)

**Vernacular Name:** Nil

*Macrurus investigatoris* Alcock, 1889. Ann. Mag. Nat. Hist., p.391; Journ. As.Soc. Bengal, Vol.LXIII. pt.2, 1894, p. 126. Illustrations of the Zoology of the Investigator, Fishes, pl. III. Fig. 4.
Manilo & Bogorodsky 2003:S98, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** *Macrurus investigatoris*

**Diagnostic characters (Based on 2 specimens 18.9–32.5 cm TL):**

**B.7; D. 11; A. 100; P. 20-21; V. 8**

HL 0.25 and PrDL 0.26 in TL, PrOL 0.16-0.18, ED 0.23-0.25, PrDL 0.98-1.02, DFH 0.44-0.47, PL 0.75-0.77 and VL 0.60-0.63 in HL. Snout not much elongated, overlapping mouth; nostrils in a scale less fossa. Width of inter-orbital space 0.67 of ED. Mouth rather small, completely inferior: upper jaw, which overlaps lower and is about as long as snout, about reaches to middle of eye. Teeth in jaws in broad bands, none of teeth enlarged. Barbell slender, hardly half as long as eye. Scales of body of moderate size; each with from 9 to 13 quite similar, nearly parallel, longitudinal ridges which project slightly beyond edge of scale. First spine of first dorsal fin rudimentary; second spine about as long as head without snout. Outer ray of ventral fins filamentous, slightly longer than pectorals. Vent situated between ventral fins. First dorsal fin black with white root and tip.

**Geographical distribution (Previous records):** Indian Ocean: Bay of Bengal, Andaman Sea.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** Previous records 193-490 fathoms. In present study, 501-800 m.

**Order : Ophidiiformes** (Ophidiiformes)

**Key to Sub Orders**

**1a.** Oviparous, males lacking a developed external intromittent organ; pelvic fins at about level of preopercle or farther anterior in position, when present; caudal fin usually present and connected with dorsal and anal fins **Ophidioidei**

**1b.** Viviparous, males with variously developed external intromittent organ; pelvic fins at about level of opercle in position, when present; caudal fin connected with dorsal and anal fins or free **Bythitoidei**

**Sub Order : Ophidioidei**

**Family : Ophidiidae** (Cusk eels)

Medium to elongated fishes; dorsal fin rays usually equal to or longer than opposing anal fin rays; anus and anal fin origin usually behind tip of pectoral fin; scales present; some with one or more spines on opercle; supramaxillary present; pelvics sometimes absent.

**Key to Sub Families**

**1a.** Scales in form of small, non-imbricate prickles **Brotulotaeniinae**

**1b.** Scales cycloid **Neobythitinae**

**Sub Family : Brotulotaeniinae**

**Genus : *Brotulotaenia* Parr, 1933**

***Brotulotaenia*** Parr 1933:48, Bulletin of the Bingham Oceanographic Collection Yale University v. 3 (art. 6): 1-51.
Suntsov 2007:177, The Raffles Bulletin of Zoology Suppl. NO. 14: 177-186.

*Brotulotaenia crassa* Parr, 1934

**Vernacular Name:** Violet cuskeel

*Brotulotaenia crassa* Parr, 1934; 36, Fig.12 (Bahamas); Cohen, 1974; 140; Shcherbachev *et al.*, 1978: 189; Shcherbachev, 1980: 105.
Hoese et al. 2006:558, In: Zoological Catalogue of Australia. Volume 35. Fishes.

**Synonymy:** Nil

**Diagnostic characters (Based on 2 specimens 23.3–43.1 cm TL):**

**D. 123-134; A. 101-108; P. 22-23**

Head length 7.3 to 8.5 in standard length. Scales small non-imbricate prickles; opercle with no spine; median basibranchial tooth patch absent; gill rakers are tooth-bearing tubercles; otolith very small and rounded; pelvic fins absent. Colour variable but generally pale grey to brown or purple, muzzle often quite dusky. Attains 83 cm.

**Geographical distribution (Previous records):** Tropical Atlantic off South Africa and in southwest Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 7° and 15° N latitude.

**Depth:** Previous studies 900-1000 m. In present study, 201-500 m.

## Sub Family: Neobythitinae

**Key to Genera**

**1a.** Pelvic fins absent or rudimentary, rays shorter than orbit........................................................................... ***Lamprogrammus***

**1b.** Pelvic fins present, each with 1 or 2 well-developed rays **2**

**2a.** Head length much less than 1/2 preanal length ***Spectrunculus***

**2b.** Head length about 1/2 preanal length **3**

**3a.** Long gill rakers 4 or fewer **4**

**3b.** Long gill rakers 5 or more **5**

**4a.** Opercular spine present ***Luciobrotula***

**4b.** Opercular spine absent ***Hypopleuron***

**5a.** Opercular spine absent or weak, if present rather broad, flattened and flap-like incorporated in opercular bone **6**

**5b.** Opercular spine strong and narrow, sometimes hidden, usually rounded in cross-section **7**

**6a.** Eye diameter equal to or greater than snout ***Glyptophidium***

**6b.** Eye diameter less than snout **Bassozetus**

**7a.** Pectoral fins with lower rays free; pelvic fins with 2 rays in each ***Dicrolene***

**7b.** Pectoral fins entire; pelvic fins with 1 or 2 rays in each **8**

**8a.** Median basibranchial tooth patch 1 ***Monomitopus***

**8b.** Median basibranchial tooth patches 2 ***Neobythites***

**Genus : *Lamprogrammus*** Alcock, 1891

***Lamprogrammus*** Alcock 1891:32, Annals and Magazine of Natural History (Series 6) v 8 (no. 43/44): 16-34 (1 July); 119-138 (1 Aug.), Pls. 7-8.
Mincarone et al. 2008:51, Zootaxa No. 1770: 41-64.

Mouth terminal; branchiostegal rays 8; median basibranchial tooth patches 0 or 1; teeth granular, none enlarged; lateral line covered with small scales, beneath which lie vertically oriented, spindle-shaped neuromasts, each of which is mounted on a large, vertically elongate scale; pelvic fins absent in adults; caudal-fin rays 8 or 9; precaudal vertebrae 11 to 14.

**Key to Species**

**1a.** Median basibranchial tooth patch absent ***L. niger***

**1b.** Median basibranchial tooth patch 1 ***L. exutus***

*Lamprogrammus niger* Alcock, 1891

(Plate VII, Fig. 64)

**Vernacular Name:** Nil

*Lamprogrammus niger* Alcock, 1891. Ann. Mag.Nat.Hist., p.33, fig.2; Illustrations of the Zoology of the Investigator, Fishes, pl.I. fig. 2.
Garrido-Linares & Acero P 2006:292, 297, Biota Colombiana v/ 7 (no. 2): 283-299.
**Synonymy:** Nil

**Diagnostic characters (Based on 5 specimens 43.8–55.9 cm TL):**

**D. 105-115; A. 84-91; P. 16-19; Gr. 17-21**

HL 0.2-0.24 in TL, BD 0.94-0.95 in HL. ED 0.52-0.58 in PrOL, 0.12-0.14 HL. Upper jaw, overlaps lower. Villiform teeth in a broad band in upper jaw, in a narrow band on lower jaw and on each palatine, and in a narrow broken inverted V shaped band on vomer Angle of preoperculum notched, angles of notch rounded off. About ten long gill-rakers on outer side of first branchial arch. Body and head covered with deciduous, almost membranaceous, scales of moderate size. Scales of lateral line adherent and greatly enlarged; they lie beneath a continuous sheath of black skin, which is loop holed over a long narrow groove with raised margins situated along vertical diameter of each scale. These grooves are filled with an opaque white substance, which probably has a luminous function. Rays of fins are weak, those of dorsal fin are much more strongly developed than those of anal. Pectorals are short. Jet black. Attains 56 cm or more.

**Geographical distribution (Previous records):** Bay of Bengal, near Andamans, Caught off Natal; probably circumtropical.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Bathypelagic, 405-561 fathoms; but larger specimens are sometimes taken in bottom trawls in 800 to 2000 m. In present study, 801-1100 m.

*Lamprogrammus exutus* Nybelin and Poll, 1958

(Plate VII, Fig. 65)

**Vernacular Name:** Legless cuskeel

*Lamprogrammus exutus* Nybelin and Poll, 1958: 4, fig.1 (Gulf of Guinea); Trunov, 1971: 733; Golovan, 1978; 223.
Fahay & Nielsen 2003:210, Ichthyological Research v. 50 (no. 3): 209-220.

**Synonymy:** Nil

**Diagnostic characters (Based on 12 specimens 34.9–73.4cm TL):**

**D. 1-8-119; A. 88-96; P. 18-21; Gr. 9-12**

Body shorter, flabby; head moderate, HL 0.23-0.24 in SL, snout longer than eye diameter, PrOL 0.23-0.24, ED 0.12-0.13 in HL. Mouth terminal, maxilla sheathed posteriodorsally. Median basibranchial tooth patch 1. Posterior margin of opercle weakly fimbriate. Dorsal fin originate on same line with posterior margin of opercle, PrDL 0.23-0.25. Body taporing towards tail, BD 0.25-0.27, DPF 0.23 and DA 0.22-0.23 in SL. Body pale rose – pink. Attains more than 75 cm.

**Geographical distribution (Previous records):** Gulf of Guinea to Walvis Bay.

**Distribution in the Southwest coast (Present study):** Between 9° and 15° N latitude.

**Depth:** Caught on above continental slope in 260-650 m. In present study, 501-1100 m.

**Genus : *Spectrunculus*** Jordan & Thompson 1914

***Spectrunculus*** Jordan & Thompson 1914:301, Memoirs of the Carnegie Museum v. 6 (no. 4): 205-313, Pls. 24-42.
Uiblein et al. 2008:543, Copeia 2008 (no.3): 542-551.

*Spectrunculus grandis* (Günther 1877)

(Plate VII, Fig. 66)

**Vernacular Name:** Giant cusk-eel

***Sirembo grandis,*** Günther 1877:437 [Annals and Magazine of Natural History (Series 4) v. 20 (no. 119); Near Yokohama, Japan, Challenger station 237, 34°37'N, 140°32'E, depth 1875 fathoms. Holotype (unique): BMNH 1887 12.7.40. Valid as *Spectrunculus grandis* (Günther 1877)
Uiblein et al. 2008:544, Copeia 2008 (no.3): 542-551.
**Synonymy:** *Parabassogigas* Nybelin, 1957, *Sirembo grandis* Günther, 1877

**Diagnostic characters (Based on 3 specimens 25.4–38.9cm TL):**

**D. 0,121-148; A. 0, 90-113; P. 23-33; V. 2; Gr. 5-10.**

Body tapering towards tail, head short, 0.42 in preanal length and 0.18-0.19 in TL, eye shorter than snout, 0,69-0.7, 0.17 in HL. PrOL 0.25 in HL. Dorsal fin origin behind pectoral and PrDL 0.27 in TL. Dorsal and anal extending to caudal fin. Anterior nostril with a thick, fleshy raised rim; opercular spine strong; 2 median basibranchial tooth patches; 5 to 10 developed rakers on anterior gill arch. Body uniformely dark. Attains 127 cm.

**Geographical distribution (Previous records):** Below tropical and temperate areas of all oceans. Off west coast of South Africa; also known from Japan.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Benthopelagic at bathyal and abyssal depths (800 to 4 255 m). In present study, also 501-800 m.

**Genus:** ***Luciobrotula*** Smith and Radcliffe 1913

***Luciobrotula*** Smith & Radcliffe in Radcliffe 1913:170, Proceedings of the United States National Museum v. 44 (no. 1948): 135-176, Pls. 7-17
Nielsen & Møller 2008:29, Steenstrupia v. 30 (no. 1): 21-46.

### *Luciobrotula bartschi* Smith and Radcliffe 1913

(Plate VII, Fig. 67)

**Vernacular Name:** Kuro-umidojô

*Luciobrotula barstchii* Smith and Radcliffe in Radcliffe, 1913: 171, Pl. 16, fig. 2 (Palawan passage, Philippines); Cohen, 1981: Tab. 1,3.
Nielsen & Møller 2008:30, Steenstrupia v. 30 (no. 1): 21-46.
**Synonymy:** Nil

**Diagnostic characters (Based on 3 specimens 37.3–40.4 cm TL):**

**B. 8; D. 87-93; A. 68 – 75; V. 2; C. 10-12; GR. 3.**

Head large, 0.55-0.57 in AL, 0.24-0.26 in TL, snout depressed, naked, bearing fleshy flaps and ridges at tip, 0.27 in HL. Eye small, 0.37-0.39 in PrOL and 0.09-0.1 in HL, rear margin of preopercle free, lacking spines; opercle with spine at upper angle; teeth granular; median basibranchial tooth patches 1. Maxilla reaches well beyond eye. Tubular lateral line ends near level of anal-fin origin. Dorsal fin origin above pectoral, 0.26-0.28 in TL. Pectoral falling far short of anal origin, PL 0.52-0.53 in HL. Anal origin just behind anus, AFB 0.72-0.74 in DFB. Body pale, lighter than fins, head colour variable. Attains about 45 cm length.

**Geographical distribution (Previous records):** Off Natal; known from Hawaii, Philippines, and several localities in western Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** Trawled in 500-800 m. In present study, 501-800 m.

### **Genus : *Hypopleuron*** Smith & Radcliffe 1913

***Hypopleuron*** Smith & Radcliffe in Radcliffe 1913:164, Proceedings of the United States National Museum v. 44 (no. 1948): 135-176, Pls. 7-17
Hoese et al. 2006:561, In: Zoological Catalogue of Australia. Volume 35. Fishes.

## *Hypopleuron caninum* Smith & Radcliffe 1913

(Plate VII, Fig. 68)

**Vernacular Name:** Whiptail cusk

***Hypopleuron caninum,*** Smith & Radcliffe in Radcliffe 1913:165, Pls. 13 (fig. 2), 14, Proceedings of the United States National Museum v. 44 (no. 1948); Near Kayoa Island, 0°07'30"N, 127°29'00"E, Indonesia, Albatross station 5626, depth 265 fathoms. Holotype: USNM 74147 Paratypes: USNM 99198 (1), 99202 (1). Two small specimens were included with question and are not regarded as types. Valid as *Hypopleuron caninum* Smith & Radcliffe 1913.

Hoese et al. 2006:561, In: Zoological Catalogue of Australia. Volume 35. Fishes.

**Synonymy:** Nil

**Diagnostic characters (Based on 8 specimens 42.1-73.8cm TL):**

**D. 0,125-130; A. 0, 80-85; P. 26; V. 1**

Mouth oblique, two canine teeth on margin of maxilla, eyes moderately large, maxilla reaches up to hind border of eye, prominent lateral line. Some teeth on vomer are large, teeth on mandible, outer row large, head naked. Body elongated, head Jaws equal in length or lower jaw slightly protruding; no spines on opercle or subopercle; a canine tooth at front of each upper jaw bone; median basibranchial tooth patch 1; branchiostegal rays 8; lateral line with small scales that overlie an inner series of larger scales that bear neuromasts; precaudal central 22. Attains 79 cm.

**Geographical distribution (Previous records):** Indo-West Pacific: Arabian Sea, Andaman Sea and Philippines.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Continental shelf at depths of 300 to 575 m. In present study, 201-800 m.

### Genus : *Glyptophidium* Alcock 1889

***Glyptophidium*** Alcock 1889:390. Neut. *Glyptophidium argenteum* Alcock 1889. Type by monotypy. Valid as *Glyptophidium* Alcock 1889.

Nielsen & Møller 2008:28, Steenstrupia v 30 (no. 1): 21-46.

Body elongate, compressed, of good height; tail long tapering to a lash-like filament: head compressed with soft, almost membranaceous, frilled and crested bones. Both head and body covered with thin caduceus scales. Lateral line absent. Snout not overhanging lower jaw, without barbells. Mouth wide, villiform teeth in bands on jaws and palatines and in an upturned V shaped band on vomer. Gill openings wide, operculum with a feeble flat spine. Branchiostegals 8. The ventral fins arise close together behind clavicular symphysis, each consists of either 1 or 2 filamentous rays.

**Key to Species**

**1a.** Pelvic-fin rays 1; median basibranchial tooth patches 1; long gill rakers on anterior arch 14 to 23 **2**

**1b.** Pelvic-fin rays 2; median basibranchial tooth patches 2; long gill rakers on anterior arch 21 to 41 **3**

**2a.** Horizontal diameter of orbit 0.31 to 0.41 in head length; pseudobranchial filaments 11 to 15; pectoral-fin rays 23 to 26 ***G. lucidum***

**2b.** Horizontal diameter of orbit 0.21 to 0.31 in head length; pseudobranchial filaments 7 to 12; pectoral-fin rays 20 to 24 ***G. argenteum***

**3a.** Long gill rakers 35–37, and horizontal orbit 0.35–0.38 in head length ***G. oceanium***

**3b.** long gill rakers 39-41, horizontal orbit 0.24-0.25 in head length ***G. macropus***

*Glyptophidium lucidum* Smith & Radcliffe 1913

(Plate VII, Fig. 69)

**Vernacular Name:** Nil

***Glyptophidium lucidum*****,** Smith & Radcliffe in Radcliffe 1913:161, Pl. 12 (fig. 3), Proceedings of the United States National Museum v. 44 (no. 1948); Between Gillolo and Kayoa islands, 0°07'00"N, 127°28'00"E, Indonesia, Albatross station 5625, depth 230 fathoms. Holotype: USNM 74144. Paratypes: BMNH 1939.4.1.6 [ex USNM] (1); USNM 99105-07 (2, 4, 7), 99109 (1), 99111 (3), 99113 (1). Valid as *Glyptophidium lucidum* Smith & Radcliffe 1913.
Hoese et al. 2006:560, In: Zoological Catalogue of Australia. Volume 35. Fishes.

**Diagnostic characters (Based on 2 specimens 13.5–16.2 cm TL):**

**D. 0, 133-146; A. 0, 109–122; P. 23-25; V. 1; Gr. 21-23.**

HL 0.21-0.24, PrDL 0.17-0.19, 0.35-0.37 and BD 0.16-0.17 in TL. PL 0.42-0.46 in HL. Prominent head and body with an attenuate caudal part; head bones with large, thin crests; eye equal to or greater than length of snout; opercular spine broad, flat and weak; basibranchial with 1 median and a pair of tooth patches; long gill rakers. Horizontal diameter of orbit 0.29-0.34 of head length. Median basibranchial tooth patches 1. Dorsal fin origin before pectoral origin, pectoral tips not reaching anal. Anal and dorsal not confluent with caudal.

**Geographical distribution (Previous records):** Western Pacific: northern Philippines to off Northwest Australia; including southwestern Taiwan.

**Distribution in the Southwest coast (Present study):** Between 9° and 11° N latitude.

**Depth:** Bathydemersal, 395 – 685 m. In present study, 201-500 m.

*Glyptophidium argenteum* Alcock 1889

(Plate VII, Fig. 70)

**Vernacular Name:** Nil

***Glyptophidium argenteum*****,** Alcock 1889:390 [16], Annals and Magazine of Natural History (Series 6) v. 4 (no. 23); Andaman Sea, off Ross Island, Investigator station 7 [or 8], depth 271 fathoms. Holotype (unique): ZSI F11661.
Nielsen 1999:1980, Order Ophidiiformes. In: Carpenter and Niem 1999

**Synonymy:** Nil

**Diagnostic characters (Based on 5 specimens 14.2-17.7 cm TL):**

**D. 0, 140-158; A. 0, 114–133; P. 20-22; V. 1; Gr. 18-21**

HL 18-.19, PrDL 0.2-0.24, AL 0.34-0.36 and BD 0.17-0.19 in TL. PrOL and ED 0.18-0.19, HD 0.68-0.7 in HL. Prominent head and body with an attenuate caudal part; head bones with large, thin crests; eye equal to length of snout; opercular spine broad, flat and weak; basibranchial with 1 median and a pair of tooth patches; long gill rakers on anterior arch. Dorsal fin originates above pectoral fin, pectoral not elongated. Anal origin in anterior half of body; dorsal and anal confluent with caudal fin. Body uniformly black.

**Geographical distribution (Previous records):** off East Africa to Japan and Australia. Indo-West Pacific: Bay of Bengal to Philippines, off Travancore coast.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Benthopelagic at 40 to 823 m. In present study, 501-800 m.

*Glyptophidium oceanium* Smith & Radcliffe 1913

(Plate VII, Fig. 71)

**Vernacular Name:** Nil

***Glyptophidium oceanium***, Smith & Radcliffe in Radcliffe 1913:162, Pl. 12 (fig. 4) [Proceedings of the United States National Museum v 44 (no. 1948); North of Samar, 12°43'51"N, 124°58'50"E, Philippines, Albatross station 5444, depth 308 fathoms. Holotype: USNM 74145. Paratypes: (2). *Glyptophidium oceanicum* is a misspelling. Valid as *Glyptophidium oceanium* Smith & Radcliffe 1913 Nielsen & Møller 2008:28,
Kurup et al., 2008, *JMBA2 - Biodiversity Records* online.
Synonymy: **Nil**

**Diagnostic characters (Based on 3 specimens 14.3–18.8 cm TL):**

**D. 0, 124-127; A. 0, 100–103; P. 20-23; C. 8-10; Gr. 35-37**

Origin of dorsal fin close to head; dorsal fin rays 2–3 times as long as corresponding anal fin rays; pectoral fins placed below midline of body; caudal fin small with 8–10 rays. Scales cycloid and deciduous, head without scales. Lateral line indistinct. Mouth large with maxillary reaching posterior margin of orbit, numerous irregular rows of granular shape teeth in dentary, premaxillary, vomer and palatine. Vomerine teeth somewhat longer than those on other bones, dentigerous part V-shaped. Anterior nostril placed midway between upper lip and orbit; posterior nostril larger. Anterior gill arch with many long rakers, longest of which are 2–3 times length of gill filaments. Basibranchial with two median and a pair of tooth patches.

**Geographical distribution (Previous records):** Off north-western coast of Australia, off south-western coast of Indonesia, East China Sea, and also at Tosa Bay (Japan), West coast of India.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** Benthopelagic, 200–700 m. In present study, 201-500 m.

*Glyptophidium macropus* Alcock 1894

(Plate VIII, Fig. 72)

**Vernacular Name:** Nil

***Glyptophidium macropus,*** Alcock 1894:122 (8), Pl. 6 (fig. 3) Journal and Proceedings of the Asiatic Society of Bengal v. 63 (pt 2); Bay of Bengal, 13°51'12"N, 80°28'12"E, Investigator station 162, depth 145-250 fathoms. Lectotype: ZSI F13534. Paralectotypes: ZSI F13529-33 (5), 13635 (1).
Manilo & Bogorodsky 2003:S99, Journal of Ichthyology v 43 (suppl. 1): S75-S149.
**Synonymy:** Nil

**Diagnostic characters (Based on 7 specimens 17.4–21.6 cm TL):**

**D. 0, 117-125; A. 0, 90–102; P. 20; C. 8-10; Gr. 39-41**

Head and trunk portion prominent and deep tapering towards caudal. Head bones with large, thin crests. ED 0.98-1.2 in PrDL, 0.24-0.25 in HL and 0.39-0.4 in HD. Opercular spine broad, flat and weak; basibranchial with 2 median and a pair of tooth patches; long gill rakers on anterior arch. Pelvic-fin length 0.97-1.1 in HL, PrDL 0.22-0.24 in SL and 0.20-0.21 in TL. AL 0. 51-0.52 in SL and 0.46-0.48 in TL. Dorsal fin origin before pectoral origin, pectoral tip reaching anal. Anal and dorsal confluent with caudal. Pale brown, fins dark.

**Geographical distribution (Previous records):** Indo-West Pacific: Gulf of Aden to off Lombok, Indonesia, Bay of Bengal.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** Benthopelagic, 40–550 m. In present study, 501-800 m.

**Genus : *Bassozetus*** Gill, 1883

*Bassozetus* Gill 1883, Proceedings of the United States National Museum v. 6 (no. 380): 253-260.
Nielsen & Møller 2008:24, Steenstrupia v. 30 (no. 1): 21-46.

*Bassozetus robustus* Smith and Radcliffe, 1913

(Plate VIII, Fig. 73)

**Vernacular Name:** Nil

*Bassozetus robustus* Smith and Radcliffe, 1913, Proceedings of US National Mseum, 44.135-176
Mincarone et al. 2008:50, Zootaxa No. 1770: 41-64
Cubelio *et al.*, 2009, JMBAI, 51(1).
**Synonymy:** Nil

**Diagnostic characters (Based on 1 specimen 28.0 cm SL):**

**B. 8; D. 0, 102; A. 0, 93; P. 23; C. 7; Gr. 13**

Body elongated and compressed; BD 0.25, DDF 0.23 and DA 0.21 in SL. Snout rather blunt, eye small, shorter than snout, ED 0.48 in PrOL. Mouth large and terminal, upper jaw ends behind the eye and almost double the head length. Premaxilla with two palatine and vomer teeth patchs, opercular spine weak. PrOL 0.23 in HL. One median basibranchial tooth patch. HL and PrDL equal, 2.3 times PoOL.Pelvic fin placed below preopercle and length of the rays short; pectoral fin 3.6 times that of DFL. Anal fin length more or less equal to preanal length; dorsal and anal fin connected with caudal fin. Pale brownish in formalin, no blotches and sports on body.

**Geographical distribution (Previous records):** Indo-West Pacific: Philippines.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N latitude.

**Depth:** Benthopelagic, 40–550 m. In present study, 801-1100 m.

### Genus : *Dicrolene* Goode & Bean 1883

*Dicrolene*, Goode and Bean, Bull. Mus. Comp. Zool. X. 1883, p.202, and Oceanic Ichthyology, p.337· Gunther, Challenger Deep-Sea Fishes, p.107· Jordan and Evermann, Fishes N. Amer. III. 2522.
*Pteriodons*, Gunther, Challenger Deep-Sea Fishes, p. 106: Goode and Bean, Oceanic Ichthyology, p. 337
*Paradicrolene*, Alcock, Ann.Mag.Nat.Hist., Nov. 1889, p. 387

Opercular spine strong and narrow, sometimes hidden, usually rounded in cross-section. Pectoral fins with lower rays free; pelvic fins with 2 rays in each. Eye diameter equal to half or more of snout length; pelvic-fin rays filamentous.

**Key to Species**

**1a.** One median basibranchial tooth patch — ***D . multifilis***

**1b.** Two median basibranchial tooth patches. — **2**

**2a.** Developed gill rakers 10 — ***D. nigricaudis***

**2b.** Developed gill rakers 11-12. — ***D. tristis***

*Dicrolene multifilis* (Alcock 1889)

(Plate VIII, Fig. 74)

**Vernacular Name:** Slender brotula

***Paradicrolene multifilis***, Alcock 1889:387 [13], Annals and Magazine of Natural History (Series 6) v 4 (no. 23); Bay of Bengal, Investigator station 14, depth 193 fathoms; Andaman

Sea, East of Port Blair, depth 271 fathoms. Syntypes: BMNH 1890.7.31.2-3 [ex ZSI F11711 and 11714] (2); MNHN 1890-0342 and 0343 [ex ZSI] (1, 1); USNM 231714 (1) depth 193 fathoms; ZSI F11717 (1) depth 193 fathoms.
Nielsen 1999:1980, Order Ophidiiformes. In: Carpenter and Niem 1999
**Synonymy:** *Paradicrolene multifilis*

**Diagnostic characters (Based on 3 specimens 16.9–18.6 cm TL):**

**D. 102-115; A. 82-95; P. 23-30** (9-11 lower rays free); **V.2; Gr. 11-17.**

Head 0.21-0.22 in TL with distinct pores, PrOL 0.86-0.88 in ED. One median broad basibranchial tooth patch. Spines in supraorbital absent and on preopercle absent or weak. Rear margin of preopercle with 2-3 spines. ED 0.15-0.16 in HL and 0.21-0.23 in BD. Dorsal origin behind pectoral origin, PrDL 0.26-0.28 in TL. Pectoral elongated, 0.28-0.31 in TL. Scales in 34 or 35 rows between dorsal fin and vent: lateral line ends in last third of tail. Distance of 1st anal ray from base of pectoral is equal to length of head without snout. Pectoral filaments are never as much twice length of head. Inner ray of ventral fin is not half length of head. Body dark, fins dark grey. Attains 20 cm.

**Geographical distribution (Previous records):** Off Table Bay and east coast of south Africa; also from other parts of Indian Ocean; Bay of Bengal; Andaman Sea.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Recorded from 400-1750 m. In present study, 501-800 m.

*Dicrolene nigricaudis* (Alcock 1899)

(Plate VIII, Fig. 75)

**Vernacular Name:** Nil

***Paradicrolene nigricaudis***, Alcock 1891:30 [Annals and Magazine of Natural History (Series 6) v. 8 (no. 43/44); Andaman Sea, 11°31'40"N, 92°46'40"E, Investigator station 115, depth 188-220 fathoms. Syntypes: (5) BMNH 1891.9.2.3 [ex ZSI F13042] (1); ZSI F13040 (1), F13044 (1). Type catalog: Menon & Yazdani 1968:150, Menon and Rama-Rao 1970:377, Menon & Rama-Rao 1975:41 Valid as *Dicrolene nigricaudis* (Alcock 1891)

Manilo & Bogorodsky 2003:S99, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** *Paradicrolene nigricaudis*

**Diagnostic characters (Based on 1 specimens 19.9cm TL):**

**B. 9; D. 0, 101; A. 84; P. 24 (lower free rays 6); V. 2; C. 9; Gr. 15** (well developed 10).

Body elongated; snout blunt; eye large; eye length almost equal to snout length and preorbital length. HL 0.26, PrDL 0.33, AL 0.52, PL 0.40, VL 0.12 in SL. Mouth large and terminal; upper jaw ends below posterior margin of eye. Premaxilla with two palatine and a vomerine tooth patches; opercular spine strong and straight. 3 short spines at hind margin of preopercle; 2 median and 2 basibranchial tooth patches, upper more elongated than lower. Colour in formalin pale brownish; posterior third of caudal, including posterior parts of dorsal and anal fins, black.

**Geographical distribution (Previous records):** Indian Ocean

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Bathydemersal, Recorded from 344 - 730 m. In present study, 501-800 m.

*Dicrolene tristis* Smith & Radcliffe1913

(Plate VIII, Fig. 76)

**Vernacular Name:** Nil

***Dicrolene tristis***, Smith & Radcliffe in Radcliffe 1913:145, Pl. 8 (fig. 2) [Proceedings of the United States National Museum v 44 (no. 1948); Lagonoy Gulf, Luzon Island, Philippines, 13°35'27"N, 123°37'18"E, Albatross station 5467, depth 480 fathoms. Holotype: USNM 74131. Paratypes: BMNH 1939.4.1.4-5 [ex USNM] (2); USNM 99071 (1), 99243 (2), 99275-77 (1, 1, 1); ZMUC [ex USNM 99275] (1). •Valid as *Dicrolene tristis* Smith & Radcliffe 1913 Shinohara *et al.* 2005:413, Memoirs of the National Science Musuem Tokyo No. 29: 385-452.
**Synonymy:** Nil

**Diagnostic characters (Based on 3 specimens 18.1–22.8 cm TL):**

**D. 0, 99-100; A. 80-83; P. 29-30; V. 2; Gr. 11-12**

Head 0.24-0.25 in SL and 0.2-0.21 in TL with distinct pores, PrOL 0.74-0.78 in ED. Two median basibranchial tooth patches. Rear margin of preopercle with 2-3 spines. ED 0.21-0.22 in HL and 0.27-2.9 in BD. Dorsal origin behind pectoral origin, PrDL 0.29-0.31 in SL. Pectoral elongated, 0.53-0.54 in SL and 0.48-0.49 in TL. Scales in 34 or 35 rows between dorsal fin and vent: lateral line ends in last third of tail. Distance of 1st anal ray from base of pectoral is more than length of head without snout. Pectoral filaments are more than twice length of head. Body light brownish, fins black. Attains 30 cm.

**Geographical distribution (Previous records):** Off Philippines, below tropical and subtropical areas of all oceans.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Recorded from 880 m. In present study, 501-1100 m.

### Genus : ***Monomitopus*** Alcock 1890

***Monomitopus*** Alcock 1890:297 Annals and Magazine of Natural History (Series 6) v. 6 (no. 34): 295-311
Nielsen & Møller 2008:32, Steenstrupia v. 30 (no. 1): 21-46.

### *Monomitopus conjugator* (Alcock 1896)

**Vernacular Name:** Scaly-headed blindfish

***Neobythites (Monomitopus) conjugator***, Alcock 1896:304 [4] [Journal and Proceedings of the Asiatic Society of Bengal v. 65 (pt 2, No. 3); Off Sri Lanka, Investigator station 201, depth 296-320 fathoms; off Travancore, depth 406 fathoms. Syntypes: USNM 231713 (1); ZSI F56/1 (1), F57/1 (1). Type catalog: Menon & Rama-Rao 1975:41 On p. 4 of separate. Figured in Alcock 1897· Pl. 17 (fig. 4). •Valid as *Monomitopus conjugator* (Alcock 1896)
Nielsen & Cohen in Nielsen *et al.* 1999:78, FAO (Food and Agriculture Organization of the United Nations) Fisheries Synopsis No. 125: i-xi + 1-178.
**Synonymy:** *Neobythites conjugator*

**Diagnostic characters (Based on 2 specimens 17.4- 9.1cm TL):**

**D. 0, 95-104; A. 0, 78-85; P. 28; V. I; Gr. 12-16.**

Head length 4.2 to 4.3 in standard length. Opercular spine strong and pungent. Ventrals equal head without snout. ED 4.5-4.6 in HL. Maxillary reaches slightly beyond hind border of eye. Brownish or yellowish, belly darker due to black peritoneum showing through. Oblique scale rows between origin of dorsal fin and lateral line 7 to 10. Posteroventral margin of preopercle with 2 or 3 broad, strong points. Scale pouches black.

**Geographical distribution (Previous records):** Indian Ocean: Bay of Bengal, Arabian Sea.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Bathydemersal; depth range 540-760 m. In present study, also 201-500 m.

### Genus : ***Neobythites*** Goode & Bean 1885

***Neobythites*** Goode & Bean 1885:600, Proceedings of the United States National Museum v. 8 (no. 543): 589-605.
Mincarone et al. 2008:53, Mincarone et al. 2008:53

Body elongate, compressed; head not compressed, its bones firm, both head and body covered with small cycloid scales; tail not filamentous. Lateral line never continued to end of tail, sometimes very indistinct. Snout slightly overhanging lower jaw; without barbells. Villiform teeth in bands on jaws and palatines, and in an upturned V shaped band or a patch on vomer. Operculum with a spine. 8 branchiostegals. Dorsal and anal more or less confluent with caudal. Each ventral fin consists of two rays which may either be fused or separate in all or part. The dorsal profile of cranium and snout form a single common curve of no great convexity.

**Key to Species**

**1a.** Dorsal fin with ocelli or large, dark blotches ***N. multistriatus***

**1b.** Dorsal fin without ocelli or large, dark blotches **2**

**2a.** Preopercular spines 0 or 1 (weak) ***N. steatiticus***

**2b.** Preopercular spines 2 (rarely 1 or 3) ***N. macrops***

*Neobythites multistriatus* Nielsen & Quéro 1991

(Plate VIII, Fig. 77)

**Vernacular Name:** Nil

***Neobythites multistriatus,*** Nielsen & Quéro 1991:194, Figs. 1-4, Cybium v. 15 (no. 3); Off Réunion Island, 20°57.9'S, 55°14.5'E, depth 450-580 meters. Holotype: MNHN 1988-1945. Paratypes: MNHN 1988-1946 (2), ZMUC P77809 (1). •Valid as *Neobythites multistriatus* Nielsen & Quéro 1991.
Nielsen 2002:59, Galathea Report v. 19: 5-104.
**Synonymy:** Nil

**Diagnostic characters (Based on 5 specimens 43.1–48.7 cm TL):**

**B. 8; D. 0, 83-88; A.0, 65-68; P. 21-22; V. 2**

Body elongated, head not much compressed, tail not filamentous. Lateral line never continued to end of tail, sometimes very indistinct. Snout slightly overhanging lower jaw; without barbells. Villiform teeth in bands on jaws and palatines, and in an upturned V shaped band or a patch on vomer. Operculum with a spine. 8 branchiostegals. Dorsal and anal more or less confluent with caudal. Dorsal fin with 7 or 8 and anal fin with 3 or 4 dark blotches; 4 to 10 dark, vertical bars on body; developed gill rakers 12 to 15. Each ventral fin consists of two rays which may either be fused or separate in all or part.

**Geographical distribution (Previous records):** Off Reunion and Rodriques

**Distribution in the Southwest coast (Present study):** Between 13° and 15° N latitude.

**Depth:** Recorded at 300 to 580 m. In present study, also 201-500 m.

*Neobythites steatiticus* Alcock 1894

**Vernacular Name:** Nil

***Neobythites steatiticus,*** Alcock 1894:181 [13], Pl. 9 (fig. 3) [Journal and Proceedings of the Asiatic Society of Bengal v. 62 (pt 2, No. 4); Bay of Bengal, 15°04'07"N, 80°25'07"E, Investigator station 137, depth 128 fathoms. Holotype (unique): ZSI F13435. Non-types: BMNH [ex ZSI F13473-74] (2?), USNM [ex ZSI F13475] (1).
Manilo & Bogorodsky 2003:S99, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.

**Synonymy:** Nil

**Diagnostic characters (Based on 5 specimens 43.1–48.7 cm TL):**

**B. 8; D. circ.85; A.circ. 65; P. circ. 22; V. 2**

HL 0.24-0.25 in TL, ED 0.15-0.17 in HL, bands of teeth in jaws are not very broad; no spinules at angle of pre-operculum; distance between first anal ray and base of pectoral fin is 0.98-1.12 in POL. Pectorals rounded, their length not much more than half that of head. Ventrals are equal in length to post-orbital portion of head; each consists of two stout filaments- inner of which is slightly longer-bound together in their basal half. Creamy yellow, clouded marbled and mottled like soap-stone with shades of light brown; a large oval ocellus, consisting of a black centre and a creamy white ring, on dorsal fin between 20$^{th}$ and 30$^{th}$ rays or beyond: anal jet black with a milk-white border.

**Geographical distribution (Previous records):** Bay of Bengal to Arabian Gulf.

**Distribution in the Southwest coast (Present study):** Between 13° and 15° N latitude.

**Depth:** Recorded at 195-460 m. In present study, also 501-800 m.

*Neobythites macrops* Günther 1887

(Plate VIII, Fig. 78)

**Vernacular Name:** Spotfin cusk

***Neobythites macrops,*** Günther 1887 102, Pl. 20 (fig. A) [Report on the Scientific Results of the Voyage of H. M. S. Challenger v. 22 (pt 57); Off Philippines, Challenger station 210, depth 375 fathoms. Lectotype: BMNH 1887 12.7.41. Paralectotypes: BMNH 1887 12.7.42 (1) Fiji. Additional non-type material: USNM 188820 (4), ZMUC [ex USNM] (1).
Hoese et al. 2006:563, In: Zoological Catalogue of Australia. Volume 35. Fishes.

**Synonymy:** Nil

**Diagnostic characters (Based on 6 specimens 17.3–22.9 cm TL):**

**B. 8; D. 0, 100-106; A. 0, 80-86; P. 24-28; V. 2**

Head 0.2–0.22, DA 0.15-0.16 in SL. BD 0.97-1.2 in head without snout. Snout broad, rounded, hardly overhanging upper jaw, as long as eye and about equal to width of flat interorbital space. ED 0.21-0.22 HL. Teeth in broad bands in jaws, in an inverted **'V'** shaped patch on vomer, and in an elliptical patch on each palatine. Opercular spine long and sharp. Two spinules at preoperculum. Gill-rakers on outer idea of first branchial arch numerous, of good length. Body head and bases of fins covered with small scales. Lateral line extends more than halfway along tail. Dorsal and anal fins are confluent with caudal. Distance between first anal ray and base of pectoral fin is equal to length of head without snout. Pectorals pointed, their length is equal to post-orbital portion of head. The ventrals are bifid. Yellowish grey mottled with brown; some large black blotches on dorsal fin.

**Geographical distribution (Previous records):** From Bay of Bengal to Philippines and Northwest Australia Andaman Sea; Arabian Sea, off Travancore coast.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** Recorded in depth range 350-505 m. In present study, also 501-800 m.

**Sub Order : Bythitoidei**

**Family : Bythitidae** (brotulas, viviparous brotulas)

**Sub Family : Bythitinae**

**Key to genera**

**1a.** Palatine teeth absent ***Grammonus***

**1b.** Palatine teeth present ***Hephthocara***

**Genus *Grammonus*** Gill 1896

***Grammonus*** Gill in Goode & Bean 1896:317, Special Bulletin U. S. National Museum No. 2: Text: i-xxxv + 1-26 + 1-553, Atlas: i-xxiii, 1-26, 123 pls.
Castellanos-Galindo et al. 2006:206, Biota Colombiana v. 7 (no. 2): 245-262.

*Grammonus ater* (Risso 1810)

(Plate VIII, Fig. 79)

**Vernacular Name:** Nil

***Oligopus niger,*** Risso 1827:338 [Histoire naturelle des principales productions de l'Europe méridionale, v 3
Nielsen & Cohen in Nielsen et al. 1999:104, Fisheries Synopsis No. 125: i-xi + 1-178.
**Synonymy:** *Oligopus ater, Oligopus niger*

**Diagnostic characters (Based on 8 specimens 21.3-27.9cm TL):**

**B. 8; D. 0, 69-74; A. 0, 51-52; Gr. 2-3**

Body relatively short and stubby; head not depressed, HL 0.31-0.33, AL 0.54-0.57, PrDL 0.42-0.45 and BD 0.29-0.3 in TL, eyes well developed, ED 0.12-0.14 in HL and 1.14-1 16 in PrOL, body completely covered with imbricate scales; head partly naked; posterior part of maxilla expanded, with a pointed projection at posteroventral angle PrOL 0.12-0.13, UJL 0.52-0.54 and PL 0.54-0.56 in HL. Mouth wide, palatine lacking teeth; tongue massive, with an anterior projection. Preopercle margin with no or small and weak spines; lateral head canal with 0 or 1 pore. Lateral line consisting of 2 or more series of papillae on body; pelvic fins with a single ray in each. Dark, to black in colour.

**Geographical distribution (Previous records):** Circumtropical to subtropical seas. Northwest Mediterranean and Adriatic.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** 500-800 m. In present study, 501-800 m.

### Genus: *Hephthocara* Alcock 1892

***Hephthocara*** Alcock 1892:349. Neut. *Hephthocara simum* Alcock 1892. Type by monotypy. Valid as *Hephthocara* Alcock 1892
Nielsen & Cohen in Nielsen et al. 1999:105, FAO Fisheries Synopsis No. 125: i-xi + 1-178.

*Hephthocara simum* Alcock 1892

(Plate VIII, Fig. 80)

**Vernacular Name:** Nil

***Hephthocara simum,*** Alcock 1892:349, Pl. 18 (fig. 1) [Annals and Magazine of Natural History (Series 6) v 10 (no. 59); Gulf of Mannar, 6°58'N, 77°26'50"E, Investigator station 128, depth 902 fathoms. Holotype (unique): ZSI F13172.
Nielsen & Cohen in Nielsen et al. 1999:106, FAO (Food and Agriculture Organization of the United Nations) Fisheries Synopsis No. 125: i-xi + 1-178.
**Synonymy:** Nil

**Diagnostic characters (Based on 7 specimens 31.2–38.9cm TL):**

**B. 8; D. 0, 130-135; A. 0, 82-86; P. 16-19; V. 0; C. 6-7; Gr. 3**

Head large and deep with tapering body, 0.26-0.28 in TL and 0.54-0.55 in AL, body depth reduced to around a half at anus that of depth at pectoral, DPF 0.23-0.25, DA 0.12-0.14 in TL, no scales on head; snout longer than diameter of eye, ED 0.57-0.58 in PrOL, head bones weak and soft; a large, pore-bearing flap above opercle, narrow bands of teeth on vomer and palatines, no pelvic-fin rays; Preanal length 0.4-0.45 in TL. Body pale, fins darker. Recorded maximum length 38.9 cm.

**Geographical distribution (Previous records):** Bay of Bengal to South America.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Benthopelagic at bathyal to abyssal depths 760-5540 m. In present study, 801-1100 m.

**Order : Lophiiformes** (anglerfishes)

**Key to Sub Orders**

**1a.** Postcephalic, spinous dorsal-fin of 1 to 3 spines; pharyngobranchial IV present; cleithrum with prominent posterior spine; subopercle with large ascending process attached to anterior margin of ventral rami of opercle; pseudobranch well developed **Lophioidei**

**1b.** Postcephalic, spinous dorsal-fin absent; pharyngobranchial IV absent; cleithral spine absent; subopercle with ascending process absent or reduced to a small projection detached from opercle; pseudobranch greatly reduced or absent; **Ogcocephaloidei**

**Sub Order Lophioidei**

**Family : Lophiidae** (anglerfishes, goosefishes, monkfishes)

Head extremely big, wide, and depressed (except *Sladenia*, with rounded head). Well developed teeth. Lower jaw and sides of head and flanks fringed with small flaps. Equipped with a movable rodlike structure above mouth, tipped with a flap of flesh resembling a flag apparently for luring prey. Mouth large.

**Key to Genera**

**1a.** Frontal ridges rugose, bearing low spines, knobs, or ridges; gill openings not extending in front of pectorals. Pectoral fin rays 19-28 ***Lophiomus***

**1b.** Frontal ridges smooth; gill opening extending in front of pectoral; Pectoral fin rays 14-21 ***Lophiodus***

**Genus : *Lophiomus*** Gill 1883

***Lophiomus*** Gill 1883:552, Proceedings of the United States National Museum v. 5 (no. 316): 551-556.
Ho & Shao 2007:29, Journal of the National Taiwan Museum v. 60 (no. 1): 19-32.

*Lophiomus setigerus* (Vahl 1797)

(Plate VIII, Fig. 81)

**Vernacular Name:** Blackmouth angler

***Lophius setigerus*** Vahl 1797:215, Pl. 3 (figs. 5-6), Skrivter af Naturhistorie-Selskabet Kiøbenhavn v. 4; Possible syntypes: AMS I.25832-004 (1, skeleton). •Valid as *Lophiomus setigerus* (Vahl 1797)
Smith, SFSA No. 1224; Caruso, 1983: 13.
Ho & Shao 2007:29, Journal of the National Taiwan Museum v 60 (no. 1): 19-32.

**Synonymy:** *Lophius setigerus, Chirolophius laticeps, Chirolophius malabaricus*

**Diagnostic characters (Based on 3 specimens 19.3–23.8 cm TL):**

**D. I + I + I + III + 8; A. 6; P. 21-25.**

HL 0.51-0.52 in TL and 0.61-0.63 in SL. PL 0.31-0.33, IOW 0.22-0.23 and PrOL 0.23-0.24 in HL. ED 0.67-0.68 in IOW and 0.65-0.66 in PrOL. D spines 1-4 long and slender, spines 5 and 6 very short, $6^{th}$ often embedded. Esca with pennant-like flap and frequently with dark, stalked, bulb like appendages that resemble shrimp eyes. Head and body mottled light to dark brown above, very light and to nearly white below; fins pigmented as adjacent areas of body except distal part of ventral surface of P with brown reticulations; first dorsal spine pale, second spine very darkly pigmented, with numerous tendrils, spines 3-6 pigmented as dorsal body surface; pigmentation of peritoneum variable, usually dusky, light or dark extremes rare. Frontal ridges rugose, bearing low conical spines; gill opening not extending well in front of pectoral-fin base, restricted to below and behind base; floor of mouth with distinct pattern of dark lines or pale circles on dark background. Attains 35 cm.

**Geographical distribution (Previous records):** Indo-west Pacific south to False Bay.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Benthopelagic, in 70-250 m. In present study, 201-500 m.

### Genus *Lophiodes* Goode and Bean 1896

***Lophiodes*** Goode & Bean 1896:537, Special Bulletin U. S. National Museum No. 2: Text: i-xxxv + 1-26 + 1-553, Atlas: i-xxiii, 1-26, 123 pls.
Ho & Shao 2008:367, Ichthyological Research v. 55: 367-373.

Gill opening extending in front of pectoral fin; bony ridge on snout smooth; soft dorsal-fin rays 8; anal-fin rays 6; pectoral-fin rays 14 to 21; vertebrae 19.

### *Lophiodes mutilus* (Alcock 1894)

(Plate IX, Fig. 82)

**Vernacular Name:** Smooth angler

*Lophius mutilus* Alcock, 1893: 179, Pl. 10, fig. 2 (Bay of Bengal). *Lophiodes mutilus*: Smith, SFSA No. 1222; Caruso, 1891: 538.
Ho & Shao 2008:371, Ichthyological Research v. 55: 367-373.
**Synonymy:** *Lophius mutilus, Chirolophius mutilus, Chirolophius japanicus*

**Diagnostic characters (Based on 4 specimens 22.7–32.1 cm TL):**

**D. I +I+I or II+ 8; A. 0, 6; P. 15-18.**

Head 0.56-0.59, third D spine 0.36–0.64 in SL, post cephalic portion reduced, dorsal spines in this region are reduced and embedded. Supraorbital crests not greatly elevated; interorbital moderately concave, but not forming U–shaped trough between eyes, 0.26-0.28 in HL. Inner frontal spines present, reduced. Esca a simple rounded or flattened bulb, lacking pennant-like flap. Long cerrii, and bulb – like appendages. Frontal ridges smooth, not rugose; gill opening extending well in front of pectoral-fin base; PL 0.37-0.39 in HL. Head and body uniform light to dark brown above, lighter below. Pectorals pigmented as body, darker distally; median fins pigmented as adjacent areas of body; inside of mouth pale, tongue dusky. Attains 35 cm.

**Geographical distribution (Previous records):** Indo-West Pacific south to Natal.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Benthopelagic, 300-500 m. In present study, 201-500 m.

**Sub Order : Ogcocephalioidei**

**Key to Super Families**

**1a.** Second dorsal-fin spine elongate, embedded beneath skin of head; third dorsal spine and pterygiophore present; epibranchial I with a medial process ligamentously attached to proximal tip of epibranchial II **Chaunacioidea**

**1b.** Second dorsal-fin spine reduced to a tiny remnant embedded beneath skin of head and lying on, or fused to, dorsal surface of pterygiophore just behind base of illicial bone; third dorsal spine and pterygiophore absent; epibranchial I simple, without ligamentous attachment to epibranchial II **2**

**2a.** Ceratobranchial V toothed, expanded proximally; pelvic fins present; obvious sexual dimorphism absent **Ogcocephalioidea**

**2b.** Ceratobranchial V toothless, reduced to a slender rod-shaped element; pelvic fins absent (except in larval caulophrynids); sexual dimorphism strongly developed, **Ceratioidea**

**Super Family : Chaunacioidea**

**Family : Chaunacidae** (coffin fishes, sea toads)

Large balloon-shaped flabby inflatable bodies; rough louse skin is covered with small spine-like scales. Mouth is large and nearly vertical with small teeths in bands on jaws, vomer, and palatines. First dorsal spine bearing a bait or esca that fits into a scaleless U-shaped depression (illicial cavity) on snout; second and third dorsal spines invisibly embedded behind first; pectorals arm-like. Gill opening behind and above pectoral fin base. Lateral lines are open canals especially conspicious on head, protected by enlarged spiny scales on either side of canal.

**Genus : *Chaunax*** Lowe 1846

***Chaunax*** Lowe 1846:81, Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1846 (pt 14): 81-83.
Caruso et al. 2007:1025, Journal of Fish Biology v. 70: 1015-1026.

*Chaunax pictus* Lowe 1846 (painted anglerfish, redeye)

(Plate IX, Fig. 83)

**Vernacular Name:** Nil

*Chaunax pictus* Lowe, 1846: 81 (also 339, pl.) (Madeira); Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1846 (pt 14): 81-83.
Smith, SFSA No. 1233; 1968: 21; le Danois, 1979: 29. Chaunax pencillatus (non Mc Culloch): le Danois, 1979: 34 (part).
Caruso et al. 2007·1025, Journal of Fish Biology v. 70: 1015-1026.
**Synonymy:** *Chaunax nuttingii* Garman, 1896.

**Diagnostic characters (Based on 7 specimens 13.8–21.4 cm TL):**

**B. 7; D. I. 11-12; A. 6-7; P. 11-12; V. 4; C. 8**

HL 0.52-0.55, second dorsal fin base 0.23-0.24 and distance between two dorsal fins 0.29-0.31 in TL, PrDL 0.10-0.11, PrOL and ED 0.12-0.13 in HL, Great cuboidal head is more than half TL, and its greatest height, behind eyes, is from a third to two-fifths the same measure. Eyes large, subcutaneous, lateral although placed high up near dorsal profile. Snout short, squarish, under hung by massive square-cut lower jaw. Nostrils two tiny pores situated near edge of snout. On top of snout, folding backwards on to a shallow smooth depression of skin is a tentacle, about half as long as eye, ending in a leaf-like tassel: this represents first dorsal fin. Skin extremely loose, covered with minute granules or prickles which are finest on throat and belly, traversed by chain-like rows of mucous pores. Pectorals fairly broad, ventrals small and narrow. Attains 40 cm. Rosy with golden spots on head and body, fins uniform pink, front of esca dusky, stem uniform rosy.

**Geographical distribution (Previous records):** Atlantic; trawled off continental shelf and often thrown up after storms between Knysna and Natal; West Indies and neighbouring Atlantic coasts of America, Madeira, C. Verde and neighbouring coasts of Africa; Arabian sea, Bay of Bengal, Fiji, Japan.

**Distribution in the Southwest coast (Present study):** Between 9° and 15° N latitude.

**Depth:** At moderate depths 130 to about 400 fathoms. In present study, 501-800 m.

**Super Family : Ceratioidea** (Deep sea angler fishes)

**Key to Families**

**1a.** Soft dorsal fin rays 12-17 **Melanocetidae**

**1b.** Soft dorsal fin rays 3-8 **2**

**2a.** Two or three bulbous swellings (caruncles) on midline in front of dorsal fin **Ceratiidae**

**2b.** No caruncles on dorsal midline **Diceratiidae**

**Family : Melanocetidae** (Black Sea devils)

Females with body short, deep, globose. First dorsal-fin spine (illicium) short, less than 70% length of head and body, bearing a conspicuous terminal bioluminescent bait (esca); bait without filaments or appendages. Snout and chin smooth, without papillae; sphenotic spines absent; skin smooth, appearing naked. Pelvic fins absent. Males free-living, not becoming parasitic on females, with eyes large, elliptical, directed laterally

**Genus : *Melanocetus*** Günther 1864

***Melanocetus*** Günther 1864:302, Proc. Gen. Meet. Sci. Busin. Zool. Soc. London 1864 (pt 2): 301-303, Pl. 25.. Masc. *Melanocetus johnsonii* Günther 1864. Type by monotypy Also as Günther 1865:333. Valid as *Melanocetus* Günther 1864.
Paxton et al. 2006:657, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Melanocetus murrayi* Günther 1887

(Plate IX, Fig. 84)

**Vernacular Name:** Murray's Abyssal Anglerfish,

***Melanocetus murrayi,*** Günther 1887:57, Pl. 11 (fig. A) Report on the Scientific Results of the Voyage of H. M. S. Challenger v. 22 (pt 57); Central Atlantic, 1°47'N, 24°26'W, Challenger station 348, depth 2450 fathoms. Lectotype: BMNH 1887 12.7 17 Paralectotypes: BMNH 1887 12.7 18 (1). Lectotype established by Regan 1926:32. Valid as *Melanocetus murrayi* Günther 1887

Paxton et al. 2006:658, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Melanocetus tumidus, Melanocetus vorax, Rhynchoceratias acanthirostris*

**Diagnostic characters (Based on 1 specimen 11.3 cm TL):**

**D. 1, 12; C. 8**

A gelatinous, mostly scale less, globose soft-bodied fish; that lacks scales and pelvic fins. Head large (HL 0.55 in SL) and generous complement of large, sharp, glassy fang-like teeth lining jaws of a cavernous, oblique mouth. UJL 0.51 and LJL 0.41 in SL. Teeth depressible and present only in females. Illicium short with a bulbous esca on snout. Length of illicium 0.29 and PrOL 0.098 in SL. Anterior margin of vomer deeply concave in female fishes. The eyes small and pupil larger than lens, ED 0.06 in SL. All fins rounded with slightly incised membranes; pectoral fins small. Single dorsal fin positioned far back, larger than and above anal fin. PrDL 0.69, DFH 0.11 and DFB 0.15 in SL. Black in colour.

**Geographical distribution (Previous records):** Worldwide in deep tropical and temperate waters, off northwestern Western Australia.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Bathypelagic. In present study, 501-800 m.

**Family : Ceratiidae** (sea devils)

Caruncles (low fleshy appendages) present before soft dorsal fin in females as a modification of 2 or 3 fin rays; soft rays usually 4 (rarely 5) in dorsal and anal fins. Cleft of mouth vertical to strongly oblique. Females are host to parasitic mature males.

## **Genus : *Ceratias* Krøyer, 1845**

***Ceratias*** Krøyer 1845:638, 648 Naturhistorisk Tidsskrift (Kjøbenhavn) (n. s.) v. 1: 639-649. Masc. *Ceratias holboelli* Krøyer 1845. Type by monotypy. Species originally as *Holbölli*, correction mandatory. Valid as *Ceratias* Krøyer 1845.
Paxton & Gates 2006:665, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Ceratias uranoscopus* Murray 1877

(Plate IX, Fig. 85)

**Vernacular Name:** Stargazing sea devil

***Ceratias uranoscopus,*** Murray in Thompson 1877:70, Fig. 20 on p. 69. Voyage of the `Challenger' Deep sea life of the Atlantic. v. 2; Northeastern Atlantic, depth 2400 fathoms. Holotype (unique): BMNH 1887 12.7 15. Synonym of *Ceratias holboelli* Krøyer 1845 -- (Maul 1973:674). Valid as *Ceratias uranoscopus* Murray 1877
Paxton & Gates 2006:666, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Manchalias uranoscopus, Mancalias xenistius, Typhlopsaras shufeldti*

**Diagnostic characters (Based on 1 specimen 18.6 cm TL):**

**D. 4; A. 4; C.8; P.14**

HL 0.25, HD 0.34, POL 0.07, UJL 0.19, LJL 0.22, PrOL 0.15, IOW 0.05, Illicium 0.21, esca length 0.04, PrDL 0.70, AL 0.72 in SL. The height of body, when stomach is empty, is about half total, caudal included. Head much larger than body and tail combined. Each frontal bone with a strong outstanding spine, situated above and behind eye. On top of snout are two isolated dorsal spines, anterior of which bears a long stout tentacle (about a third as long as body) ending in a fleshy knob, while second is almost a rudiment. Eye small, subcutaneous, about a third as long as snout: in front of it is a tubular nostril. Mouth-cleft enormous, length of maxilla being nearly one-third of total, caudal included. A series of large and small depressible teeth in each jaw: a few large teeth, decreasing in size from without inwards, on each side of vomer. Skin of head and body covered with minute prickles. Dorsal anal fins placed close to caudal, which is very large and is pointed. Body black.

**Geographical distribution (Previous records):** Banda Sea, Arabian Sea; Malabar Coast.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Bathypelagic, recorded up to 2091 m. In present study, 501-800 m.

**Family : Diceratiidae** (diceratid anglerfishes)

Females with second cephalic ray exposed, clubshaped, and with light organ distally. Spine present on skin. Dorsal fin rays 5 to 7 Anal fin rays 4. Pelvic fin small and connected with cleithrum.

**Key to genera**

**1a.** Dermal spinules extending out onto esca, covering entire dorsal and lateral surfaces, including distal filaments ***Diceratias***

**1b.** Dermal spinules densely arrayed, covering whole body including illicium, absent laterally on jaws and esca ***Bufoceratias***

**Genus *Diceratias* Günther 1887**

***Diceratias*** (subgenus of *Ceratias*) Günther 1887:52. Masc. *Ceratias bispinosus* Günther 1887 Type by monotypy Valid as *Diceratias* Günther 1887
Pietsch et al. 2006:S98, Journal of Ichthyology v 46 (suppl. 1): S97-S100.
Hoese et al. 2006:661, In: Zoological Calogue of Australia. Volume 35. Fishes.

*Diceratias trilobus* Balushkin and Fedorov 1986

(Plate IX, Fig. 86)

**Vernacular Name:** Diceratid angler fish

***Diceratias trilobus,*** Balushkin & Fedorov 1986:855, Voprosy Ikhtiologii v. 26 (no. 5): 855-856. Off Honshu, Japan, 38°20.7'N, 142°31.9'E, depth 1211-1216 meters. Holotype (unique): ZIN 47426. On p. 136 in English translation. Valid as *Diceratias trilobus* Balushkin & Fedorov 1986
Pietsch et al. 2006:S97 Journal of Ichthyology v 46 (suppl. 1): S97-S100.

**Synonymy:** Nil

**Diagnostic characters (Based on 1 specimen 16.2cm TL):**

**D. 0, 5; A. 0, 5; P. 15**

Esca unusually large, laterally compressed, greatest width 1.6 times its length 0.1 in SL, a rounded terminal escal papilla; large, rounded anterior and posterior appendages; distal margin of anterior and posterior escal appendages smooth, length, including slender terminal filament, more than one-half width of escal bulb; tiny, close-set, dermal spinules of skin extending out onto esca, covering entire dorsal and lateral surfaces, including distal filaments, in largest known specimens; proximal half of escal bulb, and distal half of slender terminal filaments of some specimens, darkly pigmented, remaining parts of esca not pigmented; escal pore at postero-basal margin of a rounded terminal papilla; head length 0.47; HD 0.53; LJL 56.3; illicium length 31.3; greatest width of esca 9.8, length of esca 6.9 in SL.

**Geographical distribution (Previous records):** Western North Pacific, south into temperate waters of Australia and Eastern Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Meso- and Bathypelagic, taken in trawls operated from 503–1216 m. In present study, 501-800 m.

**Genus *Bufoceratias* Whitley 1931**

***Bufoceratias*** Whitley 1931:334, Australian Zoologist v. 6 (pt 4): 310-334, Pls. 25-27
Pietsch et al. 2004:99, Copeia 2004 (no. 1): 98-107

*Bufoceratias wedli* (Pitschmann 1926)

(Plate IX, Fig. 87)

**Vernacular Name:** Double angler

*Phynichthys wedli*, Pitshmann, 1926: 88 (off Madeira). Uwate, 1979: 142, figs, 3,6 7B, 9, 10B, 11B, 13, 18. bertelsen, 1986: 1381, text fig. Loris, 1986: 244, figs. 1250127 Pietsch, 1986a: 376, txt fig. Machida & Yamakawa, 1990: 60, figs. 1-3, Brtelsen, 1991: 496. Bertelsen 1995: 141, text fig.
Anderson, M.E. and Leslie R. W. (2001) Review of the deep-sea anglerfishes (Lophiiformes: Ceratioidei) of sotheastern Africa. Ichthyological Bulletin, 70: 1-32.
**Synonymy:** *Phrynichthys wedli, Diceratias wedli, Paroneirodes wedli*

**Diagnostic characters (Based on 1 specimen 31.2cm TL):**

**B. 6; D. 0, 5; A. 0, 4; P. 14; C. 8**

Head and body globose, flesh gelatinous. HL 0.39, HD 0.69, BD 0.77 and POL 0.23 in SL. Skin spinules densely arrayed, covering whole body including illicium, absent laterally on jaws and esca. Escae with simple posterolateral and posterior appendages. Base of illicium on rear of head or near mid portion of body, illicial pterygiophore beneath flesh. Illicium 1.62; Illicial base to anterior most tip of upper jaw 0.49 in SL. Jaws long and strong, upper extending posteriorly well beyond eye lower jaw projecting slightly beyond upper. UJL 0.39 and LJL 0.42 in SL. Eyes small, PrOL 0.12, ED 0.05 and IOW 0.13 in SL. Pectoral lobe short, gill opening near its middle. Body black in colour.

**Geographical distribution (Previous records):** Both sides of tropical Atlantic, Southern Africa to Namibia, East China Sea.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Meso- and Bathypelagic, taken in trawls operated from 390-1750 m. In present study, 501-800 m.

**Super Family : Ogcocephalioidea**

**Family : Ogcocephalidae** Jordan, 1895 (batfishes)

Body usually considerably depressed and flattened ventrally. Relatively short illicium composed primarily of modified pterygiophore of first fin spine, remnant of second present. Illicial cavity, with its anterior opening, encloses esca upon retraction of illicium. Mouth nearly horizontal. Gill opening located in or above base of pectoral fin. Gills 2 or 2.5; first gill arch reduced and without filaments.

**Key to Genera**

**1a.** Gills 2 ½ ***Halieutaea***

**1b.** Gills 2 ***Halieutopsis***

**Genus : *Halieutaea*** Valenciennes 1837

***Halieutaea*** Valenciennes in Cuvier & Valenciennes 1837:455, Histoire naturelle des poissons. v 12: i-xxiv + 1-507 + 1 p., Pls. 344-368.
Ho & Shao 2008:296, Journal of the Fisheries Society of Taiwan v 35 (no. 4): 289-313.

**Key to species**

1a. Under surface of disk finely granular, interorbital space decidedly concave ***H. stellata***

1b. Under surface of disk with stellate spines; interorbital space hardly concave; 5 rays on dorsal fin ***H. coccinea***

*Halieutaea stellata* (Vahl 1797)

(Plate IX, Fig. 88)

**Vernacular Name:** Stellate seabat

***Lophius stellatus*,** Vahl 1797:214, Pl. 3 (figs. 3-4) [Skrivter af Naturhistorie-Selskabet Kiøbenhavn v 4; China. Beskrivelse tvende nye arter af *Lophius* (*L. stellatus* og *L. setigerus*). Skrivter af Naturhistorie-Selskabet Kiøbenhavn v. 4: 212-216. No types known. •Valid as *Halieutaea stellata* (Vahl 1797).
Ho & Shao 2008:300, Journal of the Fisheries Society of Taiwan v. 35 (no. 4): 289-313.
**Synonymy:** *Lophius stellatus, Astrocanthus stellatus, Halieutaea maoria*

**Diagnostic characters (Based on 3 specimens 10.3-11.6cm TL):**

**B. 6; D. 4; A. 4; P. 12-13; V. I.5; C. 9**

Tail including caudal fin, about three-fourths length of disk. Disk broader than long, very little elevated anteriorly. Dorsal surface covered with stout sharp spines having a broad star-shaped base. The spines on edge of disk and along side of tail are bifid or multifid, and usually have numerous short filaments between them. Skin of under surface of disk finely granular. Eyes between 0.11-0.12 in length of disk in diameter, and more than a diameter apart. Interorbital space decidedly concave. Rostral tentacle three-fold. Caudal about 0.21-0.22 in TL, not quite as long as pectoral. Ventrals moderately broad, between 0.5-0.66 in PL. Pink in colour.

**Geographical distribution (Previous records):** Indo-West Pacific: Papua New Guinea, Indonesia, Australia, Arafura Sea, India, Malay Archipelago, China and Japan.

**Distribution in the Southwest coast (Present study):** Between 07° and 13° N latitude.

**Depth:** Demersal, depth range 50 - 400 m. In present study, 201-500 m.

*Halieutaea coccinea* Alcock 1889

(Plate IX, Fig. 89)

**Vernacular Name:** Scarlet seabat

*Halieutaea coccinea* Alcock, 1889. Ann. Mag. Nat. Hist., p. 382: Illustrations of the Zoology of the Investigator, Fishes, pl. XIX, Fig. I. Andaman Sea, 7 miles southeast by south of Ross Island, Port Blair, Andaman Islands, Investigator station 13, depth 265 fathoms. Holotype (unique): ZSI F11741 Type catalog: Menon & Yazdani 1968:164, Menon & Rama-Rao 1975:47 On p. 8 of separate. Figured in Alcock 1898:Pl. 19 (fig. 1). Mention (Bradbury 1967:413). Valid as *Halieutaea coccinea* Alcock 1889.
Bradbury 2003:5, California Academy of Sciences Annotated Checklists of Fishes No. 17: 1-17

**Synonymy:** *Halieutea spicata* Smith, 1965.

**Diagnostic characters (Based on 2 specimens 8.1–8.3cm TL):**

**B. 6; D.5; A.4; C.9; P.13-14; V.I.5**

Cephalic disk circular and distinctly elevated anteriorly, cutaneous filaments on its edge few and inconspicuous. Spines on dorsal surface with needle-like points, under surface of disk well covered with stellate spines. Interorbital space slightly concave and its width much more than eye diameter. Caudal 0.19-0.21 in TL. Ventrals slender. Dorsal surface bright pink, with fine black vermicular lines; under surface crimson.

**Geographical distribution (Previous records):** Indian Ocean: Reunion, Maldives, Andaman Islands, Indonesia, Western Australia and Andaman Sea.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** In present study, 501-1100 m.

## Genus : *Halieutopsis* Garman 1899

***Halieutopsis*** Garman 1899:89, Memoirs of the Museum of Comparative Zoology v 24: Text: 1-431, Atlas: Pls. 1-85 + A-M.
Ho & Shao 2008:293, Journal of the Fisheries Society of Taiwan v. 35 (no. 4): 289-313.

Gills 2, no hemibranch on fourth arch. No teeth on ceratobranchial 5, or small pads of teeth present surrounded by epithelium, not meeting along midline.

### *Halieutopsis micropa* (Alcock 1891)

**Vernacular Name:** lesser handfish

***Dibranchus micropus,*** Alcock 1891:25, Pl. 7 (figs. 2a-b) [Annals and Magazine of Natural History (Series 6) v. 8 (no. 43/44); Bay of Bengal, 15°56'50"N, 81°30'30"E, Investigator station 120, depth 240-276 fathoms. Syntypes: ZSI F13029-30 (2). Type catalog: Menon & Yazdani 1968:164, Figured in Alcock 1898: Pl. 20 (fig. 1) as *macropus*. •Valid as *Halieutopsis micropus* (Alcock 1891).
Ho & Shao 2007:90, The Raffles Bulletin of Zoology Suppl. no. 14: 87-92.
**Synonymy:** *Dibranchus micropus* Alcock, 1891

**Diagnostic characters (Based on 1 specimen 6.3 cm TL):**

**B. 6; D. 5; A. 4; V. 5; P. 14; C.9**

Disk as long as or longer than tail, its cranial portion very decidedly elevated; not strongly dorsoventrally flattened, head nearly cube-like. Edge of frontal bridge flush with chin, not projecting. Rostral tentacle ends in a pair of fleshy lobes, surmounted by a third median, foliaceous fimbriated lobe. Eyes 0.17 in length of disk. Dorsal surface closely covered with spines which have a stelliform base and a flexible, almost setaceous, shaft; on tail, they are almost rigid. Ventral surface with similar but smaller bristle-like spines. Dorsal fin close behind gill-opening, anal fin not entirely behind dorsal. Caudal fin 4.3 in TL, equal to pectorals. Ventrals very small, 0.29 in PL. Attains nearly 8 cm. Uniform blue black.

**Geographical distribution (Previous records):** Bay of Bengal, Off Vizagapatnam coast, Andaman sea, off Trivandrum coast. South Africa to Philippines in depths of 500m or more; one specimen from 910 m off Durban.

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** Recorded previously at 500-910 m. In present study, 501-800 m.

**Super order** : **Lampridiomorpha**

**Order** : **Lampridiformes** (opahs, ribbonfishes)

**Family** : **Trachipteridae** (ribbonfishes, trachiptères)

**Genus** : ***Zu*** Walters & Fitch 1960

***Zu*** Walters & Fitch 1960:445, California Fish and Game v. 46 (no. 4): 441-451.
Paxton et al. 2006:541, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Caudal fin with 2 lobes, upper lobe sharply upturned; ventral edge of tail bears long spiny plates or bony tubercles; dorsal fin usually with more than 124 elements.

## *Zu elongatus* Heemstra and Kannemeyer 1984

(Plate IX, Fig. 90)

**Vernacular Name:** Taper-tail ribbonfish, scalloped dealfish.

***Zu elongatus,*** Heemstra & Kannemeyer 1984:29, Figs. 9A-11B [Annals of the South African Museum v. 94 (pt 2); Southwest by west of Cape Columbine, northwestern Cape Province, South Africa, bottom depth 225 fathoms. Holotype: SAM 24704. Paratypes: SAM 19870 (1), 24414 (1), 29392 (1). Valid as *Zu elongatus* Heemstra & Kannemeyer 1984
Olney 1999:1974, Order Lampridiformes. In: Carpenter and Niem 1999 [ref. 24635].
**Synonymy:** Nil

**Diagnostic characters (Based on 1 specimen 32.5cm TL):**

**D. 0, 124; LL 128**

Body strongly compressed, elongated and tail ends in a caudal fin with 2 lobes, upper lobe sharply upturned. Head small, deeper than long. HL 0.14; HD 0.15 in SL. ED 0.05 in SL, 0.34 in HL. Snout short, 0.05 in SL and 0.32 in HL. Dorsal fin origin above head, PrDL 0.12 in SL and 0.79 in HL. Ventral edge of tail bears long spiny plates or bony tubercles. Posterior portion of lateral line runs along ventral edge of tail as series of sharp spines which point in alternating directions; wavy or scalloped ventral body margin. Colour red, preserved specimens are tan in colour; front of head with triangular dark area extending onto lips and gular region; posterior dorsal rays black; caudal fin black, base of fin pale.

**Geographical distribution (Previous records):** Western Indian Ocean, southeast Atlantic: Namibia and off Western Cape coast, South Africa. Southwest Pacific: New Zealand.

**Distribution in the Southwest coast (Present study):** Between 13° and 15° N latitude.

**Depth:** Bathypelagic, 100-1400 m. In present study, 801-1100 m.

**Super Order : Acanthopterygii**

**Order : Beryciformes**

**Key to Family**

**1a.** Enlarged ventral keel scutes absent **Anoplogastridae**

**1b.** Enlarged ventral keel scutes present **2**

**2a.** No dorsal or anal fin spines **Diretmidae**

**2b.** Dorsal and anal fin spines present **3**

**3a.** Anal fin with 4 spines and 12-30 soft rays; each maxilla with 2 supramaxillae **Berycidae**

**3b.** Anal fin with 2 or 3 spines and 8-12 soft rays; each maxilla with only one supramaxilla **Trachichthyidae**

**Family : Anoplogastridae** Gill, 1893 (fangtooths, sabretooth fishes)

Head large, about one-third length of body, and deep. Body deep anteriorly, sharply tapering to narrow caudal peduncle. Head sculptured looking, with well- developed mucus cavities covered by thin skin. Eyes small, mouth large, upper jaw almost as long as head, and oblique. No spines in fins. One supramaxilla. Long, fanglike, widely spaced teeth in premaxilla and dentary. Gill rakers short spinules. Scales are thin plates, embedded in skin. Lateral line canal an open groove bridged at intervals by scales.

**Genus :** *Anoplogaster* Günther 1859

***Anoplogaster*** Günther 1859:12, Catalogue of the fishes in the British Museum. v 1. i-xxxi + 1-524.
Paxton & Gates 2006:759, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Anoplogaster cornuta* (Valenciennes 1833)

(Plate IX, Fig. 91)

**Vernacular Name:** Common Fangtooth

***Hoplostethus cornutus***, Valenciennes in Cuvier & Valenciennes 1833:470, Histoire naturelle des poissons. v. 9; South Atlantic, 26°S, 50°W (stomach content). Holotype: MNHN 0000-7443. Type catalog: Bauchot 1970:10-11. Usually reported as occurring in warm-temperate to tropical waters; but it has been reported form cold-temperate and subarctic waters of the Pacific and w. Atlantic. Valid as *Anoplogaster cornuta* (Valenciennes 1833).
Paxton & Gates 2006:760, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Hoplostethus cornutus, Caulolepis longidens, Caulolepis subulidens*

**Diagnostic characters (Based on 1 specimen 13.7 cm TL):**

**B. 7; D. 0, 18; A. 0, 9; P. 14**

Body compressed, deep, head with many ridges and groves. HL 0.38 and HD 0.45 in SL. Mouth cleft oblique, upper and lower jaws with fang like teeth, 0.42 and 0.32 respectively in HL. Parietal and preopercular spines very long in young juveniles, shorter in adults parietal 0.09 in SL. Snout longer than eye diameter, ED 0.17 and PrOL 0.27 in HL. Pectorals and ventrals moderate, 0.28 and 0.19 respectively in SL. Dorsal fin origin well behind pectorals, 0.49 in SL and its base somewhat equal to head. Anal fin near to caudal than to ventrals, 0.75 in SL. Caudal fin forked. Uniformly blackish or dark blackish brown. Lateral line an open groove, bridged by scales at intervals. No cephalic and preopercular spines; eye small; gill rakers tooth-like in groups on bony bases. Attains 18.0 cm TL.

**Geographical distribution (Previous records):** Worldwide in tropical to temperate seas. In western Atlantic it is also known from Flemish Cap.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Bathypelagic; reported from 4992m, usually 500-2000 m. In present study, 501-800 m.

**Family : Diretmidae** (spinyfins)

**Genus : *Diretmichthys*** Kotlyar 1990 (spinyfins)

***Diretmichthys*** Kotlyar 1990:145, Journal of Ichthyology v 30 (no. 2):153-162

Moore 2003:1181, In: Carpenter 2003 [ref. 27006]. The living marine resources of the Western Central Atlantic. v. 2.
Paxton et al. 2006:762, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Diretmichthys parini* (Post & Quéro 1981)

(Plate X, Fig. 92)

**Vernacular Name:** Black discfish, greater diretmid

*Diretmoides parini* Post and Quero, 1981: 49, figs. 10a – h (off Spanish Sahara in 1800 – 2100m). *Diretmus argenteus* (non Jonson): Barnard and Von Bonde, 1944: 236; Woods and Sonoda, 1973: 291. *Diretmus pauciradiatus* (non Woods): Post, 1976: 87 (in part).
Paxton et al. 2006:762, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Diretmoides parini*

**Diagnostic characters (Based on 1 specimen 23.1 cm TL):**

**D. 27; A. 22; P. 18; Gr. 17**

Body elliptic or disc like, deep and compressed, BD 0.54, HD 0.41 and 0.49. Head 0.46 in SL. Snout short and eye very big, 0.12 and 0.39 in HL. Gill covers with 3-6 radiating bony ridges on upper 3$^{rd}$, ventral midline anterior to ventral fins flat, covered with normal ctenoid scales. Anus half way between origin of ventrals and anal fin. Pectoral and ventral fins elongated, reaching beyond anal origin. Dorsal origin behind pectoral origin, PrDL 0.45 in SL. Anal origin around middle of body, 0.67 in SL. Greyish black. Attains 40 cm.

