SYSTEMATICS AND BIONOMICS OF EDIBLE PERCHES OF CENTRAL KERALA

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By

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NOVEMBER 2001

In Loving Memory of my Beloved Son
Geomon

DECLARATION

I hereby declare that this thesis entitled **"Systematics and Bionomics of Edible Perches of Central Kerala"** is the result of investigations carried out by me in the Department of Zoology, Christ College, Irinjalakuda, University of Calicut under the supervision and guidance of Dr. N. D. Inasu, Prof. & Head, Department of Zoology, Christ College, Irinjalakuda, University of Calicut and has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles or recognition.

Irinjalakkuda,
November, 2001.

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CERTIFICATE

This is to certify that the thesis entitled "**Systematics and Bionomics of Edible Perches of Central Kerala**" is the bonafide record of the work carried out by **MISS TESSY J. MANDY** under my guidance and supervision in the Zoology Department, Christ College, Irinjalakuda, University of Calicut and that no part thereof has been presented for any other degree.

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CONTENTS

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CHAPTER - 1

INTRODUCTION

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Fishes are the aquatic vertebrates, which exploit every nook and niche of the domain of water. They are specially noted for their unimaginable number about 40,000 species and bewildering forms. The aquatic environment has imparted tremendous influence on the life of fishes. The biology of fishes is so diverse that it is extremely difficult to give a concise account of the group. Fisheries form an important sector in the Indian economy with an annual production of 4.04 million tons in 1991 (Anon, 1994). India has the seventh position among the fish-producing nation.

India posses a long coast line 7,517 km bordering the Arabian sea, Bay of Bengal and the oceanic islands of Lakshadweep and Andaman Nicobar. The continental shelf area between '0' and '200' m depth is estimated at about 0.5 million km^2 and the total area of Exclusive Economic Zone (EEZ), as 2.02 million km^2. The fishery resources in the area are rich, diverse and typical of tropical water. However, before independence the marine fishing activities of the country were only at a subsistence level with a low quantum of production. But after independence the country's fish landings rose by concerted efforts. In these circumstances the country wants to increase marine fish production, which is stagnating around 1.4 million metric tons during the last few years, by various programs implemented during different national schemes. To increase fish production it is imperative to culture food fishes and shell fishes in coastal waters. It has been given priority in the context of augmenting fish production, creating employment opportunities and the improvement of rural economy. The marine fish production of the country consequent upon these developmental programs increased gradually from 0.534 million tons in 1951, 0.8 million tons in 1960's 1.2 million tons in 1970's and 1.6 million tons during 1980's to the current production of 2.29 million tons. In 1998 the production was 2.67 million tons and 1999 it came to 2.42 million tons. The export of fish products from India during 1992 was 1,91,314 tons valued at Rs. 1581.44 cores forming 3.5% of the total export earnings (Anon 1993a). In the fish landings South West region with 36.1% topped in production followed by North West 34.1% while South east and Northeast accounted for 2.34 and 5.5% respectively (Anon, 1993b).

With the intensification of fishing in the inshore regions of the Indian seas for increasing marine fish production through several innovations, a number of fishery resources have come to be exploited at optimum levels. The demand for fish and fish products both for internal consumption and for export, has been the main reason for this situation. Along with fishes many other animals are causing concern because of habitat damage or declining populations.

With the declaration of 200 nautical miles Exclusive Economic Zone (EEZ) in 1976, India acquired full right to explore, exploit, manage and conserve the living and non-living resources of nearly 2 million Sq. km of sea around it. The bottom trawl operated by FORV Sagar Sampada in the South-eastern Arabian sea revealed the existence of grounds with potentially rich unexploited deep sea fin fish resources. Maximum catch rate of deep-sea fish was observed at depths ranging from 300 to 350 m. Concentrations of deep-sea fish resources are found in comparatively shallower depths in the northern latitudes whereas a wider distribution is seen in the southern latitudes. Many workers contributed their attempts to estimate the resource potential of the EEZ by resorting to organic production and exploratory survey data. [Jones and Banerji, 1973; Silas 1977; Joseph, 1984, 1986; Sudarsan *et al* 1988 and Desai *et al*, 1990).

From the results obtained in the survey conducted by Fishery Survey of India during the past two decades the fishery potential of Indian EEZ is assessed as 3.92 million tons. Of this, the demersal stocks form about 1.93 million tons, the coastal pelagic stocks 1.74 million tons and oceanic resources 0.25 million tons. Coast-wise, west coast supports 60.1% of the resources, East coast 27.8%, Lakshadweep Sea 1.6%, Andaman and Nicobar seas 4.1% and the oceanic waters 6.3% of the fishery potential. Resource-wise, stocks in the offshore and deep-sea areas are the threadfin breams (*Nemipterus Spp*) cat fish, and bull's eye (*Priacanthus Spp*) [Sudarsan *et al*, 1988].

A thorough knowledge of the deep-sea resources was needed for the development of deep-sea fishing. There are about 34,000 mechanised boats, 170 of them having OAL above 23 m, [Joseph & John, 1987]. About 1.91 lakh non-mechanised craft, including 32,000 motorised craft, 47,000 small-mechanised craft and 180 large fishing vessels are presently engaged in fishing in the India Seas (Viscin-2020, C.M.F.R.I. Perspective Plan). From the results of the surveys it was proved that the demersal fishery beyond 100 m depth is supported by very few species in contrast to the multi-species nature seen in the inshore waters. The groups, which are represented in the deeper waters, are Priacanthids, Blackruff (*Centrolophus spp.*), Indian drift fish (*Ariomma indica*), green eye (*Chloropthalmus*) and deep-sea sharks.

The present thesis deals with the systematics of the group-'perches' and also it enlightens the biology of 2 edible perches *Priacanthus hamrur* and *Pomadasys maculatus*. Systematics is the study of organisms, the diversity and interrelationship with the aim of arranging them in an orderly manner. Biology deals with the study of growth, age, feeding, reproduction, etc. of the concerned organisms. The group perches considered to be the largest order of fishes - the Perciformes and are important marine fishery resources from the coast of India. The name is derived form Greek and Latin, through the French and it was known to the Romans as 'Perca'. The group perches include a wide variety of species of families such as Serranidae, Lutjanidae, Lethrindae called "major perches" (in view of their large size) and Nemipteridae, Siganidae, Priacanthidae, Pomadasyidae, etc. called minor perches (in view of their small size). The major perches are usually abundant in the rocky grounds and coral areas, mostly of Kerala and Tamil Nadu where these are exploited by drift nets, hooks and lines and traps with an average annual production 3,984 tons during 1988-92. In 1998 total production of perch was 1,54,103 tons (Rock cods-18, 580 tons Snappers-5,687 tons, Pig face bream-11,701 tons, Thread fins breams-81,340 tons, and other perches-36,795 tons) (Anon, 2000). The average annual production of major perches in the country during 1990-98 is estimated 23,800 tons forming 17% of the total perch catch and roughly 2% of the total fish production in the country. The highest landing of major perches is from the state of Tamil Nadu (49.5%) followed by Kerala (19.74%). Along the southwest and southeast coast, the peak fishing season is from December to April. Among minor perches, the family Nemipteridae popularly called "Threadfin bream" and pink perches are abundant in the shelf and slope waters upto depth of about 200m, exploitable by trawl nets. Until the seventies, a fishery for the group was almost non-existent in India. But due to the gradual expansion of bottom trawling operations, there has been an increase in the production of threadfin breams. All perches together are at present contributing to about 5% of the total marine fish production, the former 2% and the latter 3% with a total of 1,06,910 tons. As per a recent estimate by the government of India, the catcheable potential of all the perch within the 50 m. depth zone about 1,14,00 tons and that beyond 50 m. it is 1,25,000 tons, total being 2,39,000 tons (Anon, 1991). Within the former zone, the southwest sector is the most productive, followed by southeast and northwest. In view of the growing potential for perches, it is essential to bring together all available scientific data and information on perches for the benefit of the fishing industry.

The preches form an important fishery. But the exploitation of the resource is limited to the narrow belt of the continental shelf of about 50 m depth coming an area of 1,80,539 km. Annually on an average 59,215 tons of perches are landed by different types of gears, both by mechanised and non-mechanised vessels along the east and west coast of India (Jones and Banerjie, 1973). More than 20 families – including 37 genera and many species, represent perch like fishes available in Indian waters. The perch production by mechanised units has been assessed to be higher (72.4%) than non-mechanised units (Kasim *et al* 1987). Different types gears operated by both mechanised and non-mechanised crafts in which the mechanised commercial trawlers alone land 42% of perch catch exploit perches. Commercially important ones come under the families Serranidae, Lutanidae, Lethrinidae, Nempteridae, Priacanthidae, Sparidae, Acanthuridae, Pomadasyidae and Siganidae.

Literature so far available on perch is scanty and inadequate. They deal with some aspects of experimental fishing (Goponath, 1954, Silas 1969, Bapat *et al*, 1982, Annon, 1978), catch statistics (Chacko and Rajendran, 1955; Rao, 1973; Madan Mohan, 1983; Rao and Kasim 1985, Kasim *et al*, 1987) and perch trap fishery (Prabhu, 1955a; Lal Mohan, 1985). A part from these reports occurrence of different species of major perches in the EEZ of India and their depth wise distribution have been reported by Sivakami (1990) and Balachandran and Nizar (1989) based on the data collected by FORV Sagar Sampada. With the stagnating or diminishing landing of commercially important marine fishes in India, the urgency of culturing fin fishes needs further emphasis.

Today's world fisheries is facing the problems of stabilization of catch and growing demand for fish and fish products giving rise to the necessity of increasing the fishing effort by adopting new technologies. But sole dependence on natural resources to meet the growing demand is bound to have adverse effect on fishery stock. Moreover technological advancement is not a day's work and had saddled with another problem especially in developing countries like India, i.e. clash of interests of traditional fisherman and their mechanized counter parts.

During the period 1950 -92 the landings of demersal group of fishes varied form 23418 tons in 1953 to 2,78,012 tons in 1994. During 1999 the demersal fishes constituted 6,46,000 tons (Anon, 2000). There was not much variation in the landings of this group during 1950–1965. Large-scale introduction of trawlers in the 70's brought about increased landings of the demersal groups of fishes in Kerala. During 80's modification to the craft and gears and extension of the fishing grounds resulted in higher landings of this group. Among the demersal resources, the dominant ones are Catfishes, Perches, Croakers, Lizardfishes, Elasmobranchs, flat fishes, big-jawed jumper, silver bellies goatfishes, Penaeid prawns and Cephalopods.

The contribution of perches to the marine fish landings in Kerala during 1960–199 varied from 7910 tons in 1964 to 74,831 tons in 1993. There is an increasing trend in the landings of perches from 1973 onwards. The maximum landing was observed during 1984–1997. The average annual landing of perch during 1960–1970 was 1696 tons; it increased to 13,221 tons during 1971–1980 and to 34,180 tons during 1981–1992 and further to 60,106 tons during 1993–1994. Increased landings of perches can be attributed to the large-scale introduction of trawlers and the consequent extension of the fishing grounds.

The periodic report on the survey and the fishing charts gives detailed information on the structure, composition and seasonal abundance of the fish stocks. Joseph (1986) has described the existence of perches from the Indian

EEZ. Joseph (1987) have found that the density of the perch population in Wadge Bank as 3.37 tons per sq. km. Kasim *et al.* (1987) have described the present state of perch fishery resources in India and its prospects. Sulochanan and John (1988) have reported that the catch rate of perches in the areas below latitudinal 8°N as 62 to 96 kg during October–December and 60 to 78 kg during March–May in the 40–50 m depth zone. Premalatha (1989) has given an account on the trap fishing for rock cods of south west coast of India and recently Grace and Venugopal (1990) have detailed the hooks and line fishery for Kalava at Cochin. Depth wise catch rates obtained in demersal trawling by FSI vessel Matsya Nireikshani in March 1993 for perch was 26.00 and 37.40 kg/hr in the depths 0–50 m and 50–100 m. respectively along the south west coast, Wadge Bank and Gulf of Mannar.

The marine fisheries research programme that have been undertaken in the country have added valuable knowledge on the exploited and unexploited resources, their characteristics and dynamics in relation to their environment. Endeavours to tie up these programmes with the normal activities of the small fishermen will have a significant impact in the development of rural economy and fisheries.

In the next part we can see the works about the two groups of fishes Priacanthidae and Pomadasyidae in which *Priacanthus hamrur* and *Pomadasys maculatus* are included.

PRIACANTHIDAE

Priacanthids commonly called as Bulls eye, big eye, glass eye, snappers, etc. constitute a small group of marine percoid fishes belonging to the family priacnthidae, are available on the outer shelf in EEZ of India.85 Major specimens known are *Priacanthus hamrur*, *Priacanthus macracanthus*, *Priacanthus tayenus*, *Priacanthus cruentatus*, *Priacanthus blochii*, *Cookeolus boops* and *Pristigenys niphonia* (Naik, 1990). The fishery and oceanographic survey conducted by FORV Sagar Sampada during 1985 - 87 in her crusis 1-30 showed that the bull's eye Priacanthus specimen occurred in 62 out of 182 stations where bottom trawl was operated (Bande *et al*, 1990). It formed 40% of the total catch. The stock density of *Priacanthus hamrur* varied among depths and quarters. The depth zone 50-100 m was more productive as compared to less than 50 m depth zone. The stock density was highest during October to December and lowest during July to September and total biomass was estimated to be 88,560 tons, with maximum sustainable yield of 25,000 tons per annum (Biradar, 1988). Priacanthids in general are epibenthic in habitat and usually found associated with rock formation or coral reefs where as a few are often trawled from the open bottom areas (Starnes, 1988). Even though adults are epibenthic and occur in deeper waters, the juveniles are believed to the pelagic (Caldwell, 1962a, Hoese, 1958). In Malayalam Priacanthids, are commonly called as Chempally Kutti, in Tamil they are known as Pusuwa and in Telugu – Bochii. Bulls eye are carnivorous species feeding on other fishes, crustaceans and polychates (Naik 1990).

Review of the Important Previous Works on different Species of *Priacanthus*

Many workers have reported about Priacanthids in the previous year. Gill (1872) created the family Priacanthidae and Bleeker (1873) studied the Priacanthids as a group in his studies of the fishes of the Indonesian region. Accounts of the western Pacific and eastern Indian Ocean species were presented by Eggleston (1974). Schultz (1960) described 2 species viz. *Priacanthus hamrur* and *Priacanthus cruentatus* from Marshull and Marianas island. The family Priacanthidae consists of 4 genera viz. *Pristigenys*, *Cookelous*, *Heteropriacanthus* and *Priacanthus* (Starnes, 1988). A comparison of the members of the genus *Pristitenys* and information on their distribution was given by Myers (1958) and Smith (1966). Lindberg and Krasyukova (1969) described the Priacanthids inhabiting Japanese waters and yellow seas. Morphological and ecological aspects of Priacanthid fishes of the Western and North Atlantic were studied by Anderson *et al* (1972). Fritzsche (1978) and Fitch and Schultz (1978) recorded *Cookeolus boops* from the eastern pacific region. Senta (1977) identified 5 species of Priacanthids among which *Priacanthus macracanthus* and *Priacanthus tayenus* were predominant and *Priacanthus hamrur* occurred in small numbers. Six species of Priacanthids reported form Taiwan by Lee (1980). *Priacanthus hamrur* and *Priacanthus arenatus* were reported from the Mediterranean region by Abdelmoulch (1981) and Tortonese and Cau (1984). Shao and Chang (1985) advanced a hypothesis of the phylogenetic relationship of the different species of the genus Priacanthids of Taiwan. A comprehensive systematic account of recent Priacanthids on a worldwide basis was described by Starnes (1988). Chavez *et al* (1989) reported *Priacanthus boops* at different localities in Baja California. *Priacanthus macracanthus* comprised of mostly binomial cohort populations as the size of fish concerned - (Hayase *et al* 1988).

See Page 202 *Priacanthus* was the best specimen for surami (Pongpen - Ratogool *et al*, 1990). Sp Cling According to Joung and Chen (1992) big eye found a very good fishery along the north east coast of Taiwan. *Priacanthus tayenus* species were dominant demersal fish - distributed by depth off Chandaburi, East Thailand (Chittima *et al* 1992). Wang and Wang (1993) observed a digenetic trematode (Endoparasite) *Apocreadium priacanthi* species obtained form the intestine of *Priacanthus macracanthus*. Haimovici *et al* (1994) reported the association of *Priacanthus arenates* with the relic coral hard bottom of the shelf break of the southern Brazil. In the study of the trace metal content of fish and shellfish it was noticed that mercury was highest in deep-sea fish *Priacanthus hamrur*.

[Radhakrihnan, 1994] Tapia - Garcia *et al* (1995) studied the distribution, abundance and reproduction of *Priacanthus arenatus* (Cuv) in the continental shelf of the Gulf of Mexico. Tzeng *et al* (1997) reported the abundance of the larvae of *Priacanthus macracanthus* in Yenliao bay in northeastern Taiwan.

Primary studies on population parameters, feeding biology, sex ratio and reproduction of *Priacanthus* specimen of south China were attempted by Lester (1968), Chomjurai (1970), Wetchagarun (1971), Nugroho and Rustam (1983), Lester and Watson (1985), Dwiponggo *et al* (1986), Ambak *et al* (1987) and Joung and Chen (1992).

Salmon and Winn (1966) studied the sound producing mechanism in *Priacanthus cruentatus* and *Priacanthus meeki* from Hawaii. Sound production in *Priacanthus macracanthus* from Australia was reported by Moulten (1962) and Walls (1964) described the sound producing muscles of this species Nicol and Zyznar (1973) studied the mechanism of reflections, the efficiency of tapetum and the role of retinal pigments of the eyes of *Priacanthus* specimen from the shelf of port, Texas. Nicol *et al* (1973) found that tapita lucida of *Priacanthus* specimen is unique. Shoals of *Priacanthus macracanthus* were got attracted to light when lift nets were operated at night in Panny Gulf (Senta, 1978). Disease and Parasites in Priacanthids were studied by different workers (Hi, 1982, Hua and Dong 1983). Nematode Parasite Didymozzon specimens were found as yellow cysts on the drosal fin and the branchians of *Priacanthus* specimens, (Shaharom, 1987). A new cymothoid isopod *Nerocila priacanthusi* in collected from the marine fish *Priacanthus hamrur* of Waltair coast, Andhra Pradesh, India (Kumari *et al* 1987). Fatty acid composition of *Priacanthus arenatus* is probably controlled by its diet consisting of larval forms from deeper colder water (Phleger *et al* 1989).

Many workers have reported the occurrence of priacanthids from India. The five species of priacanthids found in Indian waters are *Priacanthus hamrur* (Forskkal), *Priacanthus blochii* (bleeker), *Priacanthus stainer* (Richardson), *Priacanthus macracanthus* (Cuvier) and *Priacanthus cruneatus* (Lacepede). Of these five species the most dominant species occurring in Bombay waters is *Priacanthus hamrur*. This species is present in the east coast of Africa, Seas of India to Malayi Archipealago. Two species from Indian region were recorded by Day (1875-78). Munro (1955) reported three species from Srilankan waters. From the Laccadive Islands two species were described by Jones and Kumaran (1980). Talwar and Kacker (1984) reported the occurrence of three species in the Indian waters. Sujatha (1986) described three species of *Priacanthus* collected from the demersal trawl catches of Visakhaptanam coast. Rao (1984) has done works on the biology of *Priacanthus macracanthus* from Indian waters. Koteswaramma (1982) studied an advanced post larwa of *Priacanthus hamrur* from Krishna history of the east coast of India.

In a study of the stock of *Priacanthus hamrur* it was noticed that the fish is mainly a deep-water inhabitant showing migration towards shallow water during pre-monsoon, which appears to be for breeding (Vijayakumaran and Naik 1988). Most of the studies on the biology - growth and mortality parameters of Priacanthids are restricted to Southeast Asian countries. Dwiponggo *et al* (1986) have worked on *Priacanthus macracanthus* from Java Sea.

Yield of edible meat from *Priacanthus hamrur* varied from 35 to 40% of the wet raw fish. Fish powders from *Priacanthus hamrur* had a balanced amino acid composition and were shown to have high nutritional value using growth experiments on Albino rats (Nair *et al*, 1990).

POMADASYIDAE

Pomadasys or *Haemuildsare* commonly called as grunts. They belong to the family Pomadusyidae or Haelmuildae coming among the minor perch group. In olden days the family was known as Pristipoma. The genus *Pomadasys* consists of about 25 species. But in India only 6 to 8 species are available. They are *Pomadasys furcatum*, *Pomadasys hasta*, *Pomadasys argenteum*, *Pomadasys maculatum*, *Pomadasys dussumierii*, *Pomadasys guoraka* or *Pomadasys argyreus*, *Pomadasys opercularies* etc. and others are foreign in origin. They are mainly *Pomadasys commersonii*, *Pomadasys corvinaeformis*, *Pomadasys stridens*, *Pomadasys incisus*, *Pomadasys auxlliaris*, *Pomadasys nitidus*, *Pomadasys leucisus*, *Pomadasys macracanthus*, *Pomadasys punctulaties*, *Pomadasys taeniatus*, *Pomadasys andamanesis*, *Pomadasys empherus*, *Pomadasys branickeri*, *Pomadasys quadrilineatus*, *Pomadasys stridens*, *Pomadasys olivaceum*, *Pomadasys leuciscus*, *Pomadasys jubelini* and *Pomadasys thalassinus*. All the fishes of this genus have a compressed and oblong body, colour of the body highly variable ranging from uniformly coloured to banded, blotched and spotted. No comprehensive and detailed account of this fishery & its fluctuations in space and time is available till now. So *Pomadasys maculatus* has been taken for the study of biology, distribution & abundance.

Review of the Previous Works on different Species of *Pomadasys*

Many workers have reported, about the different species of the genus *Pomadasys*. Most of the works concentrated in foreign countries. Deshmuk (1973) studied the fishery and biology of *Pomadasys hasta* (Bloch). The fish had shown intermittent feeding habit, feeding mainly on crustaceans like squilla, crab and prawns and teleostean fish. Turbidity induced changes in feeding strategies of fish - *Pomadasys commersonnii* of estuaries was studied by

Hecht *et al*.(1992). *Pomadasys commersonnii* was found to be a macrobenthic carnivore fish and turbidity had no effect on size selection of prey, but feeding rate was reduced at higher turbidity levels. Cyrus and Blaber (1987) found that *Pomadasys commersonnii* was indifferent to turbidity. Hussian and Naama (1992) studied the morphology of alimentary tract, relative gut length, mouth characteristics and dentition of *Pomadasys argentus*. Lewis *et al*.(1994) found that *Pomadasys maculatus* is a benthic carnivore and any toxic effect of gambiertoxins on shrimp would encourage these fishes to feed on selectively these infected shrimps. Various aspects of the biology of *Pomadasys stridens*, Forskaal from the west coast of the United Arab Emirates were studied by Al-ghais (1995). Biology and biometry of the roughneck grunt, *Pomadasys corbinaeformis* was studied by Costa *et al* (1995). Diet included food item such as crustacean, polychaetes, fishes and seaweed.

Pomadasys hasta was one of the important catches obtained in hooks and lines by mechanised vessels at Sassoon Docks, Bombay, India (Krishnapillai, 1982). *Pomadasys corvinaeformis* is more abundant in mangrove area during a specific stage of its life cycle and does not use this area to maturation and spawning (de-Tarso-da-Cunha-Chaves, 1998). In the study of fish species composition and richness of lagoons and estuaries of Ghana, Dankwa and Entsua, (1997) found that *Pomadasys* specimen was one of the most common and abundant finfish species. During the study of the exploitation and conservation of angling fish in two South African estuaries. Baird *et al* (1996) found that gill net catches indicate a decline in the abundance of the most popular angling fish species-the spotted grunter, *Pomadasys commersonnii.* Their specimens of *Pomadasys incisus* were caught near San Remo (Italy) in October 1991. (Gavagnin *et al*, 1994). *Pomadasys maculatus* was obtained during the biological investigations of the coastal fish stocks of the Sofala Bank Mozambique (Schultz, 1991) du-Preez *et al*.(1986) observed that the routine oxygen consumption of *Pomadasys commersonnii* was higher during the night than during the day. The somatic karyotype of *Pomadasys hasta* from Indian brackish water (2n = 48T) belonging to Haemulidae was studied by Khuda - Bukhsh and Nayak (1990). *Pomadasys commersonnii* laid pelagic eggs in the St. Lucia estuary (Connell, 1996). *Pomadasys hasta* (Bloch) exhibited single restricted spawning period during October to December (Deshmukh, 1973). Zang-Renzhai (1987) in his study of the development of fertilized egg and larvae of spotted grunt found that eggs of this fish are spherical, isolated and buoyant measuring 0.66–0.81 mm in diameters. The yolk is colourless and transparent with a single oil globule, 0.19–0.23 mm in diameters. Sexual dimorphism of *Pomadasys maculatus* was studied by Tessy and Inasu (1998 b). Samuel *et al* (1987) observed that even though *Pomadasys argenteus* have clear marks on their otoliths, validation shows that the marks are not formed annually. Brothers and Mathews (1987) found that growth increment, width patterns were consistent with the regular appearance of seasonal growth interruptions and other zonations in *Pomadasys argenteus*. Iqbal (1989) presented the length frequency data for *Pomadasys kakkan* obtained during a survey conducted in Pakistan waters. The growth marks on otolith were used to estimate the age in *Pomadasys stridens* (Al-ghais, 1995). Thermoregulatory behaviour of Juvenile spotted grunter *Pomadasys commersonnii* was studied by Deacon and Hecht (1996). During the study of the effect of reduced salinity on growth of *Pomadasys commersonnii*, Deacon and Hecht (1999) found that this fish can be successfully cultured in salinities ranging form 12 ppt to full strength sea water (35 ppt). Growth of *Pomadasys kakkan* from the coast of Pakistan was studied by Majid and Imad (1991). Ahmad and Al-ghais (1997) observed in their study of relation between age and heavy metal content in the otoliths of *Pomadasys stridents*, that the weight of otolith at the age two years was significantly different with other age group sample and between both sexes. In *Pomadasys argenteus* age determination was done by the application of otolith microstructural studies.

Two new species of digenetic trematodes namely *Proctotiema gruptai* and *Ametrodaptes fischthali* were obtained from the intestine of *Pomadasys maculatus*. Rabbani *et al*.(1990) found that a dinoflogellate bloom caused mass mortality of fishes like congresox species (pike conger), *Pomadasys maculatum* (saddle grunt) and *Terapon puta* (small scaled terapon). The Parasitic dinoflagellate *Oo-dincum ocellatum* was reported in *Pomadasys olivaceum* of Karachi coast (Bilqees, 1992). A new species of parasitic copepod, Parashinoa found attached at the base of the dorsal fins of two species of Australia haemulid fishes, *Pomadasys maculatus* and *Pomadasys argenteus*. Nine species of monogenus were collected form the fish *Pomadasys hasta*, by Lim (1995) Gibbons and Saayman (1996) found parasite *Dichelyne rasheedac* from the intestine of Pomadasys commersonnii, during a survey of parasites of fish in lake St. Lucia, South Africa. *Koronacantha mexicana*, a new species and genus of Accanthocephala was found in the intestine of *Pomadasys leuciscus* form the marine waters of Chamela Bay, Mexico (Monks *et al* 1996). Santha *et al*.(1985) studied the occurrence and nature of fin and tail rot disease in *Pomadasys hasta*. In the study of multiple ciguatoxins in the flesh of fish, Lewis and Sellin (1992) found that in *Pomadasys maculatus*, ciguatoxin-1, cigcatoxin-2 and ciguatoxin-3 were present in order 0.67, 0.61 and 0.06 mg/kg of flesh, respectively.

Even though many works on the family - Pomadasyidae were carried out in different species of the genus *Pomadasys* in foreign countries, the works of the genus in India are scarce and scanty. So I have selected *Pomadasys maculatus* for detailed biological study in my thesis.

Scope of the Present Work

In the last 10 years, the worlds catch of fish in fresh water and in the sea have doubled. Due to this some stocks are under exploited. Many methods used in the study of fishery biology by which stocks may measure, conserved and properly exploited. Though finfish culture practices are well established in the inland waters, scientific way of sea farming has not developed in our country when compared with the remarkable progress achieved in the field, employing open sea farming techniques like pen culture, cage culture, etc.; in other parts of the world. Many species of fishes such as milkfish, mullets, perches and eels are found to be suitable for culturing in saline lagoons and ponds. It has been admitted all around that a considerable portion of future addition to the world marine fish production may have to come from culture fisheries of brackish waters and estuaries, swamps, mangroves, coastal lagoons and coastal areas. In this global strategy India can play a catalytic role. Comprehensive public information on marine fish and fisheries of India is not adequate and the information available at present is widely scattered. In this context I have selected this topic i.e., to study the biology of *Priacanthus hamrur* and *Pomadasys maculatus*, which are having high commercial and nutritional importance.

Priacanthids are compitable with other popular table fishes in nutritive value. These fishes from the Waltair coast are consumed both in fresh and dried condition and are very popular with the poorer section of the people (Rao, 1984). Its meat is of high nutritional value with 17.5% protein and 5.1% fat (John & Sudarsan, 1988). In South East Asian countries Priacanthids are highly prized and have a good international market. It would be very useful to popularise the priacanthids in the domestic as well as international markets because of the paucity of fish protein in the present days. *Pomadasys* is also having favourable nutritive value and it is popular with the poor people.

The first part of the present work aims to explore the entire edible perches of Central Kerala. The knowledge of fish fauna will also give an insight in to the fish distribution. The distribution of a locality is solely determined by the prevailing ecological factors.

Perches constitute an important group of edible fish species of sea. The investigations on the biology of these fishes are inadequate for their conservation. The second part of the present work aim to study the different biological aspects of these two species *Priacanthus hamrur* and *Pomadasys maculatus*. The success of the fishery contributed by a species mainly depends on the high rate of fecundity, growth and feeding. The investigation on the entire biology of the species may also bring out certain applications and techniques leading to the spawning and culture of these fishes. For technologically and economically viable culture practice selection selection of the candidates species is equally or more important than any of the environmental factors and culture system management. In order to achieve the maximum production from a well managed culture system it is highly imperative to have a deep knowledge on the biology, behaviour and physiological requirements of the species cultured. In this thesis an attempt is made to bring out all the important biological aspects such as age and growth, length-weight relationship, feeding habits and reproductive patterns of *Priacanthus hamrur* and *Pomadasys maculatus*.

CHAPTER - 2

SYSTEMATICS

CHAPTER – 2

SYSTEMATICS

INTRODUCTION

Fishes are the most abundant, diverse and poorly known group of vertebrate animals. They are considered to be the largest group of vertebrate known. Joseph Nelson (1984) in the second edition of his excellent book "Fishes of the world" estimates that, there are some 21,723 species of living fishes. By the discovery of new fishes, the number of living fish species may eventually approach 28,000 (Smith 1978, 1986). Fishes have colonised every aquatic habitat on earth from lakes, rivers, caves and hot (44° C) fresh water pools to polar sea (-2° C), tropical reefs and the deepest ocean bottoms.

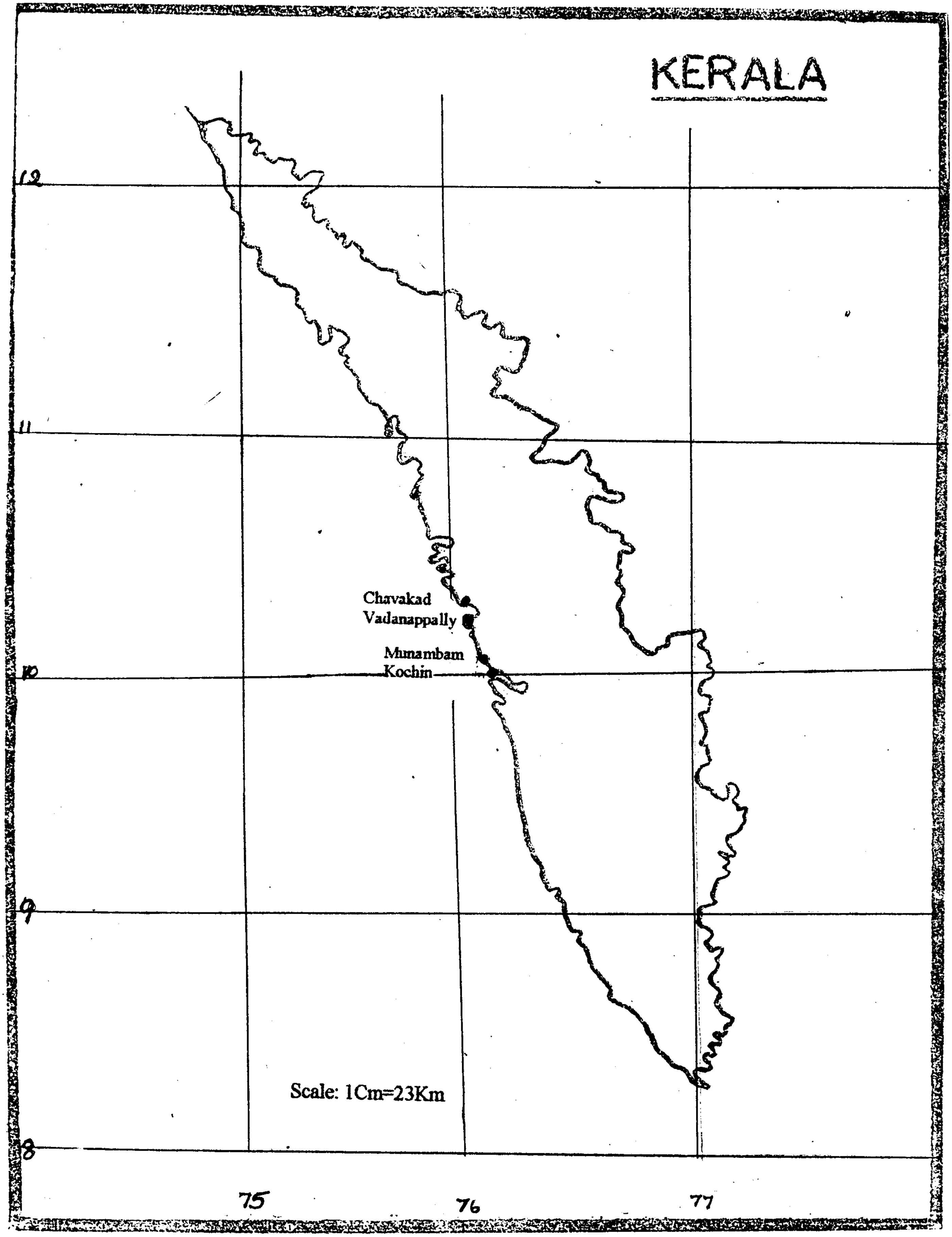
Of the total fishes known about 60% are known to live in tropical waters, others are fresh water or diadromous. Classification as marine, diadromous or fresh water is impossible except as a generalization for same species. Taxonomy of fishes is a tool for the identification of species, thereby providing the fishery workers in the country with an aid, which will allow continued improvement of precision in future data gathering and analysis (Talwar & Kacker, 1984). Not only that, for the harvest of these aquatic resources, a scientific understanding of the fish species with respect to their morphological, biological and adaptive characters along with their natural distribution is imperative to back up their optimum exploitation. In the investigation of fishery biology and distribution of concerned species the correct identification of fish is an essential pre-requisite. Systematics is the study of organisms, their diversity and interrelationship with the aim of arranging them in an orderly manner.

The two functions of taxonomy are 1, to identify and describe the basic taxonomic units (species) and 2, to devise an appropriate way of arranging and cataloguing these units. As mentioned above taxonomy is ordering the organism into groups based on their relationships. In higher organisms much attention is paid to trace out the ancestry while ordering them into groups in the phylogenetic trace. Many scientists have contributed on the field of taxonomy of fishes. The major contributions from the Indo-Pacific region are by Day (1875-1878), Weber and de Beaufort (1929), de Beaufort (1940), Smith (1949), de Beaufort and Chapman (1951), Munro (1955), Gunther (1963), Thobias (1973), Rangarajan (1973), Fisher and Whitehead (1974), Kurup (1981), Talwar and Kacker (1984) and Inasu (1991).

The group of perches belongs to the order perciformis. This order is the most diversified of all fish orders and indeed the largest vertebrate order comprising about 150 families and some 7,800 species (Joseph Nelson, 1984). These fishes are abundant in coastal waters and more particularly around the coral reefs and on rocky sea bottom of sea even at considerable depths. Many families of this group show similarity and are very difficult to separate them from one another. It is very difficult to prepare a relatively simple operative key to the numerous families of the order. So the present study focussed entirely on the distribution of edible perches of central Kerala. No attempt has been made so far to conduct a comprehensive integral study on the systematics of the perches of central Kerala. The collection was made from Munambum, Chavakkad and Kochi during the period from 1996 June to 1997 May. During this period 36 species of perches belonging to 10 families were collected. Characters of the various families of the perches collected, and a key to the classification of their genera and species (occurring in this area) were presented in this chapter.

Next page April 1996 to March 1997 Which is correct?

19A



KERALA
12
11
10
9
8
Chavakad
Vadanappally
Munambam
Kochin
Scale: 1Cm=23Km
75
76
77

10

MATERIALS AND METHODS

The fishes for the present study belonging to the order "Perciformis" were collected from the trawl landings at Munambum, Chavakkad and Kochi(76^0E 10^0N) during the period from April 1996 to March 1997. Immediately after collection they were put in icebox and brought to the laboratory. After careful washing, the specimens were kept on a plywood board to spread out the dorsal, anal and caudal fin by using small pins. With the help of a camel brush a little concentrated formalin was applied on the fins and allowed to remain for a few minutes to harden these structures. Then these fishes were preserved in 5% formalin for the detailed study of morphometric and meristic characters. Details of the colouration in the fresh specimens were noted. In the laboratory the specimens were carefully washed and the following measurements were taken. Then the collected fishes were identified up to the species level with the help of best and recently available identification keys. The following measurements of all the collected fishes were taken.

Total Length: The greatest distance between the most anterior projected part of head to the posterior most tip of caudal fin including filamentous prolongation.

Standard Length: Distance from the tip of the snout to the end of the vertebral column.

Greatest Body Depth: Vertical measurement from a point in the body of the fish on its back where its height is greatest to a straight line to the ventral surface or profile.

Head Length: Taken from the tip of the snout to the posterior most point reached by the fleshy margin of the opercle.

Pre-dorsal Length: Measurement from the tip of the snout or upper lip or anterior most part of the head to the structural base of the first dorsal fin ray.

Caudal Peduncle Length: Distance from the last point of anal fin posterior to the end of vertebral column.

Snout to Anal Fin Length: Length from the tip of the snout to the basal part of the beginning of the anal fin.

Length of the basal part of Dorsal fin: The length of the basal part between the two ends of the dorsal fin.

Length of the basal part of Anal fin: The length of the basal part of the anal fin between the two ends of it.

Eye Diameter: Distance between margins of the cartilaginous eyeball across the cornea.

Inter Orbital Width: The least distance between the upper rims of each orbit wherever the eyes are separate.

Snout Length: The distance between the tip of the snout to the anterior rim of fixed eye.

Of these, all body measurements are expressed in percentage of total length except snout length, orbit diameters and inter orbital width, which are expressed in percentage of head length. Due to morphological differences, the number of characters studied varied from family to family. The accurate enumeration of eristic data or counts of fin rays is of diagnostic importance. The number of simple and branched rays of fins was taken with great care to get the fin formula.

CHARACTERS AND KEY OF THE IDENTIFIED FISHES

The out line classification of Perches is as follows:

Super class	–	***Gnathostomata***
Class	–	***Osteichthyes***
Sub class	–	***Actinopterygii***
Sub division	–	***Teleostei***
Infra division	–	***Euteleostei***
Super order	–	***Acanthopterygii***
Order	–	***Perciformis***
Sub order	–	***Percoidei***

Distinguishing Characters of the Order Perciformis

Body was generally oblong and not elongated. Eyes were lateral in position. Pre-opercula were entire or serrated. Mouth in front of the snout, had a lateral cleft. Teeth are present in the jaws. Body covered with ctenoid scales. Spines are present on the dorsal, anal and pelvic fins. Pelvic fin has a single spine with five or few soft rays. Adipose fin is absent and slit seen behind the last gill. Five to seven branchiostegals are present. A total of 36 fishes of the order perciformis were collected from the centers. They belong to 10 different families. Characters of these families and key to the genera and species of the collected fishes are presented here.

Family – Ambassidae

Small translucent brilliant silvery fishes of shallow tropical waters. They are commonly called as glassfishes. Body is oblong, laterally compressed. Mouth is large. Teeth are present in jaws and on roof of mouth. A single poorly developed spine present on the operculum. A characteristic feature of the family is the presence of the pre-operculum with double edge. Dorsal fin deeply divided before last spine. The first dorsal fin with 7 spines and the 2nd dorsal fin with one spine and 9 to 17 soft rays. Pectoral fins rounded. Anal fin with 3 spines. Pelvic fin with one strong spine and 5 soft rays and caudal fin is forked. Body covered with thin small cycloids scales. Dorsal and anal fins in a scaly basal sheath. Branchiostegal rays six. Usually brilliant silvery white in colour. Not of commercial importance, but useful as bait. They are also used as manure.

Key to Genera

Only one genus obtained.

1. (a) Scales large, 1 or two transverse rows of scales are present on cheek – *Embassies*

   (b) Scales relatively small, 4 or more transverse rows of scales on cheek – 2 *China or Parambassis*

Genus – Ambassis (Cuvier)

Body compressed and covered with large cycloid scales. Mouth quite large and oblique. Teeth present in jaws, roof of mouth and tongue. Spinous dorsal fin deeply notched to form 2 separate dorsal fins. Second dorsal spine longest and usually stouter.

Key to Species

1. (a) The Supra orbital ridge dentate. Inter operculum entire. Pre orbital dentate on both edge and ridge – 2

   (b) Supra orbital ridge smooth, with a single backwardly directed spine – 3
2. Posterior edge of pre operculum entire. Second dorsal spine longer. The third anal spine is longer – *Ambassis gymnocephalus*
3. (a) Inter operculum smooth – 4

(b) Inter operculum denticulate posteriorly – 5

4. Lateral line is continuous. Only one transverse row of scales was present on cheek. Pectoral fin shorter than the head, but longer than ventral –

Ambassis commersonnii

5. (a) Posterior margin of pre-operculum was denticulate. Lower jaw longer lateral line scales are about 30 in number –

Ambassis dayi

(b) Half of the posterior margin of the inter-opercula is strongly serrated. Lateral line scales about 35 to 43 –

Ambassis thomassi

(Plate-1) *Ambassis dayi* (Bleeker)

Ambassis malabraricus : Cuv & Val, 1849; *Jerdon, Madr. Journ Lit & Science,* 1849; No. XV, p. 140

Ambassis dayi : Bleeker, 1874; *Nat – Verh. D. Holland Maats. d. Weten. 3 de Verz. Deel 11*, No. 2, p. 95

Ambassis nalua : Day, 1878; Fish Malabar, p. 15

Specimens Examined

A total of 14 specimens collected during the period.

Munambum – 0, Chavakkadu – 10, Vadanappally – 4, Kochi – 0

Total length – 84 mm, Standard length – 65 mm, Body depth – 19%, Head length – 20%, Pre dorsal length – 35%, Caudal peduncle length – 28%, Snout to anal fin length – 12%, Length of basal part of dorsal fin – D_1 30%, D_2 32%, Length of basal part of anal fin – 12%, Eye diameter – 39%, Inter orbital space – 69%, Snout length – 46%.

Description

B. Vi, D. (1/10-11), P. 16, V. (1/5), A. (3/10), C. 16

Body is elongate and more or less elevated. Snout pointed. Lower jaw longer. Mouth opening not very oblique. Pre-orbital serrated along its lower border. Vertical limb of pre opercula with some very minute serration in the largest specimen. Two separate dorsal fins present. The 1st and 2nd anal spines are equal length, but second one is stronger. Caudal fin deeply forked. Lateral line continuous.

Colour:- Body silvery in appearance glossed with purple, interspinous membrane between the 2nd and 3rd dorsal spines is dark. Caudal lobes are dark or black in colour. The edges of the dorsal and anal fins are dark.

Distribution:- Malabar coast of India. Found in the inland waters of Munambum and Chavakkadu.

Remarks:- Not great value as food fish.

(Plate-2) *Ambassis commersonnii* (Cuvier)

Ambassis commersoni : Cuv & Val, 1828; *Hist. Nat. Poiss.*; 2: 176, pl. 25, fig.29
Ambassis macracanthus : Bleeker, 1870; *Hist. Nat. Poiss.*, perc. p. 30, Gunther
Ambassis ambassis : Flower, 1905; *Proc. Acad Nat Acit* – Philadelphia
Chanda ambassis : Chaudhari, 1923; *Mem Indian Mus.*, 5: 715
Ambassi urotaenia : Blecker: Day, 1875, *fishes of India* 55

Specimens Examined

40 specimens collected from central Kerala during the period.
Munambum – 18, Chavakkadu – 10, Vadanappally – 6, Kochi – 6

Plate 1 . *Ambassis dayi* (Bleeker)

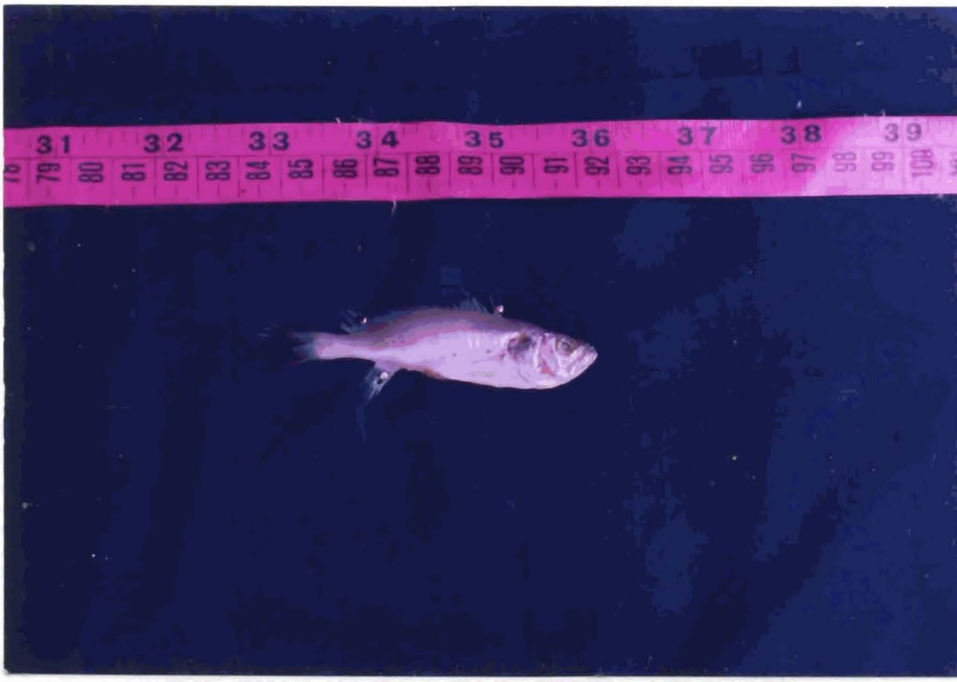


Plate 2. *Ambassis commersonnii* (Cuvier)

Total length – 78 mm, Standard length – 55 mm, Body depth – 38%, Head length – 33%, Pre dorsal length – 47%, Caudal peduncle length – 42%, Snout to anal fin length –20%, Length of basal part of dorsal fin – D_1 32%, D_2 33%, Length of basal part of anal fin – 22%, Eye diameter – 44%, Inter orbital space – 28%, Snout length – 33%.

Description

B. Vi, D. 7(1/9-11), P. 13, V. (1/5), A. (3/9-10), C. 15

Body oblong and laterally compressed. Dorsal profile ascending in a curved line. Inter operculum entire, not serrated. Mouth oblique chin prominent pointed teeth in the upper jaw and in the lower jaw. Teeth present on the tongue. First dorsal spine minute, second one stronger and longer than others, third anal spine somewhat longer than the second one pectorals shorter than head, but longer than ventrals. Caudal fin deeply forked. Lateral line straight and continuous scales small, cycloid lateral line continuous, one row of scales on cheek.

Colour:- Yellowish or silvery with a silvery lateral band. Fin membranes between second and third dorsal spine dusky, blackish in its distal part.

Distribution:- They extend from red sea through those of India to North Australia. It ascends rivers and estuaries, attaining to six inches in length. Found in the inland waters of Munambum, Chavakkadu and Cochin.

Remarks:- Very common along the coast of India used as food, and as a bait for capturing other economically important fishes.

(Plate-3) *Ambassis thomassi* (Day)

Ambassis thomassi : Day, 1870; Proc. Zool. Soc. p. 369

Paraambassis thomassi : Guha & Talwar, 1985; *J. Inland Fish. Soc. India*, 8: 77

Specimens Examined

A total of 30 specimens collected from the regions of central Kerala during the period.

Munambum – 15, Chavakkadu – 10, Vadanappally – 5, Kochi – 0

Total length – 80 mm, Standard length – 60 mm, Body depth – 37%, Head length – 33%, Pre dorsal length – 47%, Caudal peduncle length – 35%, Snout to anal fin length – 68%, Length of basal part of dorsal fin – D_1 36%, D_2 32%, Length of basal part of anal fin – 28%, Eye diameter – 30%, Inter orbital space – 20%, Snout length – 30%.

Description

B. Vi, D. 7(1/10-12), P. 15, V. (1/5), A. (3/9-10), C. 15

The younger specimens are rather more oval than the adults. Lower jaw longer. Ventral limb of pre opercula finely serrated, posterior half of the interopercle strongly serrated. Mouth large, teeth present in both jaws. No teeth on tongue. Second dorsal spine strong. The ventral reaches as far as the anal spines. Second anal spine equals to that of the third. Caudal fin deeply forked. Lateral line continuous.

Colour:- Silvery greyish. There are brownish basal spots on many of the scales, more especially along the back.

Distribution:- The coasts of Canara as low as Cochin. It is found some distance inland even in elevated localities. Found in the inland waters of Munambum, Chavakkadu and Cochin.

Remarks:- Very common in our area. Not of much food value.

(Plate-4) *Ambassis gymnocephalus* (Lacepede)

Lutianus gymnocephalus : Lacepede, 1802; Hist. Nat. Poiss.; 3: 181, 21b, pl.23,fig. 3

Ambassis dussumieri : Cuv & Val, 1828; *Hist – Nat Poiss.*, 11

Chanda dussumieri : Gunther, 1850; *Cat. Brit. Mus.*, I

Ambassis gymnocephalus : Bleeker, 1874; *Nat. Verh. Hall*

Ambassis gymnocephalus : Day, 1875; *Fishes of India*

Priopis gymnocephalus : Jordan and Seale, 1905; *Pro. U.S. – Nat*, p. 780

Priopis gymnocephalus : Chaudhuri, 1923; *Mem. Indian Mus.*

Specimens Examined

50 specimens collected from central Kerala.

Munambum – 20, Chavakkadu – 12, Vadanappally – 14, Kochi – 4

Total length – 110 mm, Standard length – 88 mm, Body depth – 25%, Head length – 28%, Pre dorsal length – 40%, Caudal peduncle length – 35%, Snout to anal fin length – 14%, Length of basal part of dorsal fin – D_1 22%, D_2 18%, Length of basal part of anal fin – 15%, Eye diameter – 45%, Inter orbital space – 72%, Snout length – 50%.

Description

B. Vi, D. 6-7(1-/8-10), P. 15, V. (1/5), A. (3/9-10), C. 17

Body elongate and laterally compressed supra orbital ridge dentate with 2 or 4 developed spines. Scales small and cycloid lateral line interrupted in middle portion. Mouth much more oblique. Villiform teeth in jaws. Teeth on tongue. First dorsal spine is small, but the second one is about equal to the head length, dorsal spines are strong. The 2^{nd} being a little longer. The ventral fin reaches about two thirds of the distance to the anal. The third anal spine is longer. Caudal fin forked.

Plate 3 . *Ambassis thomassi* (Day)

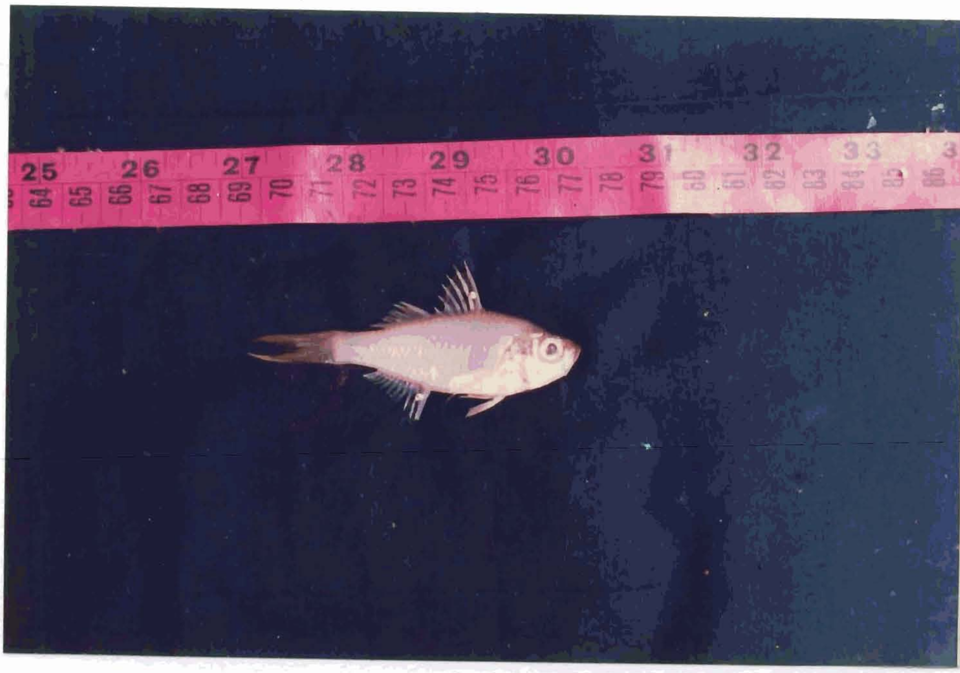
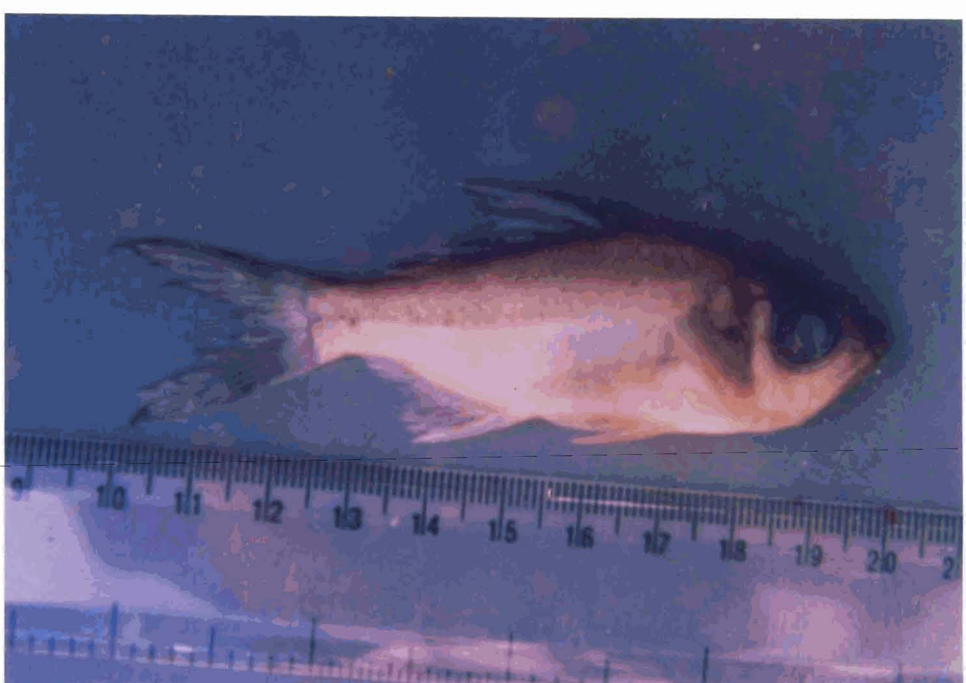


Plate 4. *Ambassis gymnocephalus* (Lacepede)



Colour:- The body colour is silvery with a bright longitudinal lateral band. Alcohol specimens seem to be yellowish brown with silvery reflection on the side of head and body. A dark stripe in median line of tail, not always distinct. A black spot posteriorly on fin membrane between 2nd and 3rd dorsal spines. The third anal spine is longer.

Distribution:- East coast of Africa, Seas of India to Malay Archipelago and China. Found in the inland waters of Munambum, Chettuvai, Vadanappally and Cochin.

Remarks:- This species though small in size, is caught in fairly large numbers along the coast of our region.

Family – Apogonidae

Body oblong and compressed, covered usually with ctenoid scales, sometimes cycloid scales are also present. Mouth usually large. Teeth present in jaws. 6 to 8 spines in the 1st dorsal fin. In the second dorsal fin only one spine and 8 to 14 rays present. Anal fin with 2 spines and 8 to 18 branched soft rays. No scaly sheath on dorsal and anal fins. Seven branchiostegals are present. They occur usually in shallow waters. Some found in deep water. Carnivorous in diet. Many of these fishes are attractively patterned and brightly coloured. No commercial importance, but play a role in the food cycles.

Key to Genera

About 22 genera. Only one genus obtained during collection.

1. Anal fin with 2 spines dorsal fin with 6 to 8spines. Teeth in jaws present – 2
2. Opercle with a single poorly developed spine, first dorsal fin with 6 to 8 spines – 3
3. Teeth feeble, no canines – 4

4. Longest secondary caudal rays bilateral and segmented – 5
5. Lateral line complete. Pre-opercle always serrated – 6
6. Anal fin with 2 spines and 10 or less rays. Caudal fin emarginated – *Apogon*

Genus – *Apogon*

Elongate oblong body with ctenoid scales posterior margin of pre-opercle serrated. Teeth feeble. Palatine teeth present. Six spines in 1st dorsal fin, anal fin with 2 spines. Lateral line complete.

Key to Species

Only one species was obtained during collection.

1. First dorsal fin has 7 spines – 2
2. Pre-opercle ridge serrated. Suborbitals with spines – 3
3. Dark stripe along body narrowing towards tail – *Apogon frenatus*

(Plate-5) *Apogon frenatus* (Valenciennes)

Apogon frenatus : Val., 1832; *Nonv. Ann. Mus. Hist. Nat.*, p. 57

Apogon vittiger : Bennett, 1833; *Proc., Zool. Soc.*, p. 32

Apogon melanorhynchos : Bleeker, *Amb & Cream*, p. 255 & I.C.P. 26

Amia frenatus : Bleeker, *Atl. Ich. Perc. t. IXIV*, fig. 2, & Apogonini, p. 42

Pristiapogon frenatus : Smith, 1961

Specimens Examined

A total of 36 specimens collected from various regions of central Kerala during the period of 1995 April to 1996 December.

Munambum – 4, Vadanappalli – 6, Chettuvai – 26

Total length – 78 mm, Standard length – 60 mm, Body depth – 35%, Head length – 33%, Pre dorsal length – 30%, Caudal peduncle length – 47%, Snout to anal fin length – 40%, Length of basal part of dorsal fin – D_1 31, D_2 28%, Length of basal part of anal fin – 22%, Eye diameter – 44%, Inter orbital space – 28%, Snout length – 33%.

Description

B. Vii, D. 7/(1/9), P. 16, V. (1/5), A. (2/8) C. 17

Body elongate. Jaws are about equal length. The outer edge of the pre-opercle serrated. A small opercular spine present. Pectoral fin as long as the head excluding the snout. The ventral reaches two thirds of the distance to the anal. Caudal fin notched. Lateral line is well developed.

Colour:- Slight reddish. A dark band passes from the eye to the middle of the caudal fin. A black band is present along the bases of the second dorsal and anal. All the fins are black tipped. Sometimes a black spot may be present at the base of the caudal fin.

Distribution:- Mauritius, Seas of India to the Malay Archipelago and beyond. Found in the inland waters of Munambum, Kochi, Vadanappalli and Chavakkadu.

Remarks:- Very common in Central Kerala. Not of much commercial importance as food fish.

Family – Gerridae

Small to medium sized fishes. Body rather compressed and oblong. Scales large and shiny. Mouth small, strongly protrusible, pointing downward when protracted. Gill membranes free from isthmus. Teeth small present in both jaws. No teeth on roof of mouth. Dorsal fin long with spines and soft rays. Pectoral fins long and pointed. Pelvic fin bears a long scaly process. Caudal fin deeply forked. Flesh excellent, but spoils very rapidly. Occurring in all warm seas. A few species prefer more temperate waters. Many genus. Only one genus collected.

Key to Genus

1. Anal fin with 3 spines and 7 soft rays – 2
2. Dorsal fin with 9 spines –

Gerres

Genus – *Gerres*

Body oblong and slightly compressed. Mouth small, highly protrusible fine teeth in jaws. Dorsal fin with 9 spines and 9 or 10 soft rays. Scales moderate, cycloid or finely ctenoid.

Key to Species

1. (a) Second dorsal spine greatly elongated longer than head – 2
   (b) Second dorsal spine not forming a long filament usually much less than head length – 3
2. Pre dorsal distance equal to or less than body depth a series of vertical or horizontal rows of dusky blotches on back and sides of body –

G. filamentosus

3. (a) Body elongate, its depth at least 3 times in standard length –

G. oblongus

   (b) Body deep, its depth 2.0 to 2.8 times in standard length – 4
4. (a) Scales 4 rows between lateral line and dorsal fin origin –

G. limbatus

   (b) Fins very short. Third dorsal spine slightly longer than the second –

G. lucidus

Plate-6) *Gerres filamentousus* (Cuvier)

Gerres filamentosus : Cuvier, 1829; *Regne Animal*, (ed. 2) 2 : 188.

Gerres filamentosus : Day, 1875; *Fishes of India* 98, pl 25

Gerres punctatus : Chaudhuri (nec Cuvier), 1923. *Mem. Indian Mus.*, 5

Gerres punctatus : Smith, *SFSA* No. 628

Specimens Examined

24 specimens collected.

Munambum – 8, Chavakkadu – 6, Vadanappally – 9, Kochi – 1

Total length – 134 mm, Standard length – 105 mm, Body depth – 46%, Head length – 27%, Pre dorsal length – 47%, Caudal peduncle length – 29%, Snout to anal fin length – 71%, Length of basal part of dorsal fin – 52%, Length of basal part of anal fin – 19%, Eye diameter – 34%, Inter orbital space – 17%, Snout length – 50%.

Description

B. Vi, D. 9/(10/11), P. 15, V. (1/5), A. (3/7), C. 17

Body oblong, compressed. Mouth small, strongly protrusible. Fine teeth in jaws. Head and body completely covered with scales which are firmly attached, pre-opercle entire. Opercle with two blunt points. Dorsal fin with 9 spines and 10 or 11 soft rays. Second spine greatly elongated into a filament and longer than head. Caudal fin deeply forked.

Colour:- Body silvery, with 6 to 8 vertical or horizontal rows or dusky blotches on back and sides of body. Caudal greyish, the other fins yellow with numerous fin dots on the fine membrane.

Distribution:- Indo-West Pacific. Inhabits shallow waters, usually found in

Plate 5 . *Apogon frenatus* (Valenciennes)

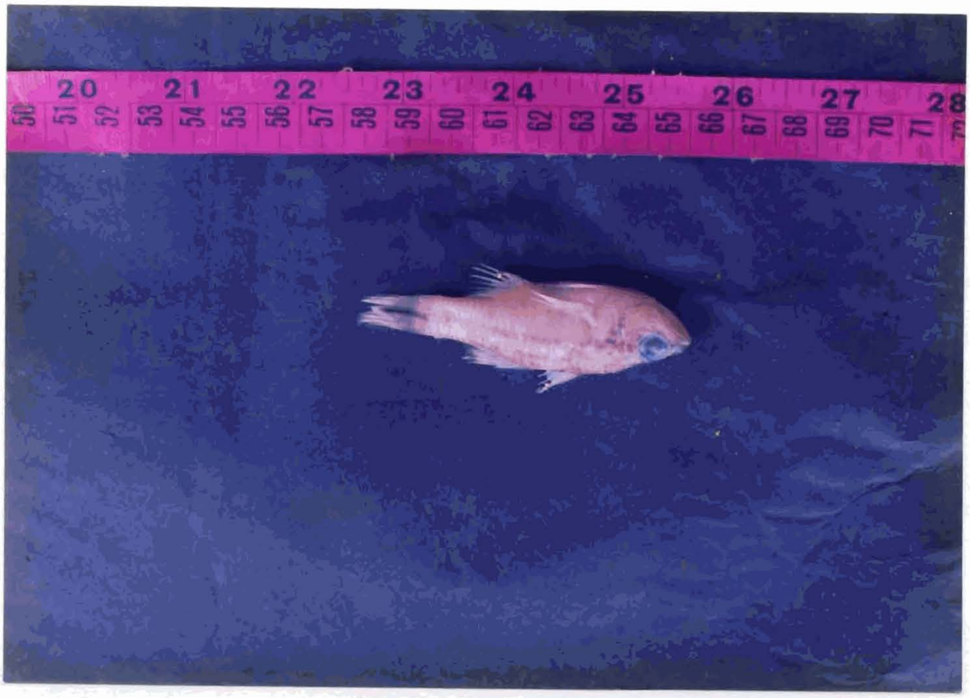


Plate 6. *Gerres filamentousus* (Cuvier)

shoals. Found in the waters of Central Kerala. Collected from Munambum, Kochi, Chavakkadu and Vadanappally.

Remarks:- Excellent food fish. Important fishery on the Rameswaram Island, the peak season being June and July.

(Plate-7) *Gerres limbatus* (Cuvier)

Gerres limbatus : Cuvier, 1830, *Hist. Nat. Poiss.*, 6 : 476

Gerres limbatus : Day, 1875; *Fishes of India.*

Diapeterus limbatus : Bleeker, *Revis. Gerr.*, p. 17

Gerres kapas : Herre (nec Bleeker), 1939; *Rec. Indian Mus.* 41: 336

Specimens Examined

A total of 4 specimens collected.

Munambum – 4, Chavakkadu – 0, Kochi – 0

Total length – 114 mm, Standard length – 83 mm, Body depth – 48%, Head length – 37%, Pre dorsal length – 48%, Caudal peduncle length – 36%, Snout to anal fin length – 78%, Length of basal part of dorsal fin – 58%, Length of basal part of anal fin – 19%, Eye diameter – 18%, Inter orbital space – 10%, Snout length – 21%.

Description

B. Vi, D. (9/10), P. 15, V. (1/5), A. (3/7), C. 17

Body oblong and slightly compressed. Mouth small, strongly protractile. Fine teeth in both jaws. Dorsal fin with 9 spines and 10 soft rays. The 2nd and 3rd spines are longer and about equal length. But, shorter than head. Head and body completely covered with scales which are firmly attached. Lateral line with 33-39 scales.

Colour:- Body silvery with a dark margin to the dorsal and anal fins and a spot on each spine.

Distribution:- Seas of India. Found in the inland waters of Central Kerala.

Remarks:- Good food fish. But minor fishery significance in Central Kerala.

(Plate-8) *Gerres oblongus* (Cuvier)

Gerres oblongus : Cuvier, 1830; *Hist. Nat. Poiss.*, 6 : 479

Gerres oblongus : Day, 1875; *Fishes of India*

Gerres gigas : Gunther, Catal. IV, p. 262

Specimens Examined

A total of 5 specimens collected.

Chavakkadu – 3, Vadanappally – 2

Total length – 120 mm, Standard length – 100 mm, Body depth – 41%, Head length – 31%, Pre dorsal length – 51%, Caudal peduncle length – 35%, Snout to anal fin length – 74%, Length of basal part of dorsal fin – 50%, Length of basal part of anal fin – 15%, Eye diameter – 38%, Inter orbital space – 17%, Snout length – 30%.

Description

B. Vi, D. (9/10), P. 17, V. (1/5), A. (3/7), C. 17

Body elongate and slightly compressed. Mouth small, strongly protrusible. Fine teeth in jaws. Pre-opercle entire dorsal fin with 9 slender spines and 10 soft rays. The second spine longest, but smaller than head length. Anal spines weak. Caudal deeply forked. Body completely covered with scales which are firmly attached. Lateral line with 44 to 48 scales.

Plate 7 . *Gerres limbatus* (Cuvier)

Plate 8. *Gerres oblongus* (Cuvier)

Colour:- Body silvery, eye golden.

Distribution:- Indo-West Pacific. Found in the inland waters of Central Kerala.

Remarks:- Food fish. But minor fishery significance in Kerala.

Family – Lethrinidae

Moderate sized fishes with a large head. Snout pointed. Sub-orbital space is deep. Mouth terminal, moderate, the lips thick and fleshy. Teeth rather small, with 2 or 3 enlarged canines. No teeth on the roof of mouth, dorsal fin continuous with 10 spines and 9 soft rays. Anal fin with 3 spines and 8 rays. Pectoral fins long and pointed. Pelvic fins with auxillary process. Body covered with moderate sized ctenoid scales. No scales on cheeks and top of head. Cornivorous fishes in habiting coastal waters of the tropical and subtropical Indo-West Pacific. Popular food fish two genera one in Kerala.

Genus – *Lethrinus* (Cuv)

Body covered with ctenoid scales. But the cheek naked and smooth. Pre-orbital deep, jaws with canines. Highly coloured tropical fishes of considerable commercial value. About 26 species. Only one obtained during collection. A good character for distinguishing the species is however, the no. of scale rows between the middle of spinous dorsal fin and the lateral line.

Key to Genera

1. Inner base of pectoral fin densely covered with scales – 2
2. No large black blotch on side of body – 3
3. Six scale rows between lateral line and median dorsal spines – 4
4. Pelvic fin membranes with fewer melanophores, especially few on the inside of distal portion. – 5

5. Snout length distinctly more than cheek width, several bright yellow longitudinal stripes conspicuous on body –

L. ramak

(Plate-9) *Lethrinus ramak* (Forsskal)

Sciaena ramak : Forsskal, 1775; *Descript Animal* : 52

Lethrinus ramak : Day, 1875; *Fishes of India.* 137. Day, 1889; *Fauna Br. India*, Fishes, 2 : 40

Lethrinus obsoletus : (Forsskal) Jones and Kumaran, 1980; *Fishes of Faccadive arcehipelago* : 332, Fig. 282

Specimens Examined

A total of 6 specimens collected.

Munambum – 6, Chavakkadu – 0

Total length – 150 mm, Standard length – 124 mm, Body depth – 35%, Head length – 34%, Pre dorsal length – 42%, Caudal peduncle length – 20%, Snout to anal fin length – 76%, Length of basal part of dorsal fin – 50%, Length of basal part of anal fin – 16%, Eye diameter – 29%, Inter orbital space – 15%, Snout length – 32%.

Description

B. Vi, D. (9/9), P. 1, V. (/), A. (3/8), C.

Body fairly compressed. Teeth present in jaws. Canines moderate. Dorsal fin continuous. Six rows of scales between lateral line and base of medium dorsal spines. Inner bases of pectoral fins densely covered with scales.

Colour:- Head dark purple, body paler orange longitudinal stripes on fresh fishes.

Distribution:- Indo-West Pacific. Found in the inland waters of Munambum.

Remarks:- Utilised commercially in small quantities.

Family - Lutjanidae

Body moderately elongate and oblong. It is compressed and covered with moderate or small ctenoid scales. No scales on anterior part of head. Some rows of scales on pre-operculum and on gill cover. Upper jaw protractile. Jaws with distinct canines. Teeth present on roof of mouth also. Preopercle serrate. Dorsal fin continuous or with a shallow notch, with 10 to 12 spines. Snappers are important food fishes. They are generally found in shallow waters.

Key to Genera

Many genus. Only two specimens obtained.

1. Soft dorsal and soft anal fins scaled or with a low basal scaly sheath – 2
2. (a) Caudal fin strongly forked, the lobes usually slender – 3
   (b) Caudal fin slightly forked, often truncate, emarginate or lunate. Pectoral fin with 15 to 17 soft rays – 4
3. Lower jaw without median knob. Pectoral fin with 20 to 22 soft rays – *Caesio*
4. Soft dorsal and soft anal fins with scales on their bases – 5
5. Caudal fin truncate, emarginate or lunate. Soft dorsal and anal fins not forming long, pointed lobes – 6
6. Mouth larger, not upturned, some caniniform teeth in jaws – *Lutjanus*

Genus – *Lutjanus* (Bloch)

Medium sized fishes. Body oblong or somewhat elongate, rather compressed covered with moderate ctenoid scales. Mouth moderately large.

Teeth present in jaws and on roof of mouth. Outer row of caniniform teeth also present. Pre-operculum serrate, dorsal fin continuous, with 10 or 12 spines and 11 to 16 soft rays. Pectoral fin long and pointed, with 15 to 17 soft rays. Caudal fin truncate, or slightly forked.

Key to Species

Several species. 4 species obtained during collection.

1. (a) Longitudinal rows of scales above lateral line parallel to it anteriorly – 2

   (b) Longitudinal rows of scales above lateral line appear to rise obliquely to dorsal profile – 3

2. A large black blotch usually present above lateral line at junction of spinous and soft dorsal fins –

   Lutianus johni

3. (a) Scales on head beginning above middle of eyes. Temporal region scaly– 4

   (b) Scales on head beginning above behind eyes. Temporal region naked – 9

4. Pre-opercular notch slightly developed – 5

5. (a) Dorsal fin with 10 spines. 6 or more rows of scales between lateral line and medium dorsal spines – 6

   (b) Dorsal fin with 11 spines 5 rows of scales between lateral line and 8 median dorsal spines – 8

6. No dark lateral band from eye to caudal fin – 7

7. Scale rows 6, between lateral line and median dorsal spine. Preorbital and sub-orbital bones rugose. An yellow mid lateral stripe from eye to caudal fin base –

   L. lutjanus

8. Lower pre-opercular rim scaly. A pominent dark yellow lines extends from tip of snout through eye to caudal fin –

   L. lineolatus

9. Longitudinal rows of scales below lateral line appear to rise obliquely – 10

10. Anal fin with 8 or 9 soft rays. No dark transverse bands – 11

11. Dorsal fin with 11 spines – 12

12. Inter orbital width broader 3.0 to 3.7 times in head length. Pre-opercular notch shallow. A saddle like black blotch on caudal peduncle –

L. malabaricus

(Plate-10) *Lutjanus malabaricus* (Day)

Sparus malabaricus : Bloch & Schneider, 1801; *Syst. Ic bth.* 278

Lutianus malabaricus : Day, 1875; *Fishes of India* : 31 pl. 9

Lutianus dodecacanthus : (Bleeker): Day, 1875, *Fishes of India*: 33, pl 10

Lutjanus malabaricus : Day, 1889; Fauna Br. India, Fishes 1: 466

Mesoprion malabaricus : Cuv. & Val. ii, p. 480

Specimens Examined

A total of 12 specimens collected.

Munambum – 8, Chavakkadu – 4

Total length – 150 mm, Standard length – 124 mm, Body depth – 48%, Head length – 40%, Pre dorsal length – 44%, Caudal peduncle length – 28%, Snout to anal fin length – 89%, Length of basal part of dorsal fin – 58%, Length of basal part of anal fin – 20%, Eye diameter – 24%, Inter orbital space – 20%, Snout length – 32%.

Description

B. Vi, D. (11/13), P. 17, V. (1/5), A. (3/9), C. 17

Body not compressed, a slight concavity over the orbits. Body depth 2.2 to 2.3 times in standard length, with head profile cover in adults. Interorbital space strongly convex, 3.0 to 3.7 time in head length. Edge of pre-operculum finely serrated. Small teeth are present in jaws. Canine teeth present on the

Plate 9 . *Lethrinus ramak* (Forsskal)

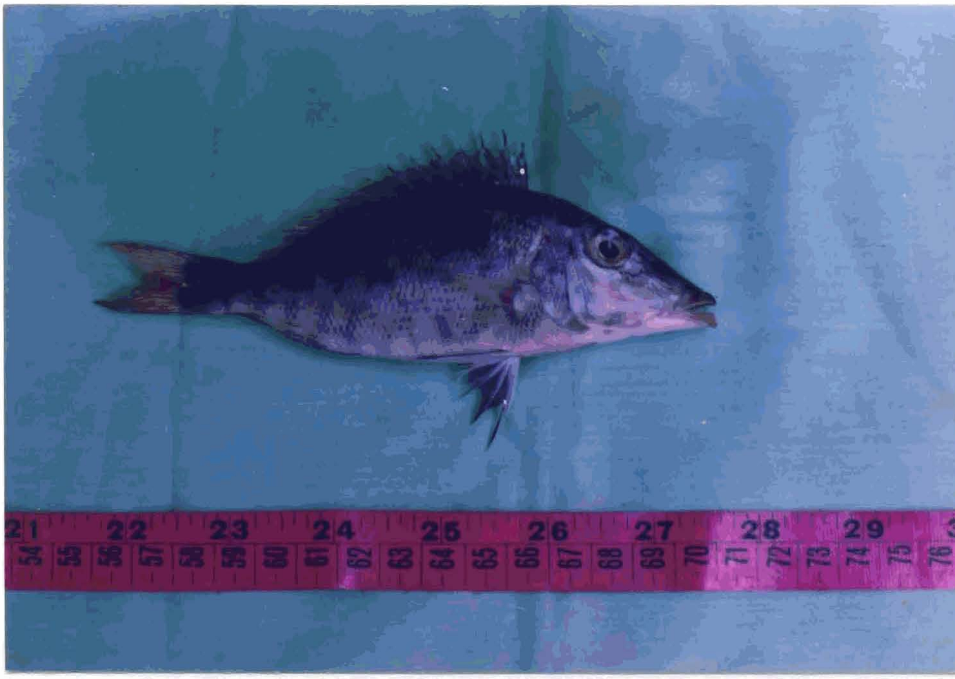


Plate 10. *Lutjanus malabaricus*(Day)

upper jaw. Caudal fin truncate or slightly emarginate. Longitudinal rows of scales above and below lateral line appear to rise obliquely. Lateral line 57 to 60 scales.

Colour:- Body crimson red, silvery below. A saddle like blotch in present on the caudal peduncle.

Distribution:- Wide spread in the Indo-West Pacific region. Found in the inland waters of Central Kerala.

Remarks:- Food fish. Not commercially utilised in large quantities.

(Plate-11) *Lutjanus lutjanus* (Bloch)

Lutjanus lutjanus : Bloch, 1790; *Naturges ausland. Fische*, 4: 107
Lutjanus madras : (Cuvier): Day, 1875; *Fishes of India* : 47 pl. 14
Lutjanus madras : Day, 1889; *Fauna Br. India*, Fishes 1 : 480
Mesoprion madras : Cuv. & Val. vii, p. 446; Bleeker, Perc., p.44, Gunther, Catal; p. 200, Day, Fish.

Specimens Examined

A total of 9 specimens collected.

Munambum – 5, Chavakkadu – 4

Total length – 138 mm, Standard length – 110 mm, Body depth – 37%, Head length – 34%, Pre dorsal length – 36%, Caudal peduncle length – 26%, Snout to anal fin length – 78%, Length of basal part of dorsal fin – 62%, Length of basal part of anal fin – 14%, Eye diameter – 23%, Inter orbital space – 11%, Snout length – 43%.

Description

B. Vii, D. (10/14), P. 16, V. (1/5), A. (3/9), C. 17

Small sized fish. Body elongate and compressed with pre-opercular notch indistinct. Vertical limb of pre-opercle not emarginate. Teeth present in jaws. Canines are also present. Caudal fin emarginate. Opercle with two points. Longitudinal rows of scales above lateral line appear to rise obliquely to dorsal profile. Lateral line with 48 to 52 scales.

Colour:- Overall pale grey to yellowish with yellow mid lateral stripe from eye to caudal fin base. Fins pale yellow.

Distribution:- Coast of India, Srilanka and the Andaman Sea. Found in the inland waters of Central Kerala.

Remarks:- Food fish. But minor fishery significance in Central Kerala.

(Plate-12) *Lutjanus lineolatus* (Ruppell)

Serranus nouleny : Cuv. & Val. ii, p. 247; Gunther, Catal. ip. 126

Diacope lineolatus : Ruppell, 1828; *Altas Reise Nordl. Africa, Fische, Rothen Meeres*: 76, pl. 19

Lutianus lineolatus : Day, 1875; *Fishes of India*: 35, pl. 11

Lutjanus lineolatus : Day, 1889; *Fauna Br. India*, Fishes, 1: 469

Mesopreor lineolatus : Bleeker, Pereas. p. 46; Gunther, Catal, ip. 205

Specimens Examined

A total of 14 specimens collected.

Munambum – 5, Chavakkadu – 4, Cochin – 5

Plate 11 . *Lutjanus lutjanus* (Bloch)

Plate 12. *Lutjanus lineolatus* (Ruppell)

Total length – 212 mm, Standard length – 173 mm, Body depth – 35%, Head length – 36%, Pre dorsal length – 41%, Caudal peduncle length – 28%, Snout to anal fin length – 69%, Length of basal part of dorsal fin – 43%, Length of basal part of anal fin – 17%, Eye diameter – 29%, Inter orbital space – 15%, Snout length – 32%.

Description

B. Vii, D. (11/12-13), P. 16, V. (1/5), A. (3/8), C. 17

Body elongate, with head profile moderately convex. Eyes large, 3.7 to 4.0 times in head length. Inter orbital space flat. Teeth in jaws and a pair of canines in upper jaw. Caudal fin slightly forked. Soft parts of dorsal and anal fins with a scaly sheath. Lateral line with 45 to 51 scales.

Colour:- Yellowish or pale brown. Prominent dark yellow line along sides from snout to caudal fin.

Distribution:- Indo-West Pacific region. Found in the inland waters of Central Kerala.

Remarks:- Abundant in Tamil Nadu Coast. Good fish.

(Plate-13) *Latjanus johnii* (Lacep)

Anthias johnii : Bloch, 1792; *Naturages ausland. Fische*, 6 : 113, 318

Lutjanus johnii : Lacep. iv, p. 235, Bleeker, Lutjanii, p. 20, Valliant, 1874; *Soc. Phil.* de Paris, May, 1874

Lutianus johnii : Day, 1875; *Fishes of India* : 42, pl. 13

Lutianus yapilli (Cuvier): Day, 1875; *Fishes of India* 45, pl.

Lutianus johnii : Day, 1889; *Fauna Br. India. Fishes* 1. 476

Lutjanus yapilli : Day, 1889; *Fauna Br. India*, Fishes, 1: 479

Specimens Examined

A total of 16 specimens collected.

Munambum – 10, Chavakkadu – 4, Vadanappalli – 2

Total length – 162 mm, Standard length – 124 mm, Body depth – 44%, Head length – 38%, Pre dorsal length – 48%, Caudal peduncle length – 31%, Snout to anal fin length – 73%, Length of basal part of dorsal fin – 42%, Length of basal part of anal fin – 23%, Eye diameter – 23%, Inter orbital space – 11%, Snout length – 43%.

Description

B. Vii, D. (10/13-14), P. 16, V. (1/5), A. (3/8), C. 17

Moderately deep-bodied, with head profile straight or slightly convex. Teeth present in jaws. Opercle with two flat points. Vertical limb of pre-opercle serrated. Canines are present in upper jaw. Dorsal fin with 10 spines and 13 or 14 soft rays, caudal fin slightly concave. Scales fairly large. Soft parts of dorsal and anal fins with a scaly sheath. Caudal fin slightly emarginate. Lateral line with 48 to 50 scales.

Colour:- Body silvery green or bronze-red, with a distinct dark spot on each scale. A large black blotch usually present above lateral line at the junction of spines and soft dorsal fins. Dorsal, anal and caudal fins dusky..

Distribution:- Indo-West Pacific in habits shallow waters. Found in the inland waters of Central Kerala.

Remarks:- Food fish. But minor fishery value in Central Kerala.

Family – Nemipteridae

They are commonly called as Threadfin breams. Small to moderate sized, slightly compressed fishes. Mouth terminal. Teeth in jaws. Canines are present. Dorsal fin continuous with 10 spines and 8 to 11 soft rays. Anal fin with 3 spines and 5 to 8 soft rays. Pelvic fin with one spine and 5 soft rays. Caudal fin forked or emarginate, the upper lobe with a filament scales on body are large and ctenoid. Three genera. All genera were collected during the study.

Key to Genera

1. Canine teeth present at least in upper jaw. No spines below eye. Three transverse scale rows on pre-opercle –

   Nemipterus

2. No canine teeth in jaws, a backward pointing spine below eye distinct –

   Scolopsis

3. Sub orbital spine weak, canine absent. 4-6 transverse scale rows on pre-opercle –

   Parascolopsis

Genus – *Nemipterus*

Body rather elongate and moderately compressed, covered by large scales. Suborbital spine absent. Mouth moderate. Teeth small and conical. Canine teeth present in upper jaw. Dorsal fin with 10 spines and 9 soft rays. Anal fin with 3 spines and 7 soft rays. Caudal fin forked. Ctenoid scales on body. All species are bright rosy in colour, usually with yellow stripes on body. They are essentially bottom dwellers.

Key to Species

1. (a) Upper lobe of caudal fin prolonged into a filament – 2

   (b) Upper lobe of caudal fin normal with no filamentous prolongation – 5

2. Dorsal spines normal – 3

3. Canines only in upper jaw, the lower jaw with uniform teeth. Dorsal fin base with a longitudinal yellow band, anal fin with two 2 several yellow streaks, a brilliant spot on shoulder – 4

4. (a) Anal fin with several irregular yellow streaks. Shoulder spot and caudal filament yellow. Its upper lobe prolonged into a distinctive filament –

   N. japonicus

   (b) Anal fin white. No shoulder spot at origin of lateral line. Caudal fin rosy with a yellow filament –

   N. nemurus

   (c) Anal fin with 2 yellow streaks, shoulder spot and caudal filament rosy red. First spine of dorsal fin very small –

   N. mesoprion

5. Dorsal fin spines more or less sub equal with its soft rays – 6

6. (a) Five to seven distinctly curved longitudinal streaks below lateral line. Anal fin with 3 longitudinal yellow streaks. Tip of upper caudal fin pale rosy –

   N. delagoae

   (b) 2 to 8 straight lateral yellow bands or streaks on sides of body, base of anal fin with an yellow streak. Tip of upper caudal fin lobe yellow – 7

7. (a) Two longitudinal bands on body. Anal fin milky white –

   N. bleekeri

   (b) Two distinct yellow bands on flanks of body. Caudal fin red, its upper lobe tipped yellow –

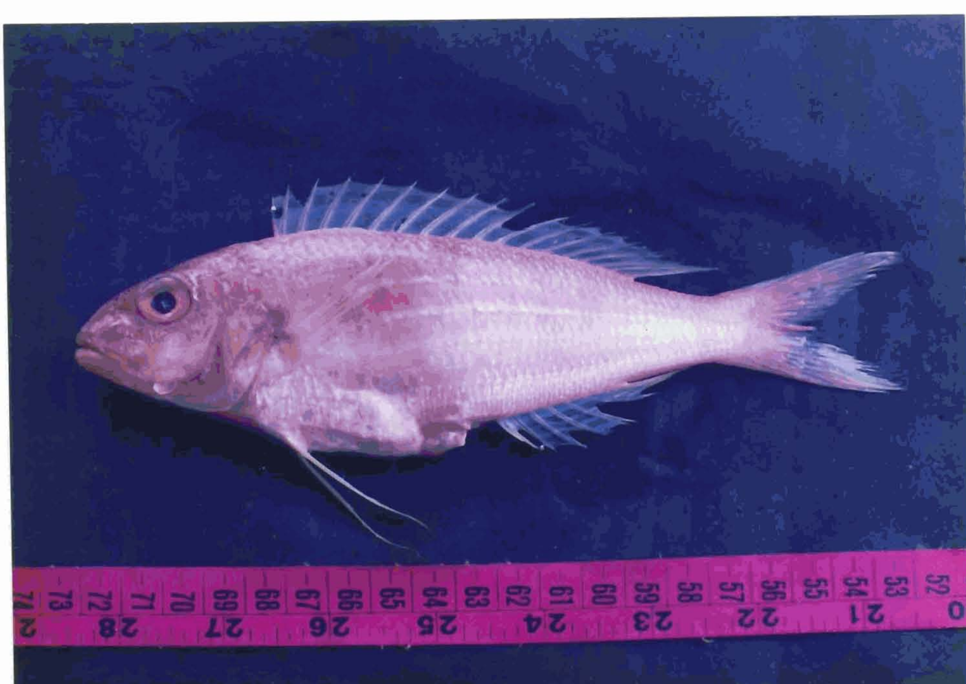
   N. marginatus

(Plate-14) *Nemipterus bleekeri* (Day)

Syngris bleekeri : Day, 1875; *Fishes of India*, 92 pl. 24 fig. 1

Plate 13 . *Lutjanus johnii* (Lacep)

Plate 14. *Nemipterus bleekeri*(Day)



Specimens Examined

A total of 33 fishes collected.

Munambum – 15, Chavakkadu – 12, Vadanappally – 6

Total length – 198 mm, Standard length – 155 mm, Body depth – 20%, Head length – 31%, Pre dorsal length – 36%, Caudal peduncle length – 36%, Snout to anal fin length – 67%, Length of basal part of dorsal fin – 51%, Length of basal part of anal fin – 23%, Eye diameter – 23%, Inter orbital space – 13%, Snout length – 40%.

Description

B. Vi, D, (10/9), P. 17, V. (1/5), A. (3/7), C. 17

Body slightly compressed. Teeth present in both jaws. Canines are present in upper and lower jaws. A blue spot on the opercle. No filaments in fins. Scales fairly large.

Colour:- Body reddish above, silvery with bright yellow bands on sides and beneath. Fins reddish. Dorsal fin margin orange, with a golden streak along its base.

Distribution:- India, Srilanka, Malaya, Gulf of Thailand and Vietnam.

Remarks:- This species forms a minor fishery at Kakinada (Andhra Pradesh) and on Tamil Nadu coast.

(Plate-15) *Nemipterus delagoae* (Smith)

Nemipterus delagoae : Smith, 1941

Specimens Examined

A total of 9 specimens were collected.

Munambum – 9

Total length – 214 mm, Standard length – 162 mm, Body depth – 33%, Head length – 34%, Pre dorsal length – 36%, Caudal peduncle length – 32%, Snout to anal fin length – 65%, Length of basal part of dorsal fin – 56%, Length of basal part of anal fin – 22%, Eye diameter – 22%, Inter orbital space – 13%, Snout length – 36%.

Description

B. Vi, D. (10/9), P. 17, V. (1/5), A. (3/7), C. 17

Body slender, head without spines, Body covered with scales, anterior part of head without scale. No spot below origin of lateral line and no dark saddle on back. Dorsal fin single with 10 spine and 9 soft rays. No filaments in fins. Caudal fin forked.

Colour:- Yellowish pink in colour. Dorsal fins rosy, pelvic fins milky white, caudal fin rosy. Yellowish in middle.

Distribution:- Indian seas, Indian Australian archipelago. Found in the inland waters of Munambum.

Remarks:- Bottom living, caught mainly with trawls. Marketed mainly in fresh condition.

Genus – *Parascolopsis*

This genus shows great similarity with that of scolopsis. But close examination of specimens indicates a number of osteological differences. Body elongate suboribita. spines are very weak. Canines are absent. Only one species got.

(Plate-16) *Nemipterus japonicus* (Bloch)

Nemipteus japonicus : Bloch, 1791; *Naturges Ausland. Fische.*, 5:

Synagris japonnicus : Gunther, 1859; *Catal i*, p. 378

Synagris gramicus : Day, 1875; *Fish*, Malabar, p. 26

Dentex tambulus : Cuv. and Val., vi pp. 249, 558

Specimens Examined

34 specimens collected.

Munambum – 12, Chavakkad – 18, Cochin – 4

Total length – 250 mm, Standard length – 181 mm, Body depth – 35%, Head length – 33%, Pre dorsal length – 39%, Caudal peduncle length – 39%, Snout to anal fin length – 63%, Length of basal part of dorsal fin – 54%, Length of basal part of anal fin – 16%, Eye diameter – 27%, Inter orbital space – 10%, Snout length – 31%.

Description

B. Vi, D. (10/9), P. 17, V. (1/5), A. (3/7), C. 17

Body slightly compressed, Teeth in lower jaw numerous, No canine teeth in lower jaw. 6 to 12 canines are present in the upper jaw. Caudal fin forked, its upper lobe prolonged into a distinctive long yellow filament. No filament in other fins. Scales are fairly large.

Colour:- Body silvery rose, a brownish saddle on top of head. 1 or 3 longitudinal yellow streaks above lateral line and a yellow band along belly. A

Plate 15 . *Nemipterus delagoae* (Smith)

Plate 16. *Nemipterus japonicus* (Bloch)

bright red blotch near the origin of lateral line. Caudal fin rosy with a yellow filament.

Distribution:- Mediterranean Sea, Indo West Pacific. Found in the inland waters of Munambum, Chavakkadu and Cochin.

Remarks:- It is very common in the catches both from the west and east coasts of India. This fish spawns first at 160 – 170 mm and for a second time at 220 mm.

(Plate-17) *Nemipterus marginatus* (Val)

Nemipterus marginatus : Valenciennes, 1830

Specimens Examined

16 specimens collected.

Munambum – 10, Vadanappally – 6

Total length – 216 mm, Standard length – 172 mm, Body depth – 30%, Head length – 33%, Pre dorsal length – 35%, Caudal peduncle length – 25%, Snout to anal fin length – 63%, Length of basal part of dorsal fin – 52%, Length of basal part of anal fin – 21%, Eye diameter – 22%, Inter orbital space – 13%, Snout length – 36%.

Description

B. Vi, D. (10/9), P. 17, V. (1/5), A. (3/7), C. 17

Body compressed, covered with scales. Anterior part of head without scales and spines. No spot at the origin of lateral line. Dorsal fin single with 10 spines and soft rays. No filaments on fins. Caudal fin forked, red in colour, its upper lobe tipped yellow.

Colour:- Pinkish yellow in colour. Dorsal fin rosy, pelvic fin pale white or pink, anal fin whitish, caudal fin red, upper lobe of it is yellow.

Distribution:- Coastal waters of Thailand, Malaysia and India. Found in the inland waters of Munambum and Vadanappalli.

Remarks:- Caught mainly with bottom trawls, good food fish, marketed in fresh condition, also dried and salted.

(Plate-18) *Nemipterus mesoprion* (Bleeker)

Nemipterus mesoprion : Bleeker, 1853

Synagris mesoprion : Machan, 1930

Dentex mesoprion : Bleaker, 1853, *Nat. Tijidschr, Ned – India*, 4: 225

Specimens Examined

28 specimens collected.

Munambum – 16, Chavakkadu – 12

Total length – 218 mm, Standard length – 171 mm, Body depth – 28%, Head length – 30%, Pre dorsal length – 31%, Caudal peduncle length – 28%, Snout to anal fin length – 62%, Length of basal part of dorsal fin – 55%, Length of basal part of anal fin – 18%, Eye diameter – 24%, Inter orbital space – 12%, Snout length – 29%.

Description

B. Vi, D. (10/9), P. 17, V. (1/5), A. (3/7), C. 17

Body slender, usually deeper than head. Teeth present in jaws, 4 to 10 slender canine teeth in front of upper jaw. No canines on the lower jaw. Red

Plate 17 . *Nemipterus marginatus* (Val)

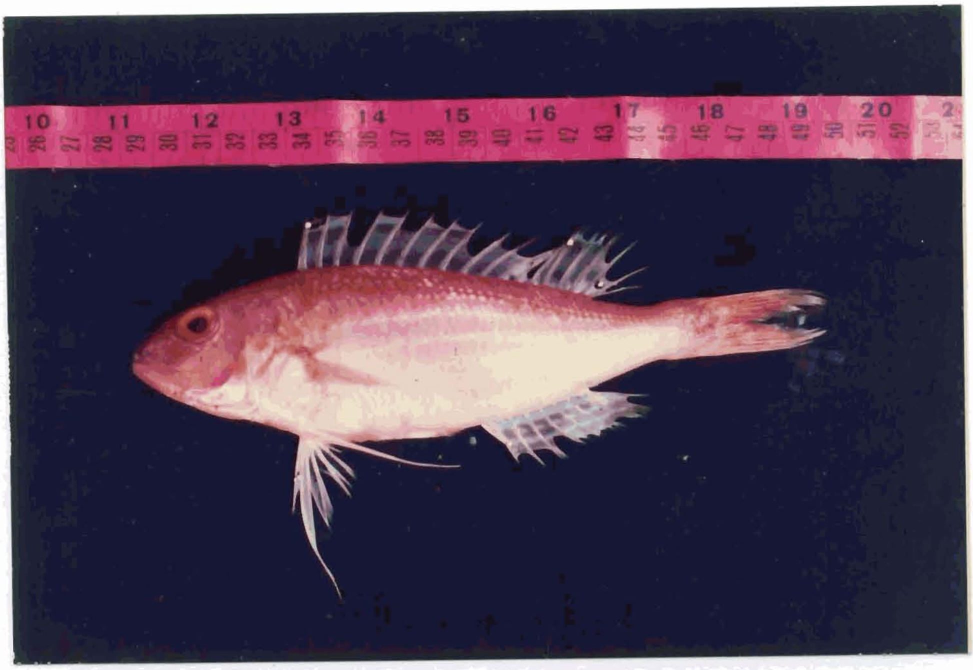
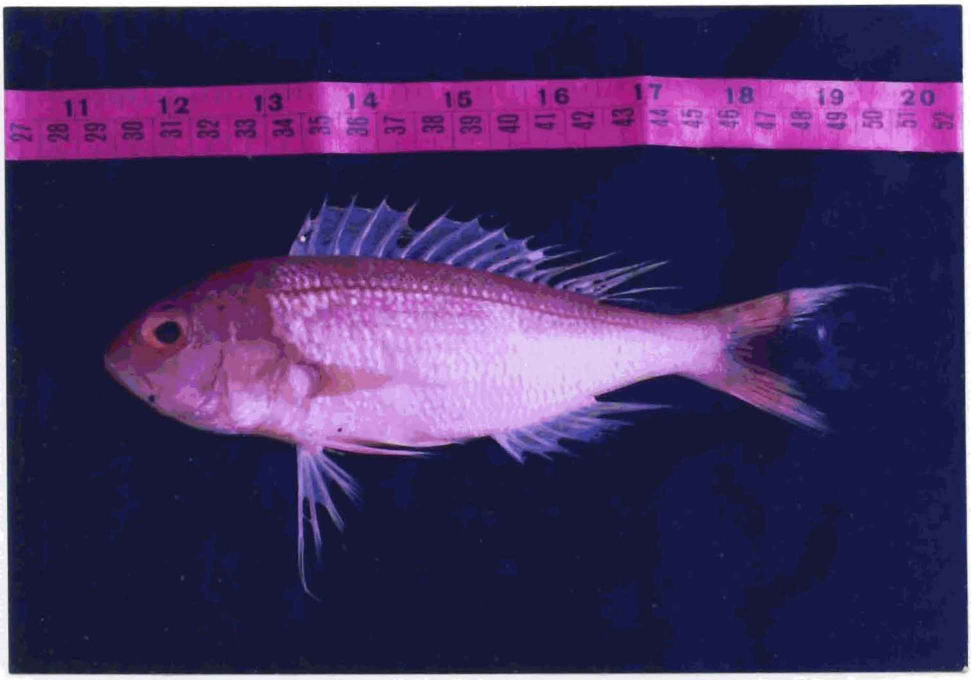


Plate 18. *Nemipterus mesoprion* (Bleeker)



spot at the origin of lateral line. Caudal fin forked, its upper lobe prolonged into a fine short red filament. No filaments on other fins. Scales fairly larger.

Colour:- Upper half of body and head rosy, below silvery. Many yellow streaks on the body. A red spot below the origin of lateral line. Dorsal fin yellow. Anal fin pink caudal fin reddish, the filament also red.

Distribution:- Andhra coast of India, Andaman Sea, Gulf of Thailand. Found in the inland waters of Munambum and Chavakkadu.

Remarks:- This species is fairly common in the trawl catches at Kakinada. Marketed mainly in fresh condition.

(Plate-19) *Nemipterus nemurus* (Bleaker)

Nemipterus nemurus : Bleaker, 1857

Synagris nemurus : Gunther, 1859

Specimens Examined

Twelve specimens obtained during collection.

Munambum – 8, Chavakkad – 4

Total length – 260 mm, Standard length – 192 mm, Body depth – 38%, Head length – 32%, Pre dorsal length – 39%, Caudal peduncle length – 37%, Snout to anal fin length – 65%, Length of basal part of dorsal fin – 53%, Length of basal part of anal fin – 21%, Eye diameter – 18%, Inter orbital space – 8%, Snout length – 32%.

Description

B.Vi, D.(10/9), V.(1/5), A.(3/7), C.17

Body rather elongate and slightly compressed. Head without spines. No spot at the origin of lateral line. Dorsal fin single, with 10 spines and 9 soft rays. Upper lobe of caudal fin prolonged into a small yellow filament. No filament in other fins.

Colour:- Pink in colour with yellow bands. Dorsal fin rosy or yellowish. Pelvic fins whitish, anal fin white, caudal fin rosy, with uppermost rays and filament yellow, fork margin red.

Distribution:- Andaman Sea, Philippines. Found in the inland waters of Munambum and Chavakkadu.

Remarks:- Caught mainly with bottom trawls, good food fish. Marketed mainly in fresh condition.

(Plate-20) *Parascolopsis eriomma* (Jordan & Richardson)

Parascolopsis eriomma : Jordan and Richardson, 1909; 188, pl. 70

Scolopsis eriomma : Jordan and Richardson

Parascolopsis eriomma : Smith SFSA

Specimens Examined

A total of 22 specimens collected.

Munambum – 12, Chavakkadu – 10

Total length – 136 mm, Standard length – 108 mm, Body depth – 43%, Head length – 32%, Pre dorsal length – 33%, Caudal peduncle length – 26%, Snout to anal fin length – 66%, Length of basal part of dorsal fin – 57%, Length of basal

Plate 19 . *Nemipterus nemurus* (Bleeker)

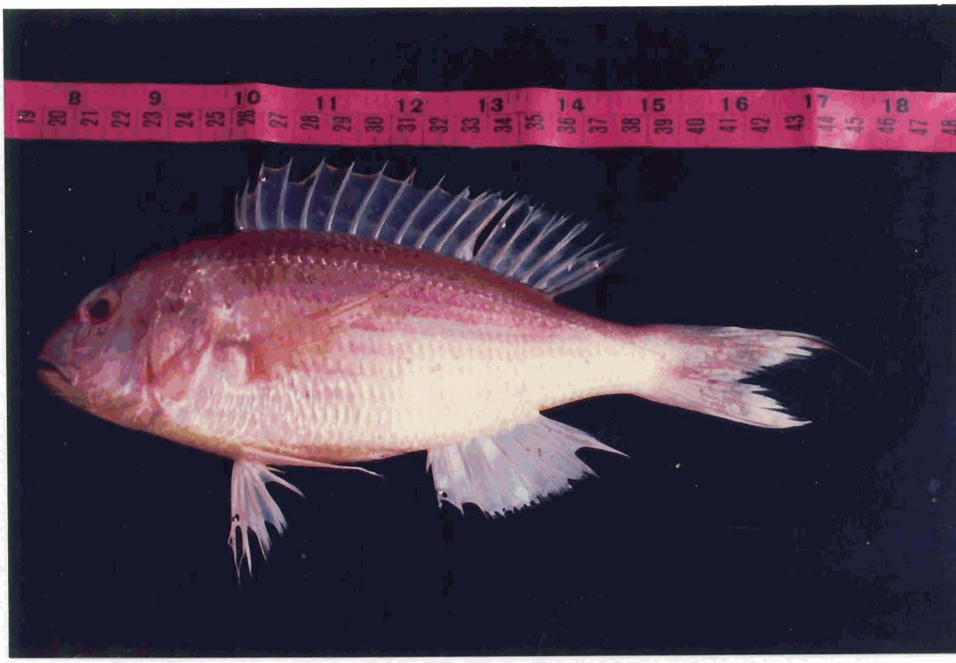


Plate 20. *Parascolopsis eriomma* (Jordan & Richardson)

part of anal fin – 20%, Eye diameter – 31%, Inter orbital space – 23%, Snout length – 29%.

Description

B. V, D. (10/9), P. 17, V. (1/5), A. (3/7), C. 17

Body greyish, elongate. Body covered with soft scales. A black blotch present on the basal part of dorsal fin. Sub-orbital spine feeble.

Colour:- Reddish pink in colour.

Distribution:- Red Sea, wide spread in tropical Indo-West pacific area. Indian Sea. Found in the inland waters of Munambum, Chavakkadu.

Remarks:- Food fish, caught in trawl catches.

Genus – *Scolopsis* (Cuvier)

Body oblong and moderately compressed covered with ctenoid scales. Eyes large. Sub-orbital spine distinct. Pre operculum margin serrated. Mouth moderate. Teeth in jaws are small and slender. Dorsal fin weakly notched with 10 spines and 9 to 11 soft rays. Anal fin with 3 spines and 7 or 8 soft rays.

Key to Species – Numerous species

1. (a) Sub-orbital spine feeble – 2

   (b) Sub-orbital spine distinct – 6
2. Gill rakers on first arch short and tubercular – 3
3. Dorsal fin uniformly pale with no dusky blotch – 4
4. Inter orbital space great – 5
5. 1 or 2 blotches in the lateral line, the first one large, the 2nd smaller or two may be conjoined –

   S. bimaculatus

6. Scales 42 or more along lateral line, maxillary smooth, without denticulate ridge – 7
7. Scales 3½ rows between lateral line and median dorsal spines – 8
8. Depth of body 2.1 to 2.3 times in standard length. Second anal spine much stronger and distinctly longer than the third. Scales about 42 in lateral line – *S. Vosmeri*

(Plate-21) *Scolopsis vosmeri* (Bloch)

Anthias vosmeri : Bloch, 1792; *Naturges, Ausland. Fische*, 6 : 120, pl. 321.

Scolopsis vosmeri : Day, 1875; *Fishes of India : 87*, pl. 23, figs. 1-3, Day, 1889; *Fauna Br. India*, Fishes, 1 : 524

Scolopsis kate : Cuv. and Val., V p. 331

Scolopsis japonicus : Gunther, catal, i, p 354, *Fish Malabar*, p. 25

Specimens Examined

A total of 19 specimens collected.

Munambum – 12, Chavakkadu – 5, Vadanappally – 2

Total length – 136 mm, Standard length – 108 mm, Body depth – 43%, Head length – 32%, Pre dorsal length – 26%, Caudal peduncle length – 33%, Snout to anal fin length – 66%, Length of basal part of dorsal fin – 57%, Length of basal part of anal fin – 20%, Eye diameter – 31%, Inter orbital space – 23%, Snout length – 29%.

Description

B. V, D. (10/9), P. 17, V. (1/5), A. (3/7), C. 17

Deep bodied and compressed, its dorsal profile very convex body depth 2.1 to 2.3 times in standard length. Mouth terminal, jaws with numerous teeth. Eyes large, pre-operculum with small feeble serrations. Dorsal fin spines stout. 2nd anal fin longer than third. Caudal fin slightly forked. Scales large. Lateral line with about 42 scales. Scales on sides of body with dark spots.

Colour:- Usually dark grey or reddish brown, abroad, vertical silvery band across operculum from top of head. Fins greyish, tinged red.

Distribution:- Indian Ocean, East India, Japan, China and Philippines. Found in the inland waters of Munambum, Chavakkadu, and Vadanappally.

Remarks:- Food fish. But minor commercial significance on the Tamil Nadu coast.

(Plate-22) *Scolopsis ciliatus* (Lacepede)

Holocentrus ciliatus : Lacep. IV pp. 333-371

Scolopsis lycogenis : Cuv. & Val; V. p. 346, pl. 127; Bleeker

Scolopsis ciliatus : Gunther, Catal; i p. 355

Specimens Examined

A total of 6 specimens collected.

Munambum – 5, Chavakkadu – 1

Total length – 188 mm, Standard length – 142 mm, Body depth – 24%, Head length – 30%, Pre dorsal length – 32%, Caudal peduncle length – 34%, Snout to anal fin length – 68%, Length of basal part of dorsal fin – 52%, Length of basal part of anal fin – 25%, Eye diameter – 22%, Inter orbital space – 12%, Snout length – 41%.

Plate 21 . *Scolopsis vosmeri* (Bloch)

Plate 22. *Scolopsis ciliatus* (Lacepede)

Descrip.ion

B. VI, D. (10/9), P. 17, V. (1/5), A. (3/7), C. 17

Body moderately elongates, its depth 2.8 to 3.0 times in standard length. A short spine just below eye. Eyes moderately large. Teeth numerous in both jaws. Dorsal fin with 10 spines and 9 rays. The spines and rays are of equal height. Anal fin with three spine and seven soft rays. The first soft ray of the pelvic fin produced into a filament. Caudal fin forked. Scales large, covering the body. Lateral line complete with 40 to 45 scales.

Colour:- Brown on upper part of head and body silvery on sides and belly. A silvery band beneath dorsal fin. Snout blotched with 6 longitudinal rows of pale yellow spots along scale rows in middle side of body. Fins dusky grey dark brown blotch in axil of pectoral fin.

Distribution:- Indian Ocean. Found in the inland waters of Munambum, Chavakkadu, and Vadanappally.

Remarks:- Food fish. But minor commercial significance.

(Plate-23) *Scolopsis bimacalatus* (Rupell)

Scolopsis bimaculatus : Rupell, 1828; 8 pl. 2

Scolopsis bimaculatus : Smith, *SFSA*, No. 684

Scolopsis inermis : Cuv. and Val. V, p. 340

Scolopsis monogramma : Bleeker, *Sciaen*, p.29

Specimens Examined

A total of 12 specimens collected.

Munambum – 8, Chavakkadu – 4

Total length – 190 mm, Standard length – 165 mm, Body depth – 34%, Head length – 31%, Pre dorsal length – 36%, Caudal peduncle length – 36%, Snout to anal fin length – 67%, Length of basal part of dorsal fin – 51%, Length of basal part of anal fin – 23%, Eye diameter – 23%, Inter orbital space – 13%, Snout length – 40%.

Description

B. VI, D. (10/9), P. 18, V. (1/5), A. (3/7), C. 17

Body compressed, covered with scales. On the body an elongate blackish patch seen beginning below 7th or 8th dorsal spine and extend posteriorly through lateral line. Reaches about 30 cm, vertical limb of pre-opercle serrated. Teeth present in jaws. Second anal spine stronger. Caudal fin lunated.

Colour:- Greyish, becoming dull white on abdomen. One or two black blotches on the lateral line Branchiostegal membranes blood red. Fins orange, eyes silvery.

Distribution:- Western Indian Ocean, Red Sea and Persian Gulf. Found in the inland waters of Munambum and Chavakkadu.

Remarks:- Food fish. Not much commercial importance.

Family – Pomadasyidae or Haemulidae

Body oblong and compressed, pre-opercle serrate, mouth terminal, small or moderate. Chin with pores. Teeth present in jaws. No teeth on roof of mouth. Dorsal fin continuous, with 9 to 14 strong spines and 12 to 26 soft rays. Anal fin short with 3 spines, the second often strong and robust and 7 to 9 soft rays. Caudal fin truncate or emarginate. Lateral line is continuous. Ctenoid scales present on the body. They are typical marine species. Some enter estuaries. These fishes make sounds, by grinding their pharyngeal teeth. 17 genera. Only two genera were collected.

Key to Genus

1. (a) Chin with 2 pores and longitudinal median groove at symphysis of lower jaw. Fin spines are strong – 2
   (b) Chin with 6 pores and no median groove or pit. Fin spines weak – 3
2. Faint grey longitudinal stripes along flanks of body –
   Pomadasys
3. Dorsal fin with 9 or 10 spines, the second longest, soft dorsal fin base markedly longer than that of spinous part –
   Diagramma

Genus – *Pomadasys*

Body compressed, covered with ctenoid scales. Mouth small. Lips rather thick. Lower jaw with a median longitudinal groove and 2 small pores at chin. Pre-opercle margin serrate. Single dorsal fin with 11 to 14 strong spines and 12 to 18 soft rays. Anal fin with 3 spines and 7 to 12 soft rays. Caudal fin truncate or slightly emarginate. Body silvery with longitudinal stripes.

Key to Species

Many species, about 25 in number. Only 2 species were collected during the study.

1. Second anal spine longer than third spine. Back and flanks of body with faint spots or large blotches – 2
2. (a) Black blotches present on nape and back and a large black blotch on spinous portion of dorsal fin. No blotch on opercle –
   Pomadasys maculatus

(b) Black blotch on opercle bars on body are neat and vertical –

Pomadasys kakkan

(Plate-24) *Pomadasys maculatus* (Bloch)

Anthias maculatus : Bloch, 1797; *Naturges ausland Fische, 7: 9.* pl. 326

Pristipoma maculatum : Day, 1875; *Fishes of India : 74*, pl. 19, Day 1889. *Fauna Br. India, Fishes,* 1 : 510.

Pomadasys maculatus : Smith, SFSA, No. 677.

Pomadasys maculatum : Vander Elst, 1981 : 254.

Specimens Examined

About 132 specimens collected.

Munambum – 62, Chavakkadu – 35, Vadanappally– 16, Kochi – 19

Total length – 170 mm, Standard length – 138 mm, Body depth – 32%, Head length – 33%, Pre dorsal length – 44%, Caudal peduncle length – 22%, Snout to anal fin length – 72%, Length of basal part of dorsal fin – 51%, Length of basal part of anal fin – 12%, Eye diameter – 25%, Inter orbital space – 10%, Snout length – 33%.

Description

B. Vii, D. (12/11-14), P. 17, V. (1/5), A. (3/7), C. 17

Body oblong and compressed. Head blunt, its upper profile convex. Mouth small, lips moderately thick. Upper jaw reaches to below the front border of the eye. Two pores present on chin. A central longitudinal groove present behind chin. Dorsal fin with 12 spines and 14 to 15 soft rays. Anal fin with 3 spines. Body covered with ctenoid scales. Lateral line slightly arched.

Plate 23 . *Scolopsis bimacalatus* (Rupell)

Plate 24. *Pomadasys maculatus* (Bloch)

Colour:- Body silvery grey, head purplish. A blackish band over the snout. A vertical black band passes over the nape and terminates about 3 scales below the lateral line. Posterior to this are certain blotches. Spinous part of the dorsal fin with a large blotch. Dorsal and caudal fins edged with black, other fins yellowish.

Distribution:- Red sea, East coast of Africa, Seas of India and New Guinea. Found in the inland waters of Munambum, Chavakkad, Vadanappilly and Cochin.

Remarks:- It is caught by the trawl and shore lines. It grows upto a length of 41 cm. The gas bladder of the species yields icing glass.

(Plate-25) *Pomadasys kakkan* (Cuv & Val)

Pristipoma kaakan : Cuv & Val, 1830 : 244

Pomadasys hasta (non Bloch) : Smith, SFSA No. 676

Pomadasys hasta : Van der Elst, 1981

Specimens Examined

A total of 9 specimens collected.

Munambum – 7, Chavakkadu – 2

Total length – 165 mm, Standard length – 140 mm, Body depth – 36%, Head length – 31%, Pre dorsal length – 39%, Caudal peduncle length – 19%, Snout to anal fin length – 68%, Length of basal part of dorsal fin – 56%, Length of basal part of anal fin –11%, Eye diameter – 21%, Inter orbital space – 22%, Snout length – 22%.

Description

B. Vii, D. (12/13-15), P. 17-18, V. (1/5), A. (3/7-8), C. 17

Body oblong and compressed, covered with rough ctenoid scales. Resembles *Pomadasys maculatus*. But a black blotch present on opercle, which is absent in *Pomadasys maculatus*. Vertical band like blotches are seen. Two pore and a longitudinal groove is present on the chin. Dorsal Fin with 12 spines. Fin spines are very strong. Dorsal fin with dusty membranes. Lateral line with about 45 scales.

Colour:- Body silvery grey with lines joining sometime to form bars. Bars break up with growth to become obsolete in large specimen.

Distribution:- Red sea, East coast of Africa, Seas of India. Found in the inland waters of Munambum and Chavakkadu.

Remarks:- Attains 45 cm. sometimes enters estuaries and tolerates fresh water. Adults generally solitary but shoal for spawning. An excellent food fish.

Family – Priacanthidae

These fishes are commonly known as big eyes or bulls eye. Body some what compressed, ovoid and covered with strong ctenoid scales. The scales are rough, difficult to detach from the skin and eyes are very large, hence the name bulls eye. Colour of the body is bright red. Mouth large and oblique, the lower jaw is projecting and small conical teeth present in jaws. Two closely set nostrils are present. Gills are four in number. Branchiostegals are six and dorsal fin is median and single, which consists of 10 spines and 10–15 rays. Anal fin with 3 spines and 10–16 soft rays. Pectoral fins small, pelvic fins large joined to body along their length by a membrane. This fin has a single strong spine and 5 soft rays. The caudal fin is truncate. Lateral line is single.

These fishes are bottom dwelling marine fishes found in rocky areas or reefs of tropical and temperate regions in depths of 1–400 m. Family consists of two genera both are found in our area. But only one genus – *Priacanthus* alone was collected during this study.

Key to Genera

1. Body ovate, middle spines of dorsal fin longest, scales large, less than 55 in lateral line. Body depth 1.9 – 2.1 in standard length –
   Pristigens
2. Body oblong, last spine of dorsal fin longest. Scales more than 70 in lateral line. Body depth 2.3 – 2.9 in standard length –
   Priacanthus

Genus – *Priacanthus*

Body ovoid with small, rough scales, very difficult to detach from the skin. Mouth large and oblique. Head completely covered with scales. Dorsal fin with 10 spines, last spine of dorsal fin is the longest. Pelvic fin large with a single spine and 5 soft rays. Anal fin with 3 spines. Caudal fin truncate and body is bright red in colour.

Key to Species

1. (a) Pelvic fins very large; conspicuously longer than head; pelvic fin spine about 31% of standard length; pelvic fins black.
   (Subgenus *Cookeolus* Fowler, 1947)
   Priacanthus boops

   (b) Pelvic fins shorter than head length; pelvic fin spine less than 30% of standard length – 2
   (Subgenus *Priacanthus*, 1817)

2. (a) Dorsal fin with 14 or 15 soft rays. Spine present at the angle of pre-operculum is short and indistinct. Pelvic fins black or partly black. No spots. Caudal fin truncate –

Priacanthu hamrur

(b) Dorsal fin with 12 or 13 soft rays. Spine present at the angle of pre-operculum is flat and strong. Dorsal and pelvic fin spines strongly spinulose and no spots on pelvic fins.

Priacanthus cruentatus

(Plate-26) *Priacanthus boops* (Talwar)

Cookeolus boops : Schneider, 1801; Long finned Bull eye
Anthias boops : Schneider, 1801; *Syst. Ichth. Bloch* : 308
Priacanthus japonicus : Cuvier, 1829; *Hist. Nat. Poiss.* Vd3, 106 (Japan)
Priacanthus boops : Talwar, 1975; *Neusl. Zool. Surv.* India 1(1); 8

Specimens Examined

Three specimens collected from central Kerala during the period of 1996 April to 1997 May.

Chavakkadu – 3

Total length – 180 mm, Standard length – 147 mm, Body depth – 41%, Head length – 40%, Pre dorsal length – 38%, Caudal peduncle length – 26%, Snout to anal fin length – 61%, Length of basal part of dorsal fin – 54%, Length of basal part of anal fin – 34%, Eye diameter – 45%, Inter orbital space – 5%, Snout length – 35%.

Description

B. Vi, D. (10/14), P. 16, V. (1/5), A. (3/8), C. 17

Body ovoid and laterally compressed. Eyes very large. Mouth oblique. Pre-operculum serrated and at the angle of pre-operculum there is a

Plate 25 . *Pomadasys kakkan* (Cuv & Val)

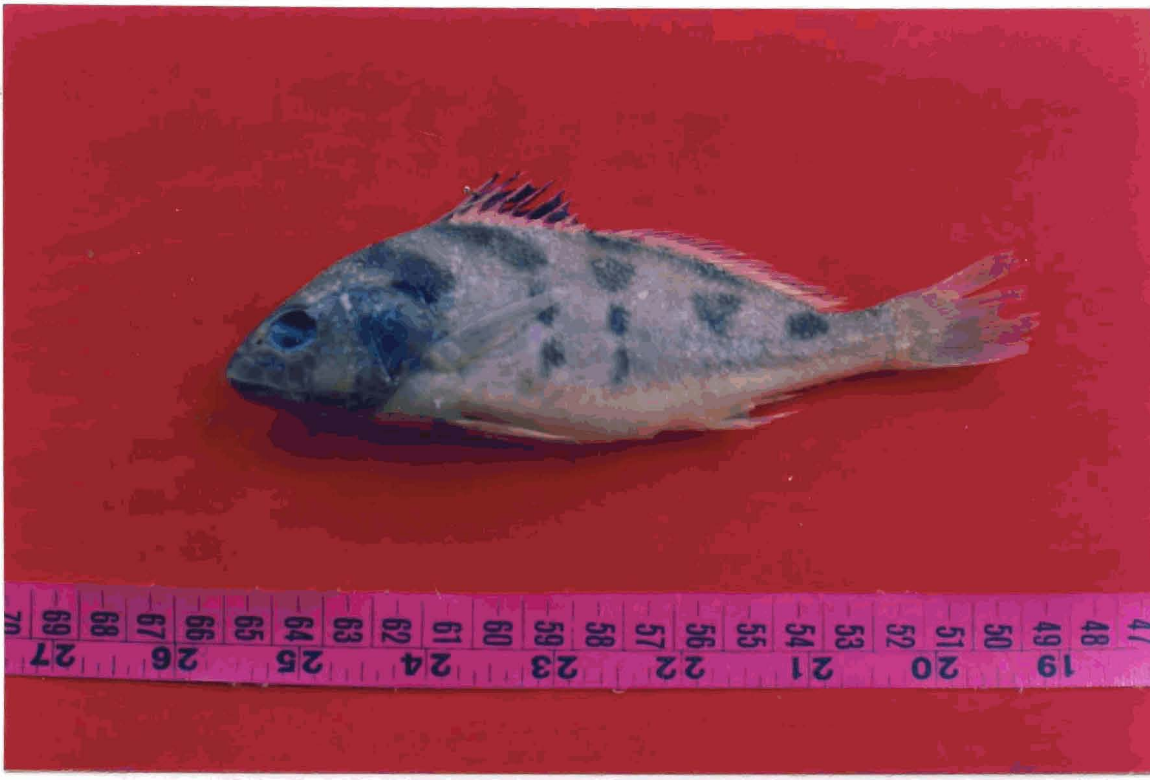
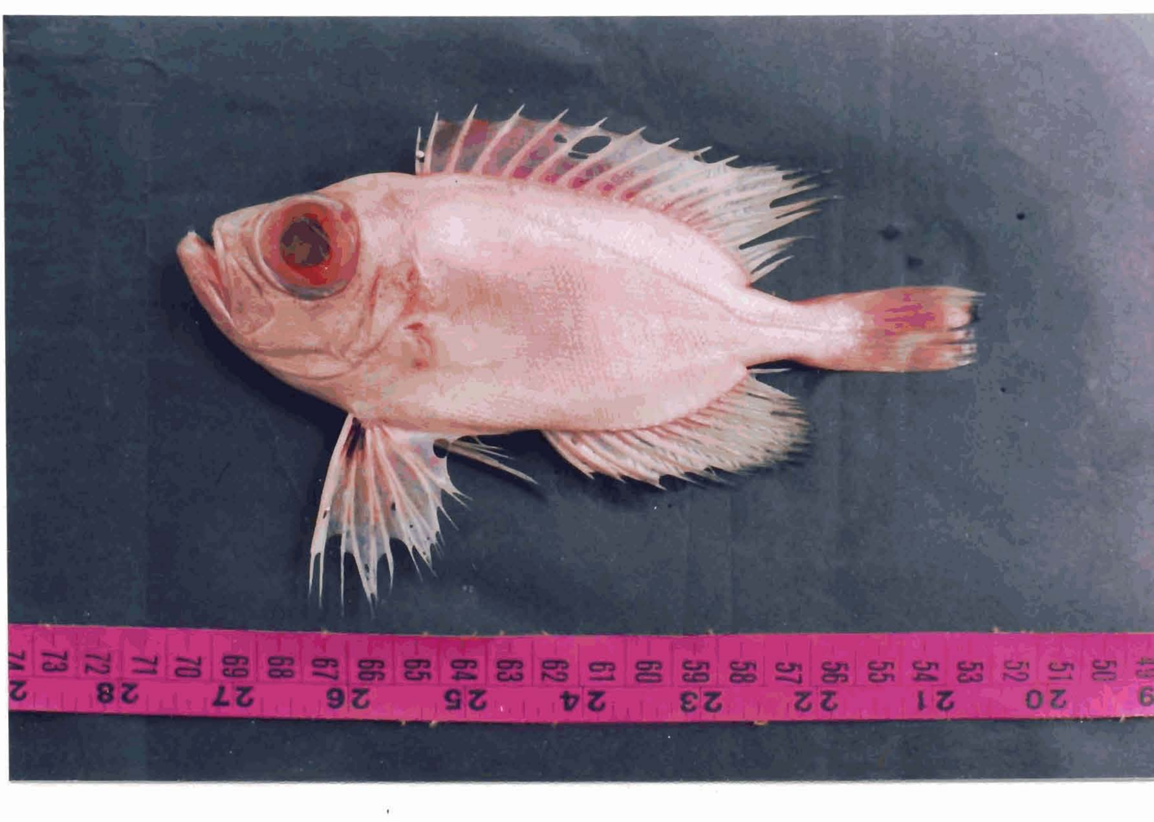


Plate 26.*Priacanthus boops* (Talwar)



spine. Teeth present in jaws. Head completely covered with scales. A single dorsal fin with 10 strong spines and 12 rays, 10^{th} spine longest, soft rays serrated. Pelvic fin large reaching the base of the first soft anal rays; it is joined to the body along their length by a membrane. It is black in colour and much longer than head. Caudal fin truncate. Body covered with closely set scales.

Colour:- Body brilliant crimson red; paler ventrally. Pelvic fins black Membranes and rays of fins generally pale or dusky, caudal fin margin is black.

Distribution:- They are bottom living forms. Found in depths of 100 – 400 m of Sea – South West coast of India, Bay of Bengal, Pacific Ocean and East coast of Africa.

Remarks:- This species is of minor fishery value being caught in the trawl catches off the Kerala coast.

(Plate-27) *Priacanthus hamrur* (Forsskal)

Priacanthus hamrur : Forsskal, 1775; Dusky finned bull eye

Sciaena hamrur : Forsskal, 1775; *Descript. Animal: 45.* type locality: (Djedda & Lahaja, Red Sea)

Priacanthus blochii (Bleeker): Day, 1876. *Fishes of India 48*, pl 8, fig. 2

Priacanthus hamrur : Day, 1889; *Fauna Br. India, Fishes*, 1 : 482

Priacanthus hamrur : Smith & Smith, 1966; 120

Specimens Examined

About 60 specimens collected.

Munambum – 32, Chavakkadu – 16, Kochi – 4

Total length – 262 mm, Standard length – 230 mm, Body depth – 33%, Head length – 30%, Pre dorsal length – 30%, Caudal peduncle length – 23%, Snout to anal fin length – 52%, Length of basal part of dorsal fin – 57%, Length of basal part of anal fin – 35%, Eye diameter – 38%, Inter orbital space – 6%, Snout length – 35%.

Description

B. Vi, D. (10/14), P. 18, V. (1/5), A. (3/8), C. 17

Body stock and compressed completely covered with rough ctenoid scales, very difficult to detach from skin. Mouth large and oblique. Eyes very large. Head completely covered with scale. A single dorsal fin. Pelvic fins large, black or partly black joined to the body by a membrane. Caudal fin is cresentic.

Colour:- Brilliant red, Paler below pelvic fins black. Median fins dusky without any spot.

Distribution:- Bottom fish. Red Sea, East coast of Africa, Sea of India. Found in the inland waters of Munambum, Chettuvai, Vadanappilly and Cochin.

Remarks:- This is very common in the trawl catch off the east coast of India in depths ranging from 60 to 250 m.

(Plate-28) *Priacanthus cruentatus* (Lacepede)

Priacanthus cruentatus : Lacepede, 1801

Labrus cruentatus : Lacepede, 1801; 452, 522 (America)

Priacanthus cruentatus : Fowler, 1936; 66

Specimens Examined

Specimens examined about seven fishes collected.

Munambum – 4, Chavakkadu – 3

Plate 27 . *Pricanthus hamrur* (Forsskal)

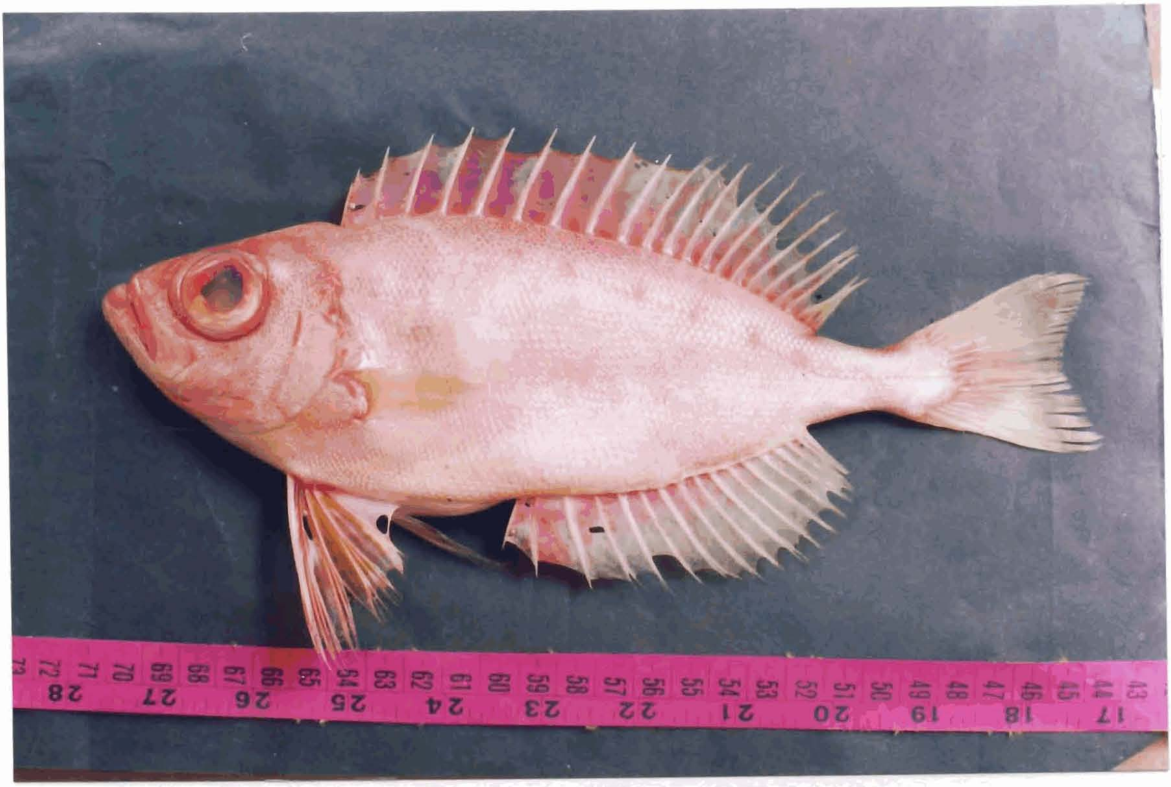


Plate 28.*Priacanthus cruentatus* (Lacepede)

Total length – 228 mm, Standard length – 194 mm, Body depth – 32%, Head length – 33%, Pre dorsal length – 32%, Caudal peduncle length – 23%, Snout to anal fin length – 59%, Length of basal part of dorsal fin – 57%, Length of basal part of anal fin – 34%, Eye diameter – 39%, Inter orbital space – 6%, Snout length – 31%.

Description

B. Vi, D. (10/12-13), P. 18, V. (1/5), A. (3/8), C. 17

Body laterally compressed. Completely covered with ctenoid scales. Mouth large and oblique, resembles *Priacanthus hamrur* in general, but in this pre opercle spine distinct. Ventrals shorter than in *Priacanthus hamrur.*

Colour:- Silvery red, Median fins with some faint spots. Ventral without spots.

Distribution:- East coast of Africa Atlantic ocean and Indian sea. Found in the inland waters of Munambum and Chavakkadu.

Remarks:- It is found in trawl catches of the East Coast of India in depths ranging from 100–200 m, used in surami preparation.

Family – Serranidae

Body robust and moderately elongate. Mouth protractile and the maxilla is exposed for most or all its length. Teeth present in jaws. Operculum with 3 flat spines. Pre-operculum usually serrate. A single dorsal fin. The spinous portions and soft rays of the dorsal fin separated by a notch. Anal fin with spines, mostly strong. Pelvic fin with one spine and 5 rays. Caudal fin rounded, truncate or lunate (never forked). Scales usually ctenoid, sometimes cycloid firmly embedded in skin. Lateral line single and complete and not extend to the tail. Branchiostegals 6 to 8.

Carnivorus fishes, usually marine fishes of tropical and warm seas, some living in fresh and brackish water and valuable as food. Some are beautifully coloured. The family includes the world's most important food fishes as well as a few which are poisonous. These fishes are oviparous and protogynous or hermaphrodite. Many genus. Only one genus obtained during collection.

Key to Genus

1. Canine teeth present in jaws. Dorsal fin with 6 to 10 spines – 2
2. Scales small or moderate – sized, 80 or more along lateral line – 3
3. Dorsal fin with 9 to 11 spine. Lower edge of pre-operculum without spines – 4
4. No distinct enlarged canines on each side of lower jaw. Caudal fin rounded, truncate or emarginate – 5
5. Dorsal fin with 11 spines palatines with tooth – 6
6. Dorsal spines more or less equal in length to anterior soft rays – *Epinephelus*

Genus – *Epinephelus*

Body robust, not strongly compressed. Mouth large. Operculum with 3 spines. Pre-opercle serrated. Teeth in jaws small and in many rows. One or more pairs of canine teeth. Dorsal fin with 11 spines and 12 to 20 soft rays. Anal with 3 spines and 7 to 9 rays. Caudal is rounded slightly lunate, ctenoid scales moderate to small.

Many species 6 obtained during collection.

Key to Species

1. (a) Caudal fin rounded – 7

(b) Caudal fin truncate or emarginate – 2

2. Depth of body 2.8 to 3.4 times in standard length – 3

3. Dorsal fin with 14 to 17 soft rays – 4

4. Anal fin with 8 soft rays – 5

5. (a) Middle opercular spine nearer to lower than to upper spine 6 dark brown broad vertical bars present on body –

E. diacanthus

(b) Dorsal fin with 15 to 17 soft rays body with small or large spots or network of light lines – 6

6. (a) Pre operculum with 2 to 4 strong serrate. Dark spots on body rather large. Caudal fin edged dusky black with a distinct fine white outer margin –

E. areolatus

(b) Pre operculum with several serrae. Body and fins with numerous small hexagonal spots or caudal fin without white edge –

E. chlorostigma

(c) Pectoral fins rather short, as long as or shorter than postorbital part of head – 7

7. (a) Last dorsal fin spine considerably shorter than third dorsal spine – 8

(b) Last dorsal fin spine not or slightly shorter than third dorsal spine – 9

8. Middle opercular spine closer to lower than to upper spine – 10

9. Gill rakers much shorter than gill lamellae – 11

10. (a) Pored scales in lateral line 60 to 66. Body with 4 longitudinal dark lines broken into spots with interruptions in places, ventral surface of body blackish. –

E. latifasciatus

(b) Middle operecular spine about equidistant from lower and upper spines – 11

11. (a) Teeth on middle side of lower jaw in 2 rows. Upper part of head and body, pelvic and anal fins and upper half of caudal fin covered with orange or orange red spots –

E. Bleekeri

(b) Eyes not so small and interorbital less broad. The orbit diameter 0.6 to 2.0 mm – 12

12. Discrete dark spots on body round or oblong and well separated – 13

13. These dark spots on body smaller than eye. Two dark streaks running backwards from lower half of eye. Lower jaw with 2 rows of teeth. –

E. andersonii

(Plate-29) *Epinephelus chlororstigma* (Morgans)

Serranus chlorostigma : Valenciennes, 1828; *Hist. Nat. Poiss.* 352

Epinephelus chlorostigma : Morgans, 1982

Specimens Examined

A total of 4 specimens collected.

Munambum – 4, Chavakkadu – 0, Vadanappally – 0, Kochi – 0

Total length – 194 mm, Standard length – 158 mm, Body depth – 34%, Head length – 38%, Pre dorsal length – 41%, Caudal peduncle length – 23%, Snout to anal fin length – 67%, Length of basal part of dorsal fin – 55%, Length of basal part of anal fin – 18%, Eye diameter – 13.5%, Inter orbital space – 10%, Snout length – 32%.

Description

B. Vii, D. (11/16-18), P. 17-19, V. (1/5), A. (3/8) C. 17

A fairly small serranid fish, its depth 3.0 to 3.4 times in standard length. Pre-operculum serrated. Operculum with 3 flat spines. A pair of small canines. Dorsal fin with 11 spines and 16 or 17 soft rays. Caudal fin truncate. Head scales cycloid and body scales ctenoid.

Colour:- Generally brownish, with numerous closely set hexagonal or roundish darker spots, the interspaces forming as a whole a pale retievlation. This spotted like the body.

Distribution:- Red Sea, Indian ocean. Found in the inland waters of Munambum.

Remarks:- This perch is an important component of the rock cod fishery of the South West coast of India.

(Plate-30) *Epinephelus andersoni* (Boulenger)

Epinephelus andersoni : Boulenger, 1903; 66, pl. 5 (*Natal*)
Epinephelus andersenii : Smith & Smith, 1966

Specimens Examined

A total of 5 specimens collected.
Munambum – 5, Chavakkadu – 0, Vadanappally – 0, Kochi – 0

Total length – 240 mm, Standard length – 210 mm, Body depth – 38%, Head length – 45%, Pre dorsal length – 40%, Caudal peduncle length – 20%, Snout to anal fin length – 80%, Length of basal part of dorsal fin – 58%, Length of basal part of anal fin – 16%, Eye diameter – 18%, Inter orbital space – 10%, Snout length – 21%.

Plate 29 . *Epinephelus chlorostigma* (Morgans)

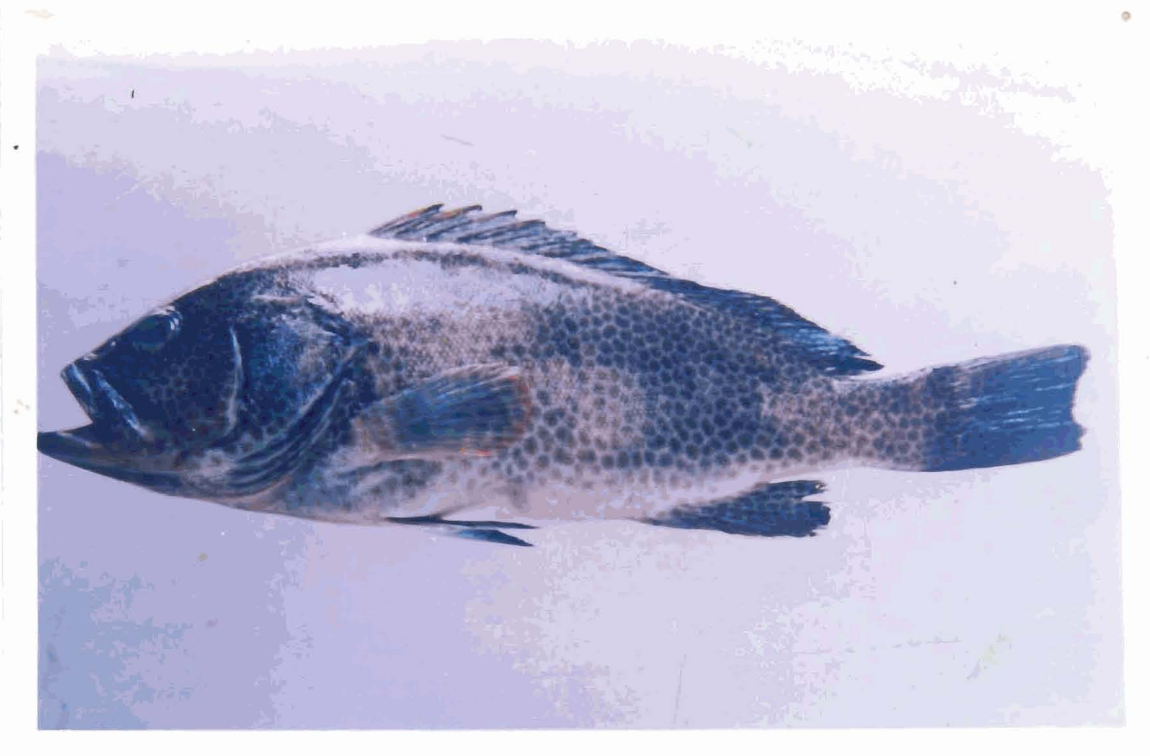


Plate 30. *Epinephelus andersoni* (Boulenger)

Description

B. Vii, D. (11/13-15), P. 17-19, V. (1/5), A. (3/8), C. 17

Attains 80 cm. Teeth present in jaws 2 or 3 rows of teeth at the side of lower jaw. Ctenoid scales present on the body.

Colour:- Body provided with a number of dark spots. Dark spots on body are round. These spots arrange in the form of 2 streaks running backwards from lower half of eye.

Distribution:- Common on reefs and rocky bottoms. Seas of India. Found in the inland waters of Munambum.

Remarks:- An edible perch.

(Plate-31) *Epinephelus areolatus* (Cuv & Val)

Perca summanaareolata : Forsskal, 1775; *Descript Animal*

Perca areolata : Forsk, 1775; p. 42

Serranus angularis : Valenciennes. Day, 1875; *Fishesof India*

Serranus aerolatus (Japonicus) : Cuv. & Val., 1867; vi, p. 353; Gunther, Catal. i, p. 126

Serranus aerolatus : Fowler and Bean, 1930

Specimens Examined

A total of 10 specimens collected from the regions of central Kerala during the period of 1995 April to June.

Munambum – 8, Chavakkadu – 0, Vadanappally – 0, Kochi – 2

Total length – 141 mm, Standard length – 120 mm, Body depth – 35%, Head length – 34%, Pre dorsal length – 38%, Caudal peduncle length – 17%, Snout to anal fin length – 75%, Length of basal part of dorsal fin – 58%, Length of basal part of anal fin – 11%, Eye diameter – 22%, Inter orbital space – 12%, Snout length – 20%.

Description

B. Vii, D. (11/17-18), P. 15, V. (1/5), A. (3/8), C. 17

A fairly small serranid fish with a slender and laterally compressed body. Pre operculum with a convex and finely serrated upper edge and 2 to 4 enlarged spinules at angle. Operculum with convex upper border and 3 flat spines. Teeth in narrow bands. 3rd to the 5th Dorsal spines are longer. Third anal spine is not strong. But longer than the second caudal emarginate, scales slightly ctenoid.

Colour:- Head ground colour body and fins pale brown, covered by dark brown spots. Dark spots become smaller and more numerous with growth. Spots on the fins usually darker. Caudal and soft parts of dorsal and anal fins edged dusky black, but with a fine white outer margin.

Distribution:- Through out warm coastal waters of area. Inhabits coastal waters down to 80 m. Found in India, Red Sea and Malay Archipelago. Found in the inland waters of Munambum and Cochin.

Remarks:- This perch forms an important element of the rock cod (Kalava) fishery of the Kerala coast in depths of 63 to 100 m.

(Plate-32) *Epinephelus diacanthus* (Cuv & Val)

Serranus diacanthus : Valenciennes, 1828; *Hist. Nat. Poiss,* 2.319

Serranus sexfasciatus : Day, 1875; *Fish Malabar*

Damba sind : Chaandeha, Belooch

Specimens Examined

A total of 65 specimens collected from the different regions of central Kerala.

Munambum – 36, Chettuva – 18, Vadanappally – 3, Kochi – 8

Total length – 174 mm, Standard length – 140 mm, Body depth – 32%, Head length – 42%, Pre dorsal length – 39%, Caudal peduncle length – 25%, Snout to anal fin length – 71%, Length of basal part of dorsal fin – 59%, Length of basal part of anal fin – 20%, Eye diameter – 22%, Inter orbital space – 12%, Snout length – 20%.

Description

B. Vii, D. (11-12/10-15), P. 18, V. (1/5), A. (3/8-9), C. 17

Serranid fish with a stout body. Pre-operculum serrated. Lower jaw longer. Vertical limb of pre-opercle strongly serrated and with two strong spines. Three spines on the opercle. The centre spine is the largest. Dorsal spines rather weak. Caudal fin rounded. Ctenoid scales present on the body. Anal fin with 3 spines and 8 soft rays.

Colour:- Body brownish with a tinge of pink on the back, becoming rose coloured on the abdomen. Six dark vertical bars, the first crossing the head, the 2^{nd} from the fourth to the sixth dorsal spines. A dark band passes from the orbit to the angle of pre opercle. Fins darkest at their margins.

Distribution:- Seas of India to the Malay Archipelago. Found in the inland waters of Munambum, Chavakkadu, Vadanappally and Cochin.

Plate 31 . *Epinephelus areolatus* (Cuv & Val)

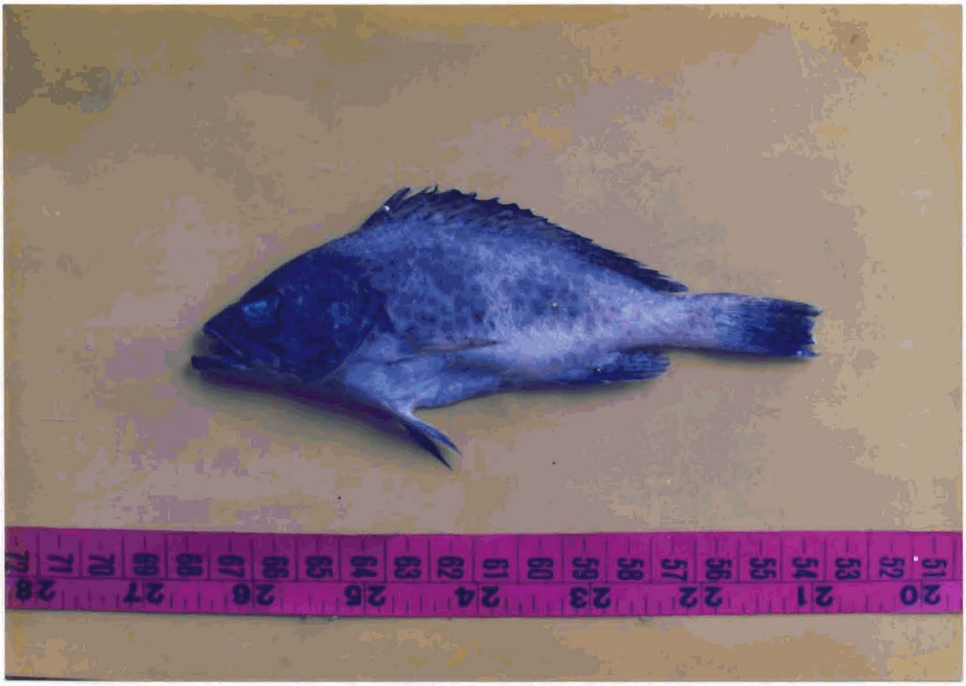


Plate 32. *Epinephelus diacanthus*(Cuv & Val)

Remarks:- This fish is an important component of the rock cod (Kalava) fishery off Kerala coast in depth of 63 to 100 m. grows to a length of 46 cm common in the commercial catches off Mumbai.

(Plate-33) *Epinephelus bleekeri* (Vaillant & Bocourt)

Serranus waandersi : Day, 1875; *Fishes of India* 12, pl. 8

Epinephelus bleekeri : Vaillant & Bocourt, 1877; *Mission Scient., Mexique Poiss.*, 69

Epinephelus waandersi : Bleeker

Serranus coromandelicus : Day, 1878; *fishes of India* 746

Specimens Examined

Two specimens collected from Munambum.

Total length – 220 mm, Standard length – 172 mm, Body depth – 32%, Head length – 40%, Pre dorsal length – 41%, Caudal peduncle length – 28%, Snout to anal fin length – 64%, Length of basal part of dorsal fin – 57%, Length of basal part of anal fin – 15%, Eye diameter – 13%, Inter orbital space – 19%, Snout length – 30%.

Description

B. Vii, D. (11/17), P. 18, V. (1/5), A. (3/8), C. 17

A medium sized serranid fish with an elongate and laterally compressed body. Vertical limb of pre-opercle strongly serrated. 3 opercular spines present. Teeth present in jaws. The central one strongest. Dorsal fin with 11 spines of moderate strength. Anal fin rounded, anal spines strong. Pectoral fin longer than the ventral. Caudal fin emarginate. Scales ctenoid.

Colour:- Ground colour, paler below upper parts of head and body, pelvic and anal fins, and upper half of caudal fin with orange red spots.

Distribution:- Persian Gulf, India, Sri Lanka, Thailand and China. Found in the inland waters of Munambum.

Remarks:- Found in the commercial catches in the Tamil Nadu and Mumbai.

(Plate-34) *Epinephelus latifasciatus* (Temminck & Schlegel)

Epinephelus latifasciatus : Temminck and Schlegel, 1842; *Fauna*, Japan
Serranus grammicus : Day, 1867; Day 1875, *fishes of India*, 23 pl. 5 Fig. 4

Specimens Examined

Three specimens collected from Munambum.

Total length – 148 mm, Standard length – 119 mm, Body depth – 36%, Head length – 42%, Pre dorsal length – 24%, Caudal peduncle length – 48%, Snout to anal fin length – 81%, Length of basal part of dorsal fin – 59%, Length of basal part of anal fin – 14%, Eye diameter – 16%, Inter orbital space – 8%, Snout length – 20%.

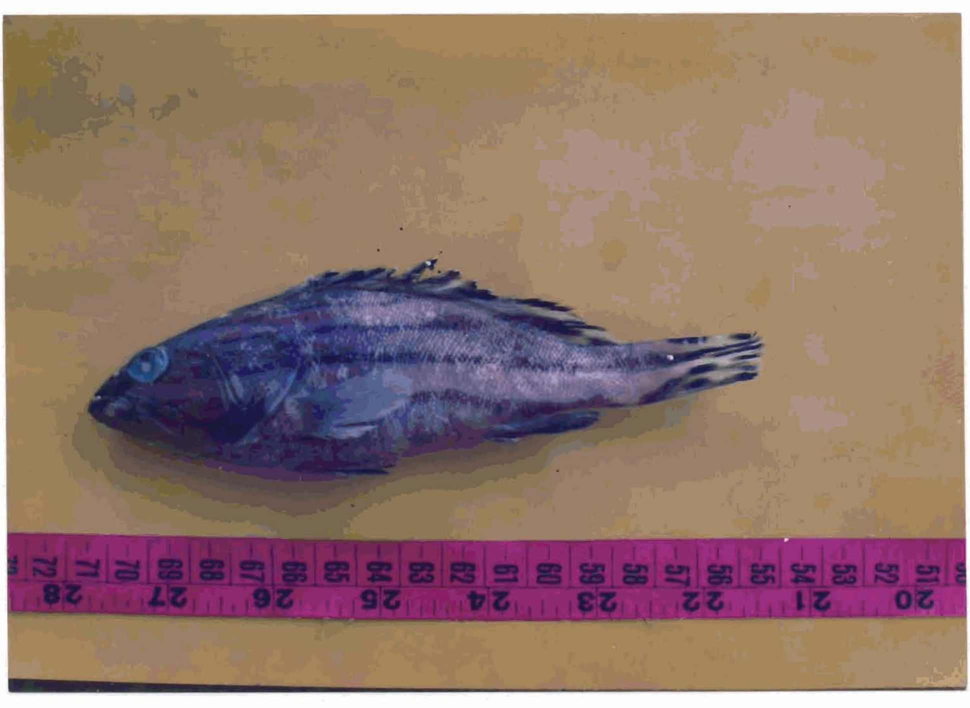
Description

B. Vii, D. (11/12), P. 19, V. (1/5), A. (3/8), C. 17

Small serranid, body laterally compressed and body depth is 2.9 to 3.5 times in standard length. Opercle with 3 spines, the central one strongest. Vertical limb of pre-opercle oblique, finely serrated Dorsal 11 spines are moderate strength, the 4^{th} is the largest. Pectoral fin longer than the ventral. Second anal spine strongest caudal fin slightly rounded. Cycloid scales are present.

Plate 33 . *Epinephelus bleekeri* (Vaillant & Bocurt)

Plate 34. *Epinephelus latifasciatus* (Temminck & Schlegel)



Colour:- Greyish with a golden glass about the head. A narrow black line runs from the upper margin of orbit to the last dorsal spine. Two or 3 more bands are seen on the body. Dorsal fin with a row of black spots along its centre and tipped with black colour. Caudal fin with numerous yellow spots. Eyes are golden.

Distribution:- India to China. Indian Sea, Madras. Found in the inland waters of Munambum.

Remarks:- Taken commercially on the Tamil Nadu coast only.

Family – Teraponidae

Small perches. Body oblong and slightly compressed. Mouth usually moderate with gape oblique. Operculum with 2 spines. The lower spine longer and stronger. Pre-operculum serrate. Teeth present in jaws. Dorsal fin divided by a notch. In some species with 11 to 14 spines and 8 to 14 soft rays are present. The anal fin with 3 spines and 7 to 12 soft rays. Pelvic fin with 1 spine and 5 rays. Caudal fin truncate or emarginate. Lateral line continous. Scales are ctenoid and adherent. Dark longitudinal stripes present on body. Branchiostegals are 6 in number. Many genera. Only one genus obtained during collection.

Key to Genera

1. Mouth small or moderate, dorsal fin with 12 to 14 spines. Operculum with 1 or 2 strong spines – 2
2. (a) Post temporal expanded and serrate postereorly. Skin and scale covering reduced. Gill membranes free from isthmus. Dorsal fin notched before last spine –

   Therapon

(b) Dorsal fin not notched –

Pleates

Genus – *Therapon*

Body moderately deep and fairly compressed, with distinct longitudinal stripes. Jaws with an outer row of strong conical teeth and inner band of smaller teeth. There are 3 species two species were collected. All are marine entering into brackish and fresh waters.

Key to Species

1. Lateral line with 46 to 56 scales. 6 to 8 scale rows above lateral line. Body stripes straight –

   Therapon theraps

2. Lateral line scales 69–93, 3 or 4 downwardly curved longitudinal strips along flank –

   Therapon jarbua

(Plate-35) *Therapon jarbua* (Day)

Sciaema jarbua : Forsskal, 1775. *Descript, Animalium*

Therapon jarbua : Day, 1875; Fishes of India 69, pl. 18, Fig. 4; Day, 1889; *Fauna of Br. India, Fishes* 1: 505.

Therapon jarbua : Smith & Smith, 1966

Therapon jarbua : Vari, 1978; *Bull. – Am Mus. nat. Hist*; 159 : 255.

Specimens Examined

About 42 specimens collected.

Munambum – 24, Chavakkadu – 12, Vadanappally – 6

Total length – 128 mm, Standard length – 101 mm, Body depth – 40%, Head length – 33%, Pre dorsal length – 44%, Caudal peduncle length – 27%, Snout to anal fin length – 67%, Length of basal part of dorsal fin – 42%, Length of basal part of anal fin – 21%, Eye diameter – 20%, Inter orbital space – 12%, Snout length – 33%.

Description

B. Vi, D. (10-12/9-11), P. 13, V. (1/5), A. (3/8-9), C. 17

The body is silvery with 3 or 4 curved dark brown or blackish stripes. Body oblong, slightly compressed. Mouth oblique. Teeth present in jaws dorsal fin notched and spines are strong. Caudal fin emarginate. The scales rough ctenoid. Pored lateral line scales 66 to 75.

Colour:- Body silvery greyish – blue, above silvery white below, with 3 or 4 longitudinal curved stripes. Dorsal fin with blackish boarder. Caudal fin with dark tips and 3 oblique lines.

Distribution:- Found in seas of India, Australia, East Africa and Hong Kong. Found in the inland waters of Munambum, Chavakkadu, Kochi and Vadanappally.

Remarks:- It is a good aquarium fish due to its ornamental colouration.

(Plate-36) *Therapon theraps* (Cuvier)

Therapon theraps : Cuvier, 1829; *Hist. Nat. Poiss*; 3: 129, pl. 53

Therapon therapn : Day, 1875; Fishes of India 70 pl. 18, fig. 6:

Therapon therapn : Vari, 1978; *Bull Ann. Mus. Nat. Hist.*, 159.

Specimens Examined

About 55 fishes were collected.

Munambum – 32, Chavakkadu – 14, Vadanappally – 5, Kochi – 4

Total length – 115 mm, Standard length – 95 mm, Body depth – 38%, Head length – 33%, Pre dorsal length – 52%, Caudal peduncle length – 22%, Snout to anal fin length – 68%, Length of basal part of dorsal fin – 44%, Length of basal part of anal fin – 23%, Eye diameter – 18%, Inter orbital space – 18%, Snout length – 30%.

Description

B. Vi, D. (10-12/9-16), P. 15, V. (1/5), A. (3/6), C. 17

Body compressed, covered with ctenoid rough scales. Mouth oblique no teeth on roof of mouth. Opercular spine strong and pungent. Pre-opercular edge serrated. Spinous and soft parts of fin seperated by a deep notch, second anal spine shorter than third. Caudal fin forked with round tipped lobes.

Colour:- Body dusky above, silvery below. 4 dark longitudinal bands on flanks, large blackish blotch present on spinous part of dorsal fin, a horizontal band on anal fin, 5 dark bands on caudal fin.

Distribution:- Found in the inshore waters. Often brackish. The young may enter into fresh waters. Indian sea, East coast of Africa, through the Malay Archipelago to China. Found in the inland waters of Munambum, Chavakkadu and Cochin.

Remarks:- A common species in the commercial catches in bays and estuaries of Central Kerala.