**Geographical distribution (Previous records):** Western Indian Ocean, Tropical to temperate in Atlantic ocean, probably circumglobal in southern oceans.

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** Mesopelagic below 500 m. In present study, 501-800 m.

**Family Berycidae** (alfonsinos, berycids)

**Genus :** ***Beryx*** Cuvier 1829 (alfonsinos)

***Beryx*** Cuvier 1829:151, Le Règne Animal, distribué d'après son organisation, pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée. Edition 2. v. 2: i-xv + 1-406.
Yoshino & Kotlyar 2001:119, Bulletin Faculty Science, University of the Ryukyus No. 72: 119-123.

Dorsal fin with III to V spines; soft anal-fin rays 25 to 30; pelvic fins with I spine and 9 to 13 soft rays; lateral-line scales 60 to 82, extending onto caudal fin; 1 or 2 small spines present on either side of snout, most pronounced in juveniles.

**Key to Species**

**1a.** Body depth contained 1.9-2.25 times in SL, dorsal rays 16-20; Lateral line scales 63-71 ***B. decadactylus***

**1b.** Body depth contained 2.4-2.8 times in SL, dorsal rays 13-15; Lateral line scales 74-80 ***B. splendens***

*Beryx decadactylus* Cuvier 1829

(Plate X, Fig. 93)

**Vernacular Name:** Broad alfonsino, red bream

***Beryx decadactylus,*** Cuvier in Cuvier & Valenciennes 1829:222, Histoire naturelle des poissons. v. 3; Unknown locality Lectotype: MNHN A-5564. Type catalog: Bauchot 1970:25. Lectotype designated by Bauchot 1970:25. Valid as *Beryx decadactylus* Cuvier 1829.
Paxton et al. 2006:774, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Actinoberyx jugeati, Actinoberyx pozzi, Beryx borealis*

**Diagnostic characters (Based on 13 specimens 11.7–14.9cm TL):**

**D. III-IV, 18-20; A. IV, 25-30; P. I, 9-13; V. 9; Lat. 68-71; Gr. 23-24.**

Body deeper, compressed and has a large eye. BD 0.40-0.45, PrDL 0.42-0.45 and AL 0.48-0.5 in SL. Head with 4 spines, 2 on snout, 1 over eye, 1 behind end of jaw. PrOL 0.14-0.15, ED 0.31-0.33 and BD 1.4-1.42 in HL. Dorsal fin origin above ventral fin origin; ventral fin reaching to anal origin when depressed; anal-fin origin below middle of dorsal fin. Top of head, iris, back and all fins bright blood red. Orbital bones, cheeks and opercular bones shiny white. Breast shiny yellowish white. Body silvery with thin lengthwise lines.

**Geographical distribution (Previous records):** Worldwide in temperate and tropical latitudes, except eastern Pacific. Eastern Atlantic: Greenland, Iceland, and Norway to Western Sahara and South Africa, including western Mediterranean. Western Atlantic: south to Brazil. Indo-Pacific: East Africa (including Madagascar Ridge and Saya de Malha Bank to Japan, Australia, and New Zealand.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Bathydemersal; depth range 110 - 1000 m. In present study, 501-800 m.

*Beryx splendens* Lowe 1834

(Plate X, Fig. 94)

**Vernacular Name:** Splendid alfonsino, Slender alfonsino

***Beryx splendens***, Lowe 1834:142, Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1833 (pt 1); Off Madeira. Holotype: BMNH uncat. (stuffed, poor condition). Specimen later illustrated and described in more detail in Lowe 1838 [possibly 1836], p. 197, pl. 3. •Valid as *Beryx splendens* Lowe 1834.
Paxton et al. 2006:774, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** Nil

**Diagnostic characters (Based on 3 specimens 22.4–39.5 cm TL):**

**D. IV, 13-16; A. IV, 26-30; P. 11-13; V. I, 9-12; LL 69; Gr. 25-28**

Body more slender, compressed and has a large eye. HL equal to PL 0.35-0.36 in SL and 0.94-0.98 in BD. PrDL 0.43-0.45, BD 0.38-0.39 and AL 0.6-0.62 in S. ED 0.42-0.44 and PrOL 0.12-0.14 in HL. First infraorbital bone with a spine projecting laterally on anterior end. Lateral line extends to caudal fin. A fleshy disk on inner face of exposed area of scale. Ventral fin not reaching to anal origin when depressed. Anal-fin origin just below posterior end of dorsal fin. Lateral-line scales extending onto caudal fin. Top of head, iris, back and all fins bright blood red. Orbital bones, cheeks and opercular bones shiny white. Attains 70.0 cm.

**Geographical distribution (Previous records):** Circumglobal, excluding northeast Pacific and Mediterranean Sea. Western Atlantic: Gulf of Maine to Gulf of Mexico. Eastern Atlantic: off south western Europe and Canary Islands to South Africa. Indo-Pacific: East Africa including Saya de Malha Bank to Japan, Hawaii, Australia, and New Zealand.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Benthopelagic, depth range 25 - 1300 m. In present study, 501-800 m.

**Family : Trachichthyidae** (redfishes, roughies, slime heads)

Angle of preopercle with a distinct spine. Posttemporal bone with posteriorly pointing spine. Pelvic fin 1 normal spine, 6-7 soft rays. Dorsal fin 3-8 spines, 10-19 soft rays. Anal fin 2-3 spines, 8-12 soft rays. Caudal fin often with 4-7 procurrent spines on each lobe. A median ridge of scutes on abdomen. Interspecific variation in type of scales. Body very deep to moderately deep. Some species are bioluminescent. Maximum length about 55 cm.

**Key to Genera**

**1a.** D spines 7 or 8; spinous D base is not shorter than A base ***Gephyroberyx***

**1b.** D spines 4-7; spinous D base shorter than A base ***Hoplostethus***

## Genus : ***Gephyroberyx*** Boulenger 1902

***Gephyroberyx*** Boulenger 1902:203, Annals and Magazine of Natural History (Series 7) v. 9 (no. 51): 197-204.
Paxton et al. 2006:768, In: Zoological Catalogue of Australia. Volume 35. Fishes.

### *Gephyroberyx darwinii* (Johnson 1866)

(Plate X, Fig. 95)

**Vernacular Name:** Big roughy

***Trachichthys darwinii***, Johnson 1866:311, Pl. 32 [Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1866 (pt 2); Madeira. Holotype (unique): BMNH 1866.6.1.2. Valid as *Gephyroberyx darwinii* (Johnson 1866).
Andrade et al. 2004:67, Aqua, Journal of Ichthyology and Aquatic Biology v. 9 (no. 2): 65-68.
Paxton et al. 2006:768, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Trachichthys darwinii, Gephyroberyx orbicularis, Gephyroberyx robustus*

**Diagnostic characters (Based on 1 specimen 16.2 cm TL):**

**D. VIII, 14; A. III, 11; P. 13; Lat. 28; GR. 6+14.**

Body moderately deep, compressed, BD 0.48, HD 0.4 and DA 0.38 in SL. Snout short, PrDL 0.58 in ED and 0.16 in HL. Eyes prominent, 0.27 in HL. Opercular flap extending till dorsal origin. Spine on lower opercle long reaching origin of ventral fin. Dorsal fin origin in anterior half of body, behind pectoral and ventral origin. PrDL 0.47 in SL. Ventral side of body with 13 scutes between ventral fin and anus. Anal fin in posterior most 0.36 of DFB. Caudal forked. Head and body dusky pink. Attains 60 cm.

**Geographical distribution (Previous records):** Known all round African coast; both sides of Atlantic and Indian Oceans, Australia and Philippines

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** In present study, 501-800 m.

## Genus : *Hoplostethus* Cuvier 1829

***Hoplostethus*** Cuvier in Cuvier & Valenciennes 1829:469, Histoire naturelle des poissons. v. 4: i-xxvi + 2 pp. + 1-518, Pls. 72-99, 97 bis.
Gomon 2008:189, Memoirs of the Museum of Victoria v. 65: 189-194.

### Key to Species

**1a.** P 14-16; 8-12 well developed scutes on belly ***H. mediterraneus***

**1b.** P 16-20; 13 – 18 well developed scutes on belly ***H. malanopus***

*Hoplostethus mediterraneus* Cuvier 1829

(Plate X, Fig. 96)

**Vernacular Name:** Mediterranean redfish

*Hoplostethus mediterraneus* Cuvier, in Cuv. And Val., 1829: 344, pl. 97 (Nice); Smith, SFSA No. 288; 1964: 295; Karrer, 1973: 223; Woods and Sonoda, 1973: 314; Kotlyar, 1980: 206. Moore 2003:1188, In:Carpenter 2003. The living marine resources of the Western Central Atlantic. v. 2.
Fricke et al. 2007:72, Serie A (Biologie). No. 706: 1-174.
**Synonymy:** *Hoplostethus mediterraneus, Korsogaster nanus, Trachichthys pretiosus*

**Diagnostic characters (Based on 12 specimens 12.3-23.8 cm TL):**

**B. 8; D. VI –VII, 12-14; A. III, 10; P. 14-16; V. 7-8; Gr. 22-26; Lat. 25-27**

Body more or less oval, deep and compressed, BD 0.46-0.48 and DA 0.37-0.4 in SL. Head with ridges and many cavities, deeper than long, HD 1.2 in HL and 0.47-0.48 in SL. Eye larger than snout, 0.3-0.33 and PrOL 0.2 in HL. Dorsal fin origin in anterior half of body, PrDL 0.5-0.56 in SL. Pectoral long, 0.3-0.33 and ventral length equal to LCP, 0.2-0.22 in SL. Dorsal fin base equal to head length. Anal fin origin near posterior end of dorsal fin base, 0.62-0.65 in SL. Body scales deciduous; D spines robust, about twice as thick as soft rays. Belly scutes between ventral fin and anus well developed, 8-12. Body dusky, pink dorsally, silvery below; paired fins pale; inside of mouth, gill cavity and peritoneum black. Attains 30 cm.

**Geographical distribution (Previous records):** Namibia to Natal. Reported from both sides of Atlantic Ocean, Mediterranean Sea, Red sea, Indian Ocean, and off south coast of Australia and New Zealand.

**Distribution in the Southwest coast (Present study):** Between 07° and 13° N latitude.

**Depth:** In present study, 201-800 m.

*Hoplostethus melanopus* (Weber 1913)

(Plate X, Fig. 97)

**Vernacular Name:** Smallscale slimehead

***Leiogaster melanopus***, Weber 1913:180, Pl. 9 (fig. 7) [Die Fische der Siboga-Expedition., Halmahera Sea, 1°10'S, 130°9'E, Siboga station 161, depth 798 meters. Lectotype: ZMA 110826. Paralectotypes: FMNH 52454 [CM 712] (1); RMNH 9985 [ex ZMA] (1); ZMA 109297 (1), 110823-25 (3, 4, 11). Type catalog: Nijssen et al. 1982:79, Ibarra & Stewart 1987:51 Lectotype designated by Karrer 1973:230. Valid as *Hoplostethus melanopus* (Weber 1913). Kotlyar 2002:476, Journal of Ichthyology v 42 (no. 6):434-439.
Paxton et al. 2006:770, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy**: *Leiogaster melanopus, Hoplostethus natalensis*

**Diagnostic characters (Based on 3 specimens 12.8-15.1 cm TL):**

**D. IV-V, 13-16; A. II-III, 8-10; P. 18-20; Gr. 21-22; Lat. 28;** Belly scutes **15-18.**

Body compressed and deep, BD 0.54-0.57 in SL. Head deeper than long, HL 0.41-0.43 and HD 0. 54-0.55 in SL. Snout shorter than eye diameter, 0.18-0.2 and ED 0.27-0.29 in HL. Dorsal origin in anterior half of body, behind pectorals and ventrals, PrDL 0.46-0.48 in SL. Pectorals long, 0.34-0.37 in SL, reaching almost posterior margin of anal base. Anal fin origin just behind anus, its base half length of dorsal base. Caudal peduncle 0.2-0.22 in SL. Body and head brownish grey; fins dusky to blackish; gill and mouth cavity dark. Attains 25 cm.

**Geographical distribution (Previous records):** Indo-west Pacific from Indonesia to Natal, also off Namibia and Cape Town.

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** Recorded from the depth range 700-900 m. In present study, 501-800 m.

**Order** : Zeiformes (boarfishes, dories, john dories)

**Sub Order** : Zeioidei

**Key to Family**

**1a.** Anal I–II, 29-30; No bony bucklers along base of both spiny and soft rayed dorsal **Parazenidae**

**1b.** Anal III, 24-26; bony bucklers (5or 6) along base of both spiny and soft-rayed Dorsal ......**Zeidae**

**Family** : **Parazenidae** Greenwood *et al.*, 1966 (dories, smooth dories)

**Sub Family: Cyttopsinae** Greenwood *et al.*, 1966 (smooth dories)

**Genus** ***Cyttopsis*** Gill 1862

***Cyttopsis*** Gill 1862:126. Fem. *Zeus roseus* Lowe 1843. Type by original designation (also monotypic). •Valid as *Cyttopsis* Gill 1862.
Heemstra 2003:1209, The living marine resources of the Western Central Atlantic. v. 2.

*Cyttopsis rosea* (Lowe 1843)

(Plate X, Fig. 98)

**Vernacular Name:** Red dory

***Zeus roseus,*** Lowe 1843:85 [Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1843 (pt 11); Off Madeira. Syntypes: (2) BMNH 1852.9.13.104 (1). The original combination was *Zeus roseus*, *Zeus* being masculine; in *Cyttopsis*, which is feminine, *roseus* apparently is an adjective, and the correct name should be *rosea* according to R. M. Bailey, pers. comm. Sept. 2003. •Valid as *Cyttus roseus* (Lowe 1843)
Nelson *et al.* 2004:110 as *rosea*, American Fisheries Society, Special Publ. 29. Bethesda, Maryland. Committee Scient. Names Fishes U.S. Canada Mexico Sixth Ed.. 1-386.
Shinohara *et al.* 2005:423 as *rosea*, Memoirs of the National Science Musuem Tokyo No. 29: 385-452.

**Synonymy:** *Zeus roseus, Cyttus roseus, Cyttopsis itea*

**Diagnostic characters (Based on 3 specimens 10.9–12.1cm TL):**
**B. 8; D. VII, 29; A. II, 29; P. 13; V. 0, 10; C. 22; Lat. 79**

Body oval, strongly compressed, BD 0.5 in SL and 1.37 in HL, covered with small, thin, deciduous, cycloid scales. Head moderate, 0.35 in SL. Upper edge of bony orbit with small spines anteriorly. Snout longer than eye diameter, 0.5-0.56 in HL, eyes moderate and not separated with a wide space in between, ED 0.36-0.37 and IOW 0.25-0.26 in HL. Mouth highly protrusible, lower jaw projecting more than upper jaw. Chest (between and in front of ventral fins) flattened and broad. Two large keeled scutes, each ending in a spine, between ventral fins and rays, and another scute midway between ventrals. Pectoral medium in size, not reaching beyond anus, but ventrals long, reaching beyond anus. Dorsal origin just above pectorals or little behind, PrDL 0.44-0.46 in SL and is equal to its base. A row of low bony ridges or bumps along bases of soft dorsal and anal fins.

**Geographical distribution (Previous records):** Western Atlantic: Canada to south eastern USA and northern Gulf of Mexico to western Caribbean; northern coast of South America. Eastern Atlantic: Bay of Biscay round South African coast to Natal. Indian Ocean: Somalia and off south-west coast of India. Western Pacific: off Japan, eastern Australia and New Zealand.

**Distribution in the Southwest coast (Present study):** Between 09$^{\circ}$ and 11$^{\circ}$ N latitude.

**Depth:** Bathypelagic; marine; depth range 150 - 730 m, usually 330 - 690 m. In present study, 501-800 m.

## Family : Zeidae Latreille, 1825 (buckler dories, dories, John dories)

## Genus : *Zenopsis* Gill 1862

***Zenopsis*** Gill 1862:126. Fem. *Zeus nebulosus* Temminck & Schlegel 1845. Type by original designation (also monotypic). •Valid as *Zenopsis* Gill 1862.
Paxton et al. 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Total pelvic fin elements 6-8; anal fin II-IV,20-39. Anal fin III-IV,20-26; scales cycloid, rudimentary (embedded) or absent; bony bucklers or spines along base of dorsal and anal fins.

*Zenopsis conchifer* (Lowe 1852)

(Plate X, Fig. 99)

**Vernacular Name:** American john dory, buckler dory

***Zeus conchifer***, Lowe 1852:247 [Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1850 (pt 18); Off Madeira. Syntypes: BMNH 1857.6.13.184 (1, skin). Valid as *Zenopsis conchifer*
Nelson *et al.* 2004:110, as *conchifera,* American Fisheries Society, Special Publ. 29. Bethesda, Maryland. Committee Scient. Names Fishes U.S. Canada Mexico Sixth Ed.. 1-386.
Nakabo *et al.* 2006:91, Memoirs of the Museum of Victoria v 63 (no. 1): 91-96.
**Synonymy**: *Zeus conchifer, Parazenopsis argenteus, Zenopsis figueirai*

**Diagnostic characters (Based on 10 specimens 18.2-43.6 cm TL):**

**D. IX-X, 24-26; A. III, 24-26; P. 12; V. I, 5-6**

Body oval,strongly compressed, without scales HL 0.43-0.45, HD 0.37, BD 0.51 and DA 0.47 in SL One or 2 rows of small teeth on jaws and a few on vomer. Scales absent; 7 large bucklers or keeled bony scutes along D bases, one to three bony plates at base of fist dorsal fin, 4-5 along base of soft dorsal, 5 or 6 along base of A; two rows of 7 or 8 keeled scutes each ending in a small spine, between V and A; 2 bucklers in front of ventrals. Snout longer than eye diameter, PrOL 0.43 and ED 0.35 in HL. Ventral origin in front of vertical through front edge of eye. Body silvery, with a dusky midlateral spot just posterior to, and slightly above, end of pectoral fins. First dorsal and ventral fins blackish. Attains 80 cm

**Geographical distribution (Previous records):** Cosmopolitan; Western Indian Ocean: Somalia and India to South Africa, but not in Red Sea. Eastern Atlantic: Bay of Biscay to South Africa. Western Atlantic: Sable Island, Canada to northern North Carolina, USA to northern Argentina.

**Distribution in the Southwest coast (Present study):** Between 09° and 13° N latitude.

**Depth:** Benthopelagic; marine; depth range 50-600m, usually 150-300 m. In present study, 201-500 m.

## Order : Scorpaeniformes

(mail-cheeked fishes, rascasses, scorpion fishes, sculpins)

**Key to Families**

**1a.** Head encased by expanded bones that are firmly attached to each other **2**

**1b.** Head not encased with bony armour **Scorpaenidae**

**2a.** Body covered with bony plates **Peristediidae**

**2b.** Body not covered with bony plates **3**

**3a.** Very long preopercular spine; one or two isolated dorsal spines on nape **Dactylopteridae**

**3b.** Short preopercular spine; no isolated D fin spines on nape **Triglidae**

## Family : Scorpaenidae (firefishes, goblinfishes, rockfishes)

**Key to Sub Families**

**1a.** Lateral line forms a broad groove, without tubed scales; head cavernous and rather weakly ossified **Setarchinae**

**1b.** Lateral line with tubed scales; head not cavernous, ossification normal **2**

**2a.** Pectoral fin rays greatly elongate, longest reaching beyond base of posteriormost segmented anal ray; a single strong spine on opercle **Pteroininae**

**2b.** Pectoral fin rays not greatly elongate, longest not reaching base of posteriormost segmented anal ray; 2 spines on opercle sometimes weak ***Scorpaeninae***

**Sub Family : Setarchinae**

**Key to Genera**

**1a.** Anterior preorbital spine on lacrimal bone as long as posterior two; top of head scaleless; orbit diameter subequal to interorbital width; anal fin with 3 spines and usually 5 segmented rays ***Setarches***

**1b.** Anterior preorbital spine much shorter than posterior two; top of head with scales; orbit diametre contained about 2 times in interorbital width; anal fin with 3 spines and usually 6 segmented rays; pectoral rays 18-20 ***Ectreposebastes***

**Sub Family: Setarchinae**

**Genus : *Setarches* Johnson 1862**

**Mandrytsa** 2001, Lateral line system and classification of scorpaenoid fishes (Scorpaeniformes: Scorpaenoidei).: 1-393.

## *Setarches longimanus* (Alcock, 1894)

**Vernacular Name:** Deepwater scorpionfish

***longimanus, Lioscorpius longiceps*** var. Alcock 1894:Pl. 10 (fig. 3) [Illustrations of the zoology of the Royal Indian marine surveying steamer Investigator,...Fishes. Part 2; Andaman Sea Investigator station 115, depth 344-402 meters. Holotype (unique): ZSI F13036. Type catalog: Talwar 1977:637 Named on legend page for Pl. 10 (fig. 3); refers back to *Lioscorpius longiceps* of Alcock 1891:23. •Valid as *Setarches longimanus* (Alcock 1894)
Shinohara *et al.* 2005:425, Memoirs of the National Science Musuem Tokyo No. 29: 385-452.
Allen *et al.* 2006:870, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** Nil

**Diagnostic characters (Based on 5 specimens 18.3–18.9cm TL):**

**B. 7; D. XII, 11; A.III, 6; P. 22-24; V. I, 5; C. 15-17; Lat. 22-23**

Height of body from 1/3 to 2/7, length of head about 4/9 total length without caudal. Head singularly large and clumsy looking. Three free divergent spines on edge of preorbital; four or five, of which three upper are usually large, on edge of preoperculum; two on operculum. No true spines on top of head, but two low ridges on occiput and one behind either orbit end somewhat acutely, as also does a short ridge at anterior supra-orbital angle and one above middle of orbit. Snout is 3 ½ in length of head. Eye diameter ¼ to 1/5 length of head, intertribal space a little wider that eye. Mouth large, oblique, with prominent lower jaw; maxilla reaches as far as posterior border of orbit. Lateral line broad, naked with double tubule. 3$^{rd}$ dorsal spine longest, about as long as snout. Pectorals very large, reaching beyond beginning of anal. Ventrals reaching rather more than halfway to anal. Red with minute black specks, and with some dusky markings that usually fade. Attains 23 cm.

**Geographical distribution (Previous records):** Indo-West Pacific: Indian Ocean east to Fukushima Prefecture, Japan, south to Australia. Reported from Arafura Sea

**Distribution in the Southwest coast (Present study):** Between 13$^{o}$ and 15$^{o}$ N latitude.

**Depth:** Demersal; non-migratory; depth range 20-500 m. In present study, 501-800 m.

## Genus: *Ectreposebastes* Garman 1899

***Ectreposebastes*** Garman 1899:53, Memoirs of the Museum of Comparative Zoology v. 24: Text: 1-431, Atlas: Pls. 1-85 + A-M.. Masc. *Ectreposebastes imus* Garman 1899. Type by monotypy. •Valid as *Ectreposebastes* Garman 1899
Poss & Eschmeyer 2003: 1234, In: Carpenter 2003 [ref. 27006]. The living marine resources of the Western Central Atlantic. v. 2.

Bones of head weak, translucent, cavernous; no pit in occiput on top of head; scales tiny, not in definite rows, roughly equivalent to 100 vertical rows above lateral line.

### *Ectreposebastes imus* Garman 1899

(Plate X, Fig. 100)

**Vernacular Name:** Nil

***Ectreposebastes imus,*** Garman 1899:53, Pls. 8, 9, 71 (fig. 1), Memoirs of the Museum of Comparative Zoology v. 24; Galápagos Islands, 0°58'30"S, 89°17'W, Albatross station 3403, depth 384 fathoms. Syntypes: MCZ 28766 (3), USNM 153606 [ex MCZ 28766] (1). •Valid as *Ectreposebastes imus* Garman 1899
Poss & Eschmeyer 2003:1239, In: Carpenter 2003 [ref. 27006]. The living marine resources of the Western Central Atlantic. v. 2.
**Synonymy:** Nil

**Diagnostic characters (Based on 1 specimen 12.1cm TL):**

**D. XI, 9; A. III, 7; Lat.29.**

Body moderately deep, compressed and fusiform. Body depth 0.43 and DA 0.28 in SL. Mouth oblique, cleft wide, upper jaw reaching to middle of eye, 0.51 in HL. Sub opercle with four small longitudinal pits. Pre opercle with 7 small spines and opercle with two long embedded spines. Head length 0.45 in SL. Dorsal fin, pectoral fin and ventral fin origin are in same line in vertical. Pectoral fin tip reaching anal origin, 0.28; ventral fin shorter than, 0.21 in SL. Anal fin short, 0.23 in DFB, which is longer than head length. Caudal peduncle moderately long, 0.08 in SL. Black overall, tips of fins light.

**Geographical distribution (Previous records):** Atlantic, Indian and Pacific: in tropical and temperate waters. Eastern Atlantic: tropical western Africa. Western Atlantic: Gulf of Mexico to Suriname.

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** 150 - 2000 m. In present study, 501-800 m.

**Sub Family : Pteroninae**

**Genus : *Pterois*** Oken 1817 (butterfly-cods, lionfishes, turkeyfishes, zebrafishes)

***Pterois*** Oken (ex Cuvier) 1817·1182, V Kl. Fische. Isis (Oken) v. 8 (no. 148): 1779-1782. Fem. *Scorpaena volitans* of Bloch (= *Gasterosteus volitans* Linnaeus 1758).
Allen & Erdmann 2008, Aqua, International Journal of Ichthyology v. 13 (nos. 3-4): 127-138.

Pectoral fin rays greatly elongate, longest reaching beyond base of posteriormost segmented anal ray; a single strong spine on opercle. Dorsal fin elongate; dorsal fin membrane between spines deeply incised. All pectoral fin rays unbranched; pectoral fin membrane between upper rays strongly incised

*Pterois russelii* Bennett 1831

(Plate X, Fig. 101)

**Vernacular Name:** Planetail firefish, spotless butterfly-cod

***Pterois russelii,*** Bennett 1831·128 [Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1830-31 (pt 1); India. No types known. Based on "Russel [P Russell], Coromandel Fishes, no. 133." •Valid as *Pterois russelii* Bennett 1831
Heemstra & Heemstra 2004:144, NISC and SAIAB. Coastal Fishes of Southern Africa.. i-xxiv + 1-488.
Allen & Erdmann 2008:128, Aqua, International Journal of Ichthyology v. 13 (nos. 3-4): 127-138.

**Synonymy:** *Pterois geniserra* Cuvier, 1829; *Pterois kodipungi* Bleeker, 1852

**Diagnostic characters (Based on 3 specimens 13.6–17.2cm TL):**

**D. XIII, 10-11; A. III, 6-7; P. 13.**

Body compressed and moderately deep, BD 0.42-0.44, HD 0.3-0.32 and DA 0.33-0.36. Head with ridges and spines, its length 0.46-0.48 in SL. Gill membranes free from isthmus. Skin at gill openings connected to each other narrowly anteriorly. Lacrimal bone (infraorbital 1) relatively immobile; strongly bound to lateral-ethmoid dorsally and to first suborbital bone (infraorbital 2) posteriorly. Opercle with a single weak ridge that typically ends in a small spine; lacrimal and suborbital bones (infraorbital bones 1 to 3) relatively broad, flat, and thin. Dorsal-fin origin in same line with pectorals, PrDL 0.34-0.35 in SL. Its membranes incised nearly entire length of all spines; dorsal-fin spines greatly. Pectoral-fin rays unbranched, very long, PL 0.72-0.74 in SL. Caudal fin and soft parts of dorsal and anal fins without spots. Anal fin base short, 0.22-0.24 in DFB. Caudal rhomboid. Reddish, with numerous thin dark bars on body and head. Few or no spines on bones below eye. Attains 30 cm.

**Geographical distribution (Previous records):** Indo-Pacific: Persian Gulf and East Africa to New Guinea, south to Western Australia.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Reef-associated; depth range 15 - 60 m. In present study, 201-500 m.

**Sub Family : Scorpaeninae**

**Genus** ***Scorpaena*** Linnaeus 1758 (scorpionfishes)

***Scorpaena*** Linnaeus, 1758: 266, Systema Naturae, Ed. X. v. 1. i-ii + 1-824.
Motomura & Senou 2008:1761, Journal of Fish Biology v 72: 1761-1772.

Scales on body cycloid. Bones of head strong; a pit in occiput on top of head in most species; scales relatively large, about 50 vertical rows above lateral lines on sides.

*Scorpaena scrofa* Linnaeus 1758

(Plate XI, Fig. 102)

**Vernacular Name:** Bigscale scorpionfish, Orange scorpionfish

*Scorpaena scrofa*, Linnaeus 1758:266 [Systema Naturae, Ed. X. v. 1; Mediterranean Sea. No types known. Type catalog: Wheeler 1958:237 •Valid as *Scorpaena scrofa* Linnaeus 1758 Motomura *et al.* 2005:867, New Zealand Journal of Marine and Freshwater Research v. 39: 865-880.

Fricke *et al.* 2007:77, Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie). No. 706: 1-174.

**Synonymy:** *Scorpaena lutea* Risso, 1810; *Scorpaenopsis natalensis* (Regan, 1906)

**Diagnostic characters (Based on 2 specimens 21.4–27.3cm TL):**

**D. XII, 9; A. III, 5; P. 18-20; Lat. 45-47**

Body fusiform, moderately compressed and deep, BD 0.4-0.43, HD 0.3-0.34 and DA 0.27-0.29 in SL. Head with many ridges and spines, more or less equal to body depth (HL 0.4-0.44 in SL). A pit on midline behind eyes. Snout short, 0.83-0.84 in ED and 0.24-0.26 in HL. Dorsal fin insertion before pectoral and ventral origins, PrDL 0.31-0.34. Pectorals reaching anal origin, its length 0.28-0.3 in SL. Ventrals short, not reaching anal origin, 0.22-0.24 in SL. Anal fin originate far behind, AL 0.75-0.76 in SL and its base is 0.22-0.23 in DFB. Body variously coloured, mostly reddish brown all over, a dark spot on spinous dorsal. Attains about 50 cm.

**Geographical distribution (Previous records):** Eastern Atlantic: British Isles (rare) to Senegal including Madeira, Canary Islands, and Cape Verde, also throughout Mediterranean except Black Sea and south western Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 13° and 15° N latitude.

**Depth:** Demersal; non-migratory; depth range 20 - 500 m. In present study, 501-800 m.

## Family : Peristediidae

## Genus : *Peristedion* Lacepède 1801

***Peristedion*** Lacepède 1801:368, Histoire naturelle des poissons. v. 3: i-lxvi + 1-558, Pls. 1-34.
Paxton et al. 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Body enclosed by 4 rows of spinous scutes on each side; lacking scales;head large, bony, with many ridges and spines; snout broad and flattened dorsoventrally, flanked anteriorly by a pair of short and broad or long and slender, projections (or rostral exsertions) of first suborbital bones; mouth inferior, jaws incompletely closing; teeth absent on mandible, vomer, and palatine bones; tongue usually absent; mandibular barbel present, lip and chin barbells usually present.

*Peristedion weberi* Smith 1934

(Plate XI, Fig. 103)

**Vernacular Name:** Crocodile fish

*Peristedion weberi* Smith, 1934: 329, Pl. 21 (off Delagoa Bay; 260 fms); Smith, SFSA No. 1075; Miller, 1974: 67; Heemstra, 1982: 292.
Kawai 2008, Species Diversity v. 13: 1-34.
**Synonymy:** Nil

**Diagnostic characters (Based on 3 specimens 12.3-14.2 cm TL):**

**D. XIII/20; A. 20-23; P. 11-13+2; GR. (4-6) + (19-22); Lat. 34-37**

Body dorso-ventrally compressed, with many ridges and plates on head. Snout extended forward as two flat blunt plates. Head length (from premaxillary symphysis to end of opercular spine) 2.6 – 2.9, Body depth 5.2 – 7 1 in SL, eye 4.3 – 4.6, interorbital width 4.3 – 5.0 in head. Filamentous lip barbell not reaching base of preopercular spine. Length of broad triangular preorbital processes is more or less equal to distance between their base and anterior border of orbit. Interorbital space concave, less than major diameter of eye. Body grey, mottled darker above; prominent black blotch at tip of pectoral; dusky mark at base and dorsally in axil of pectoral; dorsal spines, rays and margin of fin black. Attains 15 cm.

**Geographical distribution (Previous records):** Western Indian Ocean, Northern Natal to Somalia.

**Distribution in the Southwest coast** Between 09° and 13° N latitude.

**Depth:** Recorded from 170 m. In present study, 201-500 m.

**Sub Order : Dactylopteroidei**

**Family : Dactylopteridae**
(flying gurnards, grondins volants)

**Genus : *Dactyloptena*** Jordan & Richardson 1908

***Dactyloptena*** Jordan & Richardson 1908:665, Proceedings of the United States National Museum v 33 (no. 1581): 629-670.
Poss & Eschmeyer 1999:2284, In: Carpenter and Niem 1999

Head large and blunt, with bones forming a helmet; with keels and a long preopercle spine. Scales scute-like. Pectoral fins greatly enlarged, inner rays free; total 28-37 rays. Two isolated dorsal spines preceeding two dorsal fins.

**Key to Species**

**1a.** Lateral line present ***D. macracantha***

**1b.** Lateral line absent ***D. orientalis***

*Dactyloptena macracantha* (Bleeker 1854)

(Plate XI, Fig. 103)

**Vernacular Name:** Spotwing flying gurnard

***Dactylopterus macracanthus,*** Bleeker 1854:449, Natuurkundig Tijdschrift voor Nederlandsch Indië v. 7 Makasar [Ujung Pandang], Sulawesi [Celebes], Indonesia. Syntypes: (2). •Valid as *Dactyloptena macracanthus* (Bleeker 1854).
Mishra & Krishnan 2003, Records of the Zoological Survey of India. Miscellaneous Publication, Occasional Paper No. 216: 1-53.
**Synonymy:** *Dactylopterus macracanthus* Bleeker, 1854

**Diagnostic characters (Based on 1 specimen 18.8 cm TL):**

**D. I+I+V+I, 8; A. 6-7; P. 32-35**

A moderately elongated fish; body squarish in cross-section. Head broad, blunt, depressed anteriorly; a prominent keeled spine extending posteriorly from nape to below second spine of continuous part of dorsal fin; angle of preopercle with a long, prominent spine; jaws with a band of small nodular teeth. Spinous and soft dorsal fins separated by a deep notch; anterior 2 dorsal fin spines separated from remainder of spinous dorsal fin, first spine elongate, second short; pectoral divided into two sections, a short anterior part and posterior elongated part reaching caudal base, its bases horizontal. Caudal emarginate. Lower side of posterior part of trunk with 4 enlarged keel-like scales, first above anus. Scales scute like, with large sharp keels. Lateral line present and extending near base of caudal. Dusky violet above and pinkish below, an oblong black blotch over middle of pectoral.

**Geographical distribution (Previous records):** Indo-West Pacific: southern India and Sri Lanka to Philippines, south to northern Australia and Papua New Guinea.

**Distribution in the Southwest coast (Present study):** Between 07° and 11° N latitude.

**Depth:** Demersal; depth range 45 - 177 m. In present study, 201-500 m.

*Dactyloptena orientalis* (Cuvier 1829)

(Plate XI, Fig. 105)

**Vernacular Name:** Helmet gurnard, purple flying gurnard

***Dactylopterus orientalis***, Cuvier 1829:162, Le Règne Animal, distribué d'après son organisation, pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée. Edition 2. v. 2 Red Sea No types known. Cuvier specimens (non-types): MNHN 0000-4338 (1) Mauritius, 0000-6415 (1) Waigiou, 0000-6889 (1) Mauritius, 0000-6893 (1) Mauritius; SMF 475 [ex MNHN] (2).

Kyushin et al. 1982, Fishes of the South China Sea.. 1-333, Pls. 1-291

Randall 2005:135, Reef and shore fishes of the South Pacific.. i-xii + 1-707

**Synonymy:** *Corystion orientale* (Cuvier, 1829); *Dactylopterus cheirophthalmus* Bleeker, 1854; *Ebisinus procne* Ogilby, 1910

**Diagnostic characters (Based on 1 specimen 23.5 cm TL):**

**D. I+I+V+I, 9; A. 6; P. 34**

Moderately elongated heavily armoured box-like body; body squarish in cross-section. Head broad, blunt, depressed anteriorly; a prominent keeled spine extending posteriorly from nape to below second spine of continuous part of dorsal fin; angle of preopercle with a long, prominent spine; jaws with a band of small nodular teeth. Spinous and soft dorsal fins separated by a deep notch; anterior 2 dorsal fin spines separated from remainder of spinous dorsal fin, first spine elongate, second short. Winglike pectoral fins divided into two sections, a short anterior part and posterior elongated part reaching caudal base, bases horizontal. Caudal emarginate. Lower side of posterior part of trunk with 3 enlarged keel-like scales, first above anus. Scales scute like, with large sharp keels. Lateral line absent. Usually yellowish brown above, lighter brown below, small orange spots over top of head and back, with dusky, golden spots on pectoral fins. Attains 38 cm.

**Geographical distribution (Previous records):** Indo-Pacific: Red Sea and East Africa to Hawaiian, Marquesan and Tuamoto islands, north to southern Japan and Ogasawara Islands, south to Australia and New Zealand.

**Distribution in the Southwest coast (Present study):** Between 07° and 11° N latitude.

**Depth:** Marine; depth range 1-100 m. In present study, 201-500 m.

## **Family : Triglidae** (gurnards, searobins)

**Key to Genera**

**1a.** Bases of first dorsal and second dorsal spines with small plates bearing strong lateral spines; head with a deep occipital groove ***Lepidotrigla***

**1b.** Bases of first dorsal spines expanded into broad, flattened, bony plates, no spines or plates along base of second dorsal fin ***Pterigotrigla***

**Genus : *Lepidotrigla* Günther 1860**

***Lepidotrigla*** Günther 1860:196, Catalogue of the fishes in the British Museum. v. 2: i-xxi + 1-548.
Parin et al. 2002:S66, Journal of Ichthyology v. 42 (Suppl. 1): S60-S135.

Bony plates with sharp spines posteriorly along entire length of both dorsal fins. Trunk and tail scales large, usually less than 60 rows along lateral line; head usually with a deep occipital groove.

*Lepidotrigla spiloptera* Günther 1880

(Plate XI, Fig. 106)

**Vernacular Name:** Spotwing gurnard

***Lepidotrigla spiloptera,*** Günther 1880:42, Pl. 18 (fig. C) [Report on the shore fishes procured during the voyage of H. M. S. Challenger in the years 1873-1876. v 1 (pt 6); Kai Islands, Challenger station 192, Indonesia, Arafura Sea, depth 129 fathoms. Holotype (unique): BMNH 1879.5.14.269. •Valid as *Lepidotrigla spiloptera* Günther 1880
Manilo & Bogorodsky 2003:S103, Journal of Ichthyology v 43 (suppl. 1): S75-S149.
Paxton *et al.* 2006:925, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** Nil

**Diagnostic characters (Based on 9 specimens 12.1–14.8cm TL):**

**B. 7; D. IX.15; A. 0, 15; Lat. 60**

Body moderately elongated, box like. Head large, triangular, with many ridges and spines, and a fissure on top, behind eyes. Profile of snout concave. Pre-orbital projecting as a broad spine, about half as long as eye. Interorbital space very concave, its width nearly equal to vertical diameter of eye. A deep transverse groove behind orbits. Scales feebly serrated, those of lateral line unarmed, those that immediately flank dorsal fins; spines well developed. The first dorsal spine, which is highest, is not very much more than half length of head. Pectoral fin reaching to 4th or 5th anal ray. Reddish; pectoral dark blue on its inner surface, with numerous white spots and a white margin.

**Geographical distribution (Previous records):** Indo-West Pacific: Red Sea; Somalia coast; Zanzibar; Bay of Bengal, Arafura Sea and Philippines.

**Distribution in the Southwest coast (Present study):** Between 07° and 13° N latitude.

**Depth:** Demersal; depth range 54-256 m. In present study, 201-500 m.

**Genus : *Pterygotrigla*** Waite 1899

***Pterygotrigla*** Waite 1899:28, 108, Memoirs of the Australian Museum, Sydney v. 4 (pt 1): 2-132, Pls. 1-31
Richards et al. 2003, Publications in Aquatic Biodiversity Bull. 2: 1-18.

Bony plates only along base of first dorsal fin. Scales small, more than 60 rows along lateral line. Nasal spine absent, opercular spine long, nuchal spine long, antrorse rostral spine absent, cleithral spine long and strong.

*Pterygotrigla hemisticta* (Temminck & Schlegel 1843)

(Plate XI, Fig. 107)

**Vernacular Name:** Blackspotted gurnard

***Trigla hemisticta***, Temminck & Schlegel 1843:36, Pl. 14 (figs. 3-4), 14B [Fauna Japonica, sive descriptio animalium quae in itinere per Japoniam Parts 2-4; Nagasaki, Japan. Lectotype: RMNH D695 (stuffed). Paralectotypes: RMNH 501 (1). Lectotype designated by Boeseman 1947:46. •Valid as *Pterygotrigla hemisticta* (Temminck & Schlegel 1843).
Paxton *et al.* 2006:928, In: Zoological Catalogue of Australia. Volume 35. Fishes..
**Synonymy:** *Prionotus alepis* Alcock, 1889; *Otohime hemisticta* (Temminck & Schlegel, 1843); *Trigla hemisticta* Temminck & Schlegel, 1843.

**Diagnostic characters (Based on 5 specimens 17.3–18.8cm TL):**

Head large, triangular, with many ridges and spines, but without a fissure on top behind eyes. HL 0.46-0.48 and HD 0.21-0.24 in SL. Opercular spine long. Snout longer than eye, no spines projecting in front, 0.3-0.32 and ED 0.22-

0.23 in HL. Pectoral and ventral moderate, PL 0.3-0.33 and VL 0.25-0.27 in SL. Pectoral fin with black area with diagonal band of separate white spots and 12 connected rays. Dorsal insertion more or less in same line vertical with pectoral. Inter dorsal space 0.32-0.33 in first dorsal base. Bases of first dorsal spines expanded into broad, flattened, bony plates, no spines or plates along base of second dorsal fin. Mostly red with prominent black spots and large black spot in first dorsal fin. Attains 30.0 cm TL.

**Geographical distribution (Previous records):** Indo-West Pacific: Yemen and Oman; then from southern Japan to Arafura Sea and Derby, Australia.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Demersal; depth range 10 - 420 m. In present study, 201-500 m.

**Order** : **Perciformes** (perch-like fishes)

**Sub Order** : **Percoidei**

**Family** : **Serranidae** (groupers, sea basses)

**Sub Family**: **Serraninae**

**Genus** ***Chelidoperca*** Boulenger 1895

***Chelidoperca*** Boulenger 1895, Catalogue of the perciform fishes in the British Museum. Second edition. v. 1: i-xix + 1-394, Pls. 1-15.
Heemstra & Randall 1999, Family Serranidae. In: Carpenter and Niem 1999.

Dorsal fin with X to XIII spines and 9 or 10 soft rays. No scaly flap of skin joining base of upper pectoral-fin rays to body; oblique scale series not more numerous than lateral-line scales; lateral line parallel to dorsal contour of body. Nostrils close together on rear half of snout; supramaxilla rudimentary or absent; maxilla naked. Branched caudal-fin rays 15.

*Chelidoperca investigatoris* (Alcock 1890)

(Plate XI, Fig. 108)

**Vernacular Name: Nil**

***Centropristis investigatoris,*** Alcock 1890, 199, Annals and Magazine of Natural History (Series 6) v. 6 (no. 33) Off Madras coast, India, 18°30'N, 84°46'E, Investigator station 96, depth 98-102 fathoms. Syntypes: ZSI F12820-21 (2).
Chelidoperca investigatoris, Boulnger, Cat. Perciform Fishes, 1.p.305
Menon & Rama-Rao 1975, Matsya No. 1: 31-48.
**Synonymy:** *Centropristis investigatoris* Alcock 1890

**Diagnostic characters (Based on 3 specimens 15.2-18.1cm TL):**

**B. 7; D.X, 10; A. III, 6; Lat. 42**

Dorsal and ventral profiles quite symmetrical. Height of body 3.3-3.6, HL 2.06-02.1 in SL. Head inclined to depression in its anterior half, deep, broad, and inflated in its branchial region, with operculum prolonged; scaly, except on snout and upper jaw. Snout depressed, rounded; equal to major diameter of eye. Eyes in their long diameter 4.6-4.7 in HL, IOW 0.33-0.34 in ED. Nostrils superior. Mouth wide, oblique; jaws strong; maxilla reaches vertical through posterior border of orbit. Preopercular border rounded and serrated throughout; gill-rakers tuberculate. Lateral line salient with very small scales. One dorsal, with its spinous and soft portions of equal extent. Caudal emarginated, with upper lobe longer, its basal half scaly; its length is about equal to that of pectoral, which is rather longer than postorbital portion of head. Ventrals subjugular, second ray almost as long as pectoral fin. Head and body bright pink, belly and throat white; a broad bright yellow band passes from tip of snout through eye to cudal fin; indefinite bright yellow markings on cheeks, opercles, and fins.

**Geographical distribution (Previous records):** Western Indian Ocean: Malabar coast.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** In present study, 201-500 m.

## Family: Priacanthidae (bigeyes)

**Key to Genera**

**1a.** D soft rays 12-14; scales above lateral line 16-20 ***Heteropriacanthus***

**1b.** Dorsal soft rays 10-15; scales above lateral line 8-11 ***Priacanthus***

### Genus : *Heteropriacanthus* Fitch & Crooke 1984

***Heteropriacanthus*** Fitch & Crooke 1984, Proceedings of the California Academy of Sciences (Series 4) v. 43 (no. 19): 301-315.
Starnes 2003, Priacanthidae (Pp. 1379-1385). In: Carpenter 2003 [ref. 27082]. The living marine resources of the Western Central Atlantic. v 3.

Scale rows between dorsal fin and lateral line at highest point fewer than 16; pelvic fins short, less than or equal to head length; soft dorsal and anal fins moderately long, broadly rounded to very broadly pointed.

*Heteropriacanthus cruentatus* (Lacepède 1801)

(Plate XI, Fig. 109)

**Vernacular Name:** Glasseye snapper

***cruentatus, Labrus*** Lacepede 1801:452, 522, Pl. 2 (fig. 3) [Histoire naturelle des poissons. v. 3; General area south of Scotts Head, Dominica, Lesser Antilles. Neotype: USNM 285473.
*Anthias boops* Schneider, in Bloch and Schneider, 1801: 308 (Atlantic Ocean near St. Helena). *Priacanthus boops:*Smith, SFSA No. 404.
Synonym of *Cookeolus boops* (Forster 1801) (Parin 2003, Zoological Catalogue of Australia. Volume 7 v. 7: i-xii + 1-665).
Valid as *Heteropriacanthus cruentatus* (Lacepède 1801) (Starnes 1988, Bulletin of Marine Science v. 43 (no. 2): 117-203.
Mundy 2005, Bishop Museum Bulletin in Zoology No. 6: 1-704.
**Synonymy:** *Cookeolus boops* Schneider, 1801

**Diagnostic characters (Based on 2 specimens 15.8-28.9 cm TL):**

**D. X, 12-13; A. III, 12-13; P. 17-19; LL. 54 to 59; Gr. (5-7)+(15-20)**

Body deep, compressed and somewhat oval in shape, BD 0.54-0.56 and DA 0.51-0.52 in SL. Head moderate, deeper than long, HL 0.43 and HD 0.5-0.52 in SL. Snout short, 0.24-0.25 in HL, 0.68 in ED. Eye bigger, 0.37 in HL. Dorsal origin just above or in front of pectoral and on a same line in vertical with ventral fin insertion, PrDL 0.31 in SL. Pectorals moderate, 0.24 in SL, ventrals elongated, equal to dorsal fin base, 0.63-0.64 in SL. Anal fin origin below seventh or eighth dorsal spine, 0.5-0.51 in DFB. Caudal truncate. Head and body reddish silver, paler ventrally; membrane of dorsal and anal dark anteriorly; ventral membrane blackish, rays pale. Attain 60 cm.

**Geographical distribution (Previous records):** Western Indian Ocean; Beira to Algoa Bat.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Reported from the depths of 100-400 m. In present study, 201-500 m.

## Genus: *Priacanthus* Oken 1817

***Priacanthus*** Oken (ex Cuvier) 1817, V Kl. Fische. Isis (Oken) v. 8 (no. 148): 1779-1782 [for 1179-1182 + [1182a]].
Paxton et al. 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Posterior portion of preopercle with scales; anterior profile more asymmetrical, extremity of lower jaw usually above level of midline of body; fins plain or with larger dusky spots.

*Priacanthus hamrur* (Forsskål 1775)

(Plate XI, Fig. 110)

**Vernacular Name:** Crescent-tail big eye, Moontail bullseye

***Sciaena hamrur,*** Forsskål 1775:45, xi [Descriptiones animalium quae in itinere ad Maris Australis terras per annos 1772 1773 et 1774 suscepto, Jidda, Saudi Arabia, Red Sea. Lectotype: ZMUC P4773 (dry skin). Paralectotypes: ZMUC P4774 (dry skin). Type catalog: Nielsen 1974:63. Spelled *hamruhr* in Cuvier & Valenciennes 1829:104. Types figured in

Klausewitz & Nielsen 1965:Pl. 11 Lectotype designated by Klausewitz & Nielsen 1965:18.
•Valid as *Priacanthus hamrur* (Forsskål 1775)
Mishra & Krishnan 2003, Records of the Zoological Survey of India. Miscellaneous Publication, Occasional Paper No. 216: 1-53.
Heemstra & Heemstra 2004, Coastal Fishes of Southern Africa.. i-xxiv + 1-488.
**Synonymy:** *Sciaena hamrur*, Forsskål 1775; *Sciaena hamrur, Anthias macrophthalmus, Boops asper*

**Diagnostic characters (Based on 12 specimens 11.3–32.2 cm TL):**

**D. X, 13-15; A. III, 13-16; P. 17-20; LL. 64 – 75; Gr. (3-5)+(18-20).**

Body relatively deep and compressed, depth contained about 0.41-0.43 and HL 0.33-0.34 in SL. Eyes very large; mouth large and oblique, tip of maxilla reaching to a vertical through front margin of pupil, spine at corner of preopercle short in adults. Posterior portion of preopercle above and below spine scaled, Soft portions of dorsal and anal fins rounded, ventral fins shorter than head, 0.83-0.84 in HL, joined to body by a membrane, caudal emarginated, becoming crescentic with age, scales small, ctenoid. Body crimson, dusky bars sometimes present, especially in young, fins dusky to blackish, being darker near margin, a black basal spot on dorsal surface of pelvic fin bases. Attains at least 45 cm.

**Geographical distribution (Previous records):** Throughout Indo-Pacific region (Red Sea possibly to Hawaii); Mozambique to Knysna. Frequently thrown up dead by cold water on Eastern Cape coast.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Demersal, Reef-associated; depth range 8-250 m. In present study, 201-500 m.

**Family : Nemipteridae** (false snappers, threadfin breams)

**Genus : *Parascolopsis*** Boulenger 1901

***Parascolopsis*** Boulenger 1901, Annals and Magazine of Natural History (Series 7) v. 7 (no. 39): 261-263, Pl. 6. [Also in Boulenger 1902 (24 May), J. Bombay Nat. Hist. Soc. v. 14:372-374, pl. Fem. *Parascolopsis townsendi* Boulenger 1901.
Allen et al. 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Suborbital naked, with a large backwardly pointing spine and a series of smaller spines or serrations on its posterior margin; posterior margin of preopercle coarsely denticulate or serrate; canine teeth absent. Scales on top of head reaching forward to or in front of middle of eyes; temporal parts of head scaled. Suborbital spine weak or absent; 4-6 transverse scale rows on preopercle. Body depth 2.5-3.0 in SL, canine teeth in jaws absent; second anal spine usually longer and more robust than third spine.

*Parascolopsis aspinosa* (Rao & Rao 1981)

(Plate XI, Fig. 111)

**Vernacular Name:** Smooth dwarf monocle bream

***Scolopsis aspinosa***, Rao & Rao 1981:134, Figs. 1, 3 [Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen (Series C, Biological and Medical Sciences) v. 84 (no. 1); Off Waltair, eastern coast of India, 17°42'N, 83°20'E, depth 20-25 meters. Holotype: RMNH 28192. Paratypes: BMNH 1979.12.18.1 (1); Zool. Mus. Andhra Univ (20). Additional material: NTMS 10823-001 (1), •Valid as *Parascolopsis aspinosa* (Rao & Rao 1981)
Manilo & Bogorodsky 2003, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy:** *Scolopsis aspinosa, Parascolopsis jonesi, Scolopsis jonesi*

**Diagnostic characters (Based on 3 specimens 7.3–10.2cm TL):**

**D. X, 9; A.III, 7; P. 15-16; Gr. 9-10**

Body moderately deep, BD 0.36-0.38 and DA 0.28-0.29 in SL with a convex dorsal profile and a short snout which is 0.18-0.2 in HL and 0.65-0.67 in ED. Eye large, 0.30-0.31 in HL. Head scales reaching forward to between level of anterior margin of eyes and posterior nostrils. Lower limb of preopercle naked. Posterior margin of suborbital smooth or with just a few tiny spines. Dorsal origin before pectoral (PrDL 0.31-0.33 in SL), continuous and unnotched. Pectoral reaching to anus 0.31-0.32 in SL, pelvic fins moderate, not reaching to anus, 0.21-0.23 in SL. Anal origin at posterior end of dorsal fin, AFB 0.3-0.31 in DFB. A black blotch at base of middle of dorsal fin. Body rosy-orange; anal fin rosy; pectoral fin yellowish with 2 rudimentary rays. Maximum length 10.2 cm.

**Geographical distribution (Previous records):** Northwestern Indian Ocean

**Distribution in the Southwest coast (Present study):** Between 07° and 11° N latitude.

**Depth:** Demersal; non-migratory; marine; depth range 150-300 m. In present study, 201-500 m.

**Family : Bathyclupeidae** (deepsea herrings)

**Genus : *Bathyclupea*** Alcock 1891

***Bathyclupea*** Alcock 1891, Annals and Magazine of Natural History (Series 6) v. 8 (no. 43/44): 16-34 (1 July); 119-138 (1 Aug.), Pls. 7-8. Fem. *Bathyclupea hoskynii* Alcock 1891 Type by monotypy. •Valid as *Bathyclupea* Alcock 1891
Paxton et al., 2006, Sillaginidae (pp. 1121-1125), Bathyclupeidae (1281). In: Zoological Catalogue of Australia. Volume 35. Fishes.

Spineless dorsal fin in posterior half of body Long anal fin with a single spine. Dorsal and anal fins with scales. Mouth bordered by maxillae and premaxillae. Vertebrae usually 31 (10 + 21). Dorsal fin with 1 spine and 8 to 10 soft rays; anal fin with 1 spine and 24 to 39 soft rays; pectoral fin with 26 to 30 rays.

*Bathyclupea hoskynii* Alcock 1891

(Plate XI, Fig. 112)

**Vernacular Name: Nil**

*Bathyclupea hoskynii* Alcock, 1891 *Ann. Mag. Nat. Hist.*, (6) 8, p. 131, fig. 4 (type locality Andaman Sea, 11o31'40" N., 92o 46'6" E., 188-220 fms., 13.3oC.)
*Bathyclupea hoskynii* Alcock, 1900. *Ill. Zool. Investig. Fish.*, pl.28, fig.2.
*Bathyclupea hoskynii* Misra, 1953. *Rec. Indian Mus.*, 50, p. 407 fig. 22 c.
Manilo & Bogorodsky 2003, Journal of Ichthyology v 43 (suppl. 1): S75-S149.
**Synonymy: Nil**

**Diagnostic characters (Based on 3 specimens 12.8-27.3cm TL):**

**B. 7; D. 10; P.29; V.6; A.33; Lat. 38-42**

Body oblong, compressd, scaly; abdomen neither keeled nor serrated; dorsal profile horizontal, ventral concave; depth 3.1 in standard length. Head compressed, naked, 3.0 in SL. Eyes 2.9 in head, 0.8 in rectangular snout. Interorbital flat, half eye diameter. Cleft of mouth wide, obliqe. Opercular bones well developed. Preopercle partly serrated in horizontal part. A single rayed dorsal fin, nearly equal to snout; origin nearly in middle of TL and about a snout length behind anal origin. Pectorals long, 1.1 in head extending beyond anal origin. Pelvics small, subjugular, close together, 2.1 in ED. Anal long; origin nearer to pectoral base than to caudal origin; base 2.6 in TL. Caudal forked, 1.9 in HL. Lateral line distinct, almost straight. Scales large, cycloid, desiduous, except on lateral line. Middle gill rakers on outer side of first gill arch much elongated. Silvery grey becoming black along back.

**Geographical distribution (Previous records):** Andaman Sea 14°13' N., 93°40' E., 11°31'40" N., 92°46'6" E., 13.3°C., off Madrass coast, 13°51'12" N., 80°28'12" E.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N latitude.

**Depth:** Depth range 272-766 m. In present study, 201-800 m.

**Family : Epigonidae** (deepwater cardinalfishes)

**Genus : *Epigonus*** Rafinesque 1810

***Epigonus*** Rafinesque 1810, Indice d'ittiologia siciliana; ossia, catalogo metodico dei nomi latini, italiani, e siciliani dei pesci, 1-70, Pls. 1-2. Masc. *Epigonus macrophthalmus* Rafinesque 1810.
Ida et al. 2007, Ichthyological Research v 54 (no. 2): 131-136.

Maxilla reaching well beyond vertical through anterior margin of eye; gill rakers on lower limb of first arch 14 or more; branchiostegal rays 7 Orbital edge of infraorbitals 1 to 4 smooth. Soft dorsal and anal fins covered with scales. A single opercular spine, weak to strong; first dorsal-fin spines 7 or 8; anal fin with II spines and 9 (rarely 8 or 10) soft rays.

*Epigonus pandionis* (Goode & Bean 1881)

(Plate XI, Fig. 113)

**Vernacular Name:** Black Mullet, Bigeye

*Apogon pandionis* Goode and Bean, 1881: 160 (off Chesapeake Bay, Virginia, USA). *Epigonus telescopus* (non. Risso): Poll, 1954: 89. *Epigonus pandionis*: Mayer, 1974: 163. McEachran & Fechhelm 2005, Fishes of the Gulf of Mexico. Volume 2: Scorpaeniformes to Tetraodontiformes. University of Texas Press, Austin. i-viii +1-1004

**Synonymy:** *Apogon pandionis* Goode and Bean, 1881

**Diagnostic characters (Based on 3 specimens 7.9-9.2 cm TL):**

**D. VII,I, 10; A. II, 9; P. 17-19; LL. 46-49; Gr. 8-10, 18-23**

Small fish with fusiform body, depth 3.4-4.8, head 2.6-3.5, peduncle length 3.8-5.0, interorbital 8.7-11.6, all in SL, eye 2.0-2.7 in head. Small specimens (<8cm SL) with 1 row of teeth on jaws and palatines with increased number of tooth rows on jaws and palatines; vomerine patch cover entire bone surface; 2-5 poorly ossified projections dorsally to opercular spine; chin nubs absent. A dark band on peduncle and a thin black ring on central part of peduncle. Gill raker and gill chamber black; fins dark. Attains 20 cm.

**Geographical distribution (Previous records):** Western Atlantic: New Jersey, USA and the northern Gulf of Mexico to northeastern South America. Eastern Atlantic: Gulf of Guinea to Agulhas Bank.

**Distribution in the Southwest coast (Present study):** Between 09° and 13° N latitude.

**Depth:** Recorded depth range 200-600 m. In present study, 201-500 m.

**Family : Pentacerotidae** (armorheads, boarfishes)

**Genus : *Histiopterus*** Temminck & Schlegel 1844

***Histiopterus*** Temminck & Schlegel 1844, Fauna Japonica, sive descriptio animalium quae in itinere per Japoniam Parts 5-6: 73-112.
Bray et al. 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Body oblong-oval, compressed. Bones of head mostly exposed, rugose, covered with small spines and knobs in small juveniles. Dorsal fin continuous, with 4 to 14 spines and 9 to 27 soft rays; anal fin with 3 to 6 spines and 7 to 10 soft rays; caudal fin truncate to slightly emarginate; pelvic fins with 1 spine and 5 rays. Scales ctenoid, small to moderate. Dorsal fin with 4 spines and 25 to 27 soft rays.

*Histiopterus typus* Temminck and Schlegel 1844

(Plate XI, Fig. 114)

**Vernacular Name:** Sailfin armourhead

***Histiopterus typus,*** Temminck & Schlegel 1844:86, Pl. 45 [Fauna Japonica, sive descriptio animalium quae in itinere per Japoniam Parts 5-6; Nagasaki, Japan. Lectotype: RMNH 422. Paralectotypes: ?RMNH D543 (1, stuffed). Lectotype designated by Boeseman 1947:86.
•Valid as *Histiopterus typus* Temminck & Schlegel 1844
Shinohara *et al.* 2005, Memoirs of the National Science Musuem Tokyo No. 29: 385-452
Bray *et al.* 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Histiopterus spinifer*

**Diagnostic characters (Based on 1 specimen 26.9 cm TL):**

**D. IV, 25-27; A. III, 8-10; P. 16-17; LL. 60-65; GR. (5-7)+(14-17).**

Body somewhat triangular in shape, depth much greater than HL (1.24-1.26), 0.57-0.59 and HD 0.44-0.45 in SL. Chin with a patch of fine barbells or papillae, fine teeth in bands in jaws, none on palate. Dorsal profile of head sharp; steeper towards snout. Snout moderate, 0.37-0.39; Eyes more or less equal to snout length, ED 0.35-0.36 in HL. Dorsal very high, sail-like, first two spines short, 3$^{rd}$ and 4$^{th}$ much enlarged, longer than head, 1.03-1.04, subequal to first dorsal soft ray Pectorals and ventral tips reaching well beyond anus and ventral especially reaching almost posterior ends of dorsal and anal fins, PL 0.34-0.35 and VL 0.41-0.42 in SL. Body dark, with more or less distinct pale vertical bands. Attains 35 cm.

**Geographical distribution (Previous records):** Indo-West Pacific. North-western Arabian sea from the Gulf to Oman to Glf of Aden and lower part of Red Sea; also off South Africa from Cap Agalhas to Natal. Elsewhere off Korea, Philippines and Japan.

**Distribution in the Southwest coast (Present study):** Between 09° and 11° N latitude.

**Depth:** Previous records from 40-400 m. In present study, 501-800 m.

**Family** : **Cepolidae** (red bandfishes)

**Sub Family** : **Owstoniinae**

**Genus** ***Owstonia*** Tanaka 1908

***Owstonia*** Tanaka 1908, Journal of the College of Science. Imperial University, Tokyo v. 23 (art. 7): 1-54, Pls. 1-4. Fem. *Owstonia totomiensis* Tanaka 1908.
Smith-Vaniz 2001, Family Cepolidae. In: Carpenter & Niem 2001

Compressed, tapering body and lanceolate caudal fin. Mouth large, oblique; eyes relatively large and high on head; a single row of slender, slightly curved teeth in jaws. Dorsal fin continuous, last ray of dorsal and anal fins not connected to caudal fin by a membrane; total dorsal fin elements 24 or 25. Anal fin with 0 or 1 spine and 13 to 102 segmented rays; pelvic fins positioned below or slightly anterior to pectoral fins. Lateral line high on body, close to dorsal-fin base, terminating posteriorly near end of fin; lateral-line tubes or canals mostly embedded in skin.

*Owstonia simoterus* (Smith 1968)

(Plate XI, Fig. 115)

**Vernacular Name: Nil**

***Sphenanthias simoterus***, Smith 1968:11, Fig. 1; Pl. 6 (fig. C). Investigational Report. Oceanographic Research Institute Durban No. 19. Off Bazaruto, southern Mozambique, depth 260-300 fathoms. Holotype (unique): SAIAB [formerly RUSI] 605. •Valid as *Owstonia simoterus* (Smith 1968).
Smith-Vaniz 1986, Family No. 226: Cepolidae (pp. 727-728). In: Smiths' Sea Fishes (Smith & Heemstra 1986).
**Synonymy:** *Sphenanthias simoterus* Smith 1968

**Diagnostic characters (Based on 2 specimens 34.7-38.6 cm TL):**

**D. III, 21; A. I, 14; Scales in longitudinal series about 70**;

Body elongated, moderately compressed and is tapering towards tail, BD 0.31-0.32 and DA 0.25-0.27 in SL. Head moderate, its depth 0.23-0.25 and its length 0.24-0.26 in SL. Snout very short, 0.26-0.27 in ED and 0.09-0.1 in HL. Eyes much large compared to snout and is 0.36-0.37 in HL. Cheek scale rows 12. Dorsal fin origin before pectorals, PrDL 0.22-0.24 in SL. Pectoral and ventral fins reaching anal origin, later reaching beyond it. The caudal fin tapering and elongated, 0.38-0.4 in TL. Body and fins red or crimson; membrane between premaxilla and maxilla black. Attains 40 cm.

**Geographical distribution (Previous records):** Off South Africa from Cap Agalhas to Natal.

**Distribution in the Southwest coast (Present study):** Between 9° and 11° N Latitudes.

**Depth:** Recorded from the depth 475 – 500 m. In present study, also 201-500 m.

**Family : Acropomatidae**

Body oblong, more or less compressed. Mouth terminal; lower jaw slightly projecting; maxillae not covered by preorbitals; eye large; small teeth on jaws, and on roof of mouth (vomer and palatines); canines in jaws of most species; branchiostegal rays 7 Dorsal fin divided to base before last spine, or completely separated into spiny and soft-rayed fins; anal fin with 2 or 3 weak spines and 6 to 8 soft rays; pelvic fins with 1 spine and 5 soft rays, without a large axillary process of fused scales; caudal fin emarginate to deeply forked.

**Key to Genera**

**1a.** Anus nearer to ventral origin than anal fin; luminiscent organ between ventral fin **Acropoma**

**1b.** Anus much nearer anal fin than to ventral fin; no light organ between ventral fins ***Synagrops***

**Genus : *Acropoma*** Temminck & Schlegel 1843

***Acropoma*** Temminck & Schlegel 1843, Fauna Japonica, sive descriptio animalium quae in itinere per Japoniam Parts 2-4: 21-72.
Paxton et al. 2006. In: Zoological Catalogue of Australia. Volume 35. Fishes.
Yamanoue & Toda 2008, Ichthyological Research v. 55: 198-201

Body oblong, more or less compressed. Two canines at front of upper jaw, between which fits a pair of smaller canines at front of lower jaw; sides of lower jaw with a row of tiny slender teeth and several small canines; a narrow band of small, sharp teeth on front half of upper jaw, becoming broader posteriorly while teeth become smaller; Anus nearer pelvic fin origins than to anal fin; luminescent organ between pelvic fins.

*Acropoma japonicum* Günther 1859

(Plate XI, Fig. 116)

**Vernacular Name:** Lanternbelly

*Acropoma japonicum* Gunther, 1859: 250 (based on *Acropoma* Temminck and Schlegel, 1843: 31, pl. 12, Figs. 2 and 3; Japan)
Smith, SFSA No. 499. *Synagrops splendens* Lloyd, 1909: 159, pl. 47, Fig. 5 (Gulf of Oman).
Youn 2002, Fishes of Korea, with pictorial key and systematic list. 2002: 1-747
Yamanoue & Toda 2008, Ichthyological Research v. 55: 198-201.
**Synonymy:** Nil

**Diagnostic characters (Based on 3 specimens 12.4-15.9 cm TL):**

**D. VIII-IX+I, 10; A. III, 7; P. 15-16; LL. 43-45; GR. (5-8)+(15-18).**

Small sized fish, body oblong, BD more or less equal to HL, 0.52-0.53 in SL. Head moderate, its depth 0.7-0.71 in its length. Snout short, less than ED, PrOL 0.26-0.27 and ED 0.29-0.30 in HL. Eye diameter equal to anal fin base. Two large canines at front of aperture, between which fits a pair of smaller canines at front of lower jaw; sides of lower jaw with 6 or 7 small, spaced cannines, preceded by a row of tiny slender teeth; vomer and palatine with villiform teeth. Dorsal origin in anterior half of body, PrDL 0.38-0.4 in SL. The space between first and second dorsal fin base is equal to 0.56-0.57 in AFB. Light reflector a white, opalescent, opaque membrane extending from isthmus to caudal base. Scales ctenoid, more or less deciduous. Body pink; ventral surface abruptly silver and thickly covered with small dark spots. Attains 20 cm.

**Geographical distribution (Previous records):** Off Natal; also northern Indian Ocean, Philippines and Japan.

**Distribution in the Southwest coast (Present study):** Between 9° and 11° N Latitudes.

**Depth:** Recorded from 200-500 m. In present study, also 201-500 m.

**Genus : *Synagrops*** Günther 1887

***Synagrops*** Günther 1887, Masc. *Melanostoma japonicum* Döderlein 1883.
Prokofiev 2007 Journal of Ichthyology v. 47 (no. 6): 413-426.

Body depth distinctly less than head length, contained 3.2 to 4.8 times in standard length; anal fin with 2 or 3 spines and 6 to 9 soft rays; preopercle with at least a few serrae. Anal fin with 2 spines; lateral line scales 24 to 33.

*Synagrops philippinensis* (Günther 1880)

**Vernacular Name:** Nil

*Acropoma philippinense* Gunther, 1894. Challenger shore fishes, p. 51, Alcock, 1894. Journ. As.Soc. Bangal, vol. LXII. Pt. 2, p.116; Parascombrops pellucida, Alcock, 1899. Journ. As.

Soc. Bangal, Vol. LVIII. Pt. 2, p. 296, pl.xxii. fig.1; Synagrops philippinensis, Illustrations of the zoology of the investigator, fishes, pl. XXVIII. Fig. 1
Shinohara et al. 2005, Memoirs of the National Science Musuem Tokyo No. 29: 385-452.
Manilo & Bogorodsky 2003, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.

**Synonymy:**

**Diagnostic characters (Based on 5 specimens 11.3-16 cm TL):**

**B. 7; D. IX, I, 9; A.II.7; Lat. 28**

Body compressed, its greatest height between 0.33-0.35 in SL. Head, prominent, 0.24-0.26 in SL. Compressed, muciferous cavities of its vertex well developed and bounded by numerous low sharp crests, most of which are oblique: in skin covering vertex of head numerous tiny scales are embedded and almost concealed. Snout short, lower jaw prominent. Eye of good size, ED equal to LHCP, 0.28-0.29 in BD and 0.86-0.88 in IOW. Mouth-cleft wide, very oblique; maxilla reaching a little behind middle of pupil. The angle of lower limb of outer border of preoperculum strongly serrated, angle of inner border with three small spines. The dorsal fins are separated by an interspace equal to three-fourths length of eye: third spine longest and is equal to two-thirds of body height. Second anal spine as long as eye. Caudal forked. Ventrals long, spine long, outer edge closely and evenly serrated. Transparent light brown suffused woth pink from blood velssels, opercular and visceral regions like burnished silver

**Geographical distribution (Previous records):** Common in Bay of Bangal.

**Distribution in the Southwest coast (Present study):** Between 9° and 11° N Latitudes.

**Depth:** In present study, 201-500 m.

*Synagrops japonicus* (Döderlein 1883)

(Plate XI, Fig. 117)

**Vernacular Name:** Japanese splitfin

*Melanostoma japonicum* Doderlein, in Steindachnr and Doderlein, 1884: 5 Pl. I, Fig. 2 (Tokyo). *Synagrops natalensis* Gilchrist, 1921: 69 (off Natal). *Synagrops japonicus*: Smith, SFSA No. 473; smith, 1961: 413.
Paxton et al. 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Synagrops natalensis*, Gilchrist 1922

**Diagnostic characters (Based on 7 specimens 14.9-22.8 cm TL):**

**B. 6; D. IX,I, 9-10; A. II, 7-8; P. 16-17; LL. 28-30; Gr. 3+12.**

Body compressed, its greatest height between 0.28-0.29 in SL. Head 0.32-0.34 in SL, compressed, muciferous cavities of its vertex well developed. Snout short, 0.19 in HL, lower jaw prominent, 0.16-0.18 in HL. Eye of good size, its major diameter 0.28-0.29 in HL and is more or less equal to inter orbital width. Mouth-cleft wide, very oblique; maxilla reaching a little behind middle of pupil. Band of villiform teeth on upper jaw, separated by a gap at symphysis, with a canine on each side of this gap; lower jaw with narrow band of small teeth anteriorly, 3-5 canines laterally, and a pair of retrorse canines at symphysis. No fin spines serrate. Preopercle ridge smooth; suborpercle and interopercle with strong serrae. The dorsal fins are separated by an interspace almost equal to eye diameter. Caudal forked. Ventrals long, 2/3 of distance to anal; spine long, outer edge closely and evenly serrated. Head, body and fins brownish black; pectorals pale. Attains 30 cm.

**Geographical distribution (Previous records):** Widely distributed from South Africa to Hawaii; caught off Natal.

**Distribution in the Southwest coast (Present study):** Between 7° and 11° N Latitudes.

**Depth:** Recorded depth 180-400 m. In present study, 201-500 m.

**Sub Order : Stromateoidei** (butterfishes, harvestfishes)

**Family : Centrolophidae** (medusafishes, pompiles, rudderfishes)

**Genus : *Psenopsis*** Gill 1862

***Psenopsis*** Gill 1862, Proceedings of the Academy of Natural Sciences of Philadelphia v. 14: 124-127 Fem. *Trachinotus anomalus* Temminck & Schlegel 1844. Type by monotypy. •Valid as *Psenopsis* Gill 1862.
Hoese & Bray 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Slender to deep, usually somewhat compressed stromateoid fishes. Adipose tissue around or ahead of eyes developed conspicuously. Five to 7 dorsal spines, sometimes quite weak, increasing slightly in length posteriorly; dorsal fin rays 25 to 40, anal fin rays 18 to 30; insertion of pelvic fins before or just under insertion of pectorals; preopercular margin entire or finely denticulate; adipose tissue around and in front of eye well developed; sclerotic bones well ossified; golden iris appearing divided by a vertical bar; supramaxillary bone absent; scales very deciduous; lateral line following dorsal profile

*Psenopsis cyanea* (Alcock 1890)

(Plate XI, Fig. 118)

**Vernacular Name:** Nil

***cyanea, Bathyseriola*** Alcock 1890, Annals and Magazine of Natural History (Series 6) v. 6 (no. 33). Off Madras coast, India, 18°30'N, 84°46'E, Investigator station 96, depth 98-102 fathoms. Syntypes: BMNH 1890.11.28.9 [ex ZSI] (1), ZSI F12816-12817 and 12819 (4).
Parin & Piotrovsky 2004, Journal of Ichthyology v. 44, Suppl. 1 S33-S62.
**Synonymy:** Nil

**Diagnostic characters (Based on 15 specimens 11.6-18.7 cm TL):**

**D. VI, 26-18; A. III- IV, 21-23; P. 16-20**

Body laterally compressed, dorsal profile slightly convex, BD 0.30-0.35, HD 0.24-0.28 and DA 0.28-0.31 in SL. Snout blunt, 0.23-0.26 and eye diameter 0.16-0.18 in HL. Dorsal originating behind pectoral fin insertion and pelvic fins originating in front of pectoral fin insertion and folding into a prominent groove. PrDL 0.3-0.35, PL 0.2-0.23 and VL 0.11-0.14 in SL. Anal fin origin little behind dorsal fin origin, PrAL 0.46-0.5 in SL. Scales very small and deciduous. Caudal peduncle short and compressed, without keels or scutes. Generally uniform brownish to violet, with a darker head and often with a spot on shoulder. Attains 20 cm.

**Geographical distribution (Previous records):** Western Indian Ocean

**Distribution in the Southwest coast (Present study):** Between 07° and 15°N latitude.

**Depth:** In present study, 201-800 m.

**Family : Nomeidae** (driftfishes, man-of-war fishes, shepherdfishes)

Slender to deep, laterally compressed fishes, caudal peduncle deep. Adipose tissue around eyes developed in most species. 6 branchiostegal rays, Small teeth also present on vomer, palatines (roof of mouth), on basibranchials and sometimes on tongue. Two dorsal fins. pectoral fins becoming long and wing-like with growth, their bases inclined about 45°; pelvic fins attached to abdomen by a thin membrane and folding into a narrow groove, Caudal fin forked, lobes often folded to overlap one another.

**1a.** Body depth usually less than 35% of standard length, greatest in small specimens; origin of dorsal fin behind,or directly over (in small specimens), insertion of pectoral fins ***Cubiceps***

**1b.** Body depth usually greater than 40% of standard length, although it can be reduced to 17% of standard length in very large specimens); origin of dorsal fin before, or directly over, insertion of pectoral ***Psenes***

## Genus : *Cubiceps* Lowe 1843

***Cubiceps*** Lowe 1843, Ann. Mag. Nat. Hist. 1844, v. 13: 390-403.
Jordan & Evermann 1896, Bulletin of the United States National Museum No. 47· i-lx + 1-1240.
Doiuchi et al. 2004, Ichthyological Research v. 51: 202-212.