Plate 35 . *Therapon jarbua* (Day)

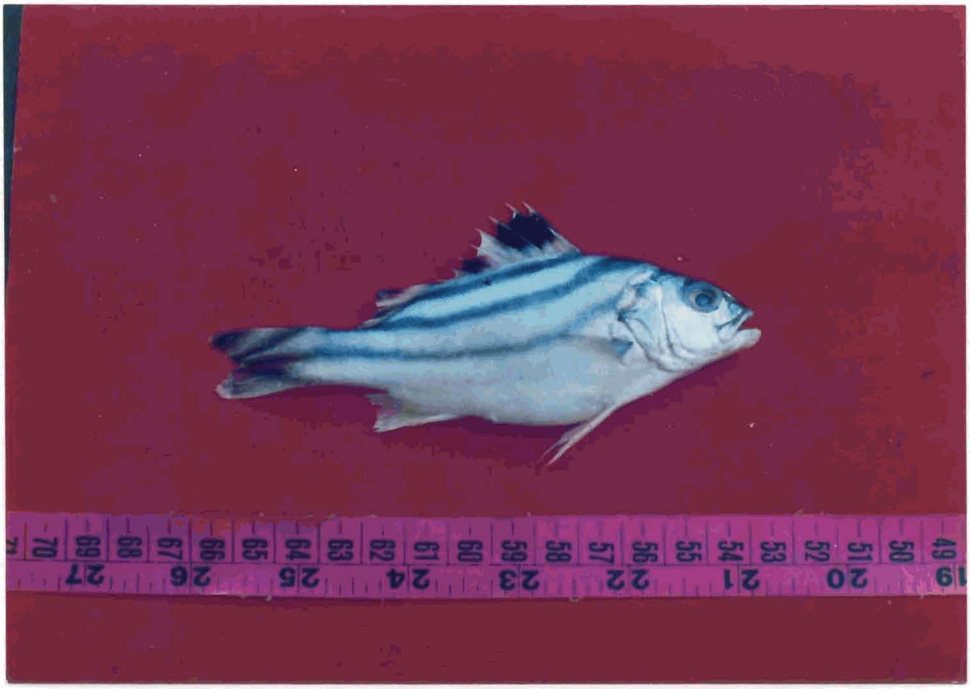
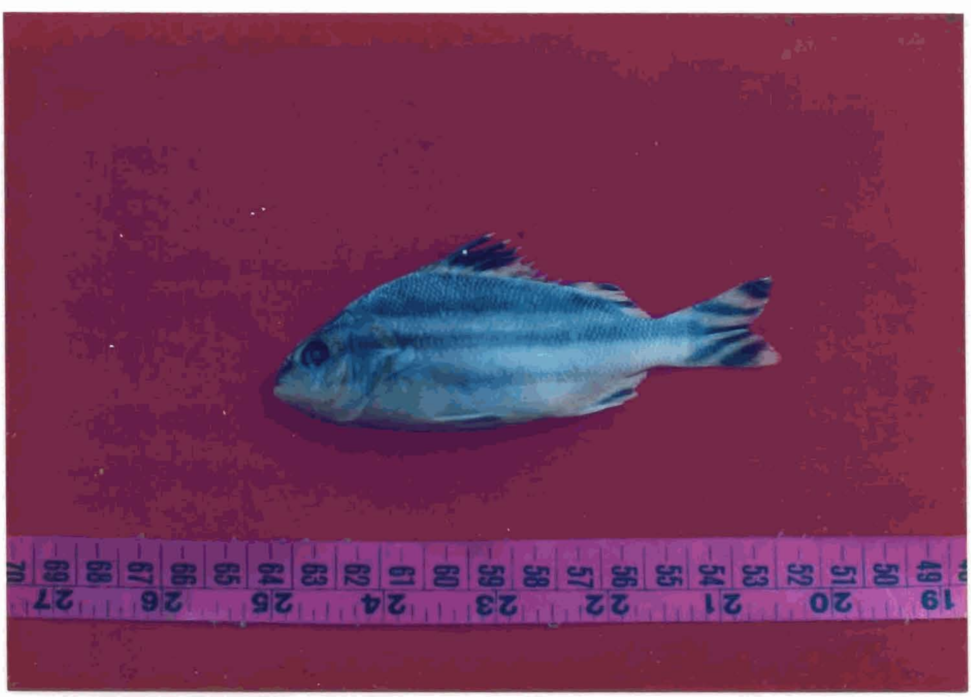


Plate 36. *Therapon theraps* (Cuvier)



CHAPTER - 3

FOOD AND FEEDING HABITS

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CHAPTER – 3

FOOD AND FEEDING HABITS

INTRODUCTION

Food and feeding habits of all organisms are essential for understanding various aspects of their biology. Generally every organism are clearly dependent on their food sources and therefore live in areas where they are able to forage effectively. Food is one of the important factors regulating growth, development, fecundity, migration and abundance of stocks. So the study of food and feeding habits of commercially important fishes is very essential now a days. Fishes, as all animals, require adequate nutrition in order to grow and survive. Through observation in the field and examination of the content of digestive tracts and through physiological studies in the laboratory, researchers have learned much knowledge concerning feeding behavior and the kinds of organisms that are eaten as well as the mechanisms that have developed for digestion. Knowledge on the diet of fishes is important in fundamental community analysis for studies of food webs, trophodynamics, resource partitioning and ecological energetics [Ivlev, 1961 and Landenberger, 1968]. Seasonal and diurnal abundance of favourable food organisms may be responsible for the horizontal and vertical movements of the fish stocks, which provide clue for the prediction and exploitation of the stocks. By noticing the favourable feeding grounds and feeding habits of commercially important fishes, appropriate fishing strategies and techniques can be designed by fishermen to extend or diversify their fishing effort. Experiments have also disclosed the dietary values of various classes of foods and have analyzed factors that affect growth of fishes. The information of nutrition gained, as a corollary of man's attempts helped to propagate fishes in the most efficient manner possible. Taking consideration of the above reason great attention has been given by the fishery biologists on this matter all over the world from the beginning of fishery biology investigation.

Based on the percentage of animal and vegetable matter consumed by fishes Das and Moitra (1956, 1963) classified them as herbivores, carnivores and omnivores. According to the zone of feeding they further classified fishes as surface feeders, column feeders and bottom feeders. The correlation between the availability of a particular food and the abundance of the predator species is well established by different authors. For instance, in the west coast waters good fishery of sardines and mackerels were noticed by George (1953) with the abundance of plankton from September to December. Seshappa and Bhimachar (1955) reported good fishery of malabar sole to have coincided with the abundance of polychactes between October- May. Venkataraman (1960) noted good fishery of silver bellies and white baits in relation with the abundance of plankton food (copepods).

Substantial works have done on the food and feeding habits of commercially important fishes. The earliest significant contribution on the study of food and feeding was made by Day (1875). Some of the other important works followed are by Herdmann and Corbin (1892), Allen (1935 & 1938), Swynnerton and Worthington (1940). Frost (1943 & 1946), Maitland (1965), Randall (1965) on reef fishes in West Indies, Collete and Talbot (1972), Burnelt and Herkes (1975), Fraser *et al* (1993), Heggens *et al* (1993) and Jobling *et al* (1998) on Salmon.

In India also a number of workers have done great works on food and feeding habits of fishes. The substantial works done in India are by Job (1940) on the perches of Madras coast, Chacko (1949) on the fishes of Gulf of Mannar, Hydes (1950) on the food of stickle backs, Prabhu (1955a) on Perch fishery by special traps, Venkataraman (1960) on the inshore fishes of Calicut, Rao Srinivasa (1964) on food and feeding habits of fishes from trawl catches, James (1967) on ribbon fishes, George *et al*. (1968) on food of some demersal fishes, Lal and Divedi (1969) on fresh water *teleosts-Rita rita* Silas (1969) on the food of Kalava, Thomas (1969) on the goat fishes, De Groot (1971) on flat fishes, Rangarajan (1970) on the Snapper *Lutjanus kasmira*, Krishnamoorthi (1971) on threadfin bream *Nemipterus japonicus*, Hussian and Abdullah (1971) on food habits of 6 commercial fishes, Qasim (1972) on some marine fishes, Burnett - Herkes (1975) on *Epinephleus guttatas*, Devaraj (1977) on biology of seer fishes of India, Neelakantan (1981) on false trevally - *Lactarius lactarius* (Bloch & Schneider), Muthaiah (1982) on japonicus in Bombay waters, Kusuma (1983) on *Johnius belangeri* (Cuvier), Prakash Nautiyal and Lal (1984) on fingerlings and juveniles of *Masheer Tor putitora* (Ham) in Neyyar, Joseph (1986) on potential fishery resources, Joseph and John (1987) on demersal fishery resources of Wadge Bank, Khan (1988) on a fresh water carp *Cyprinion macrostomus*, Devadoss (1989) on spade nose shark (*Scoliodon laticaudas*), Premalatha (1989) on rockcods, Das Gupta (1990) on *Masheer Tor tor* (Hamilton), Rao and Srinivasa Rao (1991) on *Nemipterus japonicus*, Vijayanand and Varghese (1992) on 3 marine ornamental fishes, Basudha *et al*. (1993) on endemic carp-*Osteobrama belangeri*, Tessy (1994) on the biology of 3 species of *Epinephleus*, Philip (1994) studies on the biology of family *Priacanthids*, Badrudeen and Pillai (1996) on the feeding habits of big eyed marra, *Gures macracanthus* (Bleeker), Gopal Raj and Sadasiv (1996) on the biology of *Nemipterus mesoprion* (Bleeker), Sivakamy (1996) on food habits of the family Carangidae. Das *et al* (1997) on *Accrossocheilus hexagonolepis*, Vijayakumaran (1997) on biology of striped eel, Nayak *et al* (1998) on the food and feeding habits of *Sardinella longiceps* (Val) of Gopalur coast, Rao *et al* (1998) on food and feeding habits of Channa species, Jayaprakash (1998) on flat fishes, Rao and Padmaja (1999) on the variations in the food and feeding habits of *Megalops* *cyprinoides* and Pedersen (2000) on the food consumption and feeding periodicity.

In this chapter the food and feeding habits of two edible perches *Priacanthus hamrur* and *Pomadasys maculatus* have described. Many workers from abroad as well as our country have reported the food and feeding habits of different species of *Priacanthidae* and *Pomadasyidae*. Some of the works on the genus *Priacanthus*, were by Tamura (1959) on *Priacnthids*, Chomjurai (1970) and Wetchagrun (1971) on *Priacanthus tayenus* and *Priacanthus macracanthus* in Asian waters, Collete and Talbolt (1972) on *Priacanthus cruentatus*, Senta (1977) on size composition of *Priacanthid* fishes, Appu Rao (1984) on biology of *Priacanthus maracanthus* (Cuvier), Joseph (1986) on potential fishery resources from the Indian EEZ, Naik (1990) on *Priacanthids*, Zachariah *et al* (1991) on bulls eye an emerging trawl fishery resource along Dakshina Kannada coast , Liu *et al* (1992) on the fishery biology of *Priacanthus macracanthus*, Philip (1994) on the biology and fishery of the fishes of the family *Priacanthidae*, Premalatha (1997) on the fishery and biology of *Priacanthus hamrur* and Philip (1998) on the food and feeding habits of *Priacanthus hamrur* from the upper coast of India.

Similarly some note-worthy works on the feeding habits of *Pomadasys* were done by Ahamad *et al* (1987). He reported 2 digenetic trematodes from the intestine of *Pomadasys maculatus*. Other scientists who worked on the feeding habits were Hecht *et al* (1992) on the feeding strategies of *Pomadasys commersonii* in estuaries, Hussian and Naama (1992) on the food habits of *Pomadasys argenteus*, Lewis *et al* (1992) on *Pomadasys maculatus*, Costa *et al* (1995) on the biology of roughneck grunt, *Pomadasys corvinaeformis* and Deacon & Hecht (1996) on Juvenile spotted grunter.

Although attempts were made to study the food and feeding habits of genera (genus) *Priacanthus* and *Pomadasys*, a detailed study of feeding habit of *Priacanthus hamrur* and *Pomadasys maculatus* from commercial catches of central Kerala is lacking. So, this chapter deals with a detailed account of the food and feeding habits of these two edible perches from the coast of central Kerala. Feeding index and feeding rhythm were also noted for both these fishes. Feeding activity was studied in some other groups by various scientists like Manikyal Rao and Srinivasa Rao (1991) in *Nemipterus japonicus*, Krishnamoorthy (1971) in *Nemipterus japonicus*, Rao (1964) on fishes from trawl catches. High feeding intensity was observed in *Priacanthus macracanthus* during November–December by Rao (1984). Feeding rhythm was noticed in many fishes by different scientists like Fraser et al.(1993) in Atlantic salmon, Heggens (1993) on small trout, Jobling *et al* (1998) on Atlantic salmon and Deacon & Hecht (1996) in *Pomadasys commersonnii*.

Several methods such as occurrence method, numerical method, points method, volumetric method and gravimetric method are employed for analysing fish stomach contents by scientists like Hobson (1965, 1968), Hydes (1950), Broutsky et al. (1952), Pillai (1952), Lagler (1956), Windell (1968), Windell and Bowen (1978). However, the choice of the method should suit the diet of the fish to be investigated. For example, the volumetric method is accepted as the most suitable one for the food analysis of carnivorus fishes (James, 1967). Hyslop (1980) has concluded that the best measure of dietary importance is the one where both the amount and bulk of a food category are recorded.

In tropical waters the high temperature accelerates the digestion process, so that the food remains in recognizable state more in the stomach than in the gut. Hence, the diet studies are to be made from stomachs and the rest of the gut could be ignored unless there are special reasons for doing so (Qasim, 1972)

MATERIALS AND METHODS

Specimens were collected from Munambum and Chettuvai Harbour during 1997 January to 1998 December. Samples collected from the field were immediately put in icebox with sufficient quantity of ice. Then they were brought to the lab, washed and used for food analysis. Fishes caught at night, noon and early morning were taken for the study in order to get a randum sample with reference to food items of the fish. The upper and lower jaws were dissected, separated by cutting at their junction and pinned firmly on the board. The pharyngeal teeth, their number and arrangements were examined and studied carefully. For the study of food and feeding habits of fishes different scientists adapted various methods. Here the analysis of gut contents were carried out by qualitative method-identifying the organisms in the gut to the nearest taxon possible. The prevalence of each food items in the diet during different months, size groups, and sex groups were calculated by the occurrence method Hydes (1950) for fresh water stickleback. The same method was used by Swynnerton and Worthington (1940) and in a modified form by Frost (1943) for the study of the food of minnow. In the determination of relative importance of food items of malabar sole *Cynoglossus semifasciatus* Seshappa and Bhimachar (1955) adopted the occurrence method. Pillay (1952) gave a critical review of various methods used for the analysis of food of fishes.

After recording length and weight, fish was dissected out to note the sex and stage of maturity. The gut contents were carefully washed and put into a small petridish. The various items were then sorted out using a binocular microscope and then identified qualitatively. The percentage occurrence of different items of food in different months was determined by summing the total number of occurrence of all items from which the percentage occurrence of each item was calculated.

Based on visual examination of the distension of stomachs and the contents of food present in them, they were graded into 3 categories to study the intensity of feeding, 'Heavy' – when the stomach was gorged with food and was fully distended, 'Medium' – when the stomach was half full and slightly distended, 'Empty' – when the stomach was empty (trace). The degree of fullness of stomach was determined on the basis of distension of stomach folds (Rao, 1964). According to Rao and Rao (1991) average amount of feeding was taken into consideration to determine the feeding intensity.

A total of 350-450 specimens were used in each group (family). The fishes with full stomachs were categorised as actively fed, halffull as moderately fed and empty (trace) as poorly fed. Diet analysis was done in relation to months, sexes and size groups to get an idea regarding any variation due to these variables. For the purpose of study with reference to size groups the data were analysed into 2 categories. In *Priacanthus* 0-20 cm (200 mm) group considered as small group and 20-40 cm (200-400 mm) as large group. In *Pomadasys* 0-15 cm(150 mm) group considered as small group and 15-30 cm (150-300 mm) as large group. For the sex wise study the data were grouped into males and females. The monthwise data of the two years were pooled together for arriving at a gross picture of the diet.

Depending on the degree of fullness of stomach, points such as 50, 25 and 0 are given to heavy, medium and empty stomachs respectively. For evaluating the preference of food consumed different food items were studied under 3 categories, i.e. 'Active', 'Moderate' and 'Poor'. Due consideration was given to the size of the food organisms as well as its abundance. The points gained by each food item were then summed and scaled down to percentage in order to indicate the percentage composition of food items for different months. This method gives roughly both qualitative and quantitative data without need for detailed counts.

Feeding index was worked out as described by Kow (1950) to assess the feeding intensity. According to him the feeding index was represented as the ratio between the number of specimens with heavy stomachs to the total number of specimens examined, as percentage.

$$\text{Feeding index} = \frac{\text{(No. of fishes with heavy feeding intensity}}{\text{(Total No. of fish examined)}} \times 100$$

In order to find out whether there was any rhythm in the feeding of these 2 fishes, (*Priacanthus hamrur* and *Pomadasys maculatus*) specimens were collected at 12 hours interval for a period of 72 hours and the condition of the gut of the fish from each collection was estimated. The degree of fullness of the stomach was noticed every month and percentage occurrence of stomach with different intensities of feeding was worked out in order to arrive at the feeding intensity in relation to size and season. Gastro Somatic Index (G.S.I) was calculated for the fishes of both groups.

$$\text{G.S.I} = (\text{Weight of gut/Weight of fish}) \times 100$$

A comparative study of food items of *Priacanthus* harmur and *Pomadasys maculatus* was carried out for a period of 24 months. This was done in order to assess provable interspecific competition for food.

OBSERVATIONS

The bucall cavity and alimentary canal were examined. In both fishes pharynx is provided with pharyngeal teeth (Plate-3.1.a & 3.1.b). The highest number and largest pharyngeal teeth was observed in *Pomadasys maculatus* when compared with *Priacanthus hamrur*. Pharyngeal teeth observed in perches were found weaker than the pharyngeal teeth reported by Shiny *et al* (1998) in catfishes. The pharyngeal teeth were present in both upper and lower jaws of both fishes. In *Priacanthus hamrur* upper jaw has two pads i.e. right and left pads. Each pad has three lobes. Anterior lobe with 20 large teeth boardered by a number of fine sharp teeth of different lengths. The middle lobe has 28 large teeth, which were larger than teeth of the rest of lobes. Posterior lob has 14 large teeth. Lower jaw pharyngeal teeth region was conical in shape. Teeth were present in two longitudinal pads. Each pad with 262 teeth. In *Pomadasys maculatus* the teeth were present in the upper jaw in two pads i.e. right and left. Each pad divided distinctly into two regions. 46 large and 58 small teeth were present in the pads. The lower jaw has about 78-82 teeth.

The presence of pharyngeal teeth in both fishes pointout strongly that these teeth are mainly used to engulf the live prey. It may help the fish to entangle the live preys inside its pharynx during feeding. Pharyngeal teeth may also prevent the live prey from escaping out of pharynx. The study of the alimentary canal revealed similarity in both fishes. Length of the intenstine was small in both fishes indicating the carnivorous nature of fishes (Plate-3.2.a & 3.2.b). The undigested food obtained more in the stomach than in the intestine. So the stomach was used for the analysis of food items.

RESULTS

The present investigation of the food of these fishes furnishes data on the nature of variations of food items and feeding rates in different seasons, different size groups and in different sexes. Both qualitative and quantitative analysis have done in both fishes and represented in different tables and figures. Deep sea prawns, prawn tissues, Annelida bristles, Invertebrate eggs, Animal tissues, Fat droplet, Jelly pieces of *Coelenterates* and Tentacles of *Coelenterates* were the main food items found in the stomach of *Priacanthus hamrur* [Fig. 3.1 to 3.4 . In addition, the miscellaneous items constituted occasional items like molluscan shell, alima larva, mysids, squilla, crabs, fishes, zoea larva, isopods, copepods etc. In general the crustaceans (prawn and prawn tissue) were found to be the most favourable food item as they formed more than 55% of the identifiable food items (Table 3.23 &3.24). Prawn tissues identified were mainly the deep-sea prawns, solenocera. The stomach content of some fishes contained penaied prawns such as penaeus and metapenaeus. Sand grains and vegetable matter were not at all observed in any of the fish examined.

Stomach analysis of *Pomadasys maculatus* proved that animal tissues, fat droplets, crustacean fragments, Annelida bristles and Invertebrate eggs were the chief food items [Fig. 3.5 to 3.8]. Further, more the miscellaneous part included items like mysis, worms, scales, crabs, larvae, sand grains etc. (Table 3.27 & 3.28). Crustacean fragments mainly consisted of prawn tissue, prawn appendages and larval forms. Both fishes showed a preference towards crustacean diet. Prawns were the most important food items of *Priacanthus hamrur*. In *Pomadasys* also crustaceans were not insignificant.

Ivlev's (1961) index of electivity (E) was followed to test whether any feeding selectivity of organisms exists. For this monthly percentage of food items in stomachs were used and the results of both fishes were given (Table 3.1 to 3.10). The results proved that in *Priacanthus hamrur* prawn tissue showed high percentage in all months. Prawn and prawn tissues forms 58.46% as average value for24 months during the study period. It forms 70.58% during

December, 65.61% during January, 64.71% during November, 62.77% during August, 61.26% during September and October, 58.83% during July, 57.77% during May, 55.26% during June and 50.78% during February. Prawn tissue forms less than 50% only during 2 months, i.e., 49.64% during March and 42.96% during April [Fig. 3.9 to 3.13].

In *Priacanthus hamrur*, Annelida bristles (9.99%) forms the second abundant food item as per average value for 24 months during the study period. Then comes the animal tissue (6.53%), invertebrate eggs (5.33%), coelenterate tentacles (2.35%), Fat droplet, (2.17%) and Jelly fish (1.69%). The observations undoubtedly prove that the length groups and sex groups have a real influence in the nature of feeding and preference of the food items. The female sex group feed 64.24% prawn tissue while the male sex groups feed only 52.67%. Similarly 20-40 cm length group of *Priacanthus* take 61.67% prawn tissue while 0-20 cm length group take only 49.25%.

Feeding intensity in *Priacanthus harmur* is calculated as 76.9% and this is found to be varying greatly in two sex groups. It is 71.56% in females and 80.62% in males. A considerable variation of feeding intensity was also noticed in two length groups of the population (Table 3.11 to 3.15). Feeding intensity is very high 81.76% in 0–20 cm length group, while it is only 75.54% in 20–40 cm length group [Fig. 3.19].

Monthly average G.S.I.data in males, females and pooled of *Priacanthus hamrur* were found out separately (Table 3.21). A fall in G.S.I. in females were noticed in the months November and December in both the years (Fig. 3.25.a & b).

Feeding rhythm noted in *Priacanthus* shows that there is no day-night specification in the feeding mechanism. Good / moderate rate of feeding was noted both during day and night periods. 'Medium' and 'Heavy' stomachs were observed both during day and night periods (Table 3.31.a & b).

In *Pomadasys maculatus* the result proved that the animal tissue showed high value in all months. Animal tissue form 32.73% as average value for 24 months of the study period. It forms 33.75% in January, 35.66% in February, 30.54% in March, 35.66% in April, 38.63% in May, 32.91% in June, 28.00% in July, 30.60% in August, 32.54% in September, 29.83% in October, 32.00% in November and 32.66% in December. Animal tissue forms less than 30% only in July and October [Fig. 3.14 to 3.18].

Fat droplets (22.57%) formed the 2nd abundant food item in *Pomadasys maculatus* as average value for 24 months during the study period. Crustacean fragment also stands about the same level 21.43% occupying the third position of the food item. Then comes the invertebrate eggs (10.41%) and Annelida bristles (5.73%).

The results proved that in general, the length groups and size groups have no real influence in the nature of feeding and preference on food items. The female sex group feed 32.90% animal tissue and the male sex groups feed only 32.35%, both the sex groups show the same percentage of animal tissue food. Among the length group 15-30 cm length groups of *Pomadasys* take 32.81% animal tissue while 0-15 cm length group take34.95%, while other food items show almost similar percentage in both length groups.

Feeding intensity of *Pomadasys maculatus* was calculated as 80.85%. Feeding intensity is found varying slightly in two sex groups (Table 3.16 to

3.20). It is found to be 75.97% in males, while it is 82.00% in females. In the length groups a great variation was noticed. Feeding intensity was high in 15-30 cm group (86.00%) while in 0-15 cm group it was only 75.72% [Fig. 3.20].

Monthly average G.S.I.data in males, females and pooled were found out separately in *Pomadasys maculatus.* There was no much difference in G.S.I. in both sexes in different months. The G.S.I. was maximum in January and December in both sexes (Table 3.22). The combined data showed that lowest G.S.I. noticed in March which is related with the breeding behaviour (Fig. 3.26 a & b).

Feeding rhythm noted in *Pomadasys maculatus* shows that there is no day-night specification in the feeding mechanism. Good/moderate rate of feeding was noted both during day and night periods. Medium and heavy stomachs were found both during day and night periods (Table 3. 32a &b).

DISCUSSION

Priacanthus hamrur and *Pomadasys maculatus* are found to be highly carnivorous perches. But great variation is noted in menu and feeding intensity. Zacharia *et al* (1991) reported the carnivorous nature of *Priacanthus hamrur*, feeding mainly on squids, lizardfish and *Therapon* as dominant items in the food. Lewis *et al* (1994) reported that *Pomadasys maculatus* in Platypus Bay Freezer Island feed predominantly on small crustaceans. Between these two fishes *Priacanthus hamrur* mainly feed on Prawns and related crustaceans. Prawn and prawn tissue form 58.46% among the total gut contents of *Priacanthus hamrur*. The existence of prawn and prawn tissue as the major food component was reported in other species of *Priacanthus* like *Priacanthus macracanthus* and *Priacanthus tayenus* by Rao (1967, 1984) Lester (1968), observed that *Priacanthus tayenus* from Hong Kong waters feeding mainly on shrimps and other crustaceans. Others like Chomjurai (1970) and Wetchagrun (1971) reported the affinity of different species of *Priacanthus* towards shrimps and related crustaceans. Ambak *et al* (1987) found that crustaceans were the dominant food items in *Priacanthus tayenus* and *Priacanthus macracanthus* of Malaysian waters. Philip (1994) in his study of *Priacanthus hamrur* from Vishakhapattanom harbour, observed that they are carnivorous, feeding mainly on crustaceans. The present study also agrees with the above views.

Eventhough, *Pomadasys maculatus* is also carnivorous in diet, the great affinity towards Prawn and prawn tissue is not found in this fish. Costa *et al* (1995) in his study regarding the food habits of *Pomadasys* corvinaeformis is observed that the diet of the fish includes food items such as polychaetes, fishes, crustaceans and seaweeds. In the present study of *Pomadasys maculatus* the animal tissue forms the most abundant food item in the gut contents. Fat droplets (22.57%) forms the second abundant food item in *Pomadasys maculatus.* The crustacean fragments (21.4%) forms the third abundant food item in *Pomadasys maculatus.* But in this study crustacean fragments mainly consist of the tissues of crustaceans other than the Prawn. The real prawn tissue and fragments of the Prawn are not regularly found during the gut content analysis of *Pomadasys maculatus.* So *Pomadasys maculatus* is found to be a carnivorous fish, which shows no clear- cut specificity toward Prawn and Prawn tissue. But the carnivorous nature and crustacean fragments in diet shows similarity between both groups of fishes.

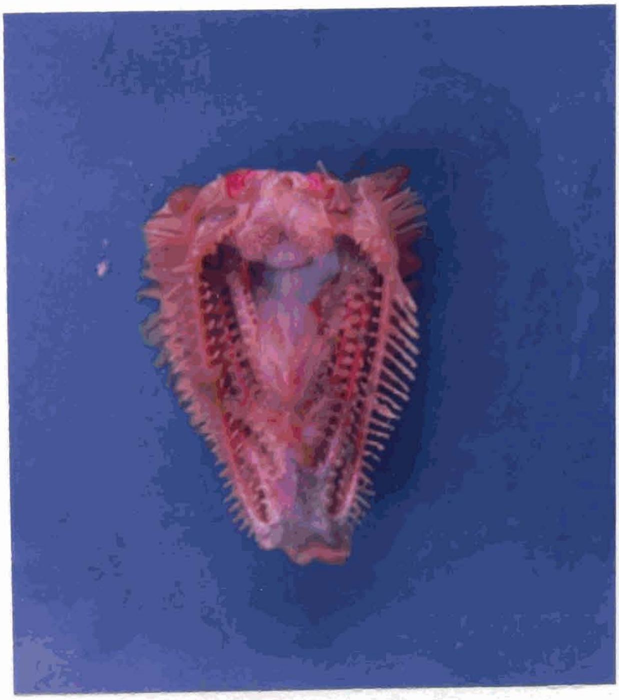
In the present study maximum prawn consumption was noted in *Priacanthus hamrur* during December. Rao (1984) noted that in *Priacanthus macracanthus* also the maximum prawn consumption was during December. Slight differences are noted among the sex groups and length groups of *Priacanthus hamrur* in connection with prawn consumption. The female sex group feed 64.24% of Prawn tissue while the male sex group feed 52.67% prawn tissue. Similarly 20–40 cm length group of *Priacanthus hamrur* takes 61.67% of prawn tissue. 0–20 cm length group takes only 49.25% prawn tissue. These results clearly illustrates that female sex groups have more affinity towards prawn tissue than that of males. Similarly the larger length group (20–40 cm) shows higher percentage of prawn food than that of small size group (0–20cm). The Annelida bristles (9.99%), Animal tissue (6.53%), Invertebrate eggs (5.33%), Coelenterate tentacles (2.35%), Fat droplets (1.83%) and Jelly fish (1.63%) are the other food items in the menu of *Priacanthus hamrur.* Lester (1968) reported the presence of Invertebrate eggs in the gut contents of *Priacanthus macracanthus* and *Priacanthus tayenus.* Because of the variation noticed in the availability of food organisms in the habitats, due to environmental factors, seasonal variations were noticed in the diet of both fishes. The present study also revealed that *Priacanthus hamrur* is not a bottom feeder because sand grains and other coarse particles are not reported from its gut contents. Philip (1994) reported that most of the species of *Priacanthus* are column feeders and so that there was complete absence of sand coarse particles in their gut contents. Tamura (1959) observed that *Priacanthids* generally feed above and ahead of it. The oblique nature of the mouth supports this statement Philip (1994) reported that most of the species of *Priacanthus* are column feeders and so that there was complete absence of sand coarse particle in their gut contents. The above-mentioned work also suggested that the upturned nature of the mouth in different species of *Priacanthus* indicate that they are column feeders and not bottom feeders.

Invertebrate eggs (10.41%) and Annelida bristles (6.36%) are also reported from the gut contents of *Pomadasys maculatus*. Their presence in the diet indicates similarity between the two fishes in the nature of food. Randall (1965) observed that groupers fed both day and night but more actively at dawn and dusk, while smaller serranids were diurnal. Allen (1935) found that summer food of perch changed with the size of the fish. Tessy (1994) reported that lower length group fish (*Epinephleus*) showed a preference for crustaceans, while the higher length group preferred fishes. Rao & Rao (1991) in *Nemipterus japonicus* reported that nature of food is size dependent and fishes in higher length group preferred large sized prey. Basudha and Vishwanath (1993) reported that 10% compositions of major food items in various size groups of fishes were different in the carp (*Osteobrama belangeri*). Sand and coarse particles are not found in the gut content of *Pomadasys maculatus* also. So the study also concludes that *Pomadasys maculatus* is a column feeder and not a bottom feeder like *Priacanthus hamrur*. Dankwa *et al* (1997) reported that most of the species of *Pomadasys maculatus* were carnivorous column feeders. Eventhough, *Priacanthus hamrur* and *Pomadasys maculatus* are column feeders there may not be much competition among the two groups because their food menu and habitat are different. Feeding intensity of *Priacanthus hamrur* is calculated as 76.9%. It is slightly higher (80.85%) in *Pomadasys maculatus*. The maximum feeding intensity in *Priacanthus hamrur* is noticed during September. Rao (1984) noticed a low feeding intensity during November–December in *Priacanthus macracanthus* of North East Coast. But in *Pomadasys maculatus* the maximum feeding was noted in a protracted manner because it is noted during six months of the year, January, April, May, July, October and November.

Feeding intensity was found varying in sex groups and length groups. Feeding intensity is 80.62% in males while it is 71.56% in females. A considerable variation in feeding intensity was also noted in the two length groups of *Priacanthus hamrur*. Feeding intensity is very high 81.76% in immature group (0–20 cm.), while it was75.59% in 20–40 cm. length group of *Priacanthus hamrur*. Menzel (1960) reported that feeding efficiency and growth rate of *Epinephleus guttatus* decreases with increase in size. This is in agreement with the present study. Krishnamoorthi (1971) noted the same in *Nemipterus japonicus*. Das *et al* (1997) reported about food spectrum and feeding intensity of *Accrossocheilus hexagonolepis*, an endemic rheophilic teleost. But in *Pomadasys maculatus* feeding intensity was found slightly higher in females (82.00%) than that of males (75.97%). Here feeding intensity is very high in 15–30 cm group (86%) while it was only (75.72%) in 0–15 cm group. The observation of the increased feeding intensity of matured fishes during their breeding season is important and it has great practical application in culture practice of this species. This finding directly points out that adding of food to the culture tanks during its breeding season will stimulate its fecundity. The feeding intensity was high during the months January, February, July and December.

Feeding rhythm was also studied in both fishes. This study proved that there was no day-night specificity in both *Priacanthus hamrur* and *Pomadasys maculatus*. This seems to be a novel result in fish biology, Since most of the fish specimen may be either nocturnal or diurnal. Hobson (1965) reported dawn and dusk rhythm in feeding intensity of a perch *Epinephleus labriformis*. He found that this feeds mainly on fishes during day and on crustaceans at night. Deacon (1996) reported a strong circadian rhythm in the behaviour of *Pomadasys commersonnii*. The feeding rhythm was diurnal in many other perches. Randall and Brock (1960) reported that crepuscular periods are correlated with greatest feeding activity in groupers. Rao (1964) reported that feeding activity appear to be much reduced in the night in *Priacanthus tayenus*. Silas (1969) observed that Kalava would stop biting after dusk. But in the present study of the feeding rhythm *Priacanthus hamrur* and *Pomadasys maculatus* exhibited no day-night specificity in feeding intensity.

3.1a *Priacanthus hamrur* **Pharyngeal teeth** 3.1b *Pomadasys maculatus*



3.2a *Priacanthus hamrur* **Alimentary canal** 3.2b *Pomadasys maculatus*

Table 3.1.a: Percentage composition of various food items in the gut of *Priacanthus hamrur* in Male during 1997

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	47.57	17.28	7.85	7.57	3.14	2	1.2	13.28
Feb.	33.33	12.33	10	6	1.67	1.67	1.67	33.33
Mar.	39.33	18.5	4	12.67	2	4.15	4.82	14.5
Apr.	22.5	17.5	12	9	1.5	0	9	28.5
May	52.75	8	5.75	5.25	2.75	1	1	23.5
Jun.	30.5	16	8.5	8.25	5.75	2.5	2.25	26.25
Jul.	60	12.25	5.75	4.5	1.75	1	1	13.75
Aug.	62.4	5.8	4.4	7	3	2	1.2	14.2
Sep.	50.75	19.25	6.25	8	0.75	1.25	2	11.75
Oct.	59.5	5.75	3	6.75	3	1.75	2.25	18
Nov.	54.6	9.4	5.2	9.8	1.2	3	3.2	13.6
Dec.	66	11.33	6	4	1.67	2	0.67	8.33

Table 3.1.b: Percentage composition of Male during 1998

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	65.00	7.33	3.67	7.67	1	0.67	3.33	11.33
Feb.	44.00	13.40	6.60	7.00	4.40	2.80	5.20	16.60
Mar.	49.51	10.50	9.50	9.50	4.25	3.50	2.00	11.25
Apr.	55.60	11.60	3.80	9.40	4.60	1.20	3.00	10.80
May	48.33	10.00	11.33	12.00	0.67	0	6.00	11.67
Jun.	54.50	12.25	3.25	7.50	2.50	1.75	2.75	15.50
Jul.	58.75	10.25	8.50	6.50	3.75	0	2.00	10.25
Aug.	65.50	4.50	6.40	5.60	0	3.00	2.50	12.50
Sep.	55.50	22.50	10.25	4.75	1.75	2.25	0	3.00
Oct.	61.60	10.00	4.00	8.40	0	2.00	3.00	11.00
Nov.	56.60	12.00	3.40	6.25	2.75	3.00	1.00	15.00
Dec.	70.00	8.00	4.00	5.00	0	0	0	13.00

Table 3.1.c: Average percentage composition of Males 1997 & 1998

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	56.28	12.30	5.76	7.62	2.07	1.33	2.26	12.30
Feb.	38.66	12.86	8.30	6.50	3.03	2.23	3.43	24.96
Mar.	44.42	14.50	6.75	11.08	3.12	3.82	3.41	12.87
Apr.	39.05	14.55	7.90	9.20	3.05	0.60	6.00	19.65
May	50.54	9.00	8.54	8.62	1.71	0.50	3.50	17.58
Jun.	42.50	14.12	5.87	7.87	4.12	2.12	2.50	20.87
Jul.	59.37	11.25	7.12	5.50	2.75	0.50	1.50	12.00
Aug.	63.95	5.15	5.40	6.30	1.50	2.50	1.85	13.35
Sep.	53.12	20.87	8.25	6.37	1.25	1.75	1.00	7.37
Oct.	60.55	7.87	3.50	7.57	1.50	1.87	2.62	14.50
Nov.	55.60	10.70	4.30	8.02	1.97	3.00	2.10	14.30
Dec.	68.00	9.66	5.00	4.50	0.83	1.00	0.33	10.66
Average	**52/67**	**11.90**	**6.39**	**7.43**	**2.24**	**1.77**	**2.54**	**15.03**

I-Prawn tissue, II-Annelida bristle, III-Invertebrate egg, IV-Animal tissue,
V-Fat droplet, VI-Coelenterate jelly, VII-Coelenterate tentacle, VIII-Miscellaneous

Table 3.2.a: Percentage composition of various food items in the gut of *Priacanthus hamrur* in Female during 1997

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	70.87	8.37	5.12	1.63	1.25	1.63	0.75	10.38
Feb.	58.13	8.13	4.38	7.00	3.00	0	3.88	15.55
Mar.	58.50	12.50	0	7.75	1.75	3.50	1.50	14.50
Apr.	38.00	19.20	5.40	15.00	3.00	2.80	1.80	14.80
May	67.75	6.50	1.00	3.75	0	0.50	1.00	19.50
Jun.	67.80	9.80	1.60	2.40	3.20	0.40	2.40	12.40
Jul.	56.80	8.40	5.40	5.60	2.40	1.00	4.00	16.40
Aug.	62.60	6.60	2.40	5.00	0.80	1.20	1.60	19.80
Sep.	70.40	8.60	2.20	7.80	1.60	1.60	1.40	6.40
Oct.	60.75	7.50	7.75	5.25	3.25	2.50	4.25	8.75
Nov.	77.25	6.50	3.00	2.25	1.25	0	2.50	7.25
Dec.	71.33	5.33	4.83	5.83	1.16	0.50	3.33	7.67

Table 3.2.b: Percentage composition of Female during 1998

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	79.00	3.00	3.00	3.60	2.40	2.00	1.00	6.00
Feb.	67.67	7.67	2.00	7.00	1.00	3.33	1.33	10.00
Mar.	51.25	11.25	5.50	8.75	3.00	1.50	3.00	15.75
Apr.	55.75	8.00	6.75	5.75	7.75	1.20	3.20	11.60
May	62.25	8.00	8.50	4.00	1.00	2.00	2.00	12.00
Jun.	68.25	6.75	3.75	5.00	2.00	0.75	1.00	12.50
Jul.	59.80	5.20	5.40	5.60	5.00	2.00	3.00	14.00
Aug.	60.60	5.40	4.80	6.20	0	3.00	5.00	15.00
Sep.	68.40	10.60	4.00	5.50	2.50	0	0	9.00
Oct.	63.20	5.80	7.00	4.00	3.20	6.80	0	10.00
Nov.	70.40	10.60	5.00	4.50	0	0	4.00	5.50
Dec.	75.00	4.20	3.80	6.00	0	0	0	11.00

Table 3.2.c: Average percentage composition of Females 1997 & 1998

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	74.93	5.68	4.06	2.61	1.82	1.81	0.87	8.19
Feb.	62.90	7.90	3.19	7.00	2.00	1.66	2.60	12.77
Mar.	54.87	11.87	2.75	8.25	2.37	2.50	2.25	15.12
Apr.	46.87	13.60	6.07	10.37	5.37	2.00	2.50	13.20
May	65.00	7.25	4.75	3.87	0.50	1.25	1.50	15.75
Jun.	68.02	8.27	2.67	3.70	2.60	0.57	1.70	12.45
Jul.	58.30	6.80	5.40	5.60	3.70	1.50	3.50	15.20
Aug.	61.60	6.00	3.60	5.60	0.40	2.10	3.30	17.40
Sep.	69.40	9.60	3.10	6.65	2.05	0.80	0.70	7.70
Oct.	61.97	6.65	7.37	4.62	3.22	4.65	2.12	9.37
Nov.	73.82	8.55	4.00	3.37	0.62	0	3.25	6.37
Dec.	73.16	4.76	4.31	5.91	0.58	0.25	1.66	9.33
Average	**64.24**	**8.07**	**4.27**	**5.63**	**2.10**	**1.59**	**2.16**	**11.90**

I-Prawn tissue, II-Annelida bristle, III-Invertebrate egg, IV-Animal tissue, V-Fat droplet, VI-Coelenterate jelly, VII-Coelenterate tentacle, VIII-Miscellaneous

Table 3.3.a: Percentage Composition of Various Food items in the Gut of *Priacanthus hamrur* in the Length Group 0–20 cm. during 1997

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	53.00	21.50	5.75	3.75	2.75	2.00	0.75	10.50
Feb.	33.33	12.33	10.00	6.00	1.67	1.67	1.67	33.37
Mar.	52.00	15.60	2.80	10.20	2.40	3.20	4.40	9.00
Apr.	45.00	10.00	6.00	10.00	9.00	0	5.00	15.00
May	37.50	10.00	8.50	6.50	2.50	0	0	35.00
Jun.	38.00	17.00	5.67	4.33	8.67	0	3.00	23.33
Jul.	60.00	12.00	5.00	0	3.00	0	0	20.00
Aug.	62.67	4.00	4.00	7.00	3.67	2.33	1.00	15.33
Sep.	42.50	27.50	7.50	6.00	0	2.50	1.52	12.50
Oct.	55.00	8.00	7.00	5.00	3.00	0	7.00	15.00
Nov.	49.60	15.67	4.33	8.33	2.00	1.33	3.67	15.33
Dec.	55.00	20.00	7.00	8.00	3.00	0	0	7.00

Table 3.3.b: Percentage composition of Length group 0–20 cm. 1998

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	62.50	4.0	10.00	9.00	2.50	2.50	2.50	6.50
Feb.	38.33	15.00	6.67	15.00	4.00	3.67	4.00	19.33
Mar.	35.00	10.00	20.00	15.00	0	5.00	5.00	10.00
Apr.	30.00	14.00	6.00	12.00	7.00	0	8.00	20.00
May	42.50	12.50	13.00	6.67	1.00	0	4.00	15.00
Jun.	60.00	12.33	3.00	6.00	1.33	0.67	3.67	12.33
Jul.	61.00	15.00	4.00	5.00	4.00	0	0	10.00
Aug.	65.60	5.00	0	4.00	3.00	2.50	1.50	17.40
Sep.	44.00	25.50	10.00	8.00	0	0	2.50	14.00
Oct.	54.60	10.00	10.40	7.00	0	4.00	4.00	9.00
Nov.	45.00	5.50	17.00	6.50	4.00	2.00	3.50	16.00
Dec.	60.00	12.00	5.00		7.00	0	0	9.50

Table 3.3.c: Average percentage composition 0–20 cm 1997 & 98

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	57.75	12.75	7.87	6.37	2.62	2.25	1.62	8.50
Feb.	35.83	13.66	8.33	10.50	2.83	2.67	2.83	26.35
Mar.	43.50	12.80	11.40	12.60	1.20	4.10	4.70	9.50
Apr.	37.50	12.00	6.00	11.00	8.00	0	6.50	17.50
May	40.00	11.25	10.75	6.58	1.75	0	2.00	25.00
Jun.	49.00	14.66	4.33	5.16	5.00	0.33	3.33	17.83
Jul.	60.50	13.50	4.50	2.50	3.50	0	0	15.00
Aug.	64.13	4.50	2.00	5.50	3.33	2.41	1.25	16.36
Sep.	43.25	26.50	8.75	7.00	0	1.25	2.01	13.25
Oct.	54.80	9.00	8.70	6.00	1.50	2.00	5.50	12.00
Nov.	47.30	10.58	10.66	7.41	3.00	1.66	3.58	15.66
Dec.	57.50	16.00	6.00	8.00	5.00	0	0	8.25
Average	**49.25**	**13.10**	**7.44**	**7.38**	**3.14**	**1.39**	**2.77**	**15.43**

I-Prawn tissue, II-Annelida bristle, III-Invertebrate egg, IV-Animal tissue, V-Fat droplet, VI-Coelenterate jelly, VII-Coelenterate tentacle, VIII-Miscellaneous

Table 3.4.a: Percentage composition of various food items in the gut of *Priacanthus hamrur* in the Length Group 20–40 cm. during 1997

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	62.55	9.27	6.64	4.64	2.00	1.73	1.09	12.18
Feb.	58.13	8.13	4.38	7.50	3.45	0	3.88	15.55
Mar.	42.00	16.60	2.00	11.20	1.40	4.60	2.20	20.00
Apr.	35.00	20.17	7.50	10.50	1.50	2.33	3.67	19.33
May	67.83	6.33	1.67	3.83	1.00	1.00	1.33	17.00
Jun.	57.83	10.33	4.17	5.33	2.17	2.00	2.00	16.17
Jul.	58.00	9.88	5.63	5.75	2.00	1.13	3.00	14.63
Aug.	62.43	7.14	3.14	5.56	1.14	1.29	1.57	17.71
Sep.	67.14	9.29	3.00	8.43	1.57	1.14	1.71	7.71
Oct.	60.86	6.43	5.14	6.14	3.14	2.43	2.71	13.14
Nov.	70.67	4.33	4.17	5.50	0.83	1.83	2.50	10.17
Dec.	71.38	5.75	5.00	4.88	1.13	1.13	2.75	8.00

Table 3.4.b: Percentage composition of Length group 20–40 cm. 1998

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	77.50	5.30	1.50	2.67	1.67	0.83	1.33	9.20
Feb.	61.60	9.00	3.80	5.80	2.60	2.60	3.60	11.00
Mar.	58.29	11.00	5.71	8.29	4.14	1.43	2.14	9.00
Apr.	56.90	9.50	7.50	8.50	0	3.50	2.88	12.00
May	66.60	7.40	3.80	5.60	1.20	1.60	1.60	12.20
Jun.	62.20	7.80	3.80	6.00	2.80	1.60	0.80	15.00
Jul.	55.00	11.80	4.20	6.75	1.25	1.50	4.80	14.70
Aug.	65.00	5.14	1.50	6.36	6.00	3.00	3.00	10.00
Sep.	64.00	12.30	3.70	3.50	2.50	2.00	1.75	10.25
Oct.	62.50	5.50	4.80	5.00	4.20	5.00	1.00	12.00
Nov.	66.67	6.33	5.00	3.50	0	2.80	3.50	12.20
Dec.	70.00	7.80	3.20	7.00	0	3.00	0	9.00

Table 3.4.c: Average % composition Length group 20–40 cm 1997 & 98

Month	I	II	III	IV	V	VI	VII	VIII
Jan.	70.025	7.285	4.07	3.655	1.835	1.28	1.21	10.69
Feb.	59.865	8.565	4.09	6.65	3.025	1.3	3.74	13.275
Mar.	50.145	13.8	3.855	9.745	2.77	3.015	2.17	14.5
Apr.	45.95	14.835	7.5	9.5	0.75	2.915	3.275	15.665
May	67.215	6.865	2.735	4.715	1.1	1.3	1.465	14.6
Jun.	60.015	9.065	3.985	5.665	2.485	1.8	1.4	15.585
Jul.	56.5	10.84	4.915	6.25	1.625	1.315	3.9	14.665
Aug.	63.715	6.14	2.32	5.96	3.57	2.145	2.285	13.855
Sep.	65.57	10.795	3.35	5.965	2.035	1.57	1.73	8.98
Oct.	61.68	5.965	4.97	5.57	3.67	3.715	1.855	12.57
Nov.	68.67	5.33	4.585	4.5	0.415	2.315	3	11.185
Dec.	70.69	6.775	4.1	5.94	0.565	2.065	1.375	8.5
Average	**61.67**	**8.855**	**4.206**	**6.176**	**1.987**	**2.061**	**2.284**	**12.839**

I-Prawn tissue, II-Annelida bristle, III-Invertebrate egg, IV-Animal tissue, V-Fat droplet, VI-Coelenterate jelly, VII-Coelenterate tentacle, VIII-Miscellaneous

Table 3.5: Average Percentage Composition of Various Food items in the Gut of Total *Priacanthus hamrur* in during 1997 and 1998

Month	Prawn Tissue	Annelida Bristle	Inverte-brate Egg	Animal Tissue	Fat Droplet	Coelenterata Jelly	Coelenterata Tentacle	Miscell-aneous
Jan.	65.61	8.99	4.91	5.11	1.94	1.57	1.57	10.24
Feb.	50.78	10.38	5.74	6.75	2.51	1.95	3.02	18.87
Mar.	49.64	13.18	4.75	9.66	2.75	3.16	2.83	14.00
Apr.	42.96	14.07	6.98	9.78	4.21	1.30	4.25	16.42
May	57.77	8.12	6.64	6.25	1.10	0.87	2.50	16.66
Jun.	55.26	11.20	4.27	5.78	3.36	1.35	2.10	16.66
Jul.	58.83	9.02	6.26	5.55	3.22	1.00	2.50	13.60
Aug.	62.77	5.57	4.50	5.95	0.95	2.30	2.57	15.37
Sep.	61.26	15.23	5.67	6.51	1.65	1.27	0.85	7.53
Oct.	61.26	7.26	5.43	6.10	2.36	3.26	2.37	11.93
Nov.	64.71	9.65	4.15	5.70	1.30	1.50	2.67	10.33
Dec.	70.58	7.21	4.65	5.20	0.70	0.62	1.00	10.00
	58.45	**9.99**	**5.33**	**6.53**	**2.17**	**1.68**	**2.35**	**13.47**

Table 3.10: Average % Composition of Various Food items in the Gut of Total *Pomadasys maculatus* (Bloch) during 1997 & 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Invertebrate Eggs	Bristle Annelida	Miscella-neous
Jan.	33.75	12.87	17.25	13.207	11.83	11.08
Feb.	35.66	16.14	21.50	12.31	8.93	5.43
Mar.	30.54	22.83	20.81	9.87	7.81	8.12
Apr.	35.66	21.21	21.18	6.25	11.50	4.18
May	38.62	25.68	17.62	12.62	1.93	3.50
Jun.	32.90	26.62	19.70	10.96	4.59	5.18
Jul.	28.00	23.91	20.10	12.16	9.45	6.36
Aug.	30.60	22.70	23.56	9.35	8.37	6.16
Sep.	32.53	22.01	23.51	10.64	7.76	3.52
Oct.	29.83	22.83	30.58	6.81	3.56	6.37
Nov.	32.00	25.00	21.91	9.98	6.51	4.58
Dec.	32.65	29.04	19.45	10.65	4.05	4.15
Average	**32.73**	**22.57**	**21.43**	**10.40**	**7.19**	**5.72**

Table 3.6: Percentage Composition of Various Food items in the Gut of *Pomadasys maculatus* (Bloch)

a) Male - during 1997

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Invertebrate Eggs	Bristle Annelida	Miscellaneous
Jan.	35.00	6.00	15.67	11.00	15.67	16.67
Feb.	33.00	11.00	17.25	14.75	10.75	13.25
Mar.	31.25	23.50	17.50	11.00	10.00	6.75
Apr.	34.75	21.00	21.25	11.00	9.00	3.00
May	35.50	28.75	22.00	7.25	2.25	4.25
Jun.	36.00	30.00	20.00	6.67	1.33	6.00
Jul.	24.00	20.00	26.00	14.33	10.00	5.67
Aug.	27.00	25.00	25.50	10.00	5.50	7.00
Sep.	32.00	23.00	24.00	12.33	5.33	3.33
Oct.	28.25	20.75	33.00	11.25	2.75	4.00
Nov.	31.00	24.25	22.25	10.75	6.00	5.75
Dec.	36.33	28.67	23.00	6.00	2.00	4.00

b) Male - during 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Invertebrate Eggs	Bristle Annelida	Miscellaneous
Jan.	32.00	21.50	18.00	19.50	4.00	5.00
Feb.	36.67	14.33	19.00	18.00	10.00	2.00
Mar.	29.75	28.00	16.25	10.00	6.00	10.00
Apr.	39.50	21.00	29.50	0	8.00	2.00
May	37.50	25.00	10.00	23.50	0	4.00
Jun.	34.00	27.00	23.00	7.00	6.00	3.00
Jul.	30.00	29.67	8.00	20.33	10.00	2.00
Aug.	29.00	23.00	29.75	0	18.00	3.25
Sep.	30.75	26.25	22.67	8.00	10.33	2.00
Oct.	33.67	24.00	29.33	5.00	0	8.00
Nov.	30.00	22.50	25.00	10.50	10.00	2.00
Dec.	34.50	25.50	18.00	12.00	6.00	4.00

c) Male - during 1997 & 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Invertebrate Eggs	Bristle Annelida	Miscellaneous
Jan.	33.50	13.50	17.00	15.25	10.84	10.34
Feb.	34.83	12.66	18.00	16.00	10.37	7.62
Mar.	30.50	25.75	16.87	10.50	8.00	8.37
Apr.	37.75	21.00	25.00	5.50	8.50	2.50
May	36.50	26.87	16.00	15.37	1.12	4.12
Jun.	35.00	28.50	21.50	6.83	3.66	4.50
Jul.	27.00	24.83	17.00	17.33	10.00	3.83
Aug.	28.00	24.00	27.50	5.00	11.75	5.30
Sep.	31.30	23.00	23.20	10.29	7.17	2.54
Oct.	30.50	21.75	31.50	8.63	1.38	6.00
Nov.	30.50	23.50	25.75	10.38	8.00	3.75
Dec.	35.47	27.00	20.50	9.00	4.00	4.00
Average	**32.35**	**22.83**	**20.73**	**10.87**	**7.19**	**6.00**

Table 3.7: Percentage Composition of Various Food items in the Gut of *Pomadasys maculatus* (Bloch)

a) Female - during 1997

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Inverte-brate Eggs	Bristle Annelida	Miscellaneous
Jan.	35.00	6.00	15.67	11.00	15.67	16.67
Feb.	35.00	19.25	23.75	14.50	5.00	2.50
Mar.	31.50	18.50	27.50	9.50	7.25	5.75
Apr.	35.00	19.25	16.00	14.00	12.00	3.75
May	39.75	23.00	18.50	9.50	5.50	3.75
Jun.	31.83	28.50	20.83	10.17	4.83	3.75
Jul.	28.00	21.20	26.40	13.00	5.60	5.80
Aug.	34.00	24.20	16.00	17.40	4.00	4.40
Sep.	34.80	18.40	23.40	12.00	6.40	5.00
Oct.	27.00	22.00	29.00	11.00	4.50	6.50
Nov.	33.00	27.67	19.00	8.67	4.67	7.00
Dec.	31.20	30.60	19.80	10.40	4.40	3.60

b) Female - during 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Inverte-brate Eggs	Bristle Annelida	Miscellaneous
Jan.	33.00	18.00	19.67	11.33	12.00	6.00
Feb.	38.00	20.00	26.00	2.00	10.00	4.00
Mar.	29.67	21.33	22.00	9.00	8.00	10.00
Apr.	33.40	23.60	18.00	0	17.00	8.00
May	41.75	26.00	20.00	10.25	0	2.00
Jun.	29.80	21.00	15.00	20.00	6.20	8.00
Jul.	30.00	24.80	20.00	1.00	12.20	12.00
Aug.	32.40	18.60	23.00	10.00	6.00	10.00
Sep.	32.60	20.40	24.00	10.25	9.00	3.75
Oct.	30.40	24.60	31.00	0	7.00	7.00
Nov.	34.00	25.60	21.40	10.00	5.40	3.60
Dec.	28.60	31.40	17.00	14.20	3.80	5.00

c) Female - during 1997 & 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Invertebrate Eggs	Bristle Annelida	Miscellaneous
Jan.	34.00	12.00	17.67	11.16	13.83	11.33
Feb.	36.50	19.62	24.87	8.25	7.50	3.25
Mar.	30.58	19.91	24.75	9.25	7.62	7.87
Apr.	34.20	21.42	17.00	7.00	14.5	5.87
May	40.75	24.50	19.25	9.87	2.75	2.87
Jun.	30.81	24.75	17.91	15.08	5.51	5.87
Jul.	29.00	23.00	23.20	7.00	8.90	8.90
Aug.	33.20	21.40	19.50	13.70	5.00	7.20
Sep.	33.70	19.40	23.70	11.12	7.70	4.37
Oct.	28.70	23.30	30.00	5.50	5.75	6.75
Nov.	33.50	26.63	20.20	9.33	5.03	5.30
Dec.	29.90	31.00	18.40	12.30	4.10	4.30
Average	**32.90**	**22.24**	**21.37**	**9.96**	**7.35**	**6.15**

Table 3.8: Percentage Composition of Various Food items in the Gut of *Pomadasys maculatus* (Bloch)

a) 0-15 cm. Length Group during 1997

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Inverte-brate Eggs	Bristle Annelida	Miscella-neous
Jan.	35.75	14.50	11.75	8.25	11.75	18.00
Feb.	44.00	10.00	17.25	14.75	10.75	3.25
Mar.	40.00	25.00	20.00	4.00	11.00	0
Apr.	33.75	21.00	21.25	11.00	9.50	3.50
May	40.00	30.00	20.00	8.00	0	2.00
Jun.	35.75	30.00	18.75	6.25	3.50	5.75
Jul.	24.33	19.00	28.33	13.33	9.00	6.00
Aug.	27.20	23.60	25.20	11.60	6.40	6.00
Sep.	36.00	25.00	20.00	19.00	0	0
Oct.	28.50	20.00	34.00	11.50	1.00	5.00
Nov.	29.00	32.50	18.50	12.50	3.00	4.50
Dec.	33.60	28.80	21.80	9.40	2.40	4.00

b) 0-15 cm. Length Group during 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Inverte-brate Eggs	Bristle Annelida	Miscella-neous
Jan.	33.75	17.25	14.00	18.00	7.00	10.00
Feb.	30.50	20.00	20.50	15.00	10.00	4.00
Mar.	44.00	30.00	22.00	0	4.00	0
Apr.	35.75	17.50	25.75	11.00	2.00	8.00
May	37.80	32.00	16.40	5.80	6.00	2.00
Jun.	40.00	26.00	18.00	10.50	0	5.50
Jul.	28.00	23.60	24.00	12.40	8.00	4.00
Aug.	32.60	29.40	22.00	10.20	4.80	1.00
Sep.	37.50	30.50	17.00	8.00	1.00	6.00
Oct.	30.20	24.80	25.00	14.00	4.00	2.00
Nov.	33.00	30.00	17.25	9.00	6.75	4.00
Dec.	36.75	30.25	16.00	8.00	5.40	3.60

c) 0-15 cm. Length Group during 1997 & 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Invertebrate Eggs	Bristle Annelida	Miscella-neous
Jan.	34.75	15.87	12.87	13.12	9.37	14.00
Feb.	37.25	15.00	18.87	14.87	10.37	3.62
Mar.	42.00	27.50	21.00	2.00	7.50	0
Apr.	34.75	19.25	23.50	11.00	5.75	5.75
May	38.90	31.00	18.20	6.90	3.00	2.00
Jun.	37.87	28.00	18.37	8.37	1.75	5.62
Jul.	26.16	21.30	26.16	12.86	8.50	5.00
Aug.	29.90	26.50	23.60	10.90	5.60	3.50
Sep.	36.75	27.75	18.50	13.50	0.50	3.00
Oct.	33.00	25.25	25.50	9.75	1.00	5.50
Nov.	33.00	30.00	17.25	9.00	6.75	4.00
Dec.	35.17	29.52	18.90	8.70	3.90	3.80
Average	**34.96**	**24.74**	**20.22**	**10.08**	**5.33**	**4.65**

Table 3.9: Percentage Composition of Various Food items in the Gut of *Pomadasys maculatus* (Bloch)

a) 15-30 cm. Length Group during 1997

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Inverte-brate Eggs	Bristle Annelida	Miscella-neous
Jan.	25.75	12.50	12.75	4.50	13.25	31.25
Feb.	43.75	23.00	9.00	14.50	5.00	4.75
Mar.	30.20	20.14	22.85	12.00	8.20	6.60
Apr.	35.00	19.25	16.00	14.00	12.00	3.75
May	37.29	25.86	20.29	8.43	4.43	3.70
Jun.	32.20	27.60	22.00	11.20	3.80	3.20
Jul.	33.00	26.00	20.00	14.00	2.00	5.00
Aug.	35.50	25.75	14.00	17.25	2.50	5.00
Sep.	33.40	19.43	24.14	11.14	6.86	5.00
Oct.	25.67	21.83	31.33	11.33	4.50	5.33
Nov.	33.00	23.00	21.80	8.80	6.40	7.00
Dec.	29.33	31.67	21.00	9.33	5.33	3.33

b) 15-30 cm. Length Group during 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Inverte-brate Eggs	Bristle Annelida	Miscella-neous
Jan.	30.25	14.00	16.00	9.75	12.00	18.00
Feb.	39.75	18.00	11.00	14.00	8.00	9.25
Mar.	32.20	17.00	20.60	16.20	6.00	8.00
Apr.	33.00	21.00	15.00	11.00	10.00	10.00
May	39.30	23.00	10.70	10.00	11.00	6.00
Jun.	35.60	25.40	17.00	15.00	0	7.00
Jul.	31.00	29.60	16.00	13.40	8.00	2.00
Aug.	33.00	27.00	18.00	12.60	5.00	4.40
Sep.	35.60	21.00	23.40	9.00	8.00	3.00
Oct.	28.80	24.20	28.00	0	14.00	5.00
Nov.	32.00	25.00	23.00	10.00	4.80	5.20
Dec.	30.00	30.00	24.00	8.60	5.00	2.40

c) 15-30 cm. Length Group during 1997 & 1998

Month	Animal Tissue	Fat Droplet	Crustacean Fragment	Invertebrate Eggs	Bristle Annelida	Miscella-neous
Jan.	28.00	13.25	14.37	7.12	12.62	24.62
Feb.	41.75	20.50	10.00	14.25	6.50	7.00
Mar.	31.20	18.57	21.72	14.10	7.10	7.30
Apr.	34.00	20.12	15.50	12.50	11.00	6.87
May	35.14	23.43	17.64	9.71	7.21	6.85
Jun.	33.90	26.50	19.50	13.10	1.90	5.10
Jul.	32.00	27.80	18.00	13.70	5.00	3.50
Aug.	34.25	26.37	16.00	14.92	3.75	4.70
Sep.	34.50	20.21	23.77	10.07	7.43	4.00
Oct.	27.23	23.01	29.66	5.66	9.25	5.16
Nov.	32.50	24.00	22.40	9.40	5.60	6.10
Dec.	29.66	30.83	22.50	8.96	5.16	2.86
Average	**32.84**	**22.88**	**19.25**	**11.12**	**6.87**	**7.00**

Table 3.11.a: Feeding Intensity of Male *Priacanthus hamrur* Percentage of Fish with various Stomachs during 1997

Month	No. of Fish	Empty	Medium	Heavy
January	7	28.57	28.57	42.86
February	3	66.67	0	33.33
March	6	50.00	50.00	0
April	2	50.00	0	50.00
May	4	50.00	50.00	0
June	4	50.00	25.00	25.00
July	4	25.00	50.00	25.00
August	5	0	100.00	0
September	4	25.00	75.00	0
October	4	0	50.00	50.00
November	5	0	100.00	0
December	3	33.33	66.67	0

Table 3.11.b: Percentage of Fish with various Stomachs during 1998

Month	No. of Fish	Empty	Medium	Heavy
January	3	0	33.33	66.67
February	5	20.00	80.00	0
March	4	0	75.00	25.00
April	5	0	60.00	40.00
May	3	33.33	33.33	33.34
June	4	0	25.00	75.00
July	3	0	33.33	66.67
August	3	0	100.00	0
September	3	0	100.00	0
October	2	0	100.00	0
November	4	0	100.00	0
December	3	33.33	66.67	0

Table 3.11.c: Percentage of Fish with various Stomachs during 1997 & 1998

Month	No. of Fish	"Empty"	"Medium"	"Heavy"
January	10	14.28	30.95	54.77
February	8	33.44	40.00	16.67
March	10	25.00	62.50	12.50
April	7	25.00	30.00	45.00
May	7	41.67	41.67	16.67
June	8	25.00	25.00	50.00
July	7	12.50	41.67	45.83
August	8	0	100.00	0
September	7	12.50	87.50	0
October	6	0	75.00	25.00
November	9	0	100.00	0
December	6	33.33	66.67	0
Average		**18.56**	**58.41**	**22.20**

Table 3.12.a: Feeding Intensity of Female *Priacanthus hamrur* Percentage of Fish with various Stomachs during 1997

Month	No. of Fish	Empty	Medium	Heavy
January	8	0	25.00	75.00
February	8	12.50	37.50	50.00
March	4	66.67	33.33	0
April	5	0	80.00	20.00
May	4	50.00	25.00	25.00
June	5	40.00	60.00	0
July	5	40.00	40.00	20.00
August	5	40.00	60.00	0
September	5	0	80.00	20.00
October	4	25.00	75.00	0
November	4	100.00	0	0
December	6	66.67	33.33	0

Table 3.12.b: Percentage of Fish with various Stomachs during 1998

Month	No. of Fish	Empty	Medium	Heavy
January	5	0	40.00	60.00
February	3	0	33.33	66.67
March	4	0	100.00	0
April	4	25	75.00	0
May	4	0	75.00	25.00
June	4	0	100.00	0
July	3	0	100.00	0
August	3	33.33	66.67	0
September	2	0	100.00	0
October	3	33.33	66.67	0
November	2	100.00	0	0
December	2	50.00	50.00	0

Table 3.12.c: Percentage of Fish with various Stomachs during 1997 & 1998

Month	No. of Fish	Empty	Medium	Heavy
January	13	0	32.50	67.50
February	11	60.25	35.42	58.34
March	8	33.33	66.67	0
April	9	12.50	77.50	10.00
May	8	25.00	50.00	25.00
June	9	20.00	80.00	0
July	8	20.00	70.00	10.00
August	8	36.67	63.33	0
September	7	0	90.00	10.00
October	7	29.17	70.83	0
November	6	100.00	0	0
December	8	58.33	41.67	0
Average		**32.93**	**56.49**	**15.07**

Table 3.13.a: Feeding Intensity of 20-40 cm size group of *Priacanthus hamrur*
Percentage of Fish with various Stomachs during 1997

Month	No. of Fish	Empty	Medium	Heavy
January	12	9.09	36.36	54.55
February	8	12.50	37.50	50.00
March	7	60.00	40.00	0
April	6	16.67	33.33	50.00
May	6	33.33	50.00	16.67
June	6	28.57	57.14	14.29
July	8	37.50	37.50	25.00
August	7	28.57	71.43	0
September	8	14.29	71.42	14.29
October	7	28.58	57.12	14.29
November	6	66.67	33.33	0
December	8	62.50	37.50	0

Table 3.13.b: Percentage of Fish with various Stomachs during 1998

Month	No. of Fish	Empty	Medium	Heavy
January	6	0	16.67	83.33
February	6	0	60.00	40.00
March	7	0	85.71	14.29
April	8	12.50	62.50	25.00
May	5	0	60.00	40.00
June	5	0	100.00	0
July	5	0	80.00	20.00
August	4	25.00	75.00	0
September	3	0	100.00	0
October	2	50.00	50.00	0
November	4	50.00	50.00	0
December	4	50.00	50.00	0

Table 3.13.c: Percentage of Fish with various Stomachs during 1997 & 1998

Month	No. of Fish	Empty	Medium	Heavy
January	18	4.05	26.52	68.94
February	14	6.25	48.75	45.00
March	14	30.00	62.86	7.14
April	14	14.59	47.92	37.50
May	11	16.67	55.00	28.34
June	11	14.29	78.57	7.15
July	13	18.75	58.75	22.50
August	11	26.79	73.21	0
September	11	7.15	85.70	7.15
October	9	39.29	53.56	7.15
November	10	58.33	41.67	0
December	12	56.25	43.75	0
Average		**24.36**	**56.35**	**19.23**

Table 3.14.a: Feeding Intensity of 0-20 cm size group of *Priacanthus hamrur*
Percentage of Fish with various Stomachs during 1997

Month	No. of Fish	Empty	Medium	Heavy
January	3	25.00	50.00	25.00
February	3	66.67	0	33.33
March	3	60.00	40.00	0
April	1	0	100.00	0
May	2	100.00	0	0
June	3	100.00	0	0
July	1	0	100.00	0
August	3	0	100.00	0
September	1	0	100.00	0
October	1	0	100.00	0
November	3	0	100.00	0
December	1	0	100.00	0

Table 3.14.b: Percentage of Fish with various Stomachs during 1998

Month	No. of Fish	Empty	Medium	Heavy
January	2	0	100.00	0
February	2	33.33	66.67	0
March	1	0	100.00	0
April	1	0	100.00	0
May	2	50.00	50.00	0
June	3	0	100.00	0
July	1	0	0	100.00
August	2	0	100.00	0
September	2	0	100.00	0
October	3	0	100.00	0
November	2	0	100.00	0
December	1	0	100.00	0

Table 3.14.c: Percentage of Fish with various Stomachs during 1997 & 1998

Month	No. of Fish	Empty	Medium	Heavy
January	5	12.50	75.00	12.50
February	5	50.00	33.34	16.67
March	4	30.00	70.00	0
April	2	0	100.00	0
May	4	75.00	25.00	0
June	6	50.00	50.00	0
July	2	0	50.00	50.00
August	5	0	100.00	0
September	3	0	100.00	0
October	4	0	100.00	0
November	5	0	100.00	0
December	2	0	100.00	0
Average		**18.12**	**75.27**	**6.59**

Table 3.15: Monthly overall average percentage feeding intensity of *Priacanthus hamrur* during 1997 & 1998

Month	No. of Fish	Empty	Medium	Heavy
January	23	7.14	31.73	61.14
February	19	24.85	37.71	37.50
March	18	29.17	64.58	6.25
April	16	17.75	53.75	28.50
May	15	33.34	45.84	20.84
June	17	22.25	52.50	25.25
July	15	16.25	55.83	27.92
August	16	18.33	81.67	0
September	14	6.25	88.88	5.00
October	13	14.75	72.92	12.25
November	15	50.00	50.00	0
December	14	45.83	54.17	0

Table 3.20: Monthly overall average percentage feeding intensity of *Pomadasys maculatus* during 1997 & 1998

Month	No. of Fish	Empty	Medium	Heavy
January	23	31.25	52.09	16.67
February	25	21.50	55.00	23.75
March	22	33.75	47.92	18.34
April	23	0	72.92	27.09
May	24	12.50	79.17	8.34
June	14	29.17	54.17	16.67
July	23	29.17	31.67	39.17
August	15	32.85	67.92	0
September	13	44.17	44.59	11.25
October	23	6.25	79.17	14.59
November	15	0	29.17	70.84
December	13	0	5.00	95.00

Table 3.16.a: Feeding Intensity of Male *Pomadasys maculatus* Percentage of Fish with various Stoma hs during 1997

Month	No. of Fish	Empty	Medium	Heavy
January	3	0	33.33	66.67
February	5	60.00	20.00	20.00
March	4	25.00	75.00	0
April	4	0	75.00	25.00
May	4	0	100.00	0
June	3	66.67	33.33	0
July	3	66.67	33.33	0
August	4	75.00	25.00	0
September	3	33.33	66.67	0
October	4	0	100.00	0
November	4	0	50.00	50.00
December	3	0	0	100.00

Table 3.16.b: Percentage of Fish with various Stomachs during 1998

Month	No. of Fish	Empty	Medium	Heavy
January	2	0	100.00	0
February	4	0	75.00	25.00
March	4	50.00	50.00	0
April	2	0	100.00	0
May	3	0	100.00	0
June	3	33.33	66.67	0
July	2	50.00	0	50.00
August	3	33.33	66.67	0
September	3	33.33	66.67	0
October	3	0	66.67	33.33
November	3	0	0	100.00
December	3	0	0	100.00

Table 3.16.c: Percentage of Fish with various Stomachs during 1997 & 1998

Month	No. of Fish	Empty	Medium	Heavy
January	5	0	66.67	33.33
February	9	30.00	47.50	22.50
March	8	37.50	62.50	0
April	6	0	87.50	12.50
May	7	0	100.00	0
June	6	50.00	50.00	0
July	5	58.34	16.67	25.00
August	7	54.17	45.83	0
September	6	33.33	66.67	0
October	7	0	83.34	16.67
November	7	0	25.00	75.00
December	6	0	0	100.00
Average		**21.94**	**54.30**	**23.75**

Table 3.17.a: Feeding Intensity of Female *Pomadasys maculatus* Percentage of Fish with various Stomachs during 1997

Month	No. of Fish	Empty	Medium	Heavy
January	5	60.00	0	40.00
February	4	25.00	75.00	0
March	2	75.00	25.00	0
April	4	0	50.00	50.00
May	4	50.00	50.00	0
June	6	16.67	83.33	0
July	5	0	60.00	40.00
August	5	20.00	80.00	0
September	5	60.00	20.00	20.00
October	4	25.00	50.00	25.00
November	3	0	33.33	66.67
December	5	0	20.00	80.00

Table 3.17.b: Percentage of Fish with various Stomachs during 1998

Month	No. of Fish	Empty	Medium	Heavy
January	3	0	66.67	33.33
February	2	0	50.00	50.00
March	2	50	50.00	0
April	3	0	66.67	33.33
May	3	0	66.67	33.33
June	2	0	33.33	66.67
July	3	0	33.33	66.67
August	2	0	100.00	0
September	4	50	25.00	25.00
October	2	0	100.00	0
November	3	0	33.33	66.67
December	2	0	0	100.00

Table 3.17.c: Percentage of Fish with various Stomachs during 1997 & 1998

Month	No. of Fish	Empty	Medium	Heavy
January	8	62.50	37.50	0
February	6	12.50	62.50	25.00
March	4	30.00	33.33	36.67
April	7	0	58.33	41.67
May	7	25.00	58.33	16.67
June	8	8.34	58.33	33.33
July	8	0	46.67	53.33
August	7	10.00	90.00	0
September	9	55.00	22.50	22.50
October	6	12.50	75.00	12.50
November	6	0	33.33	66.67
December	7	0	10.00	90.00
Average		**17.98**	**48.81**	**33.19**

Table 3.18.a: Feeding Intensity of 0-15 cm size group of *Pomadasys maculatus* Percentage of Fish with various Stomachs during 1997

Month	No. of Fish	Empty	Medium	Heavy
January	3	0	33.33	66.67
February	3	50.00	25.00	25.00
March	2	100.00	0	0
April	3	0	66.67	33.33
May	1	0	100.00	0
June	4	50.00	50.00	0
July	6	33.33	66.67	0
August	5	80.00	20.00	0
September	1	0	100.00	0
October	2	0	100.00	0
November	2	0	66.67	33.33
December	4	0	0	100.00

Table 3.18.b: Percentage of Fish with various Stomachs during 1998

Month	No. of Fish	Empty	Medium	Heavy
January	2	0	0	100.00
February	2	0	100.00	0
March	2	33.33	66.67	0
April	1	0	100.00	0
May	2	0	100.00	0
June	2	100.00	0	0
July	1	100.00	0	0
August	4	33.33	66.67	0
September	1	0	0	100.00
October	2	0	50.00	50.00
November	1	0	0	100.00
December	2	0	0	100.00

Table 3.18.c: Percentage of Fish with various Stomachs during 1997 & 1998

Month	No. of Fish	Empty	Medium	Heavy
January	5	0	16.67	83.33
February	5	25.00	62.50	12.50
March	4	66.67	33.33	0
April	4	0	83.33	16.67
May	3	0	100.00	0
June	6	75.00	25.00	0
July	7	66.67	33.33	0
August	9	56.67	43.33	0
September	2	0	50.00	50.00
October	4	0	75.00	25.00
November	3	0	33.33	66.67
December	6	0	0	100.00
Average		**24.16**	**46.31**	**29.51**

Table 3.19.a: Feeding Intensity of 15-30 cm size group of *Pomadasys maculatus* Percentage of Fish with various Stomachs during 1997

Month	No. of Fish	Empty	Medium	Heavy
January	5	60.00	0	40.00
February	6	20.00	60.00	20.00
March	4	42.87	57.13	0
April	5	0	60.00	40.00
May	7	0	42.00	58.00
June	5	20.00	80.00	0
July	2	0	0	100.00
August	4	0	100.00	0
September	7	57.16	28.58	14.29
October	6	16.67	66.68	16.67
November	5	0	25.00	75.00
December	4	0	0	100.00

Table 3.19.b: Percentage of Fish with various Stomachs during 1998

Month	No. of Fish	Empty	Medium	Heavy
January	3	0	100.00	0
February	4	0	33.33	66.67
March	4	66.67	33.33	0
April	4	0	75.00	25.00
May	4	0	75.00	25.00
June	3	0	25.00	75.00
July	4	0	25.00	75.00
August	1	0	100.00	0
September	6	50.00	50.00	0
October	3	0	100.00	0
November	5	0	20.00	80.00
December	3	0	0	100.00

Table 3.19.c: Percentage of Fish with various Stomachs during 1997 & 1998

Month	No. of Fish	"Empty"	"Medium"	"Heavy"
January	8	30.00	50.00	20.00
February	10	10.00	46.67	43.33
March	8	54.77	45.24	0
April	9	0	67.50	32.50
May	11	0	73.21	26.79
June	8	10.00	52.50	37.50
July	6	0	12.50	87.50
August	5	0	100.00	0
September	13	53.58	39.29	7.15
October	9	8.34	83.34	8.34
November	10	0	22.50	77.50
December	7	0	0	100.00
Average		**13.90**	**49.30**	**36.70**

Table 3.21: Monthly data of the G.S.I. of the Male, Female and Pooled fishes of *Priacanthus hamrur* during 1997 & 1998

Month	1997 G.S.I.			1998 G.S.I.		
	Male	Female	Pooled	Male	Female	Pooled
January	3.31	4.70	4.00	3.77	3.91	3.84
February	2.18	3.55	2.87	3.25	2.79	3.02
March	1.64	2.41	2.03	3.92	2.79	3.36
April	2.71	3.02	2.87	3.92	2.20	3.60
May	2.04	2.66	2.35	2.92	2.83	2.88
June	2.56	2.06	2.35	4.60	2.50	3.55
July	3.60	2.63	3.12	4.08	2.70	3.39
August	2.98	2.33	2.66	3.19	2.41	2.80
September	2.61	2.91	2.76	3.03	2.12	2.71
October	3.89	2.49	3.19	2.96	2.43	2.70
November	3.21	1.47	2.34	3.17	1.62	2.40
December	2.67	1.75	2.71	2.42	1.88	2.11

Table 3.22: Monthly data of the G.S.I. of the Male, Female and Pooled fishes of *Pomadasys maculatus* during 1997 & 1998