Body elongate, maximum depth usually less than 35% of standard length, greatest in small specimens; origin of dorsal fin behind, or directly over (in small specimens), insertion of pectoral fins; scales on top of head extending forward of eyes. Anal fin with 1 to 3 spines and 14 to 25 segmented rays; insertion of pelvic fins under end of, or posterior to pectoral fins base; teeth on tongue, knob-like or pointed.

**Key to species**

1a. Maxilla reaching to under anterior part of eye; pelvic fins long, 0.21-0.24 in SL ***C. pauciradiatus***

1b. Maxilla reaching till mid line of eye; pelvic fin short, 0.15-0.18 in SL ***C. squamiceps***

*Cubiceps pauciradiatus* Günther 1872

(Plate XI, Fig. 119)

**Vernacular Name:** Bigeye cigarfish, Longfin fathead

*Cubiceps pauciradiatus* Gunther, 1872: 418 (Misol Id.); Haedrich, 1967· 81, 1972: 79; Ahlstrom *et al.*, 1976: 346; Butler, 1979: 236. *Cubiceps longimanus* Fowler, 1934. 442, Fig. 23 (Durban). *Cubiceps brevimanus*: Smith, SFSA No. 857; 1949: 850.
Mundy 2005, Bishop Museum Bulletin in Zoology No. 6: 1-704.
**Synonymy:** *Cubiceps athenae* Haedrich, 1965; *Cubiceps longimanus* Fowler, 1934

**Diagnostic characters (Based on 7 specimens 10.8-15.7 cm TL):**

**D. X-XI,I, 15-17; A. II, 14-16; P. 17-20; Lat. 49-53; Gr. (7-9)+(16-19)**

Body moderately slender, compressed, BD 0.23-0.28, HL 0.27-0.32 in TL. Caudal peduncle broad, 0.08-0.09 in SL. Eye large, equal to snout and inter orbital width, 0.26 in HL. Mouth slightly oblique, its posterior end reaching mid line of eye. Teeth on roof of mouth and tongue in broad knobby patches. Head length equal to PrDL, 0.32-0.34 in SL. A conspicuous thin bony keel on breast. Pectorals elongate, 0.26-0.29 in SL and is equal to depth at anus. Ventral fin length 0.15-0.18 in SL. Caudal peduncle length 0.11-0.13 and least height of caudal peduncle 0.08-0.09 in SL. Light tan to brown; caudal dusky but other fins clear. Attains 20 cm.

**Geographical distribution (Previous records):** Atlantic, Pacific and Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 07° and 11° N latitude.

**Depth:** In present study, 201-500 m.

*Cubiceps squamiceps* (Lloyd, 1909)

(Plate XI, Fig. 120)

**Vernacular Name:** chunky fathead, chunky fathead

***Mulichthys squamiceps***, Lloyd 1909:158 [Memoirs of the Indian Museum v. 2 (no. 3 Arabian Sea, 20°15'N, 69°08'28"E, Investigator station 305, depth 512 fathoms. Holotype (unique): ZSI F1020/1

Haedrich 1967, Bulletin of the Museum of Comparative Zoology v. 135 (no. 2): 31-139.

Shinohara et al. 2005, Memoirs of the National Science Musuem Tokyo No. 29: 385-452.

**Synonymy**: *Cubiceps natalensis* Gilchrist and von Bonde, 1923; *Cubiceps squamiceps* Lloyd, 1909; *Mulichthys squamiceps* Lloyd, 1909.

**Diagnostic characters (Based on 16 specimens 12.8–18.9 cm TL):**

**B. 6; D. XI-XII,17-19; A. II-III,17-20; P. 18-20; Gr. (6-9)+(16-19); LL 62-66**

Body moderately elongate, compressed, chunky-looking, HD 0.3-0.33 and HL 0.32-0.35 in SL. Snout blunt and broad, PrOL 0.25-0.28 in HL. Mouth fairly small, maxilla only reaching to under anterior part of eye. Eye large, diameter about equal to length of snout and a little smaller than interorbital width. ED 0.24-0.26 in HL. Opercles thin and smooth-edged. First dorsal fin originating directly over insertion of pectoral fins, PrDL 0.33 in SL and second dorsal originating behind mid-body. Pectoral wing like and equal to PrDL and subequl to head, its base almost horizontal. Pelvic fins long, originating directly under posterior end of pectoral fin base, reaching to anus and folding into a conspicuous groove, 0.21-0.24 in SL. Caudal fin forked, but two lobes commonly folded over one another. Scales fairly small, cycloid (smooth), easily shed, also present on cheeks. Caudal peduncle somewhat deep and compressed, without keels or scutes. Silvery, darker on back than on sides, inside of opercle dark.

**Geographical distribution (Previous records):** Reported from Indian Ocean, and Australian waters.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** Depth range of 300-400 m. In present study, 201-500 m.

## Genus : *Psenes* Valenciennes 1833

***Psenes*** Valenciennes in Cuvier & Valenciennes 1833, Histoire naturelle des poissons. v 9: i-xxix + 3 pp. + 1-512, Pls. 246-279.
Parin & Piotrovsky 2004, Journal of Ichthyology v. 44, Suppl. 1. S33-S62.

### *Psenes cyanophrys* Valenciennes 1833

**Vernacular Name:** Freckled driftfish

***Psenes cyanophrys*****,** Valenciennes in Cuvier & Valenciennes 1833:260, Pl. 265. Histoire naturelle des poissons. v 9; New Ireland Island, Bismarck Archipelago. Holotype (unique): MNHN A-6852. Type catalog: Le Danois 1962:229. Valid as *Psenes cyanophrys* Valenciennes 1833.
Nelson et al. 2004, American Fisheries Society, Special Publ. 29. Bethesda, Maryland. Committee Scient. Names Fishes U.S. Canada Mexico Sixth Ed.. 1-386.
Hoese & Bray 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy**: *Cubiceps multiradiatus, Psenes auratus, Psenes chapmani*

**Diagnostic characters (Based on 1 specimens 16.3 cm TL):**

**B. 6; D. XI, 26; A. III, 24; P. 19; Gr. 9+20**

Body deep, maximum depth 0.42 in SL. Snout blunt, 0.76 in HL. HL 0.24 in TL. Origin of dorsal fin before insertion of pectoral fins; no scales on top of head in front of eyes. Teeth in lower jaw conical and slightly recurved, similar to those in upper jaw. Scales on top of head of 2 distinct sizes, anterior scales very small and extending forward to nostrils, boundary between patches sharply demarcated from each other above front half of eye. Second dorsal and anal fins higher than spinous dorsal; tail fin forked with somewhat rounded lobes; scales very tiny. Yellowish with dark longitudinal lines on side.

**Geographical distribution (Previous records):** Atlantic, Indian and Pacific. Western Atlantic: Massachusetts, USA and northern Gulf of Mexico to South America. Reported from southern Africa.

**Distribution in the Southwest coast (Present study):** Between 07$^{\circ}$ and 9$^{\circ}$ N latitude.

**Depth:** Bathypelagic, depth range 20-550 m. In present study, 201-500 m.

**Sub Order : Trachinoidei** (stargazers, vives, weevers)

**Family : Percophidae** (flatheads, flatnoses)

**Sub Family: Bembropinae**

**Genus : *Bembrops*** Steindachner 1876

***Bembrops*** Steindachner 1876, Mathematisch-Naturwissenschaftliche Classe v. 74 (1 Abth.): 49-240, Pls. 1-15.
Thompson 2003, In:Carpenter 2003. The living marine resources of the Western Central Atlantic. v.3.
Hoese & Bray 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Elongate benthic fishes. Head depressed anteriorly, snout flat and broad, resembling a duck's bill; mouth large, lower jaw projecting in front of upper; maxilla exposed; eyes large, space between them very narrow; 2 spines on opercle, one on subopercle. Two separate dorsal fins; pelvic fins inserted well in advance of pectorals; anal fin lack spines. Scales on body ctenoid; lateral line curves below first dorsal fin to below middle of side. Triangular flap of skin on rear end of maxilla.

*Bembrops caudimacula* Steindachner 1876

(Plate XI, Fig. 121)

**Vernacular Name:** Opal fish

*Bembrops caudimacula,* Steindachner, SB. Ak. Wien. LXXIV 1877, i.p.211.
Alcock, Journ. As.Soc. Bengal, Vol. LXIII. 1894, pt. 2, p.118.
Bathypercis platyrhynchus, Alcock, J.A.S.B. Vol. LXII. Pt. 2, 1893, p. 177, pl. ix. Fig. 1
Bembrops platyrhynchus, Alcock, J.A.S.B. Vol. LXIII. Pt.. 2, 1894, p.118: Illustrations of the Zoology of the Investigator, fishes, pl. XX. Fig. 6
Hoese & Bray 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy**: Nil

**Diagnostic characters (Based on 7 specimens 17.1-19.9 cm TL):**

**B.7; D. VI.14-15; A. 16-17; P. 28-29; V.I.5**

Head large, broad, depressed, HL 0.4-0.43 and HD 0.1-0.11 in SL. Body elongate, cylindrical, low, and tapering to large caudal, BD 0.31 in SL. Snout broad, much depressed, and spatulate, a little more than eye diameter PrOL 0.26-0.28 and ED 0.24-0.26. Mouth-cleft wide, slightly oblique, maxilla reaching nearly to vertical through middle of eye, and ending in a fleshy horizontally-disposed barbell. Teeth in villiform bands on jaws, vomer, and palatines. Operculum has two spines above, and one belonging to suboperculum below. Body, and head and snout above, are covered with rather large cycloid or finely ctenoid scales. First dorsal fin short, and separated from second by four or five rows of scales. Anal fin similar to second dorsal. Pectorals large and long and reach to, or even beyond, origin of anal. Ventral insertion an eye-length in front of pectorals and reach half-way to anal. Yellowish brown with thirteen incomplete and indefinite darker cross-bands: a golden-green ocellus on crown of head and one in apex of each opercle, but all these ocelli tend to fade away: spinous dorsal white at base, black in upper half.

**Geographical distribution (Previous records):** Western and Eastern Indian Ocean.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N latitude.

**Depth:** In present study, 201-800m.

**Family : Uranoscopidae** (stargazers, uranoscopes)

Body thick, compressed posteriorly, naked or with small scales. Head very large, bony and heavy; eyes dorsal; mouth large, vertical; lower jaw heavy, projecting; upper jaw protrusile; maxillaries exposed, with supramaxilla; small teeth in jaws, vomer and on palatines (roof of mouth); gill membranes widely separated, with 6 branchiostegal rays. Spinous dorsal fin small or absent, or continuous with soft-rayed part of fin; soft dorsal and anal fins similar, opposite; pelvic fins on isthmus, well in front of pectorals, with 1 short spine and 5 rays.

**Key to Genera**

**1a.** Dorsal fin origin near to pectoral base ***Uranoscopus***

**1b.** Dorsal fin origin far behind body ***Xenocephalus***

**Genus :** *Uranoscopus* Linnaeus 1758

***Uranoscopus*** Linnaeus 1758, Systema Naturae, Ed. X. v 1: i-ii + 1-824
Parin 2003, Voprosy Ikhtiologii v. 43 (suppl. 1): S1-S40.

*Uranoscopus crassiceps* Alcock 1890

(Plate XII, Fig. 122)

**Vernacular Name:** Nil

***Uranoscopus crassiceps,*** Alcock 1890, Annals and Magazine of Natural History (Series 6) v. 6 (no. 33). Off Madras coast, India, 18°30'N, 84°46'E, Investigator station 96, depth 98-102 fathoms. Syntypes: (about 25) BMNH 1890.11.28-5-8 [ex ZSI F12794-96 and 99] (4), MNHN 1890-0324 to 0326 (3), ZSI F12788 (1).
Pietsch 1989, Copeia 1989 (no. 2): 253-303.
**Synonymy**: Nil

**Diagnostic characters (Based on 8 specimens 09.8-15.3 cm TL):**

**B.6; D.IV 1/13; A. 13; P. 18; V. I.5**

Length of head about 0.62-0.66 of SL, its maximum breadth in repose (that is, when opercles are not expanded for defense) is 0.65-0.69 in TL, its greatest height is 0.23-0.26 SL. Bones of head rugose: antero-inferior angle of preorbital produced and sub acute: a spine on lower border of suboperculum and 4 or 5 along lower border of preoperculum. Two small coarse spines or tubercles on supra-clavicular region: clavicular spine about as long as major diameter of orbit. Points of pubic bones project as a pair of spines between clavicular symphysis. Eye 0.14-0.17 HL. Lips rather fleshy, papillated, especially lower lip. A large prelingual filament, more than two-fifths length of head. No scales on throat and belly. Back dirty greenish, below marbled with lighter shades, belly silvery whitey, first dorsal black.

**Geographical distribution (Previous records):** Coromandel Coast 128 fathoms and off Malabar Coast.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Depth ranged from 68 to 148 fathoms. In present study, 501-800 m.

### Genus : *Xenocephalus* Kaup 1858

***Xenocephalus*** Kaup 1858, Archiv für Naturgeschichte v. 24 (no. 1): 85-93.
Kishimoto 2001, Species identification guide for fishery purposes. Bony fishes part 4. v. 6: 3519-3531.

#### *Xenocephalus australiensis* (Kishimoto 1989)

(Plate XII, Fig. 123)

**Vernacular Name:** Nil

***australiensis, Gnathagnus elongatus*** Kishimoto 1989:310, Fig. 2 [Japanese Journal of Ichthyology v. 36 (no. 3); Northwest Shelf, 190 kilometers northwest of Port Hedland, Western Australia, 18°10'S, 118°18'E, depth 299 meters. Holotype: AMS I.22821-014. Paratypes: AMS I.22821-051 (3), I.23423-002 (1); WAM P 19119-001 (1), P.28072-006 (2), P.28086-001 (2). Valid as *Xenocephalus australiensis* (Kishimoto 1989)
Hutchins 2001, Records of the Western Australian Museum Supplement No. 63: 9-50.
Bray & Hoese 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy**: Nil

**Diagnostic characters (Based on 2 specimens 29.1-31.3cm TL):**

**B. 6; D. 0, 12-13; A. 17; P. 23; V. I, 5**

Body broader than deep, length of head about 0.31-0.34 in SL, its maximum breadth in repose is 0.58-0.61 in HL. BD 0.2-0.23 in SL. Eyes on top of head, its diameter 0.15-0.18 in HL. Mouth vertical, upper jaw 0.42-0.44 in HL. Lips rather fleshy, papillated, especially lower lip. Dorsal fin far back on body, 0.6-0.63 in SL, its base equal to head depth. Pectoral fin tip reaching to anal fin origin, 0.23-0.26 in SL. Caudal emarginated. Back dirty greenish, below marbled with lighter shades, belly silvery whitey, first dorsal black.

**Geographical distribution (Previous records):** Southwestern Pacific: Known only from continental slope of northwestern Australia.

**Distribution in the Southwest coast (Present study):** Between 11° and 13° N latitude.

**Depth:** Demersal, depth range 299 - 500 m. In the present study, 501-800 m.

### Sub Order : Callionymoidei (dragonets)

### Family : Callionymidae (dragonets, scoter blennies)

## Genus : *Callionymus* Linnaeus 1758

***Callionymus*** Linnaeus 1758, Systema Naturae, Ed. X. v. 1: i-ii + 1-824.
Fricke 2009, Stuttgarter Beiträge zur Naturkunde A, Neue Serie. v. 2: 169-175.

### *Callionymus sagitta* Pallas 1770

(Plate XII, Fig. 124)

**Vernacular Name:** Arrow headed dragonet

***Callionymus sagitta*,** Pallas 1770:29, Pl. 4 (figs. 4-5) [Spicilegia Zoologica quibus novae imprimis et obscurae animalium species iconibus, descriptionibus atque commentariis illustrantur v. 1 (fasc. 8); Mouth of Hooghli River, Sundarbans, Bengal Province, India, about 21°50'N, 88°00'E. Neotype: SU 41392. Neotype designated in Opinion 1388; name placed on Official List. Neotype described (Nakabo *et al.* 1991). •Valid as *Callionymus sagitta* Pallas 1770.
Manilo & Bogorodsky 2003, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
Adrim *et al.* 2004, The Raffles Bulletin of Zoology Suppl. No. 11: 117-130.
**Synonymy**: *Repomucenus sagitta* (Pallas, 1770)

**Diagnostic characters (Based on 7 specimens 7.3–12.9 cm TL):**

**B. D. IV, 9-10; A.0, 9-10; P. 17-19; V. I, 5.**

Body elongated, depressed, BD and DA 0.13-0.14 in SL. Head broad and depressed, HD 0.12-0.13 and HL 0.41-0.43 in SL. Pre opercular spine short and narrow with 2-4 sharp points at its dorsal side. Snout more or less equal to eye diameter, PrOL 0.21-.023 and ED 0.2-0.22 in HL. Ventrals jugular, in advance of pectoral and dorsal fins. Anal origin just behind dorsal fin origin. Caudal fin rounded and 0.3-0.32 in TL. Head and body sand yellow, covered with numerous small dark spots. Ventral sides whitish. Dorsal fin black, first membrane often (at least basally) whitish in females. Anal fin white. Second dorsal, caudal, pectoral, and pelvic fins spotted with brown.

**Geographical distribution (Previous records):** Indo-West Pacific. Arabian Peninsula to Philippines. Occurs in Mekong delta of Viet Nam and probably also in Cambodia. Southern India and Sri Lanka eastward.

**Distribution in the Southwest coast (Present study):** Between 07° and 13° N latitude.

**Depth:** In present study, 201-500 m.

**Sub Order : Scombroidei** (albacores, bonites, mackerels, ribbonfishes, tunas)

**Family : Gempylidae** (escolares, snake mackerels)

Body elongate; compressed. Exposed maxilla. Mouth large, not protractile, with strong teeth in jaws, those at front of upper jaw often fang like. Lower jaw projecting beyond tip of upper jaw. Two dorsal fins, second excluding finlets shorter than first. Usually with isolated finlets after anal and dorsal fins. Pectoral fin inserted low on body. Pelvic fins lacking or very small. Caudal fin present.

**Key to Genera**

**1a**. Skin very rough; scales medium-sized, interspersed with spinous bony tubercles; mid-ventral (abdominal) keel on belly; lateral line single, obscure........................................................................................ ***Ruvettus***

**1b**. Skin rather smooth, scales small, not interspersed with spinous bony tubercles; no mid-ventral (abdominal) keel on belly; lateral line single or double, always obvious........................................................................... **2**

**2a**. Pelvic fins rudimentary (with I spine and 0 to 4 rays) or absent **3**

**2b**. Pelvic fins well developed (with I spine and 5 rays) ***Neoepinnula***

**3a**. Lateral line single **4**

**3b**. Lateral line double ***Rexea***

**4a**. Two free anal-fin spines behind anus, first of them large, dagger-shaped; lateral line fairly strait; dorsal-fin spines XX or XXI ***Nealotus***

**4b**. No free anal-fin spines behind anus; lateral line curved abruptly downward anteriorly; dorsal-fin spines XVII or XVIII ***Promethichthys***

### Genus : *Ruvettus* Cocco 1833 (escolars)

**Cocco,** 1833, Giornale di Scienze Lettere e Arti per La Sicilia v. 42 (no. 124): 9-21, 1 pl.
Bray & Hoese 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Ruvettus pretiosus* Cocco 1833

(Plate XII, Fig. 125)

**Vernacular Name:** Escolar, Oilfish

*Ruvettus pretiosus* Cocco, 1829:, Osservationes Peloritani v. 8: 18. 21 (Messina, Italy)
Mundy 2005, Bishop Museum Bulletin in Zoology No. 6: 1-704.
Fricke et al. 2007, Serie A (Biologie). No. 706: 1-174.
**Synonymy**: *Rovetus temminckii* Cantraine, 1833.*Tetragonurus simplex* Lowe, 1834. *Thyrsites acanthoderma* Lowe, 1839. *Thyrsites scholaris* Poey, 1854. *Ruvettus tydemani* Weber, 1913. *Ruvettus pacificus* Jordan and Jordan, 1922. *Ruvettus whakari* Griffin, 1927

**Diagnostic characters (Based on 2 specimens 33.7–38.1 cm TL):**

**D. XIII-XV, 15-18, 2; A. 0, 15-18, 2; P. 15; V. I, 5**

Body semifusiform and slightly compressed; its depth 4.3 to 4.9 times in standard length. Head length 3.3 to 3.7 times in standard length; lower jaw extends slightly anterior to upper jaw; tip of both jaws without dermal processes; fang-like teeth in both jaws present in juveniles but indistinct in adults; uniserial small teeth on vomer and palatines. Gill rakers at angle of first arch T-shaped and larger than other gill rakers. First dorsal fin low; caudal fin widely forked. Lateral line single, obscure; belly keeled by bony scales between pelvic fins and anus. Small cycloid scales, interspersed with rows of sharp spiny tubercles. Body uniformly brown to dark brown, tip of pectoral and pelvic fins black, margins of second dorsal and anal fins white in young specimens. Maximum 3m total length, common to 150 cm standard length.

**Geographical distribution (Previous records):** Widely distributed in tropical and temperate waters of the world.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N Latitudes.

**Depth:** Oceanic, benthopelagic on continental slope and sea rises, 100-700 m. In present study, also 501-800 m.

**Genus : *Neoepinnula* Matsubara & Iwai 1952**

***Neoepinnula*** Matsubara & Iwai 1952, Pacific Science v 6 (no. 3): 193-212.
Bray & Hoese 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Neoepinnula orientalis* (Gilchrist & von Bonde 1924)

(Plate XII, Fig. 126)

**Vernacular Name:** Sackfish

***Epinnula*** *orientalis* Gilchrist and von Bonde, 1924:15, pl. 4, fig. 1, Report Fisheries and Marine Biological Survey, Union of South Africa Rep. 3 (no. 7) (1922).
The Peterson Field Guide Series. Boston. 1986: iii-xi, 1-354 1986: iii-xi, 1-354
Myers & Donaldson 2003, The fishes of the Mariana Islands. Micronesica v 35-36: 598-652.
**Synonymy**: *Epinnula orientalis pacifica* Grey, 1953.

**Diagnostic characters (Based on 15 specimens 17.8-27.6 cm TL):**

**B. 7; D. XVI, I, 15-19; A. II, I, 17-18; P. 12-14; V. I, 5; C. 19-21; Lat. 67-68**

Body moderately deep, its depth 3.9 to 4.2 times in standard length. Head length 3.1 to 3.5 times in standard length; interorbital space 0.7 to 0.9.times in eye diameter; anteriorly in upper jaw 3 immovable and 1 to 3 movable fangs and 1 fang anteriorly on each side of lower jaw. First dorsal fin inserted above insertion of pectoral-fin base. Pelvic fins inserted beneath or behind middle of pectoral fin. Two lateral lines, both originate above upper angle of gill opening. Body greenish brown to dark brown; first dorsal fin blackish, membranes between anterior 3 or 4 spines pigmented more intensively; buccal and branchial cavities usually black. Maximum 30 cm standard length.

**Geographical distribution (Previous records):** Indo-West Pacific species recorded from off East Africa (Natal to Kenya), Saya de Malha Bank, Arabian

Sea; eastern North Indian Ocean, Flores, Banda, Arafura Sea, Sulawesi and Sulu Seas, off Riu-Kiu and southern Japan.

**Distribution in the Southwest coast (Present study):** Between 07° and 15° N Latitudes.

**Depth:** Benthopelagic on upper slope between 200 and 570 m. In present study, also 201-800m.

### Genus : *Rexea* Waite 1911

***Rexea*** Waite 1911, Transactions New Zealand Institute Part 2 [1910]: 49-51.
Nakamura & Parin 2001, Families Gempylidae, Trichiuridae. In: Carpenter & Niem 2001. Species identification guide for fishery purposes. Bony fishes part 4. v. 6: 3698-3720.

*Rexea prometheoides* (Bleeker 1856)

(Plate XII, Fig. 127)

**Vernacular Name:** Prometheus gemfish, royal escolar

*Thyrsites prometheoides* Bleeker, 1856, [Acta Societatis Regiae Scientiarum Indo-Neêrlandicae v. 1] Ambon Island, Moluccas Islands, Indonesia. Holotype (unique): RMNH 6033. Original as *prometheoïdes*.
Boeseman 1962, JMBAI, v. 4 (no. 2): 214-216, 1 pl.
Youn 2002, Fishes of Korea, with pictorial key and systematic list. 2002: 1-747
**Synonyms:** *Jordanidia raptoria* Snyder, 1911.

**Diagnostic characters (Based on 6 specimens 34.7-40.1 cm TL):**

**D. XVIII-XIX, I, 14-17, 2; A. I, I, 12-15, 2; P. 12-14.**

Elongated and compressed body, BD 0.2-0.23, HD 0.14-0.16 in SL. Head prominent, 0.31 to 0.34 in standard length. Snout much longer than eye, 0.37-0.38, ED 0.18-0.2 in HL. Upper jaw 5 or 6 fangs and 1 smaller fang anteriorly on each side of lower jaw; palatine teeth 11 to 16. Base of second dorsal fin 0.4-0.45 in first dorsal fin base, which is 0.43-0.45 in head length; pelvic fins absent. Lateral line bifurcated below fourth to fifth spine of first dorsal fin; upper line reaches middle to end of second dorsal-fin base, lower line midlateral. Body naked except a large lancet-shaped stripe of squamation extending forward from caudal peduncle to below middle of first dorsal-fin base. Body grayish with silvery tint; fins hyaline. Maximum 40 cm standard length.

**Geographical distribution (Previous records): Geographical distribution (Previous records):** Indo-West Pacific from off Mozambique, Kenya, Reunion Island, Saya de Malha Bank, North Australia, Indonesia, Vietnam, Philippines, Riu-Kiu Islands, and southern Japan.

**Distribution in the Southwest coast (Present study):** Between 9° and 13° N Latitudes.

**Depth:** Benthopelagic, 135-540 m. In present study, also 501-800 m.

**Genus : *Nealotus* Johnson 1865**

***Nealotus*** Johnson 1865, Proc. Gen. Meetings for Scientific Business of the Zoological Society of London 1865 (pt 2): 434-437
Parin 2003, Voprosy Ikhtiologii v 43 (suppl. 1): S1-S40.

*Nealotus tripes* Johnson 1865

(Plate XII, Fig. 128)

**Vernacular Name:** Black snake mackerel

***Nealotus tripes*** Johnson, 1865, Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1865 (pt 2). Madeira, Portugal Holotype (unique): BMNH uncat
McEachran & Fechhelm 2005, Fishes of the Gulf of Mexico. Volume 2: Scorpaeniformes to Tetraodontiformes. University of Texas Press, Austin. i-viii +1-1004.
**Synonyms:** *Machaerope latispinus* Ogilby, 1899.

**Diagnostic characters (Based on 1 specimen 24.7cm TL):**

**B. 7; D. XX- XXI, 16-19, 2; A. I, I, 15-19, 2; P. 13-14; V. I**

Body elongate and compressed; body depth about 7-9 times in standard length. Head length 4 times in standard length; upper profile of head nearly straight from tip of snout to origin of dorsal fin; lower jaw extends anterior to upper jaw; tip of both jaws without dermal processes; 3 immovable and 0 to 3 movable fangs anteriorly in upper jaw; 1 fang anteriorly on each side of lower jaw; vomer edentate. Gill rakers at angle of first arch T-shaped and larger than others. A single, fairly straight lateral line. Large scales, easily deciduous. Body blackish brown; dorsal and anal fins pale brown; buccal and branchial cavities and peritoneum black. Maximum about 25 cm standard length, common to 15 cm.

**Geographical distribution (Previous records):** Tropical and temperate waters of Atlantic, Indian and Pacific oceans.

**Distribution in the Southwest coast (Present study):** Between 09° and 15° N Latitudes.

**Depth:** Oceanic, epi - to mesopelagic from surface to about 600 m depth. In present study, also 501-1100 m.

**Genus : *Promethichthys*** Gill 1893

***Promethichthys*** Gill 1893, Memoirs of the National Academy of Sciences v. 6 (mem. 5): 91-124.
Parin & Nakamura 2003, The living marine resources of the Western Central Atlantic. v 3.

*Promethichthys prometheus* (Cuvier 1832)

(Plate XII, Fig. 129)

**Vernacular Name:** Purple snake mackerel, single-line gemfish

*Gempylus prometheus* Cuvier in Cuv. and Val., 1832:213, pl. 222. Histoire naturelle des poissons. v 8; St. Helena Island, South Atlantic. Holotype (unique): MNHN A-5366.
Bray & Hoese 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.
**Synonymy:** *Prometheus atlanticus* Lowe, 1838.*Dicrotus armatus* Günther, 1860. *Thyrsites ballieui* Sauvage, 1882. *Dicrotus parvipinnis* Goode and Bean, 1896. *Promethichthys pacificus* Seale, 1906.

**Diagnostic characters (Based on 2 specimens 41.7-43.1cm TL):**

**D. XVII-XVIII, I, 17-20, 2; A. II, 15-17, 2; P. 13-14**

Body moderately elongate and compressed, BD 0.68-0.71, HL 0.34-0.36 in SL. Lower jaw extends slightly anterior to upper jaw; tip of both jaws without dermal processes; strong jaw dentition including 3 or 4 immovable and 0-3 movable fangs anteriorly in upper jaw; 1 shorter fang anteriorly on each side of lower jaw and numerous lateral compressed teeth; no vomerine teeth; palatine teeth present. Base of second dorsal 0.4-0.43 in first dorsal fin. Pectorals 0.48-0.51 in HL and ventral fins entirely absent. A single lateral line running sub dorsally from above upper angle of gill opening to under fourth spine of first dorsal fin, then abruptly curving down and, from under sixth spine, midlateral to caudal-fin origin. Caudal forked. Body grayish to copper brown; fins blackish. Buccal and branchial cavities black. Maximum 100 cm standard length.

**Geographical distribution (Previous records):** Tropical and warm temperate waters of all oceans.

**Distribution in the Southwest coast (Present study):** Between 9° and 11° N Latitudes.

**Depth:** Benthopelagic, depth range 100-750 m. In present study, also 501-800m.

**Family : Trichiuridae** (cutlassfishes, hairtails, ribbonfishes)

**Sub Family: Trichiurinae**

**Genus** ***Trichiurus*** Linnaeus 1758 (cutlassfishes, hairtails)

***Trichiurus*** Linnaeus 1758, Systema Naturae, Ed. X. v 1. i-ii + 1-824.
Bray et al. 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.
Chakraborty et al. 2006, Ichthyological Research v 53: 93-96.

Caudal fin absent, body tapering to a point; pelvic fins absent or modified to scale-like process. Pelvic fins absent; lower hind margin of gill cover concave. First anal spine small, shorter than diameter of pupil; soft anal rays slightly breaking through skin in small specimens (not breaking through skin in larger specimens); no forward directed canine teeth in upper jaw, no slit on ventral side of lower jaw.

*Trichiurus auriga* Klunzinger 1884

(Plate XII, Fig. 130)

**Vernacular Name:** Pearly hairtail

***Trichiurus auriga,*** Klunzinger 1884:120, 121, Pl. 12 (fig. 1) [Die Fische des Rothen Meeres] Kosseir, Egypt, Red Sea.
Silas and Rajagopalan 1974,
Burhanuddin & Parin 2008, Journal of Ichthyology v. 48 (no. 10): 825-830.
**Synonymy: Nil**

**Diagnostic characters (Based on 11 specimens 29.4-37.7 cm TL):**

**D. III, 109-111; A. 76-81, P. I, 8-9**

Body extremely elongated and strongly compressed, ribbon like, tapering to a point, BD 0.049-0.52 and HL 0.15-0.17 in TL. Mouth very large, with a small dermal flap at tip of each jaw, 2 or 3 pairs and one pair of fangs without barbs on upper and lower jaws, respectively. A single series of sharp compressed lateral teeth on both jaws; minute teeth on palatines, eye large, its diameter 0.2-0.21 in HL, 0.46-0.51 in PrOL. Lower hind margin of gill cover concave. Dorsal long based and rather low, anal originating below $40^{th}$ or $41^{st}$ dorsal fin ray. Pectoral as long as snout. Ventral and caudal absent. Lateral line originating at margin of gill cover, running obliquely to behind tip of pectoral. Straight near to ventral profile of body. Pearl white with dorsal slightly dusky.

**Geographical distribution (Previous records):** Western Indian Ocean, Continental shelf and slope along Kerala and Tamil Nadu, Red sea, Timor Sea.

**Distribution in the Southwest coast (Present study):** Between 7° and 11° N Latitudes.

**Depth:** Recorded from the depth range 250-360 m. In present study, 201-500 m.

**Order : Pleuronectiformes** (flatfishes, flounders, soles)

**Sub Order : Pleuronectoidei**

**Family : Bothidae** (lefteyed flounders, turbots)

Flatfishes with eyes on left side of body; spines sometimes present before eyes in males. Mouth asymmetrical, teeth present in jaws, sometimes caniniform. Preopercle exposed, its hind margin free and visible. Pectoral fins present; pelvic fins present, that on eyed side larger in some genera; dorsal fin origin above or in front of eyes; caudal fin free from dorsal and anal fins; no spiny rays in fins. A single lateral line, sometimes faint or absent on blind side.

**Key to Genera**

1a. Maxilla contained less than 2 times in HL, Lower jaw very prominent **_Chascanopsetta_**

1b. Maxilla contained more than 2 times in HL, lower jaw not prominent **_Psettina_**

**Genus : _Chascanopsetta_** Alcock 1894

***Chascanopsetta*** Alcock 1894, Journal and Proceedings of the Asiatic Society of Bengal v. 63 (pt 2): 115-137, Pls. 6-7
Hoese & Bray 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Pelvic fin base of eyed side usually much longer than that of blind side. Mouth larger; teeth on both sides of jaws. Maxilla contained less than 2 times in head length; lower jaw very prominent.

*Chascanopsetta lugubris* Alcock 1894 (pelican flounder)

(Plate XII, Fig. 131)

**Vernacular Name:** Pelican flouder

***lugubris, Chascanopsetta*** Alcock 1894:129 [15], Pl. 6 (fig. 4) [Journal and Proceedings of the Asiatic Society of Bengal v. 63 (pt 2); Bay of Bengal, 13°51'12"N, 80°28'12"E, Investigator station 162, depth 145-250 fathoms. Syntypes: ZSI F13728-29 (2).
Munroe 2003:1892, The living marine resources of the Western Central Atlantic. v. 3.
Trunov 2006:476, J. Ichthyol. v. 46 (no. 7):493-499.
**Synonymy: Nil**

**Diagnostic characters (Based on 12 specimens 17.9–29.5 cm TL):**

**B. 6; D. 0, 120-128; A. 0, 84-89; P. 14-17 on eyed side, 12-16 on blind side; LL. 183-197.**

Body rather elongate and slender, and thin. Eyes on left side, IOW narrow, maxilla long; 0.70-0.73 in HL. Extending backward well beyond posterior edge of eye; teeth small, slender (no distinct canines), depressible on lower jaw; developed gill rakers absent, although 1 or 2 rudiments may be present on lower limb of first arch. Ventral fin bases unequal in length, that on eyed side much longer. Scales small, cycloid (smooth) on both sides. Eyed side grayish or yellowish brown, with or without numerous spots, fins dusky, peritoneum black, visible through thin abdominal walls. Blind side uniformly light. Max. 40 cm. commonly 20 cm.

**Geographical distribution (Previous records):** East coast of Africa and off India and Sri Lanka, found on both sides of Atlantic and in eastern Indian ocean, western central pacific to Japan. Natal to Delagoa Bay; Indo-Pacific and Atlantic Oceans.

**Distribution in the Southwest coast (Present study):** Between 7° and 15° N Latitudes.

**Depth:** 120-977 m on sand. In present study, 201-500 m.

**Genus : *Psettina*** Hubbs 1915

***Psettina*** Hubbs 1915, Proceedings of the United States National Museum v. 48 (no. 2082): 449-496, Pls. 25-27
Hoese & Bray 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

Maxilla contained more than 2 times in head length; lower jaw not prominent. Lateral line absent or feebly developed on blind side. Eyes close together, separated by a bony ridge or narrow concave space. Scales of eyed side strongly ctenoid.

*Psettina brevirictis* (Alcock 1890)

(Plate XIII, Fig. 132)

**Vernacular Name:** Nil

*Arnoglossus brevirictis* Alcock, 1890: 433 [Annals and Magazine of Natural History (Series 6) v. 6 (no. 36);] 9.5 miles southeast by south of Bawanapadu Bacon, off Ganjam coast, Bay of Bengal, Investigator station 85, depth 30-31 fathoms. Syntypes: ZSI F12922-23 (2).
Manilo & Bogorodsky 2003, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.
**Synonymy: Nil**

**Diagnostic characters (Based on 4 specimens 09.1–14.7 cm TL):**

**D. 79-83; A. 63-67; P. 11-13 on eyed side, 10-11 on blind side; Gr. (3-5)+(5-8); LL. 46-52**

Body flat, broader, and thin, BD 0.34-0.35, HD 0.27-0.29 in SL. Eyes on right side, Interorbital area a sharp, narrow ridge. Mouth oblique, maxilla 0.49-0.53 in HL, lower jaw not much prominent. Teeth uniserial in both jaws, somewhat larger on blind side. Pectoral moderate, 0.16-0.18 in SL and 0.69-0.7 in HL. Anal fin insertion behind pectoral, AL 0.25-0.27 in SL. Eyed side brownish; dark blotches along dorsal and ventral edges of body which continue into dorsal and anal; two or three dark blotches on lateral line; dark area on pectoral of eyed side; caudal with broad dark band. Attains 15 cm TL.

**Geographical distribution (Previous records):** India, Celebes, Hong Kong and Taiwan.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Recorded from 37-137 m on sand and shell bottoms. In present study, 201-500 m.

**Family** : **Cynoglossidae** (tongue soles, tonguefishes)

**Sub Family** : **Cynoglossinae**

**Genus** : ***Cynoglossus*** Hamilton 1822

*Cynoglossus* Hamilton-Buchanan, 1822, An account of the fishes found in the river Ganges and its branches.. i-vii + 1-405, Pls. 1-39. [type-species: *Cynoglossus lingua* Hamilton-Buchanan, monotypy.]
*Dexiourius* Chabanaud, 1947b:443 [type-species: *Cynoglossus semilaevis* Giinther 1873b, monotypy.]

Vreven & Teugels 2007, In: The Fresh and Brackish Water Fishes of Lower Guinea, West-Central Africa. Volume 2.(Stiassny et al. 2007).

Body lanceolate, eyes on left side, center of migratory eye usually placed in advance of center of fixed eye and usually anterior to its anterior border, pectorals absent; only pelvic fin of blind side present, with four rays, all inserted ventrally in front of anal and connected to it by a membranous extension of its last ray. Dorsal, anal, and caudal are confluent.

**Key to species**

1a. Snout acutely pointed, rostral hook long, reaching beyond lower eye; much nearer to gill opening than to tip of the snout ***C. acutirostris***

1b. Snout obtusely pointed, rostral hook short, slightly nearer to gill opening or midway between gill opening and snout ***C. carpenteri***

*Cynoglossus acutirostris* Norman 1939

**Vernacular Name:** Sharpnose tonguesole

*Cynoglossus (Areliscus) acutirostris*, Norman 1939, Fig. 35, Scientific Reports, John Murray Expedition v. 7 (no. 1), Gulf of Aden, station 194, depth 220 meters. Holotype: BMNH 1939.5.24.1800 (only if the 215-mm spec.). Paratypes: (17) BMNH 1939.5.24.1801-1809 (9), MNHN 1939-0268 [ex BMNH] (1), USNM 109493 (1).

Menon 1977, Smithsonian Contributions to Zoology No. 238: i-iv + 1-129, Pls. 1-21

Manilo & Bogorodsky 2003, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.

**Diagnostic characters (Based on 5 specimens 8.7-11.3 cm TL):**

**D. 109-110; A. 93-95; C. 10; LL (Mid). 86-92**

Body flat and elongate, with dorsal and anal fins joined to caudal fin. Eyes on left side of body, with a rather narrow space between them; snout acutely pointed, rostral hook long, reaching beyond lower eye; much nearer to gill opening than to tip of snout. Three lateral lines on ocular side; no lateral line on blind side; scales on eyed side cycloid anteriorly, ctenoid posteriorly; scales on blind side cycloid; 18-20 rows of scales between upper and middle lateral lines. Upper side uniformly brownish, lower whitish.

**Geographical distribution (Previous records):** North western part of Indian Ocean; Gulf of Aden.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Benthic, beyond 200m. In present study, 201-500m.

*Cynoglossus carpenteri* Alcock 1889

**Vernacular Name:** Hooked tonguesole

***Cynoglossus carpenteri,*** Alcock 1889, Pl. 18 (fig. 1) [Journal and Proceedings of the Asiatic Society of Bengal v. 58 (pt 2, no. 3); 68 miles east of mouth of Devi River, Máhánaddi delta, Bay of Bengal, Investigator, depth 68 fathoms. Lectotype: ZSI F12434. Paralectotypes: ZSI F12433 (1). Non-types: BMNH 1890.7.31 10-12 [ex ZSI] (3), 1890.11.28.27-29 [ex ZSI] (3); MNHN 1890-0359 to 0362 [ex ZSI] (4).
Menon & Yazdani 1968, Records of the Zoological Survey of India v. 61 (pts 1-2) [1963]:91-190.
Menon 1977 Smithsonian Contributions to Zoology No. 238: i-iv + 1-129, Pls. 1-21
Manilo & Bogorodsky 2003, Journal of Ichthyology v. 43 (suppl. 1): S75-S149.

**Diagnostic characters (Based on 7 specimens 09.1-13.7 cm TL):**

**D. 106-109; A. 86-89; C. 10-11; LL (Mid). 88-96**

Body flat and elongate, with dorsal and anal fins joined to caudal fin. HD 0.24-0.26, HL 0.29-0.31 in SL. Snout shorter (0.33-0.38 in HL), eyes on left side of body (0.06-0.08 in HL), with a rather narrow space between them (0.03-0.06 in HL), snout obtusely pointed, rostral hook short, slightly nearer to gill opening or midway between gill opening and snout. Lips on eyed side of head not fringed with labial papillae. Three lateral lines on ocular side; no lateral line on blind side; scales larger, cycloid on both sides; 15-9 rows of scales between upper and middle lateral lines. Upper side uniformly brownish, lower whitish. Attains 23 cm TL.

**Geographical distribution (Previous records):** Indian Ocean: Gulf to Pakistan, West coast of India, Sri Lanka and Persian Gulf.

**Distribution in the Southwest coast (Present study):** Between 11° and 15° N latitude.

**Depth:** Bathydemersal; depth range 27 – 420 m; Trawled from a depth of 124-420 m. In present study, 201-500 m.

**Family : Soleidae**

**Genus** : *Aesopia* Kaup 1858

***Aesopia*** Kaup 1858, Archiv für Naturgeschichte v. 24 (no. 1): 94-104.
Hoese & Bray, 2006, In: Zoological Catalogue of Australia. Volume 35. Fishes.

*Aesopia cornuta* Kaup 1858

(Plate XIII, Fig. 133)

**Vernacular Name:** Unicorn sole

***Aesopia cornuta***, Kaup 1858:98 [Archiv für Naturgeschichte v. 24 (no.1); British Indies. Syntypes: MNHN 1998-1304 (1), 1998-1305 (1). Type catalog: Desoutter *et al.* 2001
Valid as *Aesopia cornuta* Kaup 1858
Ochiai in Masuda *et al.* 1984, The fishes of the Japanese Archipelago.. Text: i-xxii + 1-437 Atlas: Pls. 1-370.
Shinohara *et al.* 2005, Memoirs of the National Science Musuem Tokyo No. 29: 385-452.

**Diagnostic characters (Based on 4 specimens 11.2-15.8 cm TL):**

**D. 68-73; A. 60-62; P. 11-15; LL. 96-104**

Body flat and elongate, dorsal and anal fins not joined to caudal fin. Snout very short, 0.07-0.078 in HL. Body depth 0.27-0.29 in TL. Head small, 0.2-0.23 in TL and 0.78-0.81 in its depth. Eyes on right side of body, with no space between them. Lips on eyed side fleshy. Scales smaller, cycloid on both sides. First ray of dorsal fin enlarged and free. Pectoral fin short. Caudal fin confluent with dorsal and anal. Grayish or brown, with 14-16 dark bars, edged with black, first 3 on head; C blackish, with some pale spots. Attains 22 cm.

**Geographical distribution (Previous records):** Natal to Mozambique; Red Sea, India, Japan.

**Distribution in the Southwest coast (Present study):** Between 07° and 13° N latitude.

**Depth:** Demersal. In present study, 201-500 m.

**Order : Tetraodontiformes** (balistes, cowfishes, filefishes, leatherjackets, puffers, triggerfishes, trunkfishes)

**Sub Order : Triacanthoidei**

**Family : Triacanthodidae** (spikefishes, triacanthodidés)

**Genus : *Macrorhamphosodes*** Fowler 1934

***Macrorhamphosodes*** Fowler 1934, Proc. Acad. Nat. Sci. Philadelphia v. 85 (for 1933): 233-367
Matsuura 2001, Species identification guide for fishery purposes. Bony fishes part 4. v 6: 3902-3928.

*Macrorhamphosodes uradoi* (Kamohara 1933)

(Plate XIII, Fig. 134)

**Vernacular Name:** Trumpetsnout

***Halimochirus uradoi***, Kamohara 1933, Figs. 1-3 [Dobutsugaku Zasshi = Zoological Magazine Tokyo v. 45 (no. 539). Mimase, Kochi Prefecture, Japan. Kamohara "neotype": BSKU 9406.
Kamohara 1961, Reports of the Usa Marine Biological Station v. 8 (no. 2): 1-9, Pls. 1-7
Valid as *Macrorhamphosodes uradoi* (Kamohara 1933).
Tyler 1968, Monographs of the Academy of Natural Sciences of Philadelphia No. 16: 1-364.
Hoese *et al.* 2006, In: Zoological Calogue of Australia. Volume 35. Fishes.

**Diagnostic characters (Based on 4 specimens 11.5–14.3 cm TL):**

**D. VI, 14; A. 13; P. 14-15; V. I, 1; Gr. 24-27**

Body elongate, compressed, head with snout more than half of body without caudal (HL 0.55-0.56 in SL). Snout greatly elongate, tubular, PrOL 0.70-0.72 in HL, 0.39-0.40 in SL. Mouth small, superior, twisted to right; its width twice as wide as tubular snout just behind it. Eye diameter larger than interorbital width and 0.18-0.2 in HL. Teeth in lower jaw much compressed from front to back, much wider than thick, well developed and easily seen; Dorsal fins distinctly separated; first dorsal origin above pectorals. Dorsal spines gradually decreasing posteriorly; proximal half of dorsal spines covered with spinulose scales which are enlarged on lateral sides of spines, third dorsal-fin spine moderately well developed. Ventral surface of pelvis covered with scales, clearly tapering to a point posteriorly, wider anteriorly between pelvic spines than posteriorly. Pelvic spines long and rigid, their proximal two-thirds covered with spinulose scales which are developed dorsally and ventrally on spines. Scales small, each with a row of 5 to 8 spines. Caudal peduncle rounded, LHCP 0.47-0.49 in height of snout at anterior margin of eye, which in turn 0.14-0.15 in HL. Caudal fin rounded posteriorly. Pinkish red, paler below, darker red dorsally and stripe posteriorly from eye. Attains about 16.5 cm SL.

**Geographical distribution (Previous records):** Indo-West Pacific: Kenya to Japan and New Zealand. Southeast Atlantic: one record off Port Elizabeth, South Africa. one record from 400-450 m off Port Elizabeth; Kenya to Japan.

**Distribution in the Southwest coast (Present study):** Between 07° and 11° N latitude.

**Depth:** Demersal; marine; depth range 50-675m. In present study, 201-800 m.

## 2.4 Discussion

In ancient India, fishes were classified based on shape, structure and their knowledge from keen observations that are remarkable as seen from Kautilya's *'Arthashasthra'* (300 B.C). *Abhilashitarthachintamani* or Manasollasa by the Western Chalukya King Someshvardeva during 1126–1138 AD provided description of 35 kinds of marine and fresh water fishes, each with a distinct name, the feeds provided to some fishes, and the art of angling. In all 35 names have been given by Someshvardeva with minimal information on their habitat (marine or fresh water), presence or absence of scales (charmaja – scaleless; shalkaja – scaly), and size (large, medium, small). Even this information is not given for each fish (Sadhale and Nene, 2005).

The Hamilton-Buchanan's (1822) account on the fishes of Ganges or the studies by Sykes (1839), Jerdon (1849), Blyth (1858,1860), Day (1875-1878), Hora (1951) *etc.* were concentrated mainly on the coastal, estuarine and freshwaters fishes from the Indian peninsula.

It was Alcock (1889) who had done a comprehensive study on the deep sea fishes of Indian waters, which were collected during the famous Challenger Expedition. During his study, he reported many fishes from the deeper waters from west and east coast of India. Since then, it was Misra (1947, 1952 and 1953, 1969, 1976a,b) who compiled the coastal and deep sea fishes of India, reported and discussed about many species. Hora (1951) gave a detailed translation of Manasollasa, and also the identification of fishes as well as the art of angling.

In the present study, a total of 152 deep sea fish species were collected beyond the depth 200m of the area between 07° and 15° N Latitude in the Indian EEZ, along the south west coast of India are described. 71 among them were reported previously from Atlantic Ocean, 88 from Pacific and 133 from Indian Ocean including the species of shared distribution between these oceans (Alcock, 1889; Misra, 1947, 1952 and 1953; Fischer and Bianchi, 1984; Smith and Heemsta, 1986; www.fishbase.org; Eschmeyer and Fong, 2009; www.calacademy.org/research/ichthyology). 49 species are reported to have distributed in both the Atlantic and Pacific Oceans while 56 species shared between Atlantic and Indian Oceans and 74 between Pacific and Indian Oceans.

Out of the 152 species recorded from the study area, 40 were found to have a circumglobal distribution, showing their presence in all the three major oceans viz. Atlantic, Pacific and Indian Ocean. 6 species were exclusive to Atlantic Ocean and 4 species were distributed only in Pacific Ocean. The previous reports from Indian Ocean have shown that there are 43 species of fishes exclusively distributed in this Ocean among the remaining 103 (Misra, 1947, 1952 & 1953; Fischer and Bianchi, 1984; Alcock, 1890; Smith and Heemstra, 1986; www.fishbase.org). Nine species among the remaining sixty shared their geographical distribution between Atlantic and Pacific Oceans. Among the remaining 51 species, 16 are reported from both Atlantic and Indian Ocean. The rest of the 35 species were reported previously from the Pacific as well as Indian Oceans.

In the present study no species new to science could be encountered. Of the 152 fish species, 84 species are new addition to the EEZ of India while 97 are new records from the west coast and most importantly, 119 species are new addition to southwest region of Indian EEZ. *Etmopterus baxteri*, *Centrophorus lucitanicus*, *C. uyato*, *Harriotta releighana*, *Nemichthys scolopaceus*, *Neoscopelus microchir*, *Lepophidium marmoratum*, *Bufoceratias wedli*, *Epigonus pandionis*, *Eptatretus hexatrema*, *Apristurus saldanha*, *Leucoraja circularis*, *Grammonus ater*, *Rhynchoconger ectenurus*, *Lamprogrammus exutus*, *Bassozetus robustus*, *Glyptophidium lucidum*, *G.*

*micropus*, *G. oceanium* and *Neobythites multistriatus* were new records to the Indian Ocean.

The genus *Eptatretus* consists of a group of closely related species in their general morphology. The body is elongated, caudal saddle like, number of gills between one and eight. The species *Eptatretus indrambaryai* from Andaman Sea was the only species reported in Indian Ocean (Wongratana, 1983). In the present study, *E. hexatrema* is recorded for the first time from Indian Ocean which has so far been believed to be distributed only in Atlantic Ocean. The species is characterised by the presence of six gill openings and the absence of pectoral appendages when compared to other species of this genus.

*Cephaloscyllium sufflans* differs from similar species of the genus by its narrow based and lobate anterior nasal flaps, not overlapping mouth and from *C. nascione*, the closest species in possesing stout caudal peduncle and broad claspers which are not greatly elongated. It is a large species, adults measure one metre or more; colour pattern of obscure dusky saddles on back, sometimes obsolete in adults, fins not conspicuously light-edged (Fischer and Bianchi, 1984; Compagno, 1999; Bass, 1986; Inoue and Nakabo, 2006).

Among the 36 species of *Apristurus* so far reported world wide, only two viz. *Apristurus saldanha* and *A. indicus* could be collected in the present study. The caudal fin is without a crest of enlarged denticles in *A. indicus* which differentiate it from other species and found to be much related to *A. laurussoni* than *A. investigatoris*, the latter differs by the presence of an enlarged crest of enlarged denticles on caudal fin. Eye diameter is generally less than 4% of total length in *A. saldanha* while in *A. atlanticus,* eyes are larger with more than 4.2% of total length. The species is more related to *A. longicephalus* than other species including *A. indicus*, but differs due to the presence of very long interdorsal space, which is about equal to prespiracular head (Fischer and Bianchi, 1984; Compagno, 1999; Nakaya and Sato, 1999).

*Bythaelrus canescens*, *B. hispidus* and *B. lutarius* have the common character of anal fin base shorter than interdorsal space. The later two among 11 valid species were recorded in the present study. The roof of mouth with numerous small papillae is characteristic in *B. hispidis* and the eye length less than 14 times in predorsal distance in adults, while in *B. lutarius*, roof of mouth is without papillae and eye length is 14 or more times in predorsal distance in adults (Nair and Lal Mohan, 1973; Hoese *et al.* 2006).

The genus *Eridacnis* comprised of closely related species *E. radcliffei*, *E. sinuans* and *E. barbouri.* The narrowly rounded head and snout in dorsoventral view, oral papillae and gillrakers present in mouth and narrow and ribbonlike caudal fin are the common characters of this genus. *E. radcliffei* and *E. sinuans* were recorded in the present study. The preoral snout over twice mouth length and lateral dermal denticles broad and with short, wide cusps are characteristic in *E. sinuans* while, the preoral snout less than 1.5 times mouth length and lateral dermal denticles narrow and with narrow, long cusps is seen in *E. radcliffei* and *E. barbouri. E. barbouri* differs from *E. radcliffei* in having the short but well developed labial furrows and anal fin having two thirds of dorsal fin height (Compagno, 1984, Howe and Springer, 1993 and Compagno, 1999).

*Echinorhinus brucus* was the only representative in the Family Echinorhinidae collected from study area. *E. brucus* is having a few denticles on body, which are irregularly distributed, relatively large, not stellate and some fused into compound plates (Compagno, 1984; Compagno and Niem 1998; Al Sakaff and Esseen, 1999 and FAO-FIES, 2008). While the closely related species *E. cookie* differed from *E. brucus* in having body with numerous regularly distributed denticles which is relatively small, stellate and not fused into plates (Garrick, 1960, Mundy, 2005, Hoese *et al.* 2006 and FAO-FIES, 2008).

The species of the genus *Etmopterus* share common characters such as two single spined dorsal fins; no anal fin; a long deep straight oblique groove on each side of the mouth; spiracles which is wide, superior and located behind the eye. The denticles were with low, flat, concave, sessile crowns atop low bases in *E. pusillus*, while in *E. baxteri,* the denticles are with erect, thorn like, cuspidate crowns, which are more or less elevated from bases. *E. baxteri* is more nearer to other species of *Etmopterus* especially *E. spinax* than *E. pusilus* in similar characters (Compagno, 1984; Chinese Academy of Fishery Sciences, 2003; Paulin, *et al.* 1989).

*Centrophorus lusitanicus*, *C.* granulosus and *C. uyato* were the species collected from family Centrophoridae. *C. uyato* relates to *C. niaukang* more than *C. lusitanicus* and *C. granulosus* by the presence of denticles of adults with medial cusps, angular and thornlike crowns posteriorly, but differs in characters like greatly elongated free rear tips of pectoral fins which extend well behind first dorsal spine and notched postventral margin of caudal fin in adults. *C. lucitanicus* is more related to *C. granulosus* and differs from the former in the greately elongated first dorsal fin and straight postventral caudal margin in adults (Compagno, 1984; Compagno, *et al.* 2005).

*Centroscymnus crepidator* was the only species collected from the family Somniosidae. It differs from the other five reported species of this genus by having the greatly elongated snout and upper labial furrows; preoral length about equal to distance from mouth to pectoral fin origins (Hutchins, 2001; Last and and Stevens, 1994; Manilo and Bogorodsky, 2003).

In Rajidae, *Raja miraletus* was the only species recorded from the study area. It shares similar characters with *R. clavata* but differs from it in the presence of circular or slightly ovate ocellus and 3 definite rings of colour. It differs from the other species in the genus by the presence of ocellus on dorsal surface (Hulley, 1969; Stehmann, 1973; Compagno *et al.* 1989, 1991, Compagno, 1999; Heemstra and Heemstra, 2004; Fricke *et al.* 2007).

*Leucoraja circularis* differs from other species of the genus in having spinulose upper surface, 5 thorns in a complete row around inner margin of eye in contrast with uniform dorsal livery sen in *Leucoraja fullonica*; tail only slightly longer than body; eye-spots absent on the disc in contrast with *Leucoraja melitensis* and *Leucoraja naevus*. (Stehmann and Bürkel, 1984; Fricke *et al.* 2007; Consalvo *et al.* 2009).

In the Genus *Dipturus*, only *D. johannisdavisi* was collected from the study area. The more distance between the two dorsal fins than half the length of the base of either, about equal size of both and the second is confluent with the caudal distinguish this species from other related species (Weitkamp and Sullivan, 1939; Compagno, 1999; Chinese Academy of Fishery Sciences, 2003).

*Benthobatis moresbyi* differ from congeners *B. marcida*, *B. kreffti* and *B. yangi* in having uniformly dark brown ventrally without any areas of lighter colour in preservation. Both *B. moresbyi* and *B. marcida* are much larger when compared to other two species. *B. moresbyi* differs from *B. yangi* in having a very short interdorsal space and second dorsal-cadal distance (Menon and Yazdani, 1968, Carvalho, 1999, Carvalho and Randall, 2003 and Carvalho *et al.* 2003).

The original description of the species *Neoharriotta pinnata* given by Schnakenbeck, (1931) as *Harriotta pinnata* from Walvis Bay and was revised by Bigelow and Schroeder, (1950) and subsequently established the genus *Neoharriotta.* Smith (1953) and Karrer (1973) further revised and redescribed the species. Silas and Selvaraj (1980) have given a descriptive account of this species from Indian waters. *Hariotta releighana* differ from the previously reported two related species in having a long and pointed snout, lacking a hooklike process, caudal fin without tubercles on dorsal margin, dorsal head profile convex, eye above mouth, tooth plates broad and blunt-edged with ridges and knobs (Paxton *et al.* 1989; Compagno *et al.* 1989; FAO-FIES, 2008; Didier, 1995 and Stehmann and Bürkel, 1984).

*Rhinochimaera atlantica* and *R. pacifica* are lighter in colour; with short, narrower snout; somewhat short clasper glans; longer caudal fin and shorter interdorsal space than *R. africana*. A caudal tubercle count of *R. atlantica* (most with 19-33, rarely up to 43) is much lower than *R. africana* (40-46) and *R. pacifica* (41-68, rarely as low as 25-34) (Compagno, *et al.* 1990).

*Halosaurus carinicauda* differs from *H. nigricaudis* and showed similarity with *H. nigerrimus* because of the presence of disunited ventral fins and in having pre-oral of half the snout length. However, it shows similarity to *H. nigricaudis* due to the presence of scales on head and differs from *H. anguilliformis* due to the presence of same character (Alcock, 1889; McDowell, 1973; Cubelio *et al.* 2009a).

*Notacanthus indicus* differs from other species of the genus in the number of dorsal fin spines. The dorsal fin spines in *N. nasus* and *N. analis* is X-XI while it is VI-VIII in *N. bonapartii* and *N. sexspinis* (Goode and Bean, 1896; Anon, 1999; Hanel and Novák, 2001; Moser, 1996; Nakamura *et al.*, 1986 Weitkamp and Sullivan, 2003). *H. bathybius* of the genus *Histiobranchus* differ from the other species *H. infernatis* in its slender body and lower vertical fins (Goode and Bean 1896). *Synaphobranchus kaupii* differed from *S. brevidorsalis* of Pacific Ocean in the origin of dorsal fin, which is far behind in *S. brevidorsalis* and shows some similarity to *S. affinis* (Gunther, A. 1877; Goode and Bean, 1896).

*Coloconger raniceps,* the only species collected from the study area shows very close affinity to *C. sholesi* and *C. Japonicus* in all the characters, however, but for the extension of the mouth cleft to the hinder edge of the pupil, presence of a large, oval horny, granular plate behind the superior pharyngeal bones of *C. raniceps* (Alcock, 1889; Alcock, A. W., 1892; Kanazawa, 1957 and 1961; Chan, 1967; Okamura and Kitajima, 1984; Smith, 1990).

*Gavialiceps taeniola*, which is commonly confused as a nettastomid eel, differs in having the posterior nostril located far forward on the snout, closer to the anterior nostril than to the eye; in nettastomatids, the posterior nostril is closer to the eye than to the anterior nostril. In *Gavialiceps*, the supraorbital pores are enlarged and slit-like and the inner row of teeth on the upper jaw is separated from the outer rows by a longitudinal toothless groove while in nettastomatids, there is no such separation (Alcock 1889; Alcock, 1891, 1892; Karmovskaya, 1994; Bianchi, *et al.* 1999; Carpenter and Niem, 2001).

*Bathycongrus wallacei* differ with the congeners in dorsal fin origin above first quarter up to first third of length of pectorals; 1-2 enlarged vomerine teeth on elevated base; the largest vomerine tooth larger than intermaxillary teeth (FAO-FIES, 2008; Chinese Academy of Fishery Sciences, 2003; Letourneur *et al.* 2004).

The genus *Promyllantor* is monotypic and includes the species *P. purpureus*. It differs from the genus *Acromycter* in having posterior nostril on side of head below upper margin of eye. Whereas, it differs from the genera *Bassanago* and *Japonoconger* in having small mouth, its angle does not reach anterior margin of eye and presence of only 2 pores along upper lip between anterior nostril and angle of mouth (Asano, 1962; Castle, 1964, 1969).

*Rhynchoconger ectenurus* differs from its close relative *R. brevirostris* in having the inner row of maxillary and mandibular teeth not separated from outer rows by an edentulous groove; maxillary and mandibular teeth concealed when mouth closed (Chen and Weng, 1967).

The reduced lips, maxillary and the exposure of lateral mandibular teeth when mouth closed differentiate *Xenomystax trucidans* from other related species (Castle, 1969; Adam *et al.* 1998: Anon 1999; Kapoor *et al.* 2002).

*Sauromuraenesox vorax* (Alcock, 1889), a monotypic species of the genus differs from the closely related species *Oxyconger leptognathus* in having vomer with a median series of enlarged fangs; caudal fin not reduced, tip of tail soft and flexible; anus at or before midlength. While it differs from other species of the family Muraenesocidae in having the lower jaw with 1 row of teeth; head large and massive compared to body, maximum depth of head almost twice depth of body at anus. In addition, it has similar but sharper vomerine teeth as in the case of *Muraenesox* spp. uniserial teeth on jaws (Alcock, 1898; Fischer and Bianchi, 1984).

*Avocettina paucipora* differs from other genera in having caudal region not thread-like, a small caudal fin present; 1 row of pores in lateral line and small, longitudinal dermal ridges on head. While in *Nemichthys scolopaceus,* caudal region is extremely elongated and thread-like, a distinct caudal fin absent; 3 rows of pores in lateral line and no dermal ridges on head (Karmovskaya, 1990; Nielsen and Smith, 1978).

In family Alepocephalidae, the genera are related very closely and shares many characters like snout variable in shape and length, from short and obtuse (*Bathylaco*) to beak-like (*Narcetes*, *Rinoctes*, *Alepocephalus longiceps*) or very long and tubular (*Aulastomatomorpha*). Premaxillae without anteriorly directed tusks bearing enlarged teeth, variable in shape and length, usually with teeth in 1 to many series but multiserial in *Narcetes.* While teeth is biserial in *Bathytroctes* and *Talismania* where the teeth in outer series modified into horizontally directed, plate-like, subtriangular or semicircular in shape, and few in number Maxilla with uniserial teeth usually, but *Narcetes* with 2 or more rows and toothless in the remaining. Head usually scaleless except in some *Bathytroctes* (Sazonov and Ivanov, 1980; Fischer and Bianchi, 1984; Sazonov *et al.* 1993; Carpenter and Niem, 1999).

In the genus *Alepocephalus*, two species *viz. A. bicolor* and *A. blanfordii* have shown their presence in the study area. They differ each other in the dorsal fin origin, in *A. bicolor* it is before anal origin and in the case of *A. blanfordii* it is opposite or a little behind anal origin. *Rouleina nuda*, *Bajacalifornia calcarata*, *Talismania longifilis*, *Narcetes lloydi* were the single records from respective genera. *Platytroctes mirus* differs from the closely related species *P. apus* in having a slender body, the premaxillae with anteriorly directed tusks bearing enlarged teeth and pelvic girdle (Lloyd, 1909; Quéro *et al.* 1984; Carpenter and Niem, 1999).

*Ateleopus indicus* of the family Ateleopodidae differs from its close relative of Pacific Ocean *A. japonicus* byt the passion of small pelvic fins (Masuda *et al.* 1984; Adam *et al.* 1998). *Argyropelecus hemigymnus* differs from other species of the genus in having the cleft of mouth wide, sub-vertical and maxilla reaching behind anterior margin of eye (Gon, 1990; Weitzman, 1986; Hoese *et al.* 2006; Somarakis *et al.* 2002). *Astronesthes martensii* differs from *A. indicus* and *A. indopacificus* in having dorsal with lesser number of soft rays (Weitkamp, and Sullivan, 1939; Gibbs, 1986; Baranes and Golani, 1993).

The Family Evermannellidae shown its presence with *Evermannella indica* and *Coccorella atrata*. *E. indica* and its allied species *E. balbo* differs from each other in the number of anal soft rays of 27-31 in *E. Indica* and 33-37 in *E. balbo*. While in *E. ahlstromi* the number of dorsal soft rays is 10-12 while anal rays are 29-32 (Maul, 1979; Johnson, 1990; Swinney, 1994;

Ambrose, 1996; FAO-FIES, 2008). *C. atrata* typically have only four pores in the frontal canal commissure; urohyal short, much less than ceratohyal and basibyal toothplate apparently lost. Whereas in *C. atlantica*, urohyal equal to ceratohyal and basihyal toothplate cover only posterior two thirds of basihyal (Johnson, 1982, Kailola, 1987; Hoese *et al.* 2006).

*Stemonosudis rothschildi* of the Family Paralepididae differs from the other species under the same genus in having saddle-like blotches and last dorsal fin ray not before first anal fin ray. *Lestidium nudum* is characterised by one band of luminous tissue on ventral midline (from between pelvic fins) to isthmus (between opercles) while *L. bigelowi* in having three separate photophores on ventral midline, located on isthmus, between bases of pectoral fins and between bases of pelvic fins respectively. In *L. atlanticum*, body is pale with greyish dorsal band; adults with a heavily pigmented caudal peduncle except for the light band along the lateral line, whereas the body is darker, caudal peduncle not heavily pigmented and body deeper in *L. nudum* (Tinker, 1978; Fukui and Ozawa, 2004).

*Magnisudis indica* differs from the allied species *M. atlanticus* and *M. prionosa* in having pointed snout longer than eye diameter, wide terminal mouth cleft; dorsal fin origin more or less at the middle of the body and pectoral subequal to body depth (Post, 1984, 1990).

The genus *Chlorophthalmus* represented the Family Chlorophthalmidae with *C. agassizi*, *C. bicornis* and *C. nigromarginatus*. *C. nigromarginatus* showd similarity with *C. acutifrons* and differ from other species in shorter eye diameter than snout length, both head and body distinctly compressed and front back more or less elevated at the insertion of dorsal fin. However, these species differs from *C. acutifrons* in having the anterior margin of dorsal fin and posterior margin of caudal fin black and the middle portion of ventral fin with a transverse black band. Whereas in *C. punctatus,* the eye diameter is about equal to snout and with 56 lateral line scales. Eyes large, its diameter longer than snout length; body square in middle or cylindrical anteriorly; back not elevated at the insertion of dorsal fin in *C. agassizi, C. japonicus, C. oblongus* and *C. albatrossis*. *C. agassizi* differs from *C. albatrossis* in having large head, maxillary reaching the vertical line of anterior margin of eye. *C. bicornis* differs from all other species in having the lower jaw with a projecting denticulate plate (Fischer and Bianchi, 1984; Sulak, 1986; Merrett, 1990; Bianchi *et al.* 1999; Anon, 2000).

*Bathypterois atricolor* was the only species recorded from the Family Ipnopidae that consists of single genus (Nielsen, 1979; Masuda *et al.* 1984; Haedrich and Merrett, 1988; Kapoor *et al.* 2002). *Paraulopus maculatus* was the only species of the Family Paraulopidae, which differs from *P. japonicus* in having 42 pored lateral line scales and 25 caudal vertebrae however, both are similar in having a normal dorsal fin and caudal fin without black posterior margin (Sato and Nakabo, 2002).

The Family Synodontidae has shown its presence with the genera *Saurida* and *Harpodon*. Both *S. longimanus* and *S. undosquamis* were recorded in the present study under the genus *Saurida*. *S. undosquamis* differs from others in having lateral-line scales ridged on the caudal peduncle, conspicuously concave posterior margin of the pectoral fin, 51–55 pored lateral-line scales, and 50–53 vertebrae. S. *longimanus* differs from the others in having a long pectoral fin extending past the origin of the dorsal fin

(Cressey and Waples, 1984; Russell, 1999; Inoue and Nakabo, 2006). The allied species *Harpodon nehereus* differs from *H. microchir* in having pectoral fins reaching beyond origin of dorsal fin and dorsal-fin rays 12 or 13, while it shows similarity with *H. translucens* in pectoral fins reaching well short of origin of dorsal fin. But it differs from this species in pectoral fins reaching much less than 1/2 distance from snout to origin of dorsal fin (Masuda *et al.* 1984; Russell, 1999; Randall and Lim, 2000).

The Family Neoscopelidae is represented by two species *Neoscopelus microchir* and *Scopelengys tristis*. Upper lateral series of photophores extends well past midpoint of anal-fin base; gill rakers usually 14 (rarely 15 or 16) in *N. microchir* and differs from *N. macrolepidotus* in having the upper lateral series of photophores extends only to about anus; gill rakers usually 11 (rarely 12 to 14) (Nafpaktitis, 1977; Uyeno and Kishida, 1977; Burgess and Branstetter. 1985; Castellanos-Galindo *et al.* 2006).

*Physiculus roseus* has shown its presence with the Family Moridae, in the present study. *P. argyropastus, P. capensis, P. edelmanni, P. natalensis* and *P. peregrinus* are the other species known from the western Indian Ocean. In *P. roseus* the first ray of the dorsal fin prolonged, the longest ventral ray reaches only just beyond the origin of the anal. Whereas in the most allied species *P. argyropastus*, dorsal fin not prolonged and the longest ventral ray reaches far beyond the origin of the anal (Fishcher and Bianchi, 1984; Cohen *et al.* 1990; Paulin and Roberts, 1997).

The sub Family Bathygadinae represented with two species *Bathygadus melanobranchus* and *Gadomus capensis*. In *G. capensis*, the barbell is much shorter than the allied species *G. longijilis*, *G. armatus* and *G.*

*dispar*. Pelvic fins with 9-10 rays, eye small in adults and barbell is absent in *B. favosus*. While pelvic fins with 7-8 rays, eye large in adults in *B. macrops* and *B. melanobranchus*, but differ each other in the presence of a short barbell in the former (Merrett, 1986; Iwamoto and Anderson, 1994; Cohen *et al.* 1990).

The genus *Caelorinchus* represented in the study area with three species viz. *C. quadricristatus*, C. *braueri* and C. *flabellispinnis*. The upper jaw tooth band much shorter than that of lower jaw and pyloric caeca 8-11 in number in *C. braueri*. While the upper jaw tooth band as long as or longer than that of lower jaw, pyloric caeca 40-53 in *M. quadricristatus* and *M. flabellispinis*. They differs each other in having body-scales with 5 spiny ridges, 6 to 6½ series of scales between the first dorsal fin and the lateral line in the former and body-scales with 8 or 9 spiny ridges, 4 to 5 series of scales between the first dorsal fin and the lateral line in the latter (Alcock, 1890; Cohen *et al.* 1990; Iwamoto and Anderson, 1994).

*Malacocephalus laevis* differ from the allied species *M. occidentalis* and *M. okamurai* in having 9 pelvic-fin rays, 2 distinct rows of teeth in premaxillary and no black margins on snout (Cohen *et al.* 1990; Iwamoto and Schneider, 1995; Iwamoto, 2002). *Nezumia investigatoris* and *Coryphaenoides macrolophus* were also collected from the study area.

*Brotulotaenia crassa* differed from the closely allied species *Brotulotaenia nigra* in having head length 5.3 to 8.5 in standard length; dorsal-fin rays 119 to 134; anal-fin rays 98 to 108. Whereas *B. nielseni* and *B. brevicauda* have head length 5.3 to 9.9 in standard length; dorsal-fin rays 113 to 134; anal-fin rays (Nielsen and Merrette, 1999; Hoese *et al.* 2006).

In the Sub Family Neobythitinae, three species viz. *D. nigricaudis, D. tristis* and *D. multifilis* were recorded among the15 under the genus *Dicrolene*. *D. multifilis* differs from other two in having single median basibranchial tooth patch. *D. nigricaudis* bears only 10 developed gill rakers, while *D. tristis* 11-12 (Alcock, 1891; Cohen and Neilsen, 1978; Smith and Heemstra, 1986; Nielsen *et al.* 1999; Lee *et al.* 2005).

The genus *Glyptophidium* represented by G. *lucidum*, *G. oceanum, G. argenteum* and *G. macropus* from the study area. The *G. lucidum* and *G. argenteum* differs from the other two species in having a single ventral fin ray, single median basibranchial tooth patches and 14 to 23 long gill rakers on anterior arch. While they differ each other in the diameter of orbit to head length and in the number of pectoral fin rays. Whereas the *G. oceanium* and *G. macropus* differ in the number of gill rakers and the diameter of orbit (Cohen & Nielsen, 1978; Nielsen and Machida, 1988; Neilsen *et al.* 1999; Nakabo, 2002; Kurup *et al.* 2008). Monotypic genus, *Hypopleuron* with the species *H. caninum* is also recorded during the present study. (Neilsen *et al.*, 1999; Hoese *et al.* 2006). *Lamprogrammus exutus* and *L. niger* are closely related and differ each other in the presence of median basibranchial tooth patch in *L. exutus* (Cohen and Rohr, 1993; Neilsen *et al.* 1999; Fahay and Nielsen, 2003). *Luciobrotula bartschi* differs from *L. lineata* and showed similarities with *L. corethromycter* in the length of ventral fin and lateral line terminating about level of anal fin. While, it differs from the latter in the lower number of dorsal fin rays, short ventral fin and preventral distance (Nielsen *et al.* 1999). *Monomitopus conjugator* differs from other species of the genus in possessing small eye; the horizontal diameter of eye 4.3 to 4.7 in head length.

Wheras the closest allele *M. americanus* have comparatively smaller eyes and more number of dorsal-fin rays and anal-fin rays (Alcock, 1896 &1897; Menon and Rama-Rao, 1975; Carter and Cohen, 1985).

Under the genus *Neobythites*, three species viz. *N. macrops*, *N. steatiticus* and *N. multistriatus* were recorded from the study area. *N. macrops* seems to be most similar to *N. soelae* with two preopercular spines, three ocelli in dorsal fin and absence of vertical bars on body. They differ in coloration of anal fin having posterior part black in *N. macrops* while unpigmented in adult and with 2 blotches in juvenile specimens of *N. soelae*. *N. multistriatus* is similar to *N. andamanensis* and N. *fasciatus* with many rather narrow, vertical bars on body, but differs from *N. andamanensis* having more rays in dorsal fin (106-III *vs* 101-102), anal fin (91-95 *vs* 84-86) and pectoral fin (28-30 *vs* 25-27) and longer gill filaments (5.8-6.3 *vs* 12.5-13.0% length of head). *N. steatiticus* seems most similar to *N. malayanus* with no spines on preopercle, one ocellus in dorsal fin, no black bars on body and only posterior part of dorsal fin black. They differ by *steatiticus* having middle part of all anal fin rays black (vs distal part of anal fin rays black), more long gill rakers (1 1-14 vs 8-1 1) and presence of longer gill filaments (15.0-19.0 vs 5.2-13.5 % head length) (Fricke, 1999; Neilsen, 2002). The monotypic genus *Spectrunculus* is also showed its presence by the occurrence of *S. grandis*.

In the family Bythitidae, *Grammonus ater* and *Hephthocara simum* have shown their presence were repoted previously from southwest coast of India by Alcock (1892 and 1898) and Menon and Yazdani (1968). *Grammonus ater* shows similarity with *G. waikiki* and *G. diagrammus* and differ from *G. claudei* in the preopercular spines and pores on the lateral head canal (0-1 number). While it differs from all other species under this genus except *G. claudei* in having least number of dorsal and anal fin rays (Whitehead *et al.* 1986; Nielsen *et al.* 1999; Nielsen and Cohen, 2004; Nielsen, 2007).

The Family Lophiidae and has shown its presence by *Lophiodes mutilus* and *Lophiomus setigerus.* Caruso (1981) divided the genus Lophiodes into three species groups: the *Lophiodes naresi* group, the *Lophiodes caulinaris* group and the *Lophiodes mutilus* group. The *L. mutilus* group comprised of five species and is mainly characterized by the absence of fourth dorsal fin spine, the fifth and sixth dorsal fin spine reduced or embedded under the skin, the inner sphenotic spines well developed and directed upward, not recurved, and the interorbital area slightly concave, but not forming a deep U-shaped trough. *L. mutilus* differs from other species in the group in having the third cephalic dorsal-fin spine very long (36 to 64% of standard length); I or II post-cephalic dorsal-fin spines absent and the presence of inner frontal spines (reduced in large individuals) (Menon and Yazdani, 1968; Ho and Shao, 2007, 2008). *L. setigerus* shows similarity with the genus *Lophiodes* and differs with *Sladenia remiger* in the depressed head and body and presence of a third cephalic dorsal-fin spine. It differs from *Lophiodes* in frontal ridges rugose, bearing low conical spines; gill opening not extending well in front of pectoral-fin base, restricted to below and behind base; floor of mouth with distinct pattern of dark anastomosing lines or pale circles on dark background (Alcock, 1889; Kharin and Cheblukov, 2005).

The Family Chaunacidae showed its presence by *Chaunax pictus* in the study area. It differs from *Bathychaunax roseus* in having finely spinose skin, dermal denticles closely spaced; anal-fin soft rays 6 or 7, usually 7 Whereas it differs from the closely allied species C. *suttkusi* in the colour of illicial cavity and strongly concave nature, black front surface of esca and translucent or white rear surface (Caruso, 1989 & 2003; Caruso *et al.* 2007).

*Melanocetus murrayi* was recorded as the only species in the Family Melanocetidae. *Melanocetus murrayi* females can be distinguished by the presence of deeply concave shape of the anterior margin of the vomer, while it is nearly straight in *M. johnsonii* and size and shape of the escal bulb (Pietsch and Van Duzer, 1980; Bertelsen and Pietsch, 1983; Bertelsen, 1990; Stewart and Pietsch, 1998, Pietsch *et al.* 1999).

The Family Ceratiidae is represented by *Ceratias uranoscopus,* which have illicium short, nearly completely enveloped by tissue of escal bulb; subopercle with an anterior spine in *Cryptopsaras couesi.* While considerably longer illicium than escal bulb and subopercle without an anterior spine in *Ceratias. C. uranoscopus* shows similarity with *C. holboelli* and differs from *C. tentaculatus* in having esca with not more than a single distal appendage. Whereas it differs from the later in having esca without distal appendages, illicium length 14.0-28.8% SL and vomerine teeth absent. (Pietsch, 1986, 2006; Stewart and Pietsch, 1998).

Family Diceratiidae is represented in the study area with *Diceratias trilobus* and *Bufoceratias wedli.* Metamorphosed females of *Diceratias trilobus* differs from those of all other species of the genus in having an unusually large, laterally compressed esca, greatest width slightly more than 1.5 times its length (9.6–10.5% *SL*); a rounded terminal escal papilla; and anterior and posterior escal appendages well developed, each usually bearing one or more tiny, slender terminal filaments ( Pietsch and Randall, 1987; Pietsch *et al.* 2006).

*Bufoceratias wedli* is one among the reported three species each of their respective genera. It differs from its congeners *B. shaoi* and *B. thele* by having a short illicium and an unusually large and morphologically complex esca (Pietsch *et al.* 2004).

In the Family Ogcocephalidae, genus *Halieutaea* differs from other alleled genera in having the disc rounded, gill filaments present on second and third arches, an additional hemibranch present on fourth arch, lower edges of esca bearing numerous filaments. The genus has shown its presence with two of its 9 species viz. *H. coccinea* and *H. stellata*. Both have body surface covered with minute spinules between principal tubercles and differs each other in having the under surface of disk finely granular, interorbital space decidedly concave in *H. stellata* while, the under surface of disk with stellate spines; interorbital space hardly concave; 5 rays on the dorsal fin in *H. coccinea* (Paxton *et al.* 1989; Heemstra *et al.* 2006; Ho and Shao, 2008).

The genus *Halieutopsis* differs from *Halieutaea* in having 2 gills while the latter have 2½. *Halieutopsis* with ten valid species is represented by *H. Micropa* which shows similarity to the alleled species *H. galatea, H. margaretae* and *H. stellifera* in having the ventral spine. It differs from the closely alleled species *H. margaretae*, which have bifurcated ventral spines, a flat head, not box like and ventrally not reduced (Bradbury, 1986; Ho and Shao, 2007).

*Polymixia nobilis* and *P. japonica* were collected the Family Polymixiidae. The genus includes closely species and is known mainly from Indian and Pacific oceans. *P. nobilis, P. busakhini* and *P. fusca* inhabit the Indian Ocean (Hemstra, 1986; Kotlyar, 1993, 1996; Thomas *et al.* 2003). *Polymixia berndti, P. japonica, P. longispina* and *P. sazonovi* are known in the north-west part of the Pacific Ocean (Kotlyar, 1992, 1996). *P. nobilis* and *P. japonicus* differ each other in having dorsal soft rays 35-37 and 32-33 respectively (Farias *et al.* 2007).

Family Trachipteridae represented by the *Zu elongatus* from the study area. *Zu elongates* differs from its allied species *Z. cristatus* in having the body depth 12 to 16% of standard length; lateral line consists of 126 to 130 spiny scales or plates and 84 to 87 total vertebrae (Charter and Moser, 1996; Heemstra and Kannemeyer, 1984; Olney, 1984; Olney *et al.* 1993; Robins *et al.* 1986; Carpenter and Niem, 1999).

The Family Berycidae is represented by *Beryx decadactylus* and *B. splendens* from the study area. They differ from the allied genus *Centroberyx* in having dorsal fin with III to V spines; soft anal-fin rays 25 to 30. *B. decadactylus* differ from *B. splendens* in having the highest body depth 44 to 50% of standard length; 4 pairs of spines on head: anal-fin origin below middle of dorsal fin while the greatest body depth 33 to 40% of standard length; only 1 pair of spines on head (lachrymal); anal-fin origin behind or just below posterior end of dorsal fin in the later (Paxton, 1999; Moore, 2002).

*Anoplogaster cornuta* under Family Anoplogastridae differs from its allied species *A. brachycera* in having parietal 8 to 9% standard length and preopercular 7 to 8% standard length while it is much shorter in (Kotlyar, 1986).

Family Trachichthyidae showed its presence through *Gephyroberyx darwinii, Hoplostethus melanopus* and *H. mediterraneus.* The genus *Gephyroberyx* differs from the other genera in having more number of dorsal fin spines and longer spinous dorsal fin base than anal fin base, while *Hoplostethus* differ from *Paratrachichthys* in having anus immediately before anal fin and no scutes between anus and anal fin. *H. mediterraneus* and *H. melanopus* differ from *H. atlanticus* in having less number of dorsal soft rays and more number of anal soft rays. *H. mediterraneus* differs from *H. melanopus* and *H. tenebricus* in having less number of pectoral fin rays and belly scutes, while *H. melanopus* is distinguished from the closely allied species *H. tenebricus* in having the greatest body depth of 50 to 57% of standard length and length of longest gillraker 19 to 30% of head length (Woods and Sonoda, 1973; Maul, 1990; van Guelpen, 1993; Andrade *et al.* 2004).

Family Diretmidae showed its presence through *Diretmichthys parini. D. parini* and *D. pauciradiatus* differ from *D. argenteus* in the postion of anus, which is midway between pelvic and anal fins separated from anal fin by at least 5 scutes), absence of keeled scutes along ventral midline anterior to pelvic fins, less number of bony ridges on upper half of operculum and body profile elliptical in adults. Whereas *D. parini* differs from its close relative *D. pauciradiatus* in having the tips of pelvic fins extend to or beyond anal-fin origin, 26 to 30 (usually 27 or 28) soft dorsal-fin rays and 18 to 20 rakers on first gill arch (Post, 1990; Moore, 2002).

In the Family Parazenidae, *Cyttopsis* is represented by *C. rosea* from the study area. Family Zeidae is represented by *Zenopsis conchifer*. Fused anal fin spines have previously been reported in zeiform families Parazenidae (*Cyttopsis rosea)* and Cyttidae (*Cyttus novaezelandiae* and *C. traversi*) (Heemstra, 1980, Tyler *et al.* 2003). *Z. conchifer* shows similarity with *Z. nebulosa* and *Z. oblonga* in having dorsal fin spines 8–10; 3rd anal-fi n spine movable (not fused to pterygiophore) and *Z. stabilispinosa* differs from the other species in having the first two anal fin spines movable and a third fused to the pterygiophore. Whereas *Z. conchifer* differs from *Z. oblonga* and *Z. nebulosa* in having bony bucklers along spinous portion of dorsal-fi n base 1–3 and bucklers absent from base of anal fin spines (Nakabo *et al.* 2006).

In the family Scorpaenidae, differences in the lengths of the supraocular tentacle are only occasionally diagnostic in some species of *Parascorpaena* (Poss, 1999). In most scorpaenids there is considerable variation, and even presence or absence of the tentacle can be observed within a single species (Randall and Eschmeyer, 2001). Degree of the dental development and the maximum body size may be influenced by environmental conditions, including water temperature and food availability. *Setarches* and *Ectreposebastes* show similarity and differ from their allied genera in having broad groove lateral line without tubed scales and head cavernous and rather weakly ossified. They differ each other in the length of the preorbital spine, head scaled or scale less, orbit diameter and spines and rays of anal fin. The genera *Pterois* and *Scorpaena* differ each other in the length of pectoral fin rays and spines on opercle (Fischer and bianchi, 1984; Hureau and Litvinenko, 1986). *Scorpaena scrofa* distinguished from its close relative, S. *onaria* by the presence of distinct tentacles on the ventral surface of the lower jaw (Eschmeyer, 1969, 1986; Motomura *et al.* 2005). The genus *Pterois* is represented by *P. russelii*. The caudal fin, and in some species dorsal and anal fins are covered with dark spots. Furthermore, dorsal fin is with 12 spines in *P. antennata* and *P. radiata* (13 in *P. russelii*) and pectoral fin membrane between upper rays entirely absent distally in *P. mombasae* (Fischer and Bianchi, 1984; Eschmeyer, 1986). The genus *Ectreposebastes* has shown its presence by *E. imus*. Scales present on top of head in *E. imus,* while the anteriormost preorbital spine on lacrimal bone much shorter than the posterior 2; pectoral fin rays 18 to 20, usually 19 (20 to 25 in *S. guentheri*). Head not cavernous and weakly ossified; lateral line scales form tubes in other scorpaenids (Fischer and Bianchi, 1984; Eschmeyer and Collette, 1966; Eschmeyer and Dempster, 1990).

In the Family Triglidae, the genus *Lepidotrigla* is represented by *L. spiloptera*, and the genus *Pterygotrigla* by *P hemisticta*. *L. spiloptera* has smaller scales of 19 to 21 rows below lateral line while *L. faueri* with larger 12 to 16 scale rows. Other *Lepidotrigla* species differ in having rostral process either a pair of curved projections with no prominent spines, or with a single pair of prominent, blade-like spines much larger than the others. Genus Chelidonichthys has no fissure or occipital groove behind eyes and *Pterygotrigla* have broad, flattened bony plates at base of dorsal fin, but no plates or spines along base of second dorsal fin. *P. hemisticta* is distinguished from *P. guezei* in having elongated opercular spine and dark spots on body. Other species of Triglidae have small plates with strong lateral spines along bases of first and second dorsal fins (Richards and Saksena, 1977; Shinohara *et al.* 2005; Paxton *et al.* 2006; Nakabo, 2002; Hutchins, 2001).

*Peristedion weberi* and *P. barbiger* of Family Peristediidae have shown their presence in the study area (Eschmeyer, 1998; Heemstra, 1986). *Dactyloptena* of the Family Dactylopteridae is represented by *D. macracantha* and *D. orientalis*. Both the species show similarity with other species and distinguished from *D. peterseni* and *D. tilteni* in having a spine about midway between elongate anteriormost spine and those in continuous part of spinous dorsal fin. While *D. gilberti* and *D. papilio* differ in having very wide interorbit. Whereas *D. orientalis* is distinguished from *D. macracantha* in having the preopercular spine not extending further posteriorly than posttemporal spine; many dark spots on pectoral fins, upper flank, and top of head in specimens over 15 cm standard length; 1 dark ocellus about 2/3 from tip of fin in specimens between about 5 and 6.5 cm standard length (Eschmeyer, 1997).

Family Serranidae is represented by *Chelidoperca investigatoris*. *C. investigatoris* is distinguished from other species of the genus in having emarginate caudal fin with elongated upper lobe. While *C. pleurospilus* have truncate caudal fin, *C. margaritifera* and *C. hirundinacea* have normal emarginate caudal fins (Alcock, 1890; Heemstra and Randall, 1999; Eschmeyer, 2003).

The Family Priacanthidae is represented by *Priacanthus hamrur* and the monotypic genus *Heteropriacanthus* by *H. cruentatus*. *P. hamrur* distinguishable from its allied species *P. holocentrum* and *P. cruentatus* in having lateral line scales 66-80, gill raker 26-33, preopercle spine conspicuous in adults, pelvic fins black or partly black and no spots (Talwar and Kacker, 1984; Philip, 1994; Starnes, 1999). *Pristigenys niphonia* was reported from the Indian waters but was not encountered during this study (Philip, 1994; Nair and Geetha, 2006).

Family Nemipteridae is represented by *Parascolopsis aspinosa* in the genus *Parascolopsis*. *P. aspinosa* shows similarity with *P. boesemani* and differentiated from *P. eriomma, P. townsendi and P. tosensis* in having preopercle with a distinct broad naked flange bordering its free margin. While the other allied species *P. qnantasi*, *P. rufomaculatus*, *P. tanyactis* and *P. inermis* differ from *P. boesemani* in having head scales reaching forward to about middle of eyes, or between middle and anterior margin of eyes. It differ from *P. boesemani* in having posterior margin of suborbital smooth or with just a few tiny spines and a black blotch at base of middle of dorsal fin (Rao and Rao, 1981; Russell, 1990; Naik *et al.* 2002).

Family Bathyclupeidae has shown its presence with *Bathyclupea hoskynii*. Genus *Bathyclupea* was affiliated with Clupeidae (Alcock, 1891). *Bathyclupea* was placed in the Pempheridae by and Weber (1913), whereas Goode and Bean (1895), Regan (1913), Jordan (1923) and all current ichthyologists have placed it in a separate acanthopterygian Family Bathyclupeidae (Tominga, 1968). Family Epigonidae is shown its presence by *Epigonus pandionis*. *E. pandionis* and the allied species *E. denticulatus* differ from other related species in having the lateral-line scales 46 to 51 and pyloric caeca 10 to 14. It is differentiated from the closely related species *E. denticulatus* in having the body depth 22.0 to 30.0% and length of caudal peduncle 22.0 to 27.0% standard length; first dorsal-fin spine long, 5.0 to

8.5% standard length (Gon, 1986, 2002; Mauge and Mayer, 1990; Abramov, 1992).

Family Pentacerotidae is represented by only one species, *Histiopterus typus*. It differs from the allied genus *Pentaceros* in having dorsal fin with 4 spines and 25 to 27 soft rays (Heemstra, 1986, 1997; Lieske and Myers, 1994).

Family Cepolidae is represented by *Owstonia simoterus* from the study area. *Owstonia* is distinguished from the genus *Acanthocepola* in having the last ray of dorsal and anal fins not connected to caudal fin by a membrane and total dorsal fin elements 24 or 25 (Smith-Vaniz, 1986; Anon, 2000).

The Family Acropomatidae has shown its presence by the genera *Acropoma* and *Synagrops*. *Acropoma japonicum* is distinguished from allied species by anus closer to anal fin than to origins of pelvic fins and no light organs. Furthermore, scales cycloid (smooth to touch) and only 2 anal fin spines in *Synagrops* (Heemstra, 1986; Paxton *et al.* 1989). *Synagrops philippinensis* and *S. japonicus* were recorded during the present study. *Synagrops adeni* and *S. pellucidus* have pelvic spine serrate and preopercular ridge with spines. While *Neoscombrops annectens* have 3 anal fin spines (2 in *S. japonicus*) and 15 or 16 gillrakers on lower limb of first arch (12 in *S. japonicus*). Whereas in *Oxyodon macrops,* scales are ctenoid (rough to touch); no canines in jaws and opercle with 3 or 4 short spines dorsally. In *Acropoma japonicum* the anus is closer to pelvic fin origins than to anal fin; a light organ between pelvic fins and a light reflector along lower profile of body and presence of 3 anal fin spines. *S. philippinensis* resembles *S. japonicus* and *S. analis* but distinguished by the serration on the anterior edge of pelvic spine; 2 spines and 7 soft rays in anal fin; 16 rays in pectoral fin; and small body size (Alcock, 1890; Kailola, 1987).

Family Centrolophidae is represented by *Psenopsis cyanea*. Adipose tissue around or ahead of eyes not conspicuously developed except in *Psenopsis*. About 8 short, strong dorsal spines, lateral line arched anteriorly and the insertion of pelvic fins under pectoral fin bases in *Hyperoglyphe*. Whereas in *Centrolophus*, *Icichthys* and *Schedophilus*, spines of dorsal fin weakly developed and all graduating to the soft rays (Dorsal with 6 to 7 weak, short spines increasing slightly in length to the much longer 26 to 28 segmented rays in *P. cyanea*). The very closely related species *P. obscura* is distinguished from *P. cyanea* in having slightly deeper-body with a larger eye (diameter over 25% of head) and anal fin originating at about mid-body (Sommer *et al.* 1996).

Family Nomeidae is represented by *Cubiceps pauciradiatus, C. squamiceps* and *Psenes cyanophrys*. The genus *Psenes* differs from *Cubiceps* in having an oval body, toothless in the palate and the ventral fin is below the pectoral fin. *C. pauciradiatus* differs from the allied species *C. suqmiceps* in having the maxilla reaching to under anterior part of eye; pelvic fins long, originating directly under posterior end of the pectoral fin base 0.21-0.24 in SL. *Psenes cyanophrys* is having deeper body besides having a large nmber of dorsal and anal fin raysa and gill rakers when compared to *P. arafrnsis* and *P. maculatus* (Haedrich, 1986; Agafonova and Poluyaktov, 1992; Piotrovsky, 1994; Agafonova, 1994; Sommer *et al.* 1996).

Family Percophidae showed its presence by *Bembrops caudimacula*. The genera *Uranoscopus* and *Xenocephalus* are representing Family Uranoscopidae. Both the genera showed their presence with single species each viz. *U. crassiceps* and *X. australiensis* of the respective genus. *Uranoscopus* can be distinguished from *Xenocephalus* by the position of dorsal fin origin which is close to the pectoral base in the former and far behind body in the latter (Kishimoto, 1989, 2001; Eschmeyer, 1999).

Family Callionymidae is represented by *Callionymus sagitta,* differs from *C. leucopoecilus* by the caudal fin formula, (I, 7, ii principal rays in *C. sagitta*). The first spine half of length of first ray in the second dorsal in *C. sagitta* is at most one-third of that length in *C. leucopoecilus*. It is distinguishable from *C. sagitta* by its body shape and body colour pattern, which differs in more numerous small white spots in *C. leucopoecilus* but less in *C. sagitta*. *C. macdonaldi* distinguished from *C. sagitta* by the smaller distance between the first and second dorsal fins, the different proportions and colour pattern of the male's first dorsal fin, the plain black first dorsal fin of the female (Frickle and Lee, 1993).

Family Gempylidae has shown its presence with five genera in the study area. *Nealotus tripes*, *Ruvettus pretiosus* and *Promethichthys prometheus* are monotypic in their respective genera. The occurrence of the oil fish *Ruvettus pretiosus* on the upper continental slope was reported by Silas and Regunathan (1974). *Neoepinnula orientalis* represents the study area among the two species and *Rexea prometheoides* among 7 species. The very close species *P. prometheus* and *Nealotus tripes* are distinguished from each other by the 2 free, dagger-shaped spines in front of anal fin, (the second often embedded); lateral line oblique but fairly straight in the latter. *Rexea prometheoides* differs in having 2 lateral lines and a large black blotch on anterior part of dorsal fin. While in *Gempylus serpens*, body extremely elongate, 5 or 6 dorsal and 6 or 7 anal finlets (2 in *P. prrometeus*) and 2 lateral lines. Body elongate in *Diplospinus multistriatus* also, and differ in having first dorsal fin long-based, with 28 to 32 spines, no dorsal and anal finlets. In other species of Gempylidae, except *P. prometheus* pelvic fins well developed, with one spine and 5 soft rays. *Lepidocybium flavobrunneum* differs from *Ruvettus pretiosus* in having 8 or 9 dorsal fin spines (13 to 15 in *R. pretiosus*); no scaly keel on belly; scales not interspersed with tubercles; lateral line very markedly sinuous, keels present on caudal peduncle and 4 to 6 dorsal and 4 or 5 anal finlets (2 dorsal and anal in *R. pretiosus*). In other gempylid species: no scaly keel on belly; body smooth, scales not interspersed with spinous and bony tubercles. Acanthocybium, Scomberomorus, Sarda and other similar scombroid fishes have keels present on caudal peduncle; back blue or blue-grey, with bars, spots or other dark markings; 7 or 8 dorsal and anal finlets (Nakamura and Parin, 1993; Nakamura and Parin, 2001; Parin and Nakamura, 2003; McEachran and Fechhelm, 2005).

Family Trichiuridae showed its presence only by *Trichiurus auriga*. Silas and Rajagopalan (1974) reported the occurrence of *Trichiurus auriga* from the deep neritic waters and the continental slope.

Family Bothidae was represented by *Chascanopsetta lugubris* and *Psettina brevirictis*. *C. lugubris* differs from *C. prognathus* in having maxilla never exceeding 80% of head length. *C. galatheae* is having more than 122 rays in dorsal and 84 in anal fin while 114 to 122 rays in dorsal and less than 86 in anal fin in *C. lugubris* (Fischer and Bianchi, 1984). *Psettina* shows similarity with the alleled genera *Grammatobothus* and *Arnoglossus* and differ from *Chascanopsetta* in having maxilla contained more than two times in head length, and lower jaw not prominent. It differs from most close genus *Arnoglossus* due to the presence of strongly ctenoid scales on the eyed side (Fischer and Bianchi, 1984). *P. breviricti*s shows similarity with P *iijimae* and *P. variegata* and differs from *P. gigantea* and *P. profunda* due to the presence of dark spots or blotches along upper and lower edges of body include basal parts of dorsal and anal fins; a dark patch on distal part of pectoral fin and distal part of caudal fin with a broad blackish band. The most closely related species *P. varigata* differs due to presence of 72 lateral line scales (Norman, 1934; Hensley, 1986; Carpenter and Niem, 2001; Hensley and Amaoka, 2001; Froese and Pauly, 2009).

Family Cynoglossidae represented in the study area with two species viz. *Cynoglossus acutirostris* and *C. carpenteri*. Genus *Cynoglossus* differ from *Paraplagusia* due to the absence of fringed lips, and differs from the genus *Symphurus* in not having a lateral line. *C. carpenteri* and *C. marleyi* were having 3 lateral lines on eyed side but snout shorter while 33 and 42% of head length (43% in *C. acutirostris*). Furthermore, scales larger, 15 to 19 rows between upper and middle lateral line in *C. carpenteri* (18 to 20 in *C. acutirostris*) and all scales ctenoid on eyed side in *C. marleyi* (cycloid, at least anteriorly, in *C. acutirostris*). *C. capensis, C. microphthalmus, C. sealarki* and *C. zanzibarensis* are also have 3 lateral lines on eyed side but have only 1 nostril on eyed side 2 in *C. acutirostris* (Menon, 1977; Fischer and Bianchi, 1984; Randall, 1995). Family Soleidae is represented with *Aesopia cornuta* among the 29 genera so far been reported (Gloerfelt-Tarp and Kailola, 1984; Sommer *et al.*, 1996).

Family Triacanthodidae, the genus *Macrorhamphosodes* is represented by *M. uradoi. Macrorhamphosodes* and *Halimochirurgus,* are known to have a greatly elongated tubular snout. Genus *Macrorhamphosodes* is separated from the genus *Halimochirurgus* by snout width, tooth shape, twisting of the mouth, and the length of the third dorsal spine (Tyler, 1968). Genus *Macrorhamphosodes* is represented by *M. uradoi* and *M. platycheilus*. The later is found only in the Philippines and Bay of Bagal *M. uradoi* is differentiated from *M. platycheilus* by the shorter gill opening, smaller number of lower jaw teeth, and larger number of pectoral and dorsal rays (Tyler, 1968, 1983).

According to Misra (1962), the bathymetric temperatures of the temperate and tropical zones tend to be more or less uniform, while the surface temperatures are fluctuating. The isotherms may serve as an indicator to the taxonomist in dealing with the relationships of the species and subspecies from the zoogeographical point of view. A different view was expressed by Smith (1953). According to him, species common to the Indo-Pacific and the tropical Atlantic and the Mediterranean may be "relics of intermingling, for not very long ago in geological time conditions were different, and there was almost certainly a warm water connection between the Indian and Atlantic Oceans" It has been proved that in the low latitudes, thermocline is between 200-1000m (Pickard and Emery, 2003).

Many of the Families and Orders are represented in the study area with very few number of species. Many species were observed to share similar habitat as their counterparts in the other oceans. So it may also be concluded that there will be more species in the study area which may not be got in the trawling operations carried out during the present study. So the taxonomic list of fishes present in the thesis may not be final. A well organised and thorough study can unearth more number of species of fishes inhabiting the deeper waters of southwest coast of India.

FORV Sagar Sampada

SIMRAD EK 100

Trawl Deck

Catch putting into hatch

Net Shooting

A mixed catch of deep sea fishes

A catch of *Trichiurus auriga*

Hauled net on deck

Sorting in the wet lab

Fig. 2.1. Trawling operations and data collection onboard *FORV Sagar Sampada*

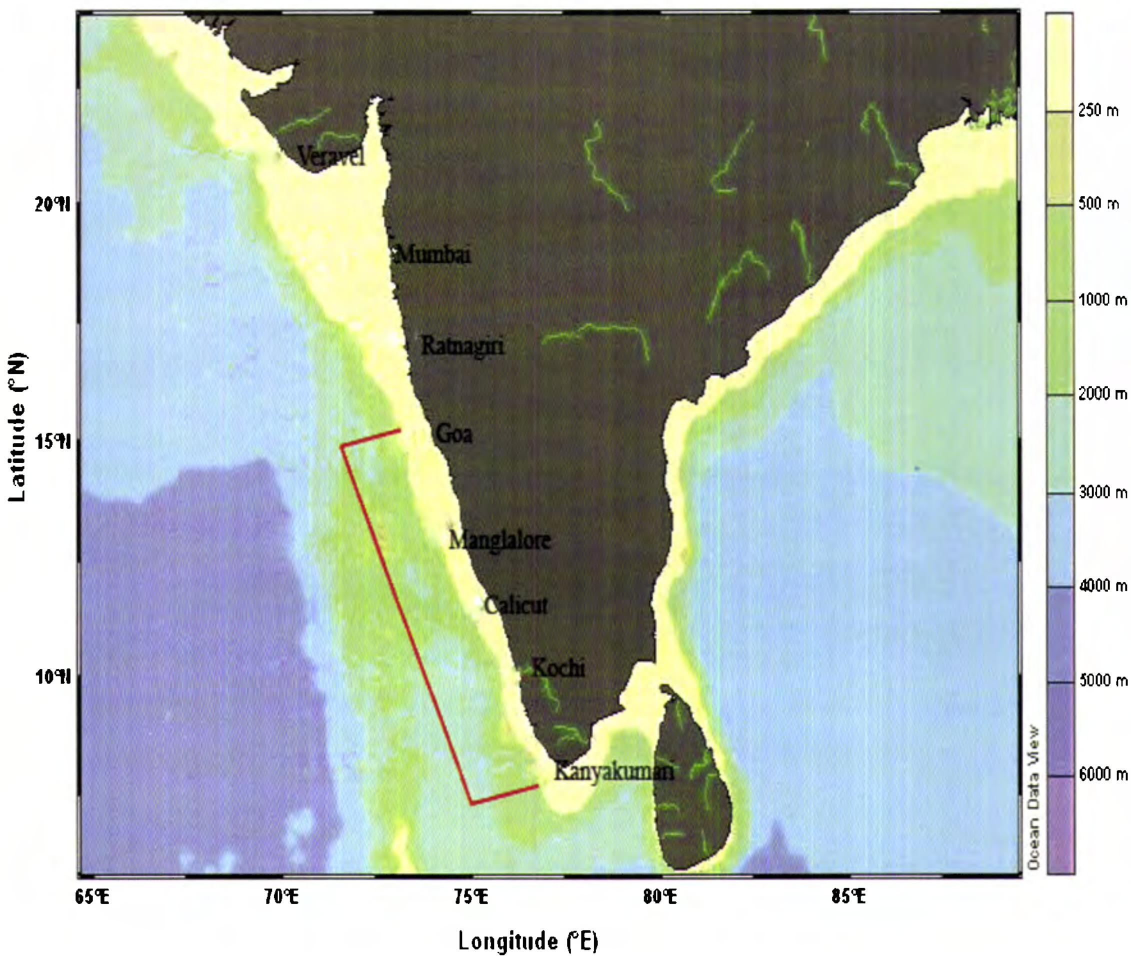



Fig. 2.2. Map showing the study area in the EEZ of India

# Plate I

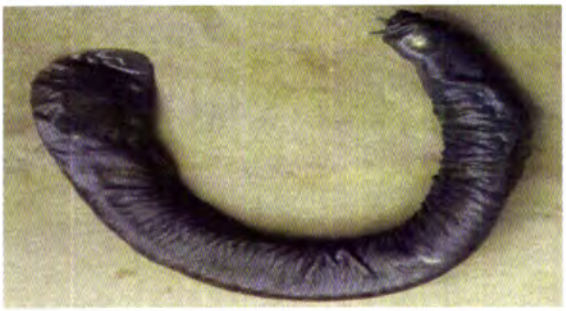


Fig. 1 *Eptatretus hexatrema*

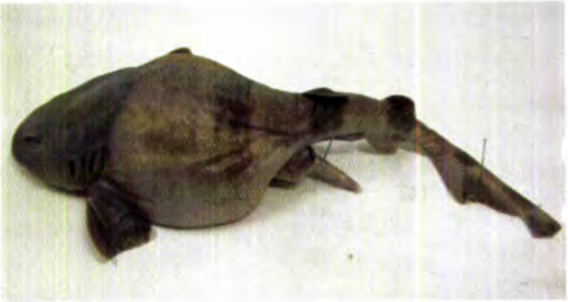


Fig. 2 *Cephaloscyllium sufflans*

Fig. 3 *Apristurus saldanha*

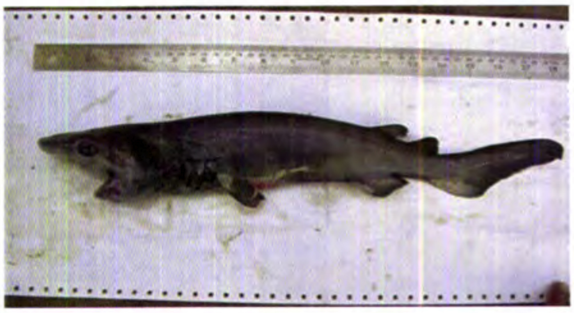


Fig. 4 *Apristurus indicusv*

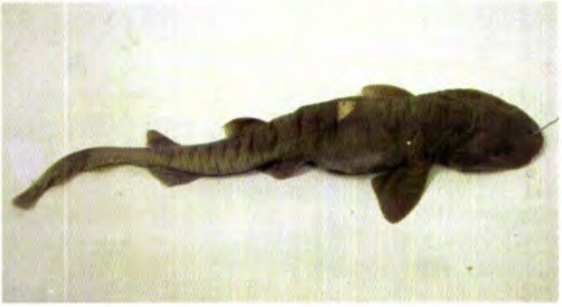


Fig. 5 *Bythaelurus hispidus*

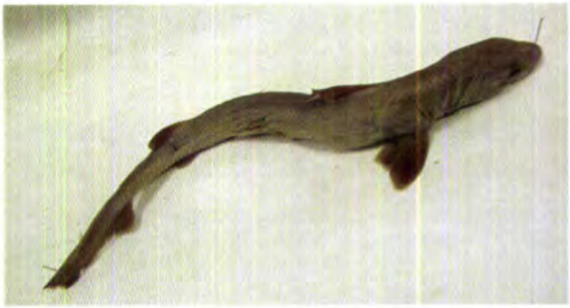


Fig. 6 *Eridacnis sinuans*

Fig. 7 *Eridacnis radcliffei*

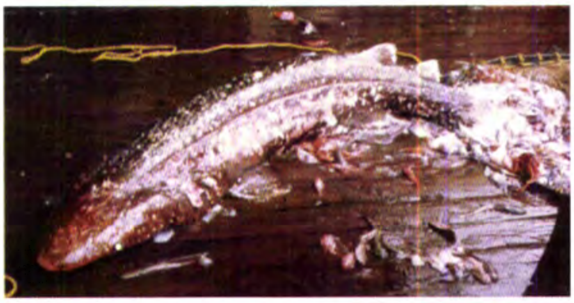


Fig. 8 *Echinorhinus brucus*

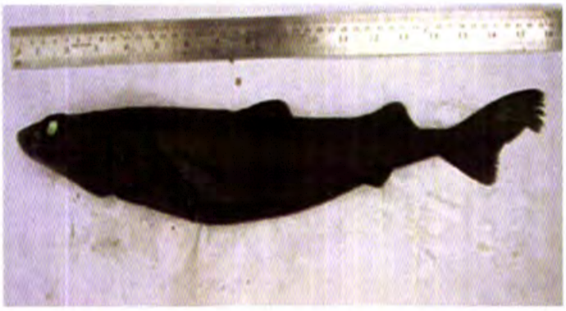


Fig. 9 *Centroscymnus crepidater*

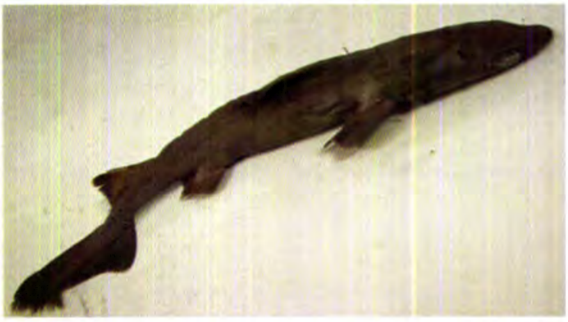


Fig. 10 *Etmopterus pusillus*

# Plate 2

Fig. 11 *Etmopterus granulosus*

Fig. 12 *Centrophorus lusitanicus*

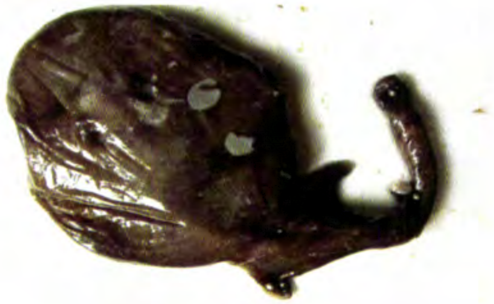


Fig. 13 *Benthobatis moresbyi*

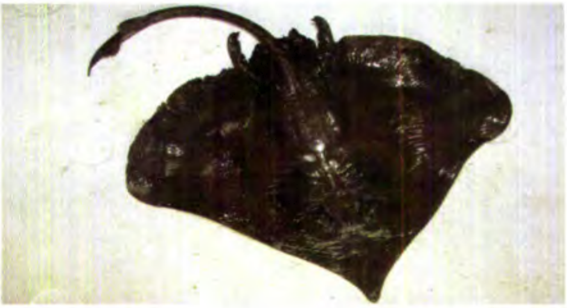


Fig. 14 *Dipturus johannisdavisi*

Fig. 15 *Neoharriotta pinnata*

Fig. 16 *Rhinochimaera atlantica*


Fig. 17 *Harriotta releighana*


Fig. 18 *Halosaurus carinicauda*

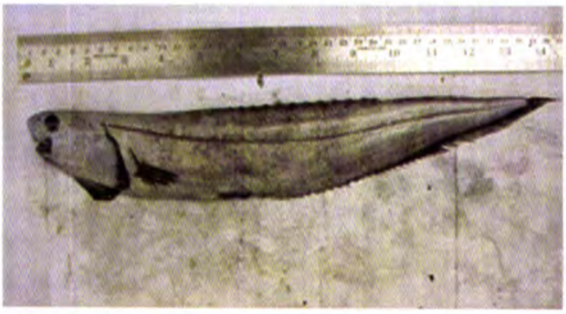


Fig. 19 *Notacanthus indicus*

Fig. 20 *Coloconger raniceps*

# Plate 3

Fig. 21 *Histiobranchus bathybius*

Fig. 22 *Bathycongrus wallacei*

Fig. 23 *Bathyuroconger vicinus*

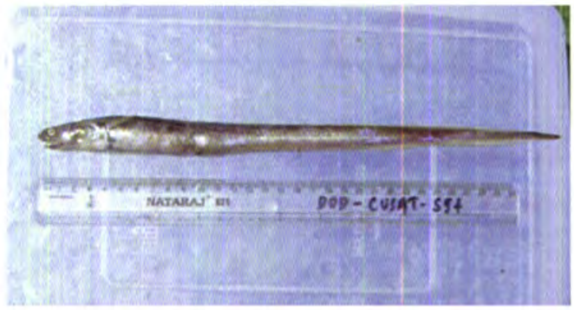


Fig. 24 *Rhynchoconger ectenurus*

Fig. 25 *Promyllantor purpureus*

Fig. 26 *Xenomystax trucidans*

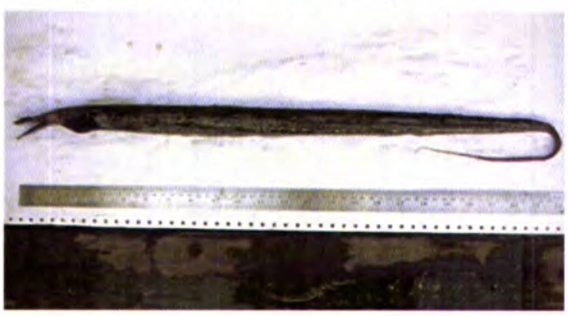


Fig. 27 *Gavialiceps taeniola*

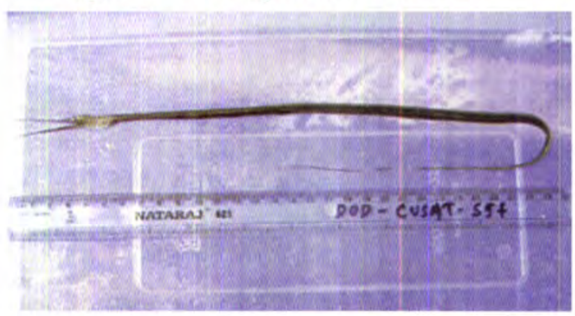


Fig. 28 *Nemichthys scolopaceus*


Fig. 29 *Rouleina nuda*

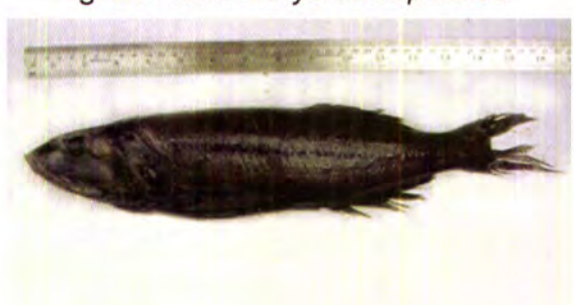


Fig. 30 *Alepocephalus bicolor*

# Plate 4


Fig. 31 *Alepocephalus blanfordii*

Fig. 32 *Talismania longifilis*

Fig. 33 *Narcetes lloydi*

Fig. 34 *Bajacalifornia calcarata*


Fig. 35 *Platytroctes mirus*

Fig. 36 *Ateleopus indicus*

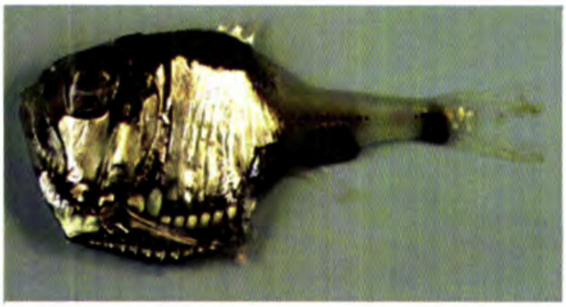


Fig. 37 *Argyropelecus hemigymnus*


Fig. 38 *Astronesthes martensii*


Fig. 39 *Evermannella indica*


Fig. 40 *Coccorella atrata*

# Plate 5


Fig. 41 *Lestidium nudum*

Fig. 42 *Stemonosudis rothschildi*

Fig. 43 *Magnisudis indica*

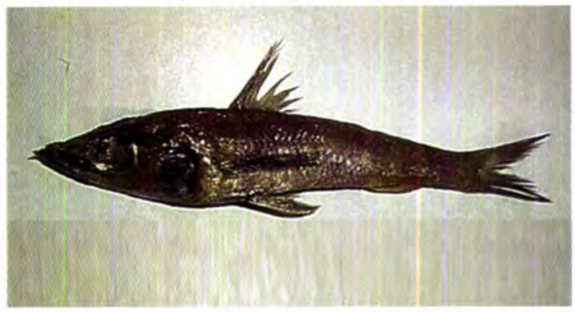


Fig. 44 *Chlorophthalmus bicornis*

Fig. 45 *Chlorophthalmus nigromarginatus*

Fig. 46 *Chlorophthalmus agassizi*

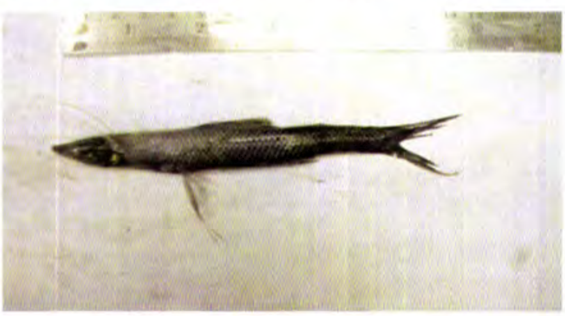


Fig. 47 *Bathypterois atricolor*

Fig. 48 *Paraulopus maculatus*

Fig. 49 *Saurida longimanus*

Fig. 50 *Saurida undosquamis*

# Plate 6


Fig. 51 *Neoscopelus microchir*

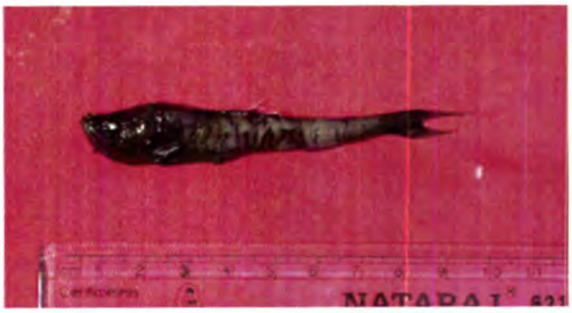


Fig. 52 *Scopelengys tristis*


Fig. 53 *Polymixia nobilis*

Fig. 54 *Polymixia japonica*

Fig. 55 *Physiculus roseus*

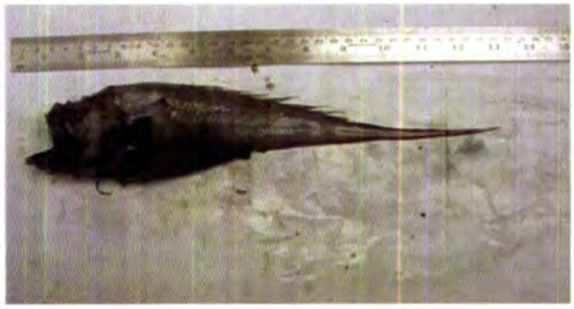


Fig. 56 *Bathygadus melanobranchus*


Fig. 57 *Gadomus capensis*

Fig. 58 *Coelorinchus braueri*

Fig. 59 *Coelorinchus quadricristatus*

Fig. 60 *Coelorinchus flabellispinnis*

# Plate 7

Fig. 61 *Coryphaenoides macrolophus*

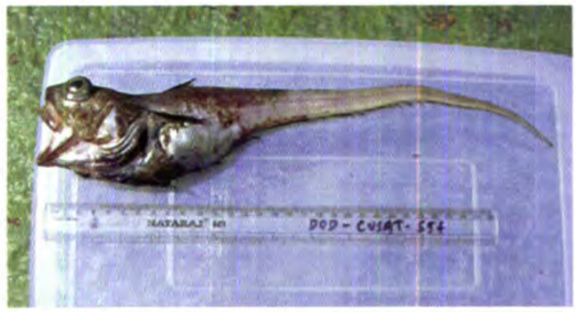



Fig. 62 *Malacocephalus laevis*

Fig. 63 *Nezumia investigatoris*

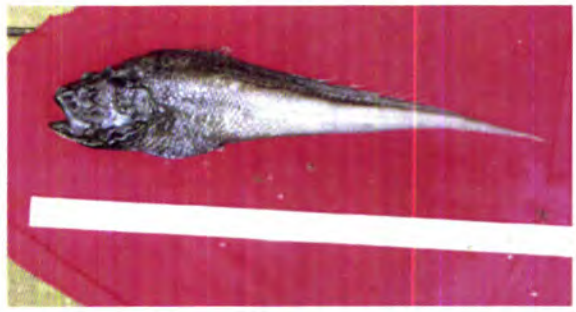


Fig. 64 *Lamprogrammus niger*

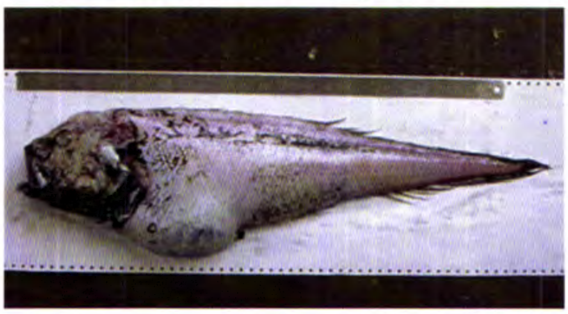


Fig. 65 Lamprogrammus exutus


Fig. 66 *Spectrunculus grandis*

Fig. 67 *Luciobrotula bartschi*

Fig. 68 *Hypopleuron caninum*


Fig. 69 *Glyptophidium lucidum*

Fig. 70 *Glyptophidium argenteum*

# Plate 8

Fig. 71 *Glyptophidium oceanium*

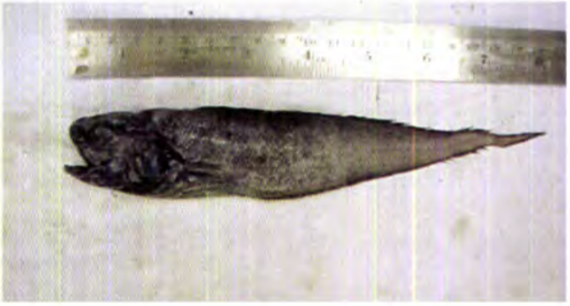


Fig. 72 *Glyptophidium macropus*

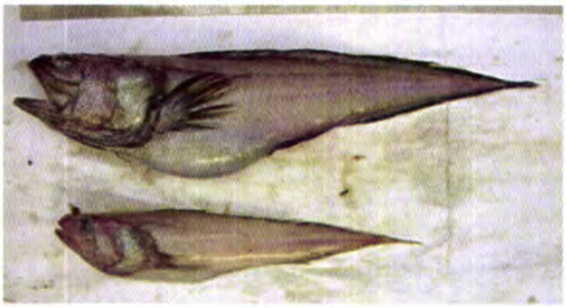


Fig. 73 *Bassozetus robustus*

Fig. 74 *Dicrolene multifilis*

Fig. 75 Dicrolene nigricaudis

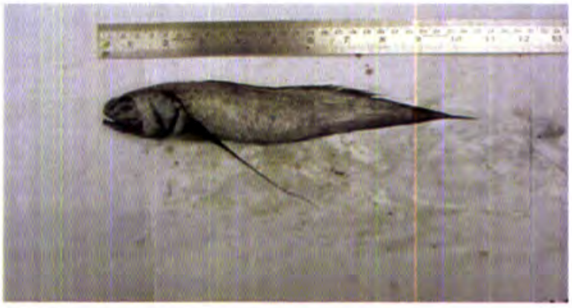


Fig. 76 *Dicrolene tristis*

Fig. 77 *Neobythites multistriatus*

Fig. 78 *Neobythites macrops*

Fig. 79 *Grammonus ater*

Fig. 80 *Hephthocara simum*

# Plate 9

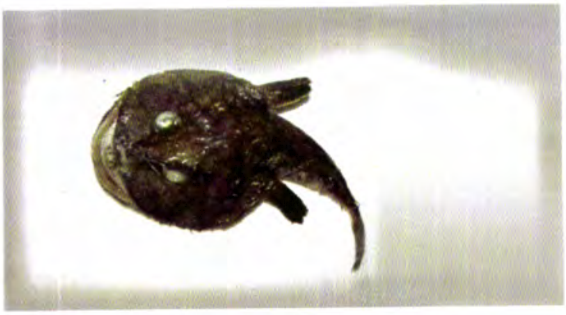


Fig. 81 *Lophiomus setigerus*

Fig. 82 *Lophiodes mutilus*

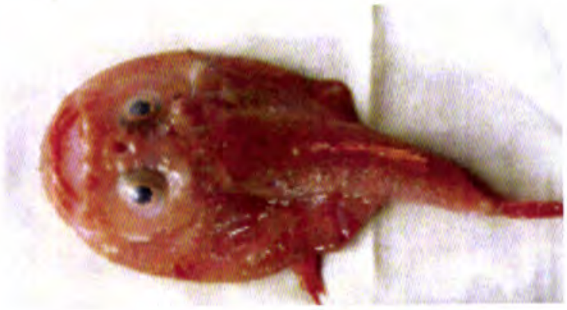


Fig. 83 *Chaunax pictus*

Fig. 84 *Melanocetus murrayi*

Fig. 85 Ceratias uranoscopus

Fig. 86 *Diceratias trilobus*

Fig. 87 *Bufoceratias wedli*

Fig. 88 *Halieutaea stellata*

Fig. 89 *Halieutaea coccinea*

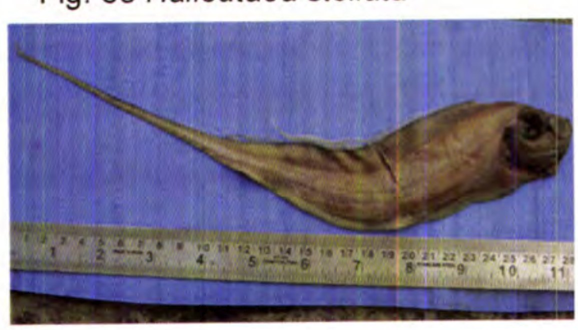


Fig. 90 *Zu elongatus*

# Plate 10

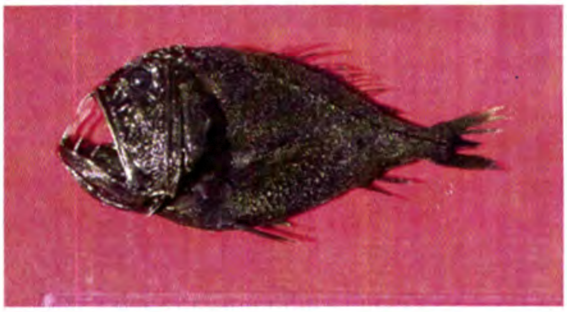


Fig. 91 *Anoplogaster cornuta*

Fig. 92 *Diretmichthys parini*

Fig. 93 *Beryx decadactylus*

Fig. 94 *Beryx splendens*

Fig. 95 Gephyroberyx darwinii

Fig. 96 *Hoplostethus mediterraneus*

Fig. 97 *Hoplostethus melanopus*

Fig. 98 *Cyttopsis rosea*

Fig. 99 *Zenopsis conchifer*

Fig. 100 *Ectreposebastes imus*

# Plate 11

Fig. 101 *Pterois russelii*

Fig. 102 *Scorpaena scrofa*

Fig. 103 *Peristedion weberi*

Fig. 104 *Dactyloptena macracantha*

Fig. 105 Dactyloptena orientalis

Fig. 106 *Lepidotrigla spiloptera*

Fig. 107 *Pterygotrigla hemisticta*

Fig. 108 *Chelidoperca investigatoris*

Fig. 109 *Heteropriacanthus cruentatus*

Fig. 110 *Priacanthus hamrur*

# Plate 12

Fig. 111 *Parascolopsis aspinosa*

Fig. 112 *Bathyclupea hoskynii*

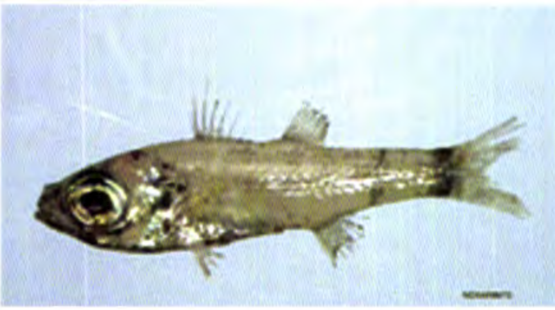


Fig. 113 *Epigonus pandionis*

Fig. 114 *Histiopterus typus*

Fig. 115 Owstonia simoterus

Fig. 116 *Acropoma japonicum*

Fig. 117 *Synagrops japonicus*

Fig. 118 *Psenopsis cyanea*

Fig. 119 *Cubiceps pauciradiatus*

Fig. 120 *Cubiceps squamiceps*

# Plate 13

Fig. 121 *Bembrops caudimacula*


Fig. 122 *Uranoscopus crassiceps*

Fig. 123 *Xenocephalus australiensis*

Fig. 124 *Callionymus sagitta*

Fig. 125 Ruvettus pretiosus

Fig. 126 *Neoepinnula orientalis*

Fig. 127 *Rexea prometheoides*

Fig. 128 *Nealotus tripes*

Fig. 129 *Promethichthys prometheus*

Fig. 130 *Trichiurus auriga*

# Plate 14

Fig. 131 *Chascanopsetta lugubris*

Fig. 132 *Psettina brevirictis*

Fig. 133 *Aesopia cornuta*

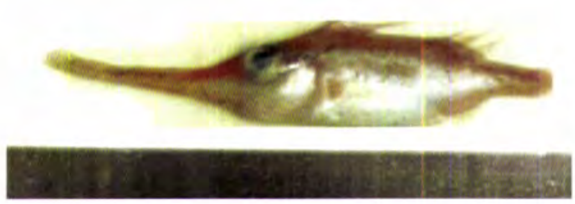


Fig. 134 *Macrorhamphosodes uradoi*

# CHAPTER 3

# DISTRIBUTION AND ABUNDANCE OF DEEP SEA FISHES BEYOND 200 M DEPTH ALONG SOUTHWEST COAST OF INDIAN EEZ

## 3.1. Introduction

The marine fish exploitation in India is mostly concentrated on the coastal resources within a depth of 100 m and the landings from marine capture fisheries in India have been stagnating around 2.7million tonnes during the past one decade against an estimated potential of 3.9 mt (Anon, 2008). The stagnation of marine landings is indicative that coastal resources have reached the critical level of exploitation. The signs are mainly pointing towards the need of expanding exploration towards the nonconventional and unexploited terrains for its fish wealth so as to avoid the extra pressure exerted on the coastal resources as well as to cater the ever increasing demands of the fish consumers. But for the marginal exploitation of some of the oceanic tunas, most of the deep-sea and oceanic resources in general and the demersal resources in particular remain either underexploited or unexploited. According to recent FAO reports that the coastal fisheries of many countries have been overexploited and are already showing the symptoms of depletion (SOFIA, 2007). The declaration of the EEZ in 1976 has reposed great responsibility as well as a golden opportunity for the fellow countries to explore and exploit the deep-sea and oceanic resources and to develop suitable fishing strategies for their sustainable exploitation and utilization. The countries like United States, Russia, Norway, Japan, Germany etc. have already started harvesting the unexploited and underexploited ocean resources since very long back itself.

As the demand for fish is escalating and there are diminishing returns from the coastal fishery, exploitation of the deep sea resources is found imperative to cater the increasing demands. Along with the shrimp and lobster resources such as *Heterocarpus* spp., *Parapandalus* spp., *Solenocera* spp., *Aristeus* spp., *Panilurus* sp., which are prone to varying degrees of exploitation levels, the deep sea fishes are also gaining importance for the commercial exploitation in the recent years. The collection of real time data on these resources require an elaborate and time bound onboard research by conducting explorative fishing surveys in different regions of the ocean. Lack of adequate information on the availability and abundance of commercially exploitable conventional and non-conventional resources beyond the present fishing grounds had been a major constraint for the development of deep-sea fishing in the EEZ of India.

Many explorative surveys have established the existence of fairly rich grounds for deep-sea fishery resources along the West Coast of India during the past decades (Silas and Prasad, 1966; Silas, 1969; Nair and Appukuttan, 1972; Nair and Joseph, 1984; Philip *et al.* 1984; Oommen, 1985; Joseph, 1984; Sivaprakasam 1986; Sivakami, 1990; James and Pillai, 1990; Panicker *et al.* 1993; Khan *et al.,* 1996; Sivakami *et al.* 1998; Sudarsan and Somavanshi, 1988; Sivakami *et al.* 1996 & 1998; Venu and Kurup, 2002b&c, 2005, 2006a & b; Thomas *et al.* 2003 and Kurup *et al.* 2005) and have made significant contributions on the availability and abundance of unexploited and underexploited demersal fishery resources in the Indian EEZ.

*FORV Sagar Sampada,* (Ministry of Earth Sciences, Govt. of India) carried out a series of fishery and oceanographic surveys along the Indian EEZ during the past three decades. The results of these surveys on the distribution and availability of various fishery resources were published in the Proceedings of the First and Second Workshops of *FORV Sagar Sampada* conducted at Cochin (Pillai *et al.* 1996). However, information on the bathymetric and spatial distribution and abundance of deep-sea resources are very scanty.

In this chapter a detailed account on the bathymetrical as well as spatial distribution and abundance of deep sea fishes in the southwest region of Indian EEZ (7° N to 14° N latitude) beyond 200 m depth is given.

**3.2. Materials and Methods**

Materials for the present study were collected during the exploratory demersal trawling operations carried out onboard *FORV Sagar Sampada* along the southwest region of Indian EEZ during the periods 1998 – 2002 and 2005 – 2007

The ground was scanned using SIMRAD EK 60 and EK 100 echo-sounders to ascertain the suitability of the bottom for the trawling. The depth contours in the navigational map was followed for fixing the scanning rout. The latitude, longitude, speed, time, depth and the bottom nature were noted down on to the paper recorder and in the case of EK 60, such recordings were saved in the instrument itself. The speed of the vessel was kept normally around 6 to 7 knots. Bottom trawling operations were conducted on the even grounds which were ascertained with the help of scanning carried out during the pervious night.

The catch and effort data generated from the bottom trawling operations carried out with the help of *FORV Sagar Sampada* in the area between 7° and 15° N lat were used for this study (Refer Chapter 2). 38m High Speed Demersal Trawl II and 45.6 m Expo- model demersal trawl were used for the bottom trawling operations. Total catch, catch composition and effort exerted were recorded at each fishing station. In each station, the catch was taken into the wet lab through the hatches and sorted species wise. The catch composition was then recorded by weighing each species. Catch per unit of effort was estimated against the total number of hours spent for fishing (Sivakami, 1990; Venu and Kurup, 2002a). The entire study area was divided into four transects based on the latitude and each transect was divided into three depth zones. The transects so studied are 7° – 9° N, 9° – 11° N, 11° – 13° N and 13° – 15° N and depth zones 201 – 500 m, 501 – 800 m and 801 – 1100 m (Panicker *et al.* 1993; Khan *et al.* 1996; Venu and Kurup, 2002a). The CPUE was calculated from the total catch in kg obtained for each species against the total hours spent in each transect and depth zone separately (Venu and Kurup, 2002a). The fishes were identified using standard references (Fischer and Bianchi, 1984; Alcock, 1899; Goode and Bean, 1895; Smith and Heemstra, 1986; Froese and Pauly, 2009).

## 3.3. Results

### 3.3.1. Trawlable grounds

During the entire period of study, 192 trawling grounds were identified and demersal trawls were operated in the depth range between 201 and 1070m. Among these, only 78 stations were found to be suitable to conduct bottom trawling for more than 60 minutes. Details in respect of various fishing grounds demarcated in the study is given in Table 3.1. The standard for the minimum viable duration of the trawling operation was kept at 60 minutes for assessing the catch. The study revealed that the bottom topography between 9° and 13° N latitudes is more suitable for bottom trawling when compared to other transects (Table 3.2). In 9° to 10° N, 19 trawlable stretches in the depth range of 201-600 m were identified in this study. Trawlable grounds up to 1070 m were surveyed in the area between 12° and 14° N latitudes. In the 7° to 9° N latitudes, trawlable grounds were found in the depth below 400 m.

### 3.3.2. Species composition

During the period of study, 152 fish species belonging to 123 genera, 70 families and 24 orders were identified and recorded (Refer Chapter 2). In general, the order Perciformes dominated with 26 species belongs to 17 families followed by the order Ophidiiformes with 17 species belonging to 2 families. The order Lophiiformes was represented by 6 families and Anguilliformes and Scorpaeniformes with 5 families each. The family Ophidiidae with 15 species belongs to 10 genera dominated the catches in the numerical strength of the species followed by family Macrouridae with 8 species belonging to 6 genera. The spatial and bathymetrical fish species composition is given in Table 3.3.

The orders Myxiniformes, Torpediniformes, Lampridiformes, Zeiformes, Tetraodontiformes and Chimaeriformes were found to be represented only by a single family each. The former three families accommodate single species each while the remaining with two species each. It is worth reporting that most of the genera and families are represented by single species. Among the total 70 families observed in the study area during the entire period of study, 32 were represented with a single species, 20 with two each and 6 with three each.

Spatially, the transect 11° 13° N recorded the highest number with 121 species belongs to 70 families followed by the transect 9° - 11° N lat. with 95 species belong to 65 families (Figure 3.1). The least number of species was recorded from 7° – 9° N latitude (34 species belongs to 26 families). Bathymetrically, the 501 – 800 m depth range recorded highest number of species while 801 – 1100 m depth zone showed the least (Fig. 3.2). Altogether 93 species of fishes belong to 45 families and 18 orders were recorded from 501 – 800 m depth zone.

Fishes of the Order Ophidiiformes have showed maximum bathymetrical as well as spatial distribution in all transects and depth zones studied except in 501 – 800 m and 801 – 1100 m in the 7° – 9° N latitude. Anguilliformes also showed a wider distribution with occurrence in all the transects and depth zones except in 501 – 800 m and 801 – 1100 m in the 7° – 9° N transect and 801 – 1100 m in the 9° – 11° N transect. Fishes of the orders Carcharhiniformes, Aulopiformes, Beryciformes, Scorpaeniformes, Perciformes and Pleuronectiformes have also shown a wide distribution in all transects.

Results of the present study revealed that *Apristurus indicus, Coloconger raniceps, Gavialiceps taeniola, Chlorophthalmus bicornis, Hypopleuron caninum, Polymixia japonica, Priacanthus hamrur, Psenopsis cyanea, Bembrops caudimacula, Cubiceps squamiceps, Neoepinnula orientalis and Chascanopsetta lugubris* were distributed in all the transects. Altogether 15 species were found to have distribution in all transects except 7°–9° N latitude. Five species have shown distribution in all transects except in the 13°–15° N latitude. Whereas two species viz. *Pterois russelii* and *Pterigotrigla hemisticta* have shown their occurrence except in the 9°–11° N latitude. *Cubiceps pauciradiatus* was absent in the catches in transect 11°–13° N latitude.

### 3.3.2.1 Latitude 7° – 9° N

In general the numerical strength of species was found to be very less when compared to other transects studied (Fig. 3.3). 35 species belonging to 26 families and 11 Orders were recorded from this transect. Altogether 8 families were recorded under the Order Perciformes. However, most of the families consisted of one or two species. Perciformes with 10 species followed by Scorpaenidae and Aulopiformes were the important orders found in this transect. Highest number of species (3 Nos.) was recorded under the family Chlorophthalmidae viz. *Chlorophthalmus nigromarginatus, C. agassizi* and *C. bicornis*. The families Gempylidae, Centrolophidae, Ophidiidae, Nomeidae, Triacanthodidae, Priacanthidae etc. were represented with two species each. All the other families have only one species in this transect.

### 3.3.2.2. Latitude 9° – 11° N

The exploratory fishing surveys conducted in this transect have recorded 95 species from the depth between 201 – 1100 m. The depth zone 501 – 800 m recorded the highest of 52 species followed by 201 – 500 m depth zone (42 species) while only a single species was recorded from depth zone 801 – 1100 m. Majority of the fish species comes under the order Perciformes in this transect with 13 in 201 – 500 m depth zone and 9 from 501 – 800 m depth zone. Order Gadiformes was represented by 9 species altogether of which 8 species were recorded in the depth zone 501 – 800 m. 6 species under the Order Aulopiformes were recorded from 201 – 500 m depth zone.

*Bathyclupea hoskynii, Bembrops caudimacula, Callionymus sagitta, Hoplostethus mediterraneus, Hypopleuron caninum, Physiculus roseus,* *Harriotta releighana and Gavialiceps taeniola* showed a wider distribution among the 95 species reported with occurrence between the depths 201 and 800 m. *Lamprogrammus exutus* of Ophidiidae family was the one species recorded from 801 – 1100 m depth zone.

**3.3.2.3. Latitude 11° – 13° N**

In this transect, 121 species were recorded 70 families. Highest of 61 species were recorded from the depth zone 501 – 800 m followed by 201 – 500 m (44 species) and least from 501 – 800 m (16 species). Members of the Order Ophidiiformes showed dominance in this transect with the representations in all the depth zones while higher number of species were encountered in the depth 501 and 1100 m. Order Perciformes dominated in the depth zone 201 – 500 m with 10 species followed by Scorpaeniformes with 6 species. In the depth zone 501 – 800 m, Order Gadiformes was represented by 8 and Carcharhiniformes by 7 species in the catches. In the depth zone 801 – 1100 m, Ophidiiformes dominated in the catches followed by Anguilliformes, Osmeriformes, Aulopiformes, Gadiformes and Lophiiformes.

Members of the families Ophidiidae and Congridae were recorded with three species each in depth zone 201 – 500 m, followed by Proscylliidae, Lophiidae, Gempylidae and Bothidae with two species each. In 501 – 800 m depth zone, Ophidiidae dominated with 9 species followed by Macrouridae (7 species). While 5 were recorded under Scyliorhinidae and 4 in Alepocephalidae. The families Stomiidae, Nemichthyidae, Congridae, Synaphobranchidae, Rhinochimaeridae and Proscylliidae were represented with two species each. In the depth zone 801 – 1100 m, four species under Ophidiidae family and two from Macrouridae were recorded.

Among the various species recorded, *Gavialiceps taeniola* was the lone species present in all the depth zones. Species like *Echinorhinus brucus, Apristurus indicus, Eridacnis radcliffei, E. sinuans, Xenomystax trucidans, Physiculus roseus, Glyptophidium macropus, Hypopleuron caninum, Hoplostethus mediterraneus, Psenopsis cyanea* etc were found distributed between 201 and 800 m. Whereas *Bathyuroconger vicinus, Bathygadus melanobranchus, Coryphaenoides macrolophus, Dicrolene tristis, Lamprogrammus exutus,* etc. showed their presence in the higher depths between 501 and 1100 m.

**3.3.2.4. Latitude 13° – 15° N**

88 species belong to 60 families were encountered from this transect. Depth zone 501 – 800 m was characterised by the highest number of species belonging to 40 families followed by 201 – 500 m with 34 while depth zone 801 – 1100 m showed the least with 14 families. The order Perciformes dominated the depth zone 201 – 500 m in this transect also while 7 species were found in the depth zone 501 – 800 m. Ophidiiformes were having 10 species in this depth zone. In the depth zone 801 – 1100 m, Osmeriformes dominated with 4 species followed by Ophidiiformes with 3 species.

Among the 60 families, Congridae, Muraenesocidae, Ophidiidae and Gempylidae showed a wide bathymetrical distribution from 201 – 1100 m. Two species each were reported in the families Proscylliidae, Congridae, Ophidiidae, Priacanthidae, Holocentridae, Nomeidae and Cynoglossidae from the 201 – 500 m depth zone. Highest number of species from a single family

Ophidiidae was recorded from 501 – 1100 m depth zone. Nine species were recorded under this family in this depth zone while three species under the family Gempylidae. Members of the families Scyliorhinidae, Rajidae, Congridae, Alepocephalidae, etc. were the other dominant species. Four species under the family Alepocephalidae was recorded from the 801 – 1100 m depth zone while three species of the family Ophidiidae were also recorded from this depth zone.

*Gavialiceps taeniola* was found to have a wide distribution in all the depth zones studied in the transect. *Echinorhinus brucus, Eridacnis radcliffei, Coloconger raniceps, Physiculus roseus, Hypopleuron caninum, Psenopsis cyanea, Neoepinnula orientalis* etc. were found to have distribution between 201 and 800 m depth. While *Lamprogrammus exutus* and *Nealotus tripes* were found distributed in the 501 – 1100 m depth zone.

### 3.3.3. Catch composition (CPUE)

The exploratory survey along the continental slope of southwest region of Indian EEZ have yielded a total catch of 12,246.25kg of fish by exerting an effort of 68.05hrs (Table 3.4). The catch per unit of effort thus calculated for the entire region was 179.96kg $hr^{-1}$ The transect 7°–9° N latitude was the highest in landings with a total catch of 7929.3kg by exerting an effort of 6.85hr and CPUE of 1157.56 kg $hr^{-1}$ The catch obtained was very low from the transect 13°–15° N latitude with 784.91kg. The CPUE estimated was 50.8kg $hr^{-1}$ with an effort of 15.45 hrs. The landings from transects 11°–13 N and 9°–11° N latitude were moderate with 2262.04Kg and 1269.99Kg respectively. A total of 26.1hrs of effort were exerted in the depth area 9°–11° N latitude while it was least with 6.85hrs in 7°–9° N latitude.

The depth zone 201–500 m had shown the maximum catch during the study period with total catch of 11013.11kg by exerting an effort of 43.25hrs. The CPUE was calculated as 254.63kg $hr^{-1}$ from this depth zone. In 501–800 m depth zone, the total catch was 1082.27kg and effort was 19.8hrs, which works out a CPUE of 54.7kg $hr^{-1}$ A total of 150.86kg fishes were caught from 801–1100 m depth zone by exerting an effort of 5 hours and resulted a CPUE of 30.17kg $hr^{-1}$

In general, catches were invariantly high in 201 – 500 m depth zone in all transects. The depth zone 201 – 500 m in the transect 7°–9° N latitude showed the highest catch as well as CPUE during the entire study period with a catch of 7929.3kg and CPUE of 1157.56 kg $hr^{-1}$ Same depth zone in the 11°–13° N latitude showed second highest catch of 1982.66kg and CPUE of 298.14kg $hr^{-1}$ In the transect 9°–11° N latitude, high catches were recorded in 201–500 m (804Kg) however, the depth zone 501–800 m showed high CPUE of 73.97 kg $hr^{-1}$ In the transect 13°–15° N latitude, catch was high in the depth zone 501–800 m (352.06kg) whereas the depth zone 801–1100 m CPUE was highest with 135.7kg $hr^{-1}$

The family Chlorophthalmidae dominated the catches with a high CPUE among all the species recorded from the entire study area. *Chlorophthalmus nigromarginatus* and *C. bicornis* were the two important species which dominated the catches during the study period. The CPUE calculated for these two species were 89.34kg $hr^{-1}$ and 20kg $hr^{-1}$ respectively with respective percentage composition of 49.64% and 11.11% among all the species caught (Table 3.5). Another dominant species was *Trichiurus auriga* with a CPUE of 15.05kg $hr^{-1}$ which formed 8.36% of the total catch. Other major species caught were *Psenopsis cyanea* (8.51kg $hr^{-1}$), *Gavialiceps taeniola* (5.21kg $hr^{-1}$), *Echinorhinus brucus* (5.1kg $hr^{-1}$), *Cubiceps squamiceps* (3.32 kg $hr^{-1}$) and *Hypopleuron caninum* (3.93 kg $hr^{-1}$).

The bathymetrical analysis of CPUE has shown that in the depth zone 201–500 m, *C. nigromarginatus* dominated the catches followed by *C. bicornis* with a CPUE of 140.57kg $hr^{-1}$ and 31.46kg $hr^{-1}$ respectively (Table 3.6). *Trichiurus auriga* with a CPUE of 23.68 kg $hr^{-1}$ was third in the landings in this depth zone. *Psenopsis cyanea* also showed moderate landings in this depth zone with a CPUE of 13.32kg $hr^{-1}$ Eel juveniles (7.27kg $hr^{-1}$) dominated the landings in depth zone 501–800 m followed by *G. taeniola* (5.06kg $hr^{-1}$) (Table 3.7). *E. brucus* (4.95kg $hr^{-1}$), *H. releighana*, *N. pinnata*, *Raja miraletus*, *Malacocephalus laevis*, *Coryphaenoides macrolophus* and *Benthobatis morsebyi* were the other dominant species appeared in this depth zone. *Lamprogrammus exutus* was the most dominant species in the depth zone 801–1100 m with a CPUE of 19.8kg $hr^{-1}$ The other species with moderate landings were *A. blanfordii*, *Bathyuroconger vicinus* and *Narcetes lloydi* (Table 3.8).

### 3.3.3.1. Latitude 7° – 9° N

The results of the analysis of the spatial distribution of the deep sea fishes in this transect has shown the dominance of *C. nigromarginatus* with a total catch of 5317kg and CPUE of 776.2 kg $hr^{-1}$ (Table 3.9). *C. bicornis* and *T. auriga* were the other dominant species with CPUE of 167.45 and 149.05 kg $hr^{-1}$ respectively. *P. cyanea* and *H. caninum* were also recorded in moderate quantities.

### 3.3.3.2. Latitude 9° – 11° N

A total catch of 1265.99Kg was recorded in this transect with CPUE 48.66 kg $hr^{-1}$ (Table 3.10). *P. cyanea* (9.59 kg $hr^{-1}$) was the most dominant species followed by *P. squamiceps* (5.14 kg $hr^{-1}$), *C. nigromarginatus* (4.89 kg $hr^{-1}$) and *G. taeniola* (4.58 kg $hr^{-1}$). The other species which have showed moderate abundance were *M. laevis, R. miraletus* and *N. pinnata.*

In the depth zone 201–500 m, *P. cyanea* was the most abundant species with 13.32kg $hr^{-1}$ followed by *P. squamiceps* (7 14kg $hr^{-1}$), *C. nigromarginatus* (6.78kg $hr^{-1}$) and *G. taeniola* (4.48kg $hr^{-1}$). Whereas in the depth zone 501–800 m, Macrourid fish *Malacocephalus laevis* was found the most dominant species with a CPUE of 12.1kg $hr^{-1}$ Other species which have dominated in this depth zone were *R. miraletus* (11.14 kg $hr^{-1}$), *N. pinnata* (8.38kg $hr^{-1}$), *B. morsebyi* (7.4kg $hr^{-1}$), *Coryphaenoides macrolophus* (6.6kg $hr^{-1}$) and *G. taeniola* (5.59kg $hr^{-1}$).

### 3.3.3.3. Latitude 11° – 13° N

*C. nigromarginatus* dominated the landings in this transect with CPUE of 32.32kg $hr^{-1}$ followed by *C. bicornis* (10.18kg $hr^{-1}$). *G. taeniola* (8.55kg $hr^{-1}$), *P. cyanea* (7.82kg $hr^{-1}$), *Bembrops caudimacula*, *H. caninum,* etc. (Table 3.11) found in this area. Eel juveniles (5.29kg $hr^{-1}$) were also shown moderate abundance.

The bathymetrical species composition in this transect has shown that the species under Chlorophthalmidae family dominated in the catches from 201 – 500 m depth zone. *C. nigromarginatus* (95.49kg $hr^{-1}$) appeared as the most dominant species followed by *C. bicornis* (30.08kg $hr^{-1}$). *P. cyanea* (22.95kg $hr^{-1}$), *G. taeniola* (18.29kg $hr^{-1}$) and *B. caudimacula* (16kg $hr^{-1}$) were also shown their moderate abundance in this depth zone. *E. brucus, Uranoscopus crassiceps*, *H. caninum* and eel juveniles were also shown their dominance.

**3.3.3.4. Latitude 13° – 15° N**

The shark *E. brucus* (18.21kg $hr^{-1}$) was the most dominant species in this transect (Table 3.12), followed by eel juveniles (9.77kg $hr^{-1}$), *L. exutus* (6.52 kg $hr^{-1}$) and *G. taeniola.*

*E. brucus* (23.27kg $hr^{-1}$) dominated in the depth zone 201 – 500 m followed by *G. taeniola* (5.03kg $hr^{-1}$) and *Priacanthus hamrur* (3.52kg $hr^{-1}$). Eel juveniles dominated the landings in the depth zone 501 – 800 m with a CPUE of 22.15kg $hr^{-1}$ followed by *E. brucus* (14.83kg $hr^{-1}$). *Neoharriotta pinnata, Luciobrotula bartschi* and *G. taeniola* were also found moderately distributed in this depth zone. *L. exutus* was the most dominant species with CPUE 99kg $hr^{-1}$ followed by *A. blanfordii* and *Bathyuroconger vicinus* in the 801 – 1100 m depth zone.

**3.4. Discussion**

The exploratory surveys carried out in the southwest region of Indian EEZ between 7° and 15° N lat have revealed many new potential fishing grounds as well as unconventional fishery resources in the deeper waters beyond 200 m depth. Although the catches from these stations were fluctuating, the results were promising towards fulfilling the attempt of delineating the resource potential of the deep sea fishery resources of the area. The new grounds identified in the continental slope area now can be utilized by the deep sea fishing industry for the harvesting of nonconventional resources for the enhancement of marine fish production from the country.