Month	1997 G.S.I.			1998 G.S.I.		
	Male	Female	Pooled	Male	Female	Pooled
January	1.13	1.72	1.43	1.30	1.63	1.47
February	0.66	0.59	0.63	0.84	0.90	0.87
March	0.51	0.43	0.47	0.61	0.59	0.60
April	0.75	0.94	0.85	0.60	0.52	0.56
May	0.68	0.86	0.77	0.77	1.12	0.95
June	0.51	0.60	0.56	0.94	0.74	0.84
July	0.84	0.85	0.85	0.69	1.10	0.90
August	0.46	0.60	0.53	0.57	0.66	0.62
September	0.84	0.47	0.66	0.58	0.63	0.52
October	0.67	0.67	0.67	0.94	0.74	0.84
November	0.89	1.47	0.68	1.60	1.47	1.73
December	1.48	1.63	1.56	1.53	1.42	1.48

Table 3.23: Average Qualitative Analysis of Stomach Content of Female *Priacanthus hamrur* during 1997 & 1998

Month	Poor	Moderate	Active
January	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle, Miscellaneous	-	Prawn tissue
February	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
March	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Annelida bristle, Miscellaneous	Prawn tissue
April	Invertebrate eggs, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Prawn tissue, Annelida bristle, Animal tissue, Miscellaneous	-
May	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
June	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
July	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
August	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
September	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle, Miscellaneous	-	Prawn tissue
October	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
November	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata entacle, Miscellaneous	-	Prawn tissue
December	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle, Miscellaneous	-	Prawn tissue

Table 3.24: Average Qualitative Analysis of Stomach Content of Male *Priacanthus hamrur* during 1997 & 1998

Month	Poor	Moderate	Active
January	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Annelida bristle, Miscellaneous	Prawn tissue
February	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Prawn tissue, Annelida bristle, Miscellaneous	-
March	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Prawn tissue, Annelida bristle, Miscellaneous	-
April	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Prawn tissue, Annelida bristle, Miscellaneous	-
May	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
June	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Prawn tissue, Annelida bristle, Miscellaneous	-
July	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Annelida bristle, Miscellaneous	Prawn tissue
August	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
September	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle,Miscellaneous	Annelida bristle,	Prawn tissue
October	Annelida bristle, Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Miscellaneous	Prawn tissue
November	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Annelida bristle, Miscellaneous	Prawn tissue
December	Invertebrate eggs, Animal tissue, Fat droplet, Coelenterata jelly, Coelenterata tentacle	Annelida bristle, Miscellaneous	Prawn tissue

Table 3.27: Average Qualitative Analysis of Stomach Content of Female *Pomadasys maculatus* during 1997 & 1998

Month	Poor	Moderate	Active
January	Fat droplet, Invertebrate eggs, Annelida bristle, Miscellaneous, Crustacean fragment	Animal tissue	-
February	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
March	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
April	Crustacean fragment, Invertebrate eggs, Annelidda bristle, Miscellaneous	Animal tissue, Fat droplet	-
May	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
June	Crustacean fragment, Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue , Fat droplet	-
July	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
August	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
September	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
October	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
November	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	
December	Crustacean fragment, Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet	-

Table 3.28: Average Qualitative Analysis of Stomach Content of Male *Pomadasys maculatus* during 1997 & 1998

Month	Poor	Moderate	Active
January	Fat droplet, Crustacean fragment, Invertebrate eggs, Annelida bristle, Miscellaneous,	Animal tissue	-
February	Fat droplet, Crustacean fragment, Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue	-
March	Crustacean fragment, Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet	-
April	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
May	Crustacean fragment, Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet	-
June	Crustacean fragment, Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue , Fat droplet	-
July	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
August	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
September	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
October	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-
November	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	
December	Invertebrate eggs, Annelida bristle, Miscellaneous	Animal tissue, Fat droplet, Crustacean fragment	-

Table 3.31.a: Gastro Somatic Index of *Priacanthus hamrur* collected during a period for 72 hours

Time	No. Fish Examined	Wt. of Stomach (gms)	Wt. of fish (gms)	G.S.I.
0 – 12 A.M.	1	4.450	210	2.1%
	2	2.850	160	1.8%
	3	3.100	120	2.6%
	4	6.250	150	4.2%
	5	2.750	110	2.5%
	6	3.500	220	1.59%
	7	2.100	125	1.68%
	8	2.520	100	2.52%
	9	2.100	90	2.33%
	10	3.400	130	2.62%
	11	2.250	125	1.80%
	12	5.200	150	3.47%
1 – 12 P.M.	1	2.750	110	2.1%
	2	3.500	220	1.6%
	3	2.100	125	1.7%
	4	2.520	100	2.5%
	5	2.150	125	1.72%
	6	4.550	200	2.25%
	7	3.100	160	1.94%
	8	2.000	85	2,35%
	9	2.400	90	2.67%
	10	3.200	170	1.88%
	11	3.350	130	2.56%
	12	2.800	90	3.11%

Table 3.31.b.: Feeding Rhythm – *Priacanthus harmrur*

Time	No. of Fishes Examined	Empty	Medium	Heavy
0 – 12 A.M.	12	Nil	6	6
1 – 12 P.M.	12	Nil	7	5

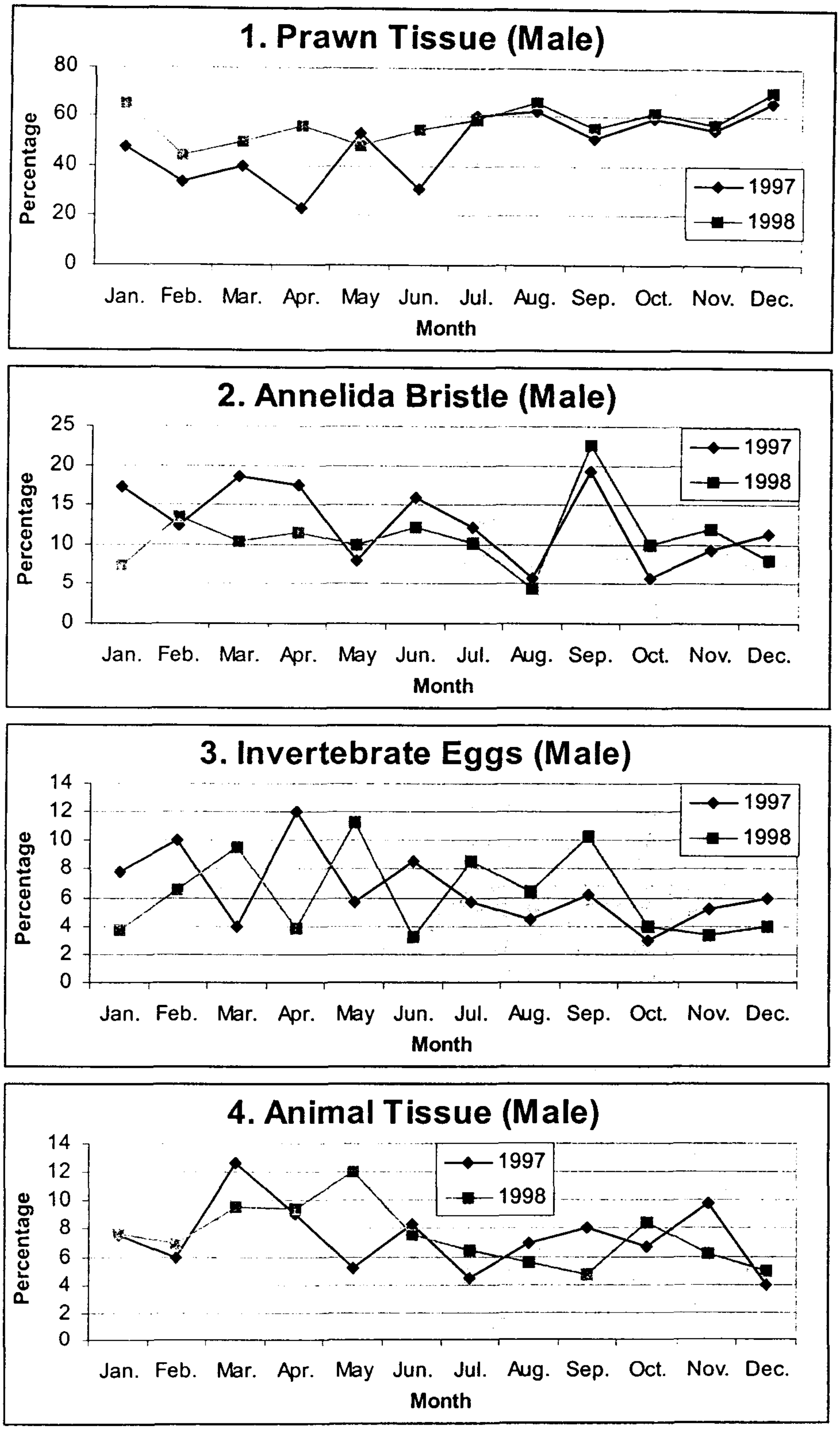
Table 3.32.a.: Gastro Somatic index of *Pomadasys maculatus* collected during a period for 72 hours

Time	No. Fish Examined	Wt. of Stomach (gms)	Wt. of fish (gms)	G.S.I.
0 – 12 A.M.	1	1.100	80	1.50%
	2	0.900	120	0.80%
	3	0.330	20	1.80%
	4	0.300	10	3.00%
	5	0.900	70	1.280%
	6	1.000	110	0.91%
	7	1.050	75	1.40%
	8	0.900	100	0.90%
	9	0.300	30	1.00%
	10	0.550	50	1.10%
	11	1.000	125	0.80%
1 – 12 P.M.	1	0.350	10	3.50%
	2	0.350	20	1.80%
	3	0.260	15	1.60%
	4	0.300	15	2.00%
	5	0.300	10	3.00%
	6	0.600	20	3.00%
	7	1.100	80	1.38%
	8	0.900	70	1.28%
	9	0.500	50	1.00%
	10	1.300	130	1.00%

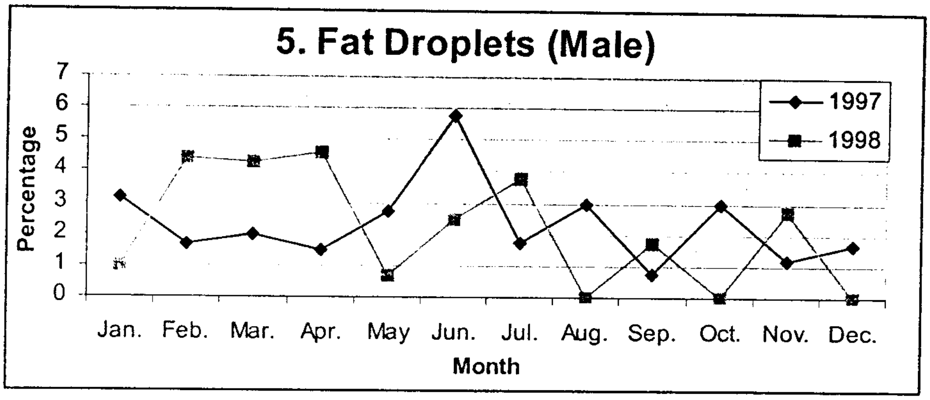
Table 3.32.b: Feeding Rhythm – *Pomadasys maculatus*

Time	No. of Fishes Examined	Empty	Medium	Heavy
0 – 12 A.M.	11	Nil	6	5
1 – 12 P.M.	10	Nil	6	4

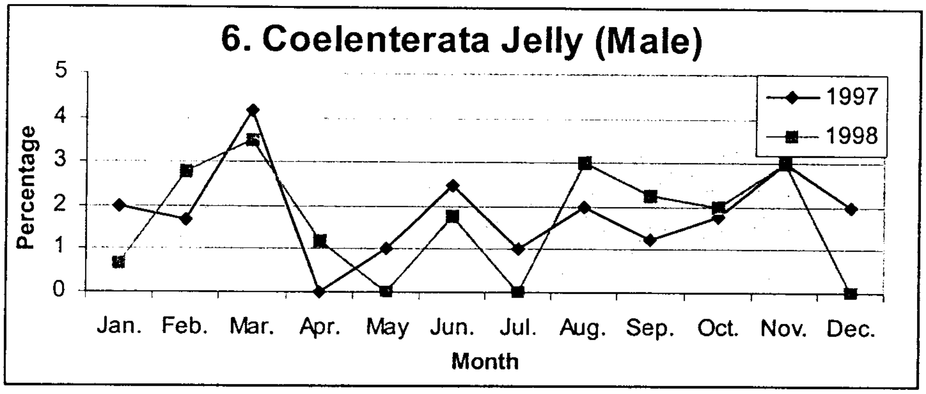
Fig. 3.1 (1– 8): Percentage Composition of Various Food Items in the Gut of Males of *Priacanthus harmur* during 1997 & 1998



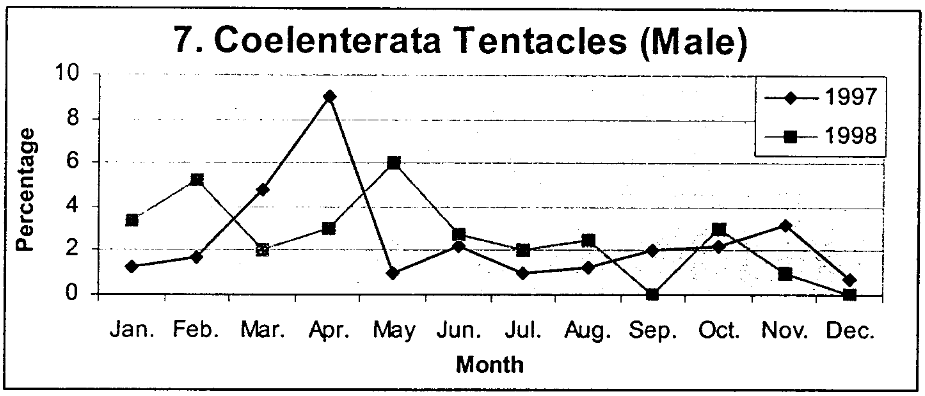
97b



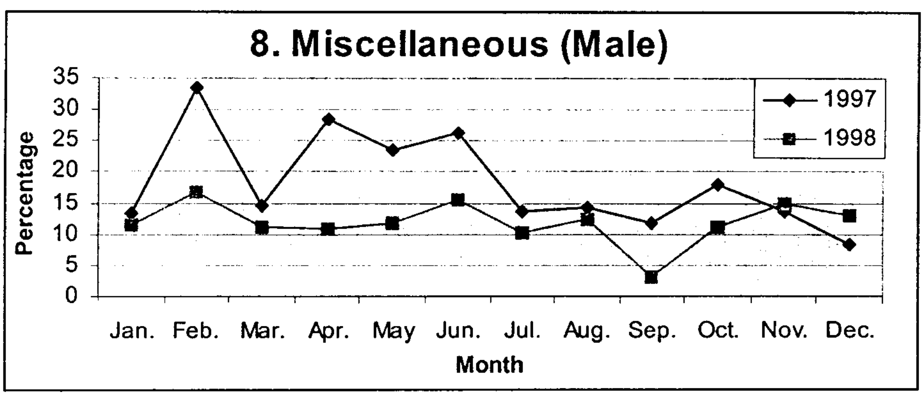
5. Fat Droplets (Male)



6. Coelenterata Jelly (Male)

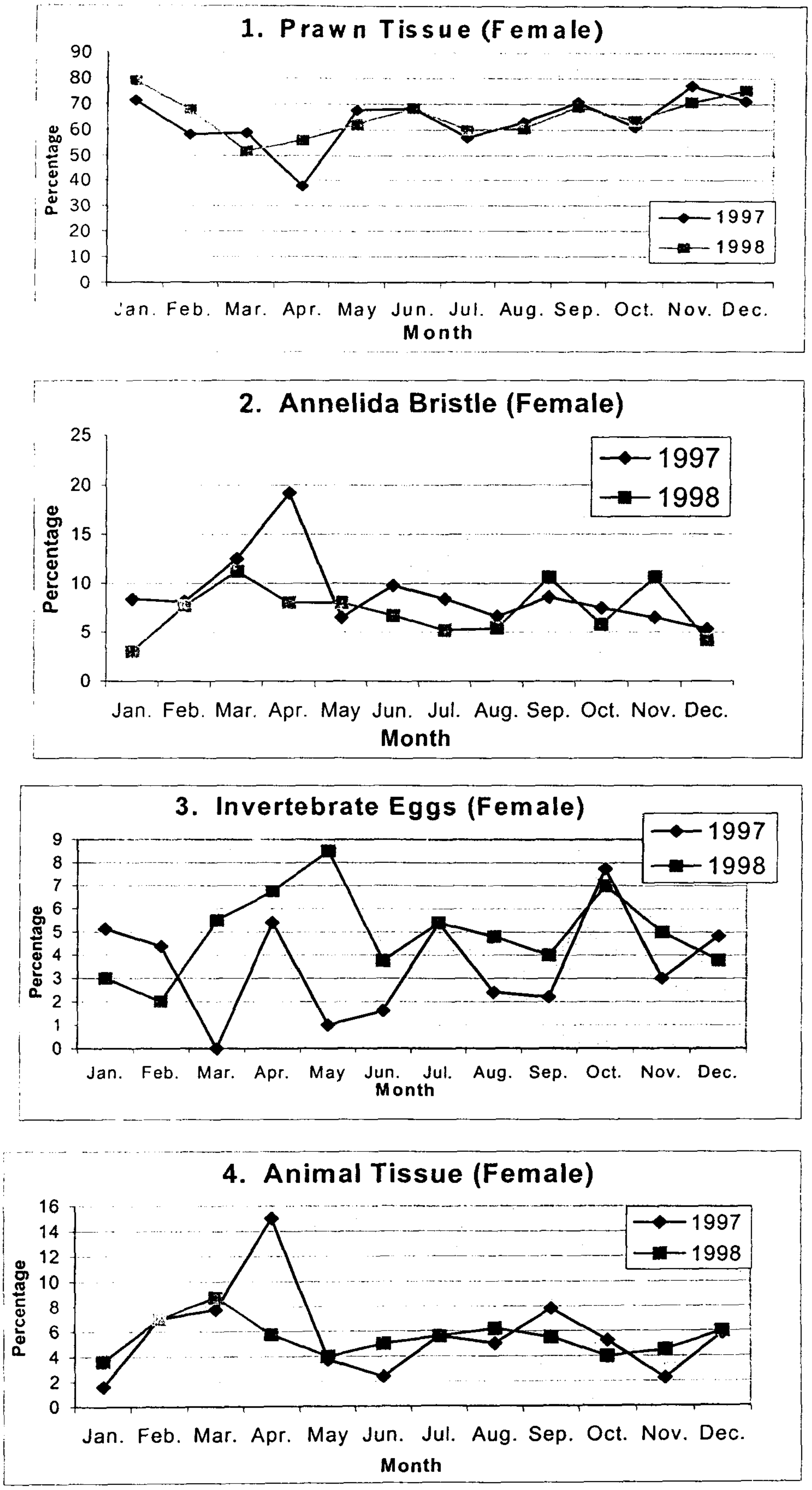


7. Coelenterata Tentacles (Male)

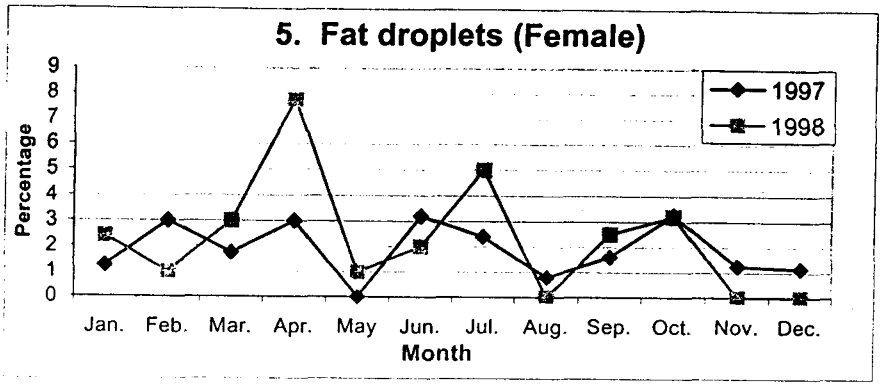


8. Miscellaneous (Male)

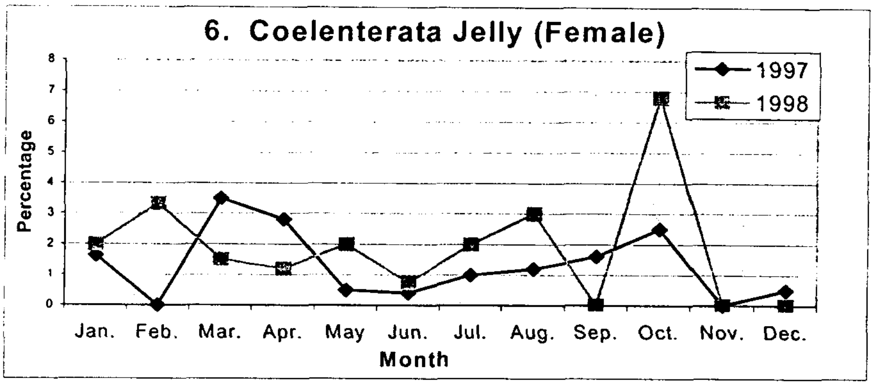
Fig. 3.2 (1 – 8): Percentage Composition of Various Food Items in the Gut of Females of *Priacanthus hamrur* during 1997 & 1998



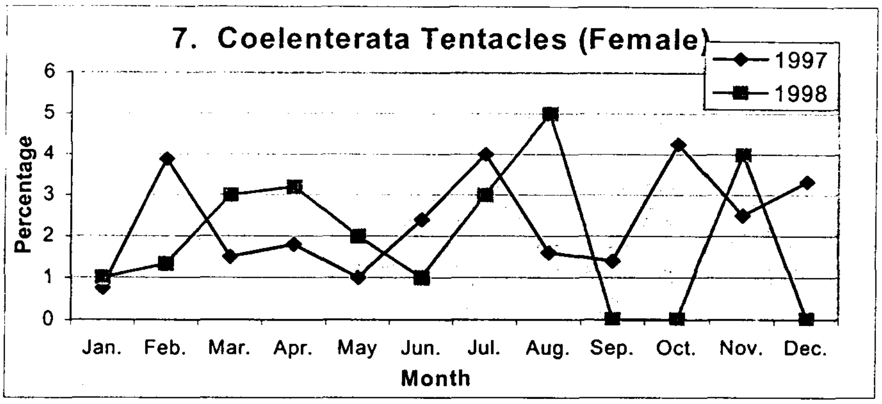
९२d



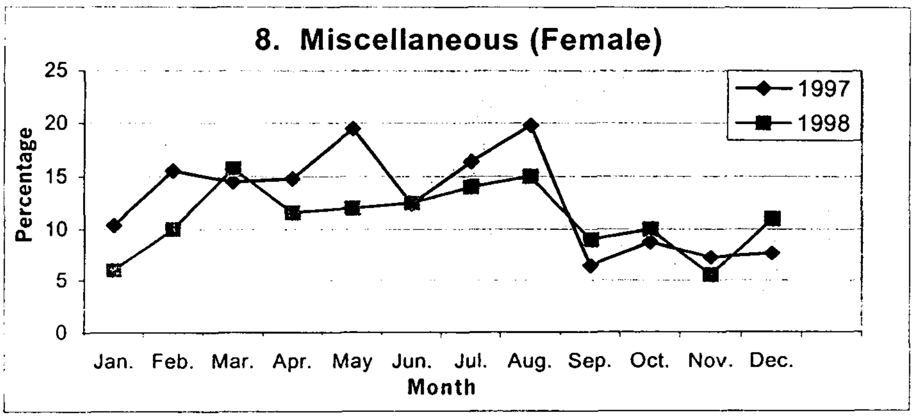
5. Fat droplets (Female)
Percentage
0
1
2
3
4
5
6
7
8
9
1997
1998
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month



6. Coelenterata Jelly (Female)
Percentage
0
1
2
3
4
5
6
7
8
1997
1998
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

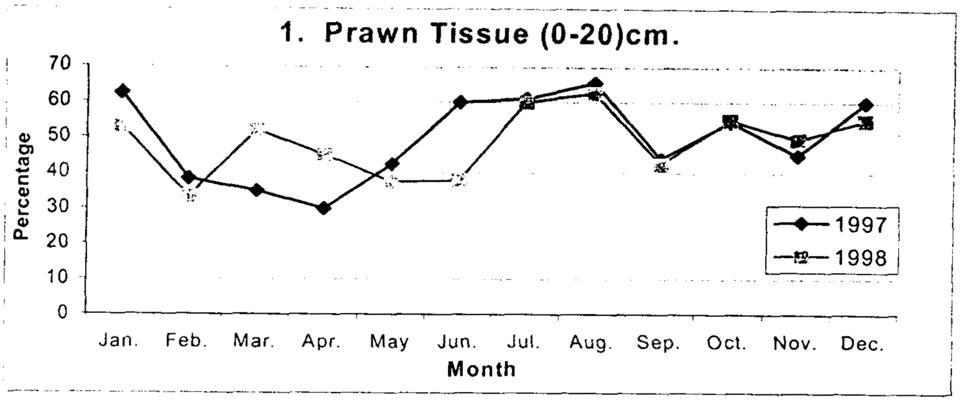


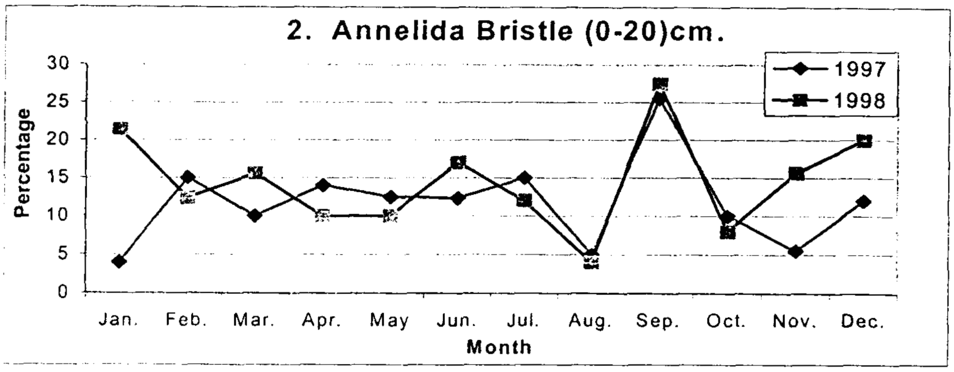
7. Coelenterata Tentacles (Female)
Percentage
0
1
2
3
4
5
6
1997
1998
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

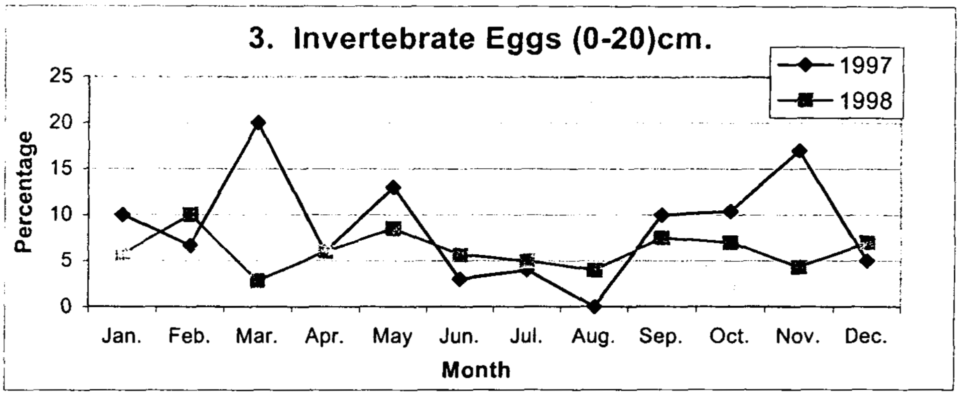


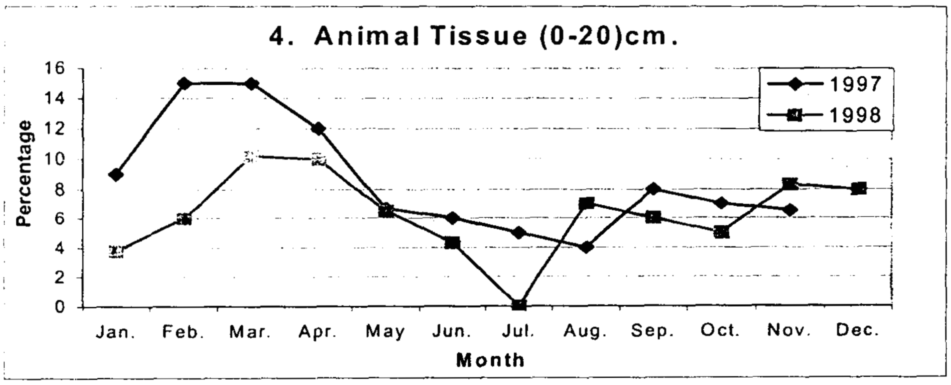
8. Miscellaneous (Female)
Percentage
0
5
10
15
20
25
1997
1998
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

Fig. 3.3 (1 – 8): Percentage Composition of Various Food Items in the Gut of Length Group 0-20 cm of *Priacanthus hamrur* during 1997 & 1998

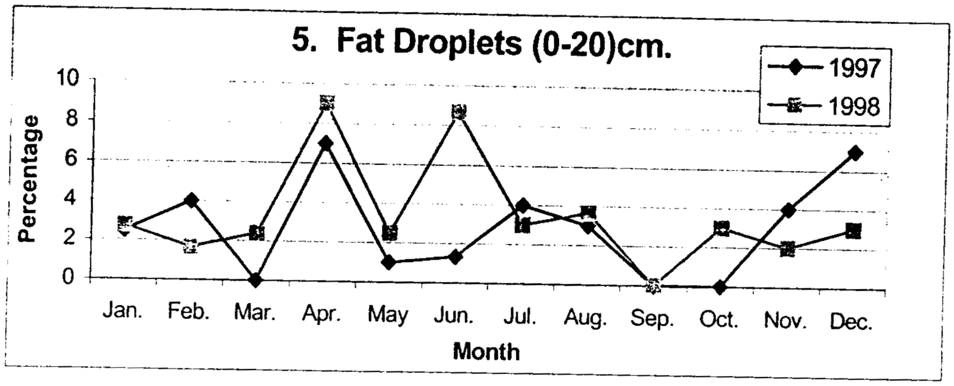


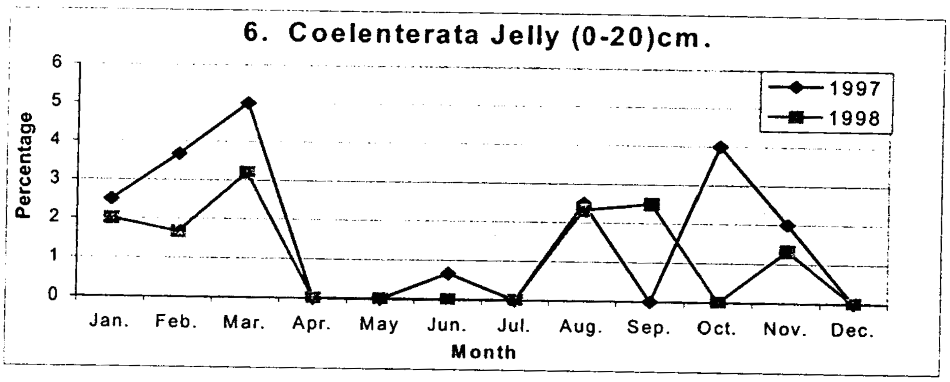


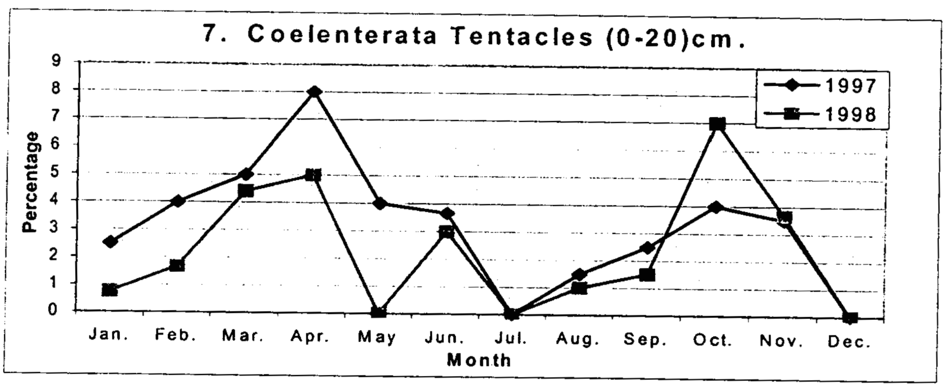




9A5


5. Fat Droplets (0-20)cm.
1997
1998
Percentage
10
8
6
4
2
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month


6. Coelenterata Jelly (0-20)cm.
1997
1998
Percentage
6
5
4
3
2
1
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month


7. Coelenterata Tentacles (0-20)cm.
1997
1998
Percentage
9
8
7
6
5
4
3
2
1
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month

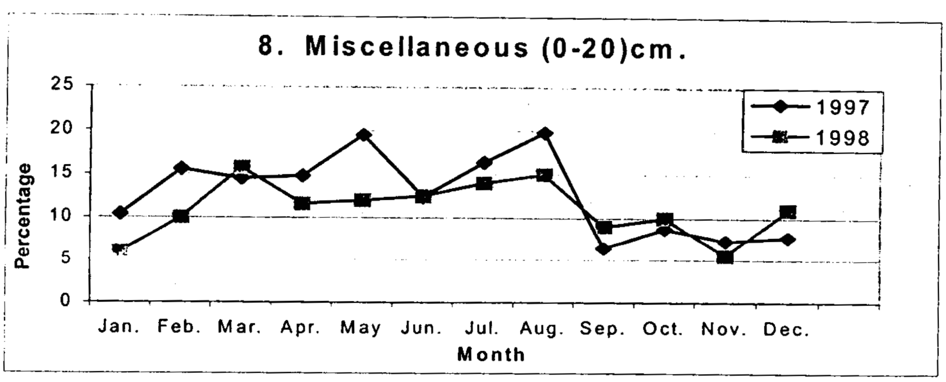

8. Miscellaneous (0-20)cm.
1997
1998
Percentage
25
20
15
10
5
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month

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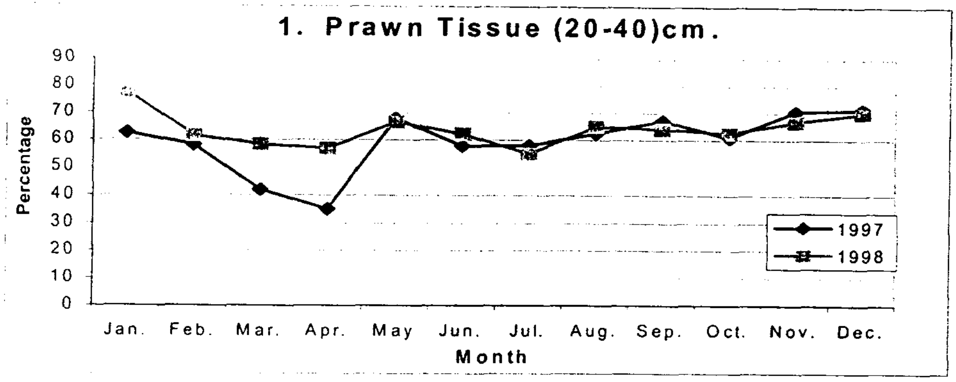
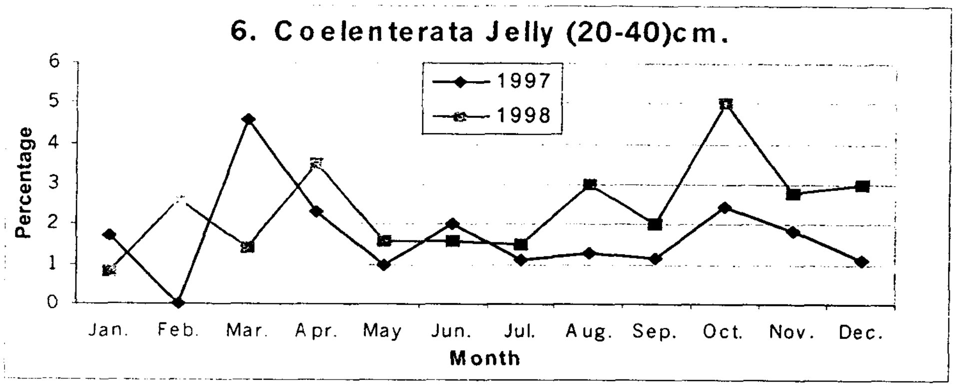
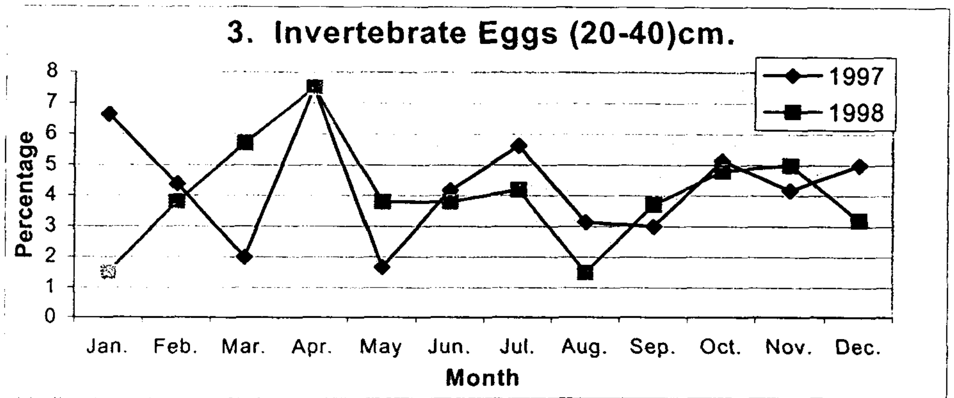
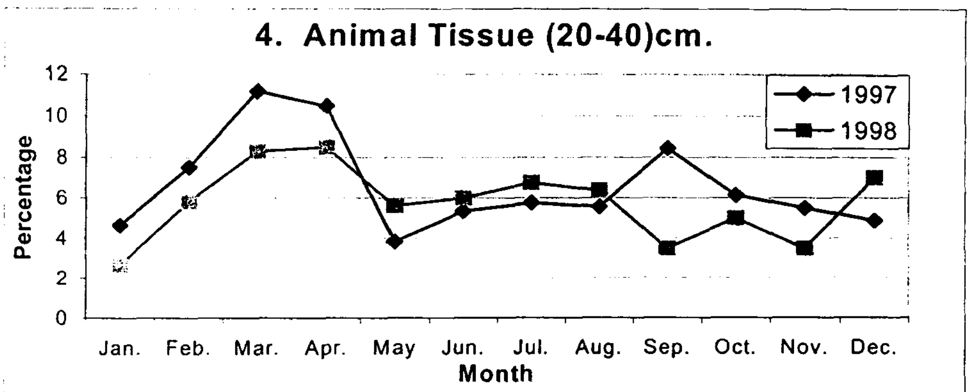
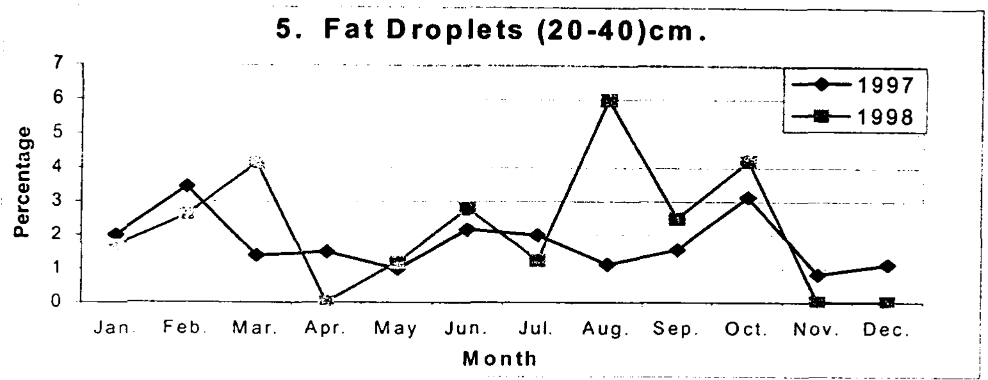
Fig. 3.4 (1 – 8): Percentage Composition of Various Food Items in the Gut of Length Group of 20-40 cm of *Priacanthus hamrur* during 1997 & 1998

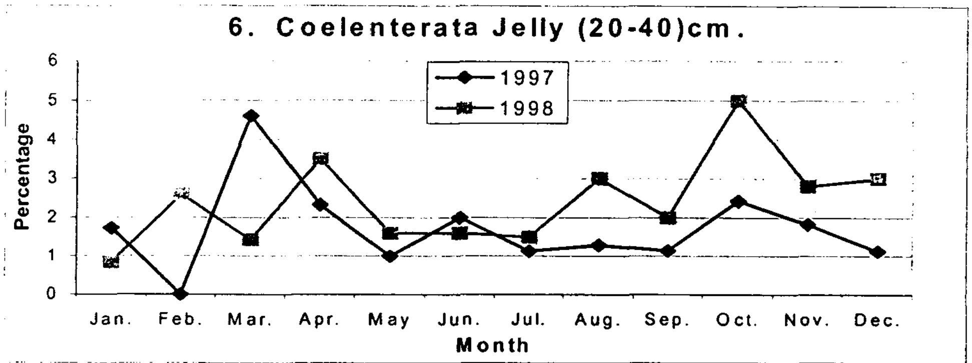


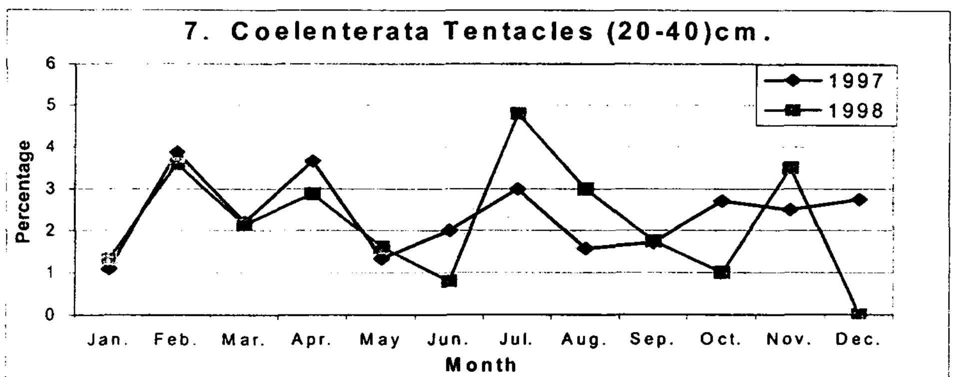







5. Fat Droplets (20-40)cm.
1997
1998
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month


6. Coelenterata Jelly (20-40)cm.
1997
1998
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month


7. Coelenterata Tentacles (20-40)cm.
1997
1998
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

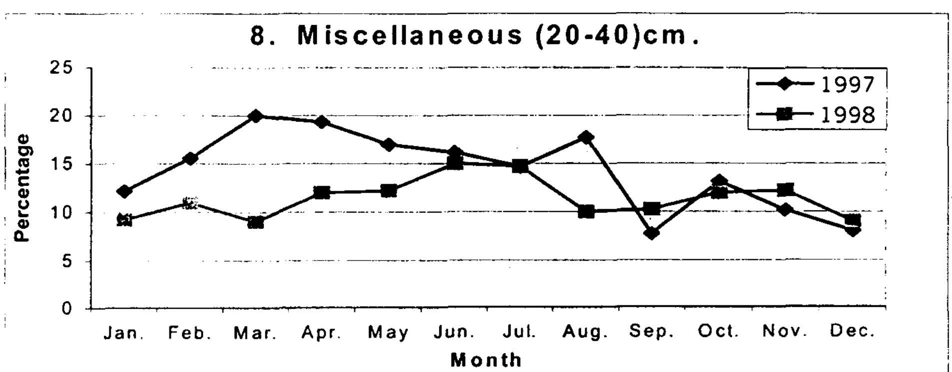
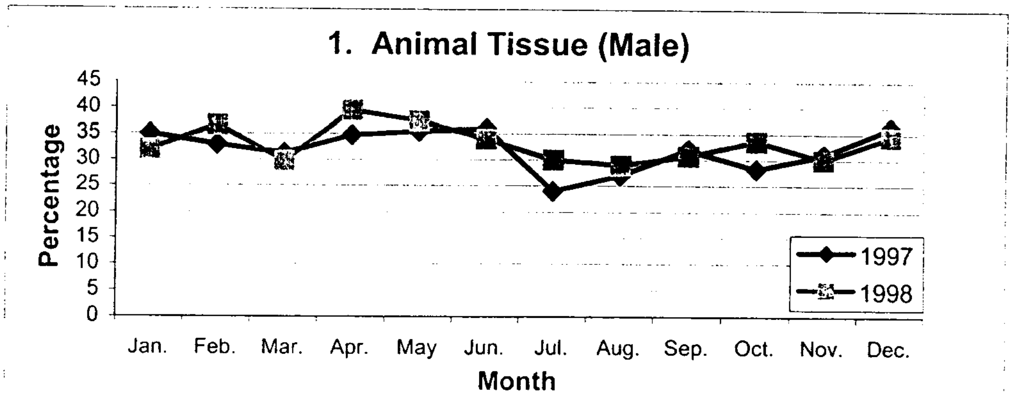
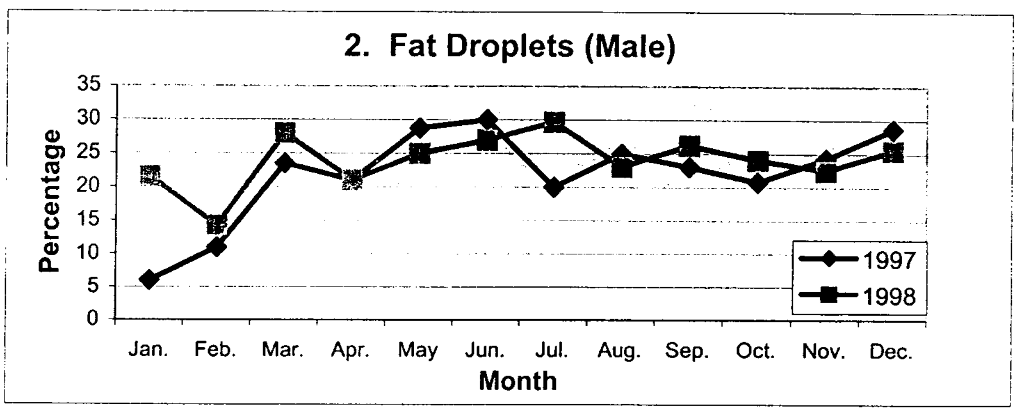
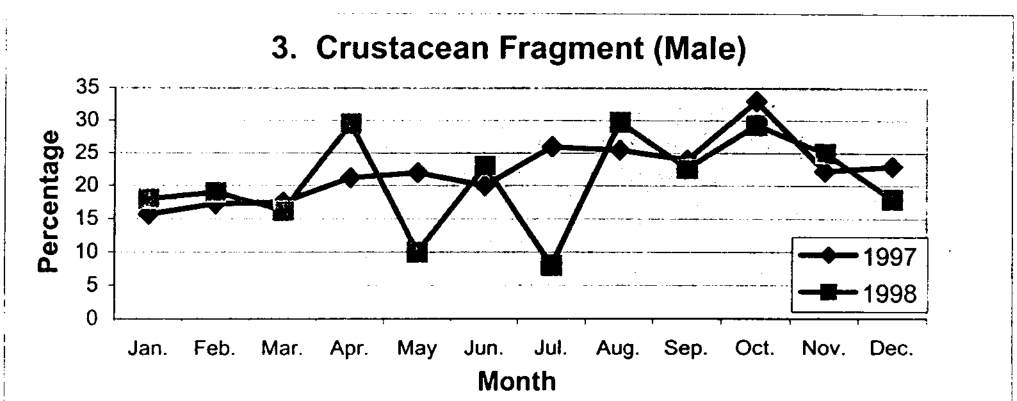
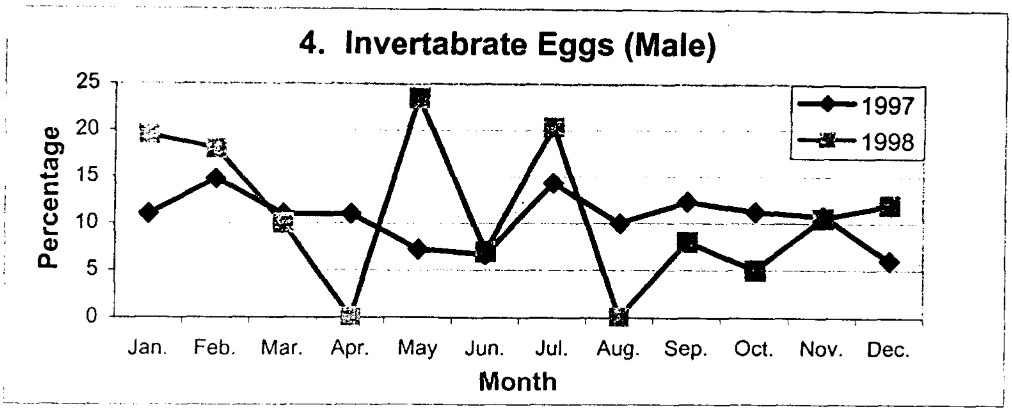

8. Miscellaneous (20-40)cm.
1997
1998
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

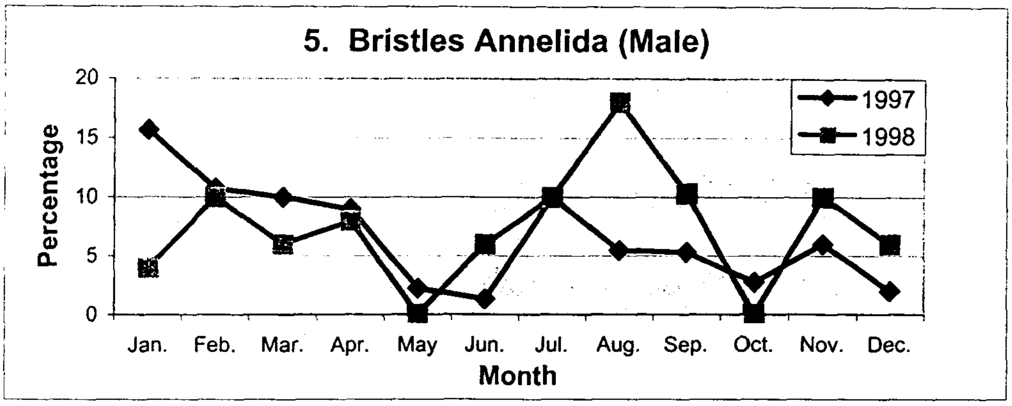
Fig. 3.5 (1 – 6): Percentage Composition of Various Food Items in the Gut of Male *Pomadasys maculatus* during 1997 & 1998








4. Invertabrate Eggs (Male)
Percentage
25
20
15
10
5
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month
1997
1998


5. Bristles Annelida (Male)
Percentage
20
15
10
5
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month
1997
1998

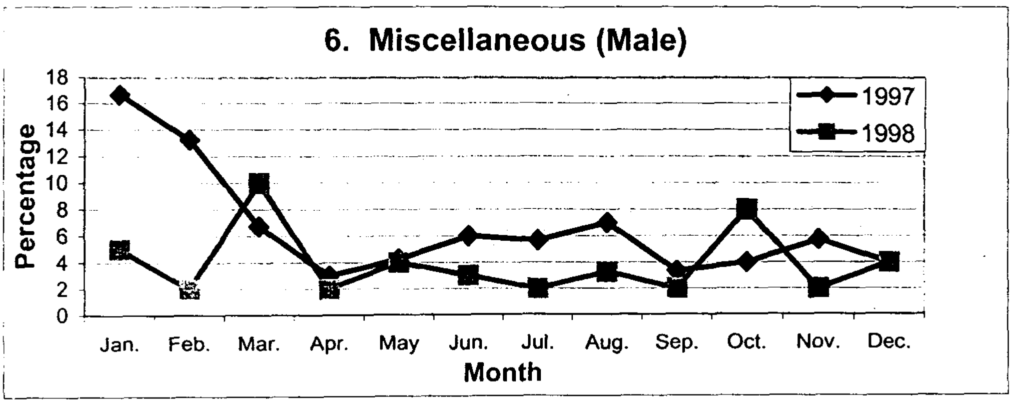
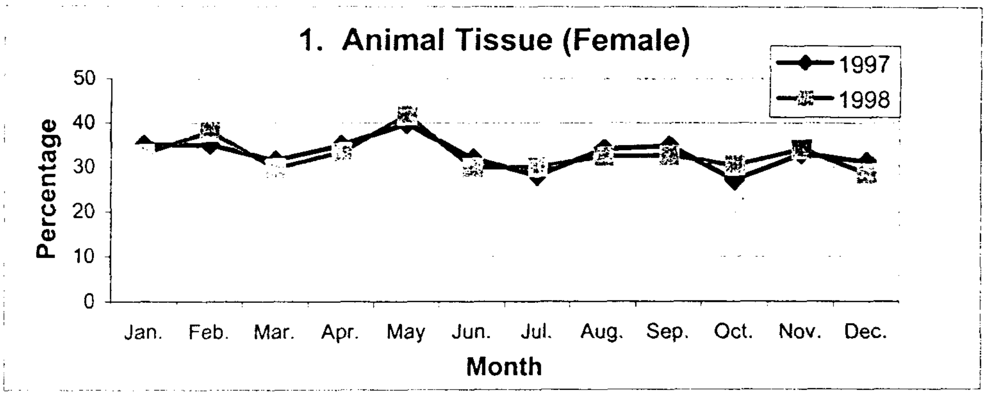
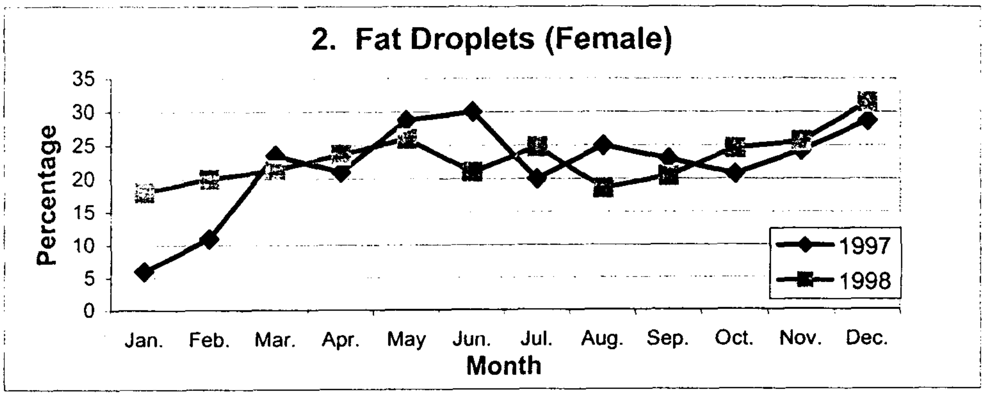
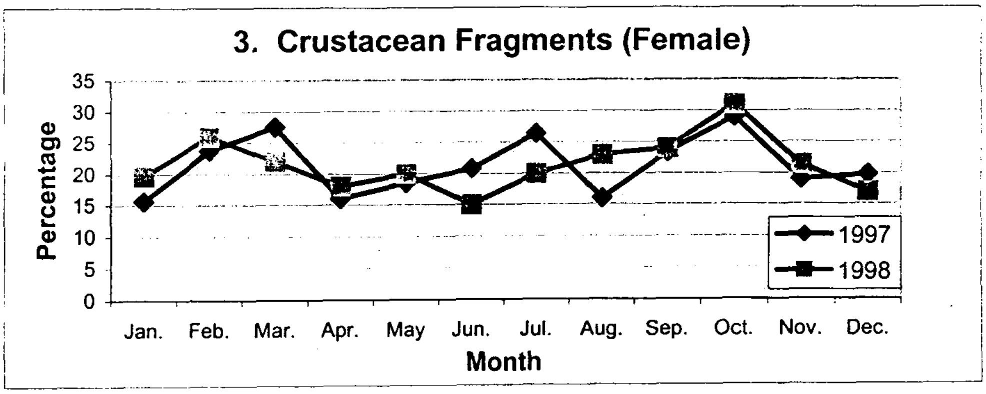
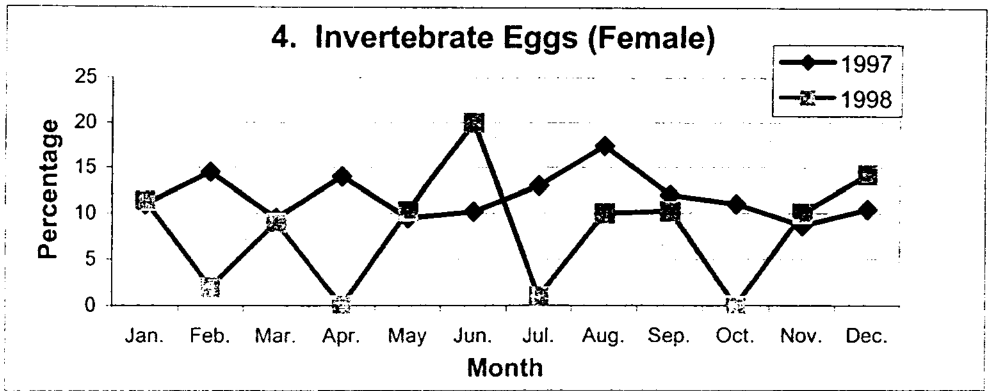

6. Miscellaneous (Male)
Percentage
18
16
14
12
10
8
6
4
2
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month
1997
1998

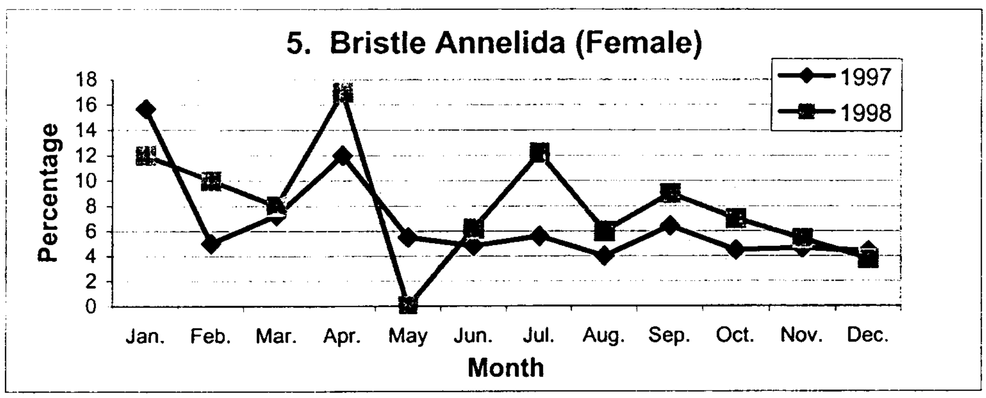
Fig. 3.6 (1 – 6): Percentage Composition of Various Food Items in the Gut of Female *Pomadasys maculatus* during 1997 & 1998








4. Invertebrate Eggs (Female)
1997
1998
Percentage
25
20
15
10
5
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month


5. Bristle Annelida (Female)
1997
1998
Percentage
18
16
14
12
10
8
6
4
2
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month

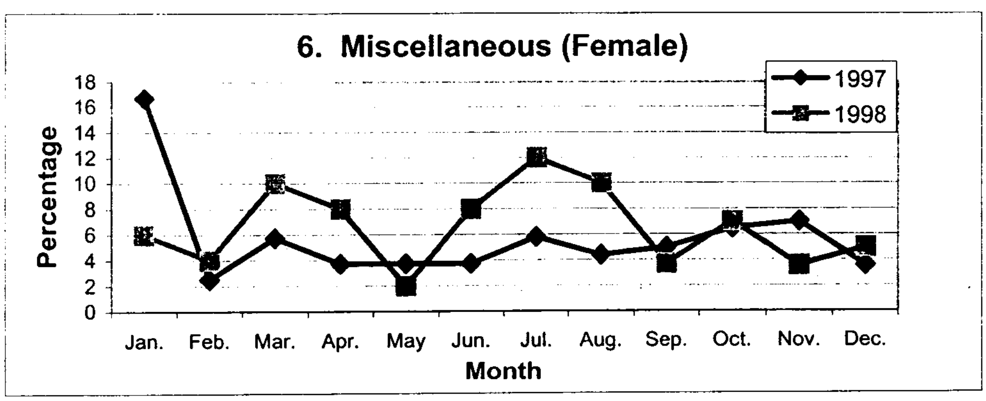
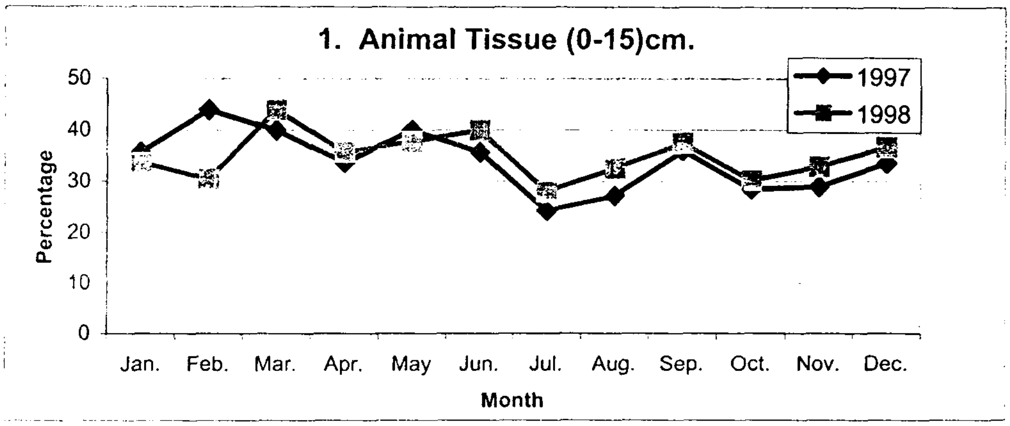
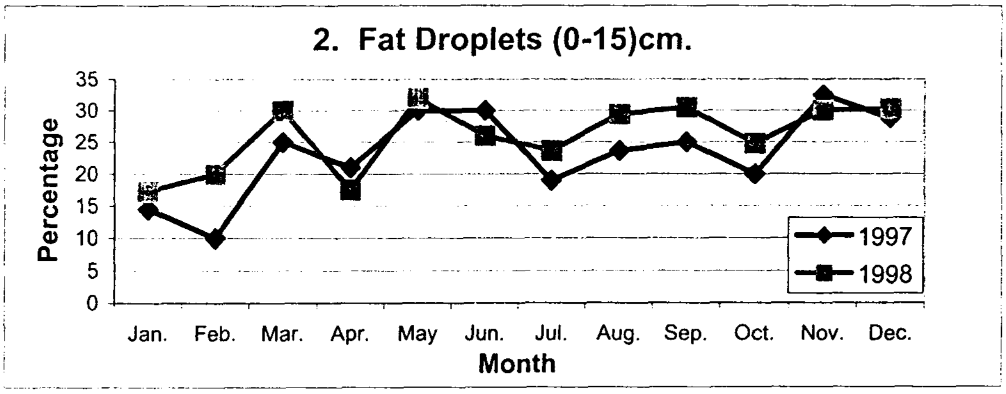
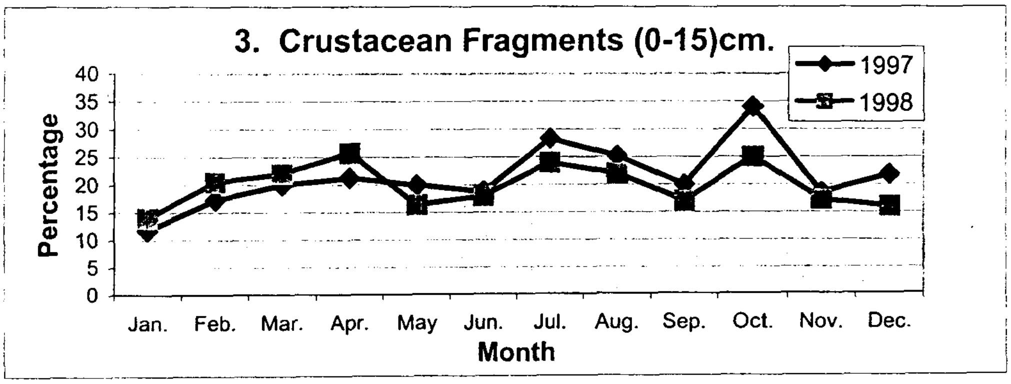
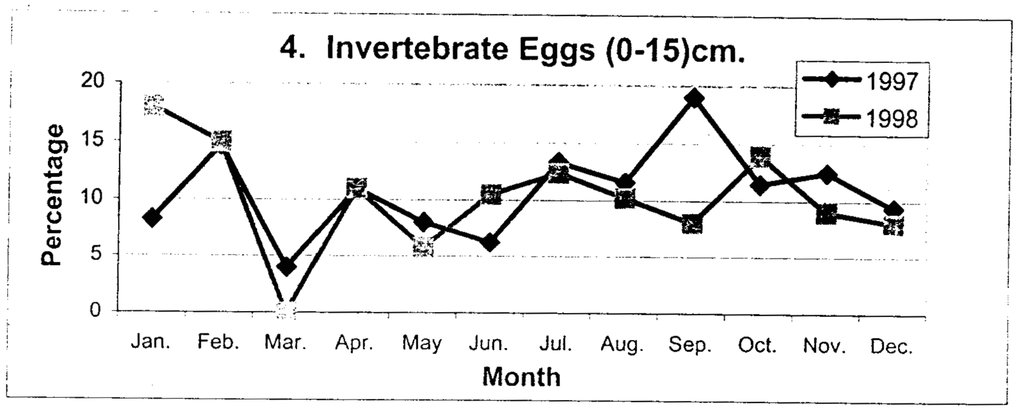

6. Miscellaneous (Female)
1997
1998
Percentage
18
16
14
12
10
8
6
4
2
0
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month

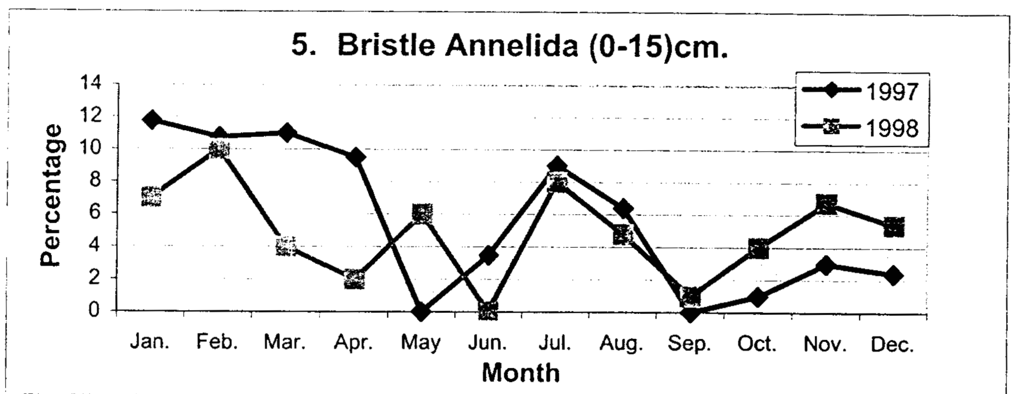
Table 3.7 (1 – 6): Percentage Composition of Various Food Items in the Gut of 0-15 cm Length Group of *Pomadasys maculatus* during 1997 & 1998








4. Invertebrate Eggs (0-15)cm.
1997
1998
20
15
10
5
0
Percentage
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month


5. Bristle Annelida (0-15)cm.
1997
1998
14
12
10
8
6
4
2
0
Percentage
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month

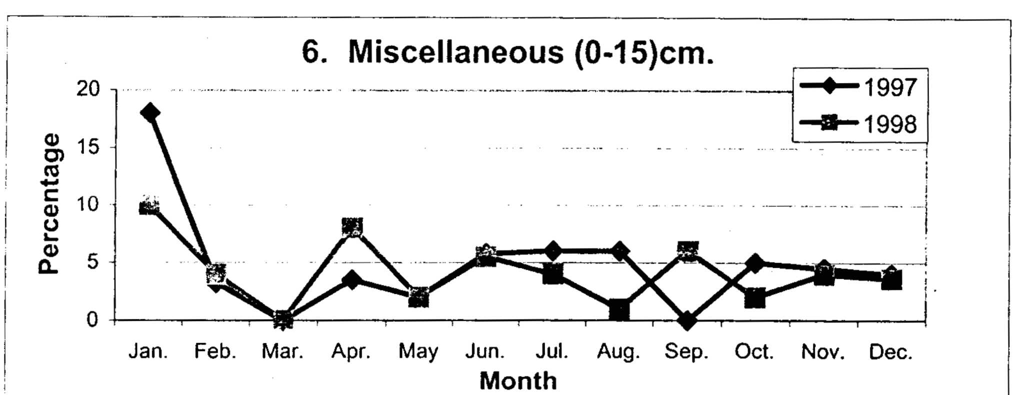
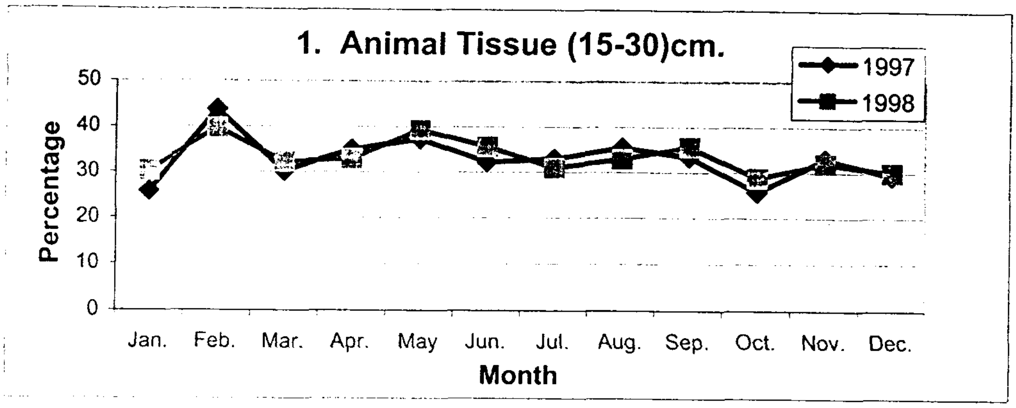
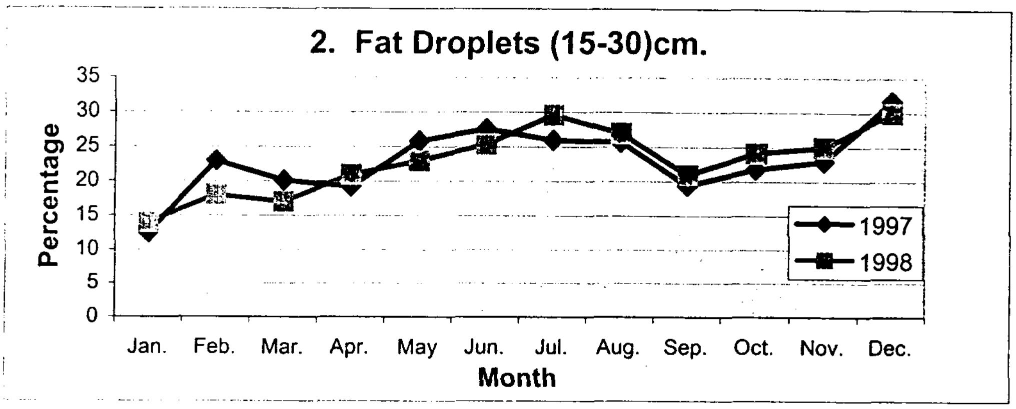
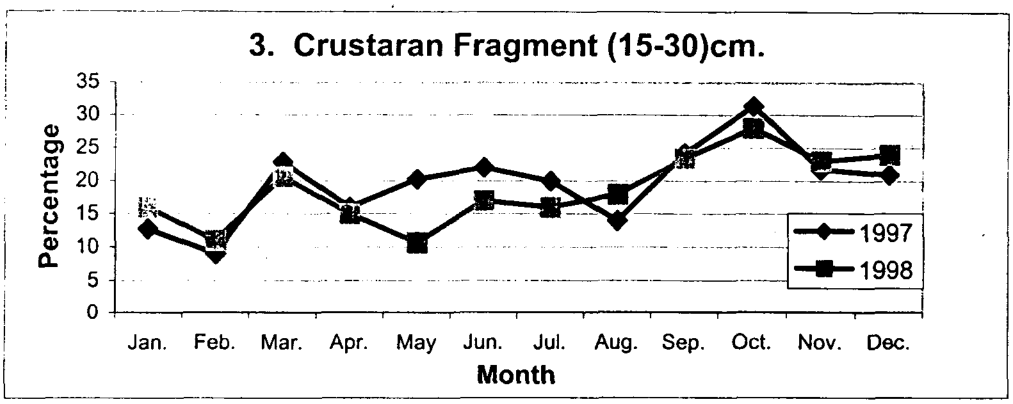
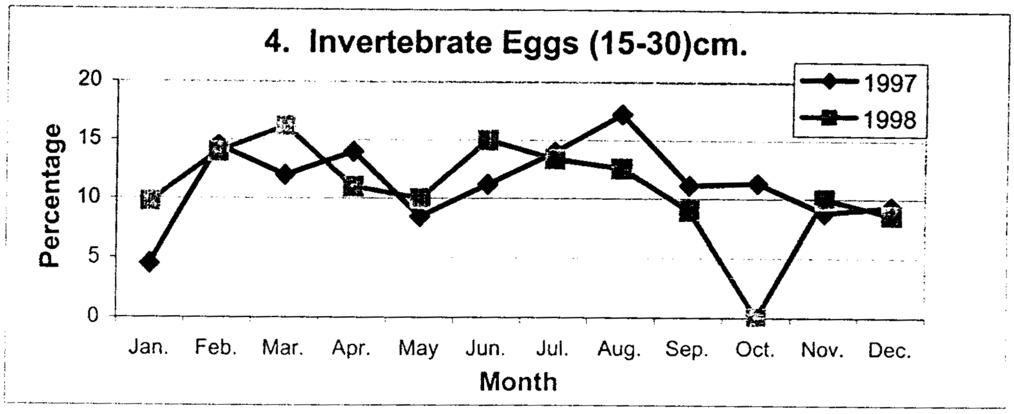

6. Miscellaneous (0-15)cm.
1997
1998
20
15
10
5
0
Percentage
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month

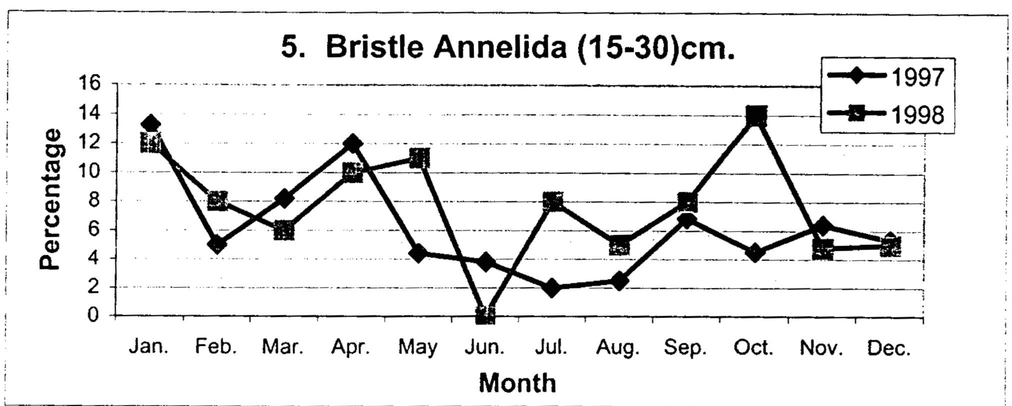
Fig. 3.8 (1 – 6): Percentage Composition of Various Food Items in the Gut of 15-30 cm Length Group of *Pomadasys maculatus* during 1997 & 1998








4. Invertebrate Eggs (15-30)cm.
Percentage
0
5
10
15
20
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month
1997
1998


5. Bristle Annelida (15-30)cm.
Percentage
0
2
4
6
8
10
12
14
16
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month
1997
1998

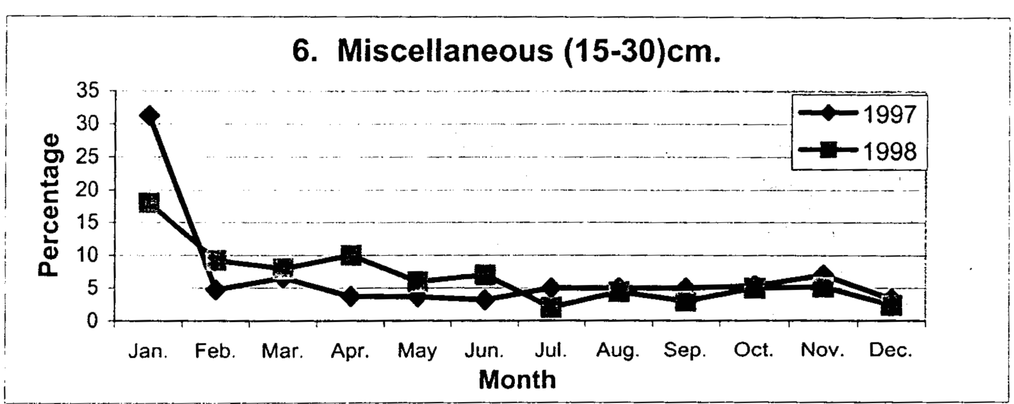

6. Miscellaneous (15-30)cm.
Percentage
0
5
10
15
20
25
30
35
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Month
1997
1998