The results of the present study have shown that 152 fish species belonging to 123 genera, 70 families and 24 orders were found embarked the entire study area with varying degrees of bathymetrical as well as spatial distribution and abundance. Also, the total catch of 12,246.25kg with a CPUE of 179.96kg $hr^{-1}$ obtained during the entire exploratory surveys further confirm the existence of high fishery potential in the continental slopes along southwest region of Indian EEZ.

The results of the distribution pattern of fishes have shown that fishes of the Order Perciformes dominated the overall landings in the numerical strength of the species in the lower depth ranges. The species belonging to orders Ophidiiformes, Gadiformes and Anguilliformes were also shown moderate dominance in the deeper waters. Ophidiiformes showed domination in higher transects towards northern latitudes. It is worth reporting that in many of the families very few species were found with majority of the families with a single species. Most of the genera are represented with single species and rarely, more than two species in a genus. The *Chlorophthalmus, Raja, Glyptophidium, Coelorhynchus and Centrophorus* are the genera represented with three species each. Among the 26 species identified in the order Perciformes, only five families represented with more than a single species. Highest number of species was recorded in the family Ophidiidae with 15 and is followed by Macrouridae with 8 species. The more representation of species in the lower depths may be due to the higher effort expended in these depth zones. It may be seen that only a meagre 5 hours effort could be exerted in the depth beyond 801m. During the bottom scanning surveys it was observed that the bottom structure in the depths more than 801m was mostly hard as well as uneven and it was very difficult to find suitable grounds for trawling due to the steep and uneven nature of bottom.

The pattern seen in the spatial distribution of deep sea fishes revealed that there are greater aggregation of species in transect 11°–13° N latitude. Whereas bathymetrically the depth zone 501–800 m accounted for the maximum number of species. The rich species diversity shown by the orders Ophidiiformes, Anguilliformes, Perciformes and Gadiformes in transect 11°–13° N latitude and depth zone 501–800 m was the reason for the rich biodiversity of fishes encountered from this depth zone. Species as high as 42 were found distributed in a single transect each. However, 12 species were found to have a distribution in all the four transects and 23 species were present in three transects. It may be noted that most of these species were absent in the 7° – 9° N latitude, and this can be attributed to restricted sampling carried out in the depth zone 201 – 500 m.

The depth zone 201–500 m was found to be very rich in the fishery resources and total catch registered was 1013.11kg with CPUE 254.63 kg $hr^{-1}$ and this is very high when compared to the other depth zones. The high CPUE observed in the depth zone 201-500 m was due to the heavy landings of Chlorophthalmids and *T. auriga*. However, the species diversity of this zone was relatively low, when compared to 501 – 800 m depth.

Results of many pervious studies also agree with the present findings. Prasad and Nair (1973) have shown high abundance of deep sea fishes such as *C. agassizi, N. orientalis, P. cyanea, C. natalensis* etc in the upper continental slope (180 –450 m depth zone) in the Indian EEZ. Philip *et al.* (1984), Oomen (1985), Sivaprakasam (1986), Panicker *et al.* (1993), Khan *et* *al.* (1996), Sivakami (1990), Venu and Kurup (2002a) and Jayaprakash *et al.* (2006) identified certain pockets at depth of 200-500 m along the southwest region of Indian EEZ as target areas for exploitation of deep sea resources. Venu and Kurup (2006a) reported that the *Neoepinnula orientalis* and *Psenes squamiceps* are more abundant in the 7° to 10° N latitude. Sivakami *et al.*, (1998) reported a potential yield of *Chlorophthalmus* spp. as 81328 t along this region.

The Centrolophid fish *P. cyanea* showed moderate catches in the depth zone 201–500 m in the 7°–13° N latitude and was found to be an exploitable nonconventional resource with tremendous potential as a commercial species. Venu and Kurup (2002a & b) reported similar results from the south west region of Indian EEZ. Panicker *et al.* (1993) reported *Centrolophus* sp. and *Chlorophthalmus* spp. as dominant species in the depth zone 200 – 500 m in lat 7° to 17° N, off west coast of India. According to Khan *et al.* (1996), *P cyanea* showed peak abundance in depth zone 301-400 m and moderate abundance both in zones 101-200 m and 201-300 m. Sivakami (1990) observed a promising potential for *Psenopsis* spp., along with other resources in the south west zone in the depth range 151 – 398m.

The dominance of *Chlorophthalmus nigromarginatus* and *C. bicornis* was very much pronounced with high CPUE since these species have shown their dominance in the landings in general and particularly in the depth zone 201–500 m during the study period. High abundance of 'green eyes', the Chlorophthalmids were reported from several exploratory surveys conducted along the southwest region of Indian EEZ (Prasad and Nair, 1973; Philip *et al.* 1984; Sulochanan and John, 1988; Sudarsan, 1993 and Khan *et al.* 1996;

Venu and Kurup, 2002a). High-density pockets of *C. bicornis* were located along the latitude 8° and 9° N and 11° - 12° latitude at depth ranges of 301-400m and 201-300m (Kurup *et al.* 2005). The consolidated CPUE calculated for these two species were 89.34kg $hr^{-1}$ and 20kg $hr^{-1}$ respectively with percentage composition of 49.64% and 11.11% among all the species landed. *T auriga* with a CPUE of 15.05kg $hr^{-1}$ and forming 8.36% of the total catch, *Psenopsis cyanea* (8.51kg $hr^{-1}$), *Saurenchelys taeniola* (5.21kg $hr^{-1}$), *Echinorhinus brucus* (5.1kg $hr^{-1}$), *Psenes squamiceps* (3.32 kg $hr^{-1}$) and *Hypopleuron caninum* (3.93 kg $hr^{-1}$) were the other potential nonconventional fish resources in this study.

Transect 7°–9° N latitude was found to harbour the lowest number of species among all the other transects with only 35 fish species. Even though this transect was explored only in the 201-500 m depth zone, 10 species under Perciformes, 6 species of Scorpaeniformes and 5 species of Aulopiformes were recorded from this transect. Species like *S. longimanus, C. maculates* and *Eptatretus hexatrema* were recorded exclusively from this transect. However, this transect has recorded the highest catches with a total catch of 7929.3kg with CPUE 1157.56 kg $hr^{-1}$ Results of several studies established that in the coastal waters, aggregation or schooling of fishes is a common phenomenon. This nature was found very relevant for the schooling fishes like Chlorophthalmids and *T. auriga* which had resulted unusual heavy landings observed in this transect. *C. nigromarginatus* landed 4950kg while, *C. bicornis* landed 1030kg in a single haul at 08 42'46" N latitude while *T auriga* also contributed 1000kg at 07 08'37" N latitude from a single haul.

Sivakami (1990) also observed similar catches of *T. auriga* from the south west zone in the depth range 151 – 398m.

With the occurrence of 95 species, transect 9-11 N latitude ranked second in the species diversity among the four transects investigated. Even though the order Perciformes which accounted for 13 species was found to be the most dominant in this transect, *P. cyanea* was the most abundant species with 13.32kg $hr^{-1}$ followed by *P. squamiceps* (7 14kg $hr^{-1}$), *C. nigromarginatus* (6.78kg $hr^{-1}$) and *G. taeniola* (4.48kg $hr^{-1}$) in the depth zone 201-500 m. Whereas the higher number of species found in the depth zone 501-800 m was due to the dominance of Gadiformes, Beryciformes and Anguilliformes with the Macrourid fishes *Malacocephalus laevis* (12.1kg $hr^{-1}$) and *Coryphaenoides macrolophus* (6.6kg $hr^{-1}$) showing their dominance. It appears that the Ophidiiformes, Gadiformes and Anguilliformes dominate the species composition in the depth zone beyond 500 m. The ray, *R. miraletus* (11.14kg $hr^{-1}$) and *B. morsebyi* (7.4kg $hr^{-1}$) and the chimera *N. pinnata* (8.38kg $hr^{-1}$) were also shown their dominance in this depth zone. A wider distribution of *Bathyclupea hoskynii, Bembrops caudimacula, Callionymus sagitta, Hoplostethus mediterraneus, Hypopleuron caninum, Physiculus roseus, Harriotta releighana and Gavialiceps taeniola* was observed in the present study when compared to other species and *Lamprogrammus exutus* which were found restricted to the 801 – 1100 m depth zone.

The highest numerical abundance of fish species were encountered from the 11-13° N latitude. Among the 121 species recorded, species in the Ophidiiformes dominated with 18 species followed by Perciformes. In this transect also, the higher depths were dominated by the species of

Ophidiiformes, Gadiformes and Anguilliformes while the 201-500 m depth zone was dominated by Perciformes. More interestingly, the 801-1100 m depth zone was mainly dominated by Ophidiiformes. Even though the number of species was less, the Aulopiformes dominated the catches with the highest CPUE of *C. nigromarginatus* (32.32kg $hr^{-1}$) followed by C. bicornis (10.18kg $hr^{-1}$). *G. taeniola, P. cyanea, Bembrops caudimacula, H. caninum* etc. were also shown in moderate catches. As in the other transects, Chlorophthalmids and *P. cyanea* (22.95kg $hr^{-1}$) were dominated in the catches in 201 – 500 m depth zone. *G. taeniola* and *B. caudimacula* were also shown moderate occurrence in this depth zone. The other depth zones showed no such abundance of a particular species and only *G. taeniola* (6.61kg $hr^{-1}$) and *Xenomystax trucidans* (5.7kg $hr^{-1}$) were showed very low CPUE in the 501-800 m depth zone.

As in the previous transect, the depth zone 501-800 m shown more species aggregation with the dominance Ophidiiformes. The overall dominance of Perciformes was discernible in this transect and especially in the depth zone 201-500 m. Wide bathymetrical distribution was shown by Congridae, Muraenesocidae, Ophidiidae, Gempylidae by their presence in all the depth zones. Moderate catch of *Gavialiceps taeniola* was recorded in all the depth zones. *Echinorhinus brucus* (18.21kg $hr^{-1}$) was emerged as the most dominant species along with *Eridacnis radcliffei, Coloconger raniceps, Physiculus roseus, Hypopleuron caninum, Psenopsis cyanea, Neoepinnula orientalis,* etc. in the depth zone 201 and 800 m depth. While *Lamprogrammus exutus* (99kg $hr^{-1}$) recorded its presence in the catches from the 801-1100 m depth zone and also showed along with *Nealotus tripes* in the 501 – 1100 m depth.

*Neoepinnula orientalis* was reported from tropical and subtropical waters of the Eastern Indian Ocean, the Western Pacific and the Western Central Atlantic. Whereas, *Cubiceps squamiceps* was previously reported from Indian Ocean and Australian waters and inhabits in the depth 300 – 400 m (Fischer and Bianchi, 1984).

There are many nonconventional fish resources other than crustaceans and oceanic resources in the deep sea habitat. The exploitation of these resources can be recommended only after ascertaining their fishable potential and feasibility of commercial exploitation. The results of the present study revealed that there exist several potential deep sea fin fish resources in the depths beyond 200 m in the southwest region of Indian EEZ. The results of bathymetrical and spatial distribution pattern revealed that there exists the overall dominance of Perciformes in terms of the numerical strength of deep sea fish species caught especially in the depths below 500 m. While the Ophidiiformes, Anguilliformes and Gadiformes dominated in the higher depths. Highest CPUE was recorded in Order Aulopiformes by the fishes of the family Chlorophthalmidae. The major resources which show the real potential for a commercial exploitation are *Chlorophthalmus nigromarginatus, C. bicornis, Trichiurus auriga* and *Psenopsis cyanea*. There are many other promising fish resources like *Neoepinnula orientalis, Psenes squamiceps, Hoplostethus mediterraneus, etc.*, however, their fishable potential need to be ascertained by conducting exhaustive explorative surveys for establishing the feasibility of commercial exploitation.

**Figure 3.1 Spatial distribution of Orders, Families and Species**

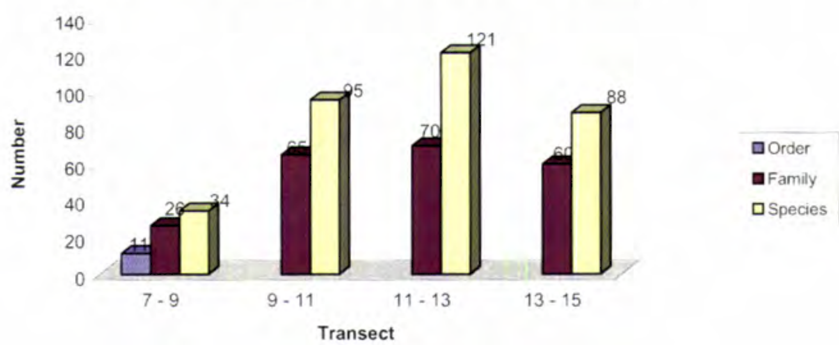



**Figure 3.2 Bathymetrical distribution of Orders, Families and Species**

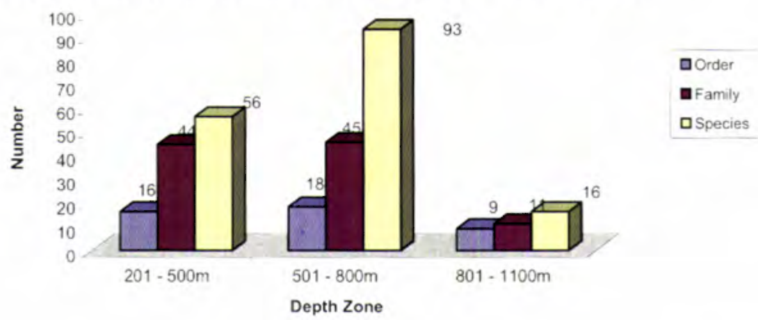



**Figure 3.3 Bathymetrical distribution of species in each transect**

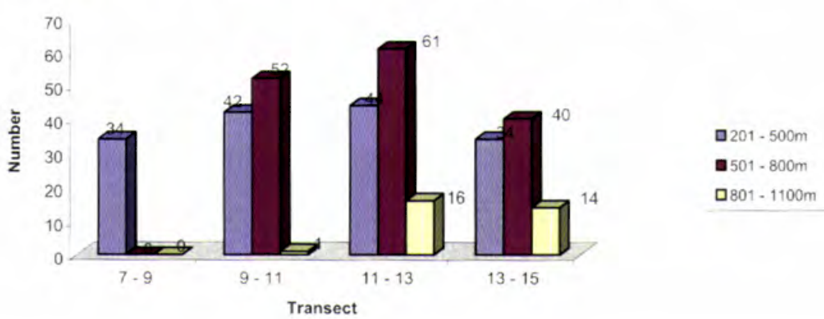


**Table 3.1. Details of the trawlable grounds explored in Southwest coast of India**

| Latitude | Longitude | Av. Depth (m) | Duration | Gear Used | Course | Bottom nature |
|---|---|---|---|---|---|---|
| 07 08 942 | 77 13 134 | 210 | 60 | HSDT CV | 80 | Muddy |
| 08 40 | 75 32 | 305 | 65 | HSDT CV | 10 | muddy |
| 08 37 | 75 39 | 320 | 60 | Long wing fish trawl | 10 | Muddy sand |
| 08 52 | 75 50 | 330 | 60 | Long wing fish trawl | 160 | Muddy sand |
| 08 42 46 | 75 39 724 | 300 | 60 | HSDT CV | 220 | Sandy |
| 08 53 258 | 75 47 719 | 332 | 85 | HSDT CV | 316 | sandy |
| 08 58 04 | 75 33 363 | 363 | 65 | HSDT CV | 38 | sandy |
| 08 58 257 | 75 40 097 | 350 | 60 | HSDT CV | 255 | Sandy |
| 08 58 388 | 75 45 498 | 329 | 60 | HSDT CV | 209 | Sandy |
| 08 54 169 | 75 33 589 | 335 | 60 | Expo | 200 | Muddy sand |
| 09 15 | 75 41 | 450 | 60 | HSDT CV | 345 | muddy |
| 09 19 | 75 50 | 315 | 90 | HSDT CV | 140 | muddy |
| 09 25 64 | 075 46 633 | 290 | 60 | HSDT | 170 | Muddy |
| 09 25 770 | 75 45 778 | 294 | 60 | HOT | 155 | Muddy |
| 09 26 323 | 075 36 288 | 600 | 60 | HSDT | 175 | Muddy |
| 09 26 552 | 75 45 323 | 299 | 60 | HSDT FV | 155 | Muddy |
| 09 28 | 75 42 | 330 | 115 | HSDT CV | 150 | Muddy |
| 09 28 566 | 075 43 506 | 333 | 88 | HSDT | 206 | Muddy |
| 09 38 | 75 36 | 330 | 85 | HSDT CV | 140 | Muddy |
| 09 54 72 | 75 35 191 | 300 | 60 | HSDT | 344 | Muddy |
| 09 00 | 75 48 | 330 | 60 | Long wing fish trawl | 160 | Muddy sand |
| 09 01 125 | 75 50 273 | 333 | 60 | HOT | 165 | Sandy |
| 09 02 3 | 75 51 641 | 324 | 60 | HSDT CV | 355 | Sandy |
| 09 02 88 | 75 48 276 | 322 | 60 | HSDT CV | 326 | Sandy |
| 09 05 87 | 75 41 85 | 350 | 60 | Expo | 210 | Sandy |
| 09 06 074 | 75 50 946 | 323 | 60 | HSDT CV | 170 | Sandy |
| 09 07 967 | 75 50 710 | 324 | 60 | HSDT CV | 170 | Sandy |
| 09 11 255 | 75 51 509 | 285 | 60 | Expo | 160 | Sandy |
| 09 33 14 | 75 38 21 | 370 | 60 | Expo | 150 | Sandy |
| 10 40 341 | 75 15 053 | 573 | 60 | Expo | 145 | Clay |
| 10.32 181 | 75 19 756 | 682 | 60 | Expo | 150 | Clay |
| 10 34 737 | 75 18 482 | 685 | 60 | EXPO | 328 | Hard |
| 10 38 527 | 075 16 324 | 706 | 60 | HSDT | 152 | Hard |
| 10 44 515 | 75 11 583 | 810 | 60 | EXPO | 322 | Hard |
| 10 19 265 | 75 33 689 | 780 | 60 | EXPO | 184 | Hard |
| 10 23 | 75 28 | 300 | 60 | HSDT CV | 320 | Muddy |
| 10 27 | 75 23 | 465 | 60 | HSDT CV | 140 | Muddy |
| 10 30 199 | 075 22 981 | 438 | 58 | HSDT | 340 | Muddy |
| 10 38 | 75 19 | 410 | 85 | HSDT CV | 135 | Muddy |
| 10 38 | 75 18 | 480 | 60 | HSDT CV | 335 | Muddy |
| 10 39 5 | 75 18 5 | 320 | 135 | HSDT CV | 340 | Muddy |
| 11 08 944 | 074 56 244 | 691 | 60 | EXPO | 316 | Muddy |
| 11 15 40 | 74 51 36 | 600 | 60 | EXPO | 306 | Muddy |
| 11 16 | 74 52 | 600 | 60 | HSDT CV | 310 | Muddy |
| 11 19 857 | 074 51 654 | 210 | 58 | HSDT | 318 | Muddy |
| 11 30 840 | 74 41 794 | 210 | 60 | HSDT FV | 149 | Muddy |
| 11 43 278 | 74 31 781 | 232 | 60 | HSDT CV | 332 | Muddy |
| 11 52 | 74 25 | 400 | 60 | HSDT CV | 330 | Muddy |
| 11 54 59 | 74 23 43 | 630 | 60 | EXPO | 162 | Muddy |
| 11 58 | 74 21 | 450 | 90 | HSDT CV | 150 | Muddy |
| 11 45 372 | 74 29 183 | 325 | 70 | HSDT FV | 155 | Muddy sand |
| 11 42 625 | 74 31 802 | 250 | 60 | HSDT FV | 325 | Sandy |
| 11 48 29 | 74 28 89 | 240 | 60 | HSDT | 163 | Sandy |
| 12 02 | 74 20 | 460 | 60 | HSDT CV | 150 | muddy |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12 11 857 | 74 08 273 | 1070 | 60 | EXPO | 153 | Muddy |
| 12 12 55 | 74 10 55 | 920 | 60 | EXPO | 146 | Muddy |
| 12 29 197 | 74 06 812 | 725 | 60 | EXPO | 230 | Muddy |
| 12 39 377 | 74 02 45 | 865 | 60 | HSDT | 335 | Muddy |
| 12 52 | 75 56 | 440 | 65 | HSDT CV | 320 | Muddy |
| 12 14 876 | 74 15 81 | 312 | 60 | HSDT FV | 159 | Sandy |
| 12 35 667 | 74 10 22 | 212 | 60 | HSDT FV | 156 | Sandy |
| 12 36 77 | 74 09 45 | 230 | 60 | HSDT | 349 | Sandy |
| 12 51 62 | 74 00 07 | 260 | 60 | HSDT | 146 | Sandy |
| 12 19 75 | 74 11 64 | 565 | 60 | EXPO | 338 | sandy mud |
| 13 45 26 | 73 25 28 | 205 | 60 | HSDT | 344 | Clay |
| 13 07 | 73 44 | 440 | 60 | HSDT CV | 325 | Muddy |
| 13 35 983 | 73 20 646 | 720 | 60 | EXPO | 330 | Muddy |
| 13 38 73 | 73 17 30 | 905 | 60 | EXPO | 343 | Muddy |
| 13 79 | 73 13 | 515 | 60 | HSDT CV | 305 | Muddy |
| 13 44 54 | 73 22 26 | 240 | 60 | HSDT | 348 | Sandy |
| 14 42 53 | 73 00 903 | 605 | 70 | EXPO | 155 | Muddy |
| 14 32 07 | 73 06 92 | 565 | 60 | EXPO | 338 | Muddy |
| 14 52 | 73 07 | 250 | 100 | HSDT CV | 300 | Muddy |
| 14 14 97 | 73 10 35 | 695 | 112 | EXPO | 345 | Muddy sand |
| 14 41 01 | 73 02 06 | 545 | 60 | EXPO | 320 | Muddy sand |
| 14 33 | 73 08 | 263 | 60 | Expo | 170 | Rocky and muddy |
| 14 32 368 | 73 08 533 | 276 | 60 | Expo | 348 | Sandy |
| 14 51 018 | 73 01 059 | 270 | 60 | HSDT | 334 | Sandy |

Table 3.2. Grounds trawled above 200m depth

| Latitude | Grounds < 60min | Grounds > 60 min | Depth Range |
|---|---|---|---|
| 7° - 8° | 15 | 1 | 201-300 |
| 8° - 9° | 26 | 9 | 301-400 |
| 9° - 10° | 32 | 19 | 201-600 |
| 10° - 11° | 27 | 12 | 301-900 |
| 11° - 12° | 29 | 12 | 201-700 |
| 12° - 13° | 24 | 11 | 201-1070 |
| 13° - 14° | 21 | 6 | 201-1000 |
| 14° - 15° | 18 | 8 | 201-700 |
| 7° - 14° | 192 | 78 | 201-1070 |

**Table 3.3 Spatial and Bathymetrical species composition of Deep sea fishes along southwest coast of India**

| Classification | 7 - 9 N | 9 - 11 N | | | 11 - 13 N | | | 13 - 15 N | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Depth m | Depth m | | | Depth m | | | Depth m | | |
| | 201 - 500 | 201 - 500 | 501 - 800 | 801 - 1100 | 201 - 500 | 501 - 800 | 801 - 1100 | 201 - 500 | 501 - 800 | 801 - 1100 |
| **ORDER-MYXINIFORMES** | | | | | | | | | | |
| **Family-Myxinidae** | | | | | | | | | | |
| *Eptatrectus hexatrema* | | | | | | | | | | |
| **ORDER-CARCHARHINIFORMES** | | | | | | | | | | |
| Family: Scyliorhinidae | | | | | | | | | | |
| *Cephaloscyllium sufflans* | | | | | | | | | | |
| *Apristurus saldanha* | | | | | | | | | | |
| *Apristurus indicus* | | | | | | | | | | |
| *Bythaelurus hispidus* | | | | | | | | | | |
| *Bythaelurus lutarius* | | | | | | | | | | |
| Family: Proscylliidae | | | | | | | | | | |
| *Eridacnis sinuans* | | | | | | | | + | | |
| *Eridacnis radcliffei* | | | | | | | | + | | |
| **ORDER-SQUALIFORMES** | | | | | | | | | | |
| Family: Echinorhinidae | | | | | | | | | | |
| *Echinorhinus brucus* | | | | | | | | | | |
| Family: Somniosidae | | | | | | | | | | |
| *Centroscymnus crepidater* | | | | | | | | | | |
| Family: Etmopteridae | | | | | | | | | | |
| *Etmopterus baxteri* | | | | | | | | | | |
| *Etmopterus pusilus* | | | | | | | | | | |
| Family: Centrophoridae | | | | | | | | | | |
| *Centrophorus lusitanicus* | | | | | | | | | | |
| *Centrophorus granulosus* | | | | | | | | | | |
| *Centrophorus uyato* | | | | | | | | | | |
| **ORDER-RAJIFORMES** | | | | | | | | | | |
| Family Rajidae | | | | | | | | | | |
| *Raja miraletus* | | | | | | | | | | |
| *Leucoraja circularis* | | | | | | | | | | |
| *Dipturus johannisdavisi* | | | | | | | | | | |
| **ORDER-TORPEDINIFORMES** | | | | | | | | | | |
| Family: Narcinidae | | | | | | | | | | |
| *Benthobatis moresbyi* | | | | | | | | | | |
| **ORDER-CHIMAERIFORMES** | | | | | | | | | | |
| Family: Rhinochimaeridae | | | | | | | | | | |
| *Neoharriotta pinnata* | | | | | | | | | | |
| *Rhinochimaera atlantica* | | | | | | | | | | |
| *Harriotta raleighana* | | | | | | | | | | |
| Order: Albuliformes | | | | | | | | | | |
| Family: Halosauridae | | | | | | | | | | |
| *Halosaurus carinicauda* | | | | | | | | | | |
| Family-Notacanthidae | | | | | | | | | | |
| *Notacanthus indicus* | | | | | | | | | | |
| **ORDER-ANGUILLIFORMES** | | | | | | | | | | |
| Family: Colocongridae | | | | | | | | | | |
| *Coloconger raniceps* | | | | | | | | | | |
| Family: Synaphobranchidae | | | | | | | | | | |
| *Histiobranchus bathybius* | | | | | | | | | | |
| *Synaphobranchus kaupii* | | | | | | | | | | |

| | | |
|---|---|---|
| Family-Congridae | | |
| *Bathycongrus wallacei* | + | |
| *Bathyuroconger vicinus* | + | + |
| *Rhynchoconger ectenurus* | | |
| *Promyllantor purpureus* | | |
| Family: Muraenesocidae | | |
| *Sauromuraenesox vorax* | | |
| *Xenomystax trucidans* | | |
| *Gavialiceps taeniola* | | |
| Family: Nemichthyidae | | |
| *Nemichthys scolopaceus* | | |
| *Avocettina paucipora* | | |
| **Order OSMERIFORMES** | | |
| **Family-Alepocephalidae** | | |
| Rouleina nuda | + | |
| *Alepocephalus bicolor* | + | |
| *Alepocephalus blanfordii* | + | + |
| *Talismania longifilis* | | + |
| *Narcetes lloydi* | | + |
| *Bajacalifornia calcarata* | | |
| Family: Platytroctidae | | |
| *Platytroctes mirus* | | |
| **ORDER-ATELEOPODIFORMES** | | |
| Family: Ateleopodidae | | |
| *Ateleopus indicus* | | |
| **ORDER-STOMIIFORMES** | | |
| Family: Sternoptychidae | | |
| *Argyropelecus hemigymnus* | | |
| Family: Stomiidae | | |
| *Astronesthes martensii* | | |
| **ORDER-AULOPIFORMES** | | |
| Family: Evermannellidae | | |
| *Evermannella indica* | | |
| *Coccorella atrata* | | |
| Family: Paralepididae | | |
| *Lestidium nudum* | | |
| *Stemonosudis rothschildi* | | |
| *Magnisudis indica* | | |
| Family: Chlorophthalmidae | | |
| *Chlorophthalmus bicornis* | | |
| *Chlorophthalmus nigromarginatus* | | |
| *Chlorophthalmus agassizi* | | |
| Family: Ipnopidae | | |
| *Bathypterois atricolor* | | |
| Family: Paraulopidae | | |
| *Paraulopus maculatus* | | |
| Family: Synodontidae | | |
| *Saurida longimanus* | | |
| *Saurida undosquamis* | | |
| **ORDER-MYCTOPHIFORMES** | | |
| Family: Neoscopelidae | | |
| *Neoscopelus microchir* | | |

| | | | |
|---|---|---|---|
| *Scopelengys tristis* | | | |
| **ORDER-POLYMIXIIFORMES** | | | |
| Family: Polymixiidae | | | |
| *Polymixia nobilis* | | | |
| *Polymixia japonica* | | | + |
| **ORDER-GADIFORMES** | | | |
| Family: Moridae | | | |
| *Physiculus roseus* | | | |
| Family: Macrouridae | | | |
| *Bathygadus melanobranchus* | | | |
| *Gadomus capensis* | | + | |
| *Coelorinchus braueri* | | + | |
| *Coelorinchus quadricristatus* | | + | |
| *Coelorinchus flabellispinnis* | | + | |
| *Coryphaenoides macrolophus* | | + | |
| *Malacocephalus laevis* | | + | |
| *Nezumia investigatoris* | | + | |
| **ORDER-OPHIDIIFORMES** | | | |
| Family: Ophidiidae | | | |
| *Brotulotaenia crassa* | + | | |
| *Lamprogrammus exutus* | | | |
| *Lamprogrammus niger* | | | |
| *Spectrunculus grandis* | | | |
| *Luciobrotula bartschi* | | | |
| *Hypopleuron caninum* | | | |
| *Glyptophidium lucidum* | | | |
| *Glyptophidium argenteum* | | | |
| *Glyptophidium oceanium* | | | |
| *Glyptophidium macropus* | | | |
| *Bassozetus robustus* | | | |
| *Dicrolene multifilis* | | | |
| *Dicrolene nigricaudis* | | | |
| *Dicrolene tristis* | | | |
| *Monomitopus conjugator* | | | |
| *Neobythites multistriatus* | | | |
| *Neobythites steatiticus* | | | |
| *Neobythites macrops* | | | |
| Family: Bythitidae | | | |
| *Grammonus ater* | | | |
| *Hephthocara simum* | | | |
| **ORDER-LOPHIIFORMES** | | | |
| Family: Lophiidae | | | |
| *Lophiodes mutilus* | | | |
| *Lophiomus setigerus* | | | |
| Family: Chaunacidae | | | |
| *Chaunax pictus* | | | |
| Family: Melanocetidae | | | |
| *Melanocetus murrayi* | | | |
| Family: Ceratiidae | | | |
| *Ceratias uranoscopus* | | | |
| Family: Diceratiidae | | | |
| *Diceratias trilobus* | | | |
| *Bufoceratias wedli* | | | |
| Family: Ogcocephalidae | | | |
| *Halieutaea stellata* | | | |
| *Halieutaea coccinea* | | | |

| | | |
|---|---|---|
| *Halieutopsis micropa* | | + |
| Order: Lampridiformes | | |
| Family: Trachipteridae | | |
| *Zu elongatus* | | |
| **ORDER-BERYCIFORMES** | | |
| Family: Anoplogastridae | | |
| *Anoplogaster cornuta* | | |
| Family: Diretmidae | | |
| *Diretmichthys parini* | | |
| Family: Berycidae | | |
| *Beryx decadactylus* | | |
| *Beryx splendens* | | |
| Family: Trachichthyidae | | |
| *Gephyroberyx darwinii* | | + |
| *Hoplostethus melanopus* | | + |
| *Hoplostethus mediterraneus* | + | + |
| **ORDER-ZEIFORMES** | | |
| Family: Parazenidae | | |
| *Cyttopsis rosea* | | |
| Family: Zeidae | | |
| *Zenopsis conchifer* | | |
| **ORDER-SCORPAENIFORMES** | | |
| Family: Scorpaenidae | | |
| *Setarches longimanus* | | |
| *Ectreposebastes imus* | | |
| *Pterois russelii* | | |
| *Scorpaena scrofa* | | |
| Family Peristediidae | | |
| *Peristedion weberi* | | |
| Family: Dactylopteridae | | |
| *Dactyloptena macracantha* | | |
| *Dactyloptena orientalis* | | |
| Family: Triglidae | | |
| *Lepidotrigla spiloptera* | | |
| *Pterygotrigla hemisticta* | | |
| **ORDER-PERCIFORMES** | | |
| Family: Serranidae | | |
| *Chelidoperca investigatoris* | | |
| Family: Priacanthidae | | |
| *Heteropriacanthus cruentatus* | | |
| *Priacanthus hamrur* | | |
| Family: Nemipteridae | | |
| *Parascolopsis aspinosa* | | |
| Family: Bathyclupeidae | | |
| *Bathyclupea hoskynii* | | |
| Family: Epigonidae | | |
| *Epigonus pandionis* | | |
| Family: Pentacerotidae | | |
| *Histiopterus typus* | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Family: Cepolidae | | | | | | | | | | |
| *Owstonia simoterus* | | | | | | | | | | |
| Family: Acropomatidae | | | | | | | | | | |
| *Acropoma japonicum* | | | | | | | | | | |
| *Synagrops philippinensis* | | | | | | | | | | |
| *Synagrops japonicus* | + | | | | | | | | | |
| Family: Centrolophidae | | | | | | | | | | |
| *Psenopsis cyanea* | + | | | | | + | | | | |
| Family: Nomeidae | | | | | | | | | | |
| *Cubiceps pauciradiatus* | | | | | | | | | | |
| *Cubiceps squamiceps* | | | | | + | | | | | |
| *Psenes cyanophrys* | | | | | | | | | | |
| Family: Percophidae | | | | | | | | | | |
| *Bembrops caudimacula* | | | | | | | | | | |
| Family: Uranoscopidae | | | | | | | | | | |
| *Uranoscopus crassiceps* | | | | | | | | | | |
| *Xenocephalus australiensis* | | | | | | | | | | |
| Family: Callionymidae | | | | | | | | | | |
| *Callionymus sagitta* | | | | | | | | | | |
| Family: Gempylidae | | | | | | | | | | |
| *Ruvettus pretiosus* | | | | | | | | | | |
| *Neoepinnula orientalis* | | | | | | | | | | |
| *Rexea prometheoides* | | | | | | | | | | |
| *Nealotus tripes* | | | | | | | | | | |
| *Promethichthys prometheus* | | | | | | | | | | |
| Family: Trichiuridae | | | | | | | | | | |
| *Trichiurus auriga* | | | | | | | | | | |
| **ORDER-PLEURONECTIFORMES** | | | | | | | | | | |
| Family: Bothidae | | | | | | | | | | |
| *Chascanopsetta lugubris* | + | | | | | | | | | |
| *Psettina brevirictis* | | | | | | | | | | |
| Family: Cynoglossidae | | | | | | | | | | |
| *Cynoglossus acutirostris* | | | | | | | | | | |
| *Cynoglossus carpenteri* | | | | | | | | | | |
| Family: Soleidae | | | | | | | | | | |
| *Aesopia cornuta* | | | | | | | | | | |
| **ORDER-TETRADONTIFORMES** | | | | | | | | | | |
| Family: Triacanthodidae | | | | | | | | | | |
| *Macrorhamphosodes uradoi* | - | | - | - | - | + | - | - | | - |

Table 3. 4 Latitude wise and depth wise catch composition of deep sea fishes along the south west coast of India

| Latitude | 201 - 500m | | | 501 - 800m | | | 801 - 1100m | | | Consolidated | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch (kg) | Effort | C/E | Catch (kg) | Effort | C/E | Catch (kg) | Effort | C/E | Catch (kg) | Effort | C/E |
| **7° - 9°** | 7929.3 | 6.85 | 1157.562 | 0 | 0 | 0 | 0 | 0 | 0 | 7929.3 | 6.85 | 1157.562 |
| **9° - 11°** | 804.00 | 18.8 | 42.77 | 465.99 | 6.3 | 73.97 | 0 | 1 | 0 | 1269.994 | 26.1 | 48.65877 |
| **11° - 13°** | 1982.66 | 9.65 | 298.14 | 264.22 | 7 | 37 75 | 15.16 | 3 | 5.05 | 2262.044 | 19.65 | 115.1167 |
| **13° - 15°** | 297.15 | 7.95 | 37.38 | 352.06 | 6.5 | 54.16 | 135.70 | 1 | 135.70 | 784.91 | 15.45 | 50.80324 |
| **Consolidated** | **11013.11** | **43.25** | **254.6385** | **1082.274** | **19.8** | **54.6603** | **150.8597** | **5** | **30.17194** | **12246.25** | **68.05** | **179.9596** |

Table 3. 5 Consolidated CPUE of deep sea fishes along the southwest coast of India

| Sl. No. | Name of the speceis | Effort = Catch (Kg) | 68.05 C/E(Kg/Hr) | % |
|---|---|---|---|---|
| 1 | *Alepocephalus bicolor* | 45.81 | 0.67 | 0.37 |
| 2 | *Alepocephalus blanfordi* | 18.00 | 0.26 | 0.15 |
| 3 | *Bathyuroconger vicinus* | 13.97 | 0.21 | 0.11 |
| 4 | *Bembrops caudimacula* | 107.39 | 1.58 | 0.88 |
| 5 | *Benthobatis morsebyi* | 55.60 | 0.82 | 0.45 |
| 6 | *Beryx splendens* | 10.00 | 0.15 | 0.08 |
| 7 | *Centrophorus granulosus* | 33.70 | 0.50 | 0.28 |
| 8 | *Chelidoperca investigatoris* | 29.30 | 0.43 | 0.24 |
| 9 | *Chlorophthalmus bicornis* | 1360.85 | 20.00 | 11.11 |
| 10 | *Paraulopus maculatus* | 10.00 | 0.15 | 0.08 |
| 11 | *Chlorophthalmus nigromarginatus* | 6079.53 | 89.34 | 49.64 |
| 12 | *Coryphaenoides macrolophus* | 55.95 | 0.82 | 0.46 |
| 13 | *Cubiceps pauciradiatus* | 43.04 | 0.63 | 0.35 |
| 14 | *Cynoglossus carpenteri* | 18.80 | 0.28 | 0.15 |
| 15 | *Echinorhinus brucus* | 347.05 | 5.10 | 2.83 |
| 16 | *Eel juveniles* | 254.90 | 3.75 | 2.08 |
| 17 | *Eridacnis radcliffei* | 24.12 | 0.35 | 0.20 |
| 18 | *Holplostethus mediterraneus* | 115.03 | 1.69 | 0.94 |
| 19 | *Hypopleuron caninum* | 267.49 | 3.93 | 2.18 |
| 20 | *Lamprogrammus exutus* | 104.16 | 1.53 | 0.85 |
| 21 | *Luciobrotula bartschi* | 29.35 | 0.43 | 0.24 |
| 22 | *Malacocephalus laevis* | 76.20 | 1 12 | 0.62 |
| 23 | *Narcetes lloydi* | 14.90 | 0.22 | 0.12 |
| 24 | *Neoepinnula orientalis* | 118.68 | 1.74 | 0.97 |
| 25 | *Neoharriota pinnata* | 52.20 | 0.77 | 0.43 |
| 26 | *Macrorhamphosodes uradoi* | 15.00 | 0.22 | 0.12 |
| 27 | *Physiculus roseus* | 73.52 | 1.08 | 0.60 |
| 28 | *Polymixia japonica* | 39.44 | 0.58 | 0.32 |
| 29 | *Priacanthus hamrur* | 28.00 | 0.41 | 0.23 |
| 30 | *Cubiceps squamiceps* | 225.78 | 3.32 | 1.84 |
| 31 | *Psenopsis cyanea* | 579.39 | 8.51 | 4.73 |
| 32 | *Pterygotrigla hemisticta* | 46.25 | 0.68 | 0.38 |
| 33 | *Raja miraletus* | 70.20 | 1.03 | 0.57 |
| 34 | *Rexea promethoides* | 24.90 | 0.37 | 0.20 |
| 35 | *Rhinochimaera atlantica* | `113.00 | 1.66 | 0.92 |
| 36 | *Gavialiceps taeniola* | 354.48 | 5.21 | 2.89 |
| 37 | *Saurida undosquamis* | 30.00 | 0.44 | 0.24 |
| 38 | *Synagrops philippinensis* | 23.70 | 0.35 | 0.19 |
| 39 | *Trichiurus auriga* | 1024.10 | 15.05 | 8.36 |
| 40 | *Uranoscopus crassiceps* | 86.65 | 1.27 | 0.71 |
| 41 | *Xenomystax trucidens* | 25.05 | 0.37 | 0.20 |
| 42 | *Zenopsis conchifer* | 18.06 | 0.27 | 0.15 |
| 43 | *Other species* | 182.73 | 2.69 | 1.49 |
| | | **12246.25** | **179.96** | |

**Table 3. 6 CPUE of deep sea fishes at 201 - 500m depth zone**

| Sl. No. | Name of the speceis | Catch (Kg) | C/E(Kg/Hr) | % |
|---|---|---|---|---|
| | | Effort = | 43.25 | |
| 1 | *Apristurus indicus* | 28.30 | 2.07 | 0.81 |
| 2 | *Bembrops caudimacula* | 107.39 | 2.48 | 0.98 |
| 3 | *Chelidoperca investigatoris* | 32.30 | 0.68 | 0.27 |
| 4 | *Chlorophthalmus bicornis* | 1360.85 | 31.46 | 12.36 |
| 5 | *Paraulopus maculatus* | 10.00 | 0.23 | 0.09 |
| 6 | *Chlorophthalmus nigromarginatus* | 6079.53 | 140.57 | 55.20 |
| 7 | *Cubiceps pauciradiatus* | 42.52 | 0.98 | 0.39 |
| 8 | *Cynoglossus carpenteri* | 18.80 | 0.43 | 0.17 |
| 9 | *Echinorhinus brucus* | 249.00 | 5.76 | 2.26 |
| 10 | *Eel juveniles* | 98.90 | 2.56 | 1.01 |
| 11 | *Holplostethus mediterraneus* | 55.93 | 1.29 | 0.51 |
| 12 | *Hypopleuron caninum* | 227.37 | 5.26 | 2.06 |
| 13 | *Neoepinnula orientalis* | 118.68 | 2.74 | 1.08 |
| 14 | *Macrorhamphosodes uradoi* | 15.00 | 0.35 | 0.14 |
| 15 | *Physiculus roseus* | 35.30 | 0.82 | 0.32 |
| 16 | *Polymixia japonica* | 39.44 | 0.91 | 0.36 |
| 17 | *Priacanthus hamrur* | 28.00 | 0.65 | 0.25 |
| 18 | *Psenopsis cyanea* | 576.02 | 13.32 | 5.23 |
| 19 | *Cubiceps squamiceps* | 212.30 | 5.22 | 2.05 |
| 20 | *Pterygotrigla hemisticta* | 46.25 | 1.07 | 0.42 |
| 21 | *Rexea promethoides* | 24.90 | 0.58 | 0.23 |
| 22 | *Rhinochimaera atlantica* | 45.20 | 1.05 | 0.41 |
| 23 | *Gavialiceps taeniola* | 254.11 | 5.88 | 2.31 |
| 24 | *Saurida undosquamis* | 30.00 | 0.69 | 0.27 |
| 25 | *Synagrops philippinensis* | 23.70 | 0.55 | 0.22 |
| 26 | *Trichiurus auriga* | 1024.10 | 23.68 | 9.30 |
| 27 | *Uranoscopus crassiceps* | 86.08 | 1.99 | 0.78 |
| 28 | *Zenopsis conchifer* | 18.06 | 0.42 | 0.16 |
| | | **11013.11** | **254.64** | |

**Table 3. 7 CPUE of deep sea fishes at 501 - 800m depth zone**

| Sl. No. | Name of the speceis | Effort = | 19.8 | |
|---|---|---|---|---|
| | | Catch (Kg) | C/E(Kg/Hr) | % |
| 1 | *Alepocephalus bicolor* | 45.81 | 2.31 | 4.23 |
| 2 | *Apristurus indicus* | 15.23 | 0.77 | 1.41 |
| 3 | *Benthobatis morsebyi* | 55.60 | 2.81 | 5.14 |
| 4 | *Beryx splendens* | 10.00 | 0.51 | 0.92 |
| 5 | *Centrophorus granulose* | 33.70 | 1.70 | 3.11 |
| 6 | *Coryphaenoides macrolophus* | 55.60 | 2.81 | 5.14 |
| 7 | *Echinorhinus brucus* | 98.05 | 4.95 | 9.06 |
| 8 | *Eel juveniles* | 144.00 | 7.27 | 13.31 |
| 9 | *Eridacnis radcliffei* | 20.40 | 1.03 | 1.88 |
| 10 | *Harriotta raleighana* | 67.80 | 3.42 | 6.26 |
| 11 | *Hypopleuron caninum* | 50.33 | 2.54 | 4.65 |
| 12 | *Luciobrotula bartschi* | 29.35 | 1.48 | 2.71 |
| 13 | *Malacocephalus laevis* | 76.20 | 3.85 | 7.04 |
| 14 | *Neoharriotta pinnata* | 52.20 | 2.64 | 4.82 |
| 15 | *Physiculus roseus* | 38.22 | 1.93 | 3.53 |
| 16 | *Raja miraletus* | 70.20 | 3.55 | 6.49 |
| 17 | *Gavialiceps taeniola* | 100.17 | 5.06 | 9.26 |
| 18 | *Xenomystax trucidens* | 25.05 | 1.27 | 2.31 |
| | | **1082.27** | **54.66** | |

Table 3. 8 CPUE of deep sea fishes at 801 - 1100m depth zone

| | | Effort = | 5 | |
|---|---|---|---|---|
| Sl. No. | Name of the speceis | Catch (Kg) | C/E(Kg/Hr) | % |
| 1 | *Alepocephalus blanfordi* | 18.00 | 3.60 | 11.93 |
| 2 | *Bathyuroconger vicinus* | 13.27 | 2.65 | 8.80 |
| 3 | *Lamprogrammus exutus* | 99.00 | 19.80 | 65.62 |
| 4 | *Narcetes lloydi* | 14.90 | 2.98 | 9.88 |
| | | **150.86** | **30.17** | **100.00** |

Table 3. 9 CPUE and percentage of deep sea fishes in the Latitude 7 - 9 N

| | | Effort = | 6.85 | |
|---|---|---|---|---|
| Sl. No. | Name of the speceis | Catch (Kg) | C/E(Kg/Hr) | % |
| 1 | *Chlorophthalmus bicornis* | 1147.00 | 167.45 | 14.47 |
| 2 | *Paraulopus maculatus* | 10.00 | 1.46 | 0.13 |
| 3 | *Chlorophthalmus nigromarginatus* | 5317.00 | 776.20 | 67.06 |
| 4 | *Cubiceps pauciradiatus* | 32.00 | 4.67 | 0.40 |
| 5 | *Holplostethus mediterraneus* | 10.00 | 1.31 | 0.11 |
| 6 | *Hypopleuron caninum* | 120.00 | 17.52 | 1.51 |
| 7 | *Neoepinnula orientalis* | 15.10 | 2.20 | 0.19 |
| 8 | *Macrorhamphosodes uradoi* | 15.00 | 2.19 | 0.19 |
| 9 | *Cubiceps squamiceps* | 32.00 | 4.67 | 0.40 |
| 10 | *Psenopsis cyanea* | 173.00 | 25.26 | 2.18 |
| 11 | *Gavialiceps taeniola* | 10.00 | 1.20 | 0.10 |
| 12 | *Saurida undosquamis* | 30.00 | 4.38 | 0.38 |
| 13 | *Trichiurus auriga* | 1021.00 | 149.05 | 12.88 |
| | | **7929.30** | **1157.56** | |

**Table 3. 10 Depth related CPUE and percentage of deep sea fishes in the Latitude 9 - 11 N**

| | | 201 - 500m | | | 501 - 800m | | | Consolidated | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | E = | 18.8 | | E = | 6.3 | | E = | 26.1 | |
| Sl. No. | Name of the speceis | Catch (kg) | C/E | % | Catch (kg) | C/E | % | Catch (kg) | C/E | % |
| 1 | *Alepocephalus bicolor* | 0.00 | 0.00 | 0.00 | 11.21 | 1.78 | 2.41 | 11.21 | 0.43 | 0.88 |
| 2 | *Benthobatis morsebyi* | 0.00 | 0.00 | 0.00 | 46.60 | 7.40 | 10.00 | 46.60 | 1.79 | 3.67 |
| 3 | *Beryx splendens* | 0.00 | 0.00 | 0.00 | 10.00 | 1.59 | 2.15 | 10.00 | 0.38 | 0.79 |
| 4 | *Centrophorus granulosus* | 0.00 | 0.00 | 0.00 | 33.70 | 5.35 | 7.23 | 33.70 | 1.29 | 2.65 |
| 5 | *Chlorophthalmus bicornis* | 13.82 | 0.74 | 1.72 | 0.00 | 0.00 | 0.00 | 13.82 | 0.53 | 1.09 |
| 6 | *Chlorophthalmus nigromarginatus* | 127.53 | 6.78 | 15.86 | 0.00 | 0.00 | 0.00 | 127.53 | 4.89 | 10.04 |
| 7 | *Coryphaenoides macrolophus* | 0.00 | 0.00 | 0.00 | 41.60 | 6.60 | 8.93 | 41.60 | 1.59 | 3.28 |
| 8 | *Cubiceps squamiceps* | 134.28 | 7 14 | 16.70 | 0.00 | 0.00 | 0.00 | 134.28 | 5.14 | 10.57 |
| 9 | *Cubiceps pauciradiatus* | 10.52 | 0.56 | 1.31 | 0.00 | 0.00 | 0.00 | 10.52 | 0.40 | 0.83 |
| 10 | *Holplostethus mediterraneus* | 14.00 | 0.74 | 1.74 | 1.00 | 0.16 | 0.21 | 15.00 | 0.57 | 1.18 |
| 11 | *Malacocephalus laevis* | 0.00 | 0.00 | 0.00 | 76.20 | 12.10 | 16.35 | 76.20 | 2.92 | 6.00 |
| 12 | *Neoepinnula orientalis* | 26.78 | 1.42 | 3.33 | 0.00 | 0.00 | 0.00 | 26.78 | 1.03 | 2.11 |
| 13 | *Physiculus roseus* | 17.00 | 0.90 | 2.11 | 27.71 | 4.40 | 5.95 | 44.71 | 1.71 | 3.52 |
| 14 | *Polymixia japonica* | 4.44 | 0.24 | 0.55 | 0.00 | 0.00 | 0.00 | 4.44 | 0.17 | 0.35 |
| 15 | *Hypopleuron caninum* | 12.37 | 0.66 | 1.54 | 19.12 | 3.03 | 4.10 | 31.49 | 1.21 | 2.48 |
| 16 | *Psenopsis cyanea* | 250.42 | 13.32 | 31.15 | 0.00 | 0.00 | 0.00 | 250.42 | 9.59 | 19.72 |
| 17 | *Raja miraletus* | 0.00 | 0.00 | 0.00 | 70.20 | 11.14 | 15.06 | 70.20 | 2.69 | 5.53 |
| 18 | *Neoharriotta pinnata* | 33.20 | 1.77 | 4.13 | 52.80 | 8.38 | 11.33 | 86.00 | 3.30 | 6.77 |
| 19 | *Gavialiceps taeniola* | 84.31 | 4.48 | 10.49 | 35.22 | 5.59 | 7.56 | 119.53 | 4.58 | 9.41 |
| 20 | *Synagrops philippinensis* | 23.70 | 1.26 | 2.95 | 0.00 | 0.00 | 0.00 | 23.70 | 0.91 | 1.87 |
| 21 | *Xenomystax trucidens* | 0.00 | 0.00 | 0.00 | 10.00 | 1.59 | 2.15 | 10.00 | 0.38 | 0.79 |
| 22 | *Zenopsis conchifer* | 18.06 | 0.96 | 2.25 | 0.00 | 0.00 | 0.00 | 18.06 | 0.69 | 1.42 |
| 23 | *Others* | 33.59 | 1.79 | 4.18 | 30.63 | 4.87 | 6.57 | 64.22 | 2.46 | 5.06 |
| | | **804.00** | **42.77** | | **465.99** | **73.97** | | **1269.99** | **48.66** | |

Table 3. 11 Depth related CPUE and percentage of deep sea fishes in the Latitude 11 - 13 N

| | | 201 - 500m | | | 501 - 800m | | | 801 - 1100m | | | Consolidated | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | E = | 9.65 | | E = | 7 | | E = | 3 | | E = | 19.65 | |
| Sl. No. | Name of the speceis | Catch (kg) | C/E | % | Catch (kg) | C/E | % | Catch (kg) | C/E | % | Catch (kg) | C/E | % |
| 1 | *Alepocephalus bicolor* | 0.00 | 0.00 | 0.00 | 34.60 | 4.94 | 13.09 | 0.00 | 0.00 | 0.00 | 34.60 | 1.76 | 1.529593 |
| 2 | *Bembrops caudimacula* | 106.39 | 16.00 | 5.37 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 106.39 | 5.41 | 4.703277 |
| 3 | *Chelidoperca investigatoris* | 26.90 | 4.05 | 1.36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 26.90 | 1.37 | 1.189192 |
| 4 | *Chlorophthalmus bicornis* | 200.00 | 30.08 | 10.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 200.00 | 10.18 | 8.841577 |
| 5 | *Chlorophthalmus nigromarginatus* | 635.00 | 95.49 | 32.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 635.00 | 32.32 | 28.07201 |
| 6 | *Coryphaenoides macrolophus* | 0.00 | 0.00 | 0.00 | 14.00 | 2.00 | 5.30 | 0.35 | 0.12 | 2.31 | 14.35 | 0.73 | 0.634383 |
| 7 | *Cynoglossus carpenteri* | 18.68 | 2.81 | 0.94 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.68 | 0.95 | 0.825803 |
| 8 | *Echinorhinus brucus* | 64.00 | 9.62 | 3.23 | 1.65 | 0.24 | 0.62 | 0.00 | 0.00 | 0.00 | 65.65 | 3.34 | 2.902248 |
| 9 | *Eel juveniles* | 104.00 | 15.64 | 5.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 104.00 | 5.29 | 4.59762 |
| 10 | *Harriotta raleighana* | 7.00 | 1.05 | 0.35 | 9.00 | 1.29 | 3.41 | 0.00 | 0.00 | 0.00 | 16.00 | 0.81 | 0.707326 |
| 11 | *Holplostethus mediterraneus* | 32.93 | 4.95 | 1.66 | 3.00 | 0.43 | 1.14 | 0.00 | 0.00 | 0.00 | 35.93 | 1.83 | 1.588389 |
| 12 | *Hypopleuron caninum* | 80.00 | 12.03 | 4.03 | 18.00 | 2.57 | 6.81 | 0.00 | 0.00 | 0.00 | 98.00 | 4.99 | 4.332373 |
| 13 | *Narcetes lloydi* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.60 | 3.53 | 69.92 | 10.60 | 0.54 | 0.468604 |
| 14 | *Neoepinnula orientalis* | 16.07 | 2.42 | 0.81 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 16.07 | 0.82 | 0.710421 |
| 15 | *Neoharriotta pinnata* | 0.00 | 0.00 | 0.00 | 18.00 | 2.57 | 6.81 | 0.00 | 0.00 | 0.00 | 18.00 | 0.92 | 0.795742 |
| 16 | *Physiculus roseus* | 13.00 | 1.95 | 0.66 | 3.70 | 0.53 | 1.40 | 0.00 | 0.00 | 0.00 | 16.70 | 0.85 | 0.738272 |
| 17 | *Polymixia japonica* | 35.00 | 5.26 | 1.77 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 35.00 | 1.78 | 1.547276 |
| 18 | *Cubiceps squamiceps* | 56.50 | 8.50 | 2.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 56.50 | 2.88 | 2.497745 |
| 19 | *Psenopsis cyanea* | 152.60 | 22.95 | 7.70 | 1.00 | 0.14 | 0.38 | 0.00 | 0.00 | 0.00 | 153.60 | 7.82 | 6.790331 |
| 20 | *Pterygotrigla hemisticta* | 46.25 | 6.95 | 2.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 46.25 | 2.35 | 2.044615 |
| 21 | *Rexea promethoides* | 22.00 | 3.31 | 1.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 22.00 | 1.12 | 0.972573 |
| 22 | *Gavialiceps taeniola* | 121.60 | 18.29 | 6.13 | 46.29 | 6.61 | 17.52 | 0.20 | 0.07 | 1.32 | 168.09 | 8.55 | 7.430709 |
| 23 | *Uranoscopus crassiceps* | 86.08 | 12.94 | 4.34 | 0.57 | 0.08 | 0.22 | 0.00 | 0.00 | 0.00 | 86.65 | 4.41 | 3.830613 |
| 24 | *Xenomystax trucidens* | 0.00 | 0.00 | 0.00 | 15.05 | 2.15 | 5.70 | 0.00 | 0.00 | 0.00 | 15.05 | 0.77 | 0.665329 |
| 25 | *Others* | 158.66 | 23.85 | 8.00 | 99.36 | 14.20 | 37.60 | 4.01 | 1.33 | 26.45 | 262.03 | 13.33 | 11.58379 |
| | | **1982.66** | **298.14** | | **264.22** | **37.75** | | **15.16** | **5.05** | | **2262.04** | **115.12** | |

**Table 3. 12 Depth related CPUE and percentage of deep sea fishes in the Latitude 13 - 15 N**

| | | 201 - 500m | | | 501 - 800m | | | 801 - 1100m | | | Consolidated | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | E = | 7.95 | | E = | 6.5 | | E = | 1 | | E = | 15.45 | |
| Sl. No. | Name of the specels | Catch (kg) | C/E | % | Catch (kg) | C/E | % | Catch (kg) | C/E | % | Catch (kg) | C/E | % |
| 1 | *Alepocephalus blanfordi* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 18.00 | 18.00 | 13.26 | 18.00 | 1.17 | 2.29 |
| 2 | *Bathyuroconger vicinus* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 | 12.00 | 8.84 | 12.00 | 0.78 | 1.53 |
| 3 | *Chelidoperca investigatoris* | 2.40 | 0.30 | 0.81 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.40 | 0.16 | 0.31 |
| 4 | *Echinorhinus brucus* | 185.00 | 23.27 | 62.26 | 96.40 | 14.83 | 27.38 | 0.00 | 0.00 | 0.00 | 281.40 | 18.21 | 35.85 |
| 5 | *Eel juveniles* | 6.90 | 0.87 | 2.32 | 144.00 | 22.15 | 40.90 | 0.00 | 0.00 | 0.00 | 150.90 | 9.77 | 19.23 |
| 6 | *Lamprogrammus exutus* | 0.00 | 0.00 | 0.00 | 1.70 | 0.26 | 0.48 | 99.00 | 99.00 | 72.96 | 100.70 | 6.52 | 12.83 |
| 7 | *Luciobrotula bartschi* | 0.00 | 0.00 | 0.00 | 24.60 | 3.78 | 6.99 | 0.00 | 0.00 | 0.00 | 24.60 | 1.59 | 3.13 |
| 8 | *Neoepinnula orientalis* | 1.66 | 0.21 | 0.56 | 0.33 | 0.05 | 0.09 | 0.00 | 0.00 | 0.00 | 1.99 | 0.13 | 0.25 |
| 9 | *Neoharriotta pinnata* | 0.00 | 0.00 | 0.00 | 26.90 | 4.14 | 7.64 | 0.00 | 0.00 | 0.00 | 26.90 | 1.74 | 3.43 |
| 10 | *Physiculus roseus* | 5.30 | 0.67 | 1.78 | 6.81 | 1.05 | 1.93 | 0.00 | 0.00 | 0.00 | 12.11 | 0.78 | 1.54 |
| 11 | *Hypopleuron caninum* | 15.00 | 1.89 | 5.05 | 3.00 | 0.46 | 0.85 | 0.00 | 0.00 | 0.00 | 18.00 | 1.17 | 2.29 |
| 12 | *Priacanthus hamrur* | 28.00 | 3.52 | 9.42 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 28.00 | 1.81 | 3.57 |
| 13 | *Gavialiceps taeniola* | 40.00 | 5.03 | 13.46 | 18.66 | 2.87 | 5.30 | 0.00 | 0.00 | 0.00 | 58.66 | 3.80 | 7.47 |
| 14 | *Talismania longifilis* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.50 | 0.37 | 0.50 | 0.03 | 0.06 |
| 15 | *Others* | 12.89 | 1.62 | 4.34 | 29.66 | 4.56 | 8.42 | 6.20 | 6.20 | 4.57 | 48.75 | 3.16 | 6.21 |
| | | **297.15** | **37.38** | | **352.06** | **54.16** | | **135.70** | **135.70** | | **784.91** | **50.80** | |

# SECTION II

# CHAPTER 4

# FOOD AND FEEDING

## 4.1 Introduction

Food is one among the basic needs of an organism. Food can be defined as any material which is ingested by an organism deliberately or accidentally, digested and absorbed for its growth and maintenance. It is an important factor regulating and influencing the growth, fecundity, migration and abundance of fish stocks. Seasonal and diurnal abundance of desired food organisms may be responsible for the horizontal and vertical movements of the fish stocks (Philip, 1994). Feeding is the means by which an organism ingests the food material from its habitat. The food of an organism can be divided into basic food, which is the most preferred food item of a particular organism; occasional food, which is present in the gut occasionally; obligatory food, which is preferred by the organism when available in sufficient quantities; accidental food items which are consumed accidentally when the fish feeds (Srivastava, 1999).

The relationship between the organisms and their prey is very important for an ecosystem. The presence of basic food item makes a place favourable feeding ground. In absence of this, organism will either search for other food items or even tries to migrate to another habitat. Food and feeding of fish depends on a number of environmental and intrinsic or biological variables. Metabolism is strongly related to size and food consumption (Margalef, 1977).

A study of food of fishes gives some general information on their relative positions in the food chains of the ecosystem. It has a lot of importance in understanding its way of living, food preferences and also its interaction with abiotic and biotic components of the immediate habitat. It is essential to know the feeding habits of commercially important fishes and to monitor it periodically to predict the abundance and exploitation of stocks as well as to design appropriate fishing strategies and techniques. This knowledge together with other life history traits will help the fishery managers to formulate the exploitation and regulation of a particular fishery. In view of the above reasons, considerable attention has been paid by the fishery biologists on this subject all over the world.

A number of studies on food of commercially important species from different localities have been carried out by various workers, mostly as a part of studies on their biology. They investigated aspects such as the nature of food, its seasonal variations, feeding habits in relation to sex, size, maturity stages, relation between fishery and availability of food (Devanesen, 1932; Chacko, 1949; George, 1953; Seshappa and Bhimachar, 1955; Natarajan and Jhingran, 1961; Venkataraman, 1961; Qasim, 1972; Philip, 1994; Pillai *et al.* 2009).

Deep sea demersal fishes account for 25 to 70% of the biomass of deep sea megabenthos and they play an important role in the horizontal energy pathway (Kishiko, 2004). Also it has been observed from the experiences of different commercially exploited deep sea fisheries that studying the food and feeding of these fishes in advance is very important for planning the fishery. Therefore, feeding habits of deep-sea fishes are one of the most interesting themes for scientists and one which is well studied for many species all over the world. Pearcy and Ambler (1974) studied the food of Macrourid fishes off the Oregon coast. The feeding biology of *Scopelogadus beanii* in the western North Atlantic (Gartner Jr. and Musick, 1989); a comparative feeding ecology of temperate and tropical deep-sea fishes from the western North Atlantic (Crabtree *et al.* 1991) and a lot of studies were conducted from Eastern Atlantic (Golovan, 1978; Marshall and Merrett, 1977; Merrett and Marshall, 1981; Mauchline and Gordon, 1984; Gordon and Duncan, 1985, 1987); Ionian sea (D'Onghia *et al.* 1998). Feeding habits of slope dwelling macrourid fishes in the eastern North Pacific (Drazen *et al.* 2001); Madagascar and southwest Pacific (Norfolk mountain ridge), continental slope of Ireland (Kotlyar, 1980), Mediterranean (D'Onghia *et al.* 1995; Cau and Deiana, 1982) and biological aspects deep-water squalid sharks *Centrocscyllium fabricii* and *Etmopterus princeps* in Icelandic waters were studied (Klara, 2001). Durr and Gonzalez (2002) studied food and feeding habits of *Beryx splendens* and *B. decadactylus* (Berycidae) off Canary Islands. The influence of trophic variables on the depth-range distributions and zonation rates of deep sea megafauna was elucidated by Cartes and Carrassón (2004). Diet of 10 species of Macrouridae from Africa's west coast and Agulhas Bank were compared by Anderson (2005).

Comparatively, very few studies on trophic relations of deep sea fishes of western Indian Ocean have been reported. Kinzer *et al.* (1993) discussed about the aspects of horizontal distribution and diet of myctophid fishes in the Arabian Sea in relation to the deep water oxygen deficiency. Felix *et al.* (2000) reported the scavenger fish assemblages under differing trophic conditions in the deep Arabian Sea. Similar works on the deep sea fishes beyond 200m depth are scanty from Indian waters especially biology of deep sea fishes from west coast of Indian EEZ was subjected to only a few studies. Nair and Appukuttan (1973) studied food and feeding habits of deep sea sharks *Halaelurus hispidus, Eridacnis radcliffei* and *Iago omanensis*. A detailed study was conducted on the food and feeding habits of *Priacanthus hamrur* by Philip (1994) and biology of deep sea fishes along the west coast of Indian EEZ was compared by Khan *et al.* (1996). Venu and Kurup (2002a, b&c, 2006 a&b) carried out detailed studies on the biology of *Psenopsis cyanea, Hoplostethus mediterraneus, Priacanthus hamrur, Psenes whiteleggi, Hephthocara simum, Neoepinnula orientalis* and *Psenes squamiceps*. The biology of *Chlorophthalmus bicornis* (Kurup *et al.* 2005), *Alepocephalus bicolor* (Deepu *et al.* 2007) and *Gavialiceps taeniola* (Divya *et al.* 2007) was also studied recently. Diet composition of deep sea fishes from eastern Arabian Sea was reported by Karuppasamy *et al.* (2008).

The food and feeding habits of the potential commercial fishes are still unknown and against this background, the present study was conceptualised and carried out with a view to unravel the nature of food and feeding habits of deep sea fishes inhabiting along the southwest coast of Indian EEZ.

## 4. 2 Materials and Methods

Materials for the present study were collected from the exploratory demersal trawling operations conducted onboard FORV Sagar Sampada along the southwest region of Indian EEZ and also from the fishing harbours located at Munambam, Neendakara and Sakthikulangara during 1998–2002 (for details see Chapter 2).

835 specimens of *Psenopsis cyanea* (ranging between 8.3 to 19.0 cm TL and 11.71 to 66.25g weight); 842 specimens of *Neoepinnula orientalis* (of size range 12.3 to 29.0cm TL and 11.71 to 86.25g weight); *Hoplostethus*

*mediterraneus* represented by 435 specimens (ranging in size 8.3 to 19.0cm TL and 11.71 to 66.25 g weight); *Cubiceps squamiceps* numbering 553 specimens (ranging 9.2 to 19.4cm TL and 8.9 to 88.7g weight) and 874 specimens of *Chlorophthalmus bicornis* (ranging 9.5 to 18.3cm TL and 8.1 to 85.27g weight) were analysed to ascertain the food and feeding habits of the above deep sea fishes inhabiting in the study area. These species were selected in recognising their importance as potential commercial species from the deep waters off Kerala coast.

The feeding intensity was studied by analyzing the stomach distension and the amount of food present through visual examination and they were graded as full, 3/4 full, 1/2 full, 1/4 full, trace and empty (Venu and Kurup, 2002a & b, 2005, 2006a, b & c; Muthiah, 1994; Philip, 1994 and Kurup and Samuel, 1986). To evaluate the importance of the various food items, occurrence method was found suitable (Hyslop, 1980; Nair and Appukuttan, 1973). Percentage composition of various food items were calculated for three seasons separately for male and females of each species. The cruises 196, 174 and 197 were carried out in June, July and August respectively representing monsoon period while 183 was in April represents pre-monsoon whereas 189 was in October-November representing post monsoon.

### 4.3 Results

In the present study it was observed that in all the five species studied, most of the food items found inside the stomachs were in advanced stages of digestion. The complete identification of the gut contents either genus or species level was thus found very difficult.

### 4.3.1 *Psenopsis cyanea*

*P. cyanea* feeds primarily on benthic and epibenthic organisms like fishes and shrimps, with dominance of the latter. The food items so identified include semi-digested shrimp, semi-digested fish and digested matter. The shrimps included mostly juveniles of *Aristeus* spp., *Heterocarpus* spp., etc. while the myctophids dominated in the semi-digested fish.

The percentage composition of stomachs in terms of degree of fullness showed that most of the stomachs in male as well as female fishes, irrespective of their distribution and seasonal availability, were empty (Table 4.1). In females, 98% stomachs examined were empty during pre-monsoon season while feeding intensity was found to be slightly high for males (78% empty and 11% full stomachs). During monsoon, about 80% of stomachs of males and females were empty. During the same season 8% of the stomachs in females were found to be ¾ full while 7% had trace quantity of food items. Meanwhile in males, ¼ full stomachs had greater preponderance (8%) and only 3% full stomachs were recorded. The feeding intensity of females was found to be the highest during post monsoon with 61% of stomachs contained food inside. Also 13% of the stomachs were found to be full during this season. On the contrary, 73% of the stomachs observed were empty in males. It could be noticed that in the remaining 27% stomachs, 10% were full.

Season wise pattern of food composition is shown in Fig. 4.1. During pre-monsoon season, only digested matter could be observed from all the stomachs analysed in the case of females, in males semi-digested shrimp comprised 81% followed by digested matter (19%). Semi-digested shrimps (58%) and digested matter (66%) dominated in the females and males respectively during monsoon. During post-monsoon, the digested matter (52%) were more predominately observed in females, while in males semi-digested shrimps and digested matter were almost equally represented (37% and 36% respectively). No significant difference could be seen in food preference of fishes inhabiting different depth zones.

### 4.3.2 *Chlorophthalmus bicornis*

Feeding intensity in *C. bicornis* was found to be very less irrespective of the seasons (Table 4.2). The empty stomach dominated in all seasons. The feeding intensity ranged between 37% (stomachs showing presence of food) during monsoon and 47% in premonsoon. The stomach fullness was observed to be 19% during premonsoon and 12% each in the monsoon and post monsoon seasons.

The composition of the diet in *C. bicornis* was similar in all the seasons, chiefly feeding on crustaceans, fish and squids (Fig. 4.2). Generally food items in the stomach were found in advanced stages of digestion making detail identification of the different items so difficult. Shrimps constituted 79 – 84% of food items irrespective of seasons. The Myctophids formed the second major category in premonsoon and monsoon seasons. While fish remains and squids were only found in trace in the guts.

### 4.3.3 *Hoplostethus mediterraneus*

Feeding intensity in *H. mediterraneus* was found very less irrespective of the seasons (Table 4.3). Empty stomachs predominated in all seasons showing the major category (64%) among the 592 fishes examined, while full and gorged stomachs were very meagrely represented (7%). In females, feeding intensity was very less compared to males irrespective of seasons.

The lowest feeding intensity was found during pre-monsoon both for females and males accounting for 82 and 58% respectively. Full stomach condition was lesser in females compared to male fishes irrespective of seasons, and post monsoon season showed high percentage of occurrence when compared to other seasons.

While analysing the food items present in the stomachs it could be seen that *H. mediterraneus* is a carnivorous fish, feeding mostly on myctophid fishes. The dominance of myctophids was clearly discernible in the gut contents during all seasons with a percentage occurrence of even up to 82% and 48% in males and females respectively. Unidentified deep-sea shrimps were found as the second dominant food item in the stomach contents. *Aristeus alcocki*, *Heterocarpus* spp. and squids were the other food items observed in the stomachs (Fig. 4.3).

### 4.3.4 *Neoepinnula orientalis*

Irrespective of seasons, in *N. orientalis*, empty stomach condition dominated in both males and females (Table 4.4). Similarly, very low feeding intensity was observed in both sexes during pre monsoon and post monsoon as more than 80% of the stomachs examined were empty. In the monsoon season, the feeding intensity was moderate since only 57% of stomachs each were found empty. The full stomach condition was found only in around 2% of the females and 4% in males during pre monsoon season. The feeding intensity during monsoon season was found to be higher when compared to other two seasons and full stomach condition was found in 19% and 12% of females and males respectively, while in post monsoon, full stomach condition was observed in 3% males and 6% females. The myctophids and shrimps were found to be the predominant in the food items during pre monsoon and monsoon seasons, while myctophids and squids were found more dominant during the post monsoon (Fig. 4.4).

### 4.3.5 *Cubiceps squamiceps*

In *C. squamiceps*, females showed moderate feeding intensity in general when compared to the males (Table 4.5). About 35% of the total female specimens observed were found to have food inside their stomach. The feeding intensity ranged between 50% in monsoon to 84% during post monsoon. In the males, the feeding intensity was lower. About 71% of the stomachs analysed were empty, the range being 54% during premonsoon to 100% in postmonsoon.

The full stomach condition was observed only in 15% and 8% of the females and males respectively in the pre monsoon season. During monsoon, 22% of the males and 4% of the females analysed were found to have stomach in full condition. All the males observed during post monsoon period were found to have empty stomachs and no specimen showed full stomach. Myctophids and shrimps dominated as food items irrespective of seasons (Fig. 4.5).

## 4.4 Discussion

The characteristics of deep sea environment differ from the coastal habitats in many aspects of biotic as well as abiotic parameters. The biomass tends to decrease with increase in the depth, growth is usually slow and life spans are long, but the biological communities are diverse, widespread and zoned with depth. Because no plants grow in the deep sea, there is only an indirect link to primary production through food webs and migration (Koslow *et* *al.* 1997) and, ultimately, all deep-water production must depend on the thin photosynthetic layer at the surface. Mauchline and Gordon (1991) pointed out the importance of a trophic connection for deep demersal fishes and thenceforth for any fishery based on them.

The observations made during the present study have confirmed the fact that the deep sea fishes are mainly carnivores and feed mostly on the available food in and around its habitat. In all the five species analysed during the study period, it was interesting to report that the feeding intensity irrespective of seasons and sexes were very low. The empty stomachs dominated in all the species under study and most significantly the diversity of food items was very less. Earlier studies on the food and feeding studies on the coastal species of fishes have shown that the qualitative variations in respect of food items were high (Pillai *et al.* 2009) because the prey is readily available in the surrounding environment. On the contrary, in the deeper environment, the species diversity is less (Mamaev and Tkachuk, 1979). This could be an indication of a probable lack of diversity of fauna obviously due to the steep descent of the shelf. The continental slope is mainly characterized by the high pressure, low temperature and less food availability compared to the shelf (Venu and Kurup, 2006a). In general, growth rates are very slow although deep-water species have high longevity and variable food availability. Due to these, a lot of adaptations are encountered in deep sea fishes to sustain in the hostile environment. It has been observed that in addition to their large mouths, deep sea fishes such as the deep sea anglerfish often have extremely long teeth that point inward. This ensures that any prey captured has little chance of escape. Deep sea species such as the gulper eel have huge hinged jaws, which enables them to swallow large prey. Some deep sea species, such as the deep sea anglerfish and the viperfish are also equipped with a long, thin modified dorsal fin on their heads tipped with a photophore lit with bioluminescence used to lure prey. So most of the deep-water fishes will have very less selectivity in food items and has to be satisfied with whatever is available in the surrounding environment. Taxa in benthic deep sea communities are defined by their ability to exploit prey species in more than one habitat zone (Chandra and Terry, 2007).

In the present study, among the five species studied, *C. bicornis* exhibited high feeding intensity because 42% of fishes contained food inside their stomach. The full stomach condition was also found to be the highest in *C. bicornis* (14%). On the contrary, *N. orientalis* showed least feeding intensity, where 75% females and 81% male fishes did not contain food inside their stomach. Similar observations were made in *P. hamrur* from Indian EEZ where the prawns dominated in 101-150m depth followed by fishes, squilla, squid, leptocephalus, alima, megalopa, crab and *Acropoma* sp. in 151-200m, alima, *Bregmacros* sp., megalopa, euphausiids, amphipods and copepods above 200m (Philip, 1994).

It appeared that during monsoon period, feeding intensity was found to be highest in *C. squamiceps* and *N. orientalis* while in the case of *P. cyanea* and *H. mediterraneus,* intensity was highest during post monsoon while in *C. bicornis* it was during premonsoon. The least feeding intensity was observed during post monsoon for *C. squamiceps, N. orientalis* and *C. bicornis* and during pre monsoon for *P. cyanea* and *H. mediterraneus*. The results of the study on the reproductive biology have shown that there is some relation between the feeding intensity and the spawning seasons of the species analysed (Refer Chapter 5). The feeding intensity was found to be the least during the season preceding the spawning and the highest during the succeeding season in all except *C. bicornis*. Spawning of *P. cyanea* and *H. mediterraneus* was observed during monsoon, while, *C. squamiceps* and *N. orientalis* reproduce during pre monsoon period. Jardas *et al.* (2004) reported lowest feeding intensity during the time of low temperature as well as during the spawning period. The feeding actively increased during spawning period as well as during summer, a feeding which concurs with Hosseini *et al.* (2009).