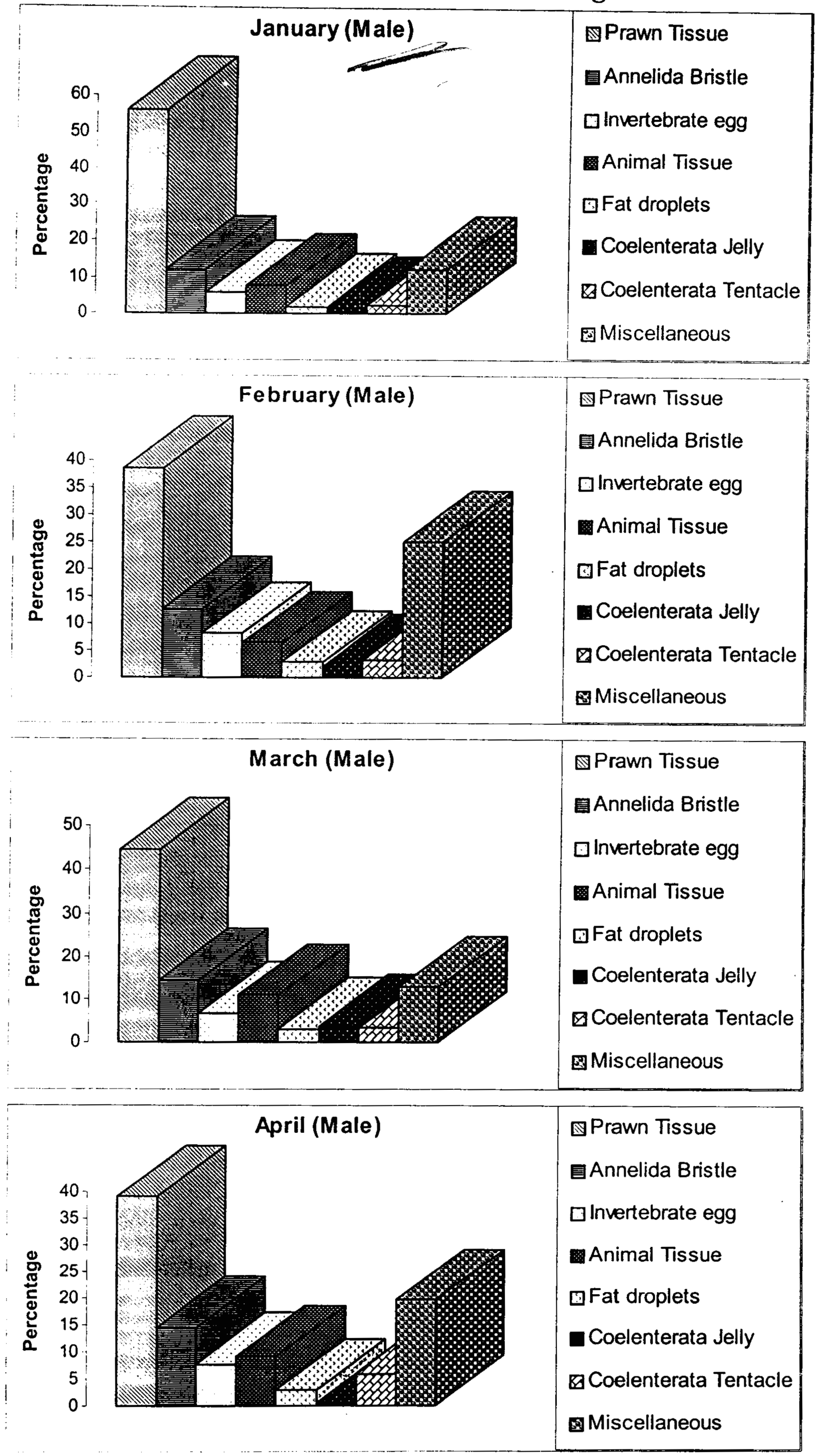
Fig. 3.9 (a – l): Monthly average % composition of various food items in the gut of Male *Priacanthus hamrur* during 1997 & 1998

a

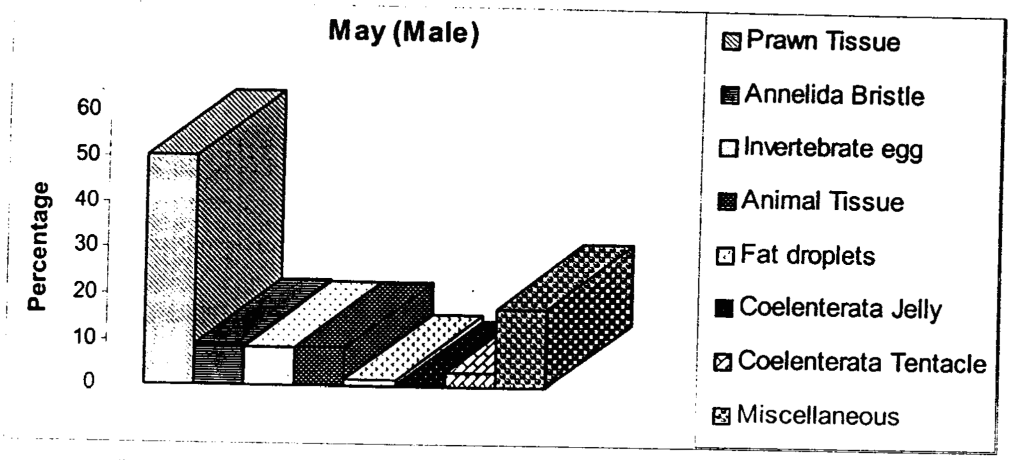
b

c

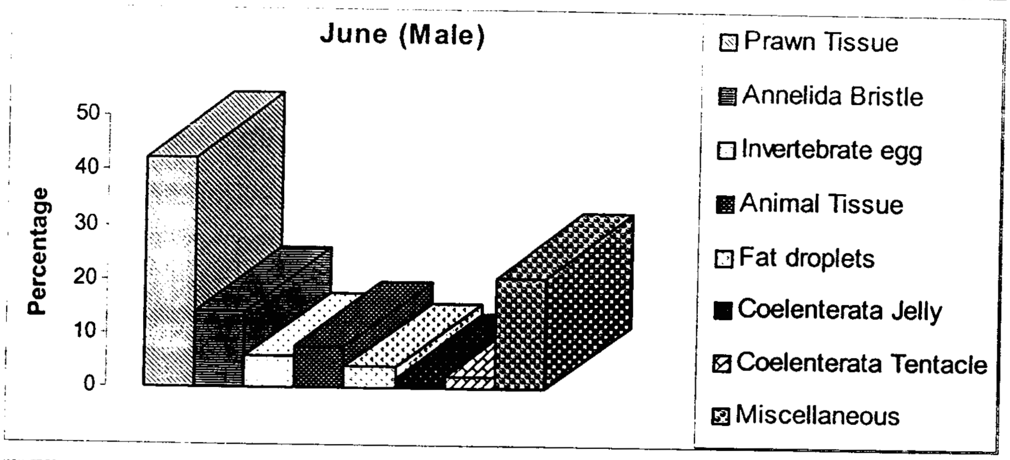
d



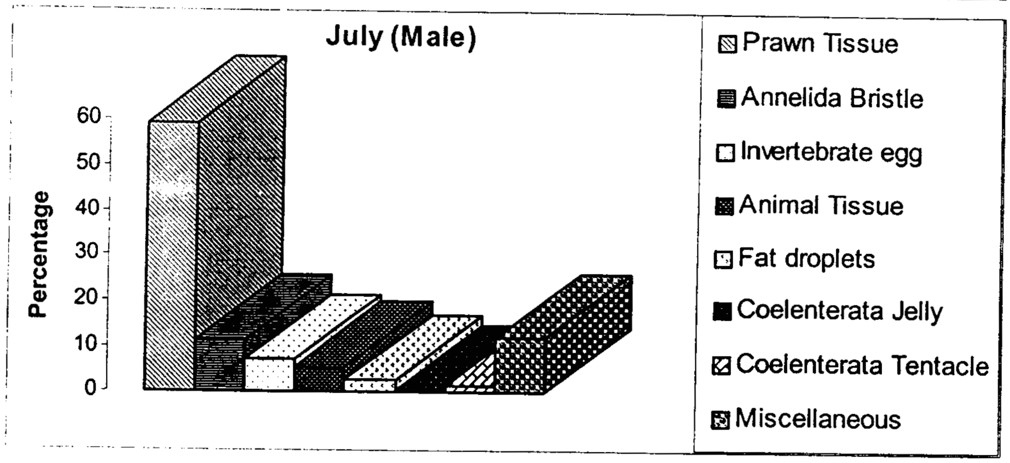
e


May (Male)
Percentage
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

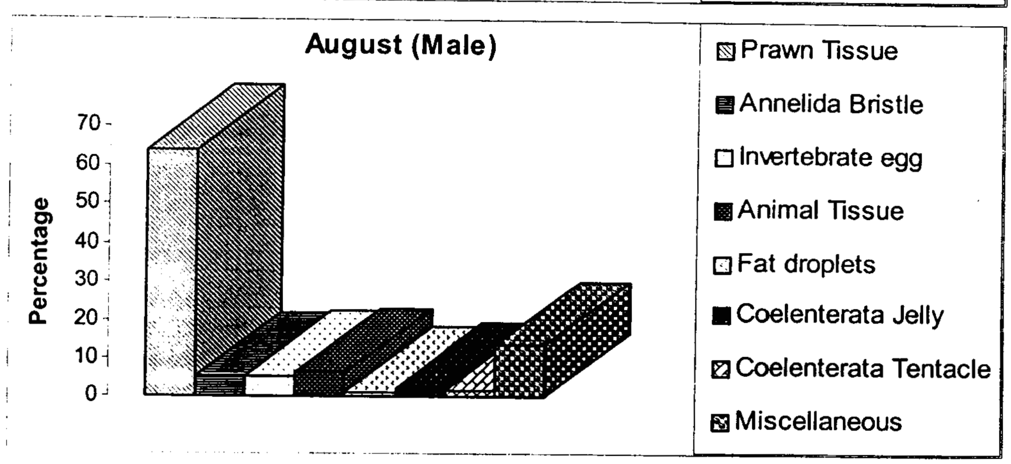
f


June (Male)
Percentage
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

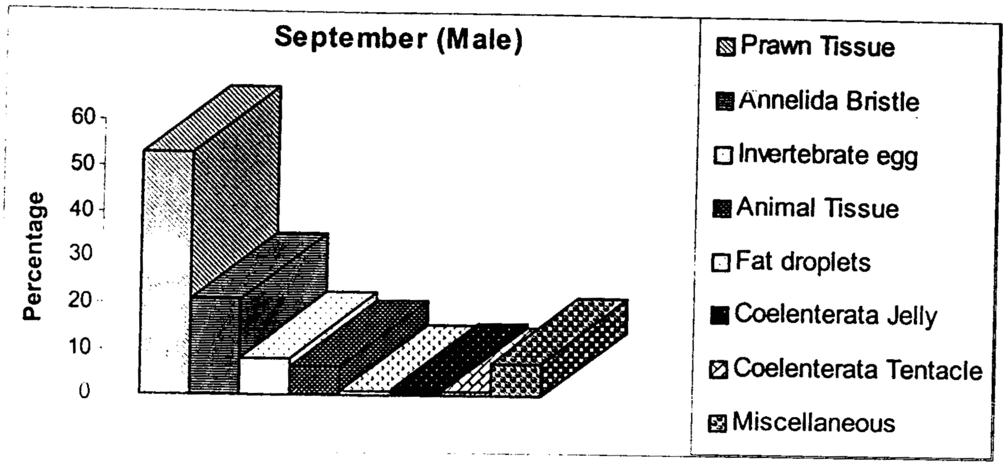
g


July (Male)
Percentage
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

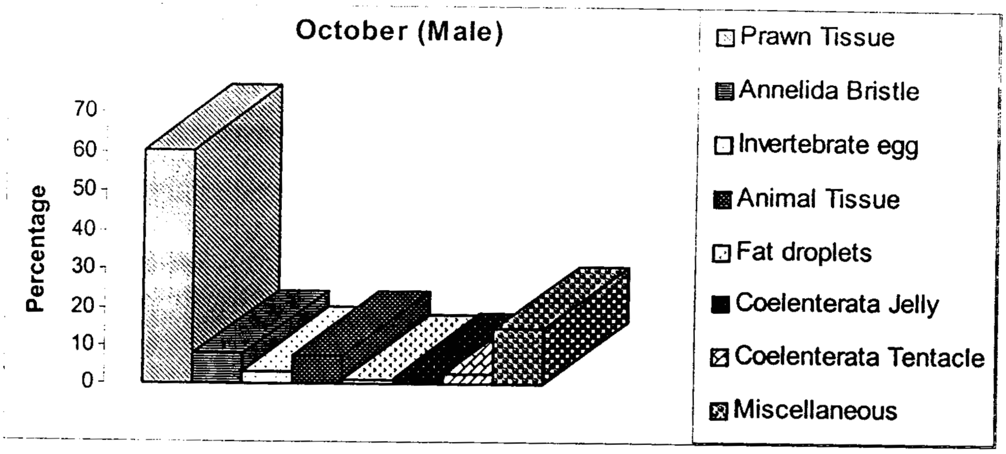
h


August (Male)
Percentage
70
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

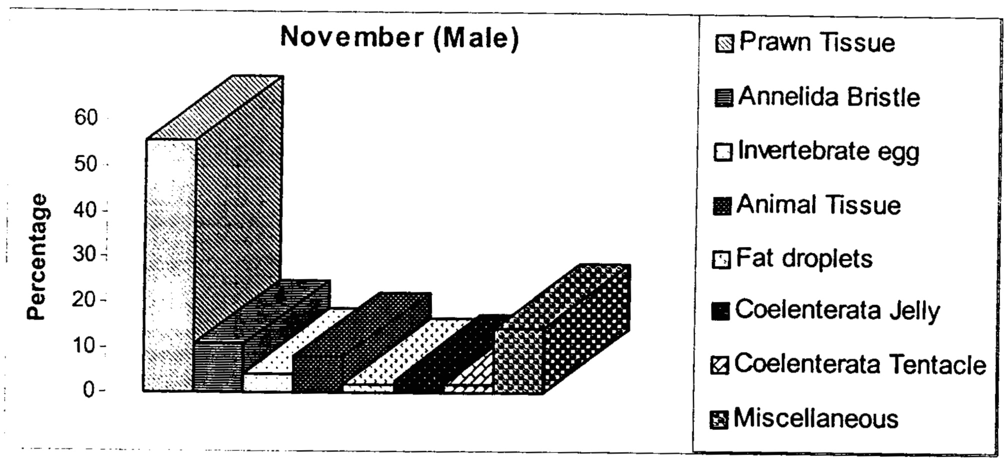
i


September (Male)
Percentage
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

j


October (Male)
Percentage
70
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

k


November (Male)
Percentage
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

l

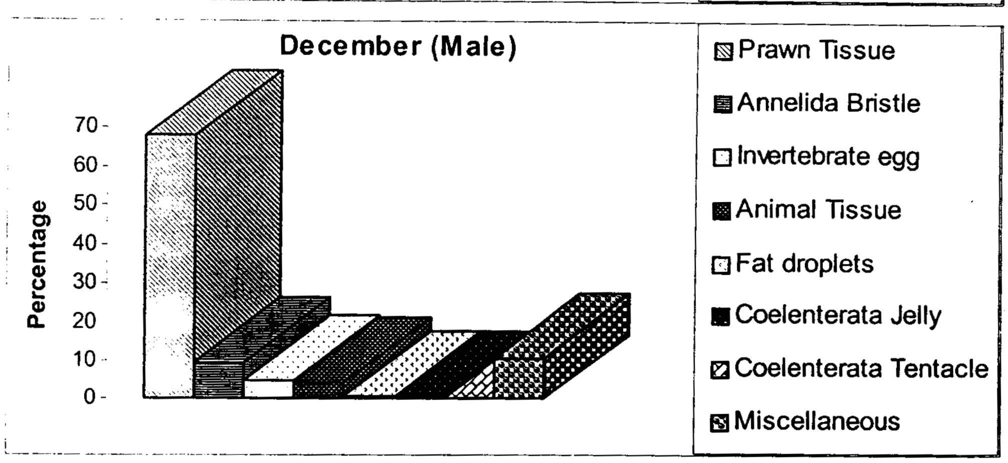
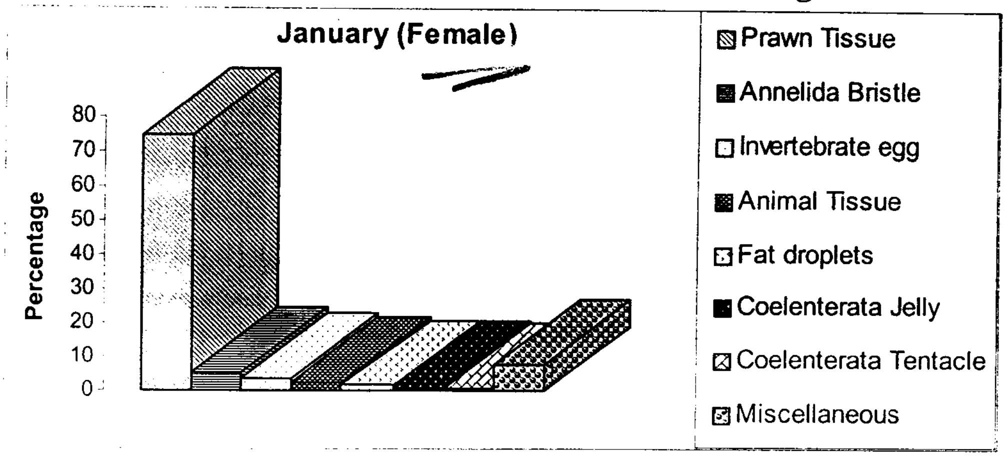
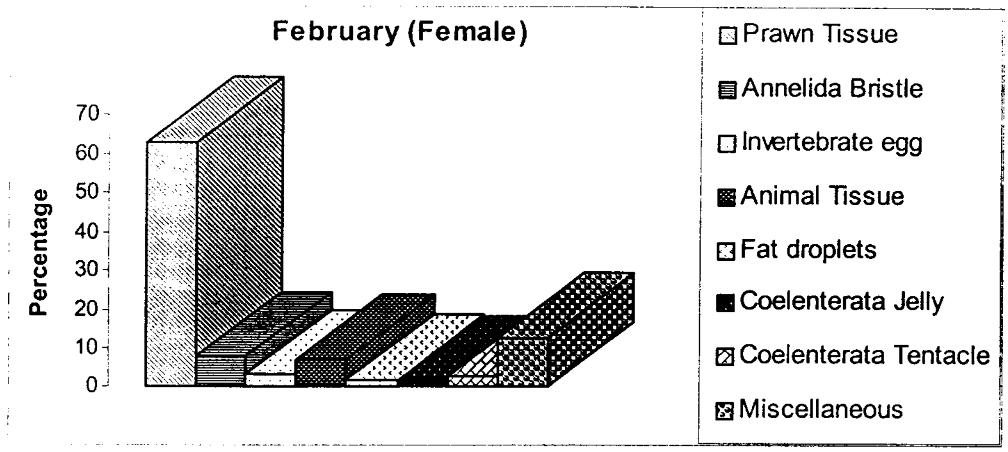

December (Male)
Percentage
70
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

Fig. 3.10 (a – l): Monthly average % composition of various food items in the gut of Female *Priacanthus hamrur* during 1997 & 1998

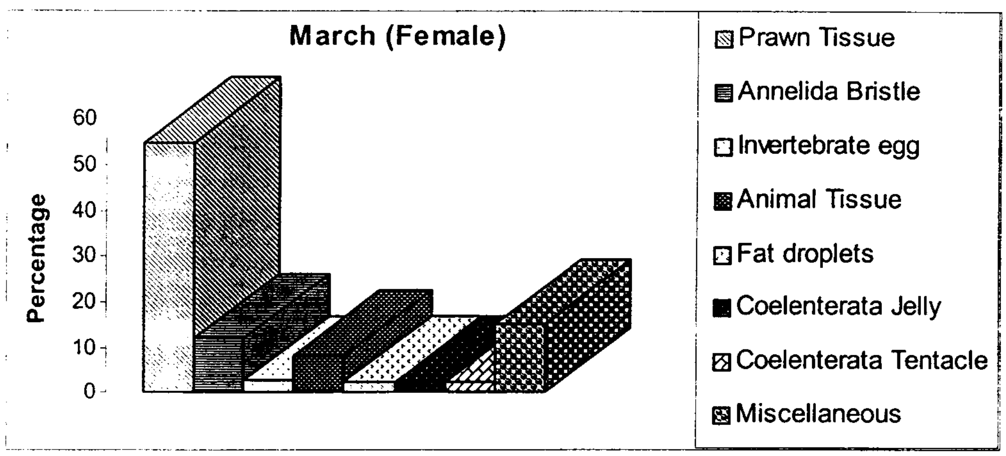
a



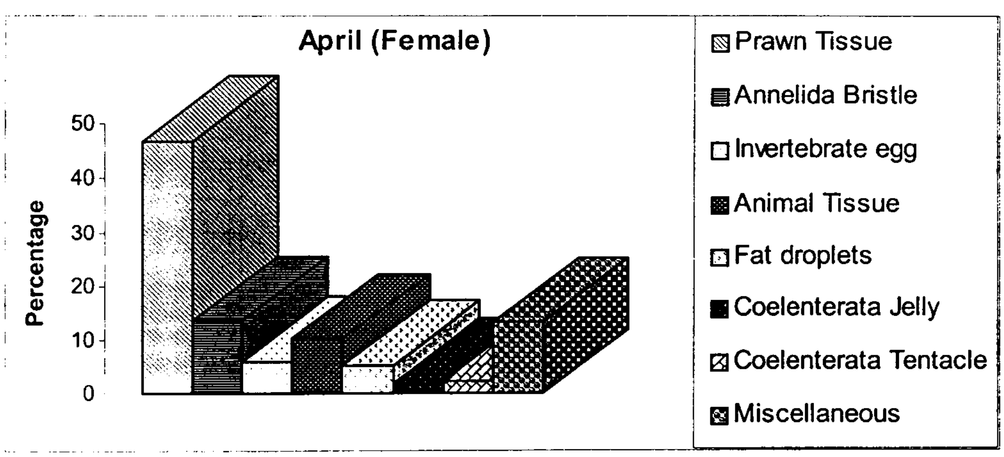
b



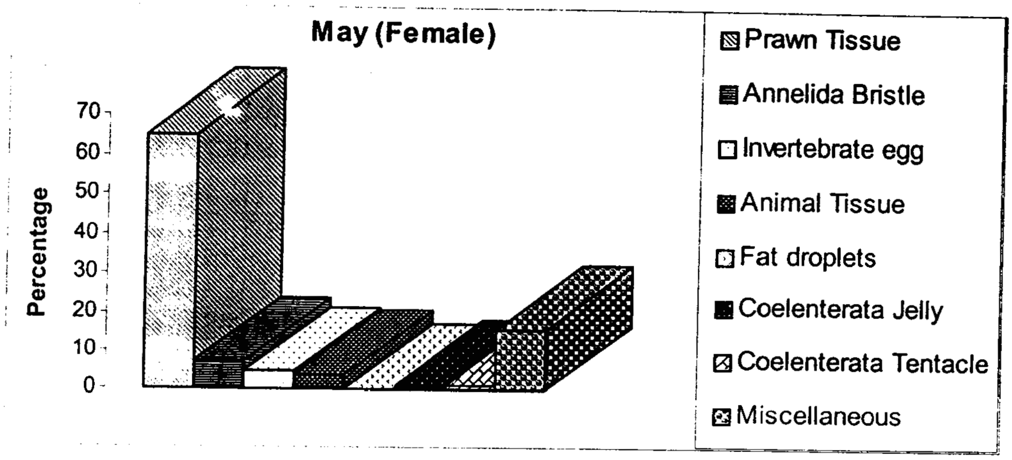
c



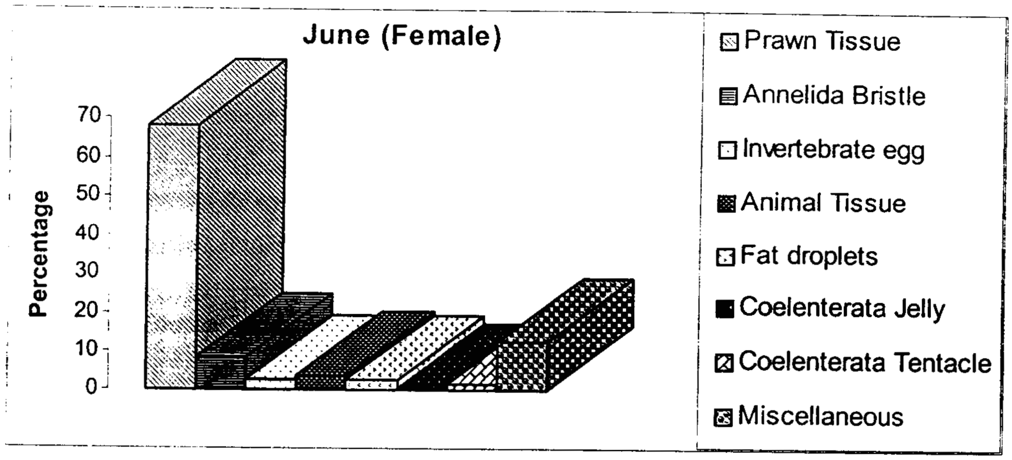
d



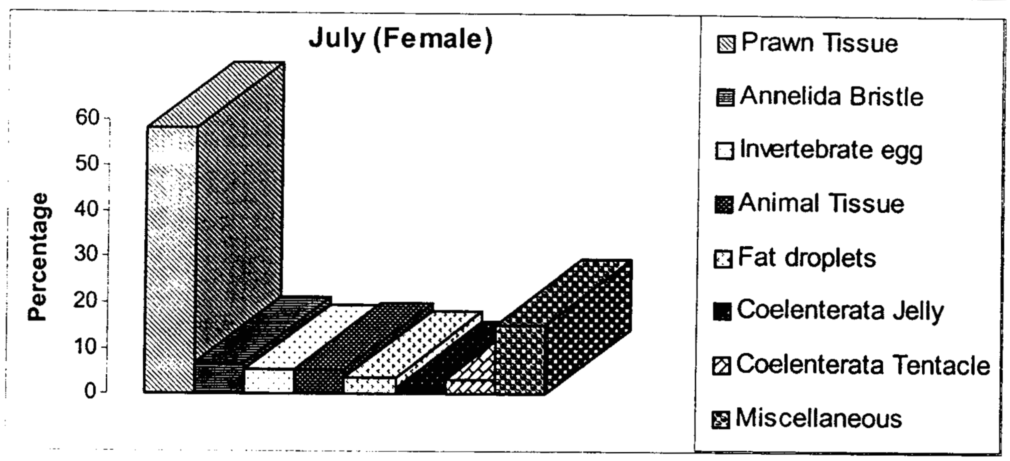
e


May (Female)
Percentage
0
10
20
30
40
50
60
70
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

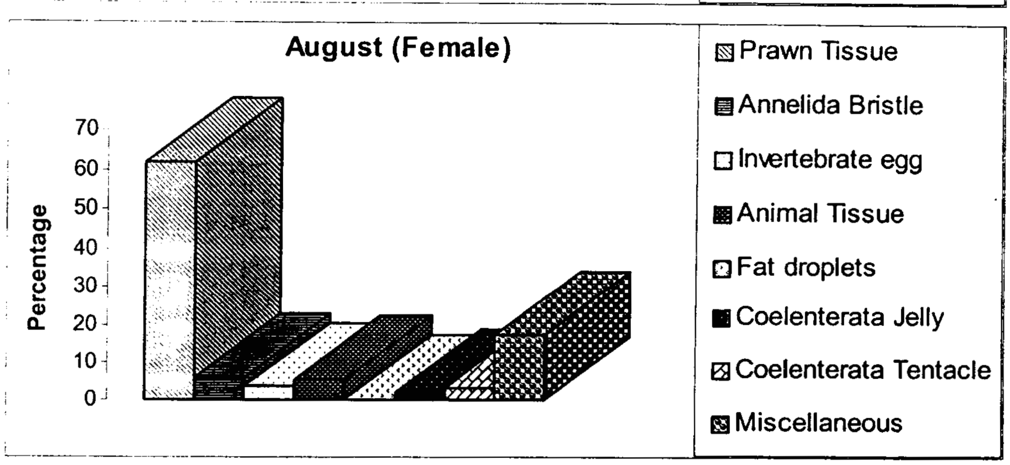
f


June (Female)
Percentage
0
10
20
30
40
50
60
70
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

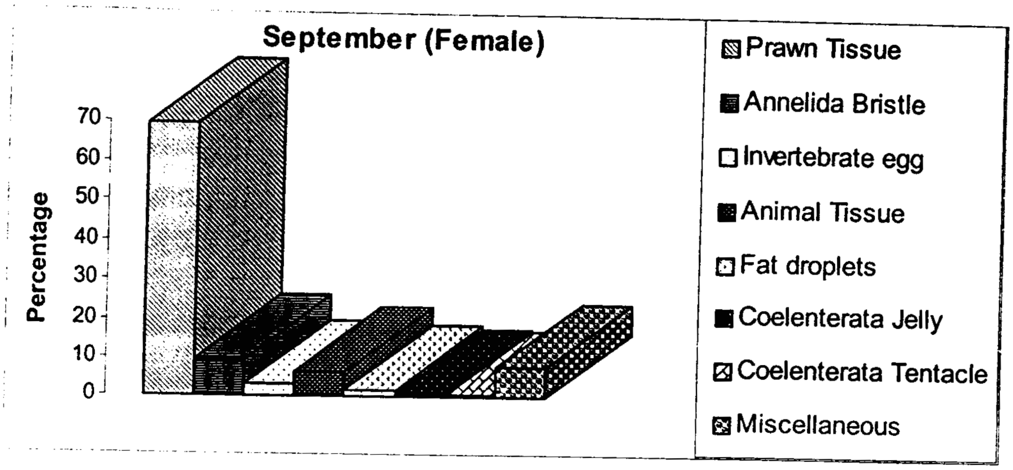
g


July (Female)
Percentage
0
10
20
30
40
50
60
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

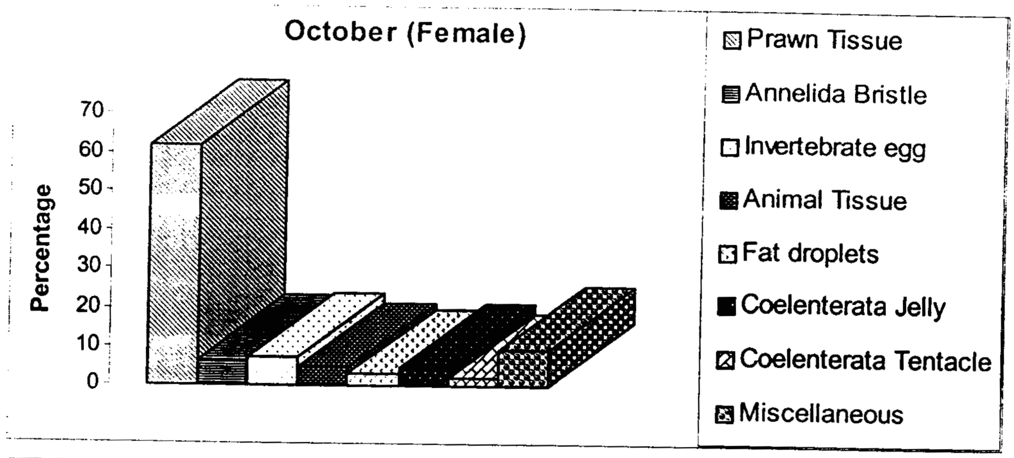
h


August (Female)
Percentage
0
10
20
30
40
50
60
70
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

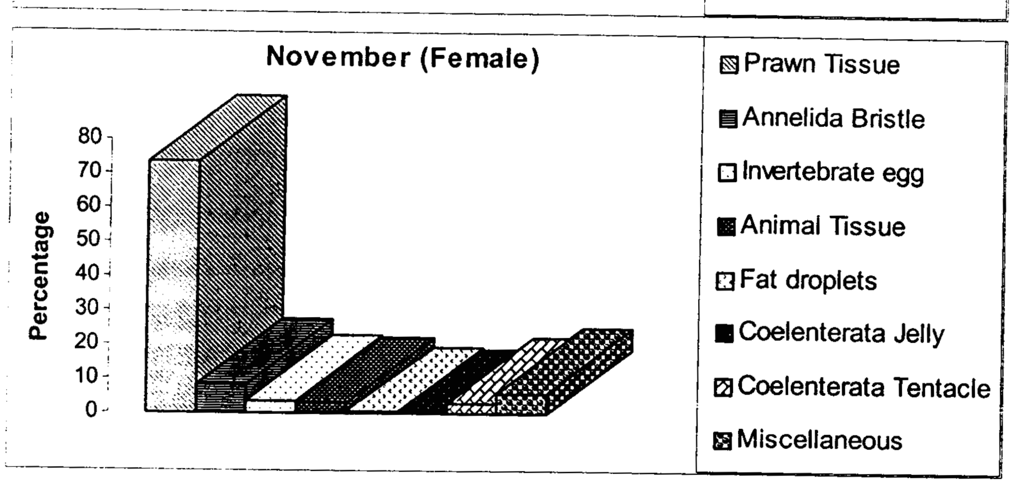
i


September (Female)
Percentage
70
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

j


October (Female)
Percentage
70
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

k


November (Female)
Percentage
80
70
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

l

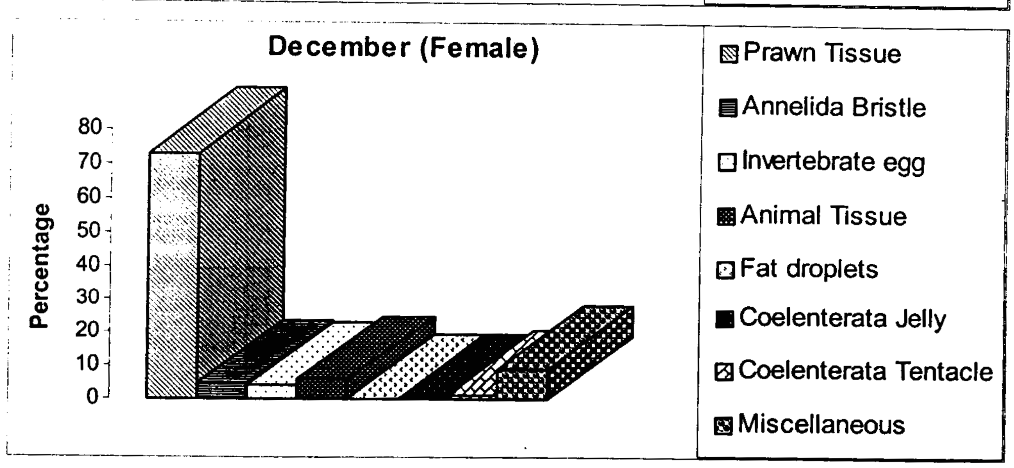
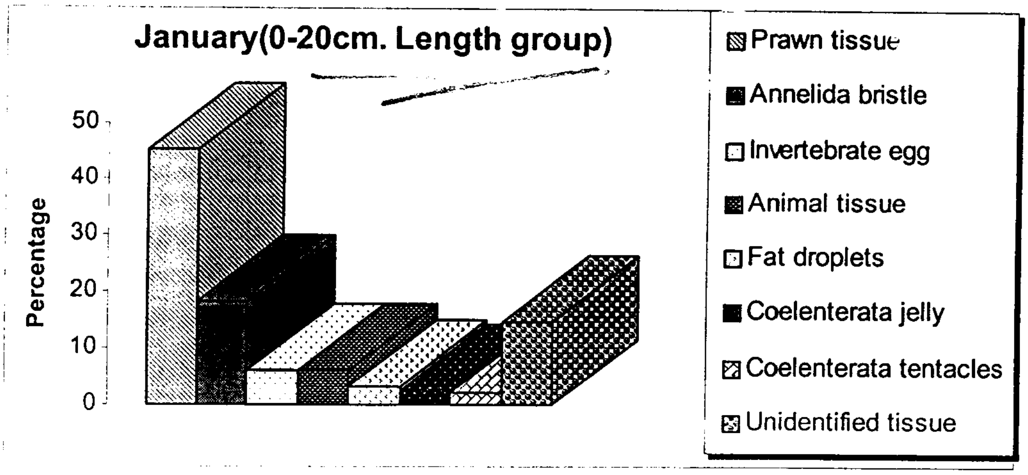
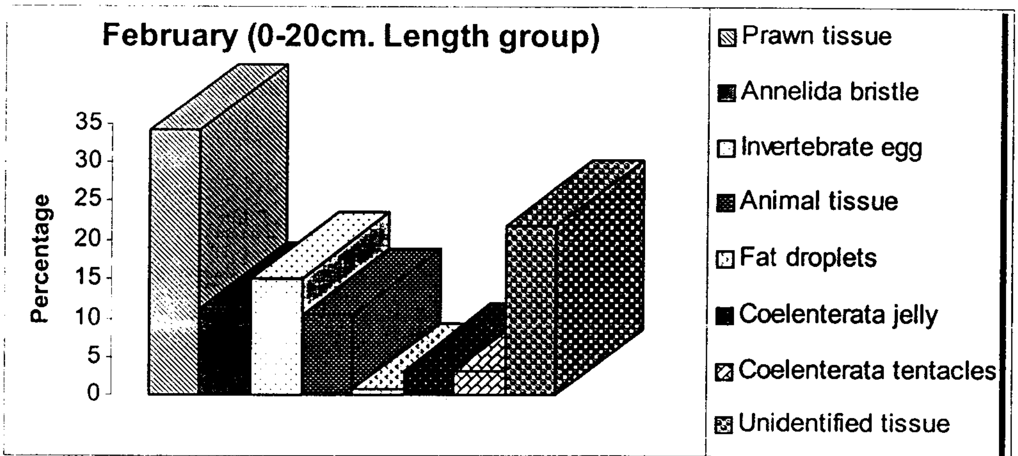

December (Female)
Percentage
80
70
60
50
40
30
20
10
0
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

Fig. 3.11 (a – l): Monthly Average % Composition of Various Food Items in the Gut of 0-20 cm Length Group of *Priacanthus hamrur* during 1997 & 199

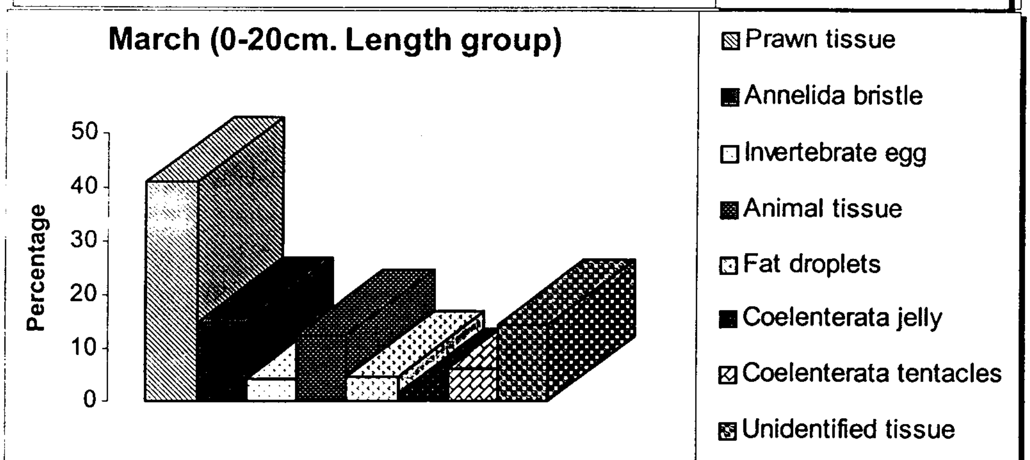
a



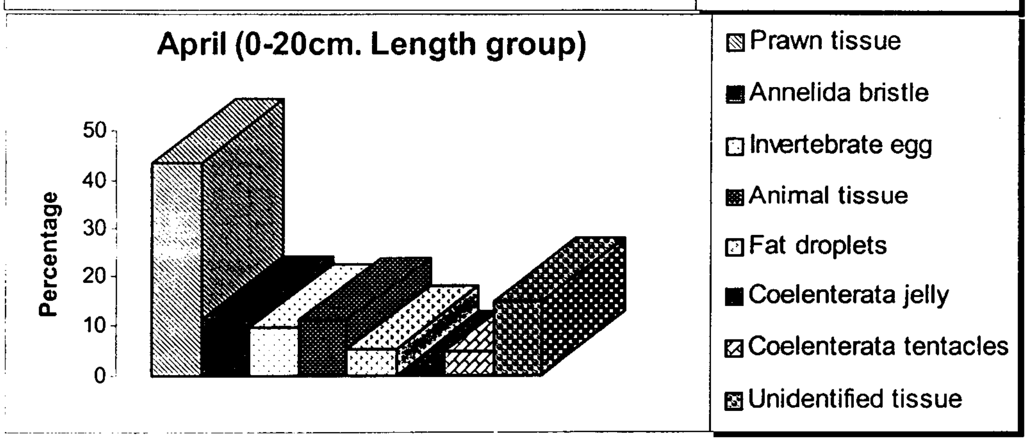
b



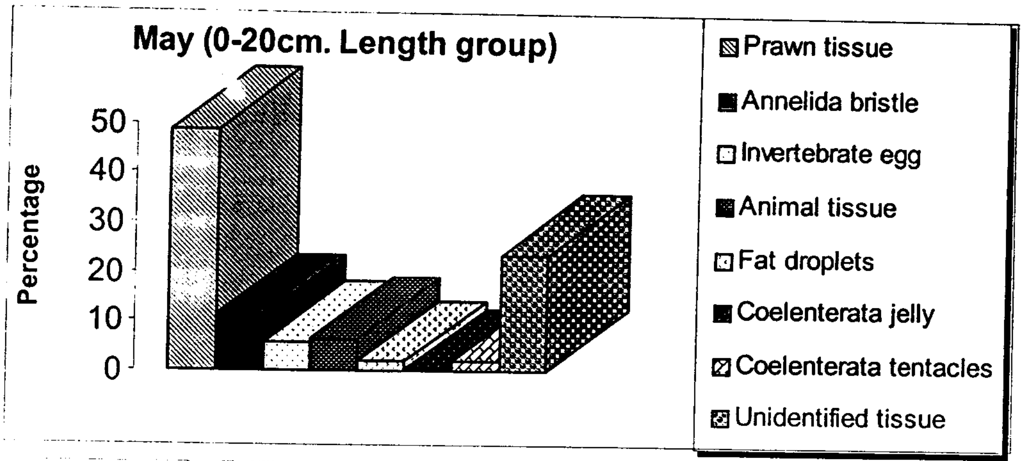
c



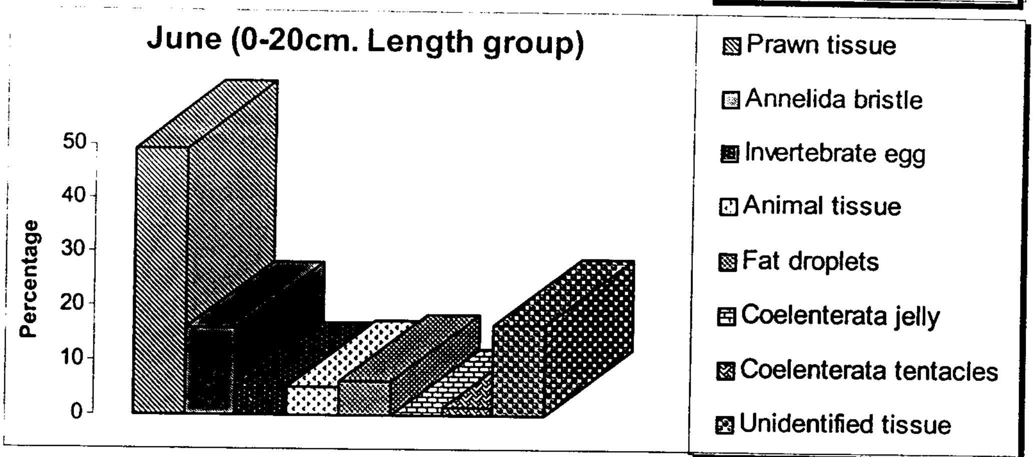
d



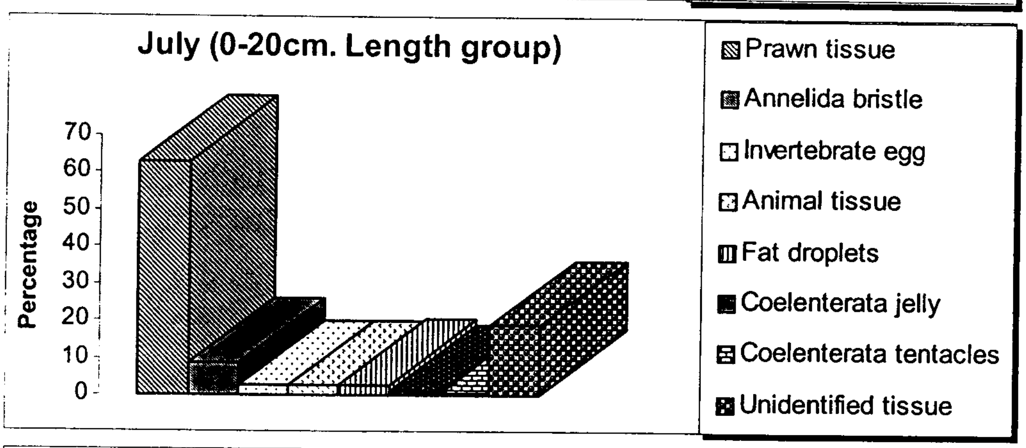
e


May (0-20cm. Length group)
Percentage
50
40
30
20
10
0
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Unidentified tissue

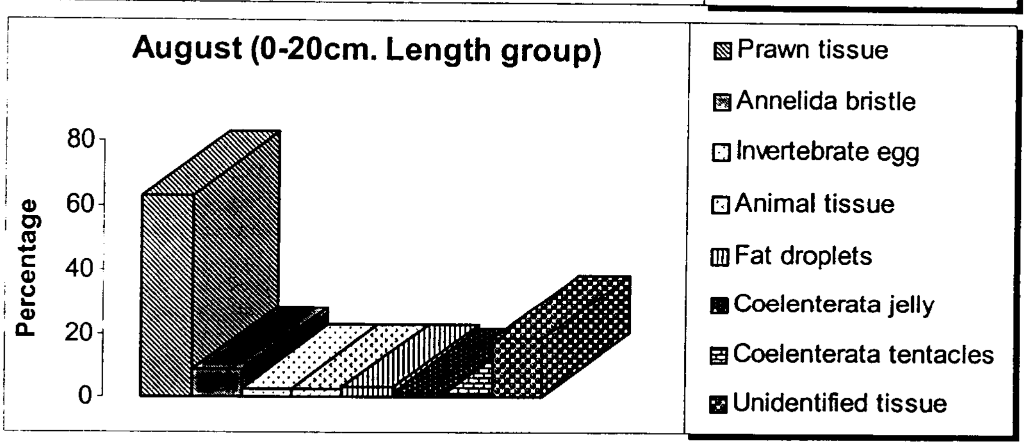
f


June (0-20cm. Length group)
Percentage
50
40
30
20
10
0
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Unidentified tissue

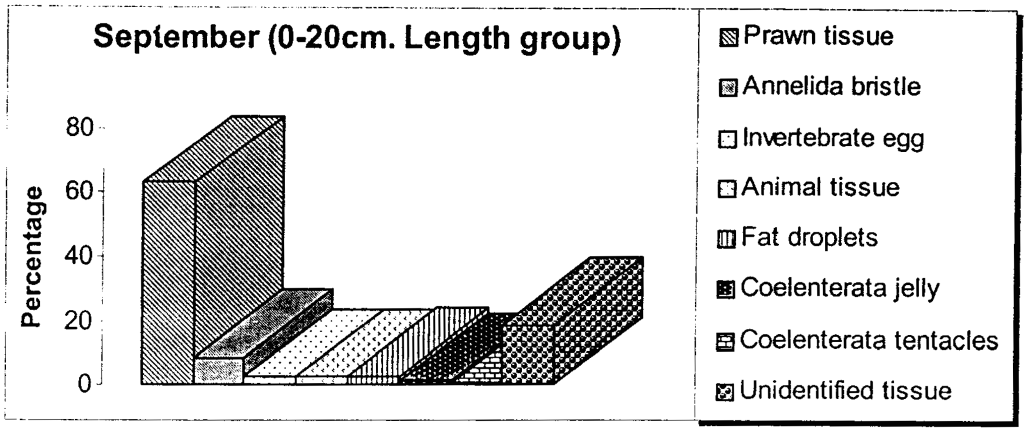
g


July (0-20cm. Length group)
Percentage
70
60
50
40
30
20
10
0
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Unidentified tissue

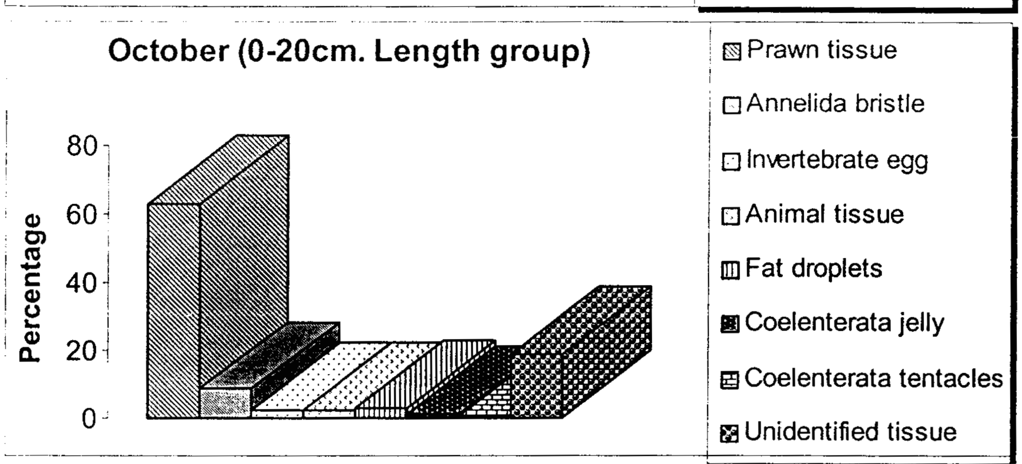
h


August (0-20cm. Length group)
Percentage
80
60
40
20
0
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Unidentified tissue

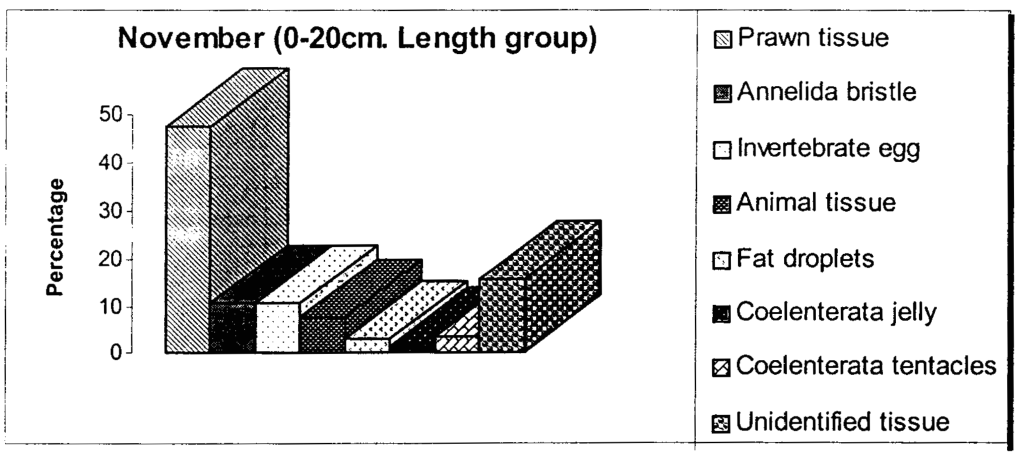
i


September (0-20cm. Length group)
Percentage
80
60
40
20
0
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Unidentified tissue

j


October (0-20cm. Length group)
Percentage
80
60
40
20
0
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Unidentified tissue

k


November (0-20cm. Length group)
Percentage
50
40
30
20
10
0
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Unidentified tissue

l

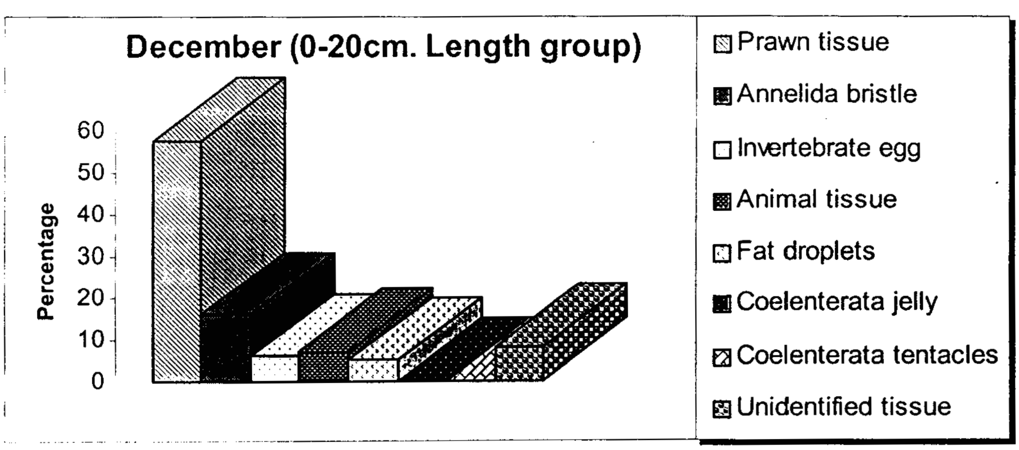
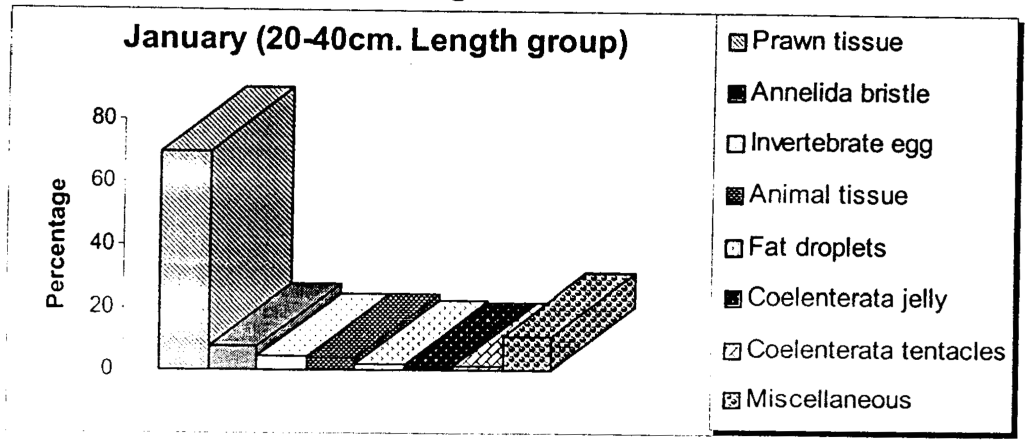
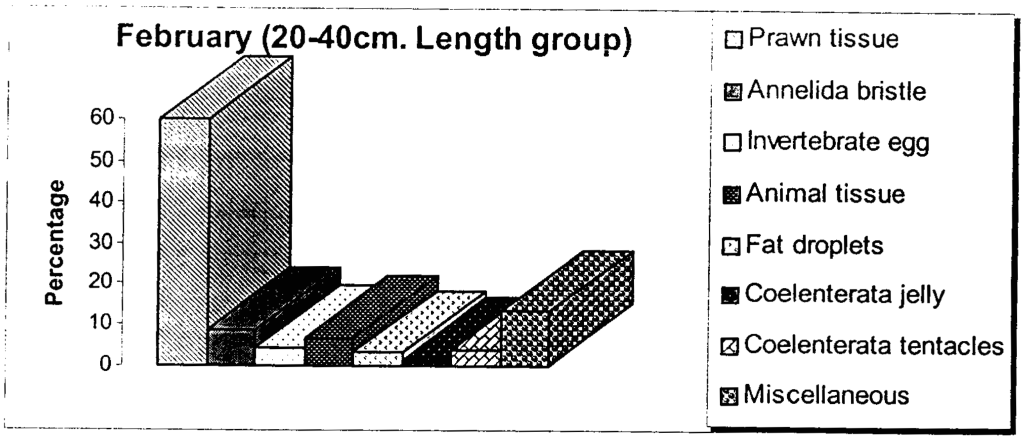

December (0-20cm. Length group)
Percentage
60
50
40
30
20
10
0
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Unidentified tissue

Fig. 3.12 (a – l): Monthly average % composition of various food items in the gut of 20-40 cm length group of *Priacanthus hamrur* during 1997 & 1998

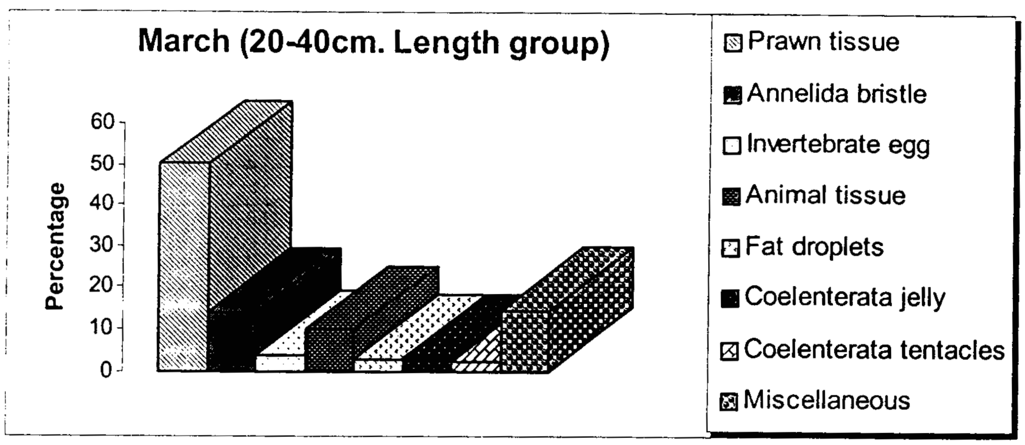
a



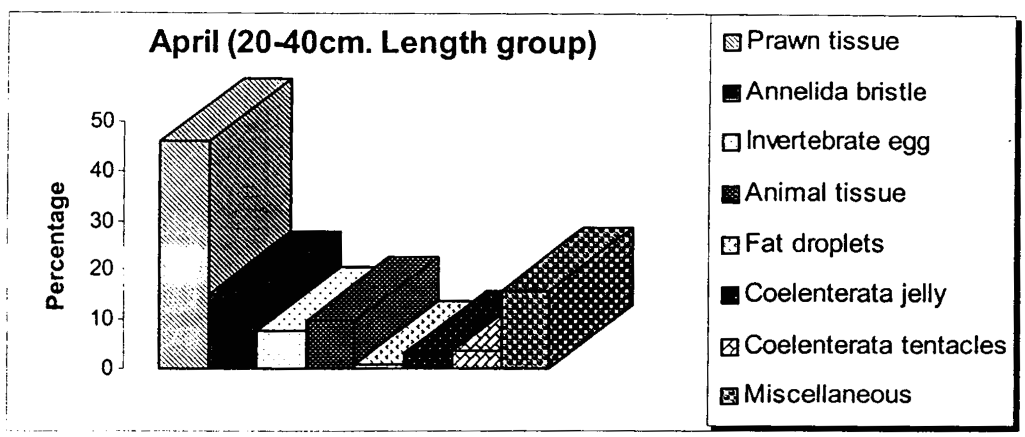
b



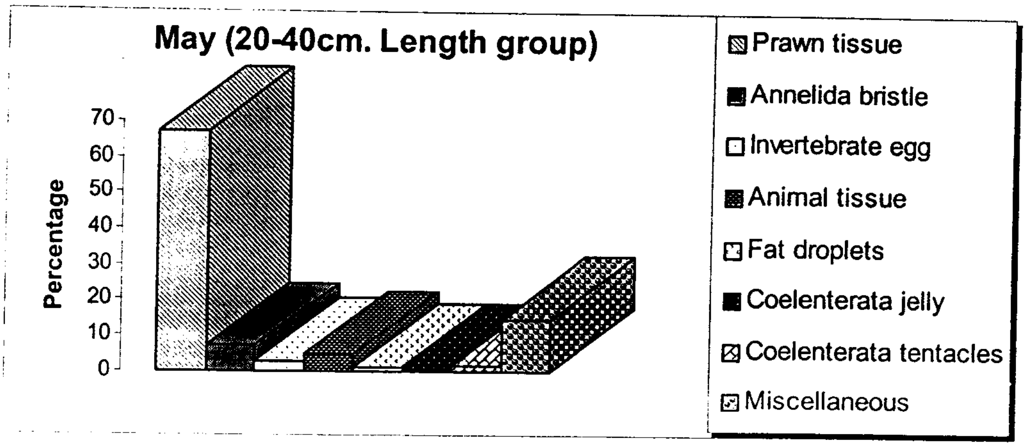
c



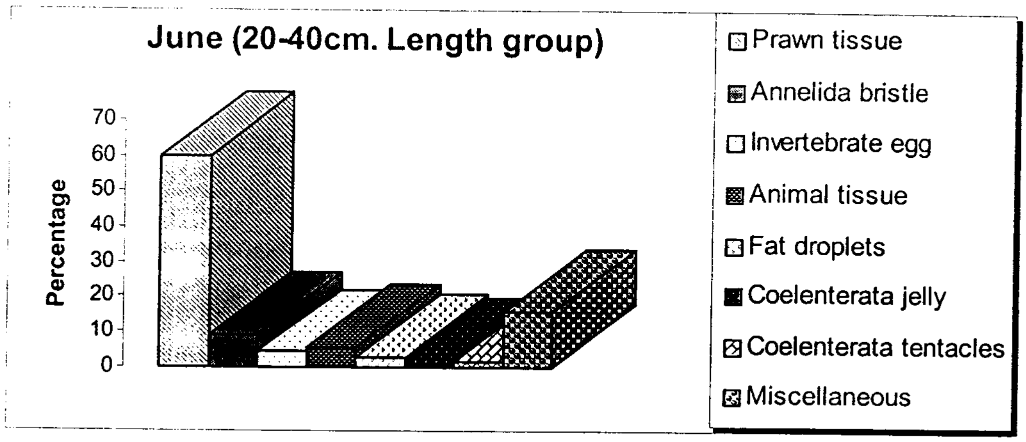
d



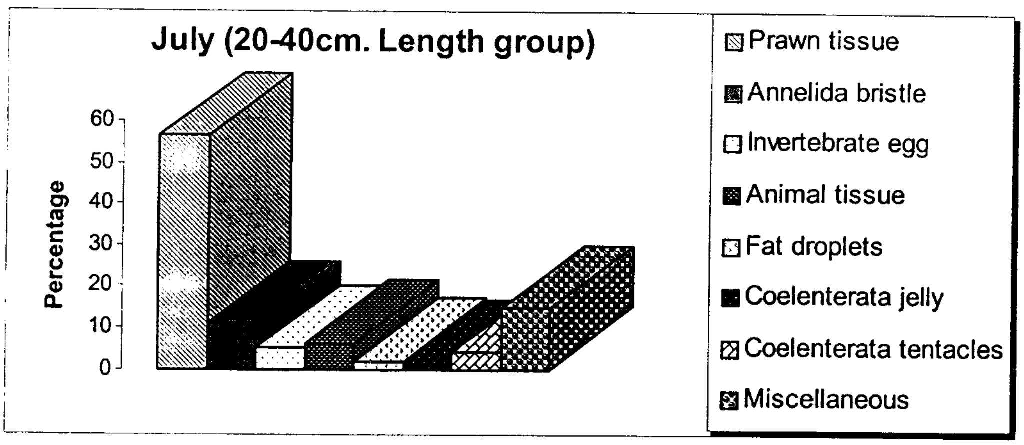
e


May (20-40cm. Length group)
Percentage
0
10
20
30
40
50
60
70
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Miscellaneous

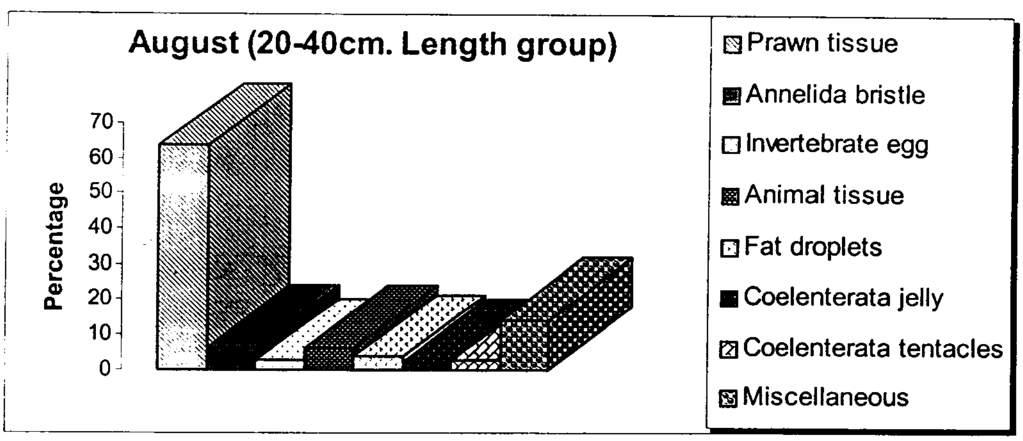
f


June (20-40cm. Length group)
Percentage
0
10
20
30
40
50
60
70
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Miscellaneous

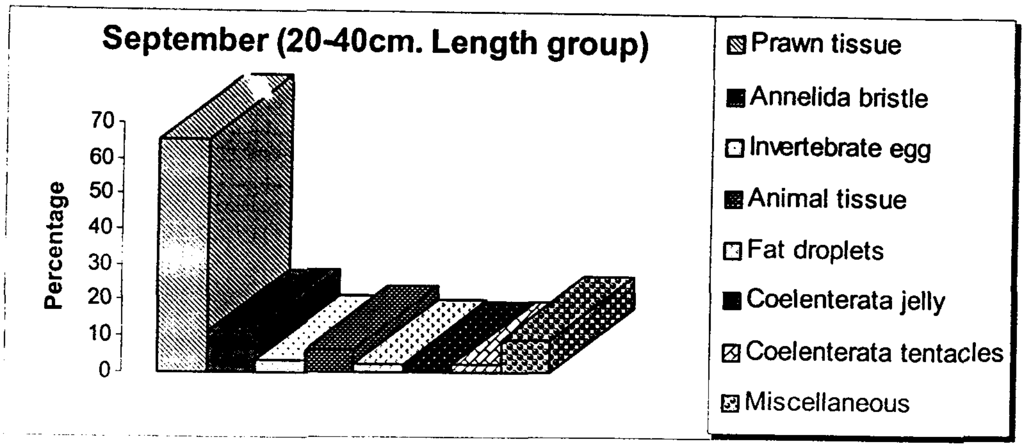
g


July (20-40cm. Length group)
Percentage
0
10
20
30
40
50
60
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Miscellaneous

h

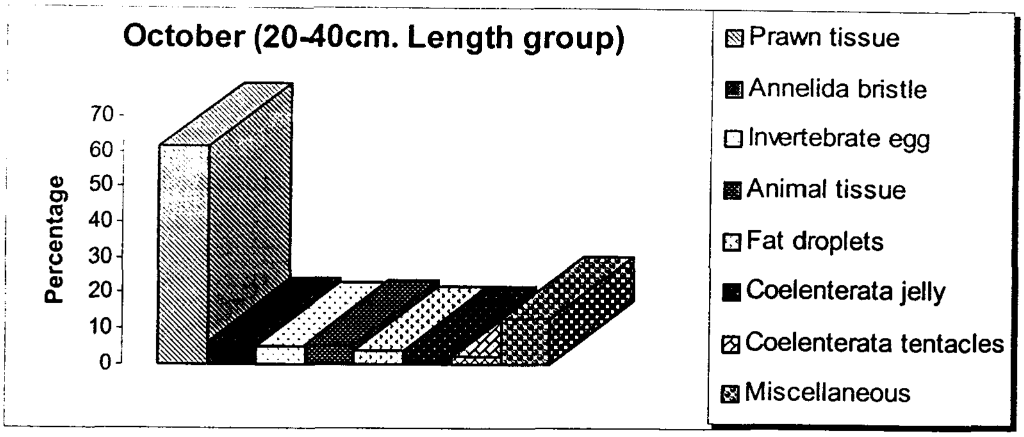

August (20-40cm. Length group)
Percentage
0
10
20
30
40
50
60
70
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Miscellaneous

i



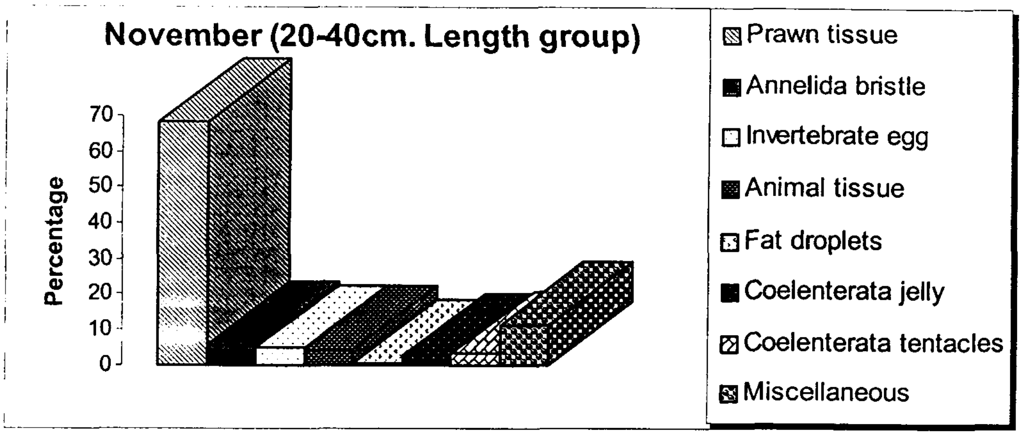
September (20-40cm. Length group)
Percentage
0
10
20
30
40
50
60
70
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Miscellaneous

j



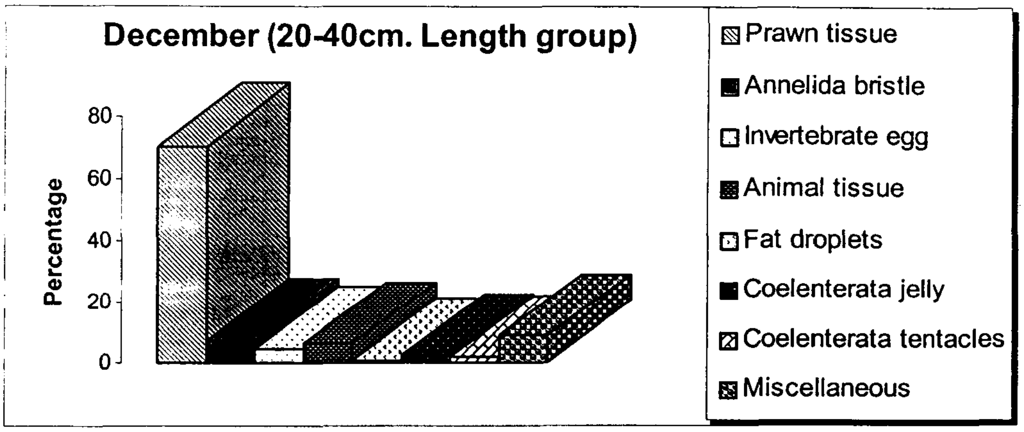
October (20-40cm. Length group)
Percentage
0
10
20
30
40
50
60
70
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Miscellaneous

k



November (20-40cm. Length group)
Percentage
0
10
20
30
40
50
60
70
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Miscellaneous

l



December (20-40cm. Length group)
Percentage
0
20
40
60
80
Prawn tissue
Annelida bristle
Invertebrate egg
Animal tissue
Fat droplets
Coelenterata jelly
Coelenterata tentacles
Miscellaneous

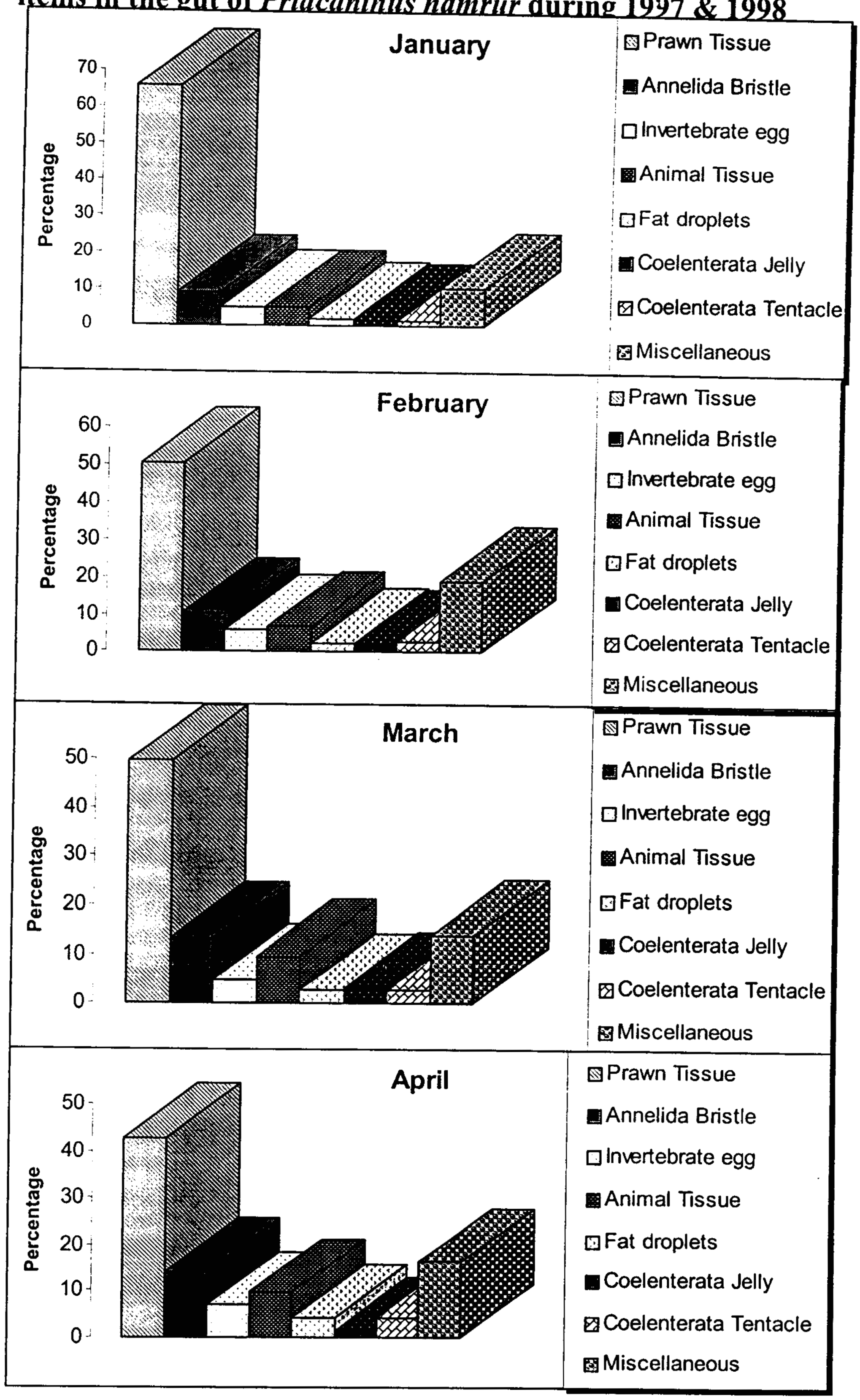
Fig. 3.13 (a – l): Monthly overall average % composition of various food items in the gut of *Priacanthus hamrur* during 1997 & 1998

a

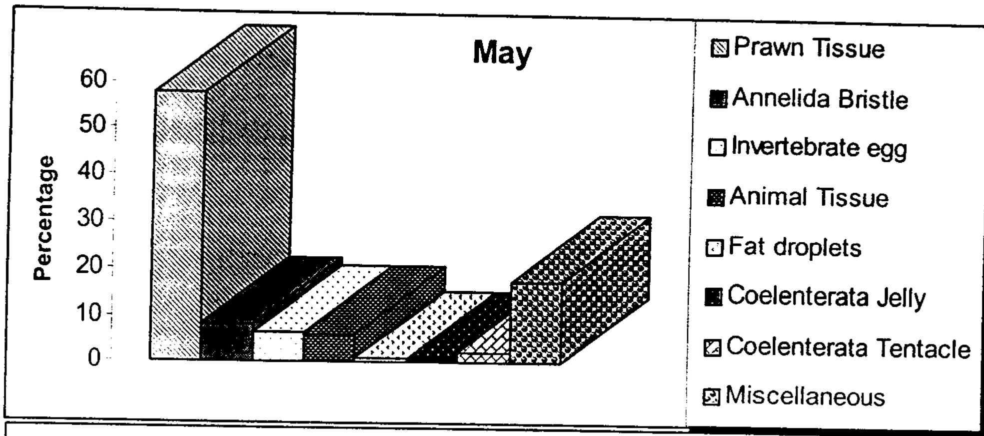
b

c

d

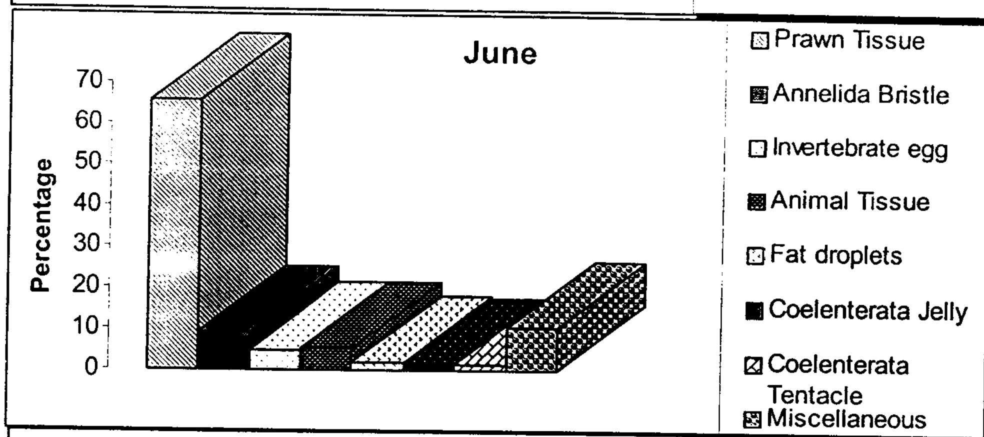


e



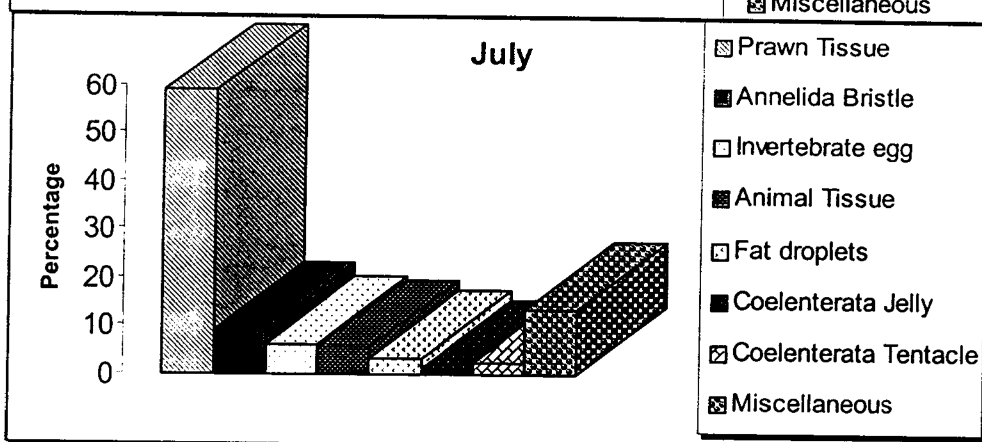
May
Percentage
0
10
20
30
40
50
60
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

f



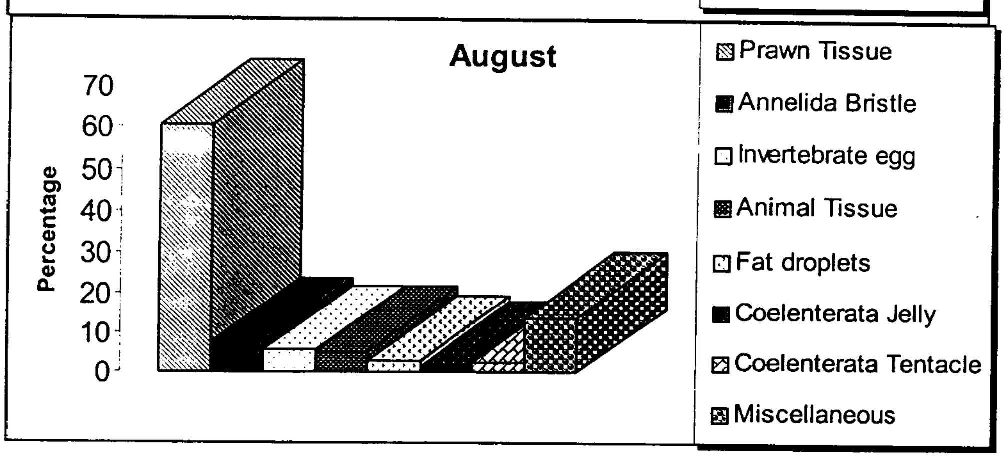
June
Percentage
0
10
20
30
40
50
60
70
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

g



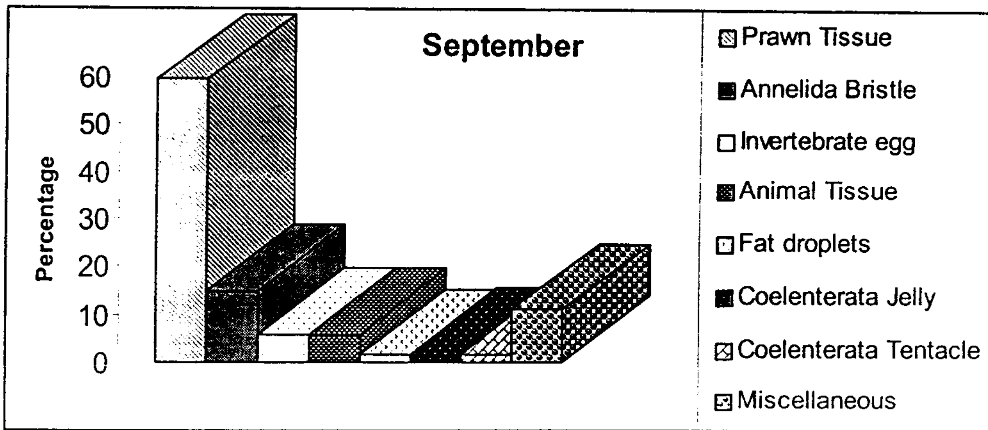
July
Percentage
0
10
20
30
40
50
60
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

h

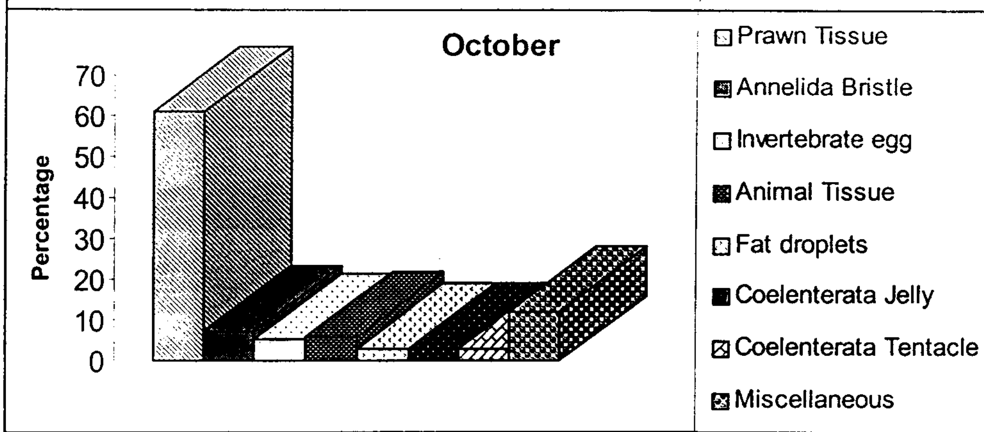


August
Percentage
0
10
20
30
40
50
60
70
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

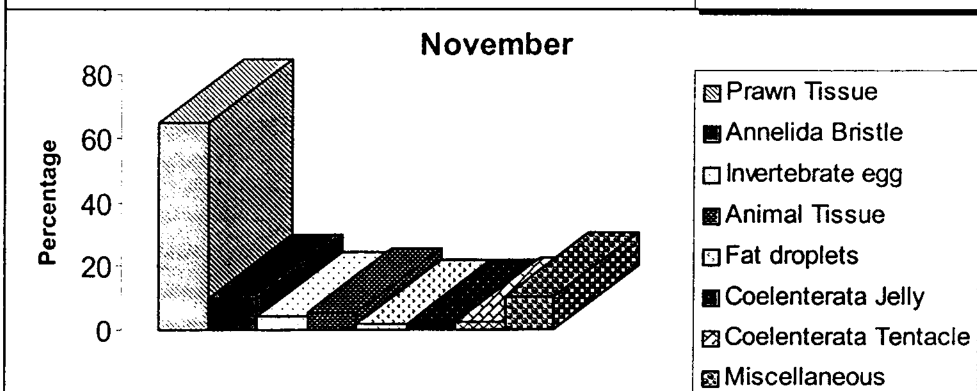
i


September
Percentage
0
10
20
30
40
50
60
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

j


October
Percentage
0
10
20
30
40
50
60
70
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

k


November
Percentage
0
20
40
60
80
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

l

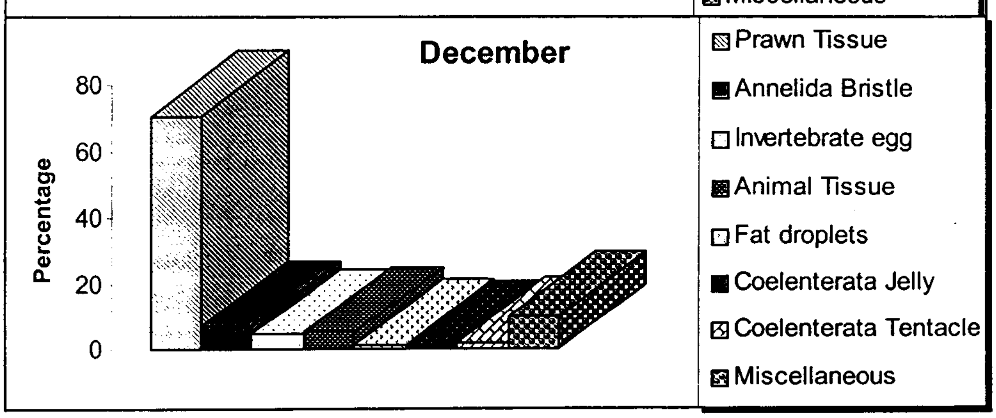

December
Percentage
0
20
40
60
80
Prawn Tissue
Annelida Bristle
Invertebrate egg
Animal Tissue
Fat droplets
Coelenterata Jelly
Coelenterata Tentacle
Miscellaneous

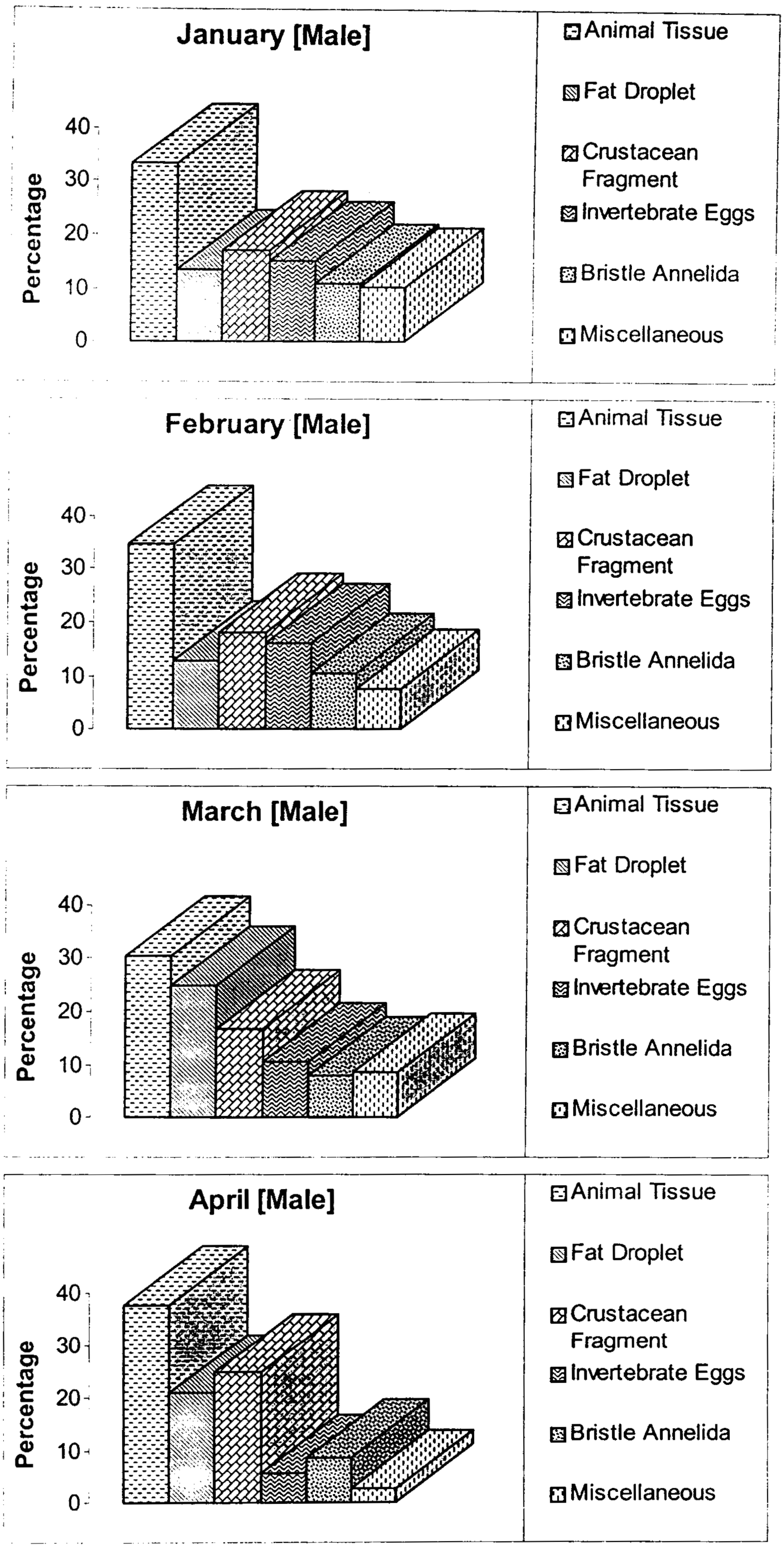
Fig. 3.14 (a – l): Monthly average % composition of various food items in the gut of Male *Pomadasys maculatus* during 1997 & 1998

a

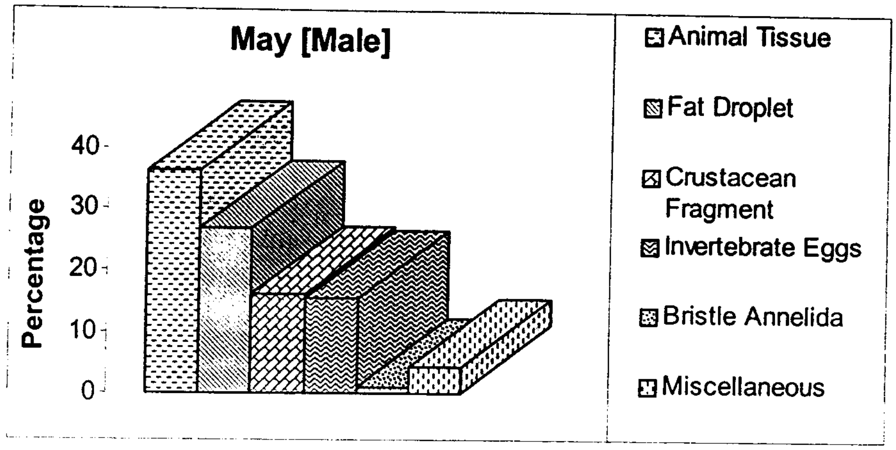
b

c

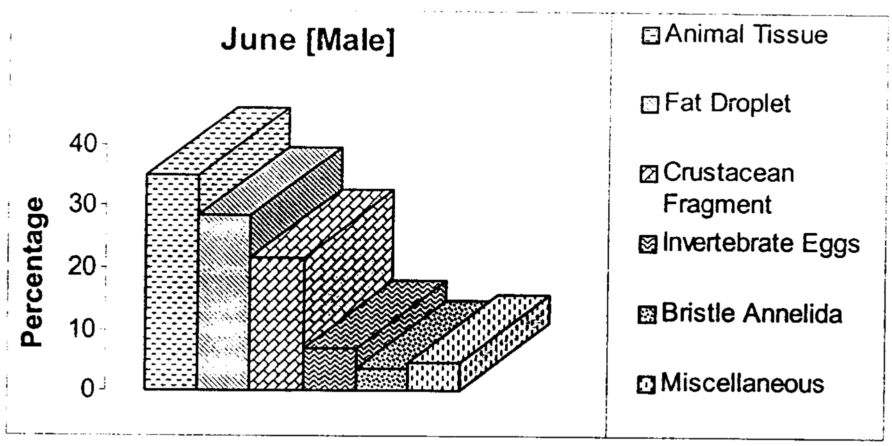
d



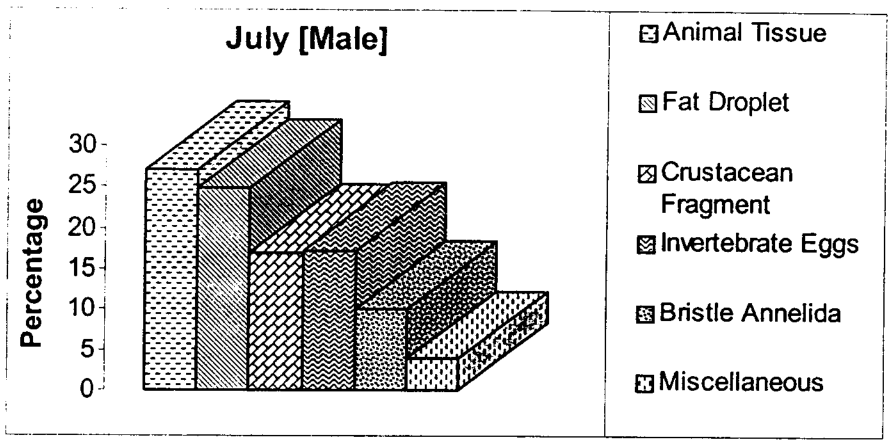
e


May [Male]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

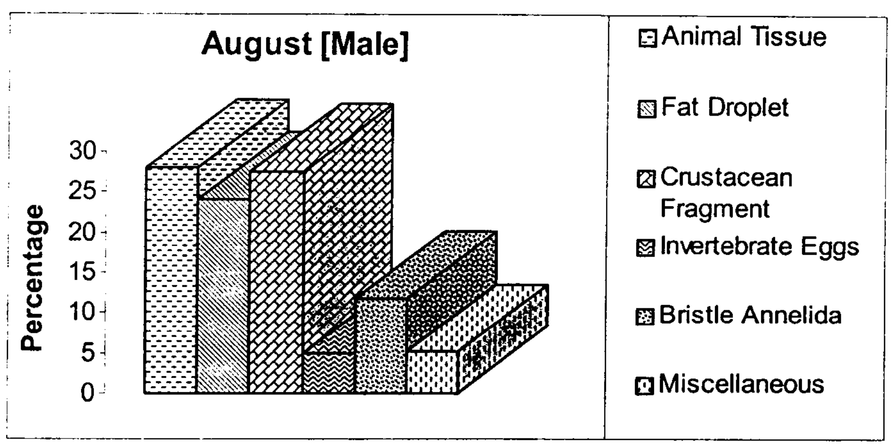
f


June [Male]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

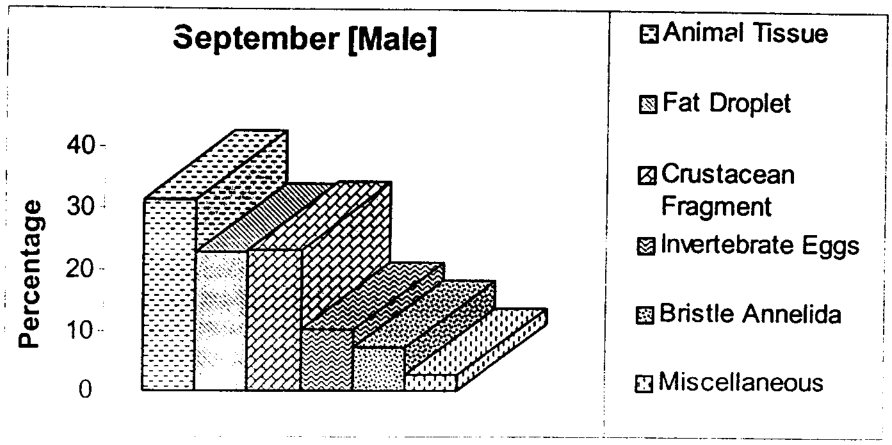
g


July [Male]
Percentage
0
5
10
15
20
25
30
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

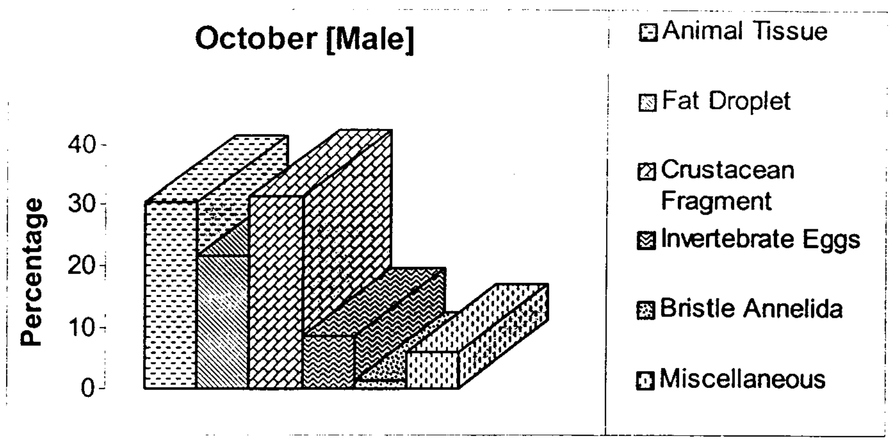
h


August [Male]
Percentage
0
5
10
15
20
25
30
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

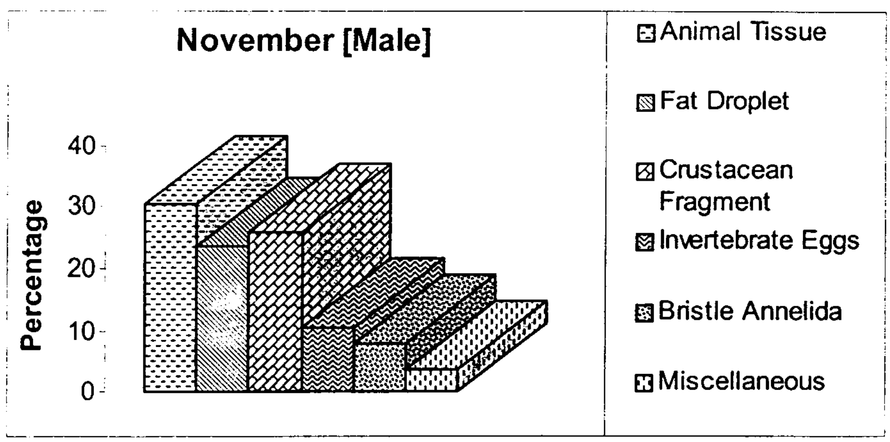
i


September [Male]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

j


October [Male]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

k


November [Male]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

l

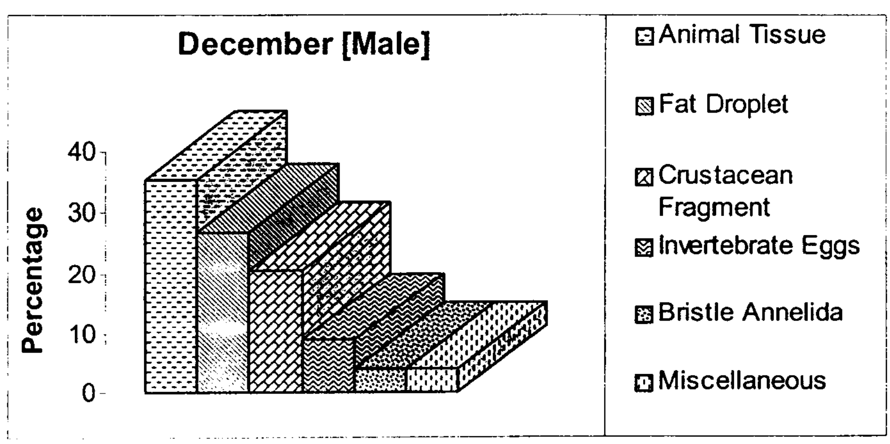
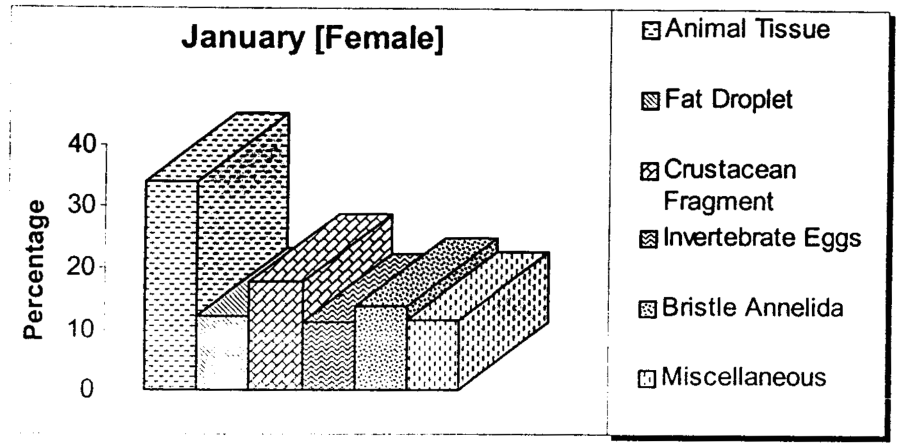
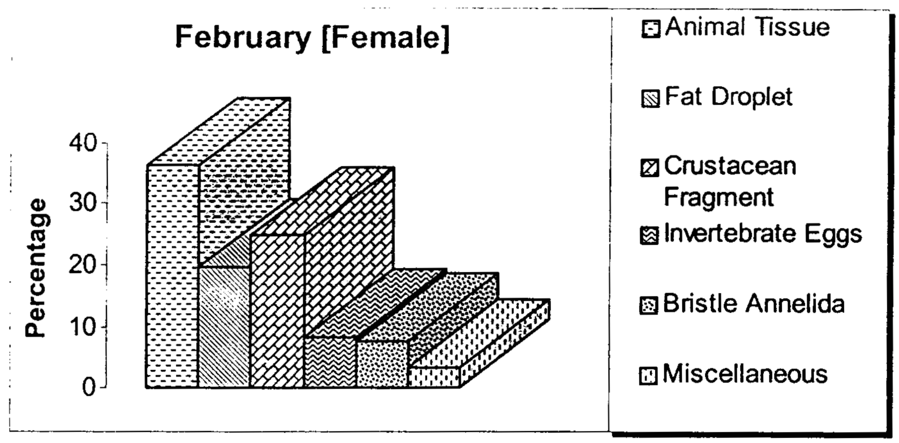

December [Male]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

Fig. 3.15 (a – l): Monthly average % composition of various food items in the gut of Female *Pomadasys maculatus* during 1997 & 1998

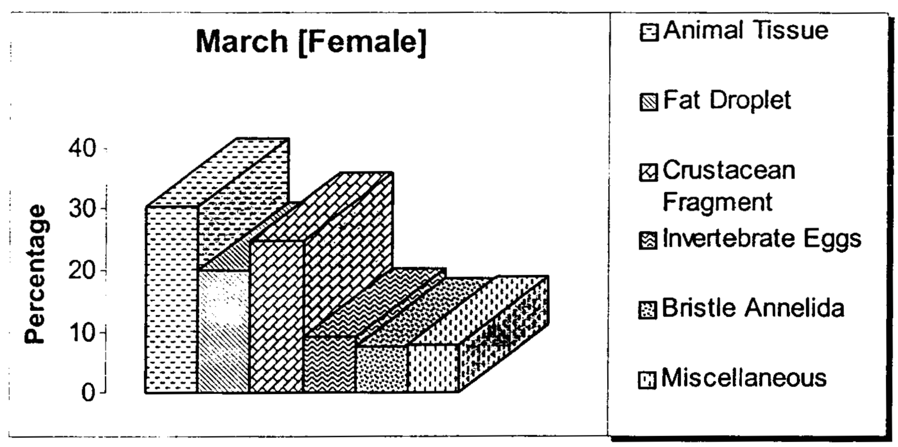
a



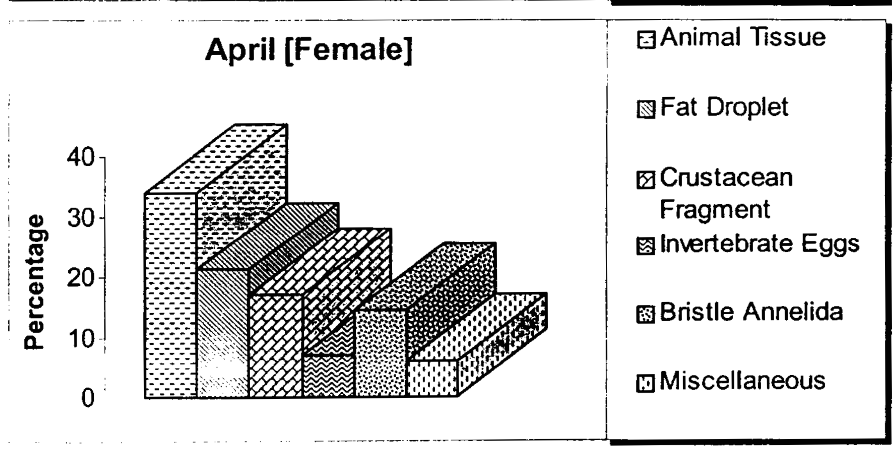
b



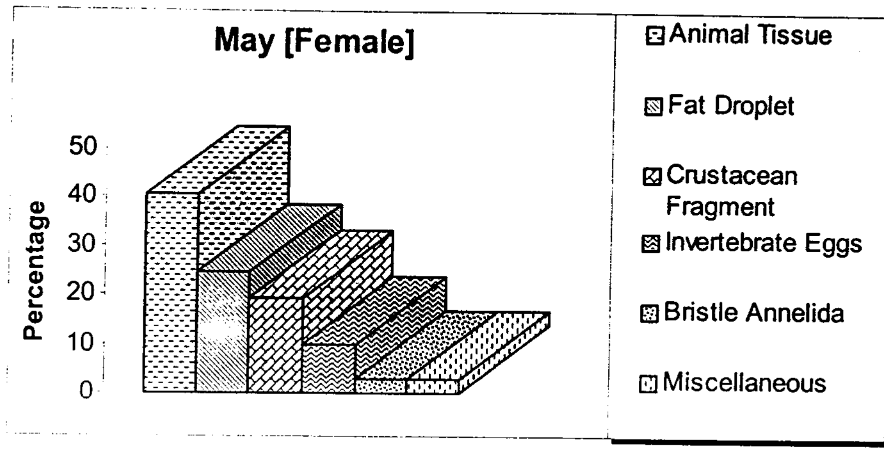
c



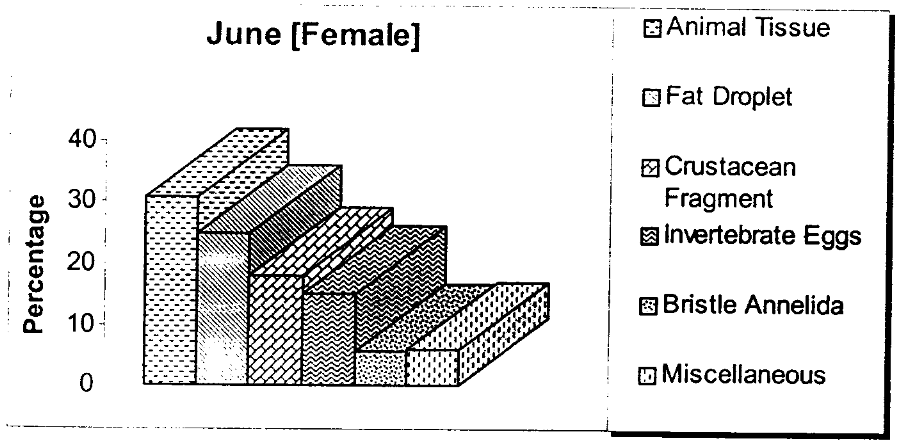
d



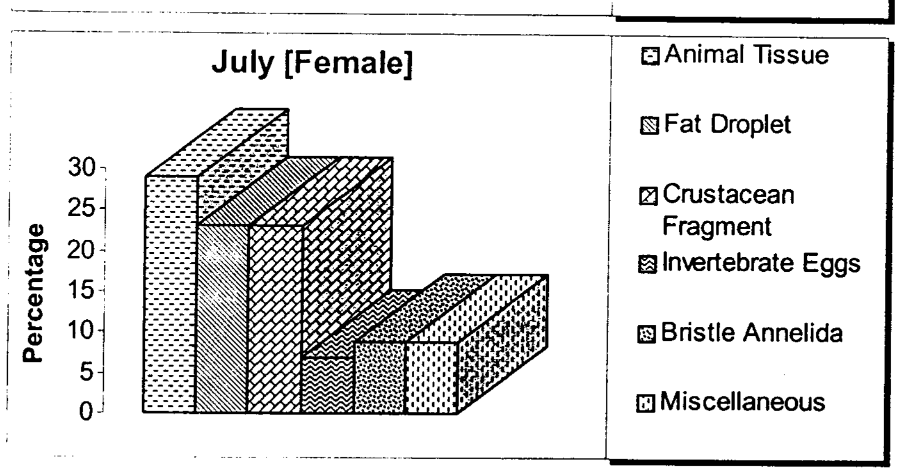
e


May [Female]
Percentage
50
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

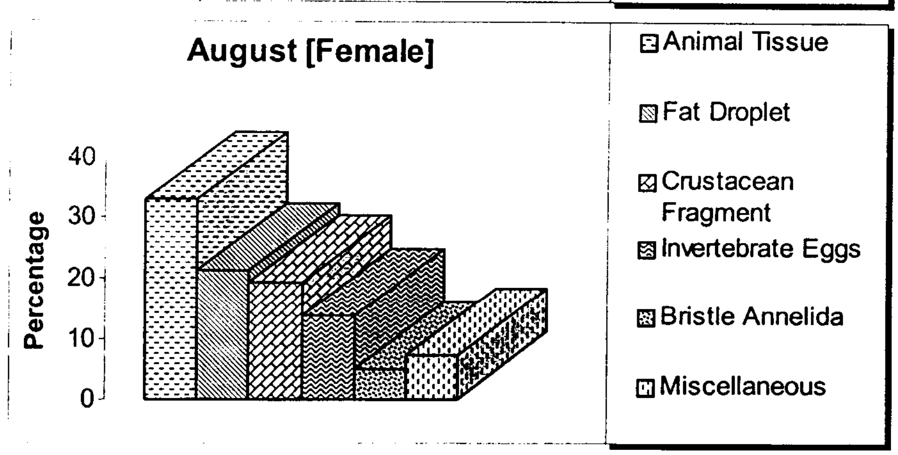
f


June [Female]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

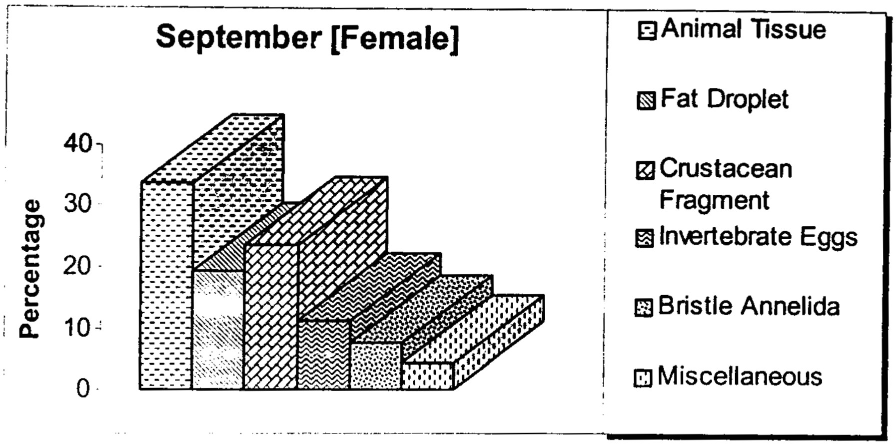
g


July [Female]
Percentage
30
25
20
15
10
5
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

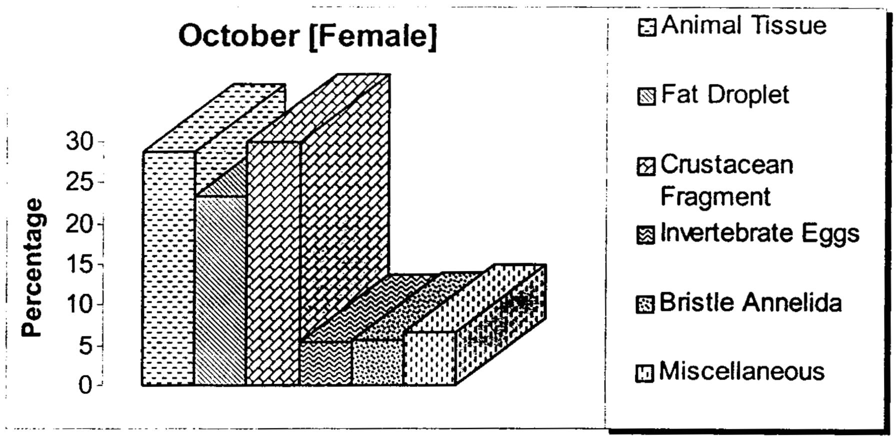
h


August [Female]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

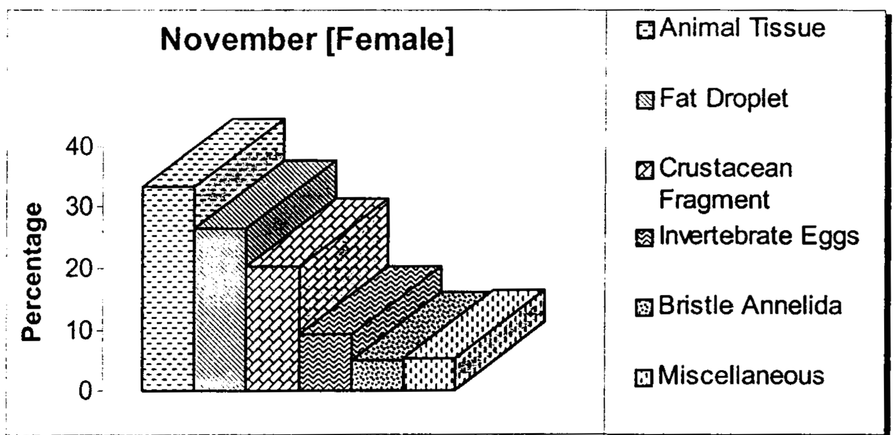
i


September [Female]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

j


October [Female]
Percentage
30
25
20
15
10
5
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

k


November [Female]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

l

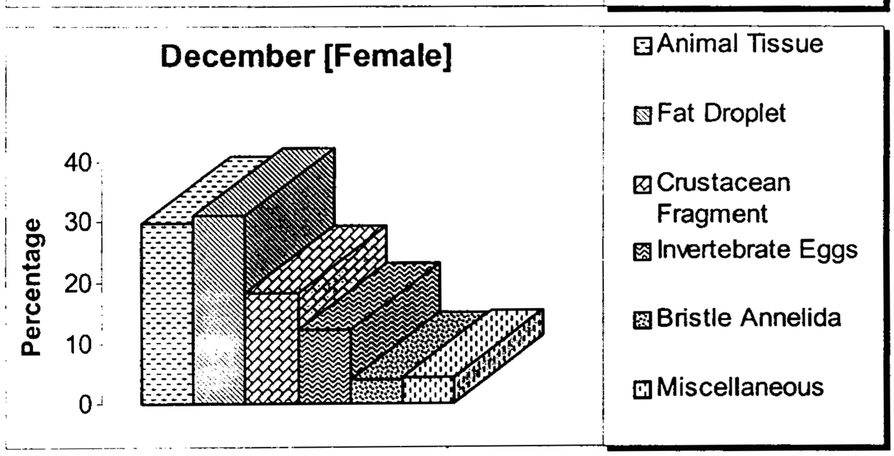

December [Female]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

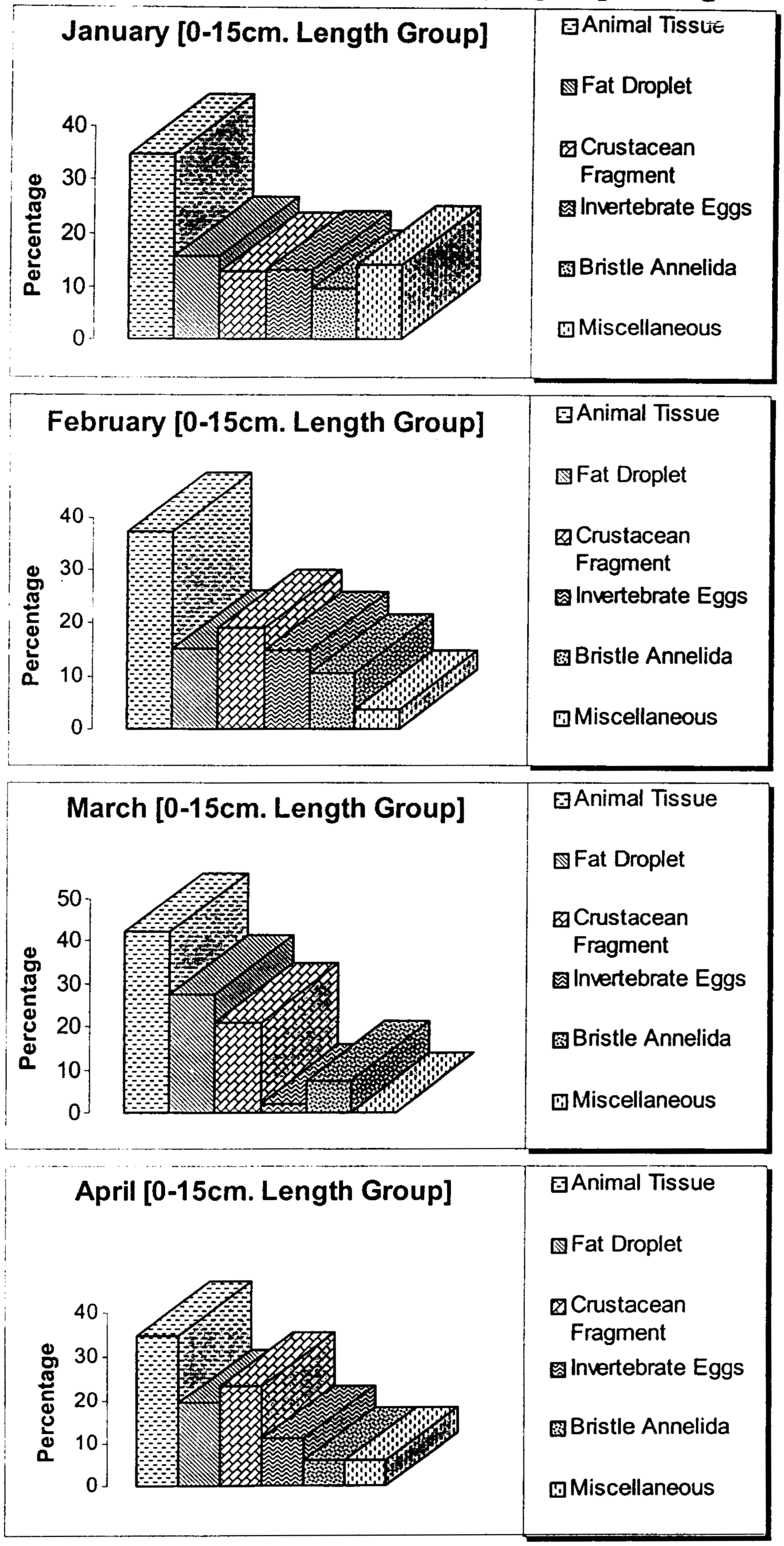
Fig. 3.16 (a – l): Average % composition of various food items in the gut of *Pomadasys maculatus* 0-15 cm length group during 1997 & 98

a

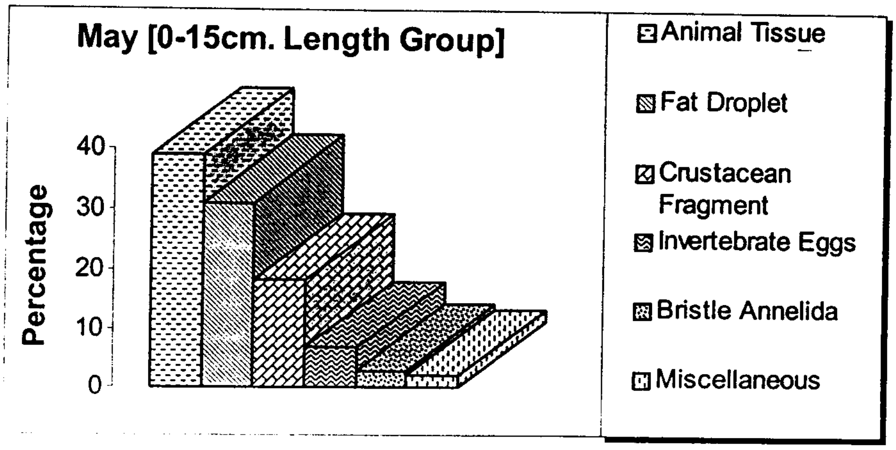
b

c

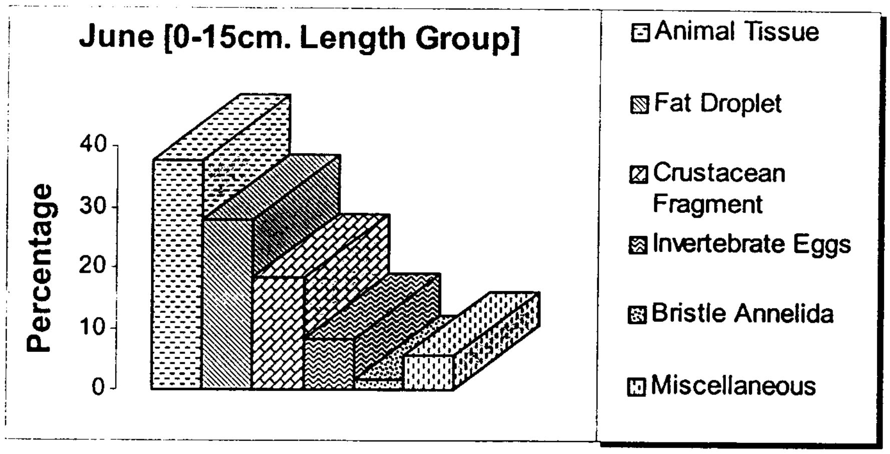
d



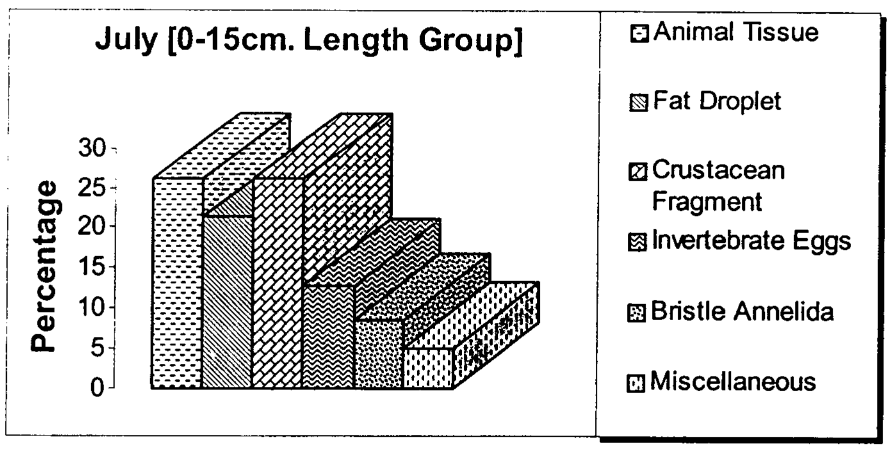
e


May [0-15cm. Length Group]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

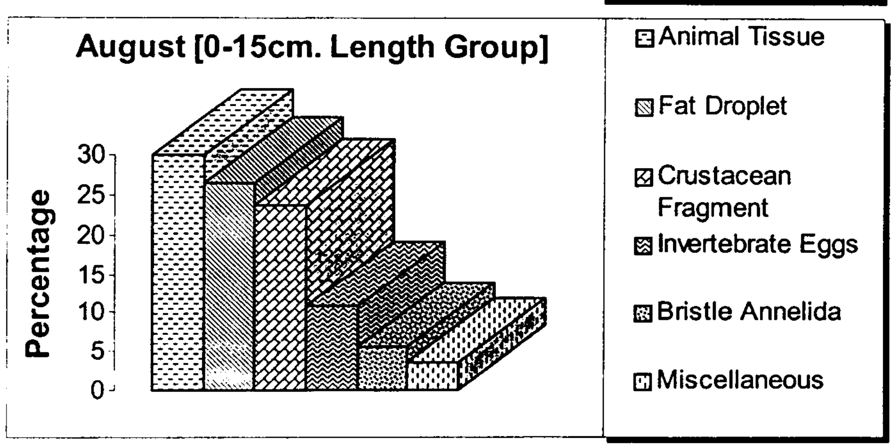
f

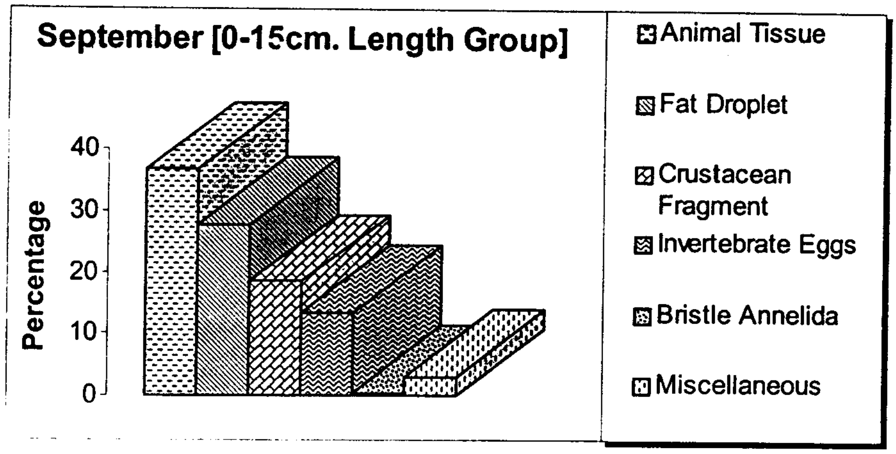

June [0-15cm. Length Group]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

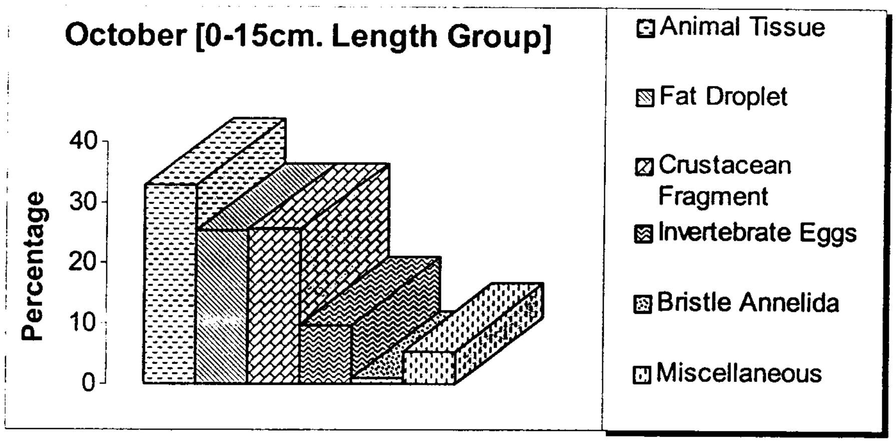
g

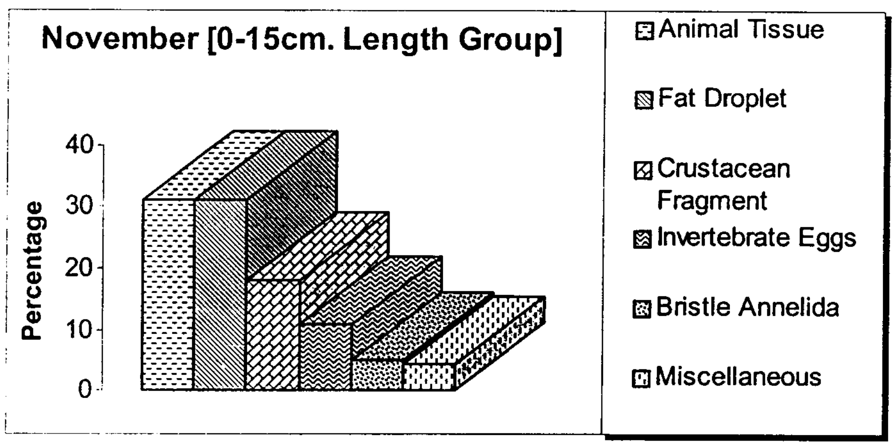

July [0-15cm. Length Group]
Percentage
0
5
10
15
20
25
30
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

h


August [0-15cm. Length Group]
Percentage
0
5
10
15
20
25
30
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

i 
September [0-15cm. Length Group]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

j 
October [0-15cm. Length Group]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

k 
November [0-15cm. Length Group]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

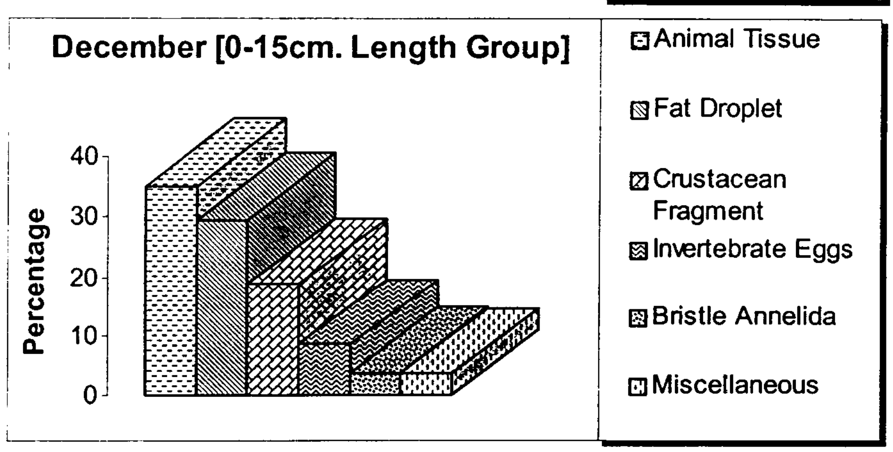
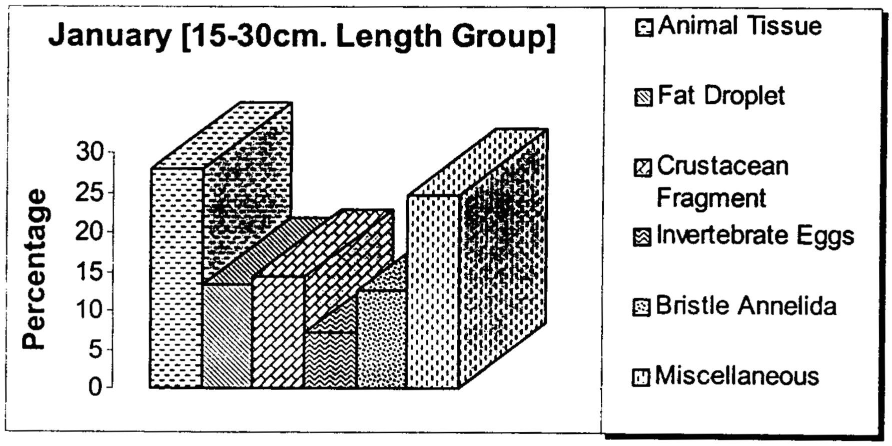
l 
December [0-15cm. Length Group]
Percentage
40
30
20
10
0
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

Fig. 3.17 (a – l): Monthly average % composition of various food items in the gut of 15-30 cm length group of *Pomadasys maculatus* during 1997 & 1998

a



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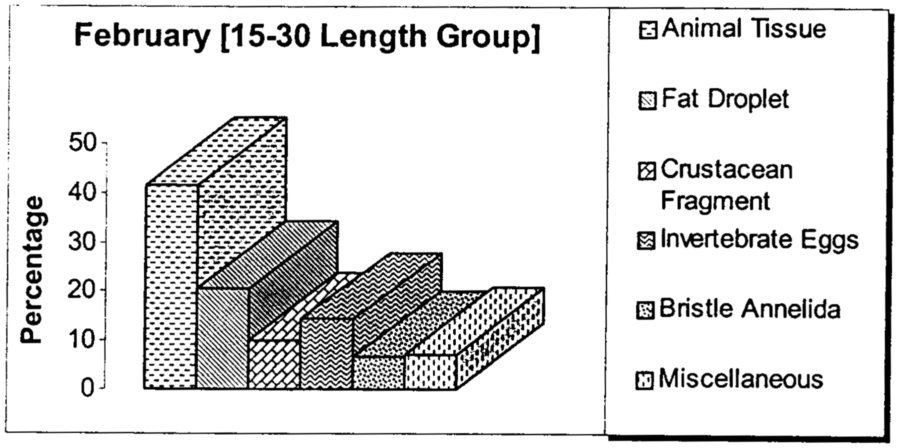

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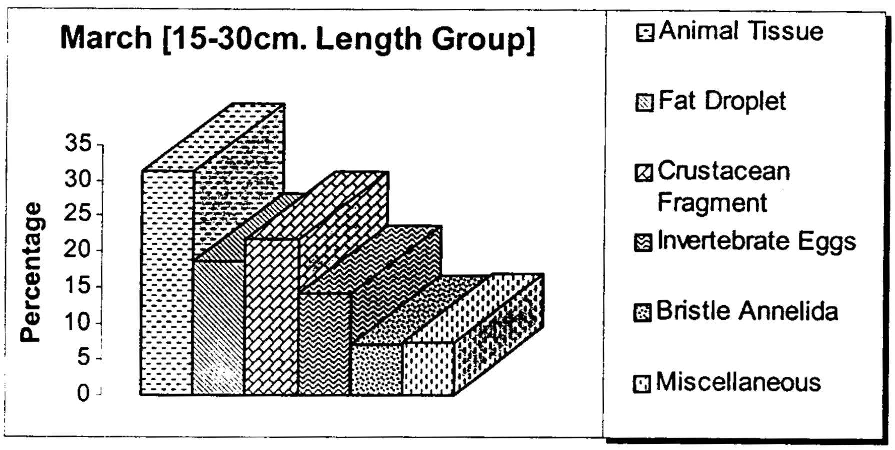
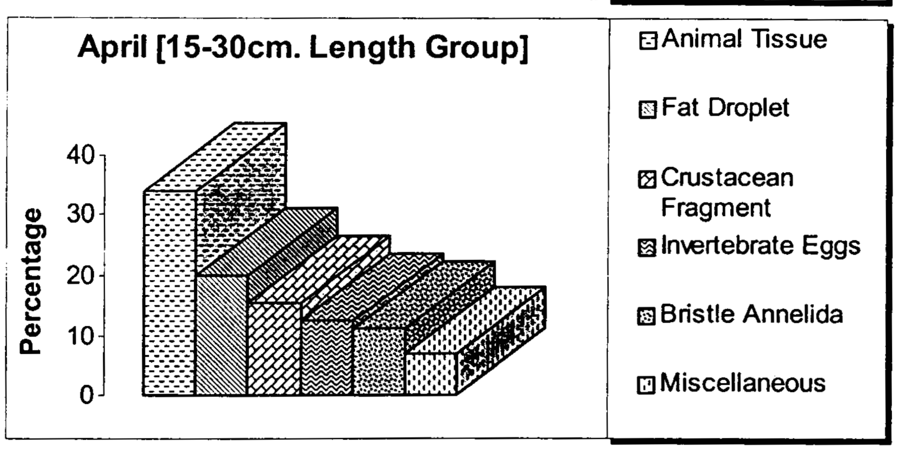


d



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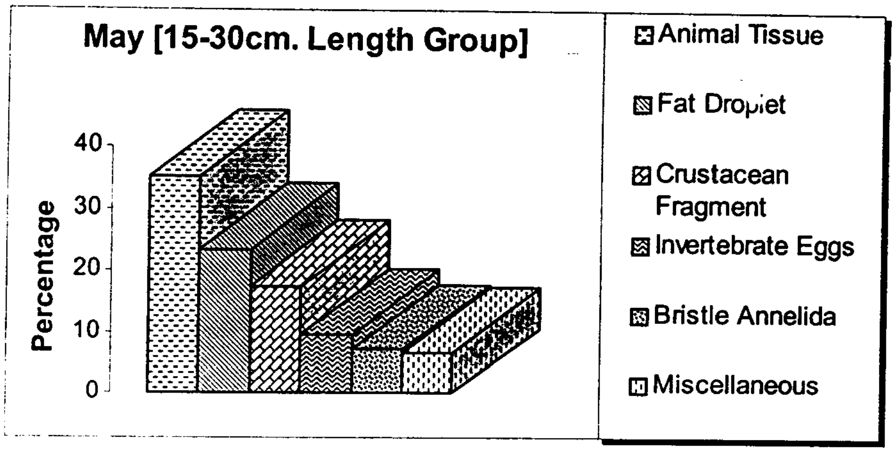
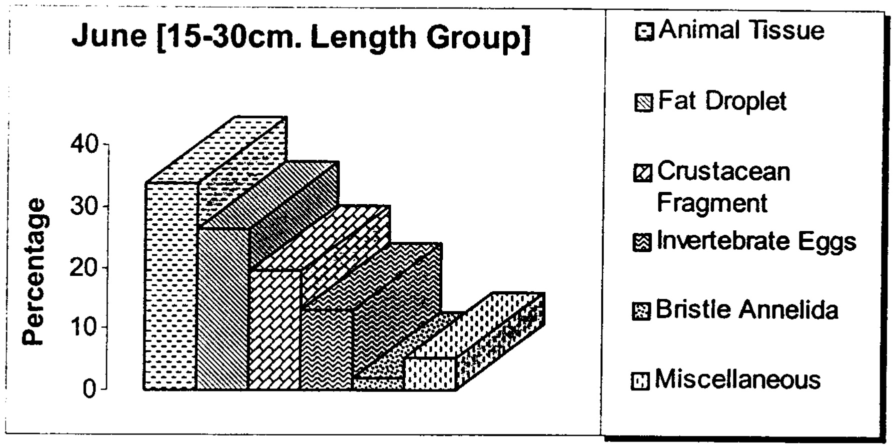
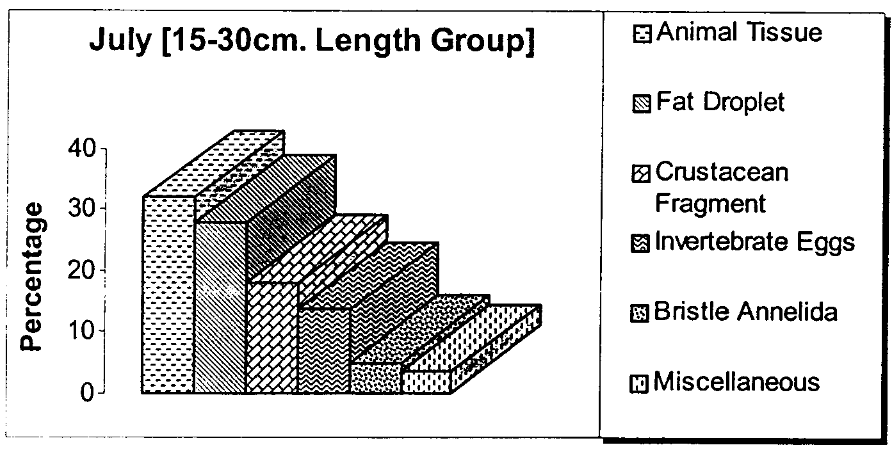

May [15-30cm. Length Group]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

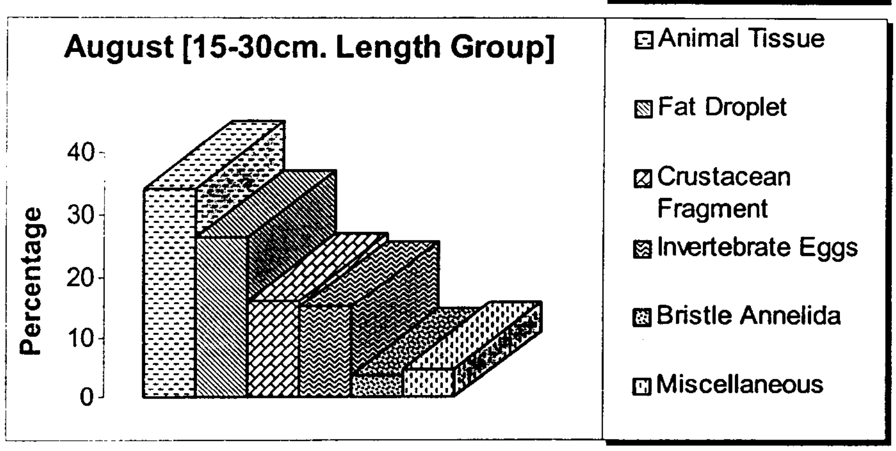
f


June [15-30cm. Length Group]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

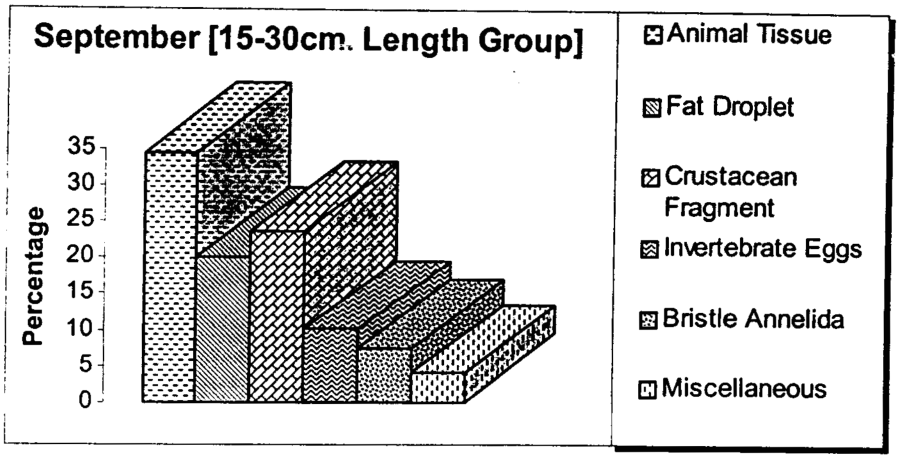
g


July [15-30cm. Length Group]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

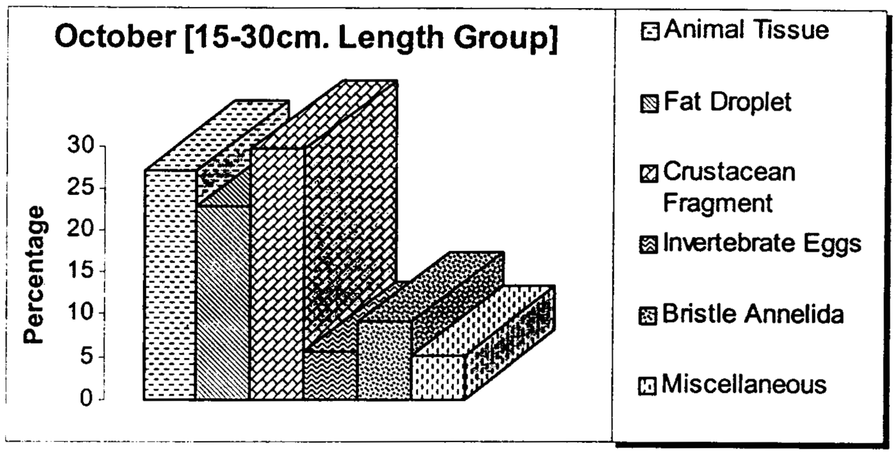
h


August [15-30cm. Length Group]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

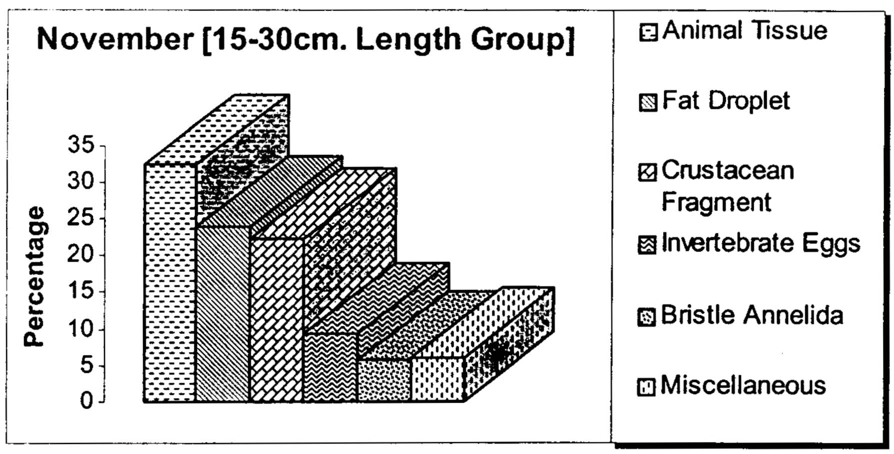
i


September [15-30cm. Length Group]
Percentage
0
5
10
15
20
25
30
35
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

j


October [15-30cm. Length Group]
Percentage
0
5
10
15
20
25
30
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

k


November [15-30cm. Length Group]
Percentage
0
5
10
15
20
25
30
35
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

l

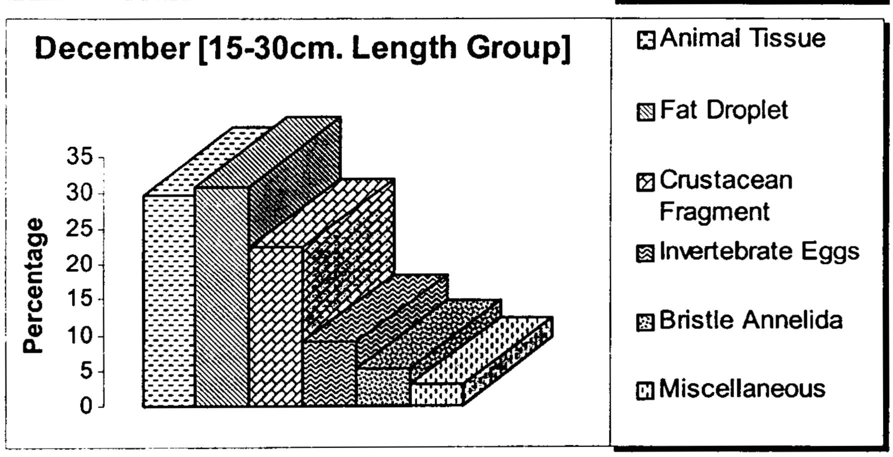
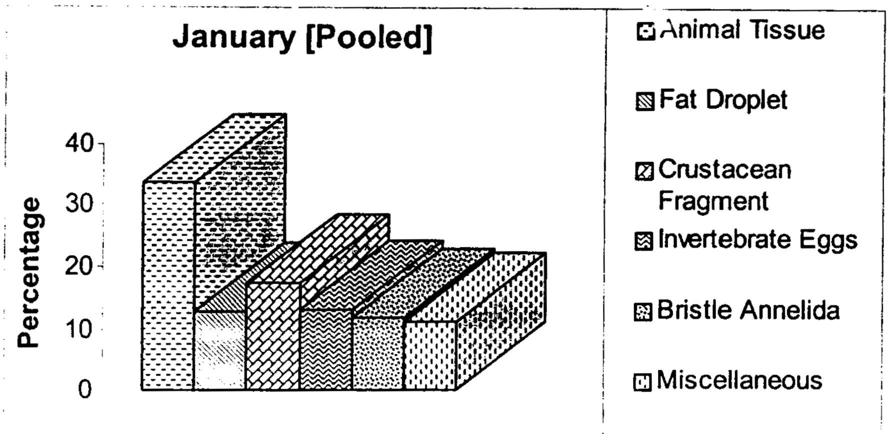
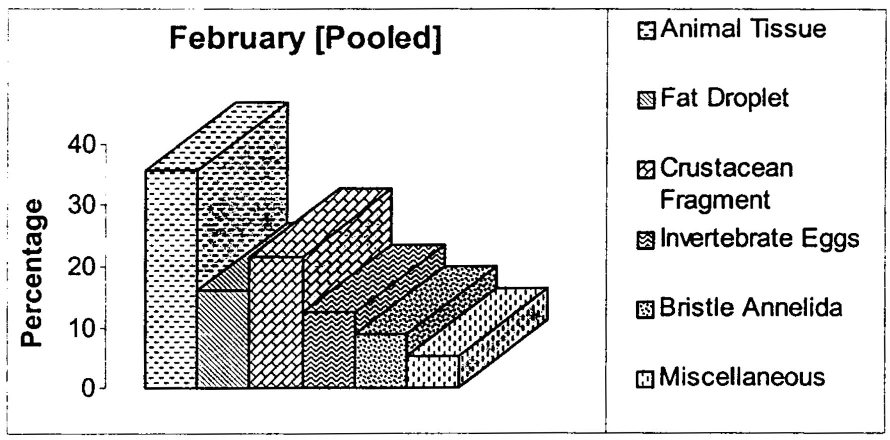

December [15-30cm. Length Group]
Percentage
0
5
10
15
20
25
30
35
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

Fig. 3.18 (a – l): Monthly overall average % composition of each food items in the gut of total *Pomadasys maculatus* during 1997 & 1998

a



b



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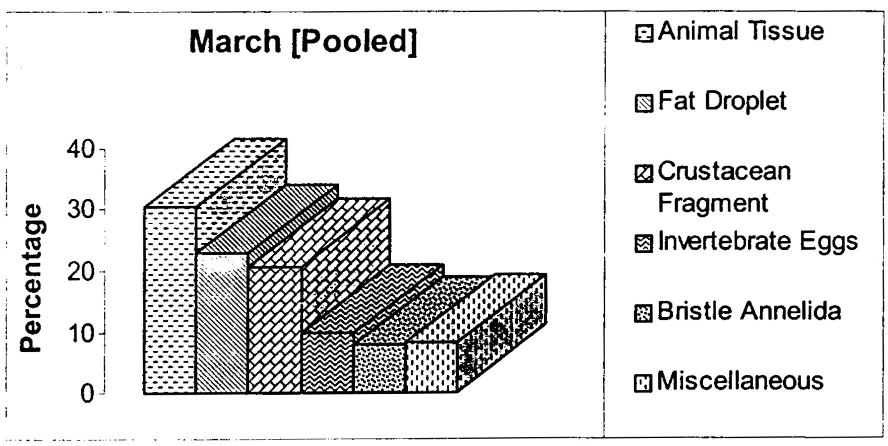

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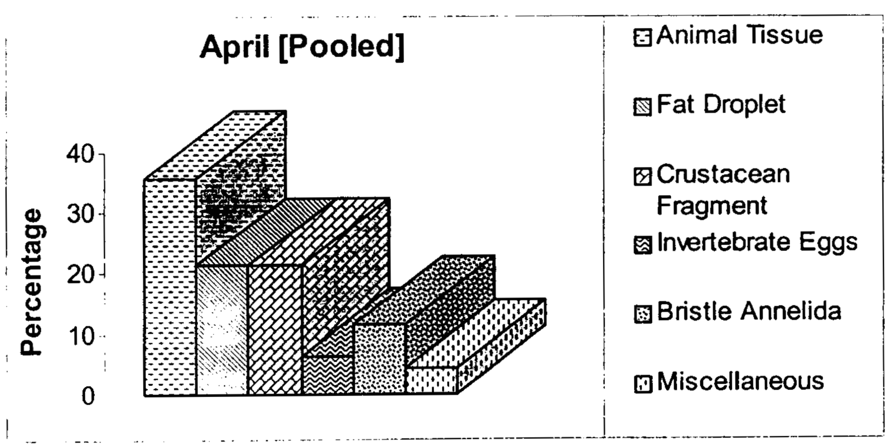
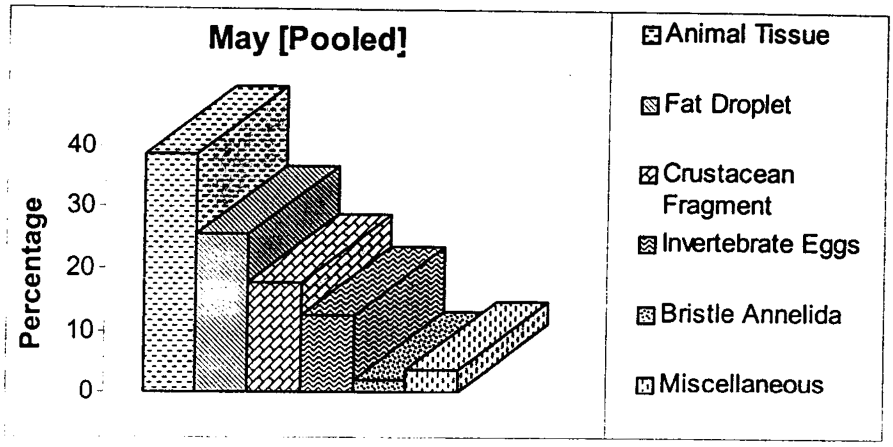
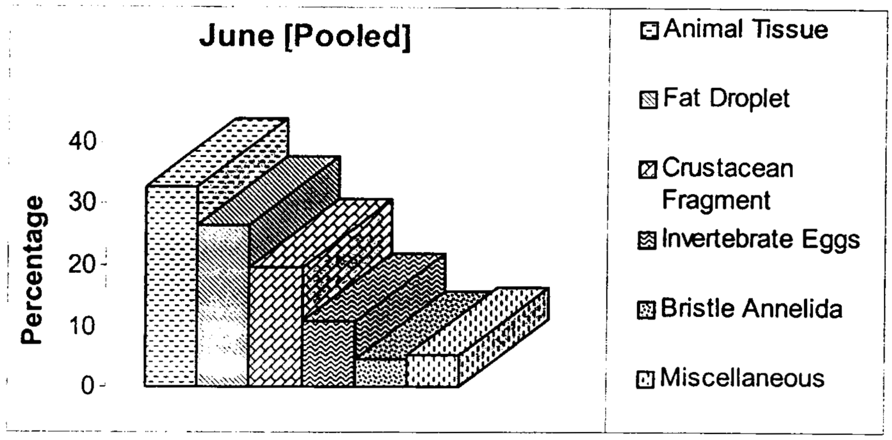


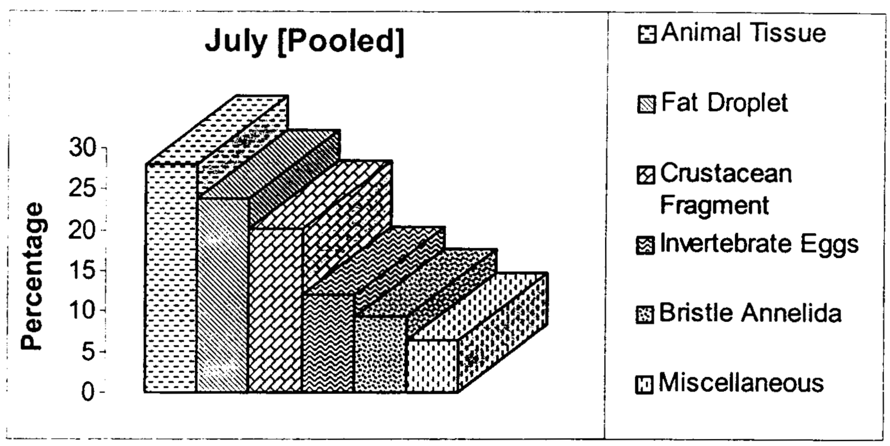
e


May [Pooled]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

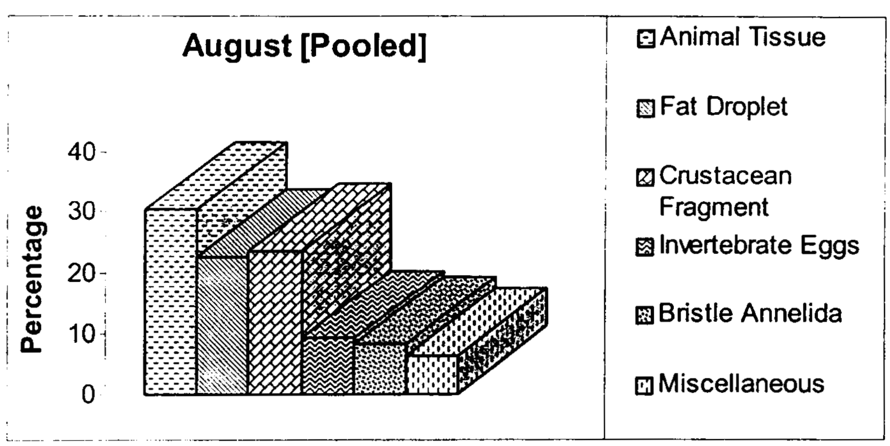
f


June [Pooled]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

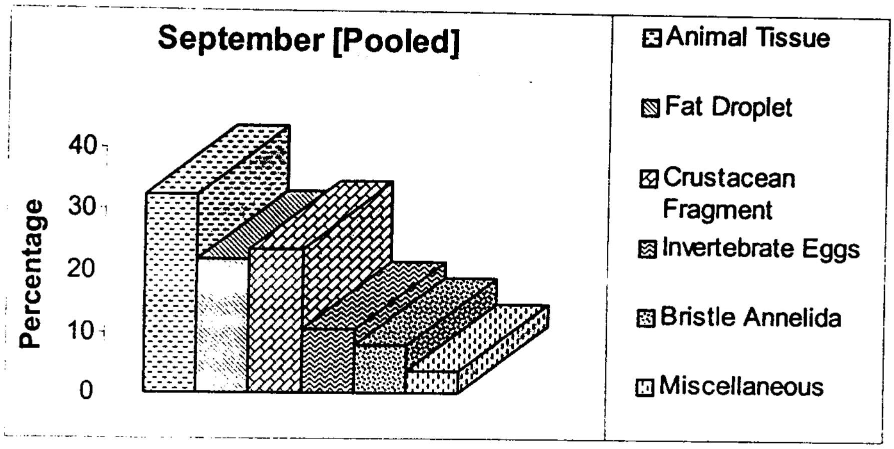
g


July [Pooled]
Percentage
0
5
10
15
20
25
30
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