Analysis on the food composition revealed that only a few items of food were present in the stomach of five species studied. The food items recorded in the present study were of Myctophids, squids, deep sea prawns like *Aristeus alcocki* and *Heterocarpus* spp. The dietary composition of species was found to be comparable with other deep sea species like *Halelurus hispidus, Eridacnis radcliffei* and *Iago omanensis* (Nair and Appukkuttan, 1973). Similar results were reported in *Priacanthus hamrur* from north east coast of India, which feeds mainly on crustaceans and fishes (Philip, 1994). Crustaceans comprised a significant proportion of the identified prey items of *Chlorophthalmus agassizii, Coelorhynchus coelorhynchus, Gadiculus argenteus argenteus, Gadella maraldi* and *Hoplostethus mediterraneus* caught off the north-western of Turkey (NE Aegean Sea) (Kabasakal, 1999). Hoff *et al.* (2000) observed that the Atlantic deep-sea fishes *Nezumia liolepis* and *N. stelgidolepis* feed primarily on crustaceans and polychaete worms. Klara (2001) also reported similar results on *Centroscyllium fabricii* and

*Etmopterus princes*. Drazen *et al.* (2001) are of the view that *Coryphaenoides acrolepis* exhibits a pronounced ontogenetic shift in diet, where the specimens <15cm pre-anal fin length consumed primarily polychaetes, amphipods, cumaceans and mysids, while larger individuals consumed increasingly larger, more pelagic prey such as fish, squid and large crustaceans. Crustaceans and fishes were the dominant food items in the diet of *Chlorophthalmus agassizi* from Ionian Sea (Anastasopoulou and Papaconstantinou, 2007) and it is seemed to be adapted to a food-scarce environment, as typified in the deep-water habitats. Venu and Kurup (2002a & c; 2006a & b), Kurup *et al.* (2005) and Divya *et al.* (2007) reported that deep sea shrimps (*A. alcocki*, *Heterocarpus* spp., etc.), deep sea fishes (*Nemichthys*, Myctophids, etc.), squids, *Leptocephalus* larvae etc. are the major components in the diet of *H. mediterraneus, P hamrur, Nettastoma parviceps, Hephthocara simum, P. cyanea, P. squamiceps*, *H. mediterraneus, C. bicornis, Gavialiceps taeniola and C. agassizi* from the south west coast of India.

The diet of the deep sea fish *Malacosteus niger* formed large copepods (Sutton, 2005) while Karuppasamy *et al.* (2008) recorded planktonic organisms in the diet composition of deep sea fishes from eastern Arabian Sea. Carrasson and Cartes (2002) reported that most of the deep sea demersal fish species inhabiting the Catalano-Balearic slope often consumed a variety of available resources in their diets, mainly comprising suprabenthos, but also infauna or planktonic prey. Sharks, *Alepocephalus rostratus* and *Nettastoma melanurum* preferentially preyed on decapods, siphonophores and pyrosomids; *Polyacanthonotus rissoanus*, macrourids, *Lepidion lepidion* and *Cataetyx alleni* preyed upon suprabenthic peracarid crustaceans; and only *Bathypterois mediterraneus* preferentially consumed copepods. Madurell and Cartes (2005) observed pelagic and epibenthic prey, mainly crustaceans were dominated by benthopelagic natantian decapods in the diets of *H. mediterraneus* from Ionian Sea. The authors also observed seasonal changes in the diet in relation with the seasonal fluctuations in the suprabenthic and zooplanktonic prey in the environment. In contrast to the above reports, Myctophids, *Aristeus alckocki*, *Heterocarpus* spp., squids and digested prey items were dominated in the gut contents of five deep sea fishes studied and no planktonic organisms were observed.

Since it is an accepted fact that the major constituent of the diet composition would be the most easily accessible and abundantly available resources present in the area where the particular fish species are generally found (Nair and Appukutan, 1973), it appears that high-density of deep-sea shrimps co exist in these latitudes and depth zones with these fishes. It has been established that there are several area or pockets of high concentration of deep sea prawn resources off South West coast of India in the depth range 100-750 m depth along latitude between $7^0$-$13^0$N (Suseelan 1985, 1988; Suseelan *et al.* 1990a & b; Radhika, 2004; Kurup *et al.* 2008).

Semi or completely digested food dominated in the stomachs examined in all species irrespective of seasons. The food present in their stomach was presumably consumed several hours before the sampling. Since the sampling was done only during day hours, it is assumed that the deep sea fishes either feed during night time or that sampling was done between two meals. In order to cross verify the above assumption, fish samples were collected by carrying out trawling in the early morning (0600-0900hrs), mid-day (1000-1300hrs) and in the afternoon (1400-1700hrs). Similar stomach condition was observed in the fishes collected irrespective of the time of sampling. Most of the stomachs were found to be upturned and contents were regurgitated when the trawl catches reached the ship's deck during sampling. Tientcheu and Djama (1994) reported similar results in *Pseudotolithus typus* and *P. senegalensis* and was attributed this condition to the struggling while dragging the trawl net. So it may be inferred that the gut contents observed during the present study were the remnants of the ingested food after regurgitation which is already in the process of digestion or were already in the digested condition.

All the five species examined for the food and feeding habitat studies were found to be carnivorous and feed mostly on deep sea crustaceans, fishes and squids. As already discussed, the gut contents observed were mostly in advanced stages of digestion and in many cases the gut of most of the specimens was upturned and the contents emptied. So there are possibilities of missing some other food items normally feed by these fishes. The feeding intensity may be related mostly to the availability of prey in the habitat as well as to the spawning periodicity. Many studies along the Kerala coast have revealed the abundance of deep sea shrimps in the southwest region of Indian EEZ (Suseelan, 1985, 1988; Suseelan *et al.* 1990 a&b; Radhika, 2004; Kurup *et al.* 2008). The predominance of deep sea shrimps in the diet of the fishes examined in the study indirectly manifest the abundance of commercially important deep sea shrimps along the south west coast of India.

**Fig. 4.1 Percentage occurrence of different food items of *Psenopsis cyanea***

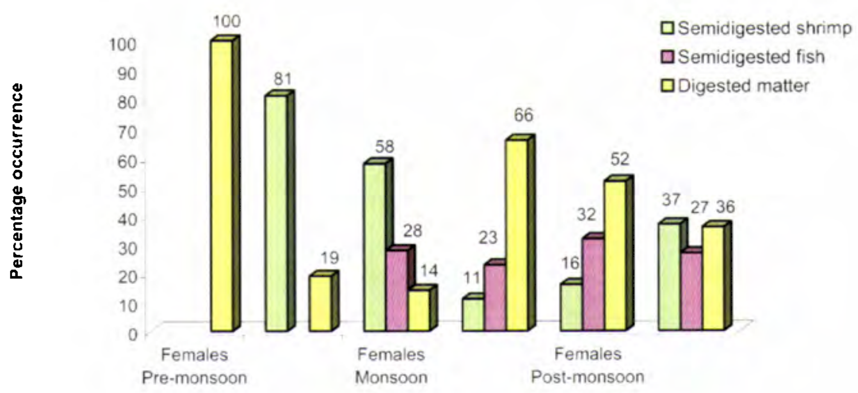
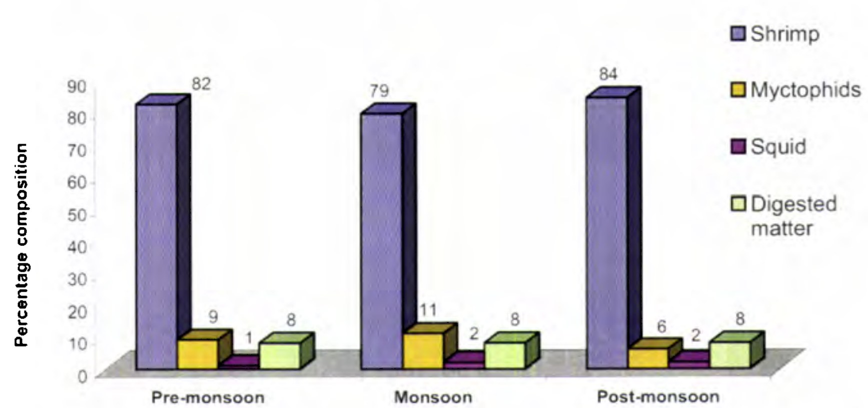



**Fig. 4.2 Percentage composition of food items of *Chlorophthalmus bicornis***



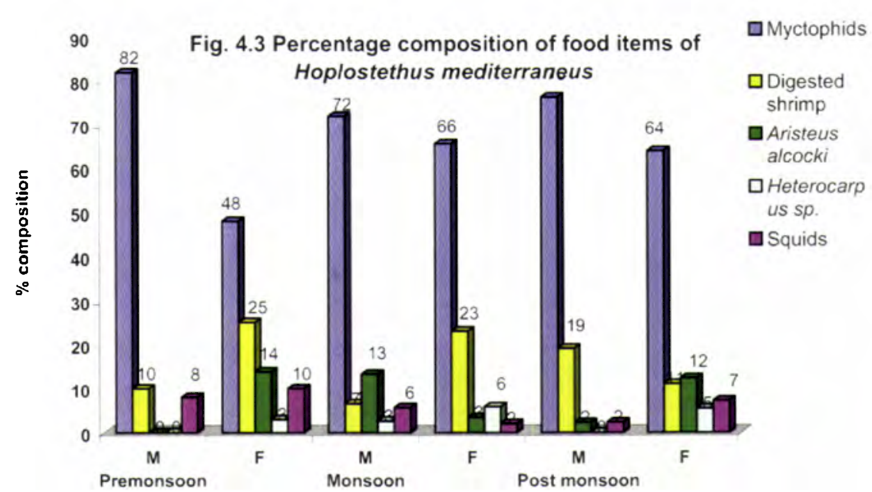




**Fig. 4.3 Percentage composition of food items of *Hoplostethus mediterraneus***

Fig. 4.4 Percentage composition of food items of *Neoepinnula orientalis*

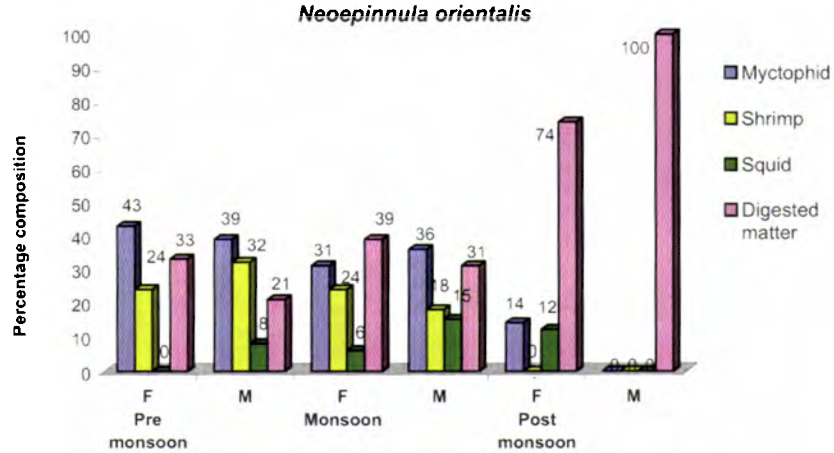



Fig. 4.5 Percentage composition of food items of *Cubiceps squamiceps*

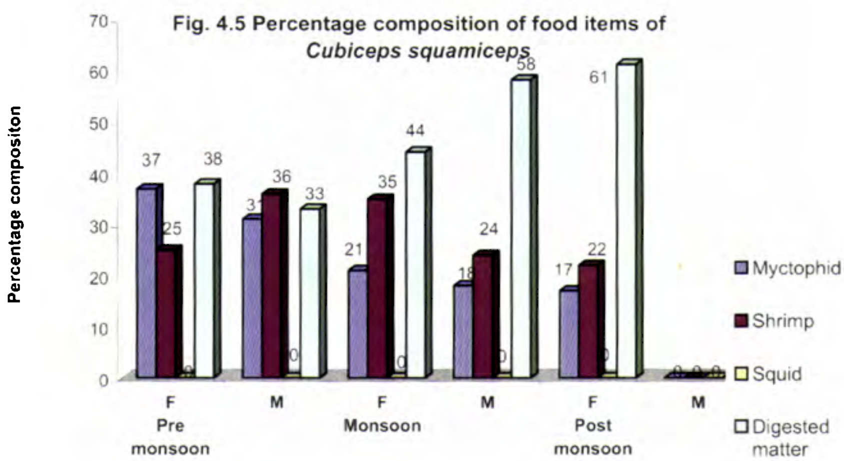


**Table 4.1 Feeding intensity of *Psenopsis cyanea***

| Feeding intensity | Premonsoon | | Monsoon | | Postmonsoon | |
|---|---|---|---|---|---|---|
| | Females | Males | Females | Males | Females | Males |
| Empty | 98 | 78 | 80 | 82 | 39 | 73 |
| Trace | 2 | 0 | 7 | 2 | 18 | 5 |
| 1/4 Full | 0 | 11 | 3 | 8 | 7 | 3 |
| 1/2 Full | 0 | 0 | 1 | 5 | 15 | 8 |
| 3/4 Full | 0 | 0 | 8 | 0 | 7 | 1 |
| Full | 0 | 11 | 1 | 3 | 14 | 10 |

**Table 4.2 Feeding intensity of *Chlorophthalmus bicornis***

| Feeding intensity | Premonsoon | Monsoon | Postmonsoon |
|---|---|---|---|
| Empty | 53 | 63 | 59 |
| 1/4 Full | 18 | 15 | 15 |
| 1/2 Full | 6 | 7 | 12 |
| 3/4 Full | 4 | 3 | 2 |
| Full | 19 | 12 | 12 |

**Table 4.3 Feeding intensity of *Hoplostethus mediterraneus***

| Feeding intensity | Premonsoon | | Monsoon | | Post monsoon | |
|---|---|---|---|---|---|---|
| | Famale | Male | Famale | Male | Famale | Male |
| Empty | 82 | 58 | 62 | 53 | 63 | 56 |
| Trace | 2 | 5 | 5 | 10 | 10 | 12 |
| 1/4 full | 7 | 17 | 10 | 11 | 7 | 14 |
| 1/2 full | 8 | 13 | 10 | 13 | 5 | 3 |
| 3/4 full | 0 | 2 | 6 | 6 | 5 | 4 |
| Full | 1 | 6 | 6 | 7 | 11 | 12 |

**Table 4.4 Feeding intensity of *Neoepinnula orientalis***

| Feeding intensity | Premonsoon | | Monsoon | | Postmonsoon | |
|---|---|---|---|---|---|---|
| | F | M | F | M | F | M |
| Empty | 85 | 91 | 57 | 58 | 83 | 93 |
| Trace | 0 | 0 | 19 | 25 | 3 | 0 |
| 1/4 full | 11 | 2 | 0 | 5 | 5 | 0 |
| 1/2 full | 3 | 4 | 0 | 0 | 3 | 3 |
| 3/4 full | 0 | 0 | 5 | 0 | 0 | 1 |
| Full | 1 | 3 | 19 | 12 | 6 | 3 |

**Table 4.5 Feeding intensity of *Cubiceps squamiceps***

| Feeding intensity | Premonsoon | | Monsoon | | Postmonsoon | |
|---|---|---|---|---|---|---|
| | F | M | F | M | F | M |
| Empty | 62 | 54 | 50 | 58 | 84 | 100 |
| Trace | 0 | 1 | 17 | 0 | 8 | 0 |
| 1/4 full | 8 | 25 | 7 | 11 | 8 | 0 |
| 1/2 full | 8 | 4 | 2 | 3 | 0 | 0 |
| 3/4 full | 8 | 8 | 20 | 6 | 0 | 0 |
| Full | 15 | 8 | 4 | 22 | 0 | 0 |

# CHAPTER 5

# MATURATION AND SPAWNING

## 5. 1 Introduction

Fishes are reproducing by several methods and are generally bisexual but hermaphroditism and even parthenogenesis are also reported (Khanna, 2006). Teleosts differ widely in the rhythm of maturation of oocytes and many Indian marine fishes appear to be continuous breeders and have a long spawning period which may extend upto 7-9 months. Spawning period may vary in the same species inhabiting different habitats due to different ecological and physiological factors (Khanna, 2004).

The main objective of a reproductive strategy is to maximize reproductively active offspring in relation to available energy and parental life expectancy (Wootton, 1984; Roff, 1984; Pinaka, 2000; Murua and Saborido-Rey, 2003). In order to achieve this, fishes follow different strategies and tactics (Ware, 1984). The reproductive strategy of a species is the overall pattern of reproduction common to individuals of a species, whereas the reproductive tactics are those variations in response to fluctuations in the environment (Wotton, 1984, 1990; Roff, 1984). It is assumed that both the overall strategy and the tactical variations are adaptive (Strearns, 1992). Fishes exhibit great diversity in reproductive strategies and associated traits (Helfman *et al.* 1997) such as breeding system, number of partners, gender role, spawning habitat, spawning season, fecundity, etc. Most commercial species are iteroparous, spawns more than once during their lives and gonochoristic, having their sexes separate, possess no sexual dimorphism and exhibit external fertilization without parental care (Murua and Saborido-Rey, 2003).

A series of studies have conducted during the past several decades on the reproductive biology of fishes inhabiting the coastal waters of India (Sreenivasan, 1981; Mohan and Velayudhan, 1986; Kurup and Samuel, 1991; Sahayak, 2005; Zacharia and Jayabalan, 2007). Besides, there are many studies embarking upon the seasonal pattern and various factors influencing reproduction in deep-sea species from various seas around the continents (Bergstad, 1990; Gage and Tyler, 1991; Koslow *et al.* 1995; Helfman *et al.* 1997; Allain, 2001; Magnússon, 2001). The results of these studies can be utilized for understanding the recruitment pattern and spatial availability of spawning stock in the wild population which are very important in managing the commercially exploited marine fisheries of world oceans.

In deep sea, large fish grow quite slowly, and restricted energy availability means that attainment of near-ultimate size must precede reproduction (Mann, 1965). A variety of reproductive strategies exist among deep sea fishes due to the extreme conditions prevail in the habitat. Hermaphroditism, extreme sexual dimorphism and unbalanced sex ratios are very common (Shotton, 2005). Despite the fewer species found in the deep seas, they display a variety of reproductive strategies ranging from strongly k – selected species, which may be semelparous, through ovoviviparous and oviparous species to those that are strongly *r* – selected. Given the low water temperature, which reduces the metabolic rate, and variable food availability, growth rates are generally very slow although deep-water species can have a high longevity. These slow growth rates are also reflected in the high age at maturity. Larval dispersal is relatively low for some deep-water species and adult fish may aggregate at certain sites, such as sea-mounts (Pankhurst and

Conroy, 1987; Bergstad, 1990; Clark 1995; Koslow, 1996; Gordon and Swan, 1996; Kelly *et al.* 1997; Tracey and Horn, 1999). Fish population parameters are often poorly understood and diverse which complicates the use of spawning models is that in several deepwater species, successful year classes may be intermittent and many do not spawn each year (Smith *et al.* 1995; Shotton, 2005). This means that reliance upon gonad stage data to determine age at maturity may be sometimes misleading (Mace *et al.* 1990; Fenton *et al.* 1991; Koslow *et al.* 1997).

The life history parameters of a population have to be studied in detail for better fishery resource management and also to avoid catastrophes like those reported in *H. atlanticus* in Australian and New Zealand fishery (Koslow *et al.* 1995). Initially, for many species, the demographic parameters like natural mortality, age of maturity and recruitment were miscalculated. Due to this many were subjected to overexploitation due to reason that managers were unaware that most of them have lesser natural mortality rates (as low as 0.05 in the case of *H. atlanticus*) and age of maturity (>20 years). This eventually led into the decrease of long term sustainable yield by 7 folds by the time when the problem was discovered (Mace *et al.* 1990).

Despite there are many studies on the reproductive biology of marine fishes carried out in Indian coast, similar studies were very scarce on fishes from slope region. Philip (1994) on *Priacanthus* spp. and Khan *et al.* (1996) gave some insight to the biology of deep sea fishes along the west coast of Indian EEZ. The biology of some of the deep sea fishes viz. *Hoplostethus mediterraneus, Neoepinnula orientalis, Psenes squamiceps, Psenopsis cyanea*, *Hoplostethus mediterraneus*, *Priacanthus hamrur* and *Hephthocara* *simum* were studied by Venu and Kurup (2002b & c; 2006a & b). Recently, biology of *Chlorophthalmus bicornis* (Kurup *et al.* 2005); *Alepocephalus bicolor* (Deepu *et al.* 2007) and *Gavialiceps taeniola* (Divya *et al.* 2007) were also reported.

Against this background, the present study was carried out to unravel some aspects of reproduction of deep sea fishes which mostly focused on the seasonal changes in maturity of the female gonads of the five species and the length groups constituting the spawning population.

## 5.2 Materials and Methods

Materials for the present study were collected from the exploratory demersal trawling operations conducted onboard FORV Sagar Sampada along the southwest region of Indian EEZ and also from the fishing harbours located at Munambam, Neendakara and Sakthikulangara during 1998–2002 (refer Chapter 2 for details).

Total length (from the tip of the snout to the tip of the upper caudal lobe to the nearest mm) and weight (nearest to 0.1 g) of both sexes were taken separately (Jayasankar, 1990). The length related Chi-square analysis of sex ratio was carried out following Rao (1983). The 5-stage classification of gonad was used to quantify the maturity stages (Table 5.1), which included visual quantification on the basis of shape and color of the gonads and the extent to which the ovary occupies the gut cavity (Kurup and Samuel, 1991; Qasim, 1973).

**Table 5.1 Maturity stages of ovary of deep sea fishes**

| Stage | Degree of Maturation | Description |
|---|---|---|
| I | Immature | Gonad about 1/3rd the length of the abdominal cavity. Ovaries thin , ribbon like |
| II | Maturing virgin or Recovering spent | Gonad occupy about ½ the length of the abdominal cavity, ovaries pinkish translucent, eggs visible under magnifying glass |
| III | Ripening | Gonads about 2/3rd of the abdominal cavity. Eggs large and readily seen. Ovary yellowish with granulated appearance |
| IV | Ripe | Gonad occupies the full abdominal cavity. Ovaries are distended and eggs are clearly seen and easily detachable |
| V | Spent | Gonads shrunken with loose walls. Ovary may contain few ripe eggs |

*Chlorophthalmus bicornis*, which is a synchronously hermaphrodite species, the observations were made on the female portion of the gonad to quantify the maturity. The male part of the gonad was not taken into consideration while expressing the stage of maturation of the gonad.

## 5.3 Results

### 5.3.1 *Psenopsis cyanea*

#### 5.3.1.1 Sex ratio

423 specimens of *Psenopsis cyanea*, of which 135 specimens were collected during premonsoon, 108 and 180 during monsoon and postmonsoon respectively were analysed for sex ratio (Table 5.2). The size of specimens ranged between 13.5 and 23.5 cm and females outnumbered males with the sex ratio of 1:1.25.

During premonsoon, the size of the fish ranged between 13.5 and 17.5 cm with mode at 16.5 cm mid length. Females dominated in the catch with a sex ratio of 1: 1.25. The chi – square analysis has shown that there is no significant dominance of either of the sex during this season with a value of 1.67 corresponding to the estimated probability of 0.22, which is evidently greater than 0.05. The length groups 13.5 and 17.5 cm have shown significant dominance of females (ratios 1:3 and 0:10) and the corresponding chi square value were 5 and 10 respectively.

The length of fish varied between 14.5 and 20.5 cm during the monsoon with a mode at 18.5 cm. The presence of females was more when compared to males in this season also with a ratio of 1:1.43. Although chi square results for males revealed lesser preponderance during this season (3.33), they still made significant difference (P>0.05). Length groups, 16.0 – 17.0 cm (ratio 1:0.08 and chi squared value 9.31) have shown significant dominance in males, while 18.0 – 19.0 (ratio 1:4.3 and chi squared value 12.5) and 19.0 – 20.0 cm (ratio 1:4 and chi squared value 5.4) showed significant dominance in females.

There was a slight dominance of females over males during the postmonsoon season with a ratio of 1:1.08. The specimens varied in lengths between 15.5 and 23.5 cm in this season with mode at 17.5 cm. While the chi square analysis has shown that there is no significant dominance in general with a value of 1.62, which corresponds to an estimated probability below 0.05. The length group 16.5 cm has shown significant dominance of males (ratio 1:0.32 and chi squared value 6.76).

### 5.3.1.2 Maturity stages

Presence of maturity stages I to V was discernible in February, March and April with a preponderance of stage IV accounting for 43%. Stages III and II collectively represented 21%, whereas the immature and ripe fishes were meagerly represented (7%). In June, July and August, most of the females were found to be in the advanced stages of maturity. Nearly 50% of the females analysed during these months from the trawl catches were found to be in the ripe stage. Spent females were also present contributing 33% of the catch. During October, November, December and January, stages I, II, III and IV could only be recorded with a distinct predominance of stage II (49%) (Fig. 5.1).

## 5.3.2 *Chlorophthalmus bicornis*

### 5.3.2.1 Sex ratio

Since the fish is a hermaphrodite, the sex ratio was not worked out.

### 5.3.2.2 Maturity stages

Maturation was found to be a continuous process resulting in the regular occurrence of mature fishes in fishes collected from all the trawling operations. The maturity stages quantified in the female gonad portion of *C.*

*bicornis* are given in Fig. 5.2. It appears that this species is a multiple spawner and completely spent fishes were scarce in the catches. It was also found extremely difficult to clearly differentiate the spent stage due to the presence of the male portion of the gonad. The ripening and ripe stages of ovarian portion were found to be at varying percentages during the premonsoon, monsoon and the postmonsoon seasons. The premonsoon season was marked by a very high percentage of specimens with female gonad portion in the ripening (31%) and the ripe (50%) stages, while the juveniles and the truly spent fishes were represented in very low percentages with 1% and 2% respectively. With the commencement of the monsoon there was a marked increase in the truly spent individuals (39%), the juveniles represented 4% of the population and specimens in the stages ripe (32%), ripening (20%) and recovering spent (5%) were also seen. In the postmonsoon season, however, truly spent fishes in the population were completely absent, and the percentage representation of juveniles was 23%, while recovering spent stages formed 26%. On the other hand, the ripening stage accounted for 49%, while only 3% of the specimens were found in fully mature condition.

### 5.3.3 *Hoplostethus mediterraneus*

#### 5.3.3.1 Sex ratio

Out of 592 fishes examined, males outnumbered females in all the three seasons (males to female ratio 1:0.39). Specimens examined were 178, 258 and 156 during premonsoon, monsoon and postmonsoon respectively (Table 5.3) with a size range of 8.5 to 19.5 cm. The specimens collected during the premonsoon ranged from 11.5-17.5 cm with modes at 12.5 and 13.5 cm mid lengths. The males have shown dominance with a sex ratio of 1: 0.33 during this season. The chi – square analysis also confirmed the dominance of males significantly (P>0.05) over females with a value of 47.51 and so it showed highly significant dominance of males during this season in general. Except the length classes 11.5 and 16.5 cm, all the other length classes have shown significant dominance of males during this season.

The length of fishes varied between 11.5 and 19.5 cm during monsoon. The dominance of males was discernible in this season also with a ratio of 1: 0.55. The mode obtained during this season was at 14.5 cm. The chi square results showed significant dominance of males (chi square value 21.22). In most of the length classes, males showed significant dominance, whereas in 17.5 and 19.5 cm length classes, females shown its dominance over males with a ratio of 1: 4 and 1: 2 respectively. The overall dominance of males was apparent during the postmonsoon season also (1:0.29). The specimens varied in size from 8.5 and 13.5 cm. The length classes 12.5 and 13.5 dominated in the catches in this season. The overall chi square value for the season was 47.41 (P>0.05) which shows high significance and males were significantly dominant in most of the length classes.

**5.3.3.2 Maturity stages**

The results of the present study showed that immature and maturing female fishes dominated in the catches during premonsoon and postmonsoon periods, while during monsoon, mature fishes dominated in the catches. Maturing fish were found in all the seasons where mature fishes were found only during premonsoon and monsoon seasons. Spent fishes were absent during premonsoon seasons. During premonsoon season, females with maturing ovaries dominated in the catches with a percentage occurrence of

55%, followed by fishes with recovering spent ovaries (23%). Immature and mature fishes were found to be very less (Fig. 5.3). During monsoon, the presence of fishes in all the maturity stages could be discernible, with 43% in ripe condition and 13% in spent condition. Immature, recovering spent and maturing ovaries were recorded in the order of 20%, 8% and 16% respectively. Recovering spent ovaries were found dominating during postmonsoon period with percentage occurrence of 48% followed by immature fishes (17%). Spent fish also showed a higher percentage (16) occurrence. Mature fishes were found in very less percentage in the catches.

### 5.3.4 *Neoepinnula orientalis*

#### 5.3.4.1 Sex ratio

During the present study, 378 specimens of *N. orientalis* were examined, 166 during premonsoon, 79 and 133 from monsoon and postmonsoon respectively (Table 5.4). The specimens ranged in size between 11.5 and 26.5 cm and males outnumbered females slightly with a sex ratio of 1:0.95.

The specimens observed during premonsoon were in the range of 14.5–26.5 cm with modes at 17.5 and 19.5 cm mid lengths. There was no significant ($P<0.05$) dominance by either sex (1:0.87) during this season. During this season, the mode was at 19.5 cm, which shows significant dominance of males along with the length classes 15.5 and 16.5 (ratios 1:0.35, 1:0.15 and 1:0.20) have shown dominance of males, while 22.5 and 23.5cm (ratios 1:7.50 and 1: 5.50) dominated significantly in female fishes.

The size range of specimens appeared in monsoon were least which varied from 11.5 - 26.5 cm. Males outnumbered females in this season also with a ratio of 1:0.88. The modes obtained during this season were at 13.5

and 16.5 cm. The chi square analysis has shown that no significant dominance ($P<0.05$) was discernible between females and males with the value of 0.32. There was no significant dominance of either sex within the length groups examined during this season.

During postmonsoon season, there was slight dominance of females over males with a ratio of 1:1.11. The length varied from 14.5 to 26.5 cm in this season which is comparable to premonsoon. The chi square analysis showed that there is no significant dominance of a particular sex in general with a value of 0.37 Length groups 15.5 and 17.5 cm were showed significant dominance of males (chi square values 7 14 and 10.00) while in 18.5 and 23.5 cm (chi square values 5.33 each), females showed dominance.

#### 5.3.4.2 Maturity stages

In *N. orientalis*, the premonsoon period was dominated by mature females in the catches with 28% followed by maturing and spent (23% and 22% respectively) (Fig. 5.4). Juvenile population was found higher in the catches during monsoon season, which registered as much as 51% in the total landings. Also a higher percentage of spent females (28%) were recorded followed by fully matured and recovering spent (22%). During postmonsoon period, most of the females were found to be in maturing (43%) stage followed by recovering spent stage (31%). Mature and spent females accounted for 9% and 3% respectively.

### 5.3.5 *Cubiceps squamiceps*

#### 5.3.5.1 Sex ratio

In the present study, 253 specimens of *C. squamiceps*, (60 during premonsoon, 105 and 88 from monsoon and postmonsoon respectively) were examined (Table 5.5). The length ranged from 9.5 to 19.5 cm and females outnumbered males in general with the sex ratio 1:1.67

The specimens observed during premonsoon ranged between 9.5 and 17.5 cm with modes at 12.5 and 13.5 cm mid lengths. There was no significant dominance shown by either sex with a sex ratio of 1: 0.9 during this season. The chi – square analysis revealed that there was no significant predominance of either of the sex. The chi square results showed no significant dominance of either sex during this season. Only in the length class 9.5 cm, a significant dominance of male fishes could be recorded, where all the five specimens examined were males while no females could be collected.

The fishes with highest lengths were observed during monsoon and postmonsoon seasons (19-20 cm length class) and the specimens ranged from 12.5–19.5 cm during both the seasons. Females outnumbered males with a ratio of 1:1.69 and 1:2.38 during monsoon and postmonsoon respectively. While the modes were recorded to be 16.5 and 13.5 cm respectively for these seasons.

The chi square results has shown that there exists a significant dominance of females on males. The chi square value for the monsoon season was 6.94, showing the significance at $P<0.05$. Dominance of females was significant in most of the length classes. During postmonsoon also, females showed dominance with the overall chi square value of 14.73.

### 5.3.5.2 Maturity stages

In *C. squamiceps*, mature specimens were found in all the seasons and dominated in the female population especially in the premonsoon and monsoon seasons (Fig. 5.5). During premonsoon season, recovering spent, maturing and mature fishes were found to be present in equal proportion (27%) and spent females could also be identified (12%). Monsoon season also showed same trend as in the premonsoon and spent females present in higher proportion than premonsoon (15%). Recovering spent females were found dominating in the catches with 30% and were followed by matured and maturing fishes (27% and 23% respectively). In postmonsoon season, maturing and recovering spent females represented higher proportion with 39% and 36% respectively. Mature and Immature fishes contributed to 13% each in the catches.

## 5.4 Discussion

The reproductive pattern of deep-sea species was analysed continuously for many years on the basis of the physico-chemical stability of the deep sea (Orton, 1920). Nevertheless, research undertaken in the last three decades on the biology of exploited deep-sea fish in Australia (Koslow *et al.* 1995), New Zealand (Clark, 1995), North Atlantic (Kelly *et al.* 1997; Coggan *et al.* 1999; Allain, 1999), North Sea (Bergstad, 1990) and Iceland (Magnússon and Magnússon, 1995; Magnússon, 2001) demonstrates that most of the fish species studied have seasonal spawning.

The results of the present study has shown that spawning period of *P. cyanea, C. bicornis* and *H. mediterraneus* commenced during the monsoon, while the spawning season of *C. squamiceps* and *N. orientalis* started in the premonsoon season and continued till monsoon. According to Qazim (1973), there is no definite pattern in the time and duration of spawning in the marine fishes as such in the Indian waters. While there were indications that along the East Coast, spawning largely occurs during the pre-monsoon months (February to May), on the other hand, along the west coast, fishes largely seems to spawn during the monsoon months (June to September) and post-monsoon (October to January). The timing and duration of the spawning peak and the maturity age varied with species, their area of distribution and the depth of occurrence. Several studies (Marshall, 1965; Gordon, 1979; Hureau *et al.* 1979; Gage & Tyler 1991) reported that in the context of a physically constant environment the reproductive cycles of deep sea fish could be synchronized with the surface primary production which is further linked to the seasonal thermocline, so that developing pelagic eggs float upwards and larvae are produced in food-rich waters. Moreover, the reproductive cycles of deep-sea fish could be linked with the consequent secondary production through vertical migration of the mesopelagic fauna. In the Mediterranean, gadiform species living in the upper-middle slope has shown a continuous reproductive pattern as in *Nezumia sclerorhynchus* (D'Onghia *et al.* 1996, 1999, 2000), *N. aequalis* (Massutí *et al.* 1995) and *Hymenocephalus italicus* (Massutí *et al.* 1995; D'Onghia *et al.* 1996). A quasi-continuous strategy with a reproductive peak shown by *Coelorhynchus coelorhynchus* (Massutí *et al.* 1995; D'Onghia *et al.* 1996, 1999) while a seasonal pattern was reported in *Trachyrhynchus trachyrhynchus* (D'Onghia, 1996). The lower slope Macrourids *Coelorhynchus labiatus* and *A. rostratus* have shown an autumn-winter spawning in Mediterranean (Massutí *et al.* 1995 and Morales-Nin *et al.* 1998).

In *P. cyanea*, the unripe and maturing fishes were found mostly in the premonsoon and postmonsoon months while mature and ripe stages were found in monsoon. Khan *et al* (1996) reported 34% mature females of *Psenopsis cyanea* during December and January at depth 100 - 400m from the southeastern Arabian Sea. It would thus appear that the spawning season of the *P. cyanea* coincided strongly with monsoon season. Wang and Chen (1995) in northeastern Taiwan reported that the sex ratio of *P. anomala* was skewed toward females during the spawning season but was dominated by males in non-spawning seasons. Females also dominated in the large size classes. The results of the present study showed a similar trend during monsoon season with the length groups 18.5 and 19.5 cm showing significant dominance of females. The spawning season of *P. anomala* began in March and lasted for about 6 months (to August). Large quantities of juveniles of *P. cyanea* were caught in the trawl nets during August from the shallower depths (Venu and Kurup, 2002b) suggests that this species exhibits a seasonally synchronized reproduction with the presence of mature adults during the late premonsoon and early monsoon and it was confirmed by the recruitment of the juveniles during late monsoon. Also, the feeding intensity of the females was very less during premonsoon and monsoon when compared to the postmonsoon months. Dighe (1977) reported low feeding activity during the spawning season in *Saurida tumbil*. Similar observations were also made by Das and Mishra (1990), Geetha *et al.* (1990) and Basudha and Viswanth (1999).

Occurrence of juveniles in the shallower waters below 150 m depth manifest the probability that it either spawns in the shelf water below 150 m or there is a possibility of the migration of juveniles from the deeper waters to inshore regions. *P. cyanea* could be encountered from depths below 200 m only during the monsoon season and there was a total absence of adults at these regions during all the other seasons (Venu and Kurup, 2002b). It may therefore, be inferred that the adults may be either migrating towards the shelf waters for undergoing spawning or the fingerlings and juveniles are undertaking migration into the shelf waters as these regions are endowed with relatively high productivity and favorable abiotic and biotic factors which can offer better survival of the eggs and juveniles.

The spawning period of *C. bicornis* commences during the onset of South West monsoon. This is further manifested by the dominance of immature fishes during the postmonsoon season constituting the fresh recruits to the population. High percentage of specimens with ripe female gonad portion during the premonsoon season, truly spent individuals in the monsoon season and dominance of recovering spent and ripening stages and presence of high percentage of juveniles in the postmonsoon season are clear indications that the spawning of *C. bicornis* is during the monsoon season. The reproductive period of *C. agassizi* extends from spring to autumn, with greater activity in the summer (Anastasopoulou *and* Papaconstantinou, 2007) in the Greek Ionian Sea. D'Onghia *et al.* (2006) observed a similar trend in the Mediterranean Sea where the adult specimens are mostly distributed on the slope, eggs and larvae develop in epipelagic waters and migrate to in-shore where juveniles get recruited on the shelf. Further, the juveniles migrate ontogenetically towards deeper bottoms and after 2–3 years start to reproduce annually within a life span greater than 10 years. The spawning season of *C. albatrossis* based on the back calculation from the number of daily increments, was estimated from January to May in one stock, May to July and from January to August other two entirely different populations (Hirakawa *et al.* 2007). Khan *et al.* (1996) reported that small sized fishes of *C. agassizi* were found to be distributed in the shallower waters whereas large sized and mature females occupied deeper areas. Philip (1994) also reported a distinct pattern of depth wise distribution in *P. hamrur* on the basis of the maturity stages and sex of the fishes. During the present study also, immature specimens could be recovered from the continental shelf at a depth around 50m. The mature forms and the spent individuals were usually concentrated beyond the depths of 200m indicating that these fishes are used to spawning in deeper waters off South West coast of India.

Kailola *et al.* (1993) reported that the Orange roughy, *Hoplostethus atlanticus* are synchronous annual spawners. They form dense spawning aggregations over sea hills and slopes (Lack *et al.* 2003). Eggs and sperms are shed into the water at the same time (Pogonoski *et al.* 2002). Individual males appear to spawn over a 1-2 week period and females spawn for up to 1 week (Anon, 2000). The Orange Roughy is thought to become sexually mature between 20 to 40 years of age (Branch 2001, DEW, 2007). It is characterised by very low fecundity, rarely producing more than 90,000 eggs per female (Morison *et al.* 2007). There may be a correlation between fish length and fecundity (Clark *et al.* 1994). Pais (2002) reported that in *H. mediterraneus* collected from south coast of Portugal, fish with gonads at various stages of maturation were present from autumn until spring, although there were no specimens with mature gonads. Immature fish ranged from 4 to 13 cm in length and were present at all seasons. Of the mature individuals, males ranged from 7 to 17 cm and females from 7 to 21 cm. During the present study, size of *H. mediterraneus* ranged from 8.5 to 19.5 cm. The immature fishes having a length range of 8.5 to 11.5 cm were collected during the present study which showed a high prevalence during postmonsoon season. D'Onghia *et al.* (1996) also reported similar findings that the reproductive peak in *H. mediterraneus* was observed during August and juveniles were mainly caught during March in the Ionian Sea. The results of the present study is concurring that spawning season of *H. mediterraneus* coincided with monsoon season. Venu and Kurup (2006) also reported similar findings from the south west coast of Indian EEZ, whereas Petrakis *et al.* (1998) reported reproductive activity of this species almost round the year with peak during January to March.

The Orange roughy (*Hoplostethus atlanticus*) can reach a maximum size of about 60 cm but in the Rockall Trough they generally attain lengths of about 40 cm. Ages of up to 125 years have been estimated and females mature at about 53 cm. The fecundity ranges from about 28,000 to 380,000. In Australian and New Zealand waters they spawn over a period of two to three weeks in winter. Spawning generally starts in mid July, but can begin as early as June (Branch 2001). There are evidences that not all of the adult population spawns each year (Kailola *et al.* 1993). There appears to be a separation of the sexes during spawning with females remaining deeper in the water than males (Branch, 2001). However, no attempt is so far been made to conduct the study on the spawning migration of *H. mediterraneus* in the Indian EEZ.

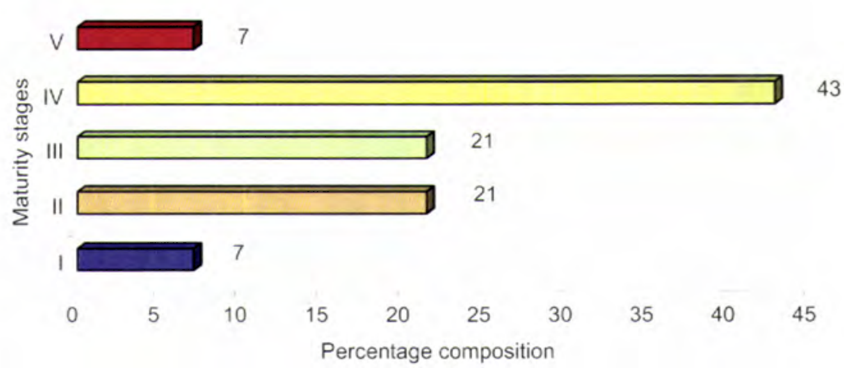
It appears that spawning is a continuous process with the occurrence of mature females in all the seasons in *N. orientalis*. Dominance of mature and spent females were discernible in the premonsoon season followed by appearance of juveniles in the monsoon season, which clearly manifests that the spawning period commences during premonsoon season. *N. orientalis* matures at about 15 cm standard length (Nakamura and Parin, 1993). Rotllant *et al.* (2002) reported that *P. blennoides*, *M. moro* and *L. lepidion* are iteroparous and females could be all-at-once or batch-spawners. An autumn mature season was observed in *P. blennoides*, whereas *M. moro* and *L. lepidion* are characterized by the presence of mature individuals all year round except in summer. *N. orientalis* also showed similar trend with the presence of mature females during all the seasons. While deep sea fishes like *H. italicus, N. sclerorhynchus* and *C. coelorhynchus* are known to reproduce as multiple batch spawners (D'Onghia *et al.* 1999).

As in the case of *N. orientalis*, *C. squamiceps* also, it appears that spawning is a continuous process with the occurrence of mature females in all the seasons in. Spent fishes were found in higher percentage in the premonsoon and monsoon seasons while immature fishes were very common during postmonsoon season when compared to other seasons. It may therefore be inferred that the spawning commences in the premonsoon season and continues till monsoon. Whereas Lamkin (1997) reported *Cubiceps pauciradiatus*, a similar species as an intermittent spawner and peak spawning in the species occurs from December to April in tropical waters.

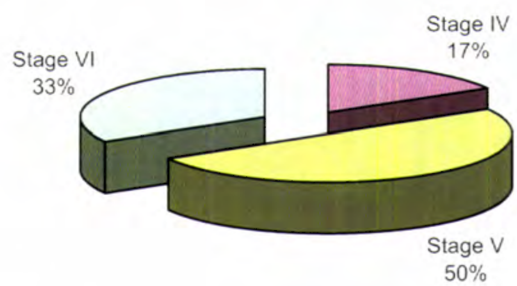
In general, the deep sea fishes examined in the present study have shown a strong seasonal pattern in their reproductive behaviour. In the coastal fish populations, the maturation and spawning of fishes generally coincides mainly with the onset of monsoon as seen in *C. bicornis, P. cyanea* and *H. mediterraneus*. While in the case of *N. orientalis* and *C. squamiceps*, spawning is a more or less continuous process commencing during the premonsoon and continuing till the end of monsoon. There is a possibility of having certain bathymetrical spawning migration in these deep sea fish species, which has to be confirmed through more extensive studies.

**Figure 5.1 Percentage composition of maturity stages of *Penopsis cynea* females**

**Premonsoon**




**Monsoon**




**Postmonsoon**

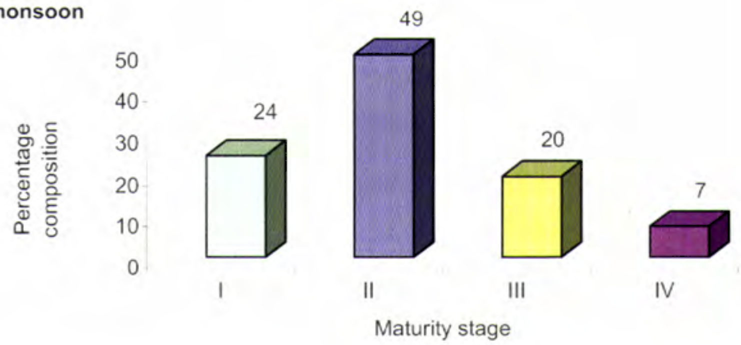


**Figure 5.2 Percentage composition of gonadal maturity of *Chlorophthalmus bicornis***

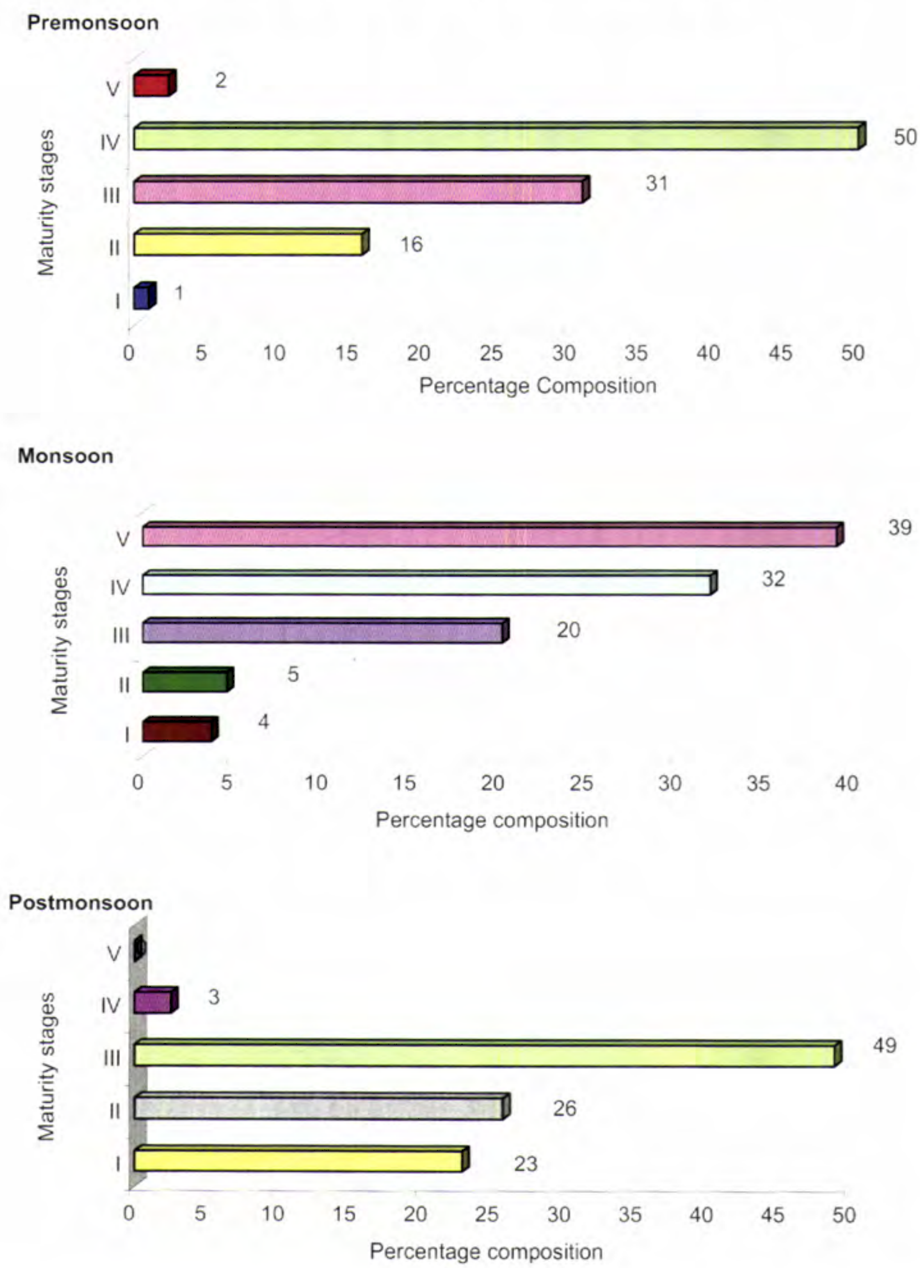
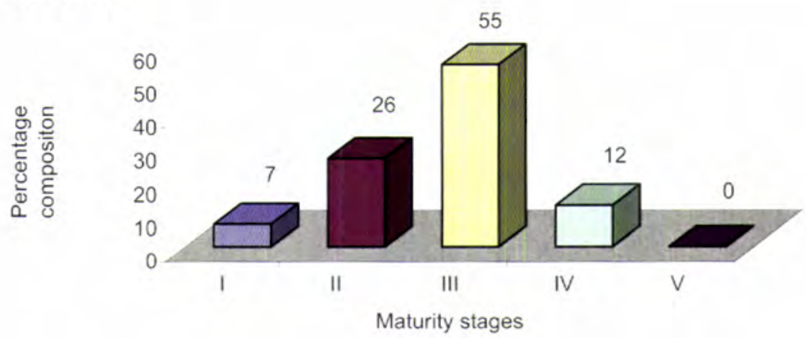
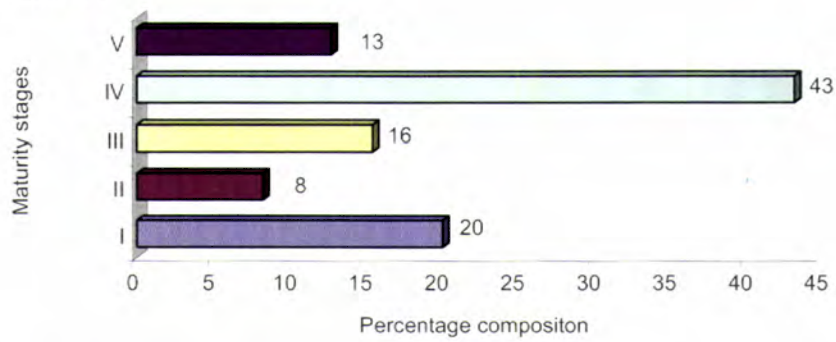


Figure 5.3 Goanad maturation of *Hoplostethus mediterraneus* females

Premonsoon




Monsoon




Postmonsoon

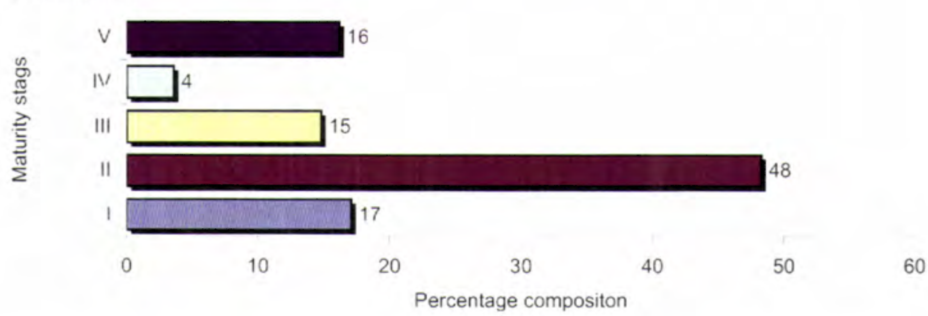
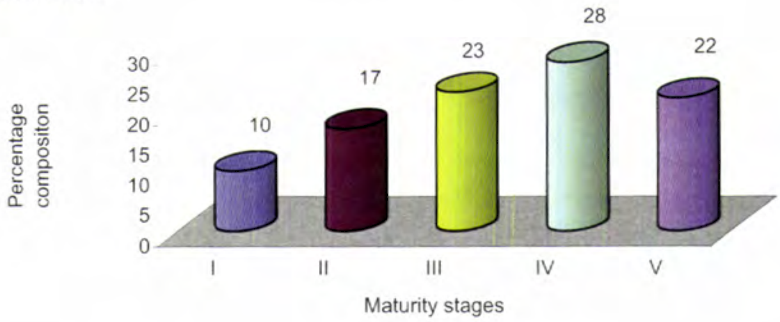
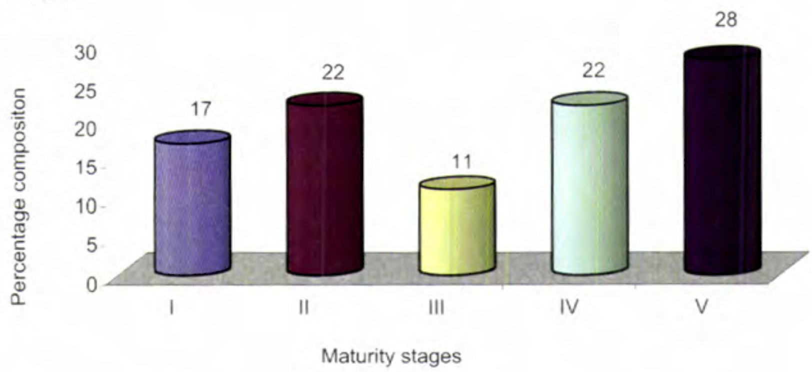


Figure 5.4 Goanad maturation of *Neoepinnula orientalis* females

Premonsoon




Monsoon




Postmonsoon

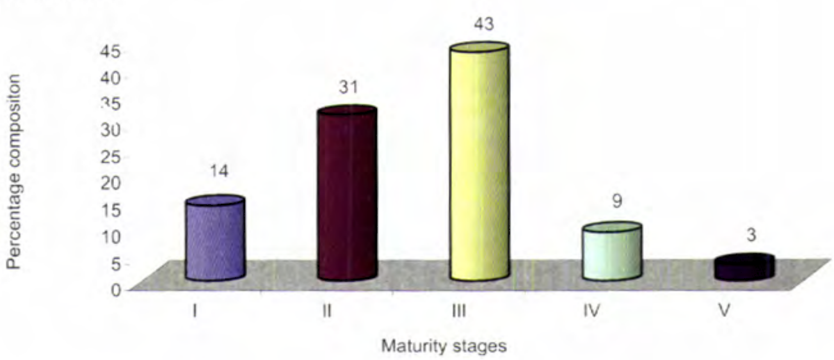


**Figure 5.5 Goanad maturation of *Cubiceps squamiceps* females**

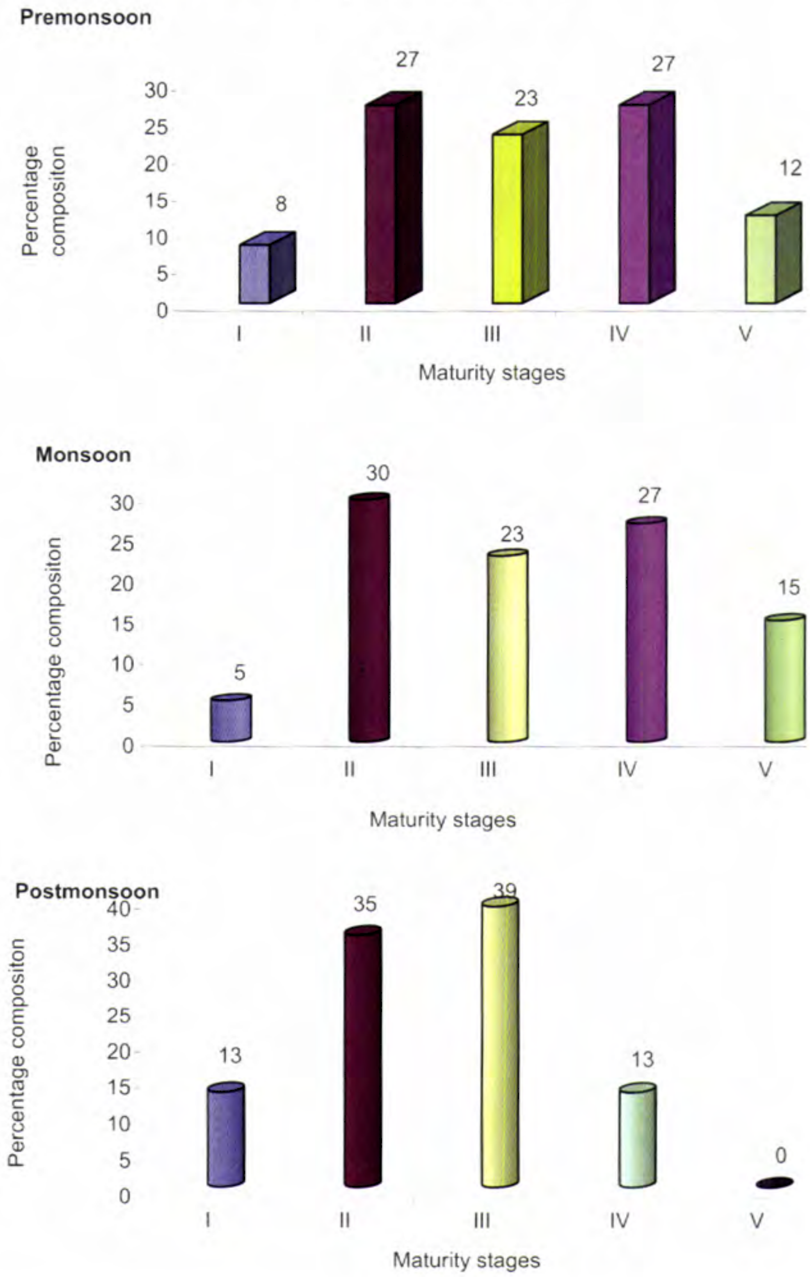


Table 5.2 Season wise sex ratio of *Psenopsis cyanea*

| Length group | No. of fish | Ratio (M:F) | Chi-square | Remarks |
| --- | --- | --- | --- | --- |
| **premonsoon** | | | | |
| 13.5 | 20 | 1 : 3 | 5.00 | S* |
| 14.5 | 15 | 1 : 2 | 1.67 | NS** |
| 15.5 | 25 | 1 1.5 | 1.00 | NS |
| 16.5 | 65 | 1 0.63 | 3.46 | NS |
| 17.5 | 10 | 0 10 | 10.00 | S |
| | **135** | **1 1.25** | **1.67** | NS |
| **monsoon** | | | | |
| 14.5 | 6 | 1 0.2 | 2.67 | NS |
| 15.5 | 12 | 1 1.00 | 0.00 | NS |
| 16.5 | 13 | 1 : 0.08 | 9.31 | S |
| 17.5 | 19 | 1 : 0.46 | 2.58 | NS |
| 18.5 | 32 | 1 4.3 | 12.50 | S |
| 19.5 | 15 | 1 4 | 5.40 | S |
| 20.5 | 11 | 1 2.67 | 2.27 | NS |
| | **108** | **1 1.43** | **3.33** | NS |
| **post monsoon** | | | | |
| 15.5 | 8 | 1 1.00 | 0.00 | NS |
| 16.5 | 25 | 1 0.32 | 6.76 | S |
| 17.5 | 47 | 1 1.04 | 0.02 | NS |
| 18.5 | 33 | 1 1.75 | 2.45 | NS |
| 19.5 | 40 | 1 0.91 | 0.10 | NS |
| 20.5 | 17 | 1 0.89 | 0.06 | NS |
| 21.5 | 10 | 1 0.43 | 1.60 | NS |
| 22.5 | 8 | 1 0.33 | 2.00 | NS |
| 23.5 | 4 | 1 1.00 | 0.00 | NS |
| | **180** | **1 1.08** | **1.62** | NS |

Significance $p>0.05$ S* - Significant NS** - Not Significant

**Table 5.3 Season wise Sex ratio of *Hoplostethus mediterraneus***

| Length group | No. of fish | Ratio (M:F) | Chi-square | Remarks |
|---|---|---|---|---|
| **Pre-monsoon** | | | | |
| 11.5 | 9 | 1 0.5 | 1.00 | NS** |
| 12.5 | 45 | 1 0.36 | 9.80 | S* |
| 13.5 | 42 | 1 0.31 | 11.52 | S |
| 14.5 | 32 | 1 0.39 | 6.13 | S |
| 15.5 | 20 | 1 0.25 | 7.20 | S |
| 16.5 | 18 | 1 0.38 | 3.56 | NS |
| 17.5 | 12 | 1 0.09 | 8.33 | S |
| **Total** | **178** | **1 : 0.33** | **45.51** | S |
| **Monsoon** | | | | |
| 11.5 | 11 | 1 0.10 | 7.36 | S |
| 12.5 | 44 | 1 : 0.26 | 15.36 | S |
| 13.5 | 41 | 1 0.46 | 5.49 | S |
| 14.5 | 73 | 1 0.74 | 1.66 | NS |
| 15.5 | 34 | 1 0.89 | 0.12 | NS |
| 16.5 | 34 | 1 0.31 | 9.53 | S |
| 17.5 | 10 | 1 4 | 3.60 | S |
| 18.5 | 9 | 1 0.8 | 0.11 | NS |
| 19.5 | 2 | 1 2 | 2.00 | NS |
| **Total** | **258** | **1 0.55** | **21.22** | S |
| **Post monsoon** | | | | |
| 8.5 | 4 | 1 0.33 | 1.00 | NS |
| 9.5 | 7 | 1 0.40 | 1.29 | NS |
| 10.5 | 20 | 1 0.25 | 7.20 | S |
| 11.5 | 33 | 1 0.27 | 10.94 | S |
| 12.5 | 47 | 1 0.38 | 9.38 | S |
| 13.5 | 45 | 1 0.22 | 18.69 | S |
| **Total** | **156** | **1 : 0.29** | **47.41** | S |

Significance p>0.05 S* - Significant NS** - Not Significant

Table 5.4 : Season wise sex ratio of *Neoepinnula orientalis*

| Length group | No. of fish | Ratio (M:F) | Chi-square | Remarks |
|---|---|---|---|---|
| **Pre-monsoon** | | | | |
| 14.5 | 6 | 1:0.20 | 2.67 | NS** |
| 15.5 | 15 | 1:0.15 | 8.07 | S* |
| 16.5 | 18 | 1:0.20 | 8.00 | S |
| 17.5 | 20 | 1:0.67 | 0.80 | NS |
| 18.5 | 15 | 1:0.50 | 1.67 | NS |
| 19.5 | 23 | 1:0.35 | 5.26 | S |
| 20.5 | 15 | 1:1.14 | 0.07 | NS |
| 21.5 | 5 | 1:4.00 | 1.80 | NS |
| 22.5 | 17 | 1:7.50 | 9.94 | S |
| 23.5 | 13 | 1:5.50 | 6.23 | S |
| 24.5 | 9 | 1:2.00 | 1.00 | NS |
| 25.5 | 4 | 1:3.00 | 1.00 | NS |
| 26.5 | 6 | 1:5.00 | 2.67 | NS |
| **Total** | **166** | **1:0.87** | **0.87** | **NS** |
| **Monsoon** | | | | |
| 11.5 | 3 | 1:0.50 | 0.33 | NS |
| 12.5 | 7 | 1:0.17 | 3.57 | NS |
| 13.5 | 9 | 1:1.25 | 0.11 | NS |
| 14.5 | 5 | 1:0.25 | 1.80 | NS |
| 15.5 | 8 | 1:3.00 | 2.00 | NS |
| 16.5 | 9 | 1:0.50 | 1.00 | NS |
| 17.5 | 2 | 1:1.0 | 0.00 | NS |
| 18.5 | 3 | 1:0.00 | 3.00 | NS |
| 19.5 | 7 | 1:0.17 | 3.57 | NS |
| 20.5 | 4 | 1:3.00 | 1.00 | NS |
| 21.5 | 1 | 1:0.00 | 1.00 | NS |
| 22.5 | 3 | 1:2.00 | 0.33 | NS |
| 23.5 | 5 | 1:1.50 | 0.20 | NS |
| 24.5 | 5 | 1:4.00 | 1.80 | NS |
| 25.5 | 3 | 1:2.00 | 0.33 | NS |
| 26.5 | 5 | 1:4.00 | 1.80 | NS |
| **Total** | **79** | **1:0.88** | **0.32** | **NS** |
| **Post monsoon** | | | | |
| 14.5 | 2 | 1:0.00 | 2.00 | NS |
| 15.5 | 14 | 1:0.17 | 7.14 | S |
| 16.5 | 20 | 1:0.43 | 3.20 | NS |
| 17.5 | 10 | 1:0.00 | 10.00 | S |
| 18.5 | 12 | 1:5.00 | 5.33 | S |
| 19.5 | 22 | 1:1.75 | 1.64 | NS |
| 20.5 | 16 | 1:1.67 | 1.00 | NS |
| 21.5 | 3 | 1:2.00 | 0.33 | NS |
| 22.5 | 10 | 1:4.00 | 3.60 | NS |
| 23.5 | 12 | 1:5.00 | 5.33 | S |
| 24.5 | 6 | 1:2.00 | 0.67 | NS |
| 25.5 | 3 | 1:2.00 | 0.33 | NS |
| 26.5 | 3 | 1:2.00 | 0.33 | NS |
| **Total** | **133** | **1:1.11** | **0.37** | **NS** |

Significance $p>0.05$ S* - Significant NS** - Not Significant

Table 5.5 Season wise sex ratio of *Cubiceps squamiceps*

| Length group | No. of fish | Ratio (M:F) | Chi-square | Remarks |
|---|---|---|---|---|
| **Pre-monsoon** | | | | |
| 9.5 | 5 | 1:0.00 | 5.00 | S* |
| 10.5 | 12 | 1:0.33 | 3.00 | NS** |
| 11.5 | 7 | 1:6.00 | 3.57 | NS |
| 12.5 | 4 | 1:3.00 | 1.00 | NS |
| 13.5 | 3 | 1:2.00 | 0.33 | NS |
| 14.5 | 5 | 1:1.50 | 0.20 | NS |
| 15.5 | 8 | 1:3.00 | 2.00 | NS |
| 16.5 | 13 | 1:6.50 | 1.92 | NS |
| 17.5 | 3 | 1:2.00 | 0.33 | NS |
| **Total** | **60** | **1:0.94** | **0.07** | **NS** |
| **Monsoon** | | | | |
| 12.5 | 16 | 1:1.29 | 0.25 | NS |
| 13.5 | 14 | 1:3.67 | 4.57 | S |
| 14.5 | 15 | 1:0.15 | 8.07 | S |
| 15.5 | 10 | 1:9.00 | 6.40 | S |
| 16.5 | 20 | 1:0.67 | 0.80 | NS |
| 17.5 | 17 | 1:16.00 | 13.24 | S |
| 18.5 | 7 | 1:6.00 | 3.57 | NS |
| 19.5 | 6 | 1:5.00 | 2.67 | NS |
| **Total** | **105** | **1:1.69** | **6.94** | **S** |
| **Post monsoon** | | | | |
| 12.5 | 9 | 1:3.5 | 2.78 | NS |
| 13.5 | 22 | 1:10.00 | 14.73 | S |
| 14.5 | 4 | 1:1.00 | 0.00 | NS |
| 15.5 | 14 | 1:1.80 | 1.14 | NS |
| 16.5 | 15 | 1:0.36 | 3.27 | NS |
| 17.5 | 16 | 1:7.00 | 9.00 | S |
| 18.5 | 6 | 1:5.00 | 2.67 | NS |
| 19.5 | 2 | 1:1.00 | 0.00 | NS |
| **Total** | **88** | **1:2.38** | **14.73** | **S** |

Significance $p>0.05$ S* - Significant NS** - Not Significant

# CHAPTER 6

# LENGTH-WEIGHT RELATIONSHIP

## 6.1 Introduction

Length-weight relationships of fishes are important in fisheries biology because they allow the estimation of the average weight of the fish of a given length group by establishing a mathematical relation between the two variables (Beyer, 1987). It serves as a tool for assessing the relative well being and changes taking place in fish populations (Bolger and Connolly, 1989). Like any other morphometric characters, the length-weight relationship can be used as a character for the differentiation of taxonomic units and this relationship is seen to change with various developmental events in life such as metamorphosis, growth and the onset of maturity. Further, this relationship can also be used to derive yield equations for estimating the number of fish landed and comparing the population in space and time (Beverton and Holt, 1957). The practical applications of this relationship include visual census (Kulbicki *et al.* 1993), estimating the mean weight of fish of a given length class, conversion of a growth equation for length into a growth equation for weight by computation of prediction of weight from age as required for yield-per-recruit models and morphological comparisons between population of the same species, or between species and related investigations (Caillouet, 1993). It can monitor the value of ***a*** whereby the value of ***a*** is related to the condition factor (*eg.* sex, stage of maturity, time of the year, stomach content and others). This value is also considered as the factor for well being of fish and can be used to determine the spawning period of the fish and consequently and hence it is useful in monitoring the natural population.

Length-weight relationships allow fisheries scientists to convert growth-in-length equations to growth-in weight in stock assessment models (Dulčić and Kraljević, 1996; Cherif *et al.* 2008), estimate biomass from length frequency distributions and calculate fish condition (Anderson and Gutreuter, 1983, Dulčić and Kraljević, 1996). It is a useful tool for comparing life history and morphological aspects of populations inhabiting different regions (Gonçalves *et al.*, 1997). Length-weight relationships are also important to raise length-frequency samples to total catch. Length-weight relationship is of great importance in fishery assessments (Garcia *et al.* 1998; Haimovici and Velasco, 2000) and in conjunction with age data, can give information on the stock composition, age at maturity, life span, mortality, growth and production (Beyer, 1987; Bolger and Connoly, 1989; King, 1996a; Diaz *et. al.*, 2000).

The empirical relationship between the length and weight of the fish thus enhances the knowledge of the biology of the deep-sea fish for which studies are scant for the Indian Ocean. The available studies on the length weight relationship of fishes beyond 200m depth from Indian waters restricted to a very few (Philip and Mathew, 1996; Khan *et al.*, 1996; Venu and Kurup, 2002 a, b&c; 2006 a&b; Thomas *et al.* 2003; Kurup *et al.* 2005; Jayaprakash *et al.* 2006; Kurup and Venu, 2006; Kurup *et al.* 2006).

## 6.2 Materials and Methods

The sampling was done as explained in Chapter 2. Specimens were sorted by sex, measured to the nearest 1 mm (total length, TL) and weighed to the nearest 0.1 g (weight, W). The relationship between the length and weight of a fish is usually expressed by the equation $W = aL^b$ (Le Cren, 1951, Ricker

1973) where W is body weight (g), L is total length (cm), ***a*** is the intercept and ***b*** is the slope (fish growth rate) (Beverton and Holt, 1957). A graph of log W against log L forms a straight line as per the following formula:

$$\log W = \log a + b \log L$$

The parameters ***a*** and ***b*** of the length-weight relationships are estimated by the least-square method based on the predictive or Type I linear regression model (Zar, 1984), using W as the dependent variable and L as the independent variable. The degree of adjustment of the model studied was assessed by the correlation coefficient (r). Student's t-test was applied to verify whether the regression coefficient (constant "b") deviates significantly from difference of 3.0, indicating the type of growth: isometric (b=3.0), positive allometric (b>3.0) or negative allometric (b<3.0) (Bailey, 1959). In all cases a significance of 5% was usually adopted.

## 6. 3 Results

In the present study, the analysis of length weight relationship of five species of deep sea fishes along the south west coast of India at a depth above 200m was done to assess its pattern of growth. Even though majority of species showed the exponential value "b" around three which is the manifestation of isometric growth, it varied from 1.5 to 3.7 Females and males of different species also showed considerable variation in the exponential value, which indicates that, the growth pattern of these deep sea fishes varied from high negative allometry to high positive allometry. For an ideal fish which maintain dimensional equality, isometric value of ***b*** tending to three has generally been observed. Slope value less than three indicates that the fish become more slender as it increase in length and with the slope value greater than 3 denotes stoutness, indicating allometric growth. However deviation from cube law is observed in most of the species as they change their body shape during growth.

### 6.3.1 *Psenopsis cyanea*

**Depth wise Length weight relationship**

**201-300m** (Fig. 6.1)

| | | |
|---|---|---|
| Pooled | log w = -2.4 + 3.3 log l | $R^2$ = 0.8194 |
| Female | log w = -2.1 + 3.1 log l | $R^2$ = 0.8238 |
| Male | log w = -2.5 + 3.4 log l | $R^2$ = 0.8194 |

**301-400m** (Fig. 6.2)

| | | |
|---|---|---|
| Pooled | log w = -0.5 + 1.8 log l | $R^2$ = 0.7305 |
| Female | log w = -0.8 + 2.1 log l | $R^2$ = 0.8611 |
| Male | log w = -0.1 + 1.8 log l | $R^2$ = 0.5733 |

**Season wise**

**Premonsoon** (Fig. 6.3)

| | | |
|---|---|---|
| Females | log w= - 1.3 + 2.3 log l | $R^2$ = 0.6988 |

| | | |
|---|---|---|
| Males | log w= - 2.0 + 2.9 log l | $R^2$ = 0.7592 |
| Pooled | log w= - 1.4 + 2.4 log l | $R^2$ = 0.6858 |

**Monsoon** (Fig. 6.4)

| | | |
|---|---|---|
| Females | log w= - 1.9 + 2.9 log l | $R^2$ = 0.7078 |
| Males | log w= - 2.3 + 3.2 log l | $R^2$ = 0.6993 |
| Pooled | log w= - 2.1 + 3.0 log l | $R^2$ = 0.769 |

**Postmonsoon** (Fig. 6.5)

| | | |
|---|---|---|
| Females | log w= - 2.7 + 3.5 log l | $R^2$ = 0.863 |
| Males | log w= - 2.6 + 3.5 log l | $R^2$ = 0.8464 |
| Pooled | log w= - 2.6 + 3.5 log l | $R^2$ = 0.8478 |

In the case of *P. cyanea*, ***b*** value of pooled population calculated for the depth ranges 201-300, and 301-400m were 3.3 and 1.8 respectively, and the corresponding values for females in the respective depth ranges were 3.1 and 2.1, and males 3.4 and 1.8. While, the ***a*** values computed were 2.4 and 0.5 for the pooled population, 2.1 and 0.8 were obtained for females and 2.5 and 0.1 for males respectively. The $R^2$ values for the pooled population were 0.82 and 0.73, for females 0.82 and 0.86 while for male population 0.91 and 0.57 respectively.

The ***b*** values calculated during premonsoon, monsoon and postmonsoon seasons for the females were 2.3, 2.9 and 3.5 while for males they were 2.9, 3.2 and 3.5 during the present study. The ***a*** values computed during the three seasons were 1.3, 1.9 and 2.7 respectively for female fishes and 2.0, 2.3 and 2.6 for males. The $R^2$ values were 0.70, 0.70 and 0.86 for females and 0.76, 0.70 and 0.85 for male fishes.

### 6.3.2 *Chlorophthalmus bicornis*

The logarithmic regression equations worked out by substituting the respective values of ***a*** and ***b*** have given an overall picture about the length-weight relationship of the combined population of C. *bicornis*. The equations worked out are as follows: -

**Depth wise** (Fig. 6.6)

| | | |
|---|---|---|
| **201 – 300m** | log w= - 2.4 + 3.2 log l | $R^2$ = 0.851 |
| **301 400m** | log w= - 2.9 + 3.6 log l | $R^2$ = 0.8757 |

**Season wise** (Fig. 6.7)

| | | |
|---|---|---|
| **Premonsoon** | log w= - 3.1 + 3.8 log l | $R^2$ = 0.93 |
| **Monsoon** | log w= - 2.3 + 3.2 log l | $R^2$ = 0.72 |
| **Postmonsoon** | log w= - 2.2 + 3.1 log l | $R^2$ = 0.81 |

The results have shown that in the case of *C. bicornis*, b value calculated for the depth ranges 201-300 and 301-400m are 3.2 and 3.6 respectively.

The ***b*** values calculated during premonsoon, monsoon and postmonsoon seasons were 3.8, 3.1 and 3.1 respectively in the present study. The ***a*** values calculated during the three seasons were 3.2, 2.2 and 2.1 respectively for female fishes and 2.6, 1.2 and 2.1 for males. Whereas the $R^2$ values were 0.95, 0.72 and 0.88 for females and 0.74, 0.64 and 0.78 for male fishes.

### 6.3.3 *Hoplostethus mediterraneus*

**Depth wise**

**201 – 300m** (Fig. 6.8)

| | | |
|---|---|---|
| Females | log w= - 1.1 + 2.3 log l | $R^2$ = 0.5477 |
| Males | log w= - 1.6 + 2.8 log l | $R^2$ = 0.8009 |
| Pooled | log w= - 1.6 + 2.7 log l | $R^2$ = 0.761 |

**301 – 400m** (Fig. 6.9)

| | | |
|---|---|---|
| Females | log w= - 0.8 + 2.1 log l | $R^2$ = 0.8318 |
| Males | log w= - 1.2 + 2.4 log l | $R^2$ = 0.8055 |
| Pooled | log w= - 1.1 + 2.3 log l | $R^2$ = 0.8226 |

**501 – 600m** (Fig. 6.10)

| | | |
|---|---|---|
| Females | log w= - 1.6 + 2.8 log l | $R^2$ = 0.9902 |
| Males | log w= - 1.4 + 2.6 log l | $R^2$ = 0.9394 |

| | | |
|---|---|---|
| Pooled | log w= - 1.4 + 2.6 log l | $R^2$ = 0.9415 |

**Season wise**

**Premonsoon** (Fig. 6.11)

| | | |
|---|---|---|
| Females | log w= - 2.1 + 3.2 log l | $R^2$ = 0.7511 |
| Males | log w= - 1.6 + 2.7 log l | $R^2$ = 0.7508 |
| Pooled | log w= - 1.6 + 2.7 log l | $R^2$ = 0.76 |

**Monsoon** (Fig. 6.12)

| | | |
|---|---|---|
| Females | log w= - 1.1 + 2.3 log l | $R^2$ = 0.8553 |
| Males | log w= - 1.22 + 2.4 log l | $R^2$ = 0.8234 |
| Pooled | log w= - 1.2 + 2.4 log l | $R^2$ = 0.84 |

**Postmonsoon** (Fig. 6.13)

| | | |
|---|---|---|
| Females | log w= - 1.6 + 2.8 log l | $R^2$ = 0.8989 |
| Males | log w= -1.5 + 2.6 log l | $R^2$ = 0.6215 |
| Pooled | log w= - 1.5 + 2.6 log l | $R^2$ = 0.65 |

In *H. mediterraneus*, ***b*** value of pooled population calculated for the depth ranges 201-300, 301-400 and 501-600m were 2.7, 2.3 and 2.6 respectively, while in females the values were 2.3, 2.1 and 2.8 and in males it was 2.8, 2.4 and 2.6 respectively. The ***a*** values computed for the pooled population were 1.6, 1.1 and 1.4 it was 1.1, 0.8 and 1.6 for females and 1.6, 1.2 and 1.4 for males respectively. The $R^2$ values for the pooled population were 0.76, 0.82 and 0.94, for females 0.55, 0.83 and 0.99 while for male population it was 0.8, 0.81 and 0.94 respectively.