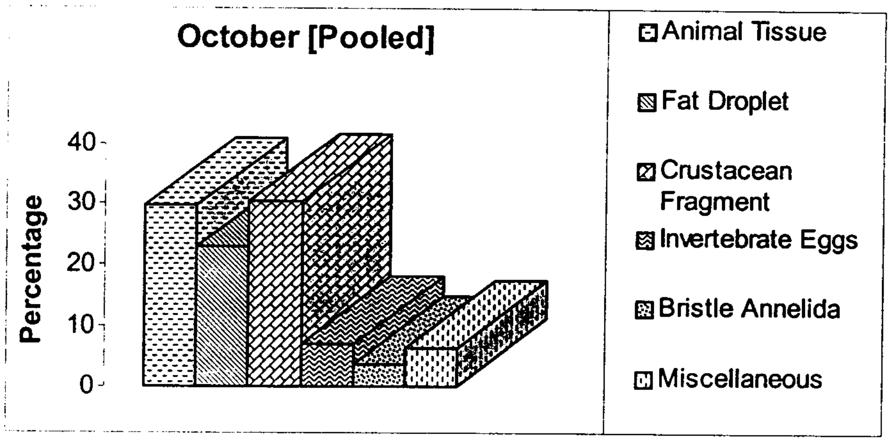
h


August [Pooled]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

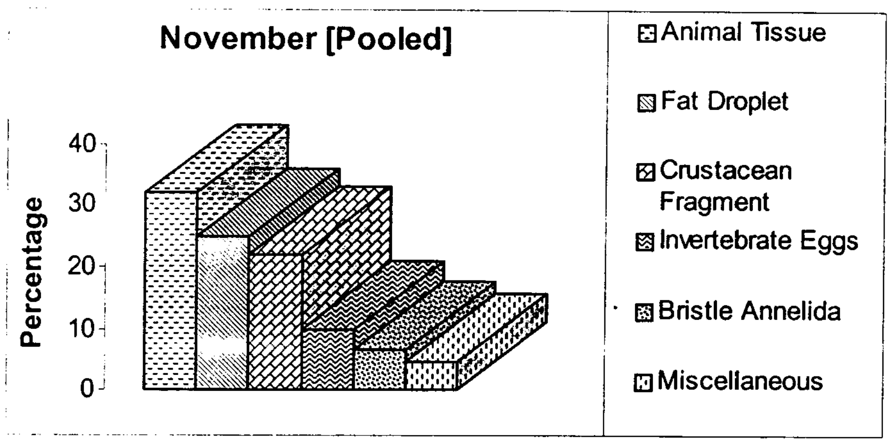
i


September [Pooled]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

j


October [Pooled]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

k


November [Pooled]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

l

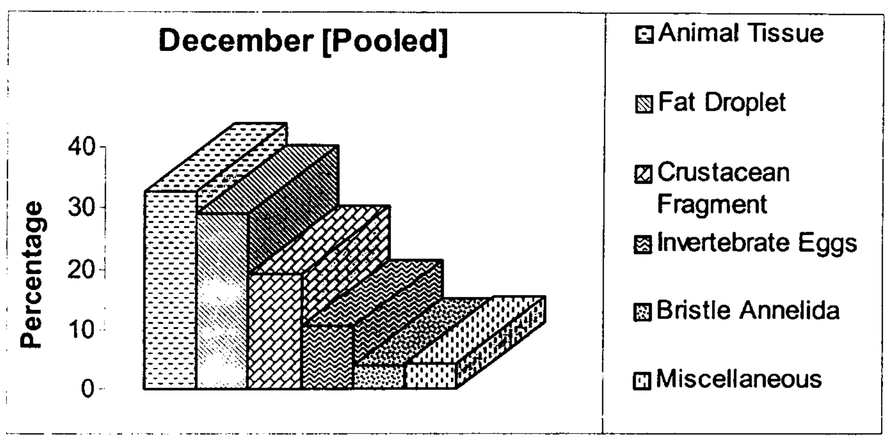
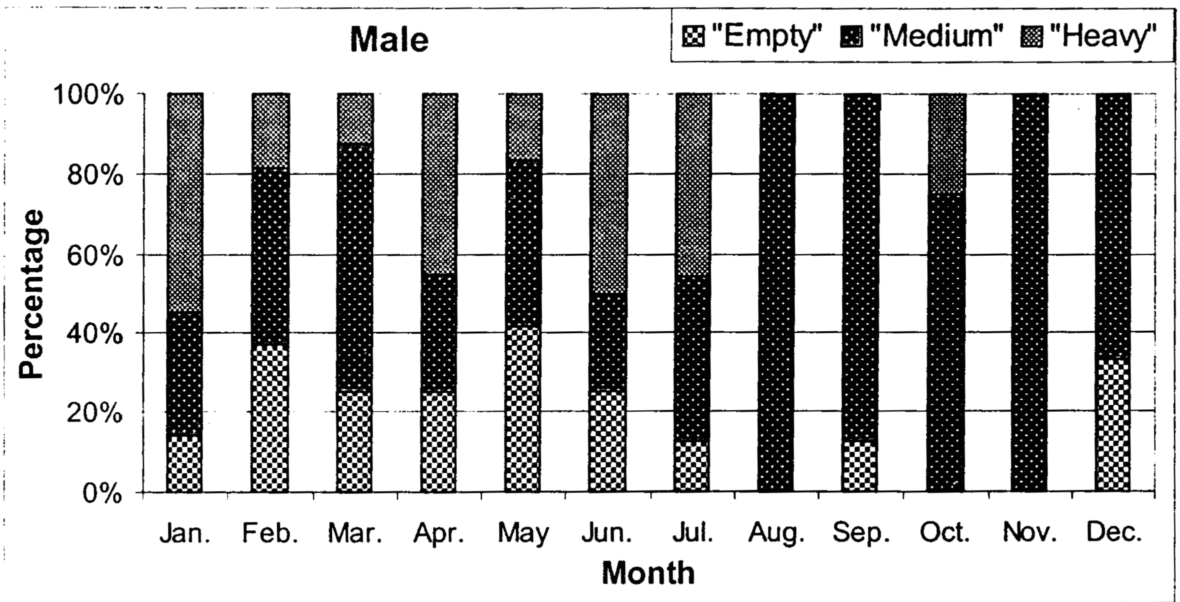
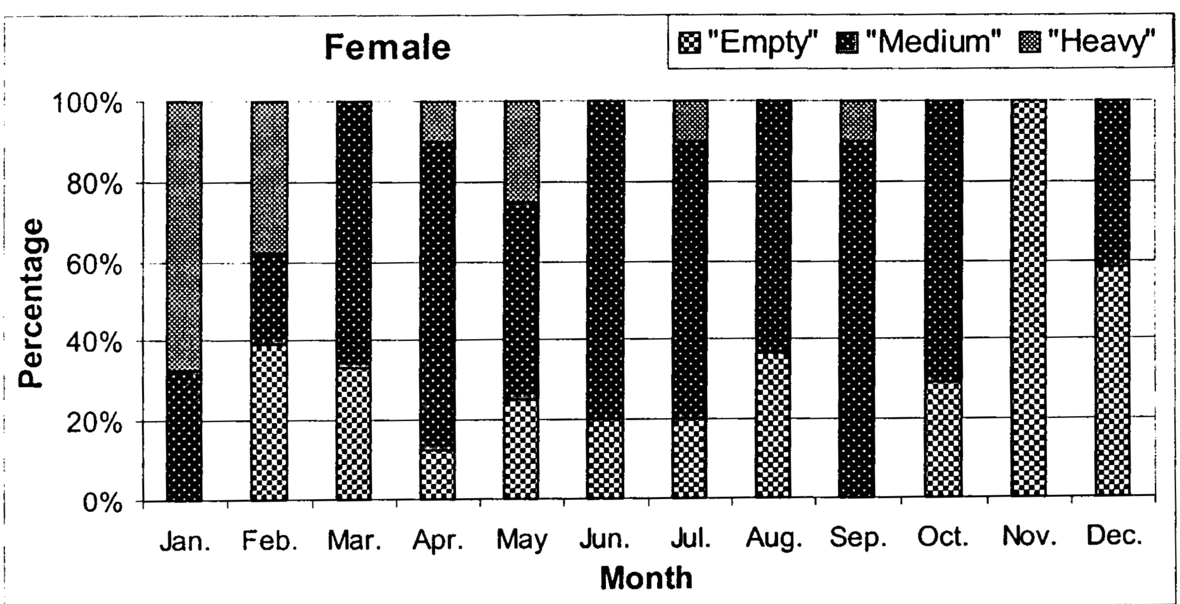

December [Pooled]
Percentage
0
10
20
30
40
Animal Tissue
Fat Droplet
Crustacean Fragment
Invertebrate Eggs
Bristle Annelida
Miscellaneous

Fig. 3.19 (a-e): Feeding intensity of *Priacanthus hamrur* monthly average percentage of various type of stomachs during 1997 & 1998

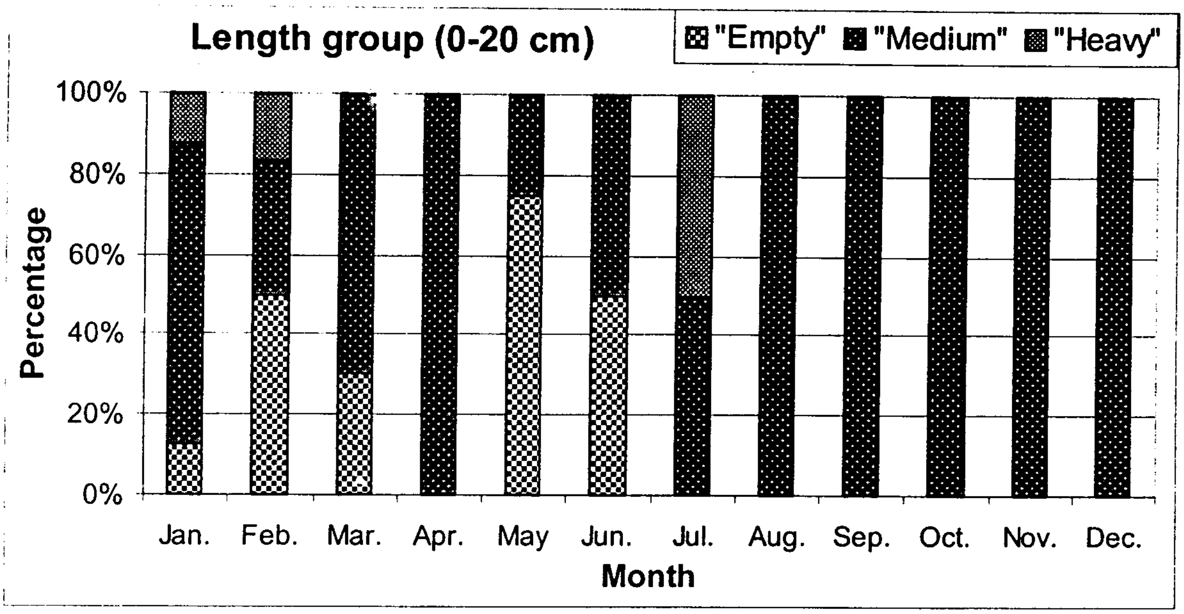
(a)



(b)

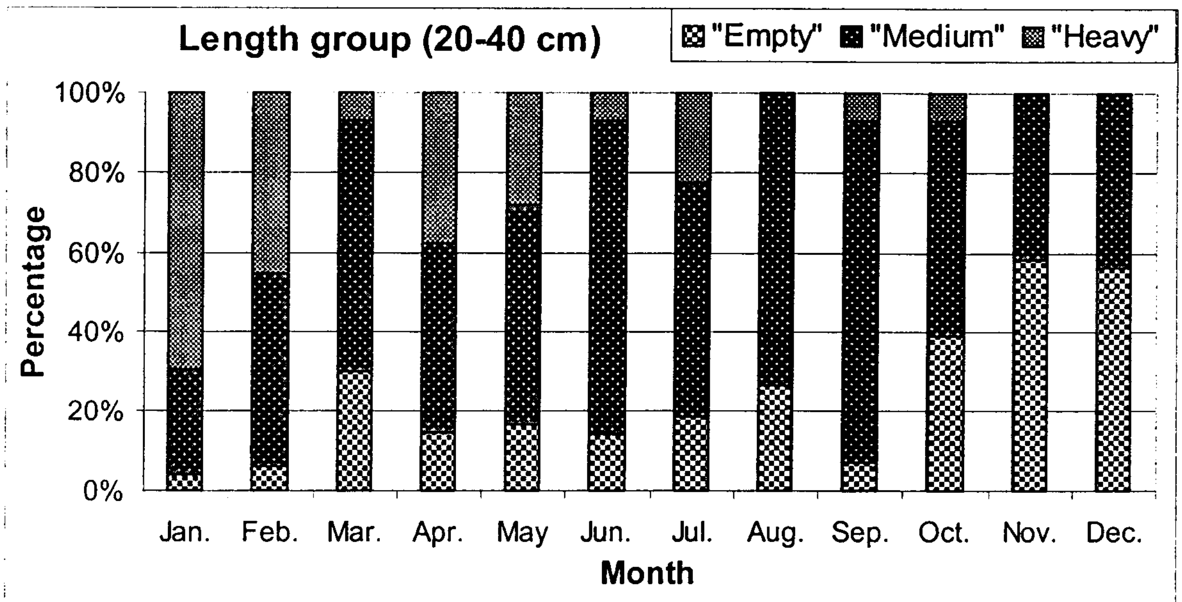


(c)



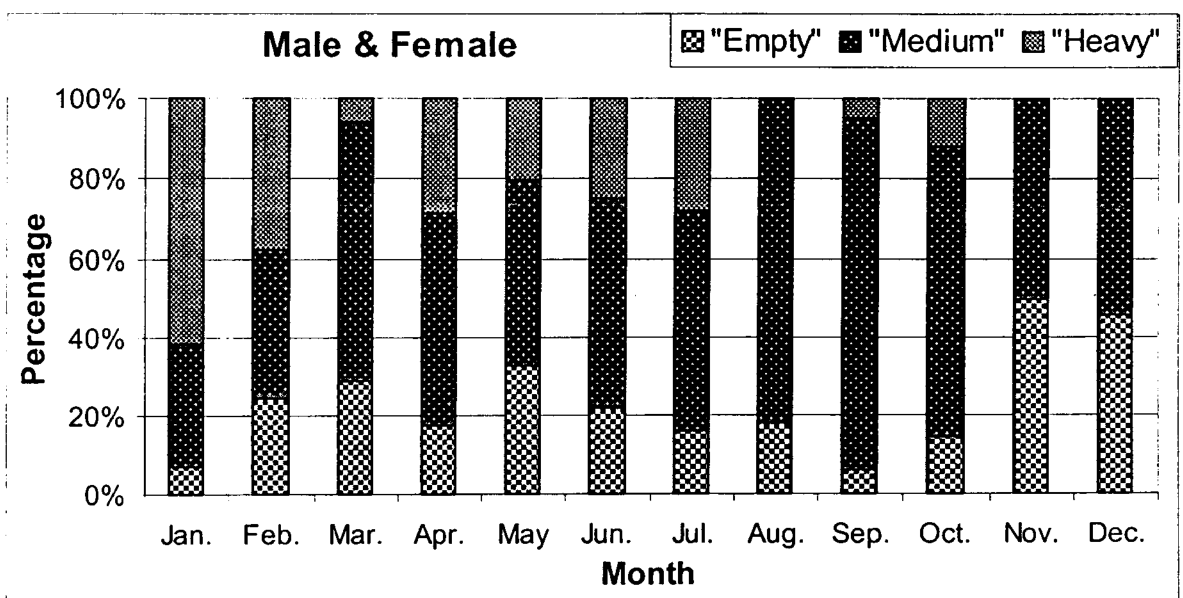
Length group (0-20 cm)
"Empty" "Medium" "Heavy"
100%
80%
60%
40%
20%
0%
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

(d)



Length group (20-40 cm)
"Empty" "Medium" "Heavy"
100%
80%
60%
40%
20%
0%
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

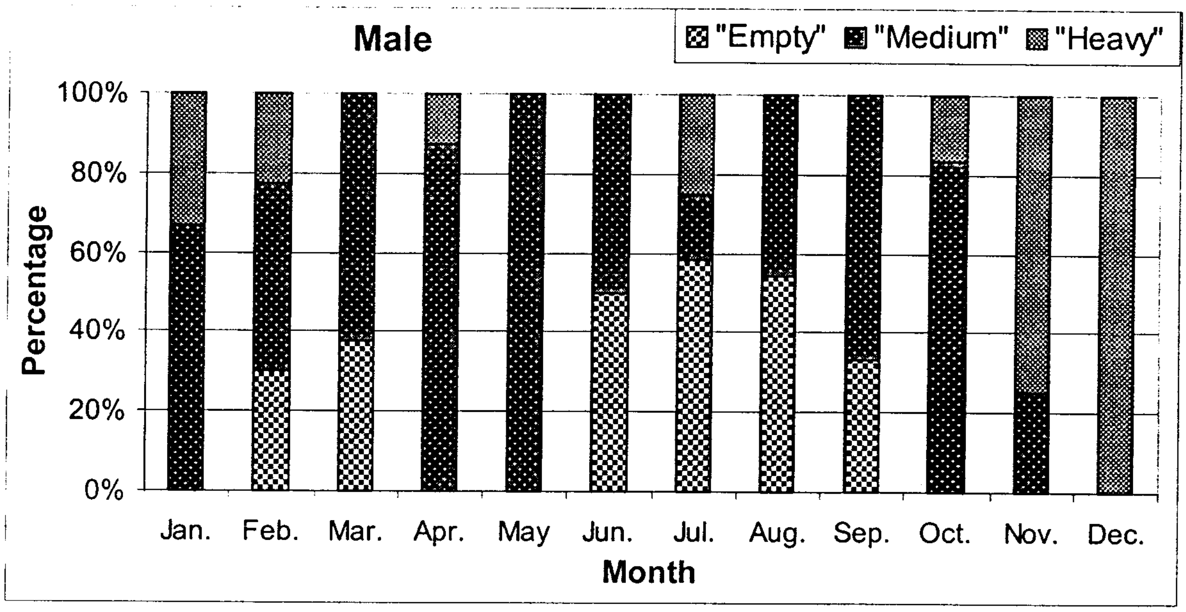
(e)



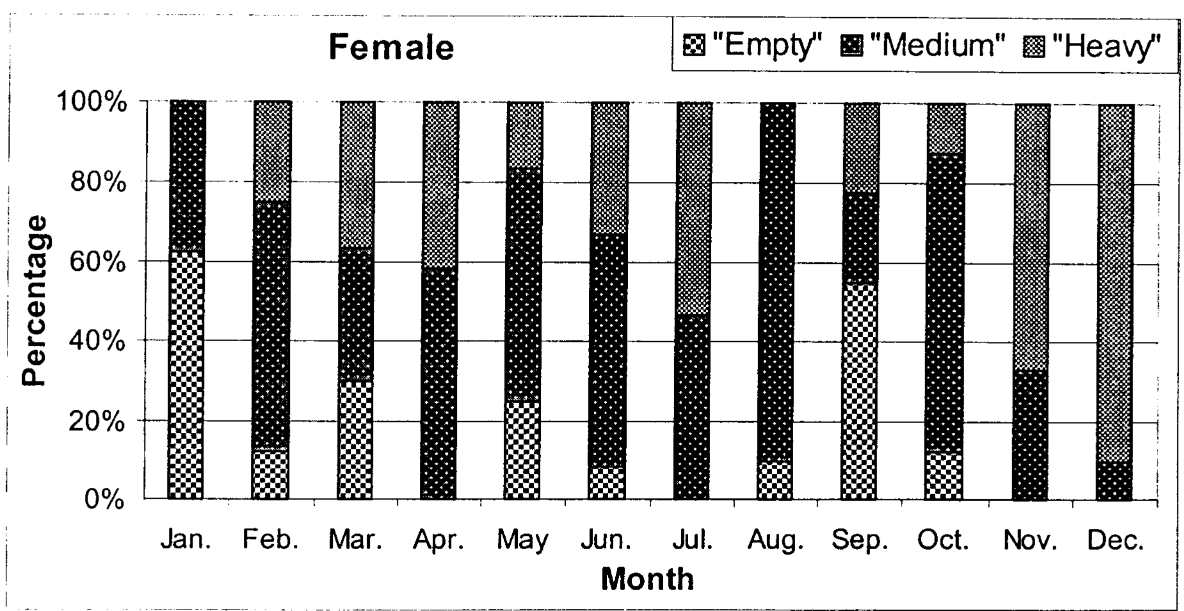
Male & Female
"Empty" "Medium" "Heavy"
100%
80%
60%
40%
20%
0%
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

Fig. 3.20 (a-e): Feeding intensity of *Pomadasys maculatus* monthly average percentage of various type of stomachs during 1997 & 1998

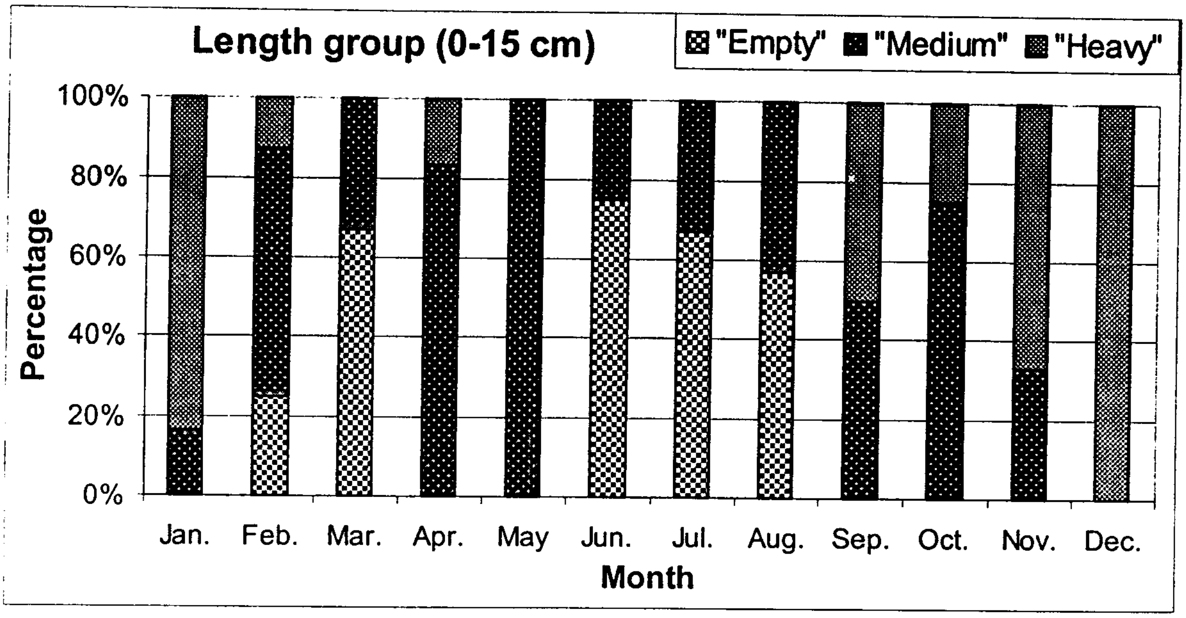
(a)



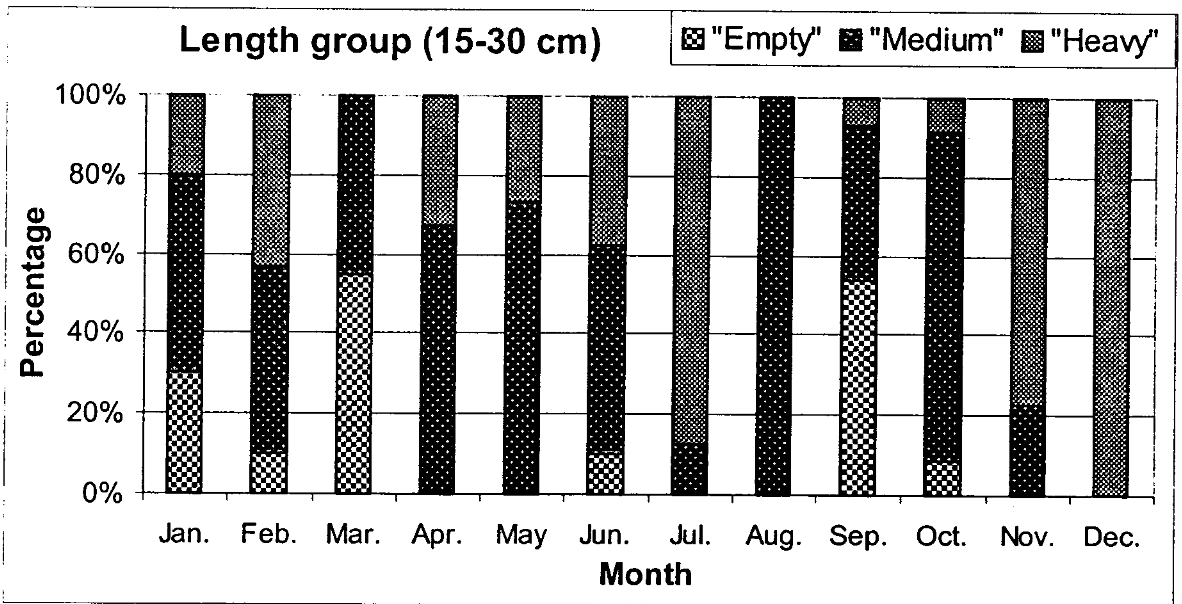
(b)



(c)


Length group (0-15 cm)
"Empty" "Medium" "Heavy"
100%
80%
60%
40%
20%
0%
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

(d)


Length group (15-30 cm)
"Empty" "Medium" "Heavy"
100%
80%
60%
40%
20%
0%
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

(e)

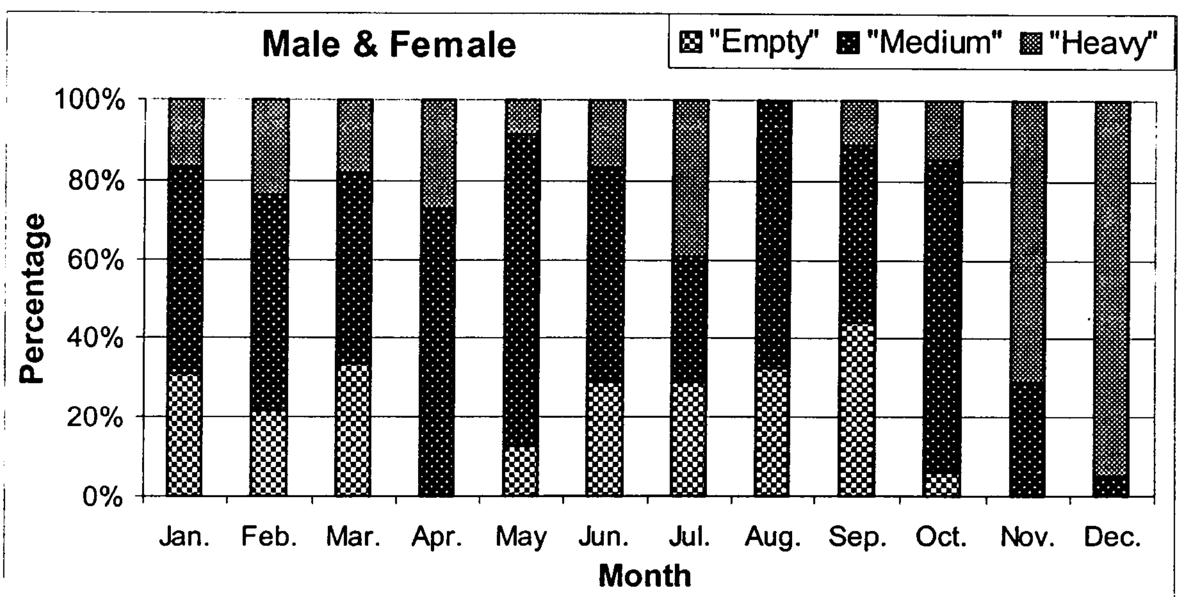

Male & Female
"Empty" "Medium" "Heavy"
100%
80%
60%
40%
20%
0%
Percentage
Jan. Feb. Mar. Apr. May Jun. Jul. Aug. Sep. Oct. Nov. Dec.
Month

Fig. 3.25.a: Monthly data of the G.S.I. of Male, Female & Pooled fishes of *Priacanthus hamrur* during 1997

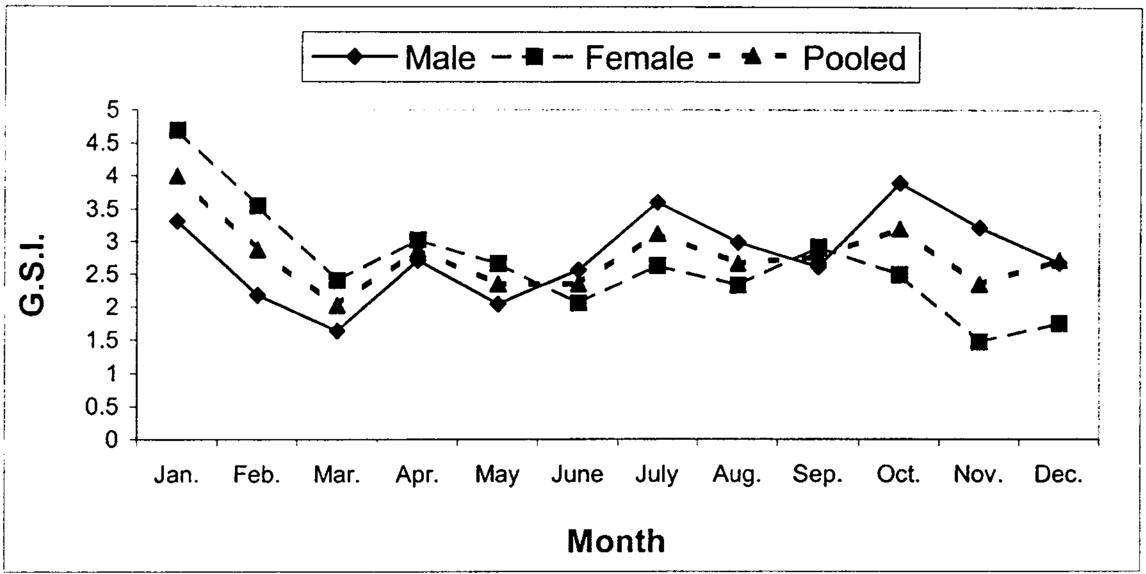


Fig. 3.25.b: Monthly data of the G.S.I. of the Male, Female & Pooled fishes of *Priacanthus hamrur* during 1998

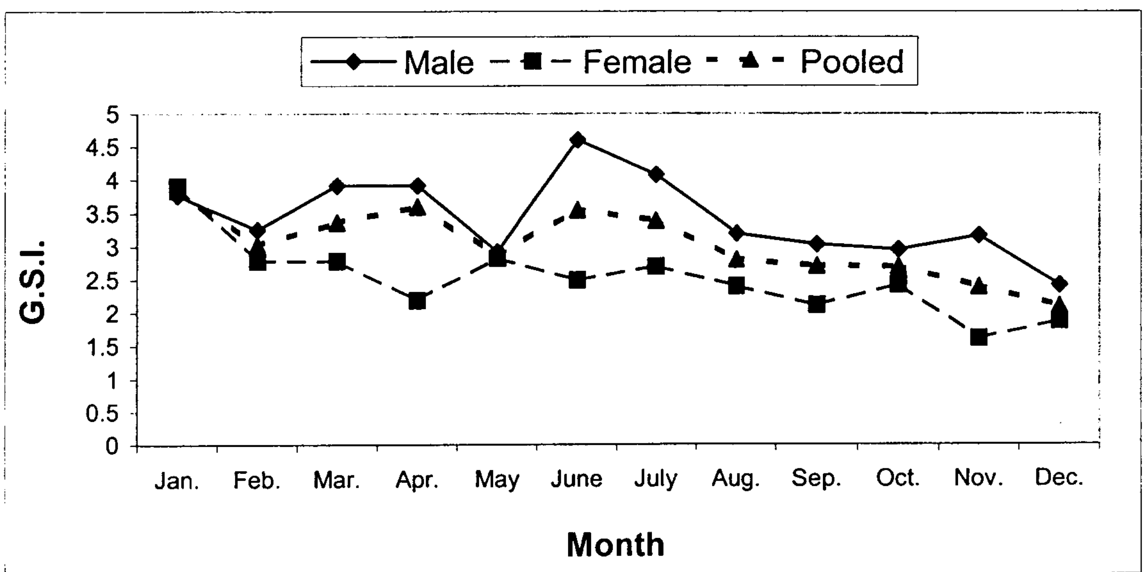


Fig. 3.26.a: Monthly data of the G.S.I. of the Male, Female & Pooled fishes of *Pomadasys maculatus* during 1997

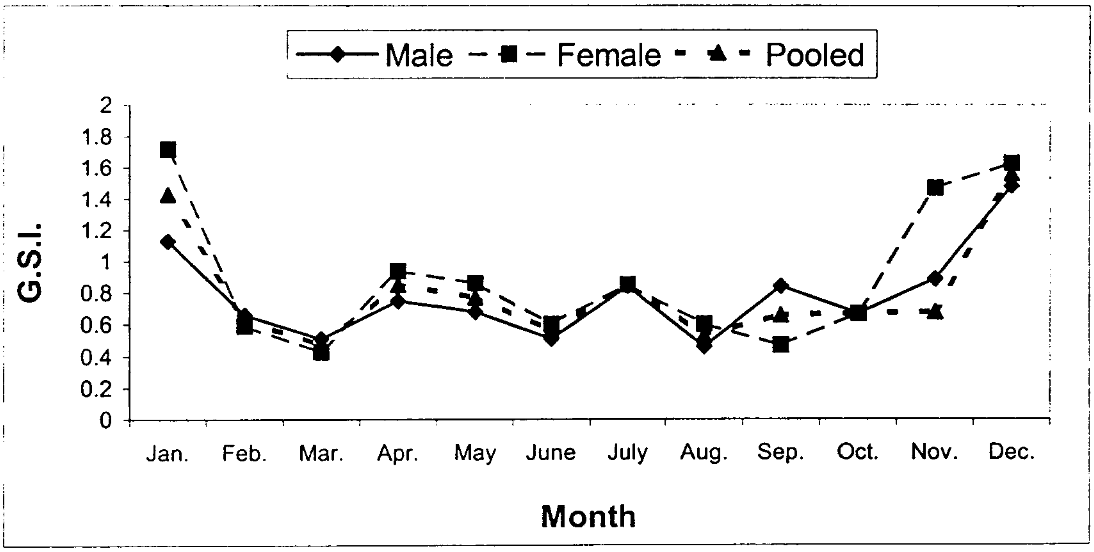
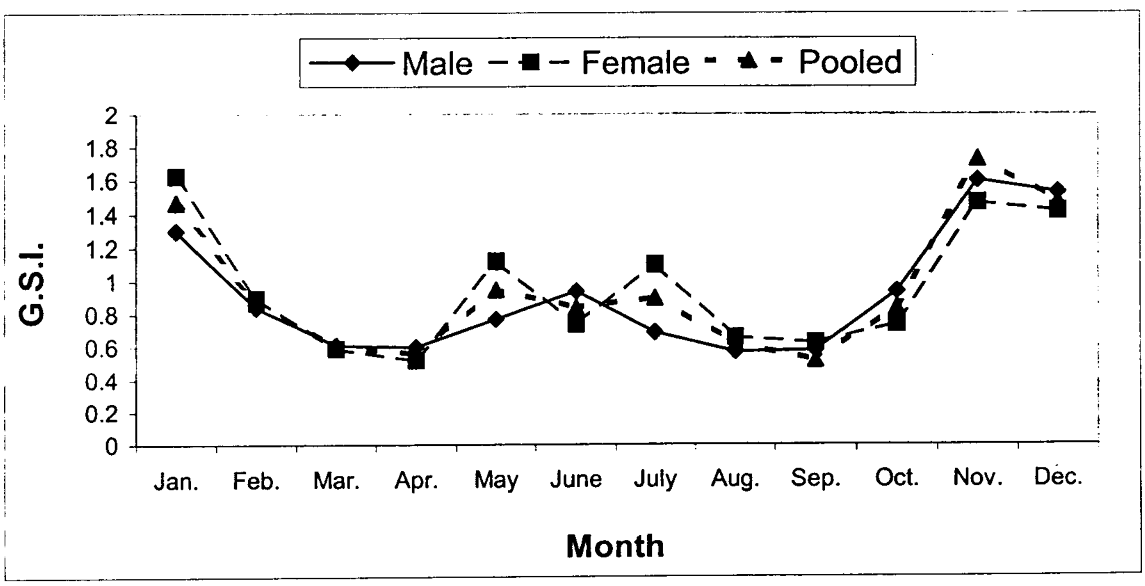


Fig. 3.26.b: Monthly data of the G.S.I. of the Male, Female & Pooled fishes of *Pomadasys maculatus* during 1998



CHAPTER - 4

AGE AND GROWTH

CHAPTER – 4

AGE AND GROWTH

INTRODUCTION

The ability to determine the age of fish is an important tool in fishery biology. Age is the life span of a fish and growth is defined as the addition of material to that which is already organised into a living pattern. The age and growth of fishes are important in the estimation of fish production in terms of quantity, in a body of water in relation to time. In the studies of biological profile of a species, age and growth form the most fundamental and important aspect. A knowledge of these parameters is essential to understand the dynamic features of the population and forms the basic key to determine the quantity of fish that could be produced in a fish population against time. Once the addition (weight) in a fish stock in relation to time is determined, the optimum size at age can be fixed for rational exploitation of a fishery. Further, the loss in a given fish stock due to natural and fishing mortality is to be estimated for arriving at maximum sustainable yield and biomass estimation. Age and growth studies of fishes was first proposed by Peterson (1895) who evolved a method for determining the age of fish from length frequency curves.

Information about the age and growth of an organism is also important in understanding the nature of stock and the role played by various year classes in the fishery constituted by the animal, the condition under which optimum growth is possible and the influence of various environmental factors on growth. Knowledge of age data, in conjunction with length and weight can give valuable information in the stock composition, age and maturity, longevity, mortality, growth and yield. Information on growth is essential for stock assessment in the context of successful resource management where simultaneous additions and loss by weight that takes place in the population are decisive factors determining the stock size.

In fishes, age and growth rate can be determined by both direct and indirect methods. The most frequently used method of age determination is the interpretation and counting of growth zones or growth checks which appear in the hard parts of fishes such as scales, otoliths, fin rays and other skeletal parts. Such of these growth checks, which are considered to be formed once a year, are called year marks, annual marks, annual rings or annuli. These are formed during alternate period of faster and slower growth or no growth at all and reflect various environmental or internal influences. Scales and bony structures have also values in the study of seasonal growth within a year from which the lengths at ages are back calculated (Blackburn 1950).

Another method of age and growth determination is the marking or tagging of fishes in an experimental body of water and recapturing them. A third method is by culturing the fishes in cages and providing congenial environment and suitable food. The fourth and simplest method for age determination is the analysis of size frequency distribution, known as the Petersen method. The growth is estimated theoretically by using Von-Bertahanffy growth equation. Another method as an age indicator is the usage of eye lens diameter and weight. This was first introduced by Lord in the age determination of a variety of animals.

Of these, second and third methods are preferable as they offer direct evidence (result), but are difficult to implement, as appropriate infrastructure facilities are required to carry out the programme. The other 3 are indirect methods. Growth determination from markings on hard parts have been successfully used in temperate waters. A characteristic feature of the growth of fishes is periodicity, i.e. growth during certain months or periods is rapid than other times (Nikolskii, 1963). This unevenness in growth rate is reflected on hard parts in the form of growth checks, which are found during periods of slow growth. The growth become slower during winter and spring when both food availability and environmental factors are relatively at low levels. Corresponding to the seasonal changes the annual markings in the hard parts are seen as widely spaced or opaque zone due to fast growth followed by narrower and more transparent spaced zones owing to slow growth.

A lot of works are available from temperate waters on the use of hard parts in the study of fish growth. Usage of hard parts in age determination is two centuries old. It is an accepted procedure for the determination of the age of many fishes. A Swedish clergyman determined the age of pike (*Esox lucius*) and other species by counting the rings on the vertebrae and his findings were comparable to the modern readings (Hederstorm, 1959, original version, 1759). Maier (1906) reviewed the history of age determination from the 17th to the end of 19th centuries. Hoffbauer (1898) worked on grouping of circulii in carp and his interpretation as yearly marks was prompted Thompson (1902) to extend this procedure to marine fishes. Many scientists used skeletal hard parts for age determination and this became an accepted procedure for the determination of the age of many fishes [Hutton (1921); Van Oosten (1929)]. Menon (1950) reviewed the literature concerning the determination of age and growth of fishes by using various bones, other than otoliths and scales. The problems involved in the age determination in tropical fishes have been discussed by De-bont (1967). Hiyama and Ichikawa (1952) injected fishes with lead acetate to mark the time in the scale and other hard tissues of fishes to see their growth. They combined the method with the tagging experiments to see the natural growth. Marzolf (1955) used pectoral spines and vertebrae for determining age and rate of growth of channel cat fish. Bagenal (1955) studied the growth rate of long rough dab

Hippoglossoides platessoides. Mc Earlean (1963) used otoliths to determine age of *Mycteroperca microlepis* and Carlstorm (1963) made a microscopic and X-ray crystallographic analysis of otoliths from a collection of vertebrates. Bilton and Jenkinson (1968) used the scale and otolith for aging sock eye (*Onchyorhynchus nerka*) and *Onchyorhynchus keta*. Moe (1969) used otoliths for the red grouper, *Epinephelus morio*. Hile (1970) reviewed the body- scale relation and calculation of growth in fishes. Length frequency distribution analysis of *Epinephelus guttatus Epinephelus fulves* and *Epinephelus cruentatus* from Jamaica was done by Thompson and Munro (1978). Bagenal (1974) studied the aging of fish (in general). Age and growth based on length frequency distribution and on otoliths were studied by Burnett – Herkes (1975). Brothers *et al* (1976) studied daily growth increments in otoliths from larval and adult fishes of anchovies, *California grunion*, Gobies, striped bass, hakes etc. *Centropristis striatus* was aged by Mercer (1978) using otoliths. Stained vertebrae are best for aging teleost fishes (Johnson, 1979) Barger (1990) have summarized age and growth of blue fish – *Pomatomus saltarix*.

In tropical waters, the marking on hard parts, though less pronounced, are found in marine and fresh water fishes, but no authentic evidences are available as to their annual nature. Because there is no marked variation in the environmental factor like temperature. In such cases various workers attribute the causative factors for such markings to spawning, fluctuations in food supply, monsoon etc. Nekrasov (1980) discussed the factors affecting annulus formation on the recording structures in the tropical fishes. It was shown that annulus formation occurs once a year in tropical fishes, especially *Trachurus indicus* and *Nemipterus virgatus* and is connected with spawning. In temperate and high latitude, the ring formation is connected with the changing seasons, and it is clear that the annulus forms once a year. Whereas the cause of annulus formation remain unclarified for tropical species, living under conditions in which there are no marked fluctuations in water temperature, in the hours of daylight, the food resources etc., although such clarifications is very important for the determination of their age (Chen *et al*, 1980). Many other scientists from foreign countries worked on the age and growth of many fishes. Some of them are Neilson and Geen (1981) on juveniles of salmon, *Onchorhynchus tschawytscha* using otolith microstructures and Campana and Neilson (1982) on starry flounder, *Platichthys stellatus*. Johnson and Saloman (1984) estimated age, growth and mortality of gray trigger fish, *Balistes capriscus* from the north eastern gulf of Mexico.

Wilson and Larkin (1982) studied the relationship between thickness of daily growth increments in sagittae and change in body weight of sockeye salmon (*Onchorhynchus nerka*) fry. The information on primary growth rings in otoliths, and the methods used to prepare them for counting and their use in ageing fish was reviewed by Gjosaeter *et al*.(1984). Johnson (1984) compared the dorsal spine and vertebrae as aging structures for tunney, *Euthynnus alletteratus* from the north east gulf of Mexico. A novel approach for aging of tropical fish was introduced by Ralston (1986). In his observation it was clear that growth rate of the otolith declines as the size of the otolith increases. In tropical serranidae, *Epinephelus microdon* a fluorescent marker, oxytetracycline was used to study the frequency of increment formation on the otoliths. Johal *et al* (1989) studied the age, growth and length-weight relationship of *Colisia fasciata* (Perciformes). A revision of literature concerning the calculation of fish lengths at successive ages from marker on scales otoliths etc. was done by Francis (1990) in blue fish *Pomatomus saltatrix* from the Northern Gulf of Mexico and U.S. South Atlantic coast. Some other works on age and growth by otoliths were by Pannella (1971), Martin and Cook (1990), Campana (1990), Panfili and Zimenes (1992), Sadovy *et al* (1992) and Luckhurst *et al* (1992) *on Epinephelus Guttatus*. Ricker (1992) described about the back calculation of fish lengths based on proportionality between scale and length increments. Johal *et al* (1993) observed growth of *Labeo cabasa* (Hamilton). Johal and Dua (1994) studied the scales of fresh water snake head *Channa punctatus* (Bloch). Seshappa (1999) determined age of Indian fishes using scales, otoliths and other hard parts.

Many scientists tried the use of eye lens diameter and weight as an age indicator in fishes. Most methods for determining the age of fish such as counting growth rings on scales or otoliths are time consuming and prone to inaccuracy due to a certain degree of subjectivity in determining what constitute a single growth ring (Boehlert, 1985). A fast objective and accurate method for determining fish age would therefore be highly desirable. The ocular lens weight and diameter technique has been suggested as an indicator of fish age. The main works were by Burkett and Jackson (1971) in fresh water drum, Carlton and Jackson (1968) in carp copcia, Crivelli (1980) in the common carp, *Cyprinus carpio*, Boehlert (1985), Douglas (1987) in brown trout, *Salmo trutta*, Saleem *et al* (1990) in some fish species, Al Hassan *et al* (1991) in *Mystus pelusius*, Al Hassan *et al* (1992) in two teleost fishes, Al Hassan *et al* (1994) in cat fish, *Siluris trigostegus* and Al Hassan *et al* (1999) in two sparid fishes.

There have been a number of studies on age determination of fishes from Indian waters using hard parts (Seshappa and Bhimachar (1951), Radhakrishnan (1957), Kutty (1961), Pantulu (1961), Qasim and Bhatt (1966), Rao (1970), etc. Seshappa (1999) had done age determination in Indian fishes.

The main propose of this study was to elucidate various aspects of the age and growth of *Priacanthus hamrur* and *Pomadasys maculatus* from the coast of central Kerala because not much information is available on the growth and age of these fishes. Moreover information on these aspects are essential for population dynamics, research, fishery forecasts, fish culture in natural habitats, acclimatization and rational commercial exploitation.

MATERIALS AND METHODS

Age determination of *Priacanthus hamrur* and *Pomadasys maculatus* was done from the growth checks on scales and Eye lens diameter and weight as an age indicator.

1. Scales

The samples for scale analysis of *Priacanthus hamrur* and *Pomadasys maculatus* were collected from Munambam harbour. The study was based on the examination of scales from 186 males and 206 females of *Priacanthus hamrur* and 140 males and 136 females of *Pomadasys maculatus*. The size range in Priacanthus was 170 mm to 340 mm and in Pomadasys was 65 mm to 250 mm in total length. The collection was done every month during the period from 1997 January to 1998 December. After measuring the length in mm from the tip of the lower jaw to the base of the caudal rays of each fish – the weight, sex, maturity and other biological details were recorded from both groups. Then 5-10 scales were taken out from the left side of the body, near the pectoral fin region just below the lower lateral line.

This procedure was followed throughout the period. The scales collected from each fish were separately placed in water in small tubes to remove dirt or mucus. The scales were then placed in 2% potassium hydroxide (KOH) solution for 20 minutes, washed further and then dried between blotting papers, examined under a monocular microscope. An oculo-micrometer was utilised to measure the radius (length) of the scale and also the radius between successive growth checks. Each micrometer division is equal to 0.0143 mm. The annual rings were distinguished from regular bony ridges (circulii) (in two ways) as recommended by Chen *et al* (1980). The annual ring has a discontinuous ridge (cutting over) in the scales' lateral field and also shows compact ridges in the scales' anterior field. Some times false rings were noted which were usually discontinuous and are recorded in frequently. Such scales were not included in the study.

Growth Checks on Scale

When annuli or growth checks are present on scales, they can be identified by the following characters.

i. The sclerites will become narrow and the intervals between successive sclerites will close up.

ii. The sclerites are wavy and broken up elsewhere, becoming continuous and nearly straight from radius to radius.

iii. The number of radii of the annulus will increase and

iv. The portions of the radii outward of the annulus being frequently not in a straight line with portions inward of it, but inclined at an angle or even disconnected at the annulus.

The scale length (radius) was measured from the centre of the scale's focus to its outer margin using ocular micrometer. The fishes were grouped into 10 mm class intervals. The frequency and the number of annuli observed on scales were then plotted against the class intervals and mean fish size was calculated. Measurements were also made to each annulus for back calculation. Each scale was examined thrice at different times and an accurate count was taken for the analysis of growth characteristics. The Lee method (Carlander, 1981) of back calculating body length from prior annuli was used.

$$L_i = a + [(L_c - a)(S_i / S_R)]$$

where L_i = Length at the time of annulus formation

a = intercept

L_c = Length at capture

S_i = Scale radius at the time of i^{th} annulus formation

S_R = Scale radius at the time of capture

This method requires knowledge of the relationship between S_R along the line of measurement and body length. The constant 'a' is obtained from this relationship and used in Lee's formula. The relation between the length of the fish and radius of the scale was found out using the equation.

$$L = a + b\,S_R$$

L = Total length of fish, S_R = Scale radius, 'a' & 'b' are constants

2. Eye lens diameter and Weight as an age Indicator

Time consumption and inaccuracy in determination of growth rings in fishes are still the major drawbacks in most age determination methods that involve otolith, vertebrae, spine and scales (Boehlert, 1985). Thus, eye lens diameter and weight as an age indicator was applied as a more convenient and faster method for age determination. For this purpose fishes of *Priacanthus hamrur* and *Pomadasys maculatus* were collected from Munambum harbour. They ranged in total length between 170 mm to 340 mm in *Priacanthus hamrur* and 65 mm to 240 mm in *Pomadasys maculatus.* The largest sizes recorded for the two species were 340 mm and 240 mm for *Priacanthus hamrur* and *Pomadasys maculatus* respectively. The eye lens diameter and weight were measured and recorded respectively in the laboratory. The eye lens was dissected out from both left and right sides of the fish and kept separately for further measurements and weighing. Then the diameter of the eye lens was recorded to the nearest millimeter using a vernier calipper. The weight of lens was taken to the nearest gram using 4-digit electronic balance. The weight and diameter of the lens was compared with the age determined by the scale method. The relationship between lens diameter and lens weight along the body length was found out. The diameter and weight of the right and left eyes were taken separately and their mean was calculated for further study.

OBSERVATION AND RESULT

Structure of Scale of *Priacanthus hamrur* and *Pomadasys maculatus*

Both these fishes have prominent ctenoid scales. The scales are embedded in pockets in the skin and each scale has a centre or nucleus and a number of circulii except in regenerated scale (Plate 4.1 & 4.2). The posterior side bears a number of closely packed spines (cteni). The anterior side is broader. The circulii in each scale are interrupted by a number of radii. The radii extends from the focus or from the breaks in circulii towards the lateral as well as anterior margin. In a scale with no annulii the structure of the circulii is more or less uniform all over the scale. The scale of *Pomadasys maculatus* was larger than the *Priacanthus hamrur*. Scales were smooth and easy to remove from the skin in *Pomadasys maculatus*, but rough and difficult to separate from skin in *Priacanthus hamrur.*

Relation between Fish length and Scale length

Knowledge of the relationship between fish length and some dimension of the scale from a given area is essential for back calculation of growth history. The scale of a fish can be considered as a birth and age certificate of it. The mean scale length for 196 fishes of *Priacanthus hamrur* ranging in total length from 172 mm to 320 mm of 10 mm intervals were plotted against length (radius) of scales as in (Fig. 4.1 & 4.2). The scatter of points clearly showed that the relationship between them is linear and of the form $L = a + b.S_R$ where L = fish length in mm, S_R = scale radius, a & b = constants. The regression equation calculated by the method of least square in *Priacanthus hamrur* is

Male → $L = 31.49631 + 0.399366\ S_R$ $(r = 0.80825)$

Female → $L = 43.584035 + 0.312444\ S_R$ $(r = 0.903345)$

Pooled → $L = 37.54018 + 0.355905\ S_R$ $(r = 0.85580)$

The same method was done in *Pomadasys maculatus* and the graph showed that the relationship between them is linear in this fish also (Fig. 4.3 & 4.4).

Male → $L = 42.93035 + 0.65596\ S_R$ $(r = 0.962282)$

Female → $L = 69.50208 + 0.495419\ S_R$ $(r = 0.876372)$

Pooled → $L = 57.4356 + 0.562691\ S_R$ $(r = 0.90865)$

In both fishes it was found that the relationship between the body length and scale radius is isometric i.e., scale radius increases with the increase of body length (Fig. 4.1 to 4.4). In the case of *Priacanthus hamrur* out of the 206 females, 18 fishes had no rings on scales, 88 showed one ring, 55 showed two rings, 38 showed three rings and 7 fishes showed 4 rings. In males out of 186 fishes examined, no ring was observed in the scales of 12 fishes, 74 fishes had one ring 72 showed two rings, 36 showed three rings and 8 showed 4 rings. The mean fish length (TL mm) worked out for 1 to 4 rings in the scales of both males and females. The average length of male Priacanthus hamrur for 1 to 4 years was 198 mm, 230 mm, 269 mm and 300 mm respectively. In the case of females it was 208 mm, 244 mm, 280 mm and 324 mm. The frequency distribution of growth checks in the scales of *Priacanthus hamrur* for males and females were given (Table 4.1 & 4.2). The growth pattern was almost similar in both males and females. But when the average lengths for each year was taken the females showed higher lengths than the males. This variation may be due to the fact of sexual dimorphism i.e., females dominated males in all morphological measurement (Tessy & Inasu, 1998a).

Similarly scales from a total of 140 males and 136 females of *Pomadasys maculatus* of the size range 60 to 240 mm in total length were used for the study of growth rings. Here also fishes were grouped into 10 mm class intervals. The frequency and the number of annuli observed on scales were then plotted against the class intervals of length groups and mean fish size were calculated towards each annulus. Out of 140 males, 12 specimens had no rings on scales, 55 showed one ring, 50 had two rings, 19 had three rings and 4 showed four rings. The mean fish length worked out for 1st year was 95 mm, 2nd year 140 mm, 3rd year 182 mm and 4th year 218 mm. In 136 females, 9 fishes had no rings, 40 had one ring, 45 showed two rings, 34 had 3 rings and 8 showed 4 rings. The mean fish length worked out in females for 1 to 4 years were 97 mm, 148 mm, 193 mm and 234 mm. The frequency distribution of growth checks in the scales of males and females were given (Table 4.3 & 4.4).

Age studies in *Priacanthus hamrur* and *Pomadasys maculatus* showed that these fishes of 1 to 4 years were represented in the catch. Four year old fish in both species did not provide an adequate sample. Although the age of these fishes were determined by means of growth rings on scales, a great difficulty was encountered in locating the growth rings. The scale rings found on the body of the two fish species appeared to be annual rings.

Back-calculated Body lengths from Scales

The method of back-calculation for determining the growth of fish was first introduced by Lea (1910) and then this method has been used by many workers (Lea, 1938; Hile 1950; Blackburn, 1949, 1950). In India a very few workers have tried this method. This method has been used by Seshappa and Bhimachar (1954) for studying the growth in malabar sole *Cynoglossus semifasciatus*, Jhingran (1959) on *Cirrhina mrigala*, Sarojini (1957) on gray mullet, *Mugil pursia*, Krishnankutty (1967) on *Cynoglossus macrolepidotus* and

Rao (1962) in *Pseudosciaena diacanthus*.

Results of back-calculation of total lengths using scales of *Priacanthus hamrur* and *Pomadasys maculatus* are presented here (Tables 4.5 to 4.8).

Back-calculated Total length of *Priacanthus hamrur*

The mean back calculated lengths for the first four years of life of *Priacanthus hamrur* using scales were presented (Table 4.5 & 4.6). In male *Priacanthus hamrur* the first four years of lengths were 185 mm, 225 mm, 260 mm and 296 mm respectively. In females the first four years of lengths were 201 mm, 245 mm, 283 mm and 320 mm. In both cases these back calculated lengths were in agreement with the lengths of the fishes obtained at the time of capture. Females were having higher length for each year than males. This was due to the fact of sexual dimorphism. Females dominated in all morphological measurements (Tessy & Inasu, 1998a). Growth increments were also represented in the chart for each year. In males second year increment was 40 mm, third year 35 mm and fourth year 36 mm. Growth increment in females for second, third and fourth year was 44 mm, 38 mm and 37 mm. A graph was drawn showing the absolute growth curve derived from mean total lengths and mean back calculated lengths for both sexes (Fig. 4.5 & 4.6). The graph showing growth curves derived from mean lengths at capture and mean back-calculated lengths based on scale radius represent a smooth curvi linear growth. In *Priacanthus hamrur* the mean length at capture was slightly higher than the mean back calculated length. Burnett- Herkes (1975) says that discrepancy is as a result growth between the time of the last ring is formed and the time of the fish was captured.

Similarly the mean back-calculated lengths for the first four years of life of *Pomadasys maculatus* using scales were presented (Table 4.7 & 4.8). In males the lengths for the four years were 106 mm, 143 mm, 175 mm and 211 mm and in females the lengths were 136 mm, 116 mm, 157 mm, 192 mm and 228 mm. Eventhough slight variations were seen, the measurements were almost in agreement with the lengths at the time of capture. Growth increment in males for the 1st and 2nd year was 37 mm, 2nd and 3rd year was 32 mm and 3rd and 4th year was 36 mm. In females it was 41 mm, 35 mm and 36 mm respectively for the years. Here also variations in the size of both sexes were noticed which points out the sexual dimorphism i.e. females dominate in all morphological measurements (Tessy & Inasu, 1998b). The absolute growth curves derived from mean total body lengths and mean back calculated lengths from scales at each age group of *Pomadasys maculatus* was represented (Fig. 4.7 & 4.8). The figure showing growth curves derived from mean body lengths at capture and mean back-calculated lengths based on scale radius illustrate a smooth curvilinear growth. However, the mean length at capture was slightly lower than the mean back calculated lengths. This was just reverse of the case of *Priacanthus hamrur.*

Use of Eye Lens Diameter and Weight

The technique of using eye lens in the age determination was used in the case of *Priacanthus hamrur* and *Pomadasys maculatus.* The relationship between the body length and eye lens weight and body length and eye lens diameter revealed linear relationship for *Priacanthus hamrur* and *Pomadasys maculatus* in both sexes (Fig. 4.9 to 4.16).

***Priacanthus hamrur* – Relation between Body length and Eye Lens diameter**

The regression equation of body length on eye lens diameter of males based on a sample size of 186 fish ranging from 165 mm to 290 mm total length is given below (Fig. 4.9).

$$L = a + b\,E_d$$

Male $L = a + b\,E_d$, $L = 111.71 + 1.605046\,Ed$ ($r = 0.9236$) where L = Total length, a & b constant, E_d = Lens diameter.

The regression equation of body length on eye lens diameter of female is $L = 104.9054 + 1.62951\,E_d$ ($r = 0.952361$) based on a sample size of 206 fish ranging from 170 mm to 324 mm total length (Fig. 4.10).

The average total length attained by male *Priacanthus hamrur* in the completion of 1 to 4 years is 198 mm, 231 mm, 269 mm and 300 mm respectively. The average lens diameter for male *Priacanthus hamrur* in the years 1 to 4 is 4.28 mm, 4.45 mm, 5.45 mm and 6 mm. In female *Priacanthus hamrur*, the mean total length attained in the completion of 1 to 4 years is 209 mm, 245 mm, 280 mm and 324 mm. The average lens diameter for female *Priacanthus hamrur* in the years 1 to 4 is 4.38 mm, 4.40 mm, 5.83 mm and 6.27 mm respectively. The usual relationship between the eye lens diameter and fish length is isometric i.e., eye lens diameter increases with the increase of the body length which shows that the diameter of lens increase with age also (Fig. 4.17 & 4.18).

***Priacanthus hamrur* – Relation between Body Length and Eye Lens Weight**

The regression equation of body length on Eye lens weight, of male *Priacanthus hamrur* based on a sample size of 186 fish ranging from 165 mm to 290 mm total length (Fig. 4.11).

$$\text{Male } L = a + b\,E_W$$

L = length, a & b constants, E_W = lens weight

$$\text{Male } L = -11.2384 + 0.337024\,E_W\ (r = 0.874152)$$

In female *Priacanthus hamrur* the regression equation of body length on Eye lens weight is

Female L = -11.35369 + 0.228608 E_W (r = 0.91919).

The collection consisted of 206 female fishes ranging from 170 mm to 340 mm total length (Fig. 4.12).

The average total length attained by male *Priacanthus hamrur* in the completion of 1 to 4 years is 198 mm, 231 mm, 269 mm and 300 mm. The average lens weight for male *Priacanthus hamrur* in the years 1 to 4 is 42.39 mg, 64.94 mg, 73.6 mg and 79.5 mg respectively. In the female *Priacanthus hamrur* the mean total length attained in the completion of 1 to 4 is 209 mm, 245 mm, 280 mm and 324 mm. The average lens weight in the years 1 to 4 is 51.60 mg, 66.21 mg, 73.73 mg and 81.16 mg respectively. In the case of Eye lens weight also the growth is usually isometric, i.e. eye lens weight increases with body length. This means the lens weight increases with age and knowing the lens weight, age of the fish can be calculated (Fig. 4.21 & 4.22).

***Pomadasys maculatus* – Relation between Body length & Eye Lens diameter**

The regression equation of body length on eye lens diameter of males based on a sample size of 140 fish ranging from 65 mm to 232 mm total length is given below. (Fig. 4.13).

Male L = 89.99075 + 1.092203 Ed (r = 0.860384)

The regression equation of body length on eye lens diameter of *Pomadasys maculatus* based on a sample size of 136 female fishes ranging from 70 mm to 240 mm total length (Fig. 4.14)

Female L – 95.12957 + 1.028143 Ed (r = 0.910779)

In *Pomadasys maculatus* the average total length reached by male in the completion of 1 to 4 years is 95 mm, 140 mm, 182 mm and 218 mm. The average lens diameter for male *Pomadasys maculatus* in the years 1 to 4 is 1.58

mm, 2.66 mm, 2.70 mm and 3.00 mm. In females the mean total length attained in the completion of 1 to 4 years is 98 mm, 148 mm, 193 mm and 234 mm respectively. Here also the relationship is isometric eye lens diameter increases with the increase of body length and age (Fig. 4.19 & 4.20).

***Pomadasys maculatus* – Relation between Body length and Eye Lens weight**

The regression equation of body length on eye lens weight of male *Pomadasys maculatus* based on a study consisting of 140 fishes ranging from 65 mm to 232 mm total length.

Male = L = -5.4292 + 0.11043 EW (r = 0.861213) (Fig. 4.15)

In female *Pomadasys maculatus* the regression equation of body length on Eye lens weight is

Female L = 3.73698 + 0.096851 (r = 0.911758) (Fig. 4.16)

The average total length attained by male *Pomadasys maculatus* in the completion of one to 4 years is 95 mm, 140 mm, 182 mm and 218 mm. The average lens weight for male *Pomadasys maculatus* in the years 1 to 4 is 2.52 mg, 10.76 mg, 11.96 mg and 15.6 mg respectively. In female *Pomadasys maculatus* the length attained at the completion of 1 to 4 years is 98 mm, 148 mm, 193 mm and 234 mm respectively. The average lens weight for the years are 2.69 mg, 9.86 mg, 13.33 mg and 16.75 mg. There is a gradual increase in the lens weight along with increase of body length and age (Fig. 4.23 & 4.24). In *Pomadasys maculatus* also the lens weight increases with body length. Here also the relationship is isometric and when age increases, lens weight also increases.

From the figures drawn, if the lens weight or lens diameter of the fishes is known, the age of the fish can be calculated. So ocular lens diameters and weight can be considered as an indicator of age. In the present study of eye lens weight of Priacanthus males and females, there is no much overlapping of eye lens weight with the range of other age groups (Fig. 4.21 & 4.22). Thus the differentiation of age groups from the rest of the year classes are possible. But in both sexes of *Priacanthus hamrur* there is slight overlapping of the age groups between 2^{nd} and 3^{rd} year. But 1^{st} year and 4^{th} year age groups can be well separated from the 2^{nd} and 3^{rd} year groups.

In *Pomadasys maculatus*, the eye lens weight of males showed overlapping of the age groups between 2^{nd} and 3^{rd} year (Fig. 4.23). So it is difficult to separate these age groups. This may be due to the inadequate number of specimen collected. But 1^{st} and 4^{th} year can be separated well from the 2^{nd} and 3^{rd} year age groups. In the case female *Pomadasys maculatus* there is no much overlapping between the 4 years of age groups (Fig. 4.24). But here also a slight overlapping is seen in the 2^{nd} and 3^{rd} year age groups. But it is not very prominent.

DISCUSSION

Chakraborthy ~~and Vidyasagar~~ (1996) worked out the growth, mortality and stock assessment of *Priacanthus hamrur*. According to them the growth of *Priacanthus hamrur* at the end of 1 to 4 years works out to be as 171 mm, 260 mm, 308 mm and 334 mm. These findings were almost in agreement with the present study where females of *Priacanthus hamrur* attain mean lengths on the completion of 1 to 4 years ~~is~~ 209 mm, 245 mm, 280 mm and 324 mm and males ~~were having~~ 198 mm, 231 mm, 269 mm and 300 mm respectively. In another age and growth study Chakraborthy (1994) observed that this species grows to 193, 283 and 323 mm at the end of 1, 2 & 3 years of its life. The relationship between the body length and age revealed a linear pattern indicating isometric growth i.e., length increase with increase of age. Philip

(1994) observed slight difference in the growth parameters obtained for males and females of *Priacanthus hamrur*. Males showed a slower growth rate than females. But in the present study there was no much difference between two sexes. In *Priacanthus macracanthus* using back-calculated data, Joung and Chen (1992) estimated the age at maximum sizes of females (290 mm FL) and males (272 mm FL) as 6.12 and 6.03 years respectively. In the present study of *Priacanthus hamrur* using back-calculated data the age at maximum size of females (320 mm) and males (296 mm) as 4 years. Most of the shallow demersal species have a longevity of about 3-6 years (Murthy, 1982, 1984). In the present study the growth rate for males and females of *Priacanthus hamrur* was 185 mm and 201 mm in the first year, 40 mm and 44 mm increase in second year, 35 mm and 38 mm in third year and 37 mm and 32 mm in the fourth year. Joung and Chen (1992) observed in *Priacanthus macracanthus* the growth in males and females was 44 mm and 40 mm in the second year, 40 mm and 35 mm in the third year and 37 mm and 32 mm in the fourth year. This was almost in agreement with the present study of *Priacanthus hamrur*.

In *Pomadasys maculatus* also the growth is found to be isometric i.e., length increasing with age growth may be influenced by many factors like, temperature, salinity, spawning period, food, toxins etc. The growth rate for males and females of *Pomadasys maculatus* was 106 mm and 116 mm in the first year, 37 mm and 41 mm in the second year, 32 mm and 35 mm in the third year and 36 mm and 36 mm in the fourth year. This increase is comparable with the growth increments of *Priacanthus hamrur*. The effect of salinity on growth of juvenile spotted grunter was studied by Deacon and Hecht (1999). Although the spotted grunter (*Pomadasys commersonnii*) is considered to be a strong osmoregulator, growth performance and survival was compromised below isometric concentration. Deacon and Hecht (1996) studied the effect of temperature and photoperiod on *Pomadasys commersonnii* and found that optimum growth, condition and food conversion of juvenile grunter occurred at 245° C and photoperiod had a more subtle influence on growth. Majid and Imad (1991) estimated the growth parameter of javelin grunter *Pomadasys kakkan* from length – frequency samples collected along the Pakistan coast.

Ahmad and Alghais (1997) studied about the relation between age and heavy metal content in the otoliths of *Pomadasys stridens*. Alghais (1995) estimated the age and growth of *Pomadasys stridens* of the native to United Arab Emirates reefs. The growth marks on otolith were used to estimate the age and the maximum length of this species was 21.0 cm (338.6 gm female). Brothers and Mathews (1987) applied otolith microstructural studies to age determination of *Pomadasys argentius*. Age determination in *Pomadasys maculatus* was not available. In the present study the average total length attained by males during the completion of 1 to 4 years is 95 mm, 140 mm, 182 mm and 218 mm and in the case of females, the total length attained during the course of 1 to 4 years is 98 mm, 148 mm, 193 mm and 234 mm respectively. This means that total lengths obtained by noting the rings on the scales were compared with the back-calculated lengths. Both of them were almost in agreement. Slight variations noted were due to the limited number of fishes collected.

Ocular lens diameter and lens weight were used as an indicator of age in *Priacanthus hamrur* and *Pomadasys maculatus*. Most methods for determining the age of fish, such as counting growth rings on scales or otoliths, one time consuming and prone to inaccuracy due to a certain degree of subjectivity in determining what constitutes a single growth ring (Boehlert, 1985). So a more accurate and fast objective method for determining fish age would therefore be highly desirable and the ocular lens weight has been suggested as such an indicator of fish age (Carlton and Jackson, 1968) Crivilli

(1980) studied eye lens weight and age in the common carp, *Cyrinus carpio.* Burkett and Jackson (1971) observed the eye lens as an indicator of age in fresh water drum and Douglas (1987) found ocular lens diameter as an indicator of age in brown trout. Eye lens diameter as an age indicator was studied by many other scientists like Al Hassan *et al* (1991) in *Mystus pelusius*, Al Hassan *et al* (1992) in two teleost fishes of Barash waters (Iraq) and Al Hassan *et al* (1994) in the cat fish, *Silurus triostegus*. However, in all these studies, although there was a general trend for an increase in average lens weight with age, there was some degree of overlapping between the lens weights of different age groups, thus greatly limiting the usefulness of the lens as an indicator of age in individual fish. These variations may be due to the difference in the environments where the fishes were living. If fishes were collected from a fish farm, their age was known precisely, then there will not be much overlapping between the lens diameters of the various age groups.

In the present study the average eye lens diameter (as the fish lens is spherical, diameter is a direct function of weight) increased with age in both fishes. The eye lens diameter and fish length relationship is isometric. In some cases this relationship is not applied especially between different age groups (Burkett and Jackson, 1971). In both species, the non-overlapping cases are in support of the results of Douglas (1987) on brown trout, *Salmo trutta*. Gerking (1966) explained how different environmental factors could alter the growth rate in the blue gill. When using the lens technique the environmental conditions must be considered. Burkelt and Jackson (1971) found that temperature is the most important environmental variable for fishes to be considered in applying the lens technique.

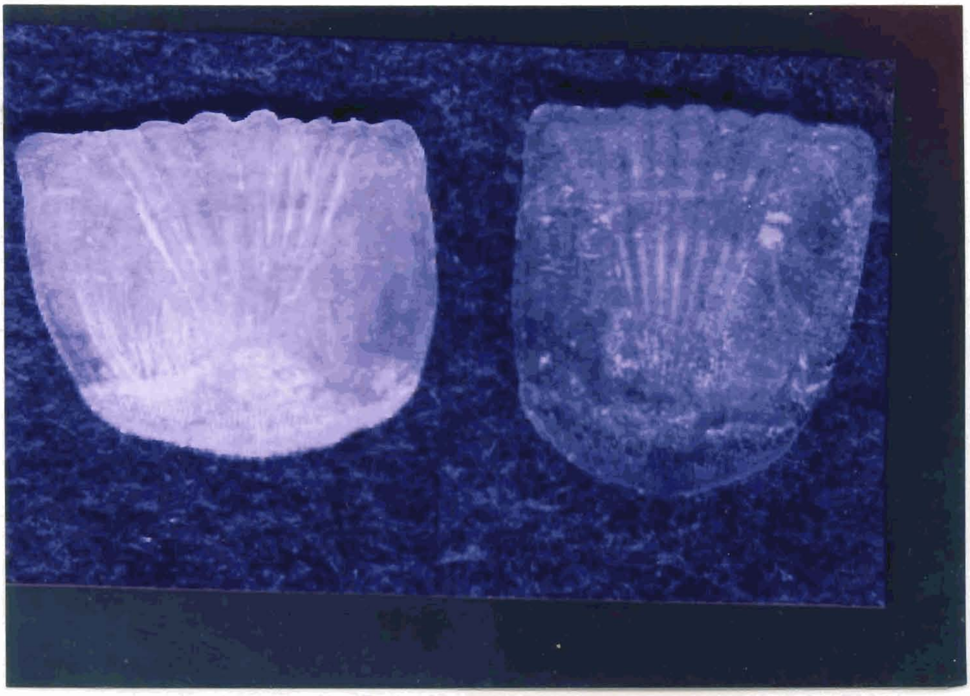
Similarly, the average lens weight in both fishes also increased with age. Here also the relationship was found to be isometric. In the case of

Priacanthus hamrur both males and females showed gradual increase in lens weights along with age groups. Since there was no much overlapping each age group can be separated from the other in both male and female. But the average lens weight in Pomadasys showed certain degree of overlapping. In males the 2^{nd} and 3^{rd} year showed overlapping. So they cannot be separated from each other easily. But 1^{st} year age and 4^{th} year age group can be identified from the other group. So it is possible to use this method for age determination in the case of younger and older individuals. Al-Hassan *et al* (1999) observed that eye lens weight technique proved well to differentiate fishes in the '0' and '1' year class of *B. boops* from the remaining age groups. In females also 2^{nd} and 3^{rd} year overlaps slightly. But the degree of overlapping is not prominent. So this method for age determination can be used in the case of all types of females fishes.

The presence of overlapping in lens weight correlates with the development of sexual maturity (Crivilli, 1980). During reproductive period energy is usually transformed from somatic to gonadal growth. Somatic growth is closely correlated with increase in lens weight. So the variation in individual reproductive development could result in an increased variation in lens weight with an annual group. Thus different year class of both species under investigation can be differentiated by using eye lens diameter technique. This method is worthwhile for a comparison between different species.

Plate 4.1 Scale of *Priacanthus hamrur* (245mm)
Showing annual growth rings

Plate 4.2 Scale of *Pomadasys maculatus*(208mm)
Showing annual growth rings



Tab: 4.1: Frequency distribution of growth checks in the scales of *Priacanthus hamrur* – Male

Size group	Number of Growth Rings				
	0	1	2	3	4
170-179	10	14			
180-189	2	22			
190-199		18	2		
200-209		5	9		
210-219		5	10		
220-229		8	8		
230-239		2	7		
240-249			5	3	
250-259			6	7	
260-269			5	6	
270-279			3	4	
280-289			1	16	
290-299					4
300-309					4
Total 186	**12**	**74**	**56**	**36**	**8**

Tab: 4.2: Frequency distribution of growth checks in the scales of *Priacanthus hamrur* – Female

Size group	Number of Growth Rings				
	0	1	2	3	4
170-179	10	4			
180-189	5	8			
190-199	3	15			
200-209		16	5		
210-219		18	10		
220-229		20	8		
230-239		5	9		
240-249		2	0		
250-259			3	8	
260-269			1	8	
270-279			8	6	
280-289			8	2	
290-299			3	4	
300-309				7	
310-319				**3**	**2**
320-329					**2**
330-39					**1**
340-349					**2**
Total 206	**18**	**88**	**55**	**38**	**7**

Table 4.3: Frequency distribution of growth-checks in the scales of *Pomadasys maculatus* – Male

Size group	Number of Growth Rings				
	0	1	2	3	4
60-69	5	9			
70-79	2	5			
80-89	4	11			
90-99	1	8			
100-109		10			
110-119		2	5		
120-129		7	6		
130-139		3	17		
140-149			9	2	
150-159			4	1	
160-169			9		
170-179				4	
180-189				4	
190-199				6	
200-209				2	2
210-219					
220-229					1
230-229					1
Total	12	55	50	19	4
Fish 150					

Table 4.4: Frequency distribution of growth - checks in the scales of *Pomadasys maculatus* – Female

Size group	Number of Growth Rings				
	0	1	2	3	4
70-79	4	2			
80-89	2	12			
90-99	3	15	2		
100-109		9	2		
110-119		2	9		
120-129			12		
130-139			2	4	
140-149			4	8	
150-159			5		
160-169			9	5	
170-179				7	
180-189				3	
190-199				2	
200-209				4	
210-219				1	1
220-229					2
230-239					2
240-249					3
Total 136	**9**	**40**	**45**	**34**	**8**

Table 4.5 : Back calculated Length from Scale measurements *Priacanthus hamrur*-Male.

Age group	No of fishes	Mean of total length in mm	Back calculated length in mm			
			1	2	3	4
1	74	1 98	187	-	-	-
2	56	231	165	206	-	-
3	36	269	188	231	258	-
4	8	300	198	237	262	296
Mean of back-calculated length.			185	225	260	296
Growth increments.			-	40	35	36
No of fishes			174	100	44	8

Table 4.6 : Back calculated length from Scales measurements *Priacanthus hamrur* - Female.

Age group	No of fishes	Mean of total length in mm	Back calculated length in mm			
			1	2	3	4
1	88	209	197	-	-	-
2	55	245	206	240	-	-
3	38	280	188	235	268	-
4	7	324	213	261	298	320
Mean of back-calculated length.			201	245	283	320
Growth increments.			-	44	38	37
No of fishes			188	100	45	7

Table 4.7 : Back calculated length from Scale measurements *Pomadasys maculats* - Male.

Age group	No of fishes	Mean of total length in mm	Back calculated length in mm			
			1	2	3	4
1	55	95	89	-	-	-
2	50	140	107	132	-	-
3	19	182	112	149	174	-
4	4	218	116	148	176	211
Mean of back-calculated length.			106	143	175	211
Growth increments.			-	37	32	36
No of fishes			128	73	23	4

Table 4.8 : Back calculated length from Scale measurements *Pomadasys maculatus*-Female.