The ***b*** values calculated during premonsoon, monsoon and postmonsoon seasons for the females were 3.2, 2.3 and 2.8 while for males the values were 2.7, 2.4 and 2.6 in the present study. The ***a*** values calculated during the three seasons were 2.1, 1.1 and 1.6 respectively for female fishes and 1.6, 1.2 and 1.5 for males and the $R^2$ values were 0.75, 0.86 and 0.89 for females and 0.75, 0.82 and 0.62 for males during the respective seasons.

### 6.3.4 *Neoepinnula orientalis*

**Depth wise**

**201-300m** (Fig. 6.14)

| | | |
|---|---|---|
| Females | log w = -1.8 + 2.7 log l | $R^2$ = 0.8958 |
| Males | log w = - 2.8 + 3.5 log l | $R^2$ = 0.8046 |
| Pooled | log w = - 2.3 + 3.1 log l | $R^2$ = 0.8519 |

**301-400m** (Fig. 6.15)

| | | |
|---|---|---|
| Females | log w = -1.7 + 2.6 log l | $R^2$ = 0.9014 |
| Males | log w = -2.1 + 2.9 log l | $R^2$ = 0.9721 |
| Pooled | log w = -1.8 + 2.7 log l | $R^2$ = 0.9175 |

**401-500m** (Fig. 6.16)

| | | |
|---|---|---|
| Females | log w = - 2.9 + 3.6 log l | $R^2$ = 0.9534 |
| Males | log w = - 2.6 + 3.4 log l | $R^2$ = 0.993 |
| Pooled | log w = - 2.8 + 3.5 log l | $R^2$ = 0.9704 |

**Season wise**

**Premonsoon** (Fig. 6.17)

| | | |
|---|---|---|
| Females | log w= - 2.5 + 3.3 log l | $R^2$ = 0.9263 |
| Males | log w= - 2.6 + 3.3 log l | $R^2$ = 0.9558 |

**Monsoon** (Fig. 6.18)

| | | |
|---|---|---|
| Females | log w= - 1.7 + 2.7 log l | $R^2$ = 0.9125 |
| Males | log w= - 2.5 + 3.2 log l | $R^2$ = 0.9359 |

**Postmonsoon** (Fig. 6.19)

| | | |
|---|---|---|
| Females | log w= - 2.0 + 2.9 log l | $R^2$ = 0.9065 |
| Males | log w= - 2.2 + 3.1 log l | $R^2$ = 0.9352 |

In *N. orientalis*, ***b*** value of pooled population for the depth ranges 201-300, 301-400 and 401-500m were 3.1, 2.7 and 3.5 respectively, whereas for the females the values were 2.7, 2.6 and 3.6 and males 3.5, 2.9 and 3.4 respectively. The ***a*** values computed were 2.3, 1.8 and 2.8 for the pooled population, 1.8, 1.7 and 2.9 for females and 2.8, 2.1 and 2.6 for males respectively. The $R^2$ values for the pooled population were 0.85, 0.92 and 0.97, for females 0.9, 0.9 and 0.95 while they were 0.8, 0.97 and 0.99 respectively for the male population.

The ***b*** values during premonsoon, monsoon and postmonsoon seasons females were 3.3, 2.7 and 2.9 while for males 3.3, 3.2 and 3.1. The ***a*** values calculated during the three seasons were 2.5, 1.7 and 2.0 respectively for female fishes and 2.6, 2.5 and 2.2 for males. The $R^2$ values were 0.93, 0.91 and 0.91 for females and 0.96, 0.94 and 0.94 for male fishes during the respective seasons.

### 6.3.5 *Cubiceps squamiceps*

**Depth wise**

**201-300m** (Fig. 6.20)

| | | |
|---|---|---|
| Females | log w = - 2.5 + 3.5 log l | $R^2$ = 0.952 |
| Males | log w = - 2.3 + 3.3 log l | $R^2$ = 0.9809 |
| Pooled | log w = - 2.4 + 3.4 log l | $R^2$ = 0.9637 |

**301-400m** (Fig. 6.21)

| | | |
|---|---|---|
| Females | log w = - 2.3 + 3.3 log l | $R^2$ = 0.9253 |
| Males | log w = - 2.0 + 3.1 log l | $R^2$ = 0.9195 |
| Pooled | log w = - 2.3 + 3.3 log l | $R^2$ = 0.9235 |

## Season wise

**Premonsoon** (Fig. 6.22)

| | | |
|---|---|---|
| Females | log w= - 1.9 + 2.9 log l | $R^2$ = 0.9513 |
| Males | log w= - 1.8 + 2.8 log l | $R^2$ = 0.9478 |

**Monsoon** (Fig. 6.23)

| | | |
|---|---|---|
| Females | log w= - 1.6 + 2.6 log l | $R^2$ = 0.8391 |
| Males | log w= - 2.0 + 2.9 log l | $R^2$ = 0.7633 |

**Postmonsoon** (Fig. 6.24)

| | | |
|---|---|---|
| Females | log w= - 2.0 + 3.0 log l | $R^2$ = 0.7831 |
| Males | log w= - 2.9 + 3.8 log l | $R^2$ = 0.9242 |

For *C. squamiceps*, the ***b*** value of pooled population for the depth ranges 201-300, and 301-400m were 3.4 and 3.3, whereas for the females, the values were 3.5 and 3.3 and males 3.3 and 3.1 respectively. While, the ***a*** values were 2.4 and 2.3 for the pooled population, the values for females were 2.5 and 2.3 and for males, 2.3 and 2.0 respectively The $R^2$ values for the pooled population were 0.96 and 0.92, for females it was 0.95 and 0.93 while for male population the $R^2$ values were found to be 0.98 and 0.92 respectively.

The ***b*** values calculated for the females during premonsoon, monsoon and postmonsoon seasons were 2.9, 2.6 and 3.0 while for males the corresponding values were 2.8, 2.9 and 3.8. The ***a*** values for the three seasons were 1.9, 1.6 and 2.0 respectively for female fishes and 1.8, 2.0 and 2.9 for males, whereas the $R^2$ values were 0.95, 0.84 and 0.78 for females and 0.95, 0.76 and 0.92 for male fishes.

## 6.4 Discussion

The exact relationship between length and weight differs among various species of fish according to their inherited body shape, and within a species according to the condition (robustness) of individual fish. The condition sometimes reflects food availability and growth within the weeks prior to sampling and is variable and dynamic. Individual fish within the same sample vary considerably, and the average condition of each population varies seasonally and yearly. Sex and gonad development are other important variables in some species. Generally, the regression coefficient fluctuates between 2.5 and 4.0 (Hile, 1936). According to Beverton and Holt (1957), deviations from isometric growth are extremely rare. The departure from cube law may be attributed to either environmental factors or condition of fish (Le Cren, 1951).

For an ideal fish which maintains a constant shape, b = 3.0 (Allen, 1938). The results of the logarithmic regression showed that the ***b*** value of males and females show inverse relationship with depth. The slope value greater than 3.0 denotes the stoutness of fish when it increases in length and the less than 3.0 indicates that fish becomes more slender (Grower and Juliano, 1976).

Whereas the lowest ***b*** value was recorded in *P. cyanea* males (1.5) and the highest in *N. orientalis* (3.5) from 201-300 m. Whereas in females, it was 2.0 for *P. cyanea* in 301-400 m and 3.6 for *N. orientalis* at 401-500 m.

In this study, the ***b*** values fluctuated between 1.8 for the pooled population of *P. cyanea* and 3.6 for of *C. bicornis* in the depth zone 301-400m. The lowest ***b*** value was recorded for *P. cyanea* males (1.5) from 301-400 m and the highest in *N. orientalis* females (3.6) from 401-500 m. Frost (1945) opined that changes in fish shape, physiological changes, environmental conditions, different food availability during life and biological span and growth increment or break in growth can all affect the growth exponent. Thus, from the results of the present study, it can be inferred that the fishes inhabiting the same depth zone can show differences in their growth pattern depending upon various environmental parameters. Khan *et al.* (1996) reported a highly differential growth pattern among males and female of *C. natalensis*; the former characterized by a low b value of 1.55. Highly skewed slope value of 1.97 was also reported in *Alepocephalus indicus* collected from 250-300m depth along the west coast of Indian EEZ (Thomas *et al.*, 2003). Kurup *et al.* (2006) reported similar trends in *P cyanea* and *N. orientalis* collected from 201-400m depth from the south west coast of India.

Khan *et al.* (1996) reported that females of *P. cyanea* are a little heavier than males with ***b*** values of 3.76 and 3.37 respectively. In the present study, the exponential value for females computed in the depth zone 201-300m was 3.09, which indicates that the growth is almost isometric, whereas in males the b value was 3.44, which indicate that males do not follow the cube law. But the ***b*** values of female and male fishes in the depth zone 301-400m showed decreasing trend when compared to 201-300 m depth zone. It would thus appear that in the shallower depth zones, the fish grows isometrically when compared to deeper zones. Hile (1936) and Martin (1949) are of the opinion that the value of the exponent ***b*** in the parabolic equation $W = aL^b$ lies between 2.5 and 4.0 and the deviation from the cube law is often observed in most of the fishes as they change their body shape during growth.

The results of the present study have also demonstrated that as in *H. mediterraneus*, *N. orientalis* also grows stouter in the deeper waters. Also, the individuals in the depth zone 301-400m show negative allometry, where the fishes seem to grow slender. Females were observed to grow stouter than males in the deeper waters while the males were found stouter in the 201-300m depth zone. The fishes grow more or less isometric in general during all the seasons. However, a slight negative allometry observed for females during the monsoon season may be attributed to spawning during these months. Feeding was found to be reduced during the premonsoon period and was higher during the monsoon, findings similar to that in H. *mediterraneus* and *C. bicornis*.

It may be seen from the value of ***b*** that there is not much difference in the pattern of growth between the two depth zones in *C. squamiceps*. In both the depth zones, the females were found to be stouter and males were more or less isometric or slightly positive allometric. Thus from the results it may be infered that the species was well distributed in both the depth zones. The female fish were found to be following the trend as in the case of *N. orientalis* and *H. mediterraneus* while the males follows *P. cyanea*. The results of the food and feeding shows that during the premonsoon and monsoon seasons *C. squamiceps* feeds more intense than postmonsoon (Refer Chapter 4). On the contrary, in females it was more or less same during the premonsoon and monsoon seasons and the spawning was found to be in a continuous pattern with a peak during the monsoon.

In *C. bicornis,* growth showed a positive allometry in general and individuals were found stouter in deeper waters. The results of the present study shown that the fish is stouter during the premonsoon and relatively isometric or slender during the monsoon and postmonsoon. This can be attributed to their feeding and breeding strategies. This species is characterised by lower feeding intensity during the premonsoon which increases during monsoon (Chapter 4). The spawning of this species commences in premonsoon and continues to the monsoon period. The difference observed in growth pattern in *C. bicornis* may be due to influence of both feeding and maturation and spawning of this species. This trend of allometric growth seen in C. *bicornis* is same as that of other deep-sea species as observed by Philip and Mathew (1996) and Khan *et al.* (1996).

*H. mediterraneus* exhibited a negatively allometric growth pattern with a slender body (Shanmugam *et al.* 2000). Even in the deeper waters the trend was found the same, in contrast to *C. bicornis*, but when compared to the depth zone 301-400m, the fishes inhabiting in the depth zone 501-600m are stouter. In general, the fishes collected from depth 301-400m showed greater negative allometry and thus were more slender when compared to other two depth zones. The ***b*** value indicated that females were relatively stouter in the 501-600m than the other depth zones, while males were stouter in 201-300m. The ***b*** value computed in *H. mediterraneus* is found on a lower side when compared to Khan *et al.* (1996). The low b value seen in *H. mediterraneus* inhabiting at depth beyond 300m indicate that the species may not be maintaining its dimensional equality during the growth. The growth of fish is much influenced by extrinsic factors like temperature, food availability and physico - chemical parameters prevailing in the environment. Depths beyond 300 m are characterised by low temperature and sparse availability of preferred food items (Mamaev and Tkachuk, 1979). The results of the studies conducted on food and feeding of deep sea fishes have shown that feeding intensity was very less throughout the seasons presumably due to the scarcity of prey (refer Chapter 4). Besides, *H. mediterraneus* was found to be distributed mainly in the depths beyond 300m and even at depths greater than 650m. All these factors contribute to the allometric growth to suit the environment in which they are living. As in *C. bicornis*, during the premonsoon season, growth was somewhat isometric and then showed negative allometry during monsoon and postmonsoon. The monsoon months showed least ***b*** value and hence the growth was negatively allometric with the fish growing more slender than in the other seasons. The spawning period of *H. mediterraneus* was found as monsoon period which further conform with the period in that change in growth trends was observed. However, the feeding intensity was less during the premonsoon season when compared to other seasons and despite these factors, it shows negative allometric growth during the monsoon season. This may be attributed to the spawning preparations of the fish during premonsoon and recovery during late monsoon and postmonsoon periods.

In *P. cyanea*, the exponential value of ***b*** has shown that the growth in the 201-300m depth zone is more or less isometric or slightly positively allometric. But in the depth zone 301-400m, the fish showed a strong negative allometry, with slender growth in the deeper waters. While analysing the distribution pattern of the species, it may be seen that *P. cyanea* is distributed mostly in the depth zone 201-300m.Thus negative allometry in the higher depth zone may be related to the unsuitable habitat conditions prevailing for the species. In a very few occasions, the species was also encountered from depths beyond 400m in the present study. The difference of values can be attributed to the lesser availability of desirable food compared to the shallower depths or the high competition from similar species. Kurup *et al.* (2006) reported significant variation in the maintenance of body dimension of the deep sea fishes inhabiting at different depth zones and inferred that variations in the dimensions observed in individuals inhabiting different depth zones might be due to the fact that habitats in various depth zones show extreme variations.

The results of the present study revealed that the spawning season of *P. cyanea* commences in premonsoon and continues till monsoon. The trend in growth seen in females shows a negative allometry during premonsoon, more or less isometric during monsoon and positive allometry during postmonsoon. It was established fact that the growth exponent changes with respect to the locality the fish inhabits, and also to its sex, length, age and gonad maturity (Ricker, 1975). Results of the feeding intensity studies revealed that the fish is having low feeding intensity during the premonsoon and moderately during monsoon (Chapter 4). Juveniles of *P. cyanea* have been caught from the shallow waters at a depth of 70 m which is indicative of its spawning ground in the shallow waters or in the near shallow waters, where the preferred habitat exists for this species. It appears that during the late premonsoon and monsoon months, the fish might be feeding on its most favoured food item which are abundant in these areas. The results of length weight relationship of these fishes have shown that the fishes grow slender in 301-400 m when compared to 201-300 m depth zone, while in deeper waters it grows comparatively stouter. An exception to this finding is that of *C. bicornis*.

In the depth beyond 200 or 300 m, the fish abundance, biomass, and numbers of fish species are inversely related with increasing depth which may be attributed to decreasing temperature and dissolved oxygen. The apparent inverse relationship between fish size and temperature and dissolved oxygen suggests that juveniles are less tolerant of physical conditions in deeper water; alternatively, the abundance of juveniles may vary directly with food availability or some other unmeasured factor that may be more favorable in shallow water (Allen and Mearns, 1977).

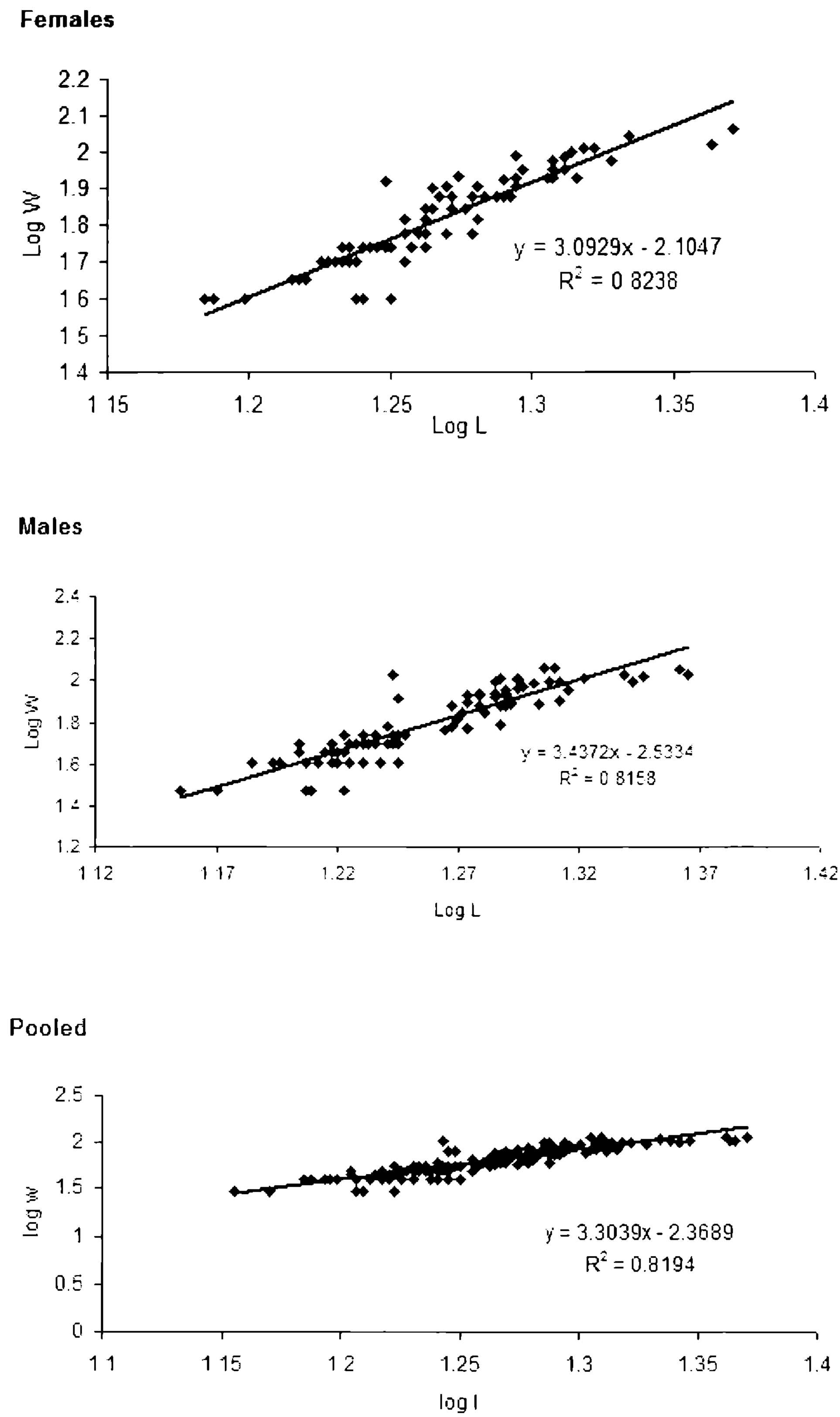
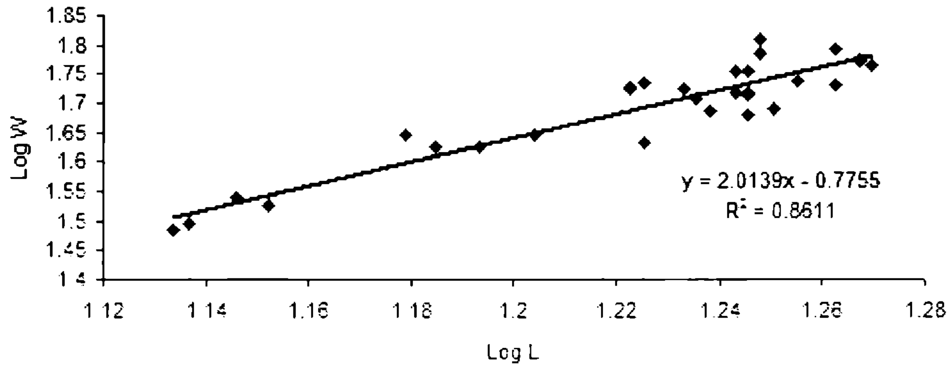
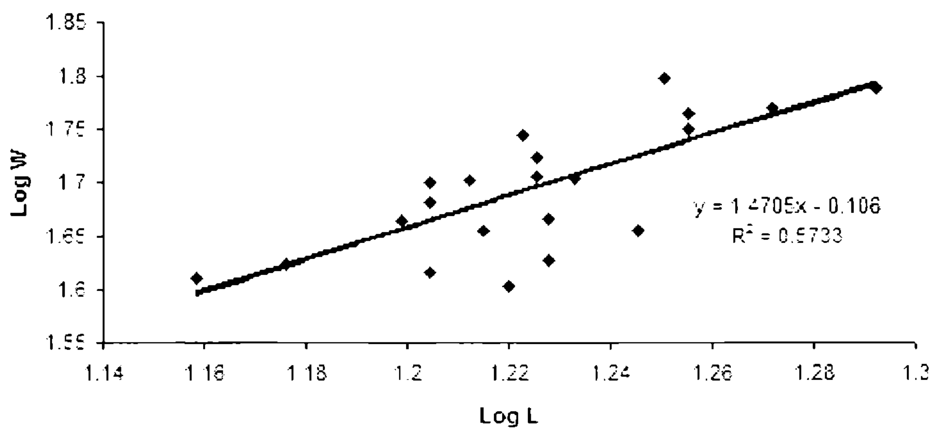



**Fig. 6.1 Length Weight Relationship of *Psenopsis cyanea* in 201-300m**

**Females**




**Males**

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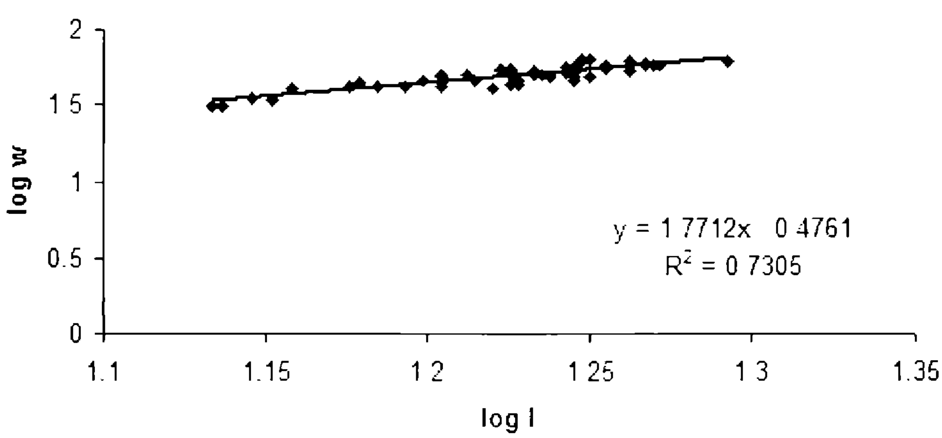
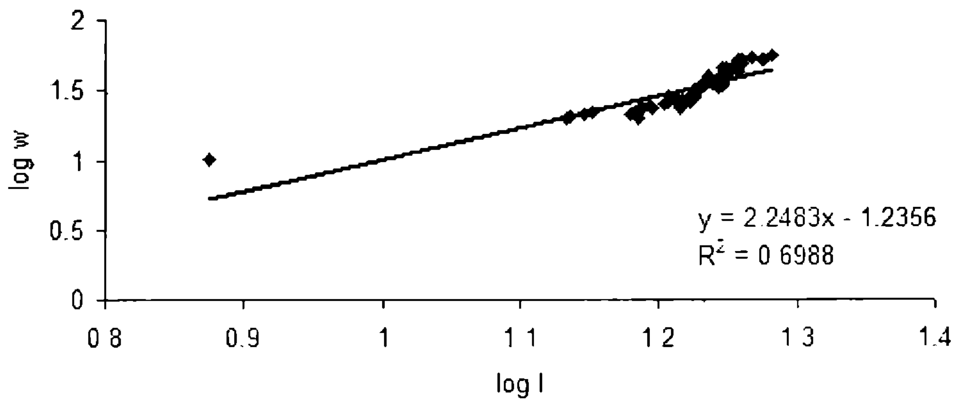
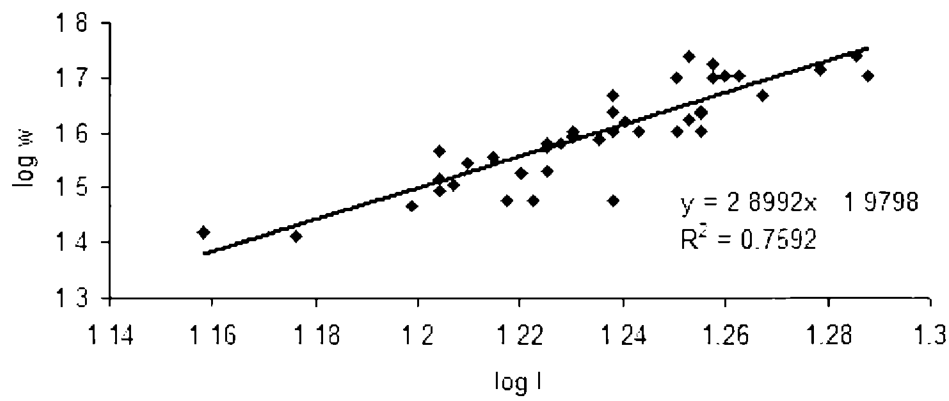



**Fig. 6.2 Length Weight Relationship of *Psenopsis cyanea* in 301-400m**

Females




Males

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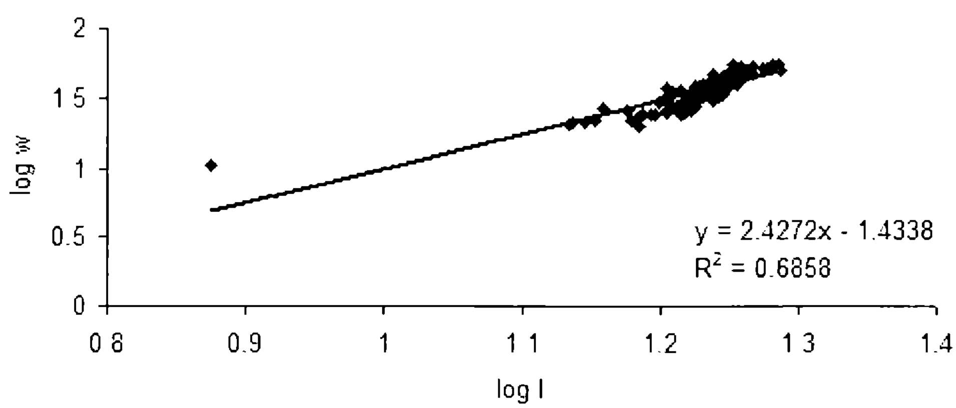
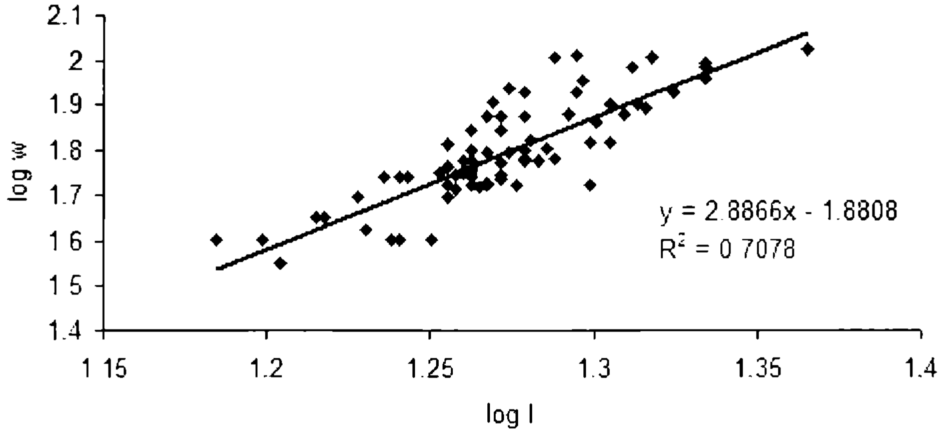
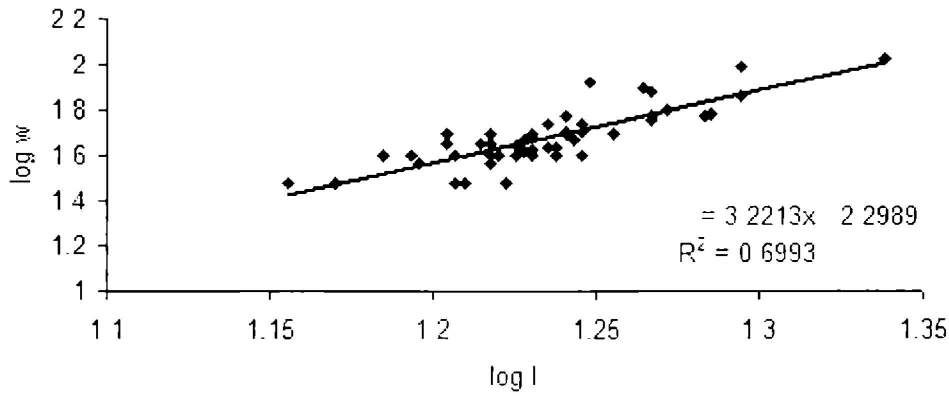



**Fig. 6.3 Length Weight Relationship of *Psenopsis cyanea* during pre monsoon**

**Females**




**Males**




**Pooled**

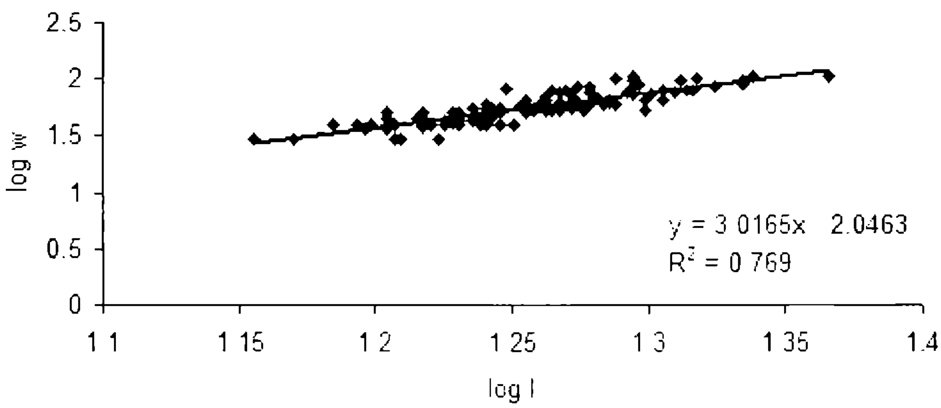
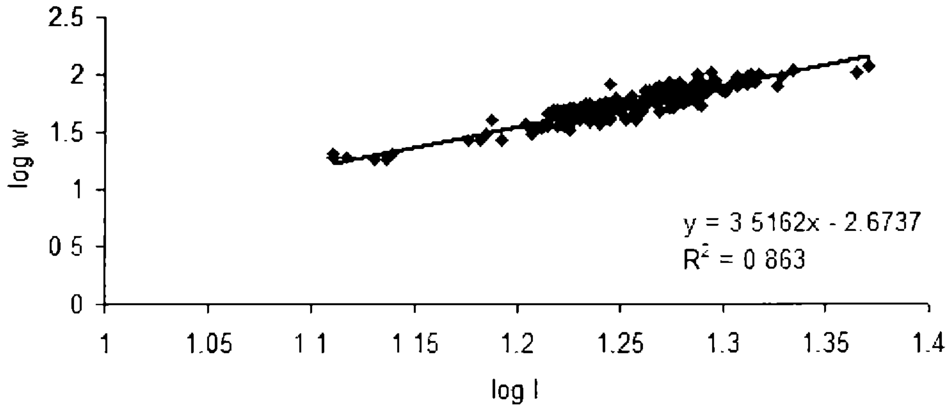
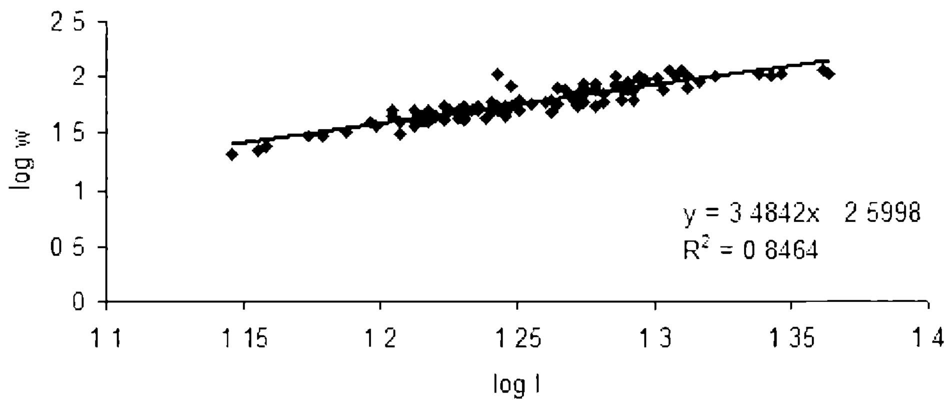



**Fig. 6.4 Length Weight Relationship of *Psenopsis cyanea* during monsoon**

**Females**




**Males**

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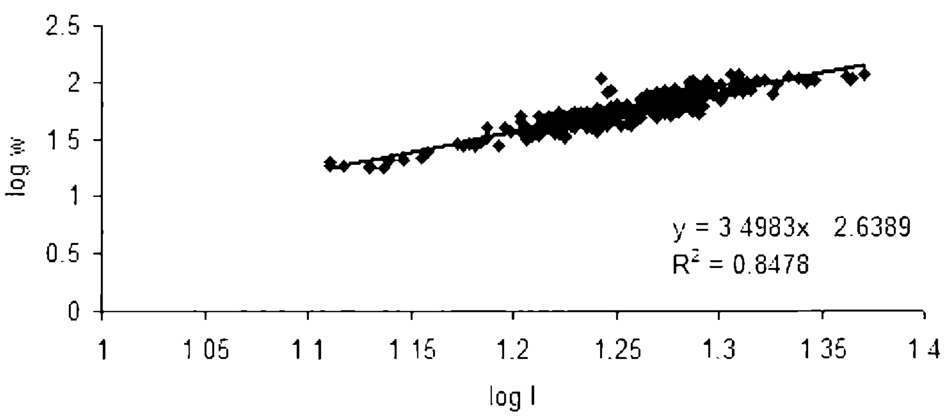
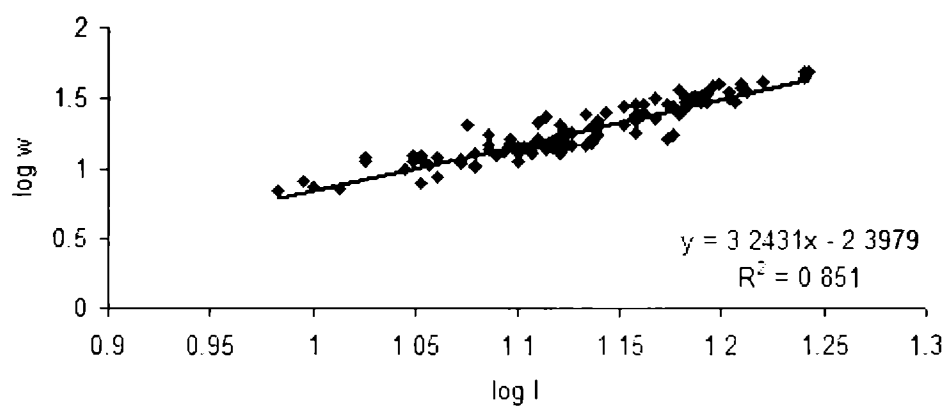



**Fig. 6.5 Length Weight Relationship of *Psenopsis cyanea* during post monsoon**

201-300 m




301-400 m

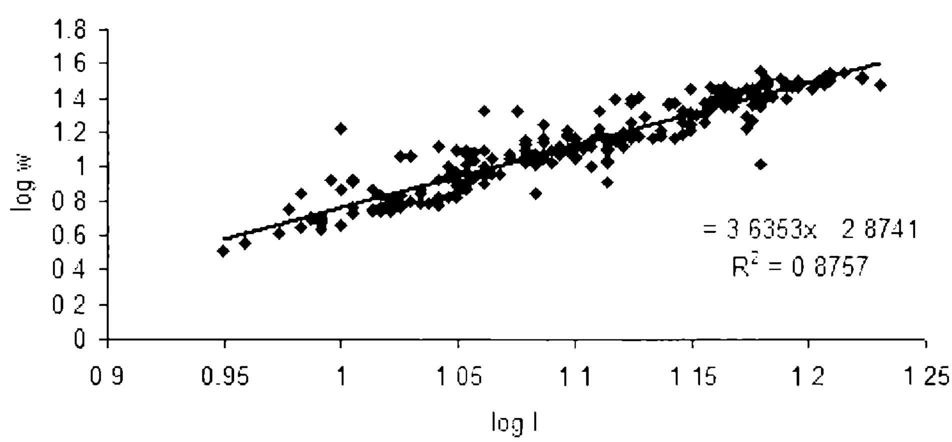
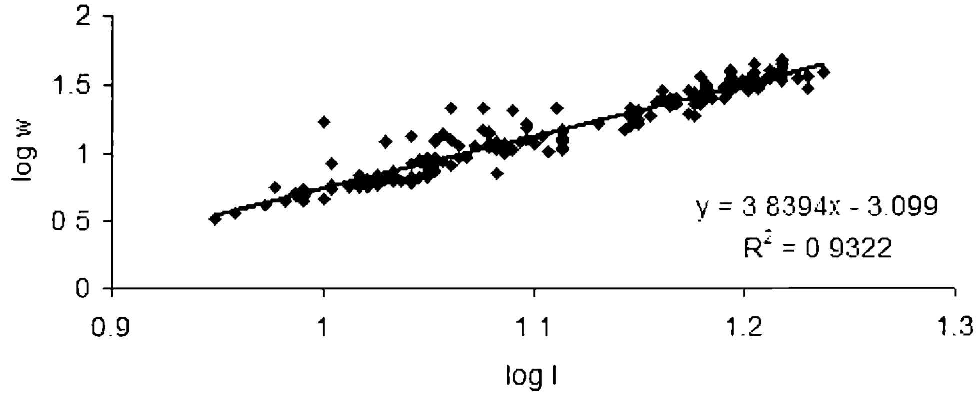
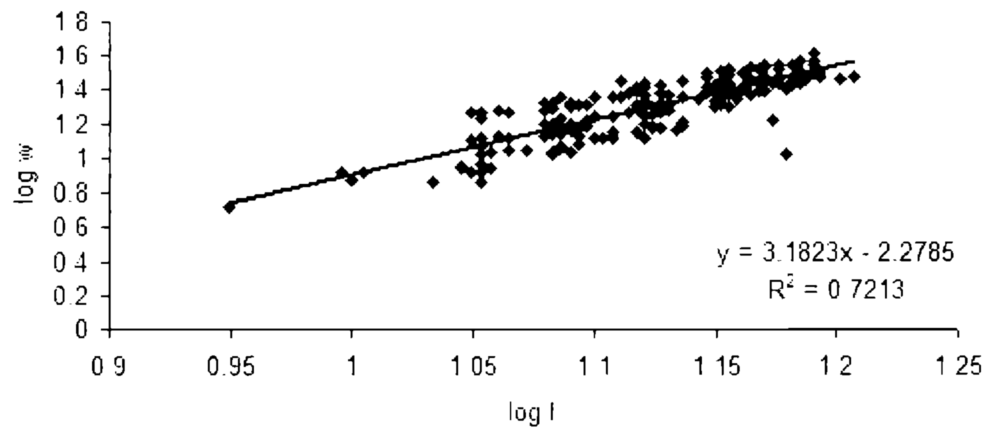



Fig. 6.6 Length Weight Relationship of *Chlorophthalmus bicornis* - depth wise

Premonsoon




Monsoon




Postmonsoon

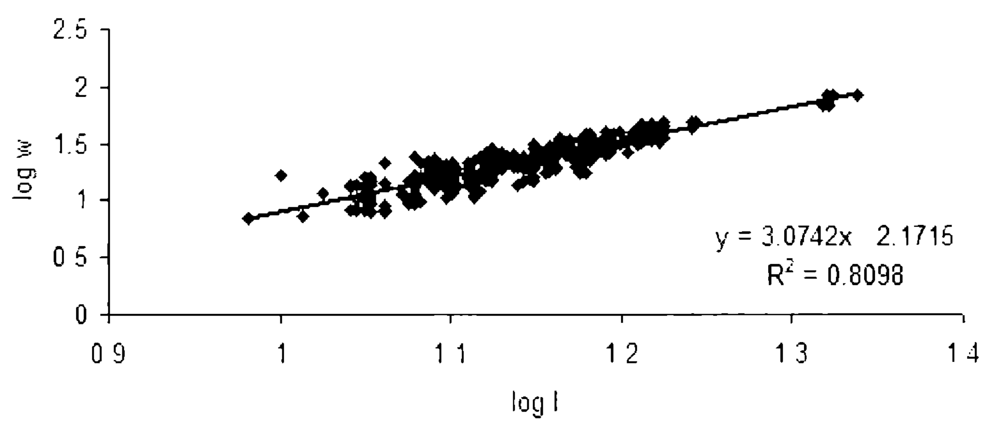
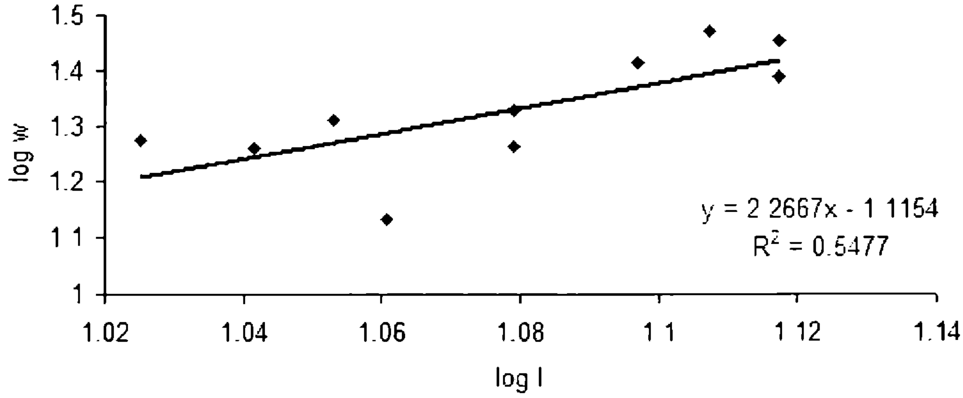
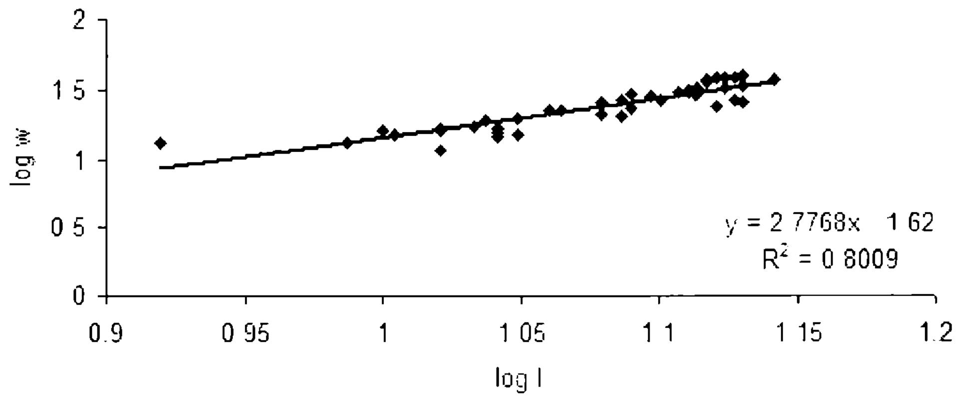



**Fig. 6.7 Length Weight Relationship of *Chlorophthalmus bicornis* - season wise**

**Females**




**Males**

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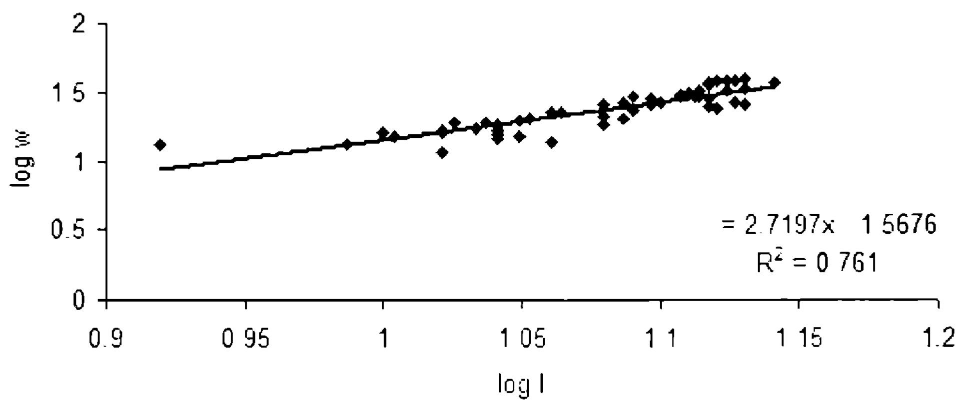
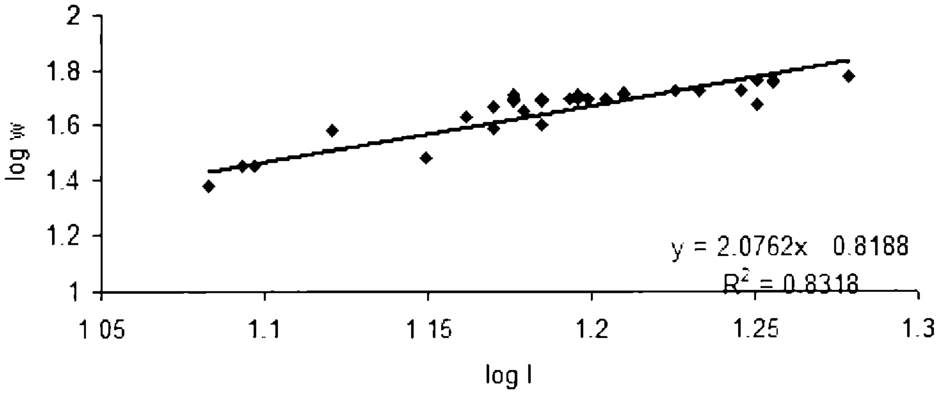
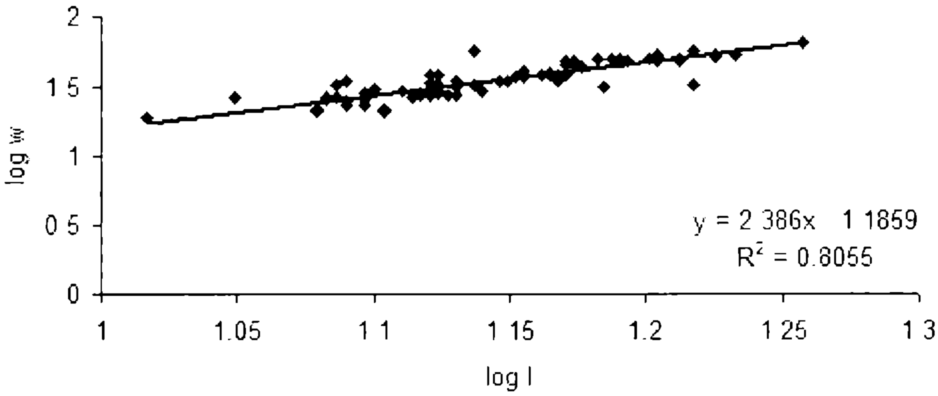



**Fig. 6.8 Length Weight Relationship of *Hoplostethus mediterraneus* in 201-300m**

Females




Males

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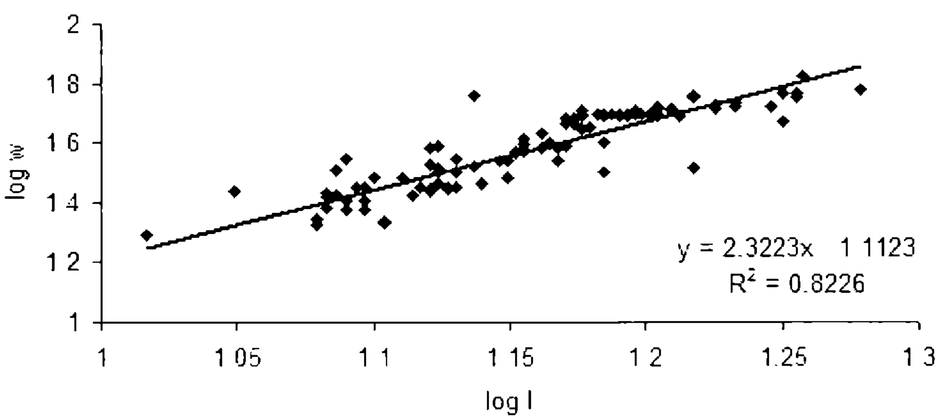



**Fig. 6.9 Length Weight Relationship of *Hoplostethus mediterraneus* in 301-400m**

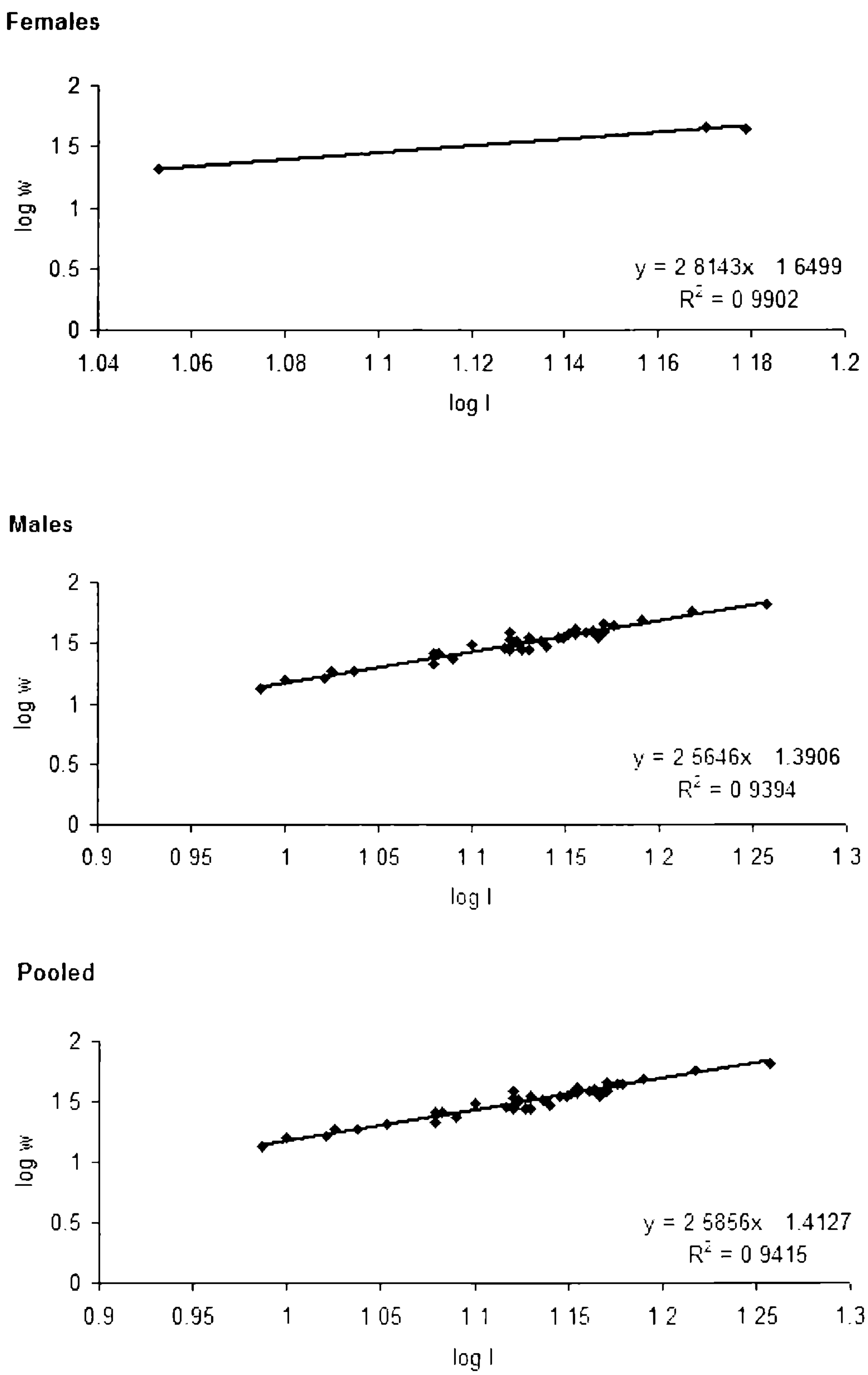



**Fig. 6.10 Length Weight Relationship of *Hoplostethus mediterraneus* in 501-600m**

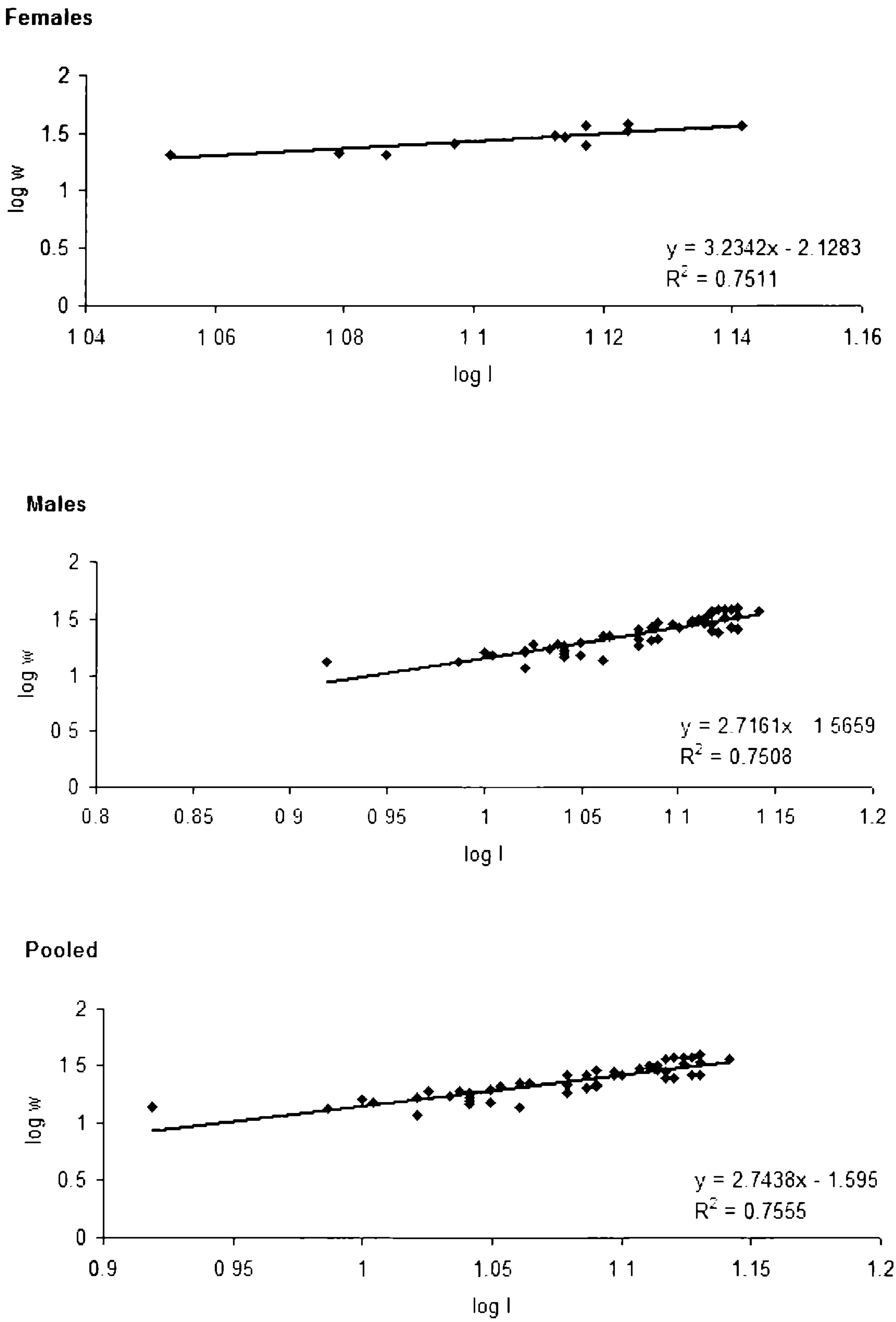
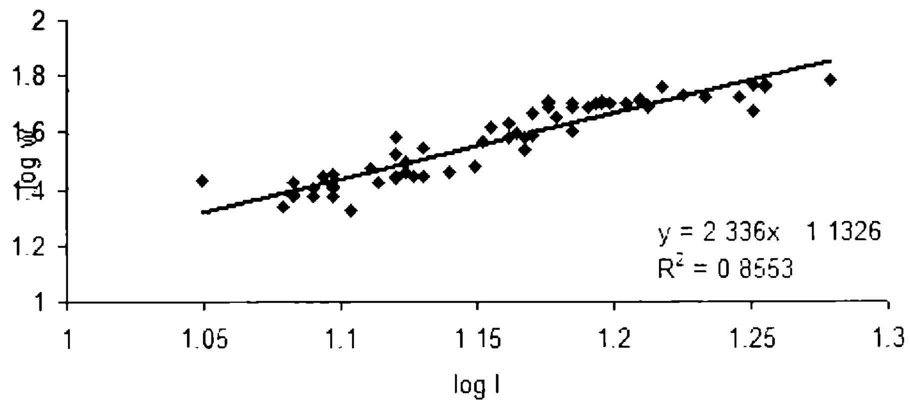
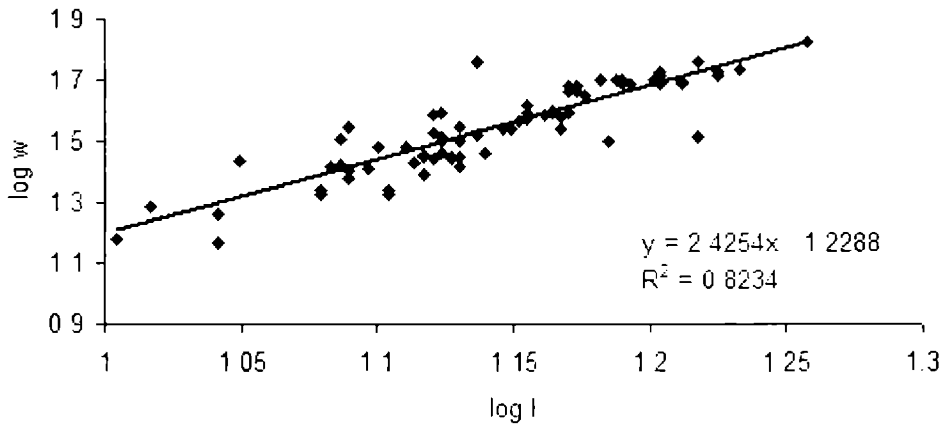



**Fig. 6.11 Length Weight Relationship of *Hoplostethus mediterraneus* during pre monsoon**

**Females**




**Males**




**Pooled**

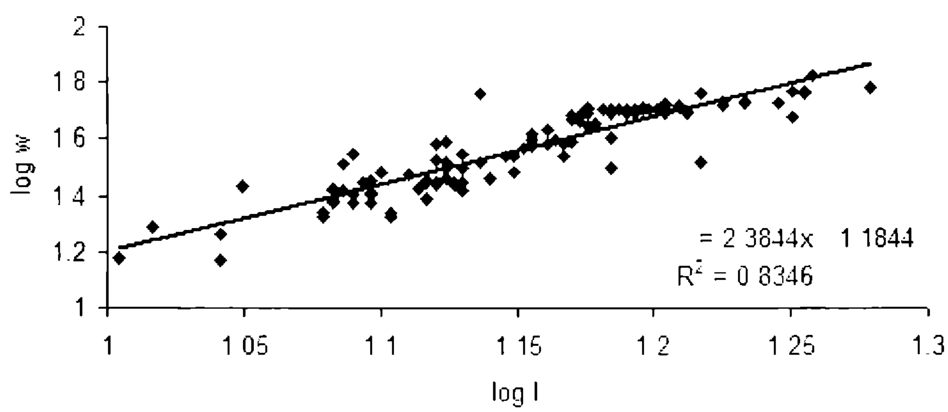
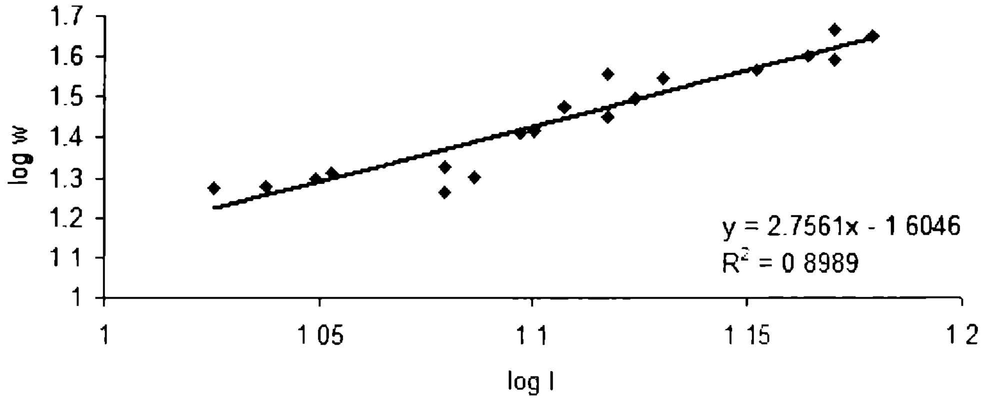
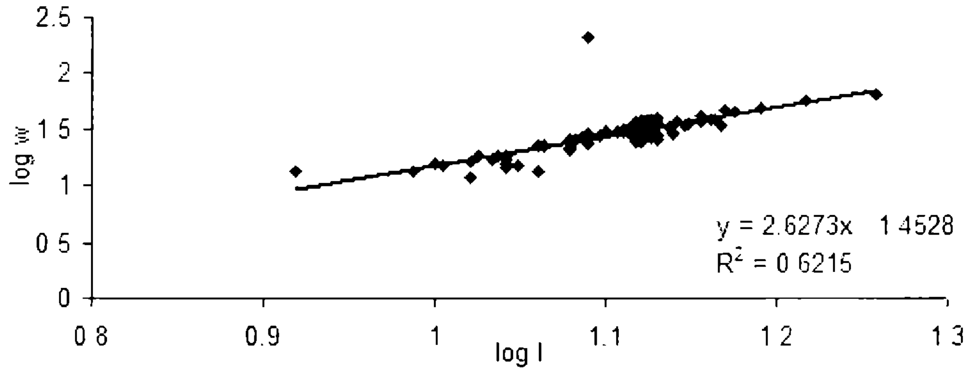



**Fig. 6.12 Length Weight Relationship of *Hoplostethus mediterraneus* during monsoon**

**Females**




**Males**

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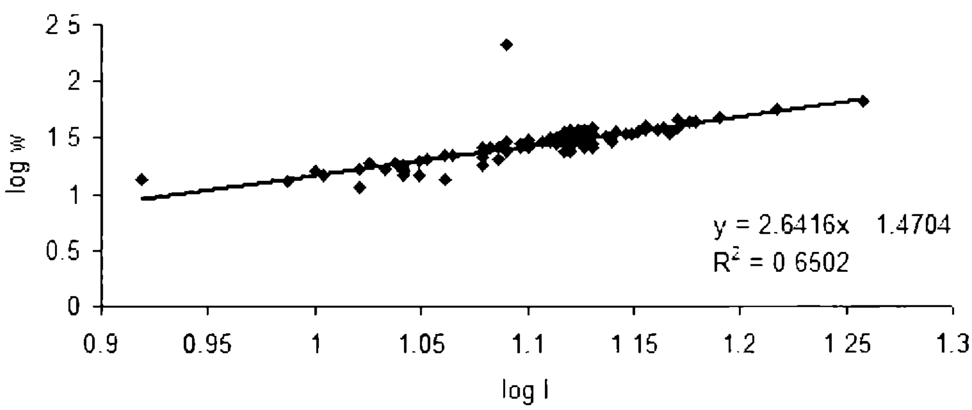
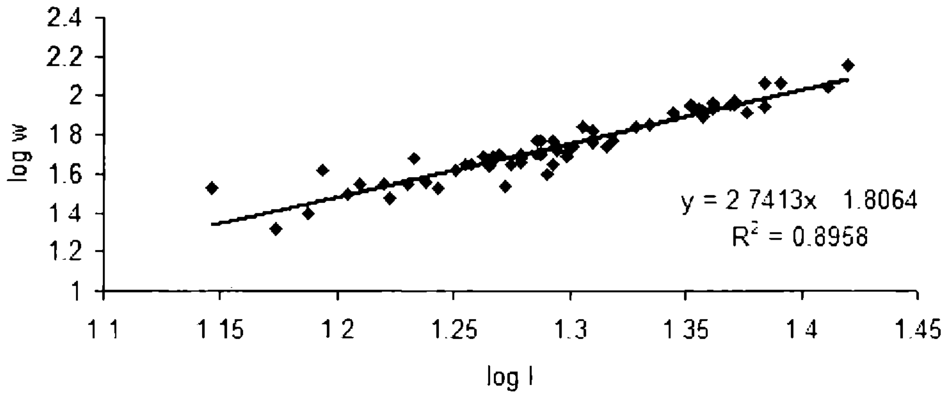
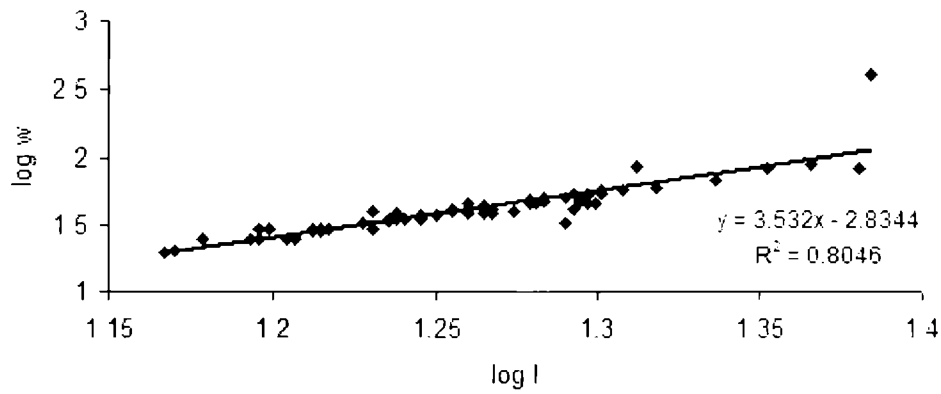



**Fig. 6.13 Length Weight Relationship of *Hoplostethus mediterraneus* during post monsoon**

Females




Males

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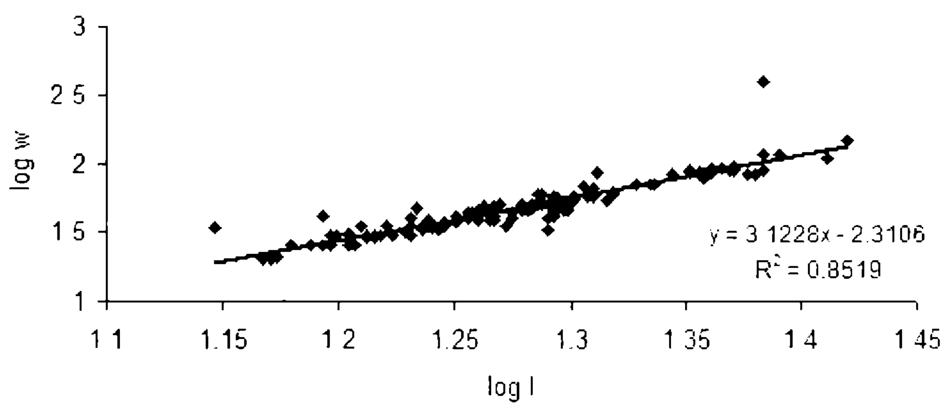
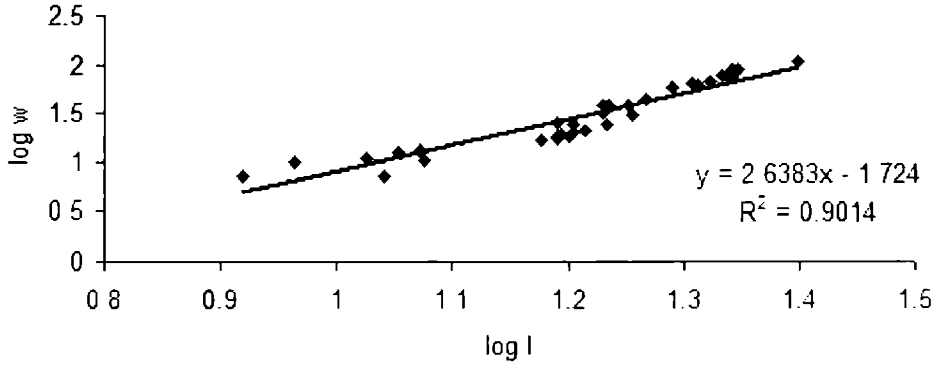
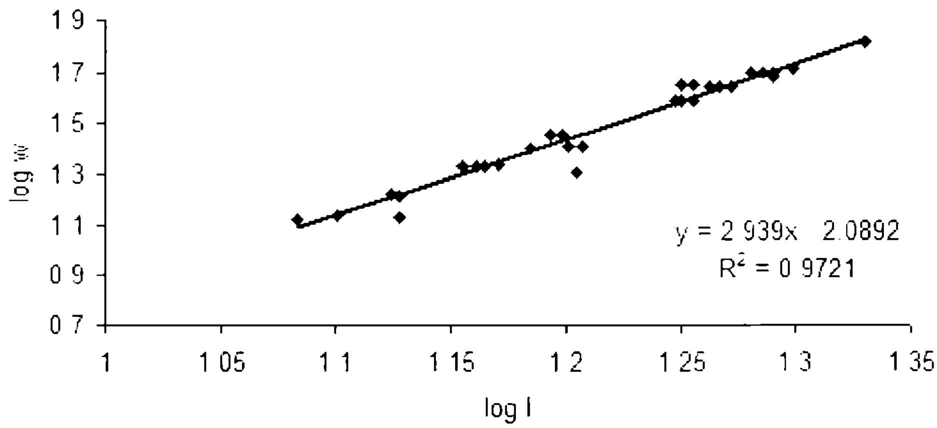



**Fig. 6.14 Length Weight Relationship of *Neoepinnla orientalis* in 201-300m**

**Females**




**Males**

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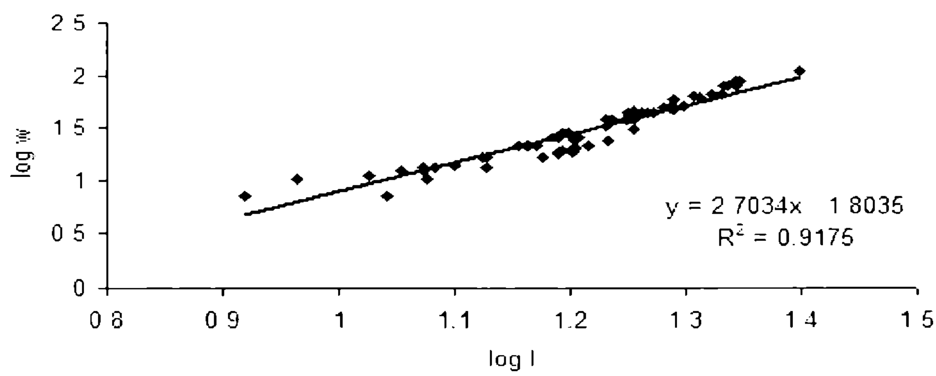
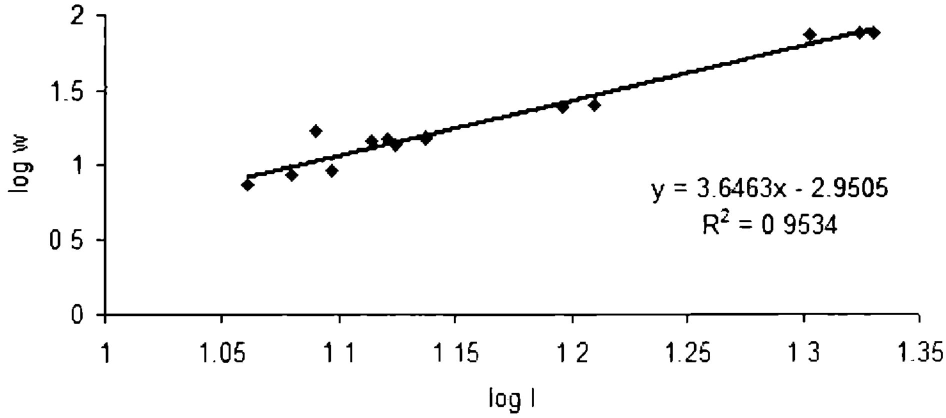
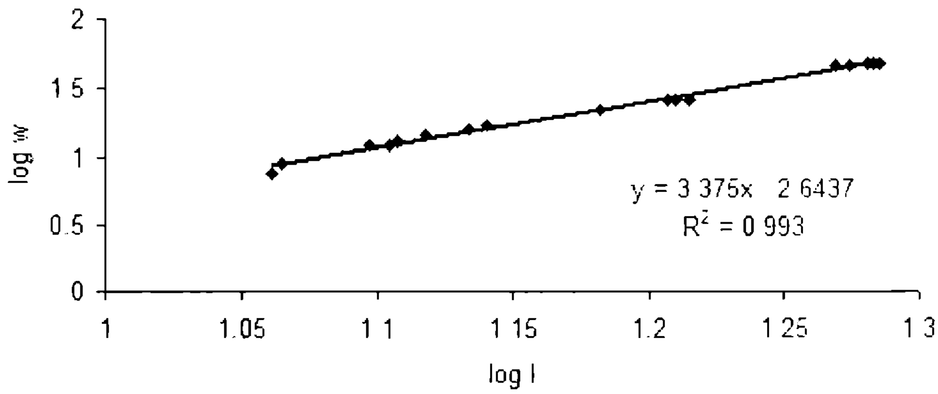



**Fig. 6.15 Length Weight Relationship of *Neoepinnla orientalis* in 301-400m**

**Females**




**Males**

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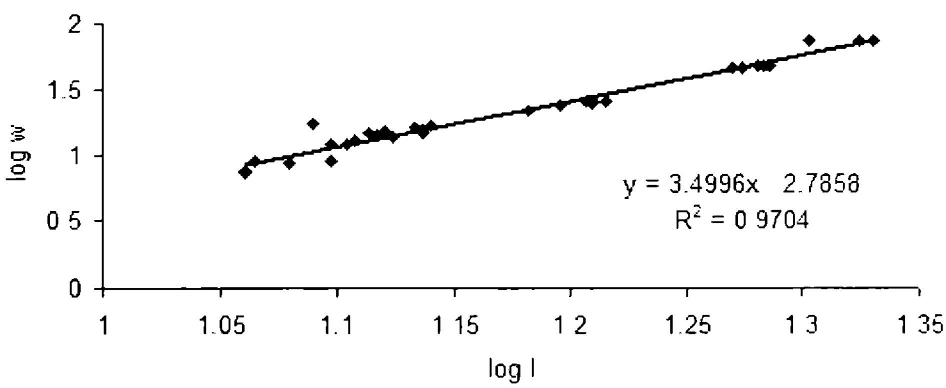



**Fig. 6.16 Length Weight Relationship of *Neoepinnula orientalis* in 401-500m**

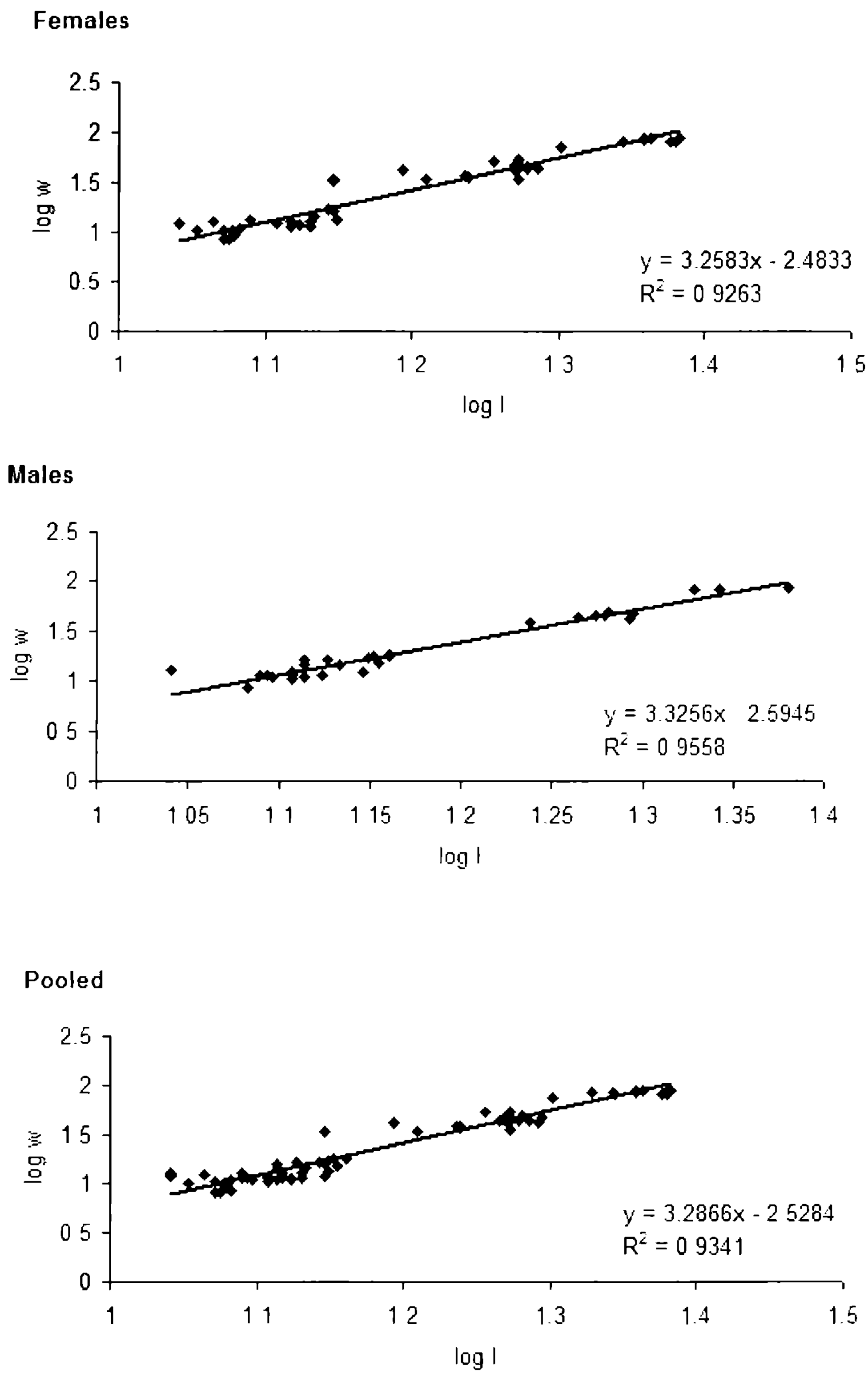
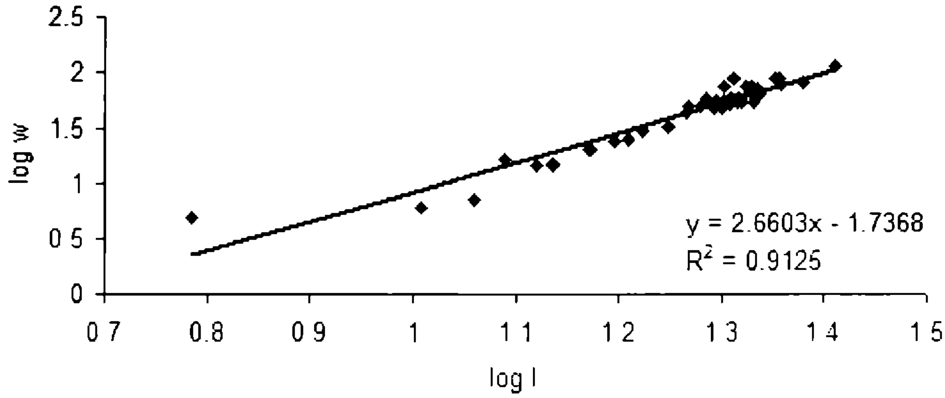
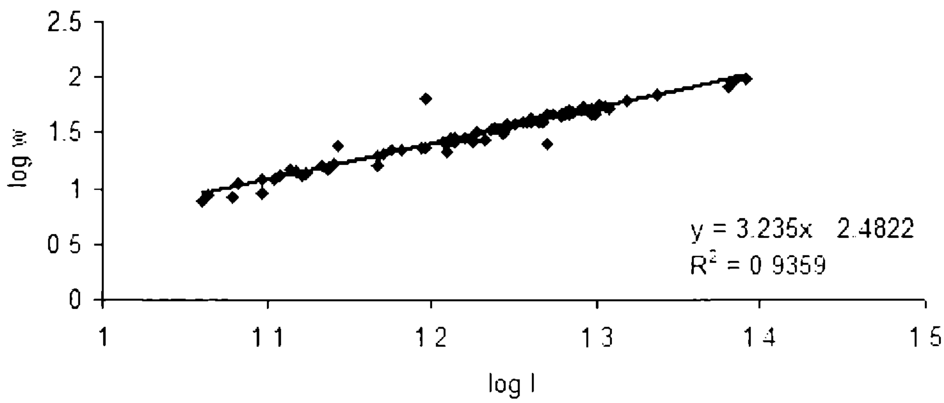



**Fig. 6.17 Length Weight Relationship of *Neoepinnula orientalis* during premonsoon**

**Females**




**Males**

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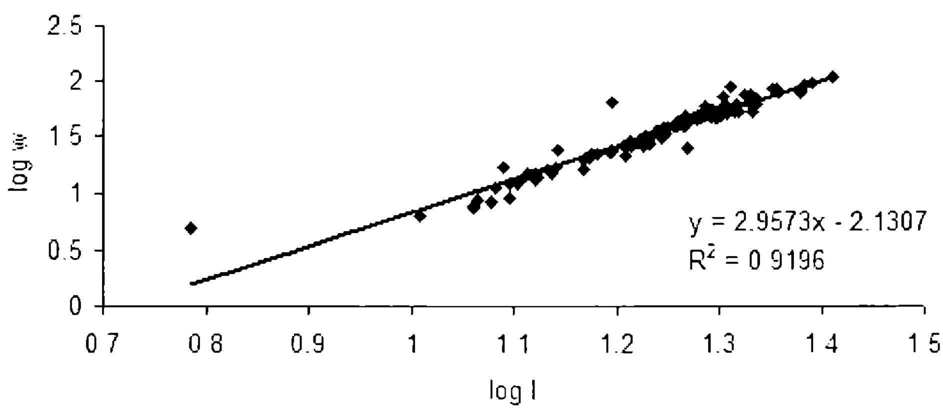



**Fig 6.18 Length Weight Relationship of *Neoepinnula orientalis* during monsoon**

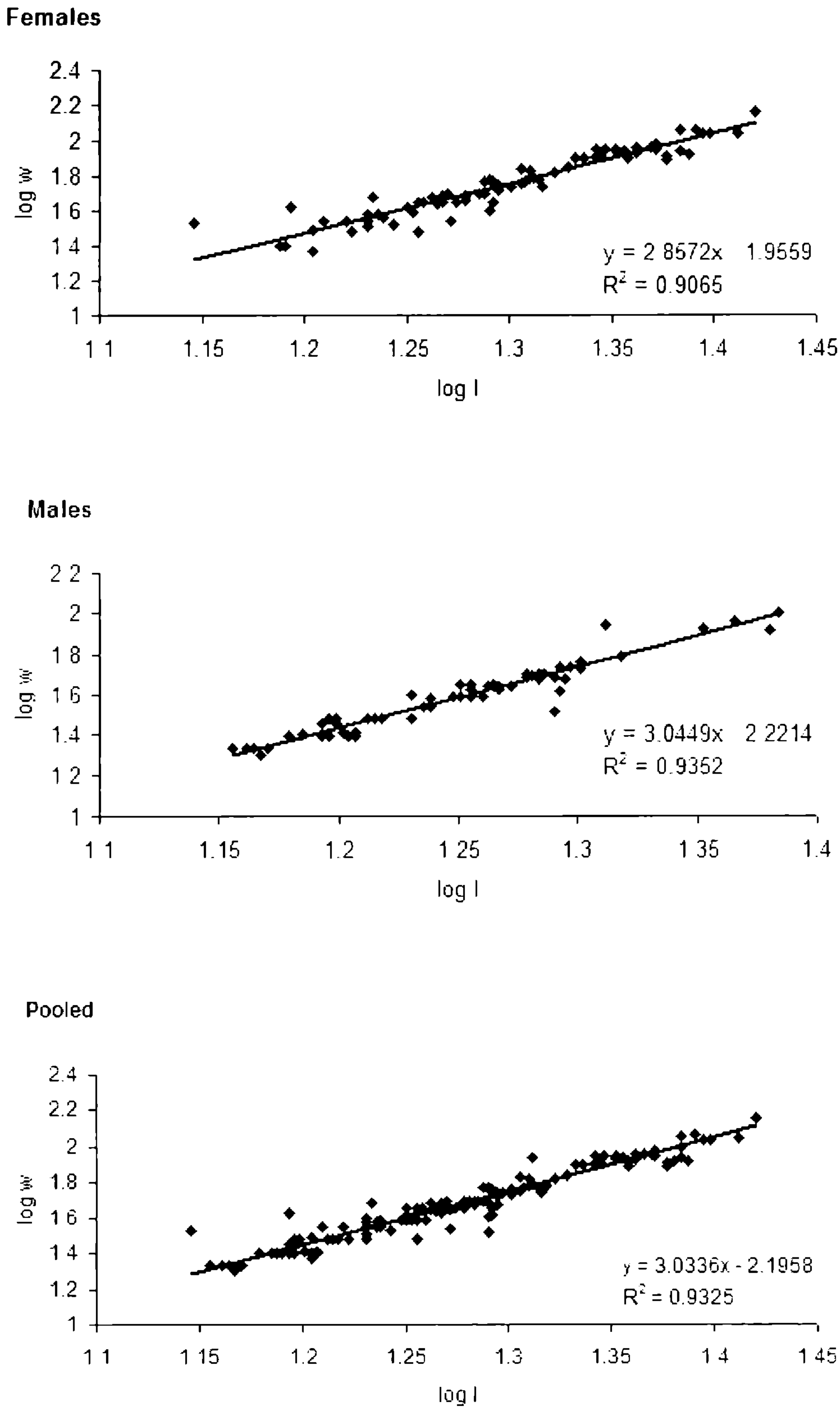
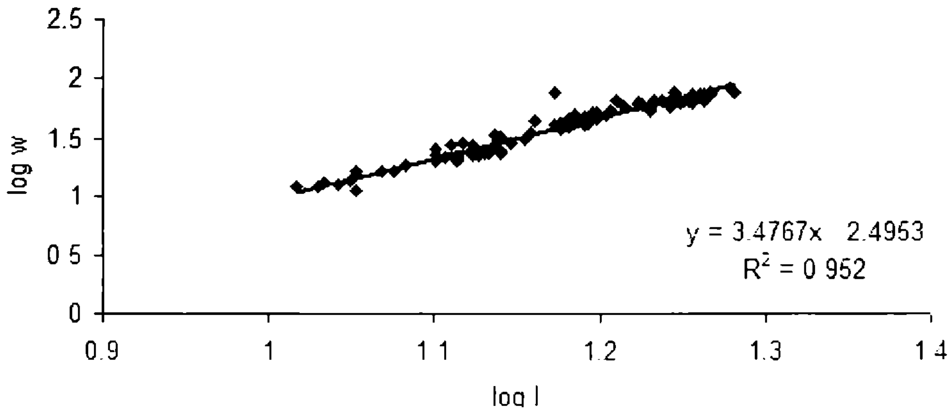
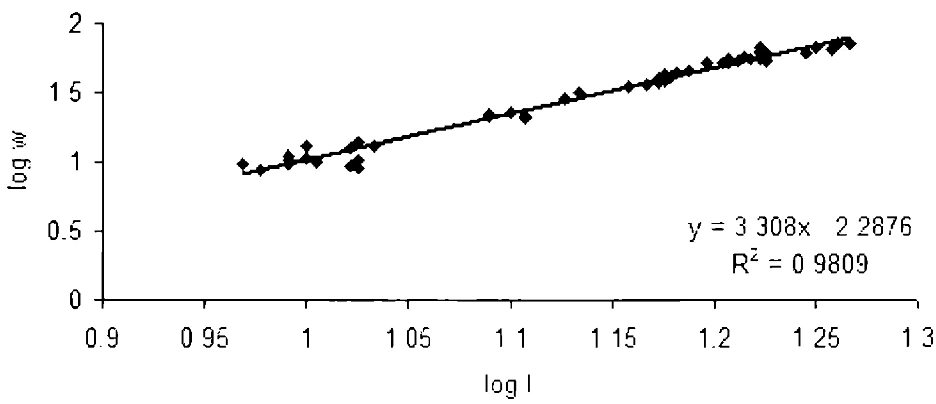



**Fig.6.19 Length Weight Relationship of *Neoepinnula orientalis* during postmonsoon**

**Females**




**Males**




**Pooled**

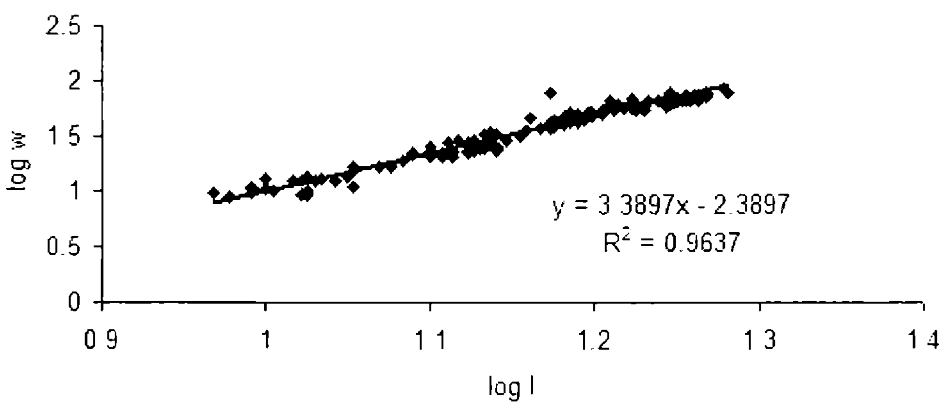



**Fig. 6.20 Length Weight Relationship of *Cubiceps squamiceps* in 201-300m**

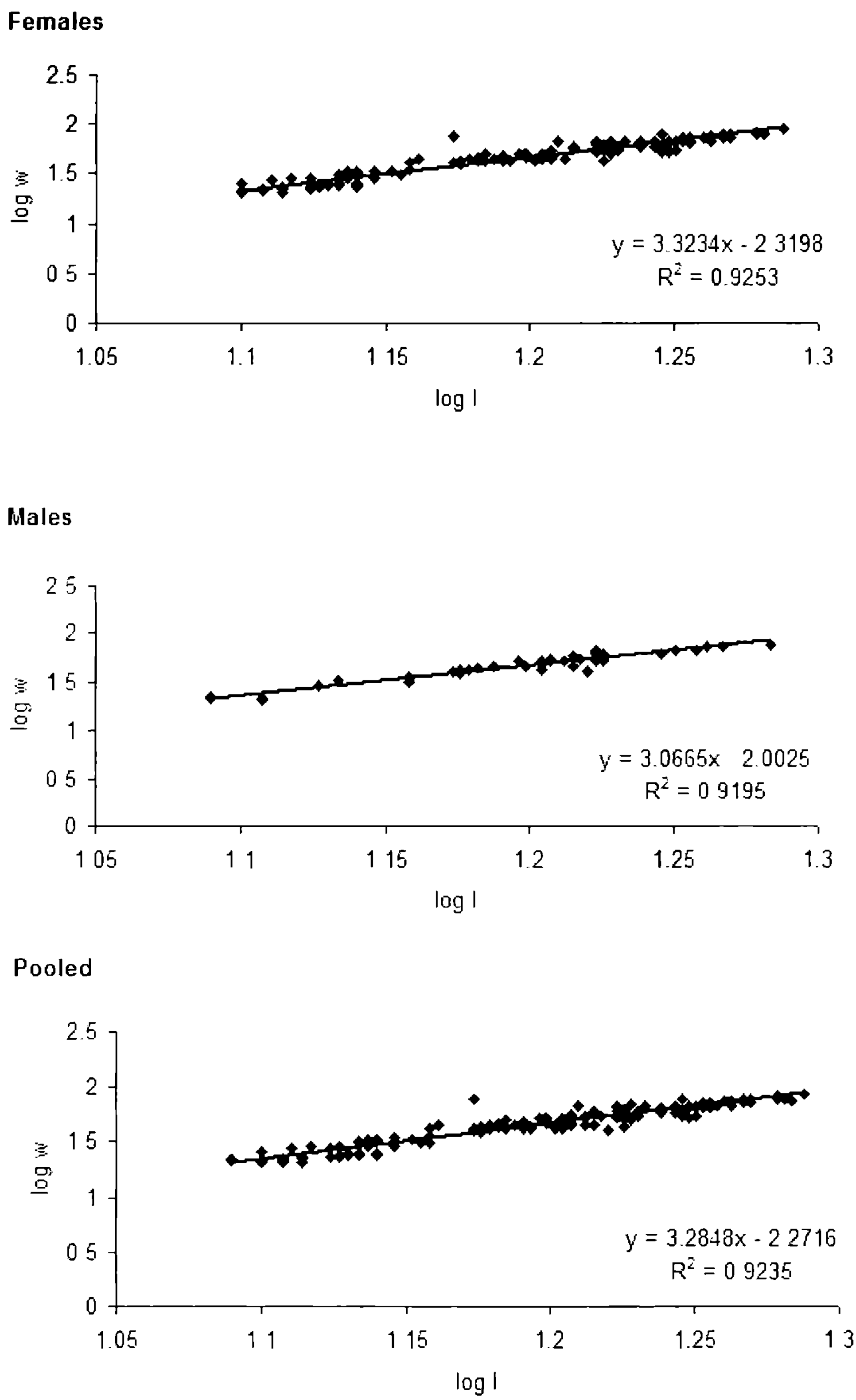
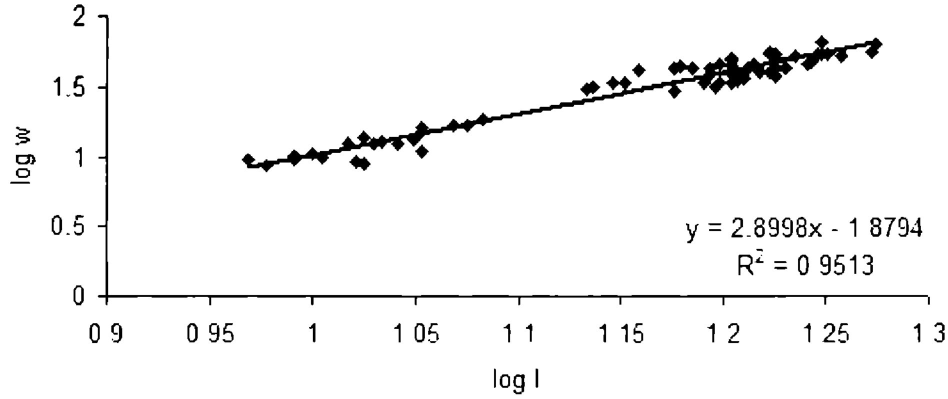
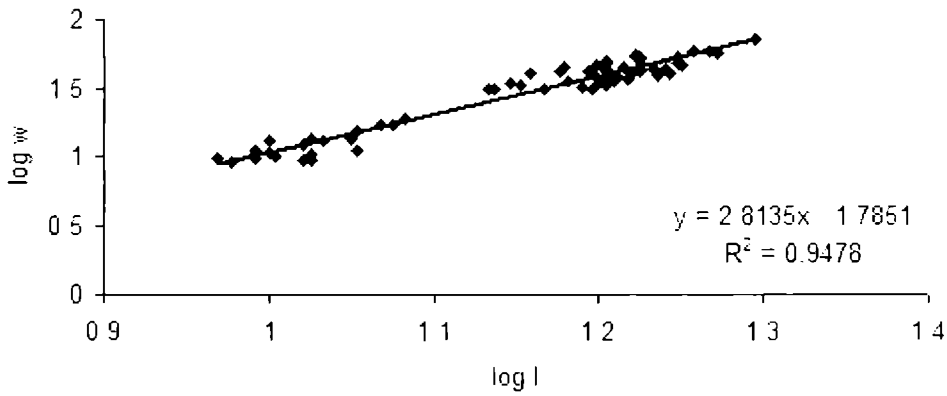



**Fig. 6.21 Length Weight Relationship of *Cubiceps squamiceps* in 301-400m**

**Females**




**Males**




**Pooled**

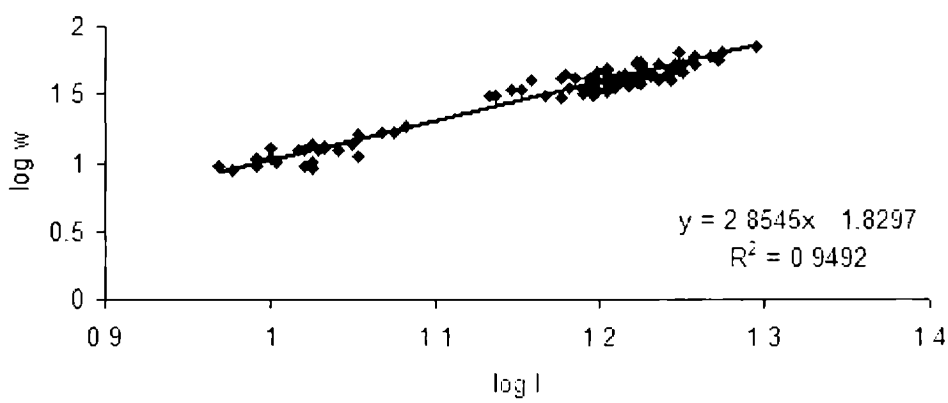
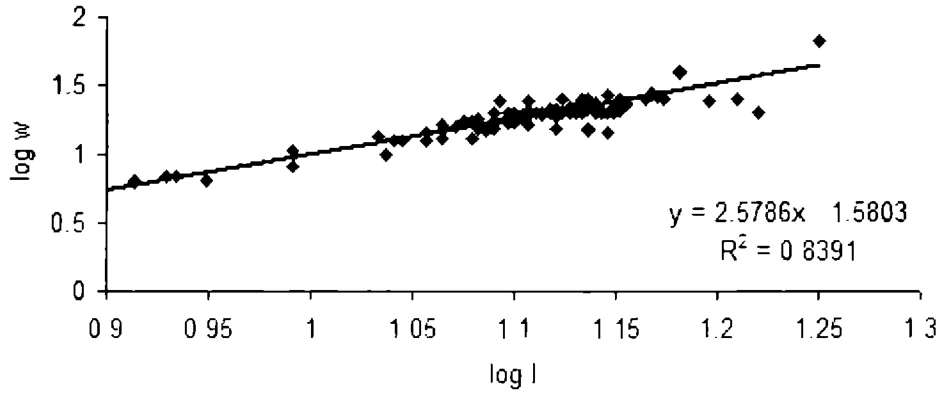
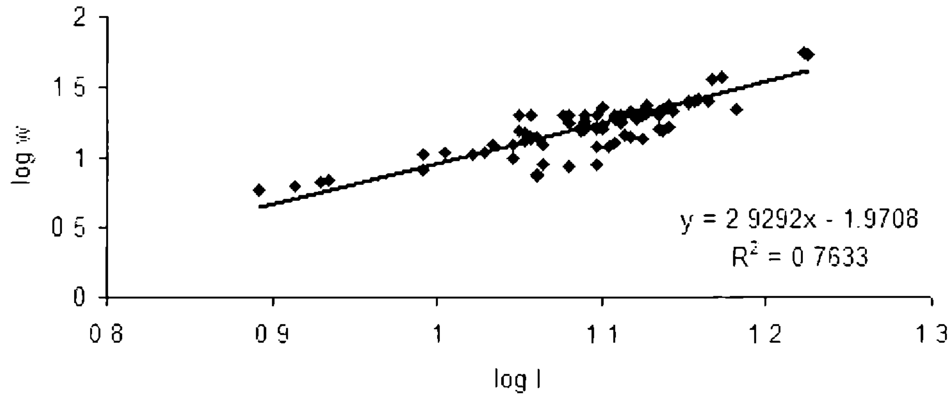



**Fig. 6.22 Length Weight Relationship of *Cubiceps squamiceps* during premonsoon**

Females




Males

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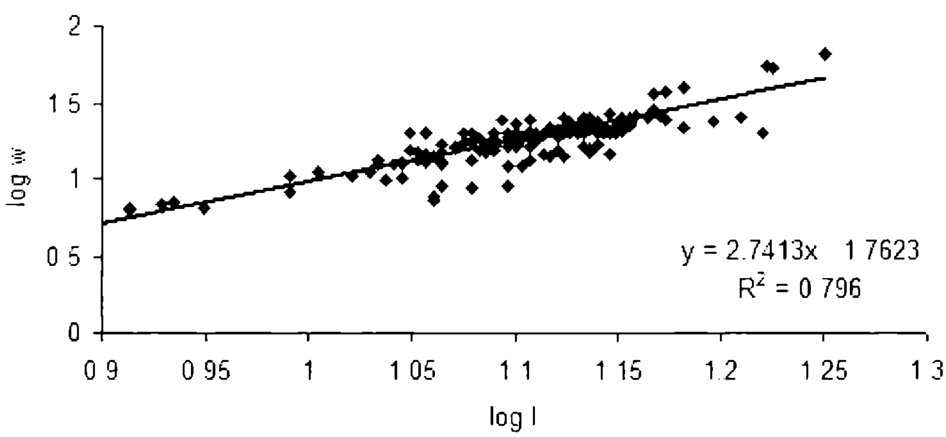
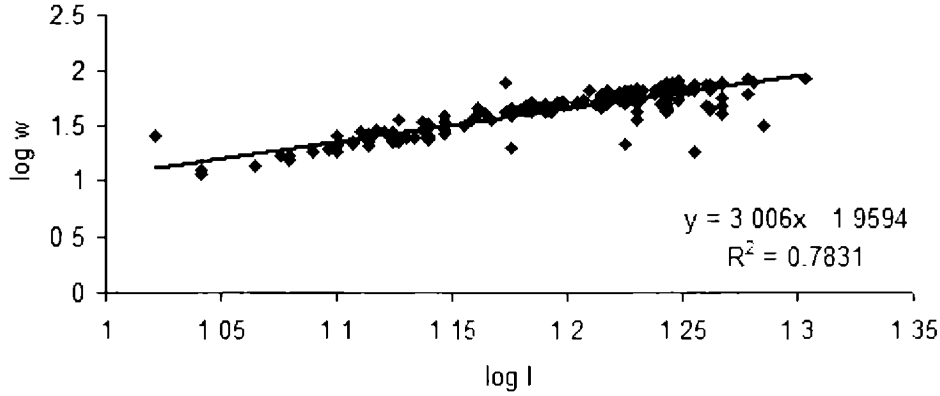
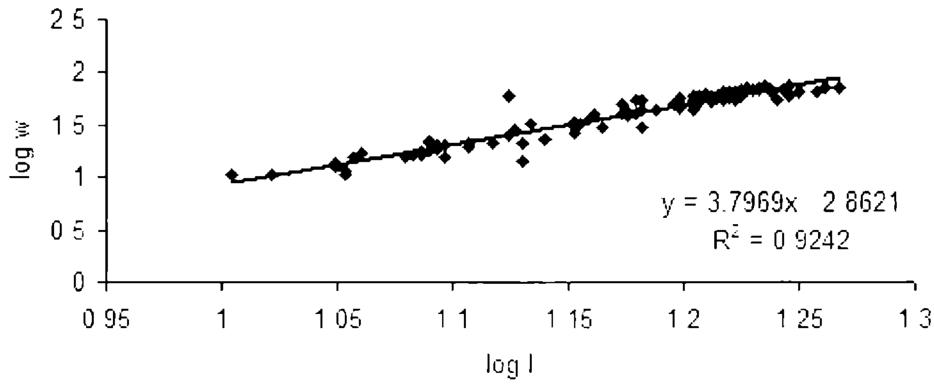



**Fig. 6.23 Length Weight Relationship of *Cubiceps squamiceps* during monsoon**

**Females**




**Males**

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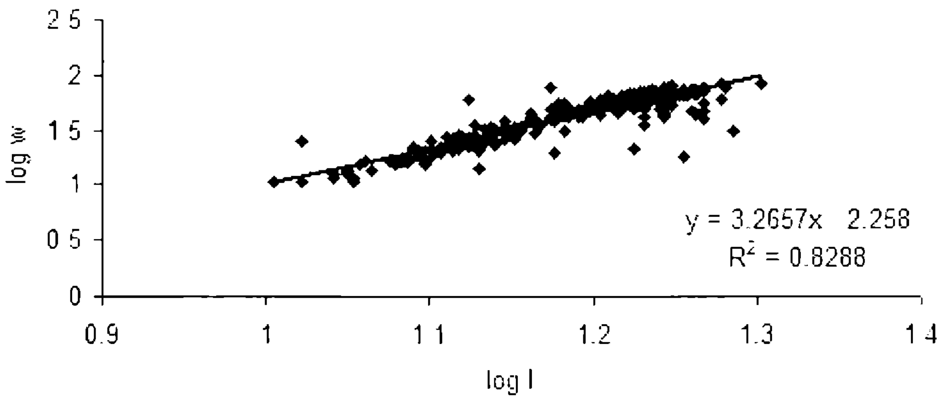



**Fig. 6.24 Length Weight Relationship of *Cubiceps squamiceps* during postmonsoon**

# CHAPTER 7

# AGE AND GROWTH

## 7.1 Introduction

The age and growth studies help in understanding the dynamics of fish populations. Most of the methods employed for assessing the state of exploited fish stock rely upon availability of age composition data (Ricker, 1957). Information on growth rate, natural and fishing mortality, age at maturity and spawning, age composition of the exploited population etc., can be evolved from age data of fish populations. Such information provide essential tools for scientific interpretation of the fluctuation in fish populations over space and time and also in formulating scientific and economic management policies for the fisheries in question (Seshappa, 1999).

Growth is an adaptive property, ensured by the unity of species and its environment (Nikolsky, 1963). It is dependent on many physical, chemical and biological factors. The habitat and its various biotic and abiotic factors will definitely affect a population's growth performance. The growth studies will allow a researcher to determine the amount of fish that can be produced with respect to time (Qasim, 1973) in a given specific habitat conditions. There are direct and indirect methods to study age and growth of fishes. The direct methods are those which include rearing of fishes under controlled conditions in captivity and study their growth increments through direct measurements or by employing mark and recapture methods on wild stock. The indirect methods include length frequency analysis and dissection of hard parts like scales, otoliths, vertebra from fishes and count the number of annual rings laid down on them. As the direct methods can be conducted only on those species which can be reared under laboratory conditions or those wild stocks which are easily accessible for a mark recapture method. The reading of annual rings of hard parts of the body can be effectively used only in temperate climates where the fluctuations are definite and annual. However, the fluctuations are seasonal and not extreme in tropical regions and thereby rings formed on hard parts may not represent annuli. Therefore, length frequency method has been widely accepted for studying age and growth in tropical fishes.

Many studies have been conducted on resource abundance and distribution deep sea fishes from Indian EEZ (Silas and Prasad, 1966; Nair and Appukuttan, 1972; Joseph, 1984; Philip *et al.* 1984; Oommen, 1985; James and Pillai, 1989; Sivakami, 1990; Panicker *et al.* 1993; Thomas *et al.* 2003; Venu and Kurup, 2002a; Jayaprakash *et al.*, 2006; Sreedhar *et al.* 2007). The life history traits of deep sea fishes were studied by Philip (1994), Muthiah (1994), Khan *et al.* (1996), Venu and Kurup (2002b), Venu and Kurup (2006 a&b), Kurup *et al.* (2005), Kurup and Venu (2006), Kurup *et al.* (2006). *Psenopsis cyanea, Chlorophthalmus bicornis, Hoplostethus mediterraneus, Neoepinnula orientalis* and *Cubiceps squamiceps* are some of the most abundantly occurring deep sea fishes in south- west coast of India. These fishes are found to have a wide distribution in the present study area. Data on their age structures are highly essential for their stock assessment and fisheries management. The studies dealing with age and growth of deep sea fish are scarce and usually incomplete (Bergstad, 1995; Allain and Lorance, 2000). In Indian waters, no studies have so far been conducted on the age and growth of deep sea fishes. Therefore, a pioneering attempt has been made to study the age and growth of *Psenopsis cyanea, Chlorophthalmus* *bicornis, Hoplostethus mediterraneus, Neoepinnula orientalis* and *Cubiceps squamiceps* of south west coast of India using their length frequency data.

**7.2 Materials and Methods**

The samples were collected as given in Chapter 2 (Materials and Methods). Length frequency data were taken only from latitude 7°–9°N and the depth range 201-500m so as to facilitate comparison of results spatially and bathymetrically. The length frequency distribution of *Psenopsis cyanea, Chlorophthalmus bicornis, Hoplostethus mediterraneus, Neoepinnula orientalis* and *Cubiceps squamiceps* were worked out by sorting the data at 10 mm class intervals. Total length of fishes were measured to the nearest milli meter from tip of snout to tip of caudal fin. The growth was described using von Bertalanffy growth formula (von Bertalanffy, 1938) using the pooled length frequency data from both sexes due to inadequate number of samples.

$$L\,(_t) = L_\alpha\,[1-e^{-k\,(t-t_0)}]$$ (Bertalanffy 1960)

Where

$L\,(_t)$ = length at age t

$L_\alpha$ = Asymptotic length or the maximum attainable length if the organism is allowed to grow

K = Growth coefficient

$t_0$ = Age at which length equals 0, i.e. the theoretical age at zero length

The growth parameters were estimated using the ELEFAN 1 programme in FISAT software (Gayanilo and Pauly, 1997). The estimate of $t_0$ was worked out using von Bertalanffy (1934) plot in which the results of the regression of –ln (1-Lt/L) against t was used to calculate $t_0$ following the empirical equation

$$t_0 = -a/b$$

The life expectancy was estimated using the equation

$t_{max} = 3/K$ (Pauly, 1983).

Growth performance was worked out by Munro's PHI prime index, $\phi$ (Munro and Pauly, 1983) which was computed by the equation:

$$\phi = \log_{10} K + 2 \log_{10} L_\alpha$$

**7.3 Results**

**7.3.1. *Psenopsis cyanea***

Length measurements from 1001 numbers of *P. cyanea* were recorded during 1999 to 2002. The lowest and highest length measurements taken were 112mm and 246mm respectively. The modal length was worked out to be 175mm. The growth parameters estimated in pooled population using ELEFAN 1 program are given in Table 1. Growth equation for the species based on the growth parameters arrived at can be expressed as follows:

$$L_t = 265\ [1 - \exp^{-0.84\ (t+0.4140)}]$$

The reconstructed length frequency data with super imposed growth curve fitted at highest levels of Rn values in the response surface is shown in Fig. 1. The growth performance in terms of length following Pauly and Munro (1984) was found to be 4.77 The life span of *P. cyanea* estimated using the equation $t_{max}$ = 3/K (Pauly, 1983) was found to 3.57 years. The lengths attained following VBGF equation at the end of I,II, III and IV years were estimated at 184mm, 230mm, 250mm and 258mm respectively (Table.2).

### 7.3.2. *Chlorophthalmus bicornis*

Length measurements from 558 numbers of *C. bicornis* in the length range 87 – 217 mm were recorded during 1999 to 2002. The modal length was worked out to be 145mm. The growth parameters estimated in pooled population using ELEFAN 1 program are given in Table 1. Growth equation for the species based on the growth parameters arrived at can be expressed as follows:

$$L_t = 226\ [1 - \exp^{-0.35\ (t+0.3724)}]$$

The reconstructed length frequency data with super imposed growth curve fitted at highest levels of Rn values in the response surface is shown in Fig. 1. The growth performance in terms of length following Pauly and Munro (1984) was found to be 4.25 The life span estimated using the equation $t_{max}$ = 3/K (Pauly, 1983) was found to be 8.57 years. The lengths attained by *C.*

*bicornis* following VBGF equation at the end of I,II, III, IV and V years were estimated at 86, 127, 157, 177 and 192mm respectively (Table.2).

### 7.3.2. Age and growth of *Hoplostethus mediterraneus*

Length measurements of 496 numbers of *H. mediterraneus* in the length range 83 – 198 mm were recorded during 1999 to 2002. The modal length was worked out to be 135mm. The growth parameters estimated in pooled population using ELEFAN 1 program are given in Table 1. Growth equation for the species based on the growth parameters arrived at can be expressed as follows:

$$L_t = 232\ [1 - \exp^{-0.43\ (t+0.3784)}]$$

The reconstructed length frequency data with super imposed growth curve fitted at highest levels of Rn values in the response surface is shown in Fig. 1 The growth performance in terms of length following Pauly and Munro (1984) was found to be 4.36 The life span of *H. mediterraneus* estimated using the equation $t_{max}$ = 3/K (Pauly, 1983) was found to be 6.98 years. The lengths attained following VBGF equation are 104 149, 178, 197 and 209mm at the end of I, II, III, IV and V years respectively (Table.2).

### 7.3.2. *Neoepinnula orientalis*

Length measurements from 578 numbers of *N. orientalis* in the length range 116 – 263 mm were recorded during 1999 to 2002. The modal length was worked out to be 195mm. The growth parameters estimated in pooled population using ELEFAN 1 program are given in Table 1. Growth equation for the species based on the growth parameters arrived at can be expressed as follows:

$$L_t = 293\ [1 - \exp^{-0.44\ (t+0.4426)}]$$

The reconstructed length frequency data with super imposed growth curve fitted at highest levels of Rn values in the response surface is shown in Fig. 1. The growth performance of in terms of length following Pauly and Munro (1984) was found to be 4.58 The life span estimated using the equation $t_{max}$ = 3/K (Pauly, 1983) was found to be 6.82 years. The lengths attained by *N. orientalis* following VBGF equation are 138, 193, 229, 252, 266, 276 and 281mm at the end of I,II, III, IV, V, VI and VII years respectively (Table.2).

### 7.3.2. *Cubiceps squamiceps*

Length measurements of 769 specimens of *C. squamiceps* in the length rang 74 – 203 mm were recorded during 1999 to 2002. The modal length was worked out to be 135mm. The growth parameters estimated in pooled population using ELEFAN 1 program are given in Table 1. Growth equation for the species based on the growth parameters arrived at can be expressed as follows:

$$L_t = 216\ [1 - \exp^{-0.45\ (t+0.3614)}]$$

The reconstructed length frequency data with super imposed growth curve fitted at highest levels of Rn values in the response surface is shown in Fig. 1. The growth performance In terms of length following Pauly and Munro (1984) was found to be 4.32. The life span of *C. squamiceps* estimated using the equation $t_{max}$ = 3/K (Pauly, 1983) was found to be 6.67 years. The lengths attained following VBGF equation are 99, 141,168,186 and 197mm at the end of I,II, III, IV, V and VI years respectively (Table 2).

**7.4 Discussion**

Among the five species of deep sea fish studied, *P, cyanea* is short lived with a life expectancy of 3.54 years. Most of the shallow water demersal fish species have longevity of about 3-6 years (Rao, 1966). Venu and Kurup (2002c) reported that *P. cyanea* has a wider range of vertical distribution of 60–448m depth in the southwest coast of Indian EEZ between the latitudes 7° and 9° N latitude. The results of the study revealed that *P. cyanea* has a higher growth performance when compared to other species with the growth performance index 4.77 This species registered a highest growth increment of 184 mm in the first year when compared to all other species. During the second year also it showed a high growth increment (46 mm) which was slightly lower only to *N. orientalis* (55 mm). This is justified by the high k of 0.84 computed for *P. cyanea* which is high when compared to other species. Physico-chemical parameters in the habitats and food availability can directly affect fish growth by influencing the physiology of the fish (Weatherly and Gill, 1987). The lower depths are known for the high productivity rates, higher population density, species diversity etc. These factors in turn facilitate the high growth rate of the species inhabiting these habitats. In the shallow water species the initial growth increments are higher owing to the high favourable biotic and abiotic factors. The results of the maturity and spawning studies revealed that the recruitment takes place during monsoon (Chapter 5). Venu and Kurup (2002b) recorded a catch of 2270 kg of juveniles got entrapped in the trawl net during the monsoon period at a depth of 76 m with a very high catch rate of 801.98 kg/hr. The monsoon period of southwest coast of India is famous for its upwelling and related high productivity in the coastal region. According to Muni (2009), the upwelling process has maximum intensity from June to September, with the coastal upwelling index varying from 20 to 260 $m^3/s$ per 100 m of coastline. The results of depth wise length weight relationship of *P. cyanea* have revealed that the species has a positive allometry in the shallower depth zone 201-300m (Chapter 6). The season wise analysis of length weight relationship has shown allometric growth during the postmonsoon season (Table 6.2). The results of food and feeding also revealed high feeding intensity for *P. cyanea* during the postmonsoon season (Refer Chapter 4).

The growth performance of *C. bicornis* was the lowest among the all other species analysed in the present study. The growth performance of deep sea fishes is considerably low when compared to the coastal species (Koslow *et al.* 1997). High-density pockets of *C. bicornis* were reported along the latitude 8° and 9° N latitude at depth ranges of 301-400m and 201-300m (Sivakami *et al.*, 1998; Kurup *et al.* 2005). Iglesias and Morales-Nin (2001) reported very low growth performance for the Mediterranean deep sea fishes. The life expectancy of *C. bicornis* was found to be 9 years, which is the highest observed among the five species studied. *H. mediterraneus*, *N.*

*orientalis* and *C. squamiceps* were found to live till an age of 7 years, while *P. cyanea* the maximum age is 4 years. It may be seen that in larger sized species, growth rate tends to slow down and life expectancy is very high when compared to the small sized ones (Pauly, 1984). Since all the five species examined during the present study were of small size, it is expected that the life expectancy also will be less. In the deep water species *Coryphaenoides rupestris,* the age estimates were ranged between 5 and 72 years by various researchers (Dank, 1987; Bergstad, 1990; Dragnik *et al* 1998; Koslow *et al.* 2000).

In this study, the growth increments of *C. bicornis* was found to be the lowest compared to the other species, it attains only upto a length of 86mm at the end of the first year and 127 mm at the end of second year with an increment of 41 mm which is the lowest among the five species studied. The spawning of *C. bicornis* occurs during the late premonsoon and continues till end of monsoon and the juveniles were found during the postmonsoon period (Refer Chapter 5). During this season, the growth was found to be more or less isometric (Refer Chapter 6) and the feeding was found to be moderate (Refer Chapter 4). The slow growth rate and long life expectancy is further substantiated by the low K value obtained for the species in the present study. The depth wise length weight relationship of *C. bicornis* did not found any influence of depth in the growth pattern of this species, but showed positive allometry in general.

The other three species studied viz. *H. mediterraneus, N. orientalis* and *C. squamiceps* have all the general features of typical deep sea fish. They are characterised by low growth performance, low K value and high life expectancy.

Venu and Kurup (2006a) reported that *H. mediterraneus* is distributed in the depth range 280–682m from the 7° to 14° N of Indian EEZ. Pais (2002) has also reported similar results from south coast of Portugal. *Hoplostethus mediterraneus* attains a maximum size of 42 cm and is a shallower living species, ages of 10 to 11 years have been reported and the fecundity ranges from 4000 to 100,000. Venu and Kurup (2006a) reported that the spawning season of *H. mediterraneus* coincided with monsoon season and thus the new recruits are available during the late monsoon and in the postmonsoon seasons. The feeding intensity of the species was found to be higher during the monsoon and postmonsoon when compared to the premonsoon (Refer Chapter 4). Whereas, *Hoplostethus atlanticus* is a very long-lived deep sea fish with a lifespan in excess of 100 years (DEW, 2009; Koslow *et al.* 1995). Maximum age has been estimated by otolith (ear bone) zone counts and radio-isotope ratios (Clark *et al.* 2000; DEW, 2009). Life-span estimates for *Hoplostethus atlanticus* range from approximately 20 years to well over 100 years, results of an improved lead-radium dating technique provided independent age estimates from sagittal otoliths indicated that fish in the oldest age group were at least 93 years old, providing robust support for a centenarian life span (Andrews *et al.* 2009).

Similarly, *N. orientalis* and *C. squamiceps* are reported to have distribution between 200-500m depth from the southwest region of Indian EEZ (Venu and Kurup, 2006b). Similarly, the spawning period of *N. orientalis* is reported during premonsoon and new recruits are expected in monsoon season (Refer Chapter 5). The feeding intensity was found to be highest during monsoon period for the species (Refer Chapter 4) and is further confirmed by the high growth increment at the end of the first year. But the results of the length weight relationship of *N. orientalis* have shown isometric growth during monsoon and post monsoon season (Refer Chapter 6). While in the case of *C. squamiceps*, the spawning was in the premonsoon and continues to monsoon season (Refer Chapter 5). The feeding intensity was also high during premonsoon and monsoon season (Chapter 4; Table 4.5) which in turn can be related to the high growth increment in the first year of growth.

In the study *P. cyanea* behaved more or less like a coastal species in general and in contrast to other four species which exhibited features of deep sea fishes. Though growth increments during the initial years of their life were found to be high for all species, high growth performance index and K value were found in *P. cyanea* when compared to other species. The present results have further shown that when the distribution of a species is more towards the deeper waters, it attains higher longevity and slow growth rate. According to Roff (1984), the benthopelagic fish species, unlike most meso- and bathypelagic fishes, are generally at the far k-selected end of the life-history spectrum. With their exceptional longevity, slow growth and delayed maturity (particularly when the juveniles grow up in deep water), these species fill a gap in the distribution of teleosts life-history patterns.

**Table 7.1 Details of growth parameters, maximum observed length, growth performance index and life expectancy in respect of five deep sea fishes under**

| Species | $L_\alpha$ (mm) | K | $t_0$ (mm) | $L_{max}$ (mm) | $T_{max}$ (years) | $\phi$ |
|---|---|---|---|---|---|---|
| *Psenopsis cyanea* | 265 | 0.84 | -0.4140 | 249 | 3.57 | 4.77 |
| *Chlorophthalmus bicornis* | 226 | 0.35 | -0.3724 | 219 | 8.57 | 4.25 |
| *Hoplostethus mediterraneus* | 232 | 0.43 | -0.3784 | 199 | 6.98 | 4.36 |
| *Neoepinnula orientalis* | 293 | 0.44 | -0.4426 | 269 | 6.82 | 4.58 |
| *Cubiceps squamiceps* | 216 | 0.45 | -0.3614 | 209 | 6.67 | 4.32 |

**Fig. 7.1 Life expectancies of deep sea fishes**

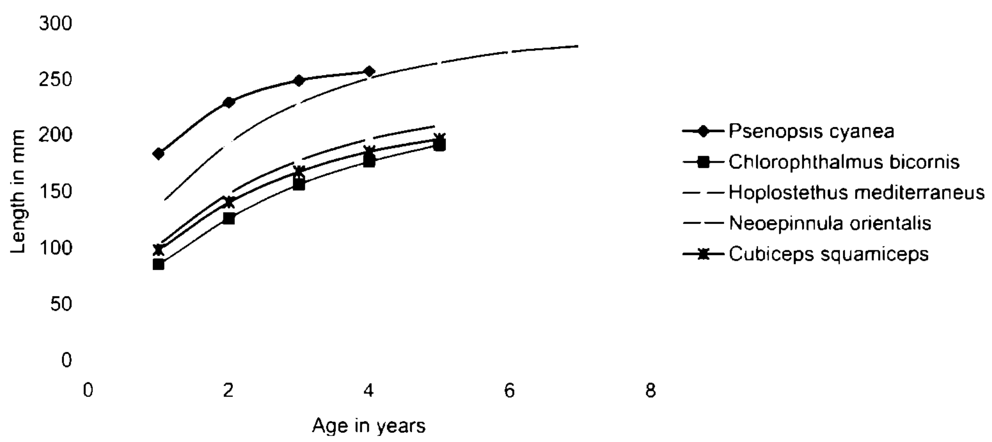


**Table: 7.2 The lengths (mm) attained during each year by the deep sea fishes as estimated using the growth parameters worked out in the present study**

| Species | Years | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX |
| *Psenopsis cyanea* | 184 | 230 | 250 | 258 | | | | | |
| *Chlorophthalmus bicornis* | 86 | 127 | 157 | 177 | 192 | | | | |
| *Hoplostethus mediterraneus* | 104 | 149 | 178 | 197 | 209 | | | | |
| *Neoepinnula orientalis* | 138 | 193 | 229 | 252 | 266 | 276 | 281 | | |
| *Cubiceps squamiceps* | 99 | 141 | 168 | 186 | 197 | | | | |

FiSAT 2: FAO-ICLARM Stock Assessment Tools
von Bertallanfy Growth Function Plot and Length Frequencies
Report Generated: 16-09-2009 17:08:10

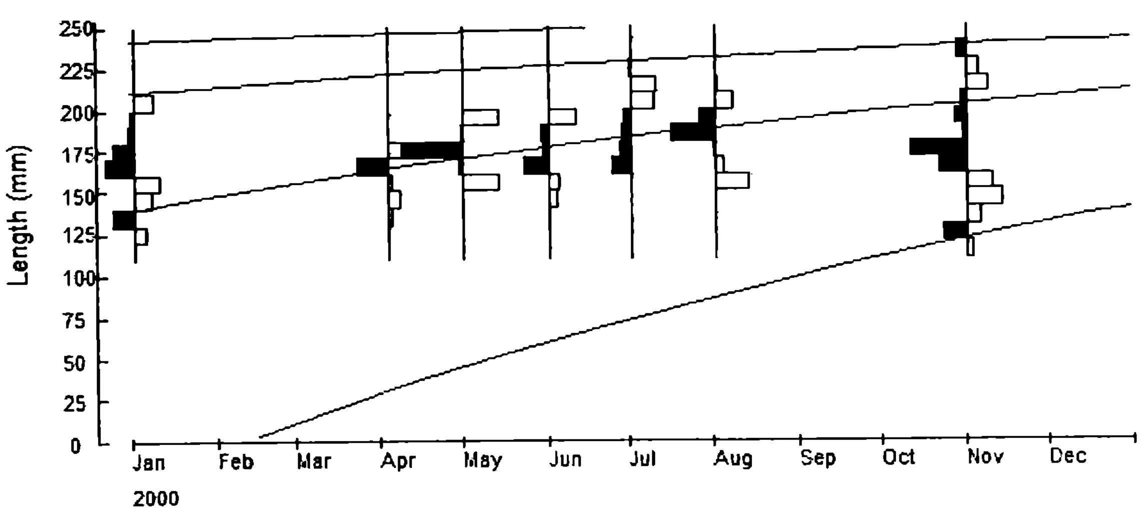
File ----------

| | |
|---|---|
| Filename: | C:\Program Files\FiSAT II\PSENOPSIS.lfq |
| Species name: | Psenopsis cyanea |
| Other identifier: | POOLED POPULATION |
| Class size: | 10 |
| Largest class: | 245 |

Parameters ------

| | | | | | |
|---|---|---|---|---|---|
| Asymptotic length (Loo): | 265.00 | Amplitude of oscillation (C): | 0.000 | Starting sample (SS): | 2 |
| VBGF growth constant (K): | 0.840 | "Winter Point" (WP): | 0.000 | Starting length (SL): | 170.00 |

Plot -----



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Report Generated: 16-09-2009 17:15:28

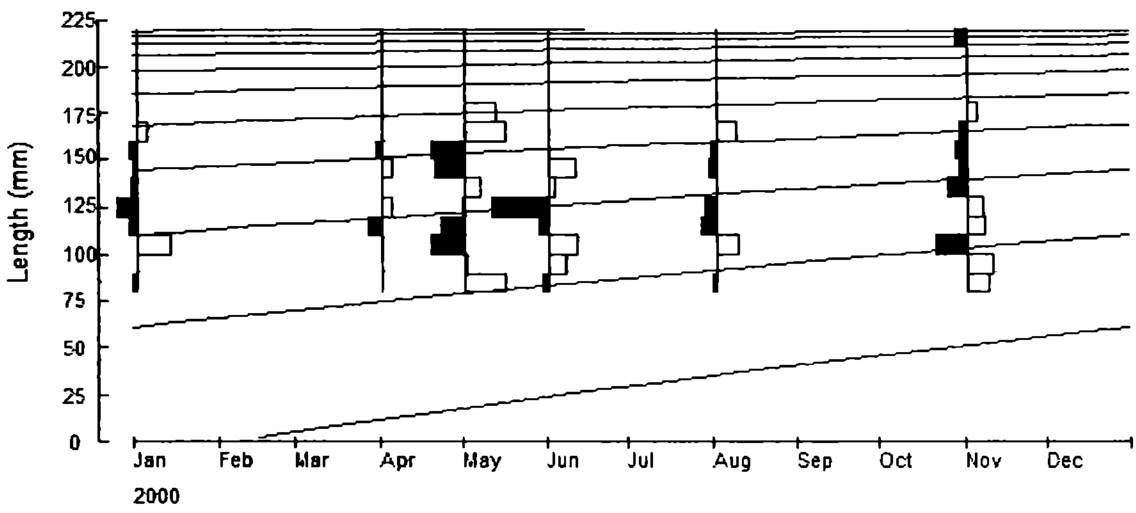
File ----------

| | |
|---|---|
| Filename: | C:\Program Files\FiSAT II\chlorophthalmus1.lfq |
| Species name: | Chlorophthalmus bicornis |
| Other identifier: | POOLED |
| Class size: | 10 |
| Largest class: | 215 |

Parameters -------

| | | | | | |
|---|---|---|---|---|---|
| Asymptotic length (Loo): | 226.00 | Amplitude of oscillation (C): | 0.000 | Starting sample (SS): | 1 |
| VBGF growth constant (K): | 0.350 | "Winter Point" (WP): | 0.000 | Starting length (SL): | 110.00 |

Plot -----



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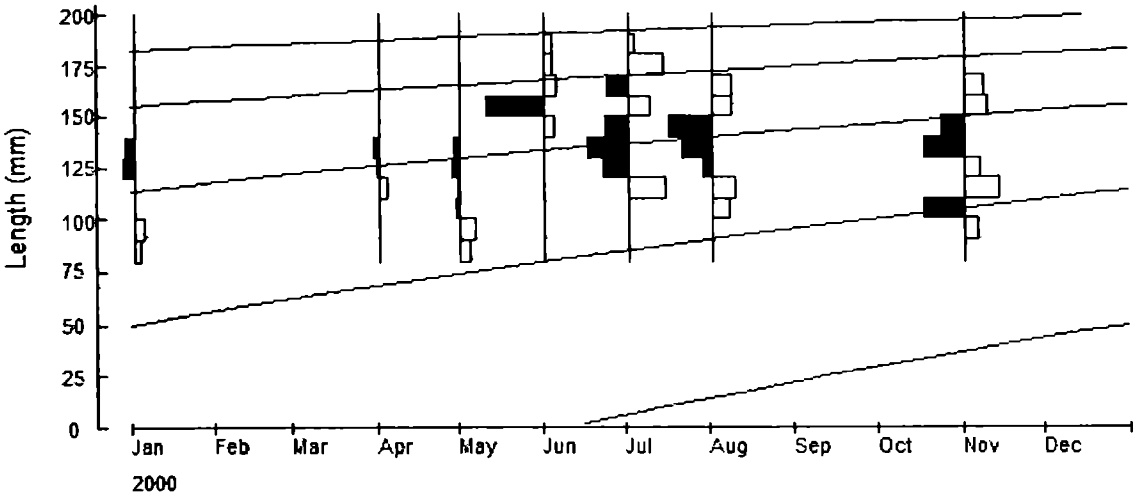
File ------------

| | |
|---|---|
| Filename: | C:\Program Files\FiSAT II\Hoplostetheus.lfq |
| Species name: | Hoplostethus mediterraneus |
| Other identifier: | POOLED |
| Class size: | 10 |
| Largest class: | 195 |

Parameters ------

| | | | | | |
|---|---|---|---|---|---|
| Asymptotic length (Loo): | 232.00 | Amplitude of oscillation (C): | 0.000 | Starting sample (SS): | 6 |
| VBGF growth constant (K): | 0.430 | "Winter Point" (WP): | 0.000 | Starting length (SL): | 140.00 |

Plot -----



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Report Generated: 16-09-2009 17:17:09

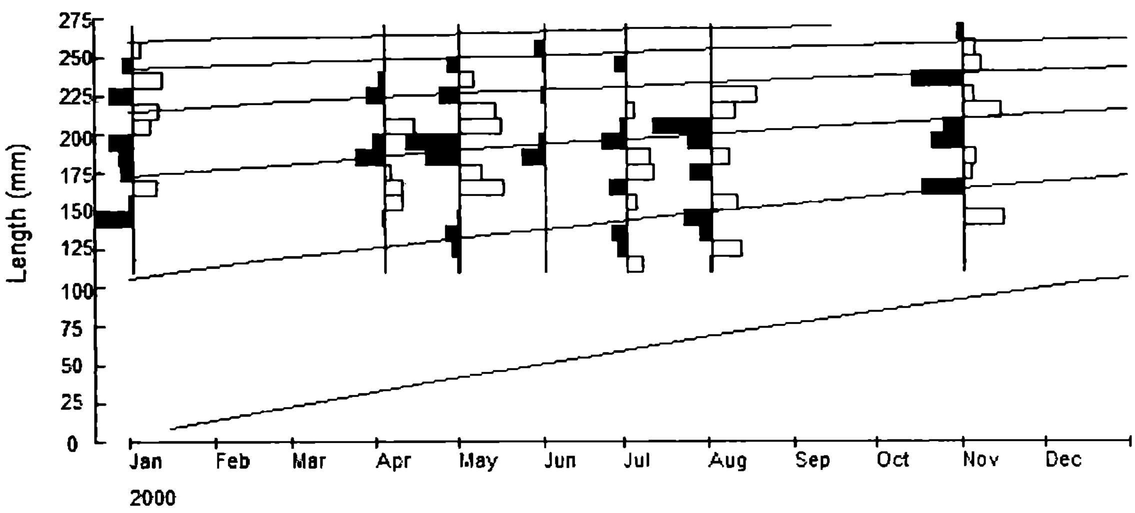
File ------------

| | |
|---|---|
| Filename: | C:\Program Files\FiSAT II\Neoepinnula1.lfq |
| Species name: | Neoepinnula orientalis |
| Other identifier: | POOLED MODIFIED |
| Class size: | 10 |
| Largest class: | 265 |

Parameters ------

| | | | | | |
|---|---|---|---|---|---|
| Asymptotic length (Loo): | 293.00 | Amplitude of oscillation (C): | 0.000 | Starting sample (SS): | 6 |
| VBGF growth constant (K): | 0.440 | "Winter Point" (WP): | 0.000 | Starting length (SL): | 200.00 |

Plot -------



FiSAT 2: FAO-ICLARM Stock Assessment Tools
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Report Generated: 22-08-2009 20:29:15

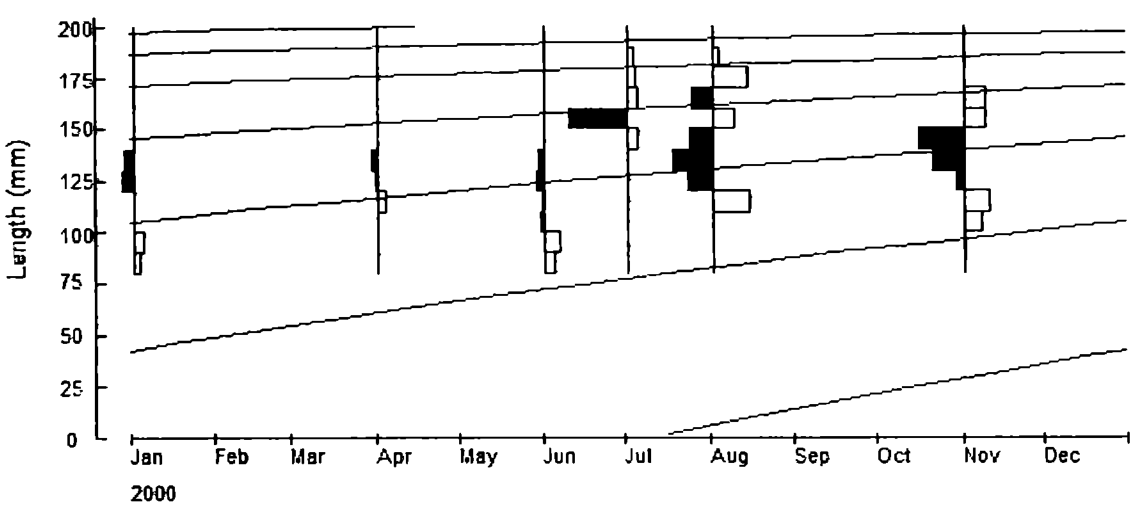
File ------------

| | |
|---|---|
| Filename: | C:\Program Files\FiSAT II\Cubiceps.lfq |
| Species name: | Cubiceps squamiceps |
| Other identifier: | POOLED |
| Class size: | 10 |
| Largest class: | 195 |

Parameters -------

| | | | | | |
|---|---|---|---|---|---|
| Asymptotic length (Loo): | 216.00 | Amplitude of oscillation (C): | 0.000 | Starting sample (SS): | 6 |
| VBGF growth constant (K): | 0.450 | "Winter Point" (WP): | 0.000 | Starting length (SL): | 140.00 |

Plot --------



# CHAPTER 8

# SUMMARY AND RECOMMENDATIONS

Marine fishery resources and are influenced by several factors such as primary and secondary productivity of the sea, physico-chemical and biological parameters, reproduction and recruitment, growth, availability of food and various oceanographic processes taking place in the sea. Fishing is not merely influenced by the need for protein food, but by economic, social and political considerations. While all these factors play significant roles in marine capture fisheries, it is the knowledge on fishing and its impact on the stocks that is most essential for formulating strategies for increasing or sustaining fish production through an informed exploitation regime. The increasing demand for seafood, improved technologies of capture and processing and increasing export opportunities have led to geographical expansion of the fishing area. In recent years, there is mounting concern on the sustainability of marine fisheries wealth of the country. Globally, certain fish stocks were already overexploited and the total landings have been declining and in the forthcoming years, there are every possibility of shortfalls in marine fish supplies which cannot be offset fully by production through mariculture.

The Working Group constituted in the year 2000 by the Government of India for revalidating the potential marine fishery resources of the country's EEZ estimated the annual harvestable potential yield as 3.93 million tonnes from the EEZ including 1.01 lakh tonnes of deep sea finfish and crustacean resources. The Working Group has observed that the bulk of the additional harvestable yield is expected from the demersal resources beyond 50 m depth.

Reducing fishing pressure in coastal waters is the need of the day in the Indian marine fisheries sector of the country which is fast changing from a mere vocational activity to a capital intensive industry. It requires continuous monitoring of the resource exploitation through a scientifically acceptable methodology, data on production of each species stock, the number and characteristics of the fishing gears of the fleet, various biological characteristics of each stock, the impact of fishing on the environment and the role of fishery-independent on availability and abundance. Besides this, there are issues relating to capabilities in stock assessment, taxonomy research, biodiversity, conservation and fisheries management. Generation of reliable data base over a fixed time frame, their analysis and interpretation are necessary before drawing conclusions on the stock size, maximum sustainable yield, maximum economic yield and to further implement various fishing regulatory measures. India being a signatory to several treaties and conventions, is obliged to carry out assessments of the exploited stocks and manage them at sustainable levels. Besides, the nation is bound by its obligation of protein food security to people and livelihood security to those engaged in marine fishing related activities. Also, there are regional variabilities in fishing technology and fishery resources. All these make it mandatory for India to continue and strengthen its marine capture fisheries research in general and deep sea fisheries in particular. Against this background, an attempt is made to strengthen the deep sea fish biodiversity and also to generate data on the distribution, abundance, catch per unit effort of fishery resources available beyond 200 m in the EEZ of southwest coast of

India and also unravel some of the aspects of life history traits of potentially important non conventional fish species inhabiting in the depth beyond 200 m.

This study was carried out as part of the Project on *Stock Assessment and Biology of Deep Sea Fishes of Indian EEZ* (MoES, Govt. of India).

It has become increasingly evident from the available literature on deep sea fishes of India that most of the researches were concentrated mainly on the biology and distribution but very little has done in the area of taxonomy of deep sea fishes. To fill up the gaps, in this study, emphasis was given mainly on the taxonomy of fishes inhabiting beyond depth 200m along the south west coast of India. The temporal, spatial and bathymetric distribution and abundance, catch rate and catch per unit effort, food and feeding habits, maturation and spawning, sex ratio, length-weight relationships and fecundity of exploitable deep sea finfish resources were studied in detail.

152 fish species belonging to 123 genera, 70 families and 24 orders were collected and identified from the southwest region of Indian EEZ. between 7° and 15° N latitude beyond 200 m depth based on the exploratory demersal trawling operations conducted onboard *FORV Sagar Sampada* during 1998 to 2007 Fish samplings from 164 stations were carried out using 38m High Speed Demersal Trawl II (HSDT) and 45.6m Expo- model Demersal Trawls during 1998–2002 and 2005–2007 during the cruise Nos. 174, 183, 189, 196, 197, 238 and 241. The data were also collected from the commercial boats operated beyond 200m along south west coast of India from Cochin, Munambam and Sakthikulangara fishing harbours of Kerala during November 2000 - February 2002. The catch composition and species

wise catch in kg at each fishing station were recorded and the specimens were taken to the laboratory for detailed identification. The entire study area was divided into four transects, 7°–9° N, 9°–11° N, 11°–13° N and 13°–15°N and three depth zones 201–500 m, 501–800 m and 801–1100 m within each transect.

Of the 152 fish species identified from the study area, 40 were found to have a circumglobal distribution, showing their presence in all the three major oceans viz. Atlantic, Pacific and Indian. 6 species were exclusive to Atlantic Ocean while 4 were distributed only in Pacific Ocean. The distribution of 43 species of fishes were found confined to Indian Ocean among the remaining 103. Nine species among the remaining sixty shared their geographical distribution between Atlantic and Pacific Oceans. Among the remaining 51 species, 16 are reported from both Atlantic and Indian Ocean. Previous reports in respect of the remaining 35 species were known from Pacific as well as Indian Oceans.

In the present study no fish species new to science was identified. Of the 152 species, 84 species are new addition to the EEZ of India while 97 are new records from the west coast and most importantly, 119 species are new addition to southwest region of Indian EEZ. *Etmopterus baxteri*, *Centrophorus lucitanicus*, *C. uyato*, *Harriotta releighana*, *Nemichthys scolopaceus*, *Neoscopelus microchir*, *Lepophidium marmoratum*, *Bufoceratias wedli*, *Epigonus pandionis*, *Eptatretus hexatrema*, *Apristurus saldanha*, *Leucoraja circularis*, *Grammonus ater*, *Rhynchoconger ectenurus*, *Lamprogrammus exutus*, *Bassozetus robustus*, *Glyptophidium lucidum*, *G. micropus*, *G.*

*oceanium* and *Neobythites multistriatus* were new records to the Indian Ocean. In this study, 192 trawling grounds were delineated and their suitability for bottom trawling was also established.

The exploratory surveys carried out in the southwest region of Indian EEZ between 7° and 15° N lat. have revealed many new potential fishing grounds as well as nonconventional resources in the deeper waters beyond 200m depth. Although the catches from these stations were showing slight fluctuation, the present results are very promising to surface the availability of fishable deep water fishery resource potential in the southwest coast of India. The new grounds delineated in the continental slope area and the potential non conventional resources available in this region can be effectively utilized by the fishing industry. The results revealed that there exist many nonconventional resources other than crustaceans and oceanic resources in the deep sea region of southwest coast of India. Information of these resources are very much indispensable before advocating any commercial fishery targeting on these resources.

The bathymetrical and spatial distribution pattern has shown the overall dominance of Perciformes with 26 species belongs to 17 families, especially in the depths beyond 500m. While the Ophiidiformes, Anguilliformes and Gadiformes dominated in the higher depths, whereas the Aulopiformes dominated the catches with highest CPUE recorded in respect of the family Chlorophthalmidae. *Chlorophthalmus nigromarginatus, C. bicornis, Trichiurus auriga* and *Psenopsis cyanea* were found as four species which showed great potential for commercial level exploitation. There are other promising resources like *Neoepinnula orientalis, Psenes squamiceps, Hoplostethus mediterraneus,* etc. However, feasibility of commercial level exploitation of these species need to be ascertained by carrying out more exhaustive trawling operations giving due emphasis to all seasons and all depth zones.

Of the total 70 families recorded in the study, 32 were represented with a single species, 20 with two each and 6 with three each. Spatially, the transect 11° - 13° N recorded the highest number of 121 species belongs to 70 families followed by the transect 9° - 11° N lat. with 95 species belong to 65 families. The least number of species were recorded from the 7° – 9° N latitude (34 species belongs to 26 families). Bathymetrically, the 501 – 800m depth range recorded highest number of species while the depth 801 – 1100m showed the least. Altogether 93 species of fishes belongs to 45 families and 18 orders were recorded from 501 – 800m depth zone.

Fishes of the Order Ophiidiformes found to show maximum bathymetrical as well as spatial distribution with the occurrence of species in all transects and depth zones except in 501 – 800m and 801 – 1100m in the 7° – 9° N latitudes. Anguilliformes also showed a wider distribution pattern with its presence in all the transects and depth zones except in 501 – 800m and 801 – 1100m in the 7° – 9° N transect and 801 – 1100m in the 9° – 11° N transect. Fishes of the orders Charchariniformes, Aulopiformes, Beryciformes, Scorpaeniformes, Perciformes and Pleuronectiformes were also showed a wide distribution encompassing all transects.

In the present study *Apristurus indicus, Coloconger raniceps, Saurenchelys taeniola, Chlorophthalmus bicornis, Hypopleuron caninum,* *Polymixia japonicus, Priacanthus hamrur, Psenopsis cynea, Bembrops caudimaculatus, Psenes squamiceps, Neoepinnula orientalis* and *Chascanopsetta lugubris* were found distributed in all the transects. Altogether fifteen species were found to have distribution in all transects except 7°–9° N latitude. Five species have shown distribution in all transects except in the 13°–15° N latitude. Whereas two species viz. *Pterois russelii* and *Pterigotrigla hemisticta* have shown wider distribution except in 9°–11° N latitude. *Cubiceps pauciradiatus* was found to be absent in the catches in transect 11°–13° N latitude.

The exploratory surveys conducted along the continental slope of southwest region of Indian EEZ has yielded a total catch of 12,246.25 kg of fish by exerting an effort of 68.05hrs. The catch per unit of effort calculated for the entire region was 179.96 $kghr^{-1}$ The transect 7°–9° N latitude showed highest catches with a total catch of 7929.3 kg by exerting an effort of 6.85 hr with a CPUE of 1157.56 $kghr^{-1}$ The catch obtained was very low from transect 13°–15° N latitude with 784.91kg. The CPUE estimated was 50.8 $kghr^{-1}$ with an effort of 15.45 hrs. The depth zone 201–500m recorded the highest catch during the study period with total catch of 11013.11 kg by exerting an effort of 43.25hrs. The CPUE was calculated as 254.63 $kghr^{-1}$ at this depth zone. In the 501–800m depth zone, the total catch was 1082.27kg and effort was 19.8hrs. Generally high catches were observed in 201 – 500m depth zone in all transects.

Family Chlorophthalmidae dominated in the catches with a high CPUE among all the species recorded from the entire study area. *Chlorophthalmus* *nigromarginatus* and *C. bicornis* were the two dominant species appeared regularly in the catches. The CPUE calculated for these two species were 89.34kghr$^{-1}$ and 20kghr$^{-1}$ respectively with percentage composition of 49.64% and 11.11% among all the species landed. Another dominant species was *Trichiurus auriga* with a CPUE of 15.05 kghr$^{-1}$ which formed 8.36 % of the total catch. Other major species caught were *Psenopsis cyanea* (8.51kghr$^{-1}$), *Saurenchelys taeniola* (5.21kghr$^{-1}$), *Echinorhynus brucus* (5.1kghr$^{-1}$), *Psenes squamiceps* (3.32 kghr$^{-1}$) and *Hypopleuron caninum* (3.93 kghr$^{-1}$).

The results of food and feeding habits study conducted in five species of deep sea fishes revealed that most of them are carnivores and feed on the available food in and around its habitat. In all the five species analyzed, feeding intensity was very low irrespective of seasons and sexes.

The results of the study on the reproductive biology have shown that there exists some relationship between the feeding intensity and the spawning seasons in deep sea fishes. The feeding intensity was found to be the least during the season preceding to spawning, in contrast, it was highest during the subsequent season in all except *C. bicornis*. Analysis on the food composition revealed that only a few items of food were present in the stomach of five fish species studied. The food items recorded were of Myctophids, squids, deep sea prawns like *Aristeus alcocki* and *Heterocarpus* spp. It appears that high-density of deep-sea shrimps co exist in these latitudes and depth zones with these fishes. From the dominance of deep sea shrimps observed in the diet of these fishes it may be inferred that there may be the possibility of abundance of commercially important deep sea shrimps along the south west coast of India.

The deep sea fishes have shown a strong seasonal pattern in their reproductive behaviour. The spawning generally coincided mainly with the onset of southwest monsoon in *C. bicornis, P. cyanea* and *H. mediterraneus*. While in the case of *N. orientalis* and *C. squamiceps*, spawning was more or less a continuous process commencing from the premonsoon and continuing till the end of monsoon. There is a possibility of having certain bathymetrical spawning migration in these deep sea fish species, which need to be confirmed through more extensive investigations. The results of the present study have shown that spawning period of *P cyanea, C. bicornis* and *H. mediterraneus* commenced during the monsoon, while, the spawning season in *C. squamiceps* and *N. orientalis* have started in the premonsoon season and continued thenceforth till monsoon.

Even though majority of species showed the exponential value ***b*** around three which in turn is an indication of isometric growth, it varied from 1.5 to 3.7 Females and males of different species also showed considerable variation in the exponential value, which indicates that, the growth pattern of these deep sea fishes strongly varied from high negative allometry to high positive allometry.

*Hoplostethus mediterraneus* and *N. orientalis* grow stouter in the deeper waters. Also, the individuals in the depth zone 301-400m show negative allometry, where the fish seems to grow slender. Females were found growing stouter than males in the deeper waters while the males were stouter in the 201-300 m depth zone. The fishes grow more or less isometric in general during all the seasons. However, a slight negative allometry was observed in females during the monsoon season which may be attributed to spawning in females during these months.

Among the five species of deep sea fishes studied, *P. cyanea* is short lived with a life expectancy of 3.54years. The results of the present study revealed that, *P. cyanea* behaved more or less like a coastal species, in contrast, the other four species showed characteristics of typical deep sea fishes. The growth increments during the initial years of life found to be high in all species, growth performance and K value were found to be higher in *P. cyanea* when compared to other species. The results of age and growth of deep sea fishes further upheld the view that irrespective of species and size, these species are endowed with a higher longevity and slow growth rate.

**Suggestions and Recommendations for the sustainable utilization of deep sea non-conventional resources inhabiting beyond 200 m depth in the Indian EEZ**

The present study is beset with some short comings such as non coverage of all latitudes and depth zones, incompleteness in casing the trawlable grounds, insufficiency in the trawling durations, etc. in all the three seasons.

So, it is recommended that exhaustive surveys and sampling of deep sea fin fish resources shall be carried out in the depth zone 200 – 1200 m along the southwest region of Indian EEZ giving sufficient representation to all depth zones, all latitudes, all seasons, full coverage of trawling grounds, spending sufficient time for trawling, etc. so as to strengthen the data on fish biodiversity, catch per unit of effort and details pertaining all suitable trawling grounds available in the EEZ of southwest coast of India.

Addition of fish species to the biodiversity of the EEZ of India is the most important deliverable of this study. Based on the present results it can be asserted that the EEZ of southwest coast of India harbours more number of fish species either new to science or new records from the area. So it is recommended that concerted studies needs to be carried out on the taxonomy and systematics of deep sea fishes of EEZ by carrying out very exhaustive surveys and sampling giving due respect to all depth zones, latitudes and seasons.

Another highlight of this study is the generation of an authentic data base on the catch and catch per unit effort of a dozen deep sea fish species which offer great potential for commercial exploitation. Data so generated need to be revalidated and strengthened by conducting more surveys and samplings. Attempt may also be made to work out the viability of commercial exploitation of these species and dissemination of information to stake holders.

The results of the life history traits of some of the potentially commercially important fishes have shown that these are characterized by slow growth, high longevity, low fecundity, irregular spawning patterns, etc. So unlike coastal resources, the commercial exploitation of these fishes need to be planned giving due emphasis on conservation and management. The information on life history traits need to be utilized for computing the harvestable catches, required effort to be exerted, numbers of vessels to be deployed, etc.

Strict enforcement of regulations such as mesh size, closed seasons, etc. shall be made mandatory to reduce impact of fishing on the stock.

Most of the non conventional fin fishes available in the deep sea are not preferred for consumption as such. So it is recommended that concerted R &D efforts may be done to develop value added products by utilizing the non conventional deep sea fin fishes of the EEZ of India.

Marine fisheries of India, plagued with problems of high capitalization and reduced catch in the existing fisheries scenario, is at its cross roads seeking proper direction and guidance. In the context of globalization, challenges of global competition in trade and economics, there is urgent need for policy interventions in deep sea fishing both at state and national level to meet the ever increasing internal and external demand of protein for millions and to ensure better livelihood for the fisher folk. It should be realized that as the scenario changes, data generation and research must go in unison so as to help the development of appropriate management plans for the sustainable utilization of deep sea resources.

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