Age group	No of fishes	Mean of total length in mm	Back calculated length in mm			
			1	2	3	4
1	40	98	94	-	-	-
2	45	148	120	142	-	-
3	34	173	116	162	184	-
4	8	234	136	169	201	208
Mean of back-calculated length.			116	157	192	208
Growth increments			-	41	35	36
No. of fishes			127	87	42	8

Fig:4-1 **Relation between Length & Scale Radius**
Priacanthus hamrur - Male

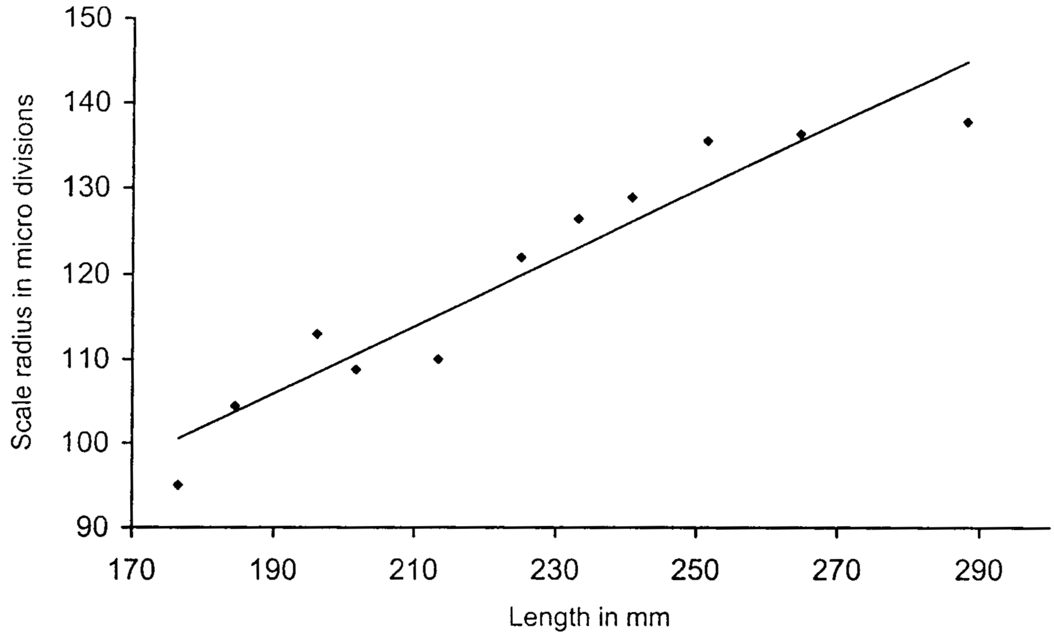


Fig:4-2 **Relation betwween Length & Scale Radius**
***Priacanthus hamrur* - Female**

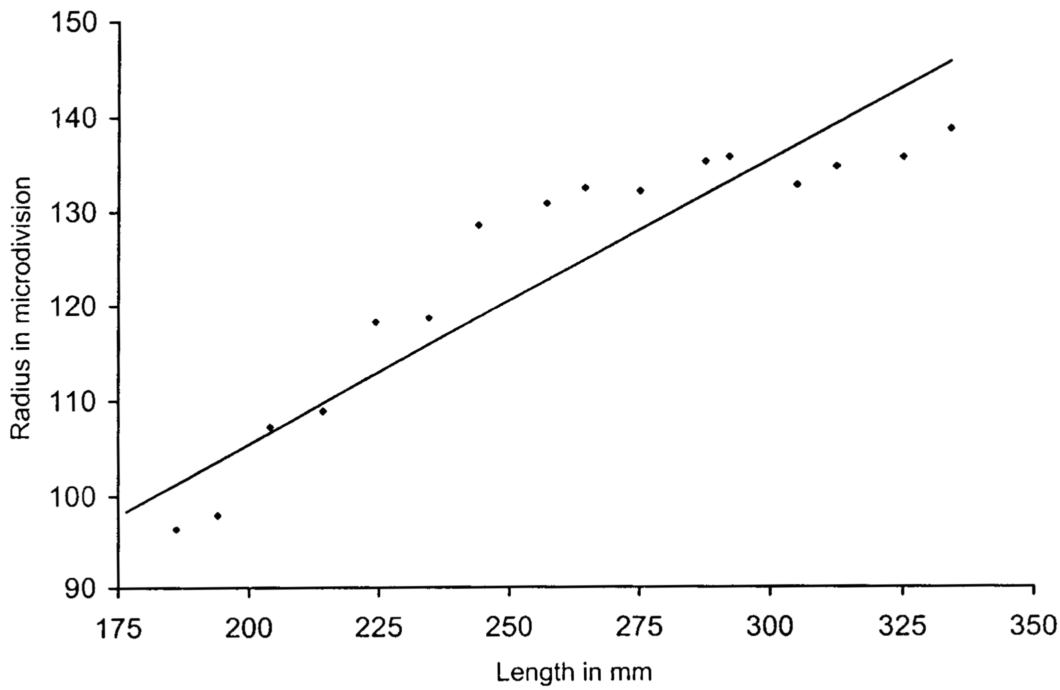


Fig:4-3 Relation between Length &Scale Radius
Pomadasys maculatus (Male)

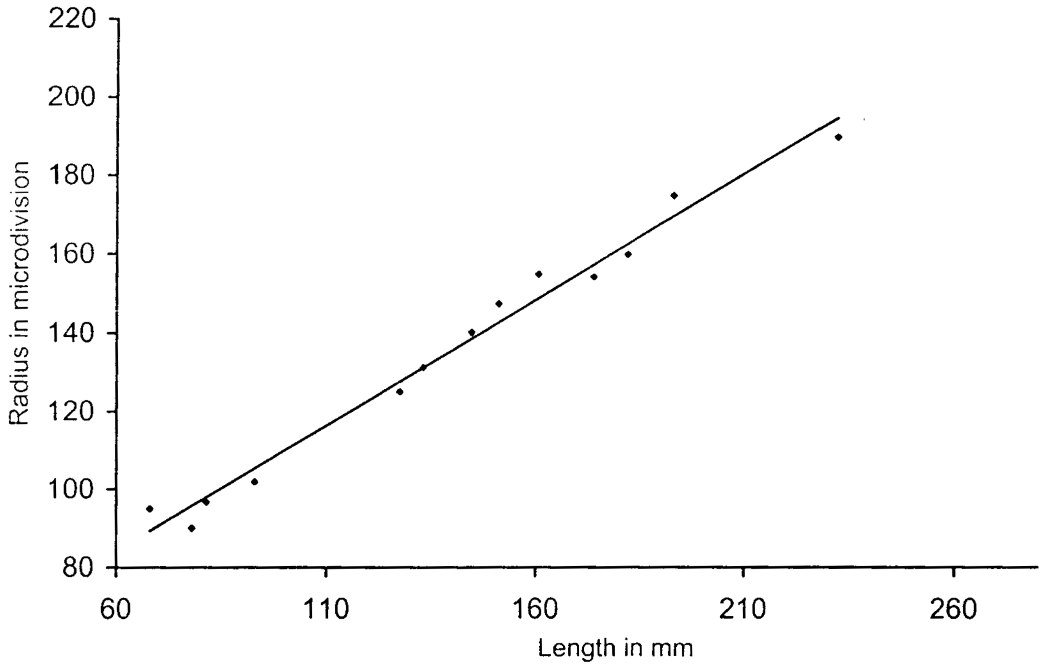


Fig: 4.4 Relation between Length & Scale Radius
Pomadasys maculatus (Female)

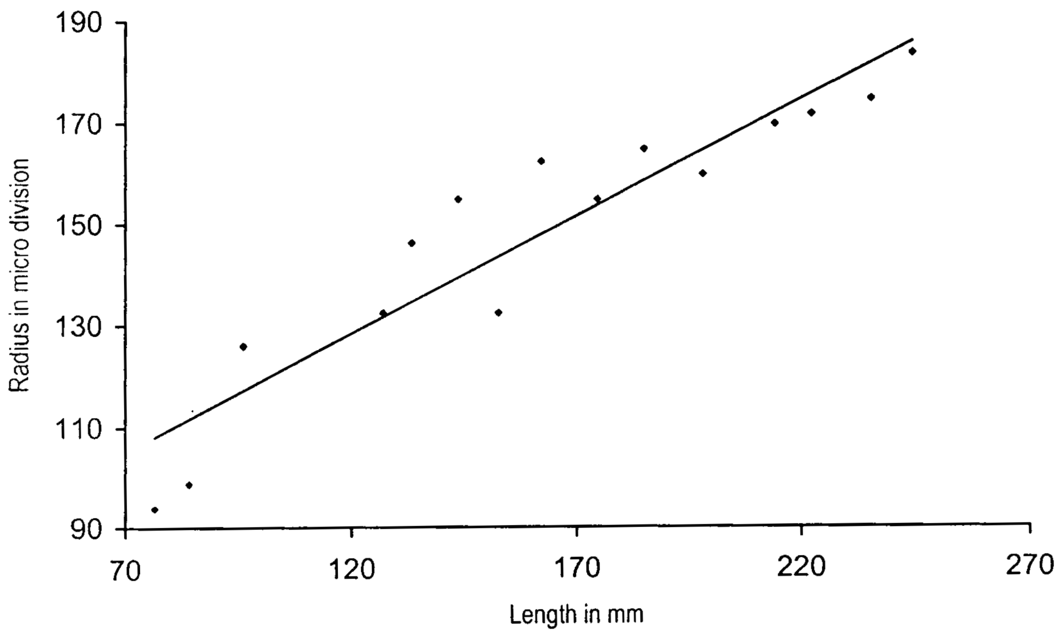


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Fig:4-5. Age verification Back calculated length & Total length Priacanthus hamrur - Male

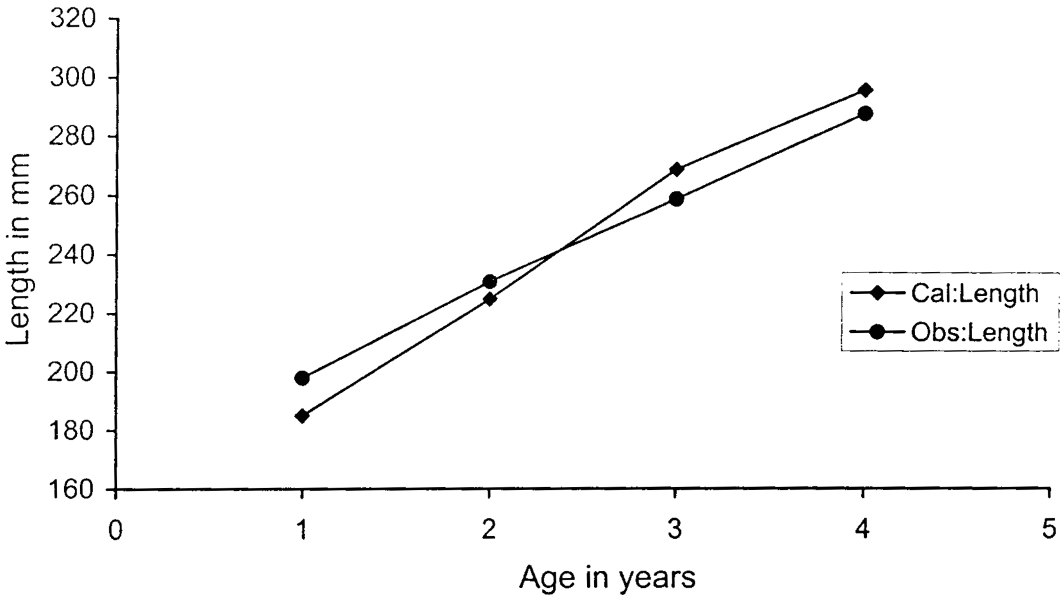

Fig:4-6. Age Verification Backcalculated length & Total length *Priacanthus hamrur* - Female

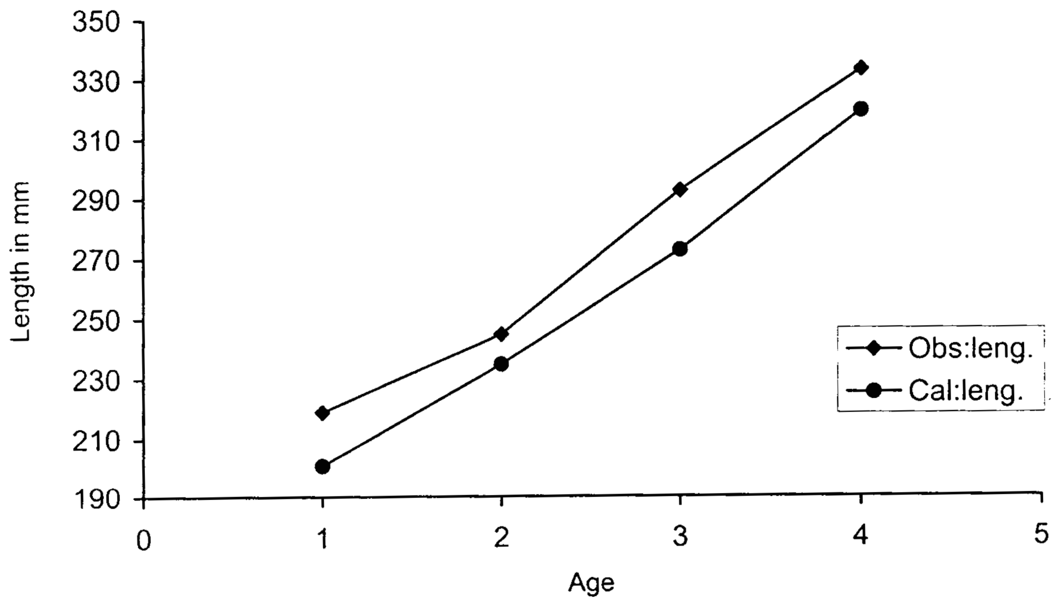

Fig:4-7 Age verification Back Calcuated length & Total length *Pomadasys maculatus* (Male)

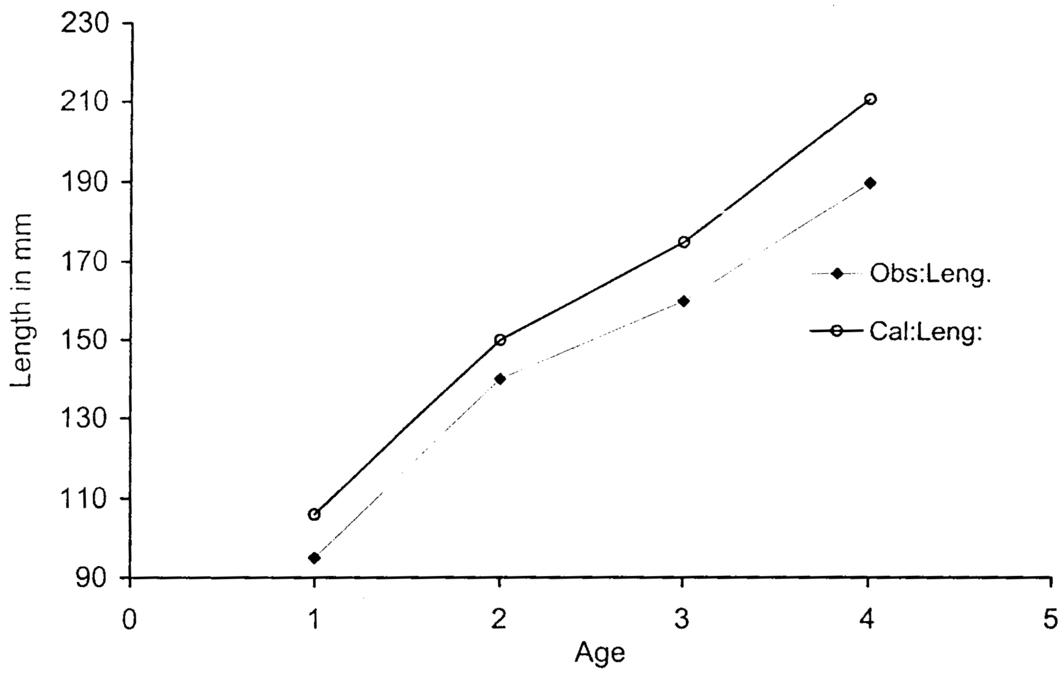

Fig:4-8 Total Length&Back calculated length Pomadasys maculatus (Female)

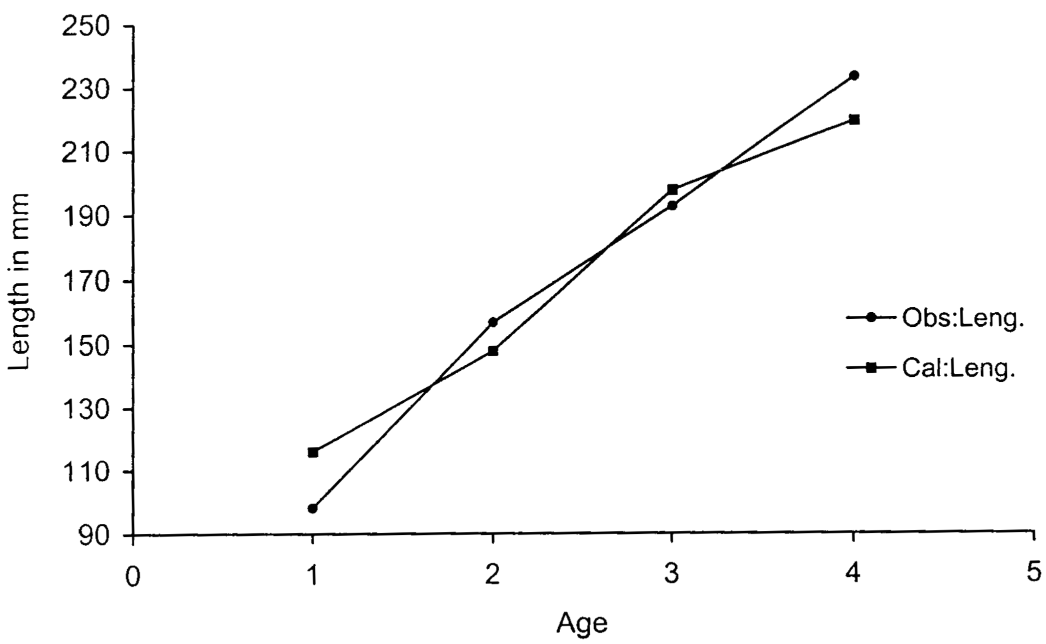

Fig:4-9 Relation between Length & Eye Diameter
Priacanthus hamrur - Male

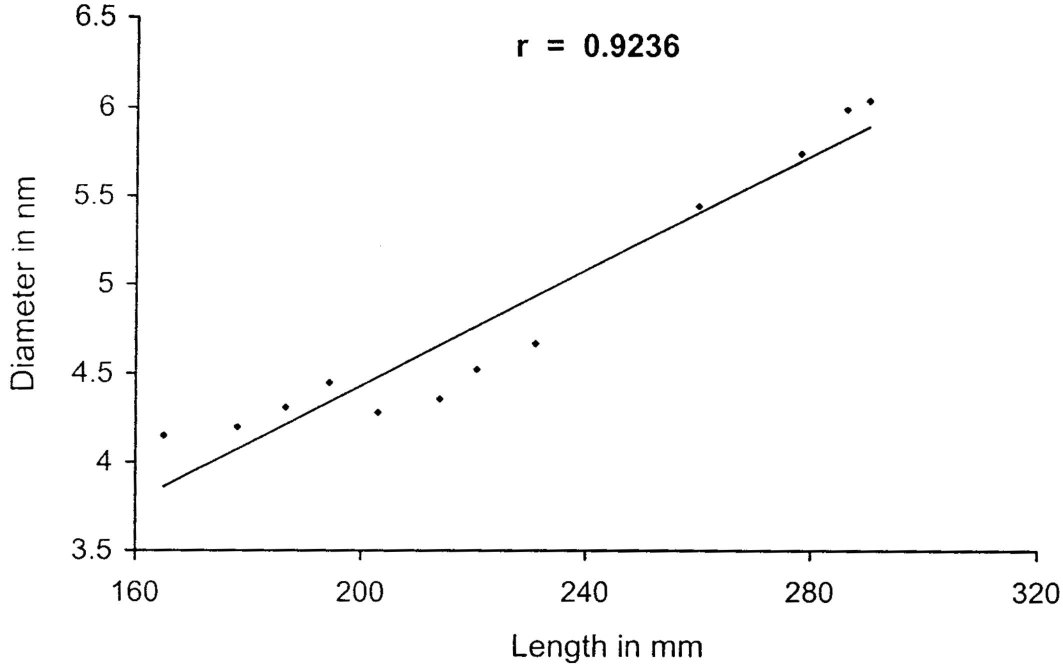

Fig:4-10 Relation between Length & Eye diameter
Priacanthus hamrur - Female

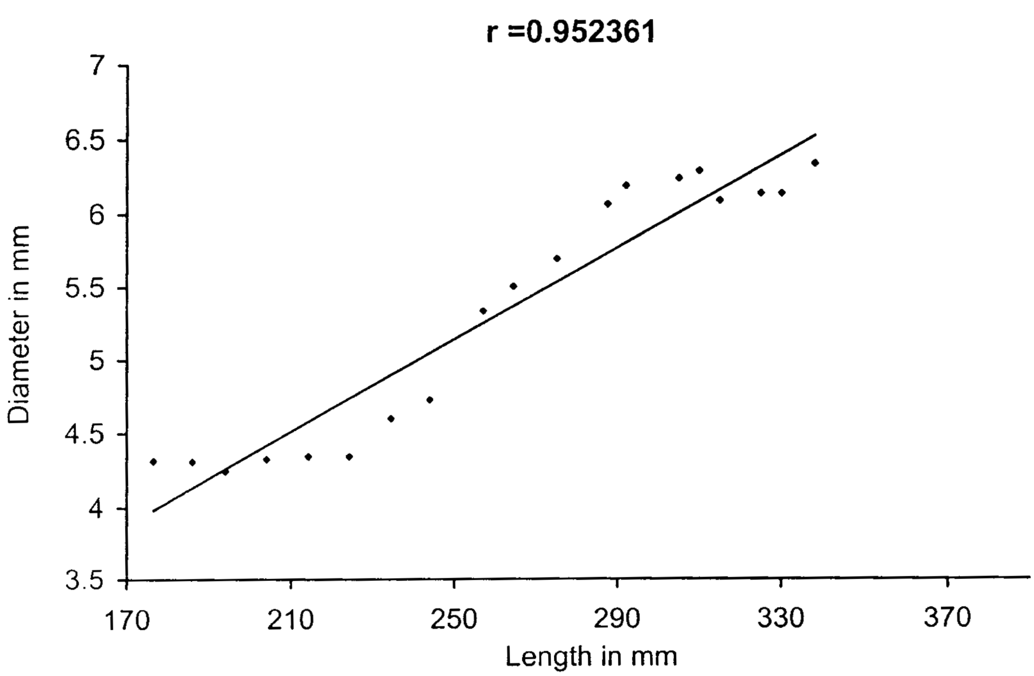

Fig:4-11 **Relation between Total length & Eye lens weight *Priacanthus hamrur* (Male)**

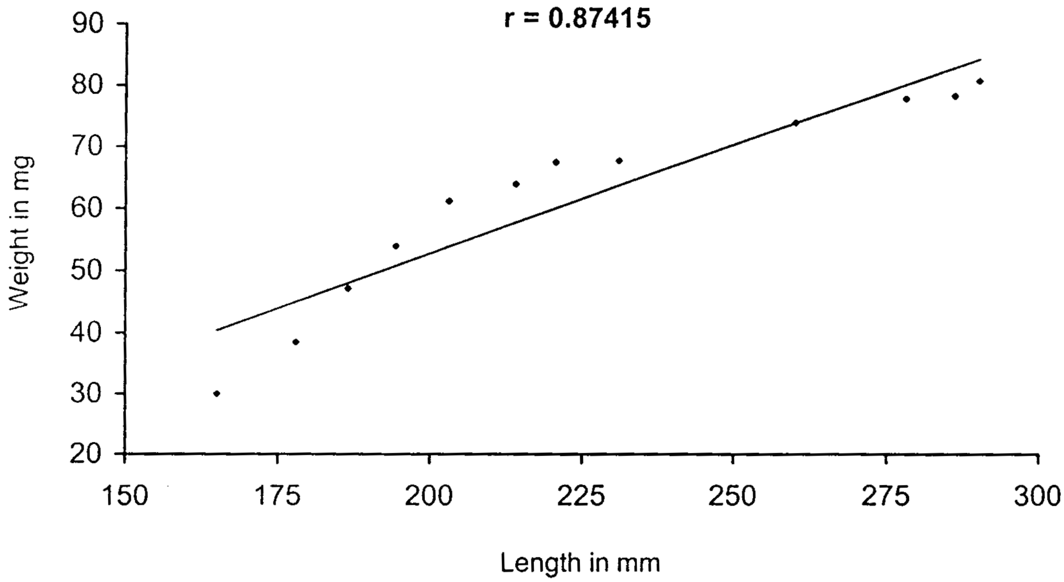

Fig:4-12 Relation between Total Lengt & Eye lens weight *Priacanthus hamrur* (Female)

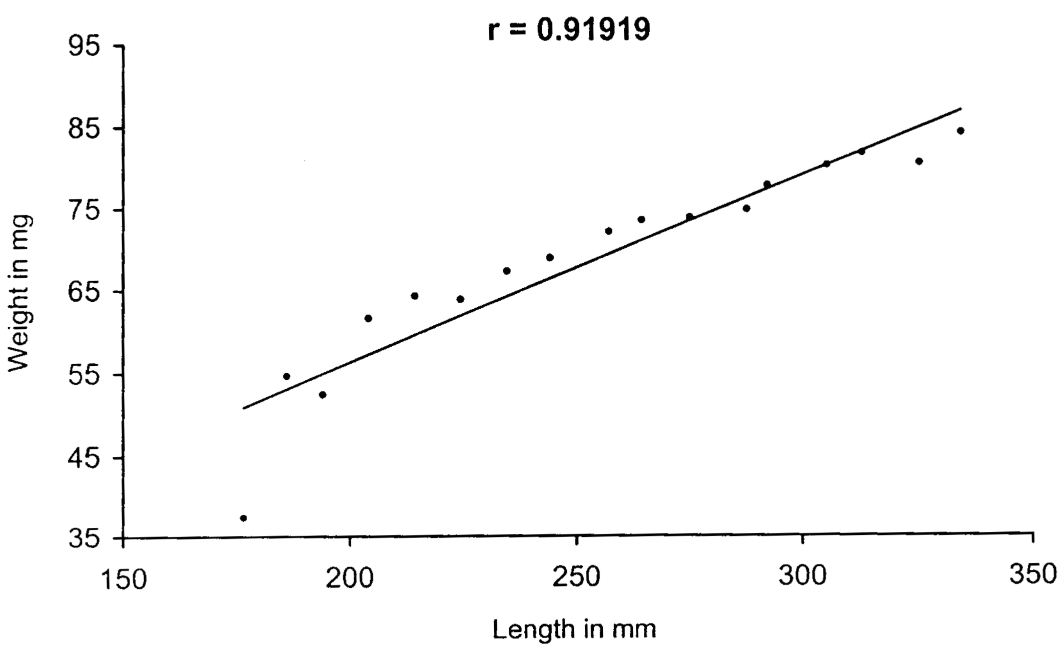

Fig:4-13 Relation between Total Length & Eye Lens Diameter *Pomadasys maculatus* (Male)

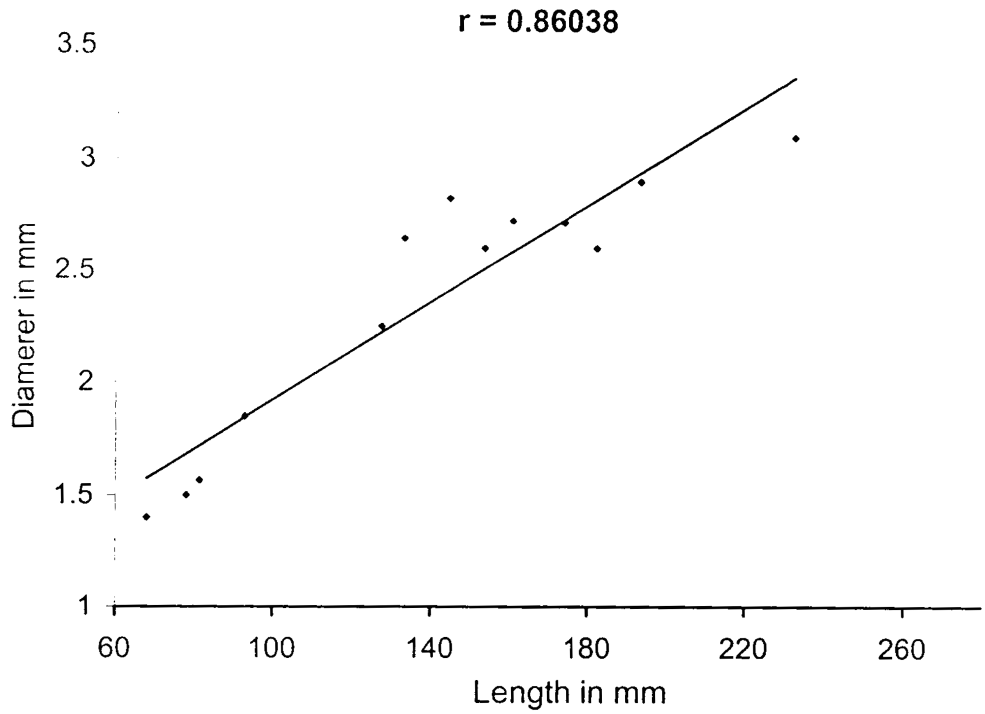

Fig:4-14 Relation between Total length & Eye lens diameter *Pomadasys maculatus* - Female

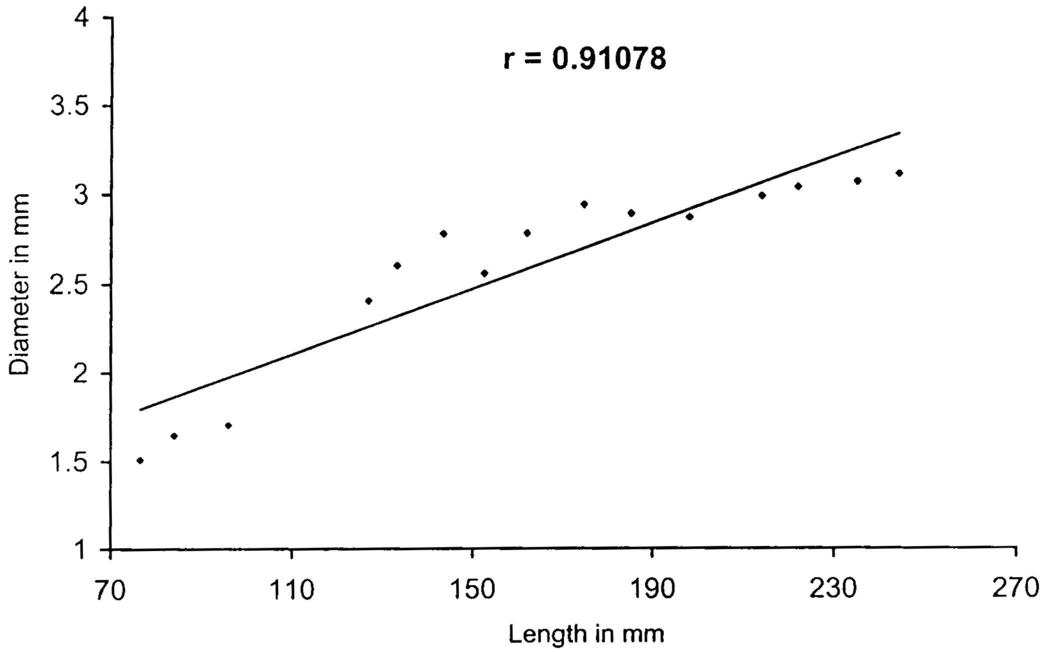

Fig:4-15 Relation between Total length & Eye lens weight *Pomdasys maculatus* (Male)

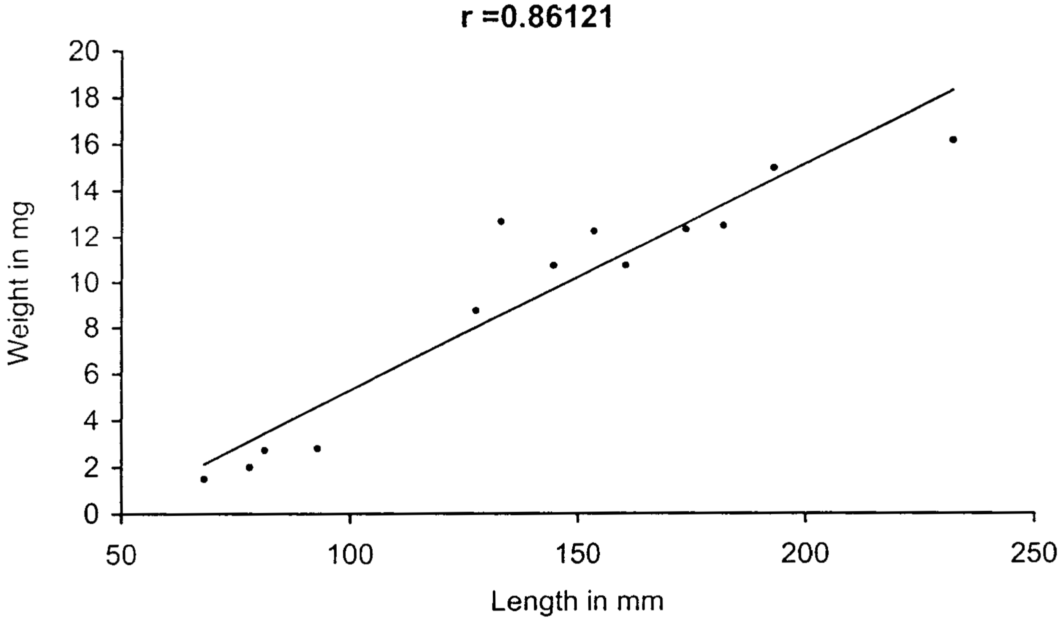

Fig:4-16 Relation between Total length & Eyelens weight *Pomdasys Maculatus* (Female)

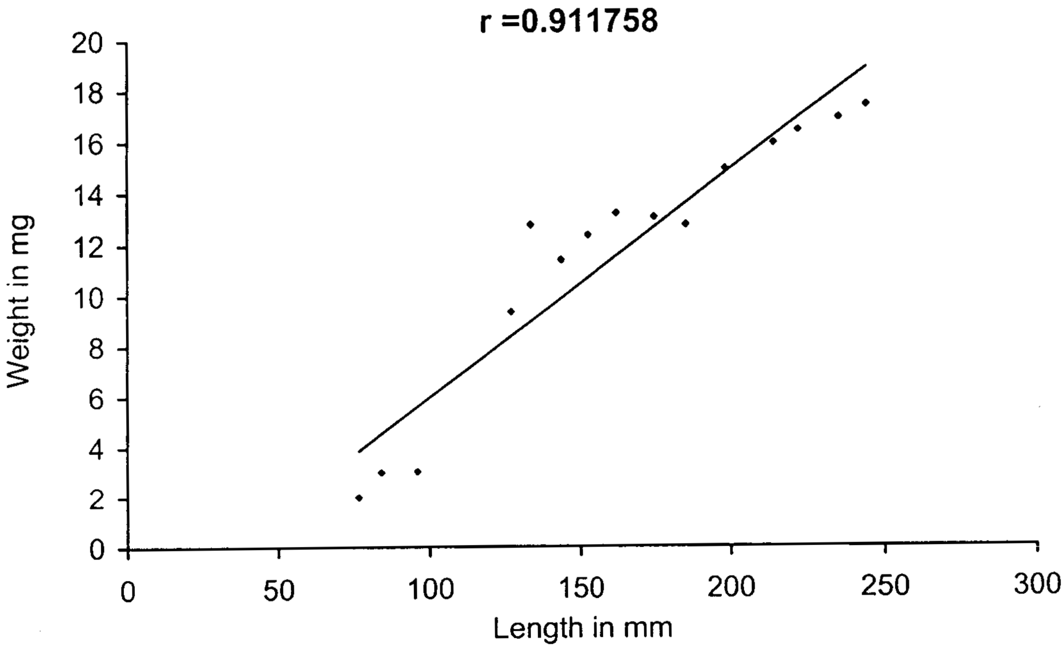

Fig:4-17 **Relation between Total Length & Age**
Priacanthus hamrur(Male)

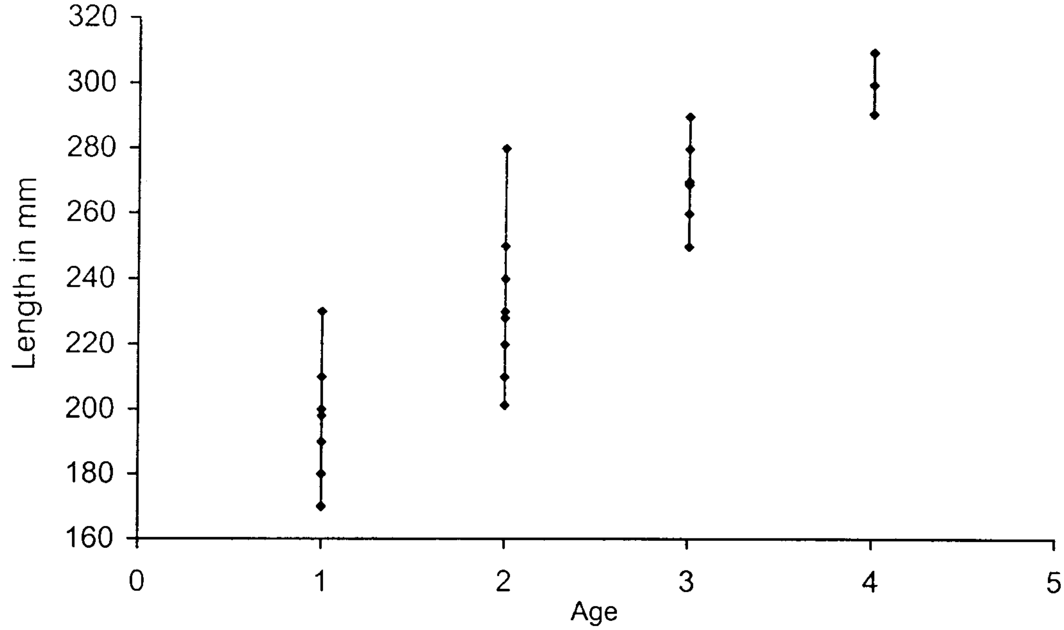

Fig:4-18 **Relation betweenTotal length & Age**
Priacanthus hamrur **(Female)**

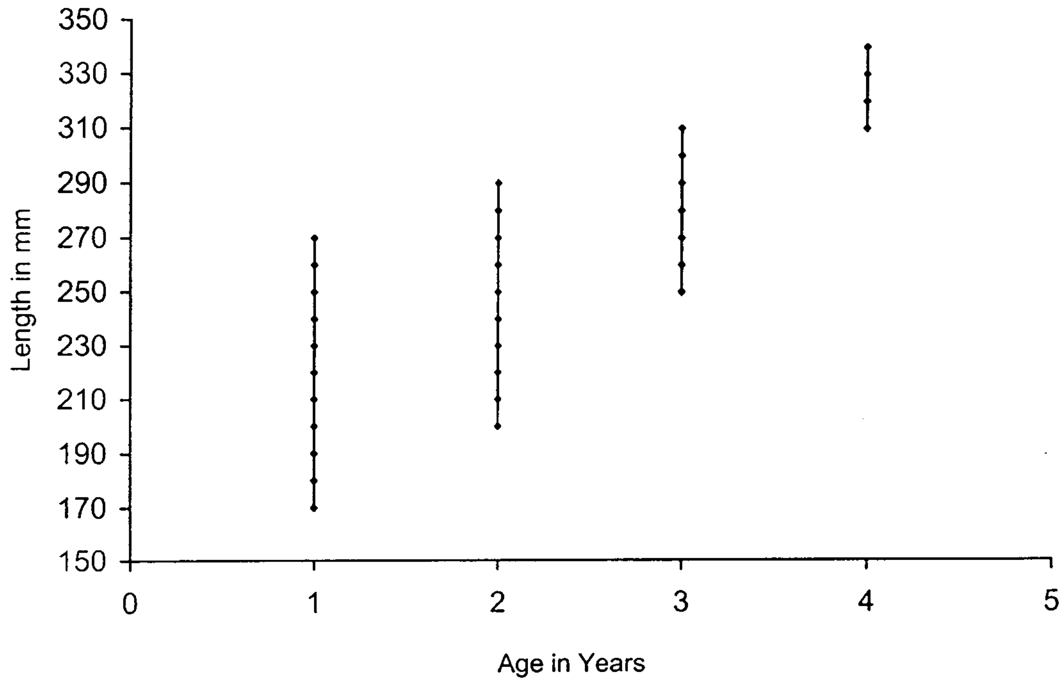

Fig:4-19 Relation between Total length & Age
Pomadasys maculatus(Male)

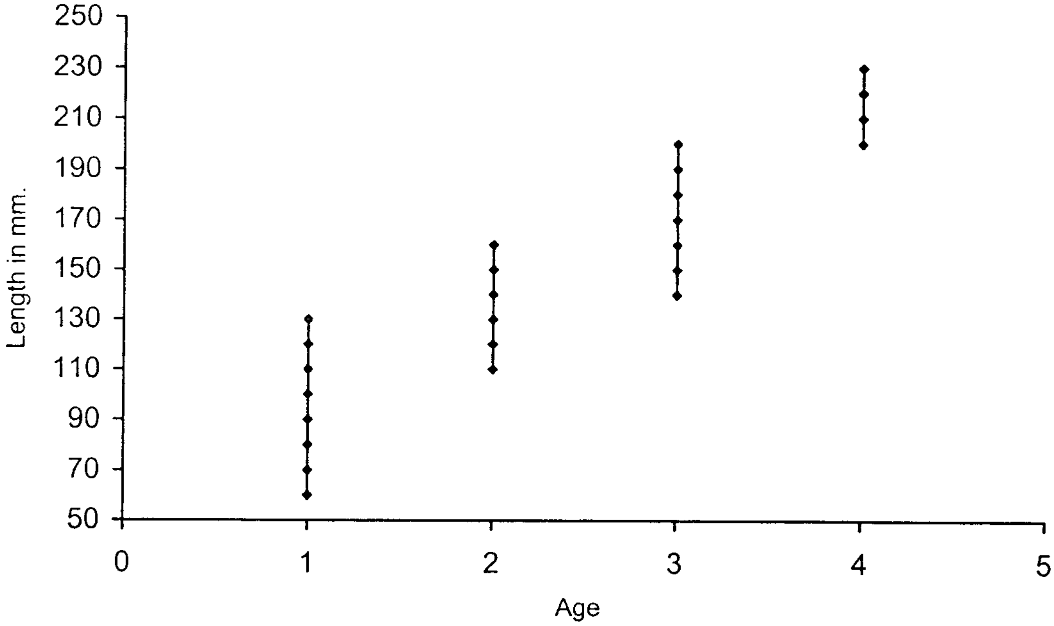

Fig. 4-20 Relation betweeTotal length & Age
***Pomadasys maculatus* (Female)**

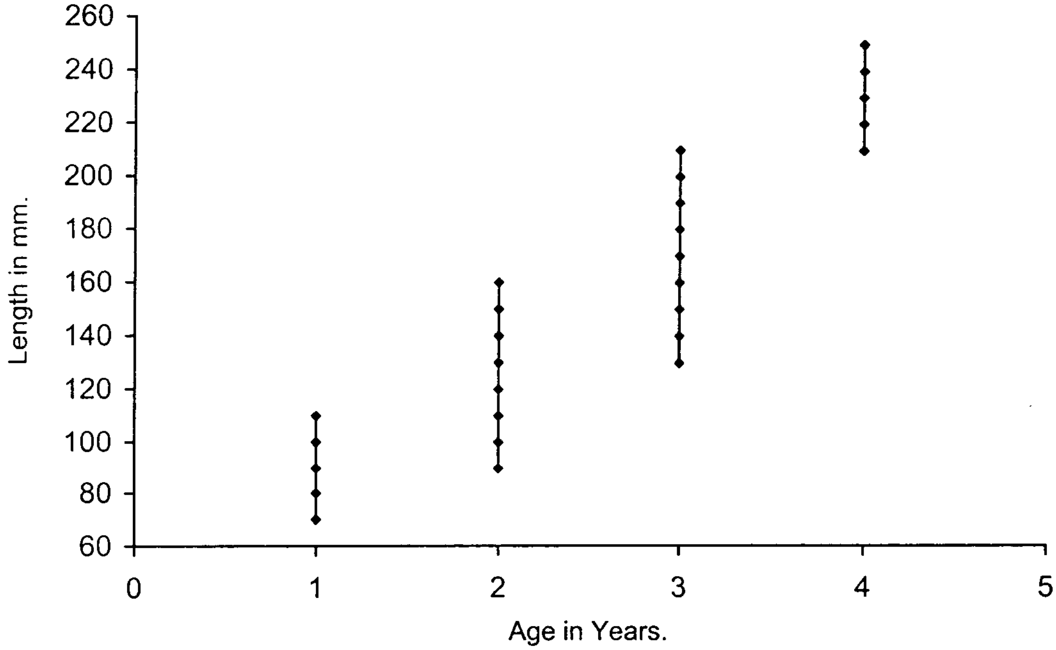

Fig:4-21 **Relation between Age &Eye Weight**
Priacanthus hamrur **(Male)**

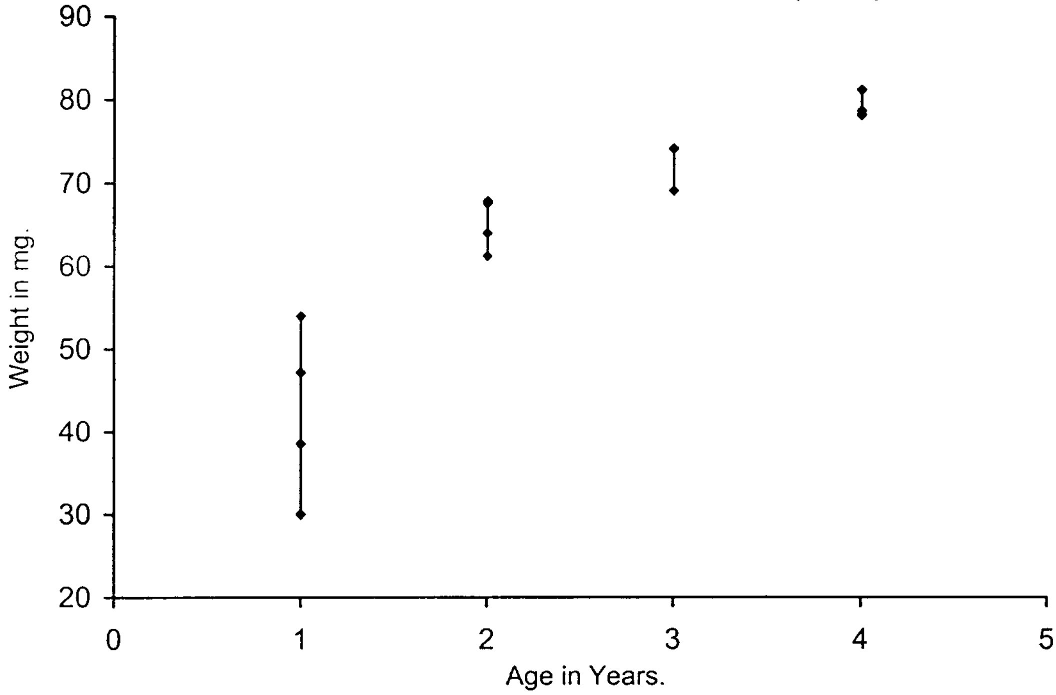

Fig:4-22 **Relation between Age & Eye Weight**
Priacanthus hamrur **(Female)**

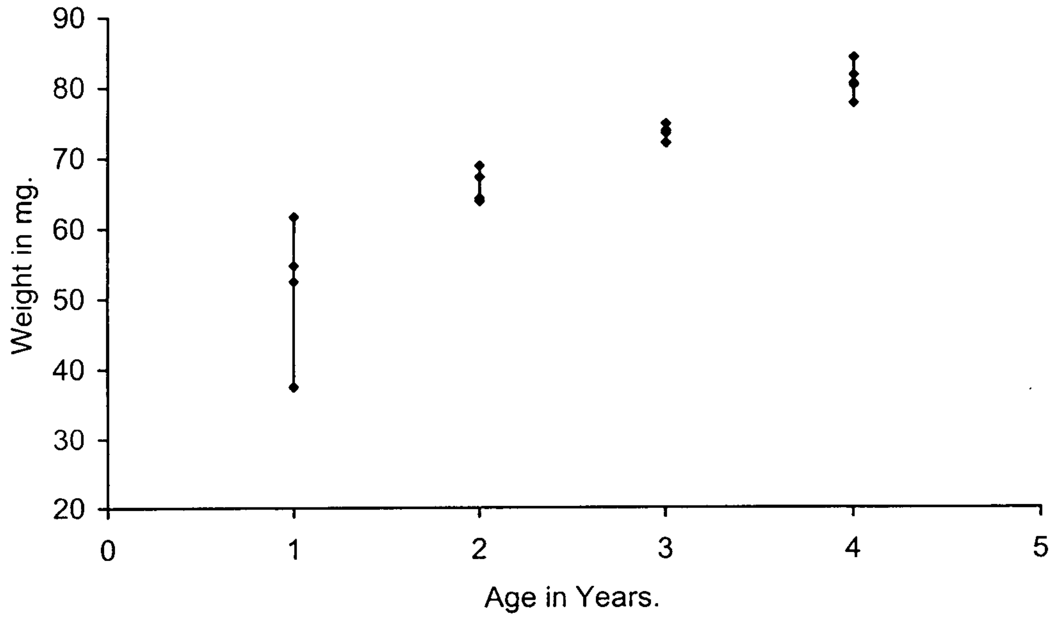

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Fig:4-23 **Relation between Age & Eye Weight *Pomadasys maculatus* (Male)**

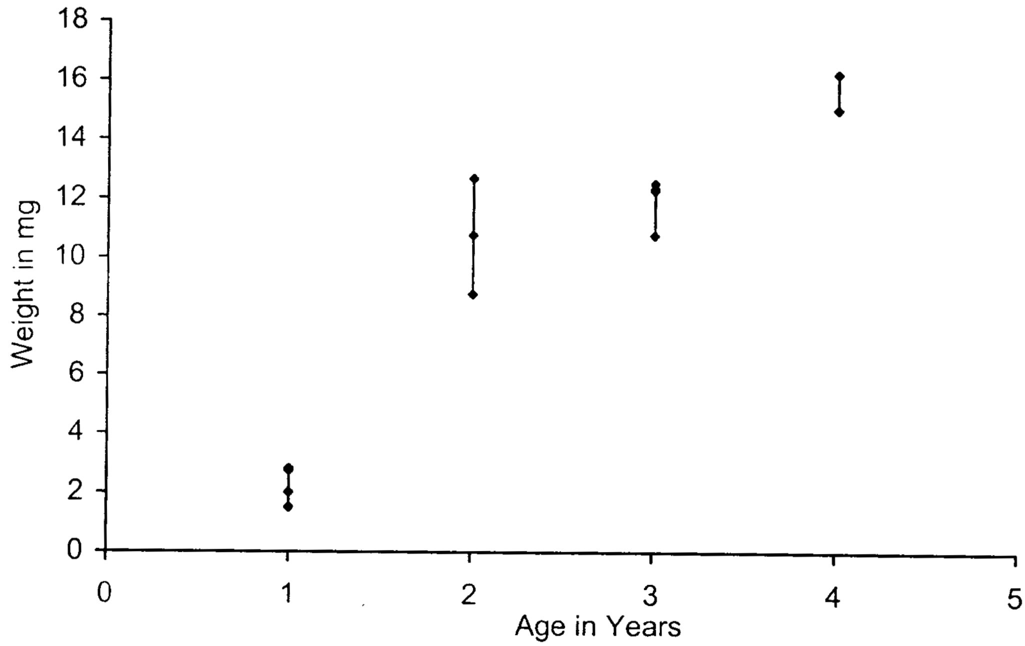
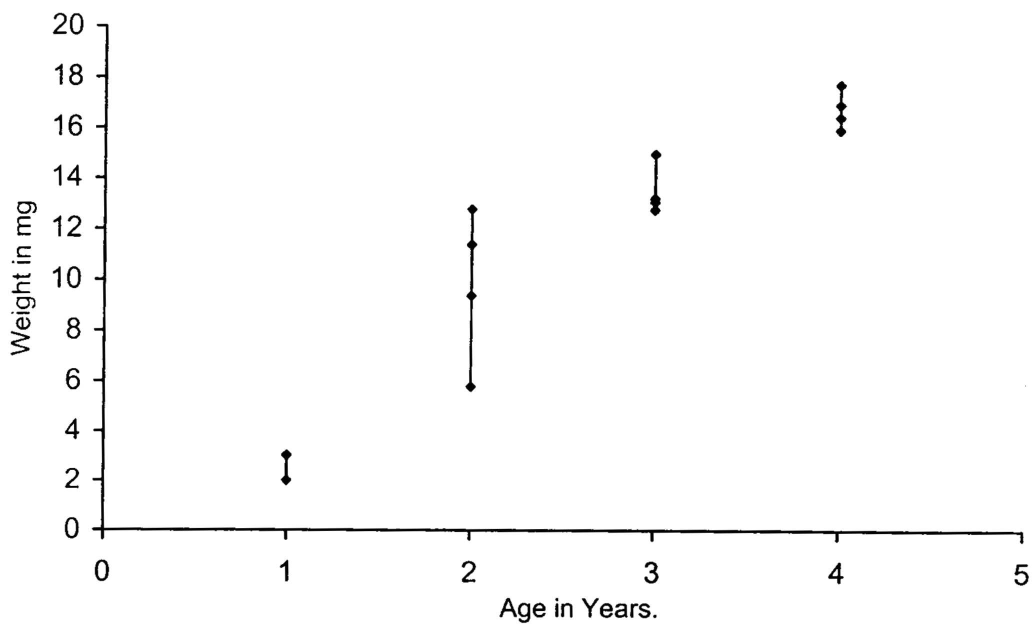


Fig:4-24 **Relation between Age &Eye Weight *Pomadasys maculatus* (Female)**



CHAPTER - 5

LENGTH WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR

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LENGTH WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR

INTRODUCTION

The study of the length weight relationship assumes great importance at present, as it is one of the standard methods, yielding authentic biological information. It provides a mathematical relationship between length and weight, enabling the calculation of one variable from the other (Lecren, 1951). It also provides the direct way of converting logarithmic growth rates into weight and indicates the taxonomic differences and events in the life history. The collection of data on length in the field can be done rather more easily and quickly than the collection of weight data. If a relationship is established between these two variables, the length data can be transformed into weight data. This study also enlights on the general well being of the fish, spawning season, minimum size at maturity, variations in weight due to feeding and growth by estimating the condition factor (K) and relative condition factor (K_n).

According to Lecren (1951) the study of relationship between length and weight in fishes has normally been directed toward two objectives. First one is to provide a mathematical relationship between length and weight, as a means of inter-conversion of these variables. This helps for setting up of yield equations and to compare the body forms of different groups of fishes for determining the pattern of growth. Secondly it helps to measure the variation from the expected weight for fish or a group of fishes of a given length as indications of fatness or general well being. Sometimes, the length weight relationship is utilized for the identification of different stocks of the same species. Beverton and Holt (1957) found that length weight relationship could also be used in setting up yield equations for estimating the number of fishes landed and comparing the population in space and time. Antony Raja (1967) noted that in the case of fishes of commercial importance, this study has been found essential to convert the catch statistics of that species from weight to number in order to obtain the abundance of stock in space and time.

The weight of the fish normally increases with increase in length showing that weight of a fish is a function of length. The weight is a measure of volume and the length is linear; it has been shown that their functional relationship can be described by the hypothetical cube law $W = cL^3$, where W = weight of the fish 'L' its length and 'c' a constant. This equation can be applied to serve as the basis for the calculation of the weight of fish of known length or vice versa, only if the form and specific gravity of the fish remains constant throughout life, obeying isometric growth pattern, in which exponent of length 'L' is found to be equal to 3 (Allen, 1938). The importance of variations in specific gravity of fish in relation to condition was studied by Tester (1940). It was later discussed by Kesteven (1947).

Lecren (1951) stated that density of fish as a whole is maintained the same as the density of the surrounding water and therefore changes in weight for lengths are related to changes in shape or volume and not to specific gravity. Thompson (1943) and Hile (1936) remarked that such changes in condition have been usually analysed by means of a condition factor or coefficient of conditions or Ponderal index. Later Lecren (1951) has pointed out that a more general parabolic equation $W = aL^b$, where W = weight, L = length, a = a constant equal to 'c' and 'b' another constant to be derived empirically from the data. The exponential value of 'b' in the parabolic equation is found to vary from 2.5 to 4 (Hile 1936 and Martin 1949). Allen (1938) has shown that for ideal fish which maintain constant shape, b = 3. Beverton and Holt (1957) has stated that value of 'a' and 'b' may vary within wide limits for very similar data and are sensitive to quite unimportant variation in the latter. Blackburn (1949) has shown that the value of n (b) was below '3' in Australian barra couta (*Thyrsites atum*). In a detailed study on the length-weight relationship of oil sardine from Calicut region Antony Raja (1967) has shown that in the groups indeterminate, immature and mature the values of 'b' in majority were between 2.5 and 3.0, although in some instances most extreme values on the lower and higher sides were significantly different from isometric growth. The constant 'a' can be used to compare an individual with others of the same species after 'b' is established. Brown (1957) stated that the value of 'a' will depend on the fatness, as the specific gravity of the fish flesh does not vary much within species and it will be high in fat fishes and low in thin fishes.

The equation $W = aL^b$ can be transformed into linear function by taking logarithmic value of the length and weight data and the values 'a' and 'b' can be estimated by regression analysis. Then the equation takes the form of

$$\log W = \log a + b \log L \text{ or}$$

$$Y = A + bx$$

where $Y = \log W$, $x = \log L$, $A = \log a$, the intercept of the line on the Y axis and b an exponent.

In India, regarding the length weight relationship many studies have been made on a large number of marine fishes. The first work in India with the application of an approved modern statistical technique was done by Jhingram (1952) on 3 species of major carps namely, *Labeo rohita*, *Cirrina mrigala* and *Catla catla*. He applied Herbert Spencer's modified cube law equation i.e. $W = aL^3$ in these fishes. Some of the other works are of Prabhu (1955) on ribbon fish on *Trichiurus haumela*, Bal & Joshi (1956) on *Coilia dussumieri*, Radhakrishnan (1957) on *Sillago sihma*, Rao (1962) on *Pseudosciaena diacanthus*, Antony Raja (1967) on *Sardinella albella*, Sekharan (1968) on

Sardinella gibbosa, Krishnamoorthi (1971) on *Nemipterus japonicus*, Kagwade (1971) on *Polynemus heptadactylus*, James and Badrudeen (1981) on *Leiognathus dussumieri*, Seshappa (1981) on *Cynoglossus semifasciatus, Cynoglossus dubius* and *Cynoglossus bilineatus*, Srinivasan (1981) on *Decapterus dayi*, Murthy (1984) on *Nemipterus japonicus*, Muthiah (1982) on *Japonicus vogleri*, Seshappa & Chakrapani(1983) on the male and females of *Cynoglossus lida*, Kulkarne *et al* (1986) on the length-weight relationship of Scolidon, Madhusoodana Kurup and Samuel (1987) on *Daysiraene albida* (Cuv) and *Gerrus filamentosus* (Cuv), Muthiah (1986) on *Euthynus affinis*, Jayachandran and Joseph (1988) on *Palaemonid Prawns*, Gopinathan (1988) on Tilapia, Rao (1988) on *Stolephorus devisis*, Das and Misra (1989) on the Indian Halibut (*Psettodes erumei*), Giasuddin khan *et al* (1989) on *Nemipterus japonicus*, Devadoss (1989) on the length weight relationship of spade nose shark, Johal *et al* (1989) on *Colisia fasciata*, Chakraborthy (1990) on *Trichiurus lepturus* from Bombay waters, Jayasankar (1990) on *Otoliths rubber* (Schneider, 1801), John and Balakrishnan Nair (1991) on relative condition in *Nandus nandus* (Hamilton), Madhusoodana Kurup and Samuel (1992) on mullet *Liza parsia*, Tessy (1994) on *Epinephleus*, Philip (1994) on *Priacanthus*, Sivakamy (1995) on *Megalaspsis cordylea*, King (1996) on *Cynoglossus canariensis,* Das *et al* (1997) on catfish *Arius tenuisponis*, Jayaprakash (1998) on *Cynoglossus* and Sadashiva Gopal Raje (2000) on five species of rays from Mumbai.

Eventhough the length weight relationship in many Indian teleost fishes are available, not many studies have done on the length weight relationship of *Priacanthus hamrur* and *Pomadasys maculatus* of Central Kerala. Some works on the related species of Priacanthus are by Chomjurai (1970) on *Priacanthus tayenus*, Wetchagrun (1971) on *Priacanthus tayenus* from gulf of Thailand, Chantawong *et al* (1984) on *Priacanthus tayenus* from Andaman Sea, Hayase *et al*. (1988) on the length weight relationship of *Priacanthus* *macracanthus* and Philip & Mathew (1996) on Priacanthus hamrur from North-East cost of India.

Some works have done on the length weight relationship of different species of Pomadasys. Some of them are Al-ghais (1995) on *Pomadasys stridens*, Hussian *et al* (1992) on *Pomadasys kakkan* and Iqbal (1989) on *Pomadasys kakken*. From all their works it is clear that no great attempt about the length weight relationship of *Priacanthus hamrur* and *Pomadasys maculatus* have been made from Kerala. So the present study enlights the length weight relationship of *Priacanthus hamrur* and *Pomadasys maculatus* of central Kerala.

MATERIALS AND METHODS

Random samples of both fishes – *Priacanthus hamrur* and *Pomadasys maculatus* were collected from the commercial landings at Munampum and Chavakkadu. Samples were brought to the lab and freezed. Then they were cleaned and excess moisture was removed, before taking the length and weight. The total length was measured in mm. from the tip of the snout to the tip of mid caudal fin end. Length and weight were taken up to 0.1 mm and 0.5 gm respectively for both males and females of *Priacanthus hamrur* and *Pomadasys maculatus*. A total of 141 *Priacanthus hamrur* and 134 *Pomadasys maculatus* were taken for the study. Of the 141 *Priacanthus hamrur* 71 were females and 70 were males. Similarly of the 134 *Pomadasys maculatus* 60 wery females and 74were males.

The length weight relationship can be expressed as

$$W = aL^b$$

For fitting the general exponential equation $W = aL^b$, least square method of estimation was made using log L = X and log W = Y for obtaining values of $\sum X$, $\sum X^2$, $\overline{X}$, $\sum Y$, $\sum Y^2$, $\overline{Y}$ and $\sum XY$. $\overline{X}$ and $\overline{Y}$ represent mean values of

X and Y respectively and 'N' number of samples. The regression coefficient or slope of the regression line (b) was computed using the equation

$$b = [\Sigma XY - (\Sigma X)(\Sigma Y) / N] / [\Sigma X^2 - (\Sigma X)^2 / N]$$

The intercept 'a' was determined by the formula $a = \overline{Y} - b\overline{X}$. Using the values the linear equation of length weight relationship Log W = log a + b log L or Y = A + bx was obtained (where log a = A). Further, converting these logarithmic values into antilogarithms the exponential form $W = aL^b$ was obtained. The relationship was established for males, females and combined data.

The significance of variation between the regression co-efficient of both sexes was tested by analysis of co-variance. Snedcor and Cochran (1967).

The estimates of regression co-efficient of males and females were tested for finding the significance of variation from the expected value of 3 by employing the 't' test using the formula.

$$t = (b - B) / S_b$$

where B is equal to 3, S_b = standard error of b.

The relationship was established for both male and female by linear regression of the natural logarithms of length and weight data. The regression analysis, ANOVA of the regression equation 't' test on 'b' and 'r' values were carried out as per standard statistical procedure (Snedcor, 1961). R. C. Factor (K_n) was estimated for males and females using the formula $K_n = W/w$ where W = observed weight and w = calculated weight from the length weight relationship. K_n values of various length groups and for different months were calculated after obtaining the mean lengths and weights for corresponding length groups and months.

RESULTS

The length weight relationship of males, females and combined (pooled) data of *Priacanthus hamrur* and *Pomadasys maculatus* was found out using the formula $W = aL^b$. This expression $W = aL^b$ can be transformed to the logarithm equation in respect of length and weight relationship.

$$\text{Log } W = \log a + b (\log L)$$

Length Weight Relationship of *Priacanthus hamrur*

In *Priacanthus hamrur*, the males of the size range 170 mm to 265 mm (59 gm to 230 g in weight) and the females of the size range 175 mm to 304 mm (62 g to 320 gm) were analysed for computing the length weight relationship. The general equation Log W = log a + b (log L) can be written as $Y = A + bX$ where $Y = \log W$, $A = \log a$ and $X = \log L$ which is a liner relationship between Y and X. This linear equation was fitted separately to the data of male, female and combined fishes. The estimates of the parameter a and b for each of these categories obtained were given (Table 5.1) and presented in the equations below.

Male $w = 0.000004442\, L^{3.165569}$

Female $w = 0.000006859\, L^{3.085506}$

Pooled $w = 0.000005681\, L^{3.119901}$

The corresponding logarithmic equation may be written as

Male $\log w = -5.35242 + 3.165569 \log L$ (r = 0.911216)

Female $\log w = -5.163722 + 3.085506 \log L$ (r =- 0.971614)

Pooled $\log w = -5.245555 + 3.119901 \log L$ (r = 0.9599)

The scatter diagram of observed value of weight (grams) against total length (mm) and the flitted curve separately for males, females and pooled are given in (Fig. 5.1, 5.2 and 5.3) which showed a curvilinear relationship for both sexes. The logarithmic form of relationships are shown in (Fig. 5.4 & 5.5).

While the above formula hold good for the length weight relationship of *Priacanthus hamrur*, the significance of variation in the estimate of 'b' for this species from the expected value for ideal fish (3.0) was tested by the 't' test (Table 5.2) as given by the formula $t = (b - B) / S_b$ the result were as follows.

Male	= t = 3.165569 – 3/0.11881295	= 1.3935 N.S at 5%
Female	= t = 3.085506 – 3/0.06302201	= 1.3567 N.S at 5%
Pooled	= t = 3.119901 – 3/0.053694	= 2.2330 N.S at 1%

The values were not significant and the cubic formula $W = aL^3$ is a proper representation of the length weight relationship of *Priacanthus hamrur*. Analysis of variance on these regressions indicates that the residual variances were homogenous and significant 'F' values obtained for the regression coefficient (Table 5.3). The analysis of variance proved that the length-weight relationship between males, females and pooled were statistically significant and highly associated.

The Length Weight Relationship of *Pomadasys maculatus*

The following length weight relationship of males, females and pooled data of *Pomadasys maculatus* were calculated and presented (Table 5.4).

Male	$W = 0.000023213\ L^{2.915242}$	r = 0.98107
Female	$W = 0.000028863\ L^{2.871908}$	r = 0.983157
Pooled	$W = 0.000024887\ L^{2.901357}$	r = 0.982321

The corresponding logarithmic equation may be written as

Male = $\log w = -4.634267 + 2.915242 \log L$ (r =0.98107)

Female = $\log w = -4.539652 + 2.871908 \log L$ (r = 0.98315)

Pooled = $\log w = -4.604013 + 2.901357 \log L$ (r = 0.982321)

Statistical details regarding length weight relationship of males females and pooled are shown in (Fig. 5.6, 5.7, 5.8) which showed a curvilinear relationship for both sexes. The logarithmic relationship between length and weight of male and female are represented in (Fig. 5.9 and 5.10).

In *Pomadasys maculatus* also the above formula holds good for the length weight relationship, the significance of variation in the estimate of 'b' for the species from the expected value for ideal fish (3.0) was tested by the 't' test (Table 5.5).

Male t = 2.915242 – 3/0.047723 = 1.776 N.S at 5%

Female t = 2.871908 – 3/0.04893 = 2.618 S at 1%

Pooled t = 2.901357 – 3/0.033748 = 2.923 S at 1%

The above results revealed that 't' values in males, females and pooled datas were not significantly deviating from '3', but slightly below 3 (Table 5.6). In the males and females the exponential value were found to be below 3, which would indicate lean pattern of growth.

While the *Priacanthus hamrur*, the exponential values were slightly above '3' thus showing stoutest pattern of growth. In both species the formula $W = aL^3$ is a proper representation of the length weight relationship. The growth is isometric in both the sexes.

Relative Condition Factor

Information regarding seasonal variations of the condition of a fish in relation to both the internal and external environment becomes an utmost necessity in fishery biological studies. The condition of a fish may be driven to great variations due to physiological, environmental, nutritional and biological cycles. Finding of the relative condition factor has got great significance for understanding the nutritional and biological cycle of a fish.

Variation from the expected weight for length of individual fish or groups of individuals is an indication of condition (Lecren 1951) of the fish due to several factors like fatness, general well being or gonad development. Tester (1940) has shown that the variation in the specific gravity in the flesh of the fish occurs and its importance in the study of condition have been discussed by Kesteven (1947). The variation in weight against length are not due to changes in specific gravity but due to changes in volume or form, since the fish always maintain the same density as that of surrounding water. These changes are analyzed by the condition factor or coefficient of condition or ponderal index (Hile, 1936; Thompson, 1943; Lagler, 1956). The cube law using the expression represents the condition factor.

$K = WL^3 \times 100$ where K = condition factor w = wt of fish, L = length of fish. But this formula does not function adequately independent of length and other variables like age, sex, maturity, food supply, parasitation, environment etc. Lecren (1951) has formulated a relative condition factor K_n and expressed by the formula $K_n = W/aL^n$ or $K_n = W/w$. where K_n = relative condition factor, W = observed weight, w = calculated weight got from the length weight relationship. The difference between K (condition factor) and K_n (relative condition factor) is that, the former measures the deviation of an individual from the average weight for length, while the latter measures the deviation from the hypothetical ideal fish.

The relative condition factor K_n for *Priacanthus hamrur* and *Pomadasys maculatus* was studied in detail by using the formula $K_n = W/w$. The K_n values in different size groups of both fishes as well as the monthly average relative condition factor (K_n) was calculated separately for males and females. The K_n of the pooled data (combined) was also found out in both fishes.

Relative condition factor in relation to size

For *Priacanthus hamrur* the mean K_n value in relation to size group of males ranging in size from 170 mm to 270 mm represented in Fig. 5.11 and for females ranging in size from 170 mm to 310 mm is represented in Fig. 5.12. The K_n values of different size group give an idea about the variation in the condition of the fish during its growth. In *Priacanthus hamrur* the fluctuation in the relative condition factor with increase in length of fish are quite apparent in Fig. 5.11, 5.12 & 5.13. The K_n value was greater than 1 for the male fishes in size groups ranging 170 mm to 220 mm. But, in 230 mm and 240 mm group, it came to a fall and the K_n value was less than 1. Again it increased in size group ranging 250 mm to 270 mm. It reached a maximum value in 250 mm group. In the case of females the K_n value was greater than 1 in size groups ranging from 170 mm to 230 mm. In 240 mm group it was lower than 1. Again the K_n value increased above 1 and reached the maximum at 260 mm group. So both in males and females the middle class group (240 mm – 260 mm) showed the maximum K_n value. Two peaks are noticed in both males and females followed each by a decrease indicating the 2 spawning seasons. The decrease in K_n value indicates spawning period.

The point of inflexion on the curve showing decrease in K_n with increasing length is a good indication of the length at which sexual maturity starts (Pillay 1958) Sarojini (1957), Parulekar and Bal (1971) and Devaraj (1977). At the tine of attaining sexual maturity a fall in K_n value can be noticed in *Priacanthus hamrur*.

In *Pomadasys maculatus* also the mean K_n value for different size groups of males ranging in size from 60 mm to 240 represented in Fig. 5.14 and for females ranging in size from 70 mm to 240 represented in Fig 5.15. The pooled data represented in Fig. 5.16. The fluctuation in the relative condition factor with increase in length of *Pomadasys maculatus* is very clear (Fig. 5.14 & 5.15). The K_n value was greater than 1 in male groups 80 mm, 140 mm, 150 mm, 200 mm, 210 mm, and 240 mm groups. It was less than 1 in groups 90 mm to 130 mm, 160 mm to 200 mm and 220 mm. It reached the maximum at 240 mm group. In female *Pomadasys maculatus* the K_n value was above 1 in size groups 80 mm, 120 mm to 160 mm, 190 to 210 mm groups. It was less than 1 in 90 to 110 mm, 170 mm to 190 mm and 210–240 mm groups. In female the maximum K_n was seen in 120 mm group. In *Pomadasys maculatus* also a fall in K_n value was noticed at the time of attaining sexual maturity. It was suggested by Pantalu (1961) and Devaraj (1977) that the increase in the K_n values between different length groups of both sexes can be related to the number of spawning during the longevity of a fish.

Relative condition factor in relation to season

K_n was computed monthly for a period from1997 January to 1998 December in the case of *Priacanthus hamrur* and *Pomadasys maculatus*. The average K_n values for the 2 years of each month represented separately for both sexes in each fish (Fig. 5.17 to 5.22). Many factors are seem to be influencing the monthly fluctuations in the K_n values. These fluctuations are independent of the reproductive cycle and can be better related to the feeding and rhythm [Hile (1936), Quasim (1973a), Blackburn (1950)].

The monthly K_n values of *Priacanthus hamrur* were worked out for 24 months for males, females as wellas pooled and their averages were presented (Fig. 5.17, 5.18 and 5.21). In male *Priacanthus hamrur* K_n value seemed to be above 1 in all months. The highest K_n noticed in July and the lowest in September. In January it was 1.0107, then K_n value declined during February, March, April again increased from April to July. After July K_n value declined, but showed a rise in November and December. In female K_n value was above 1 in all months except September and October. The highest K_n value noticed in the month of July and the lowest in October. This may be related with the maturation and spawning period. In January it was 1.145 then declined in February and March, increased in April to July. Again K_n was declined from August to October, but showed a rise in November and December. The abrupt fall in the condition factor may be attributed to the increased metabolic strain of spawning. The changes in K_n values are more or less similar in both sexes during different seasons, indicating that the metabolic strain undergone by males as well as females is almost the same in *Priacanthus hamrur*.

In *Pomadasys maculatus* also the K_n value was above 1 in all months in the case of males. Two peaks for K_n value was noticed, one was in May (1.259) and the other in October (1.27) (Fig. 5.19). The lowest value 1.04 was noticed in September. In females the highest K_n value (1.463) noted in February (Fig. 5.20) and the next peak was seen in November (1.249). The lowest value 0.969 was seen in September. The pooled data also represented (Fig. 5.22). The changes in K_n values were more or less similar in both sexes during different months indicating maturation and spawning period, which creates changes in the metabolic strain.

DISCUSSION

In this study of length weight relationship, an exponential relationship was obtained when length plotted against weight. Similarly a linear curve was obtained when logarithm of length of both fishes *Priacanthus hamrur* and *Pomadasys maculatus* plotted against logarithms of weight. In males and females of *Priacanthus hamrur,* the regression coefficients were well above the expected value of 3. But males showed a slight greater value than females indicating a higher rate of weight increase in males than in females. Philp (1994) got a higher 'b' value in males than in females. But there was no much difference between the regression coefficients of both sexes in *Priacanthus hamrur.* But Joung and Chen (1992) observed that the length weight relationship between male and female was significantly different at 5% level in the case of Priacanthus macracanthus from Gueishen Island, Taiwan. 'b' value of 2.7 and 2.9 was observed respectively for *Priacanthus tayenus* and *Priacanthus macracanthus* in Hong Kong water and found that the value did not show significant deviation ($p = 0.05$) from isometric growth. In this fish the slope of the relationship between the 2 sexes showed no significant difference at 5% and 1% level, a combined equation for males and females would explain the relationship better. Nugroho & Rumstam (1983) and Chantawong *et al*(1984) got a combined 'b' value of 2.7 for *Priacanthus macracanthus* and 2.5 for *Priacanthus tayenus* for both sexes respectively.

In *Pomadasys maculatus* the regression coefficient was below the expected value of 3 in both sexes. According to Growner *et al* (1976), the slope value less than 3.0 indicates that fish becomes more slender as it increases in length, while slope greater than 3.0 denotes the stoutness, leading to the conclusion that growth is allometric. Hussain and Ahmed (1992) observed that relative weight index of *Pomadasys kakkan* allows easy interpretation of conditions for fish of various species and lengths. It can be used as an efficient tool for assessment of fish population, condition and balance. In males of *Pomadasys maculatus* it was slightly bigger than female showing a higher rate of weight increase in males than in females as in the case of *Priacanthus hamrur*. In this fish also the slope of the relationship between length and weight showed no significant difference at 5% and 1% level, a combined equation for males and females would explain the relationship better. The value of 'b' usually varies between 2.5 and 4 (Martin, 1949). In the present study the 't' value have shown insignificant in the 'b' values from the expected value of 3 for males and females at 5% and 1% level.

Earlier worker attributed different factor for variation in the condition factor of different fishes. Hickling (1940) found the condition low before spawning and high after it in the case of *Sardina pilchardus* and he explained this as due to sexual cycle and the availability of food. Blackburn (1949) found in Australian barrcouta that it was not possible to interpret the changes in condition of this fish basing on sexual cycle or the intake of food, and that it may depend on several other factors. In the white fish *Lactarius lactarius* fluctuations in the condition are closely related to sexual cycle. Brown (1957) pointed out that the balance between maintenance and growth might vary with physico-chemical factors of the environment and with age and physiological state of the fishes. James (1967) suggested that the changes in the condition of ribbonfish *Eupleurogrammus intermedius* are related to factors other than reproductive cycle and the feeding habit. Reerben *et al* (1997) observed an inflexion in the K_n value prior to the onset of maturity indicating the physiological changes of the fish. According to Philip (1994) no such inflexion as observed in *Priacanthus hamrur* prior to or during the size at first maturity indicating that the sexual cycle of this fish does not have any profound influence on the condition of the fish. In *Pomadasys corvinaeformis*, the month condition factor is highest during summer and lowest during winter (de-Tarso-da-Cunha-

Chavs, 1998). But in the present study ~~of~~ with *Priacanthus hamrur* and *Pomadasys maculatus* it was found that condition of the fish was influenced by feeding intensity as well as sexual cycle.

In conclusion it can be said that the correlation coefficient 'r' in both fishes was found to be highly significant. The regression co-efficient of both sexes in both *Priacanthus hamrur* and *Pomadasys maculatus* did not differ significantly from" 3" indicating isometric growth.

Table 5.1: Length Weight Relationship of Male, Female and Pooled Data of *Priacanthus hamrur*

Group	N	ΣX	ΣY	ΣXY	ΣX^2	ΣX^2	b	a	γ
Males	70	161.73	137.30	317.54	373.77	270.38	3.16	.00000442	.98107
Females	71	168.79	149.03	350.16	395.96	310.96	3.08	.00000685	.98315
Pooled	141	325.94	282.63	659.24	759.26	574.49	3.11	.00000568	.98232

Table 5.2: Statistical Analysis to Test Deviation from the Cube Law of *Priacanthus hamrur*

Group	b	DF	Sb	T = (b – 3)/Sb	P %
Male	3.165569	69	0.1188123	1.393534	1.04 E-37
Female	3.085506	70	0.0630220	1.356764	2.5319 E-55
Pooled	3.119901	140	0.0536940	2.233000	6.90 E-700

Table 5.3: Analysis of Variance of Length Weight Regression of *Priacanthus hamrur*

Source	Degree of Freedom	Sum of Squares	Mean of Squares	F value	Probability
Male	69	1.06441	0.9727	709.8655	1.04 E-37
Female	70	2.29510	2.2318	2397.0021	2.53191 E-55
Pooled	141	3.968462	3.8116	3376.1750	6.9 E-100

Table 5.4: Length Weight Relationship of Male, Female and Pooled Data of *Pomadasys maculatus*

Group	N	ΣX	ΣY	ΣXY	ΣX^2	ΣX^2	b	a	γ
Males	74	153.37	104.18	220.75	319.53	161.73	2.91	.0000232	.99049
Females	60	127.42	93.56	201.48	271.57	154.36	2.87	.0000288	.99169
Pooled	134	-	-	-	-	-	2.90	.0000249	.99119

Table 5.5: Statistical Analysis to Test Deviation from the Cube Law of *Pomadasys maculatus*

Group	b	DF	Sb	T = (b – 3)/Sb	P %
Male	2.915242	73	0.047723	-1.776	8.97 E-64
Female	2.871908	59	0.048930	-2.618	2.36 E-53
Pooled	2.901357	133	0.033748	-2.923	9.10 E-118

Table 5.6: Analysis of Variance of Length Weight Regression of *Pomadasys maculatus*

Source	Degree of Freedom	Sum of Squares	Mean of Squares	F value	Probability
Male	73	14.37278	14.104489	3731.550	8.97 E-64
Female	59	8.15054	8.017919	3444.958	2.36 E-53
Pooled	133	23.28394	22.878495	7390.948	9.10 E-118

Fig: 5-1 Relation between Length & Weight
Priacanthus hamrur - Male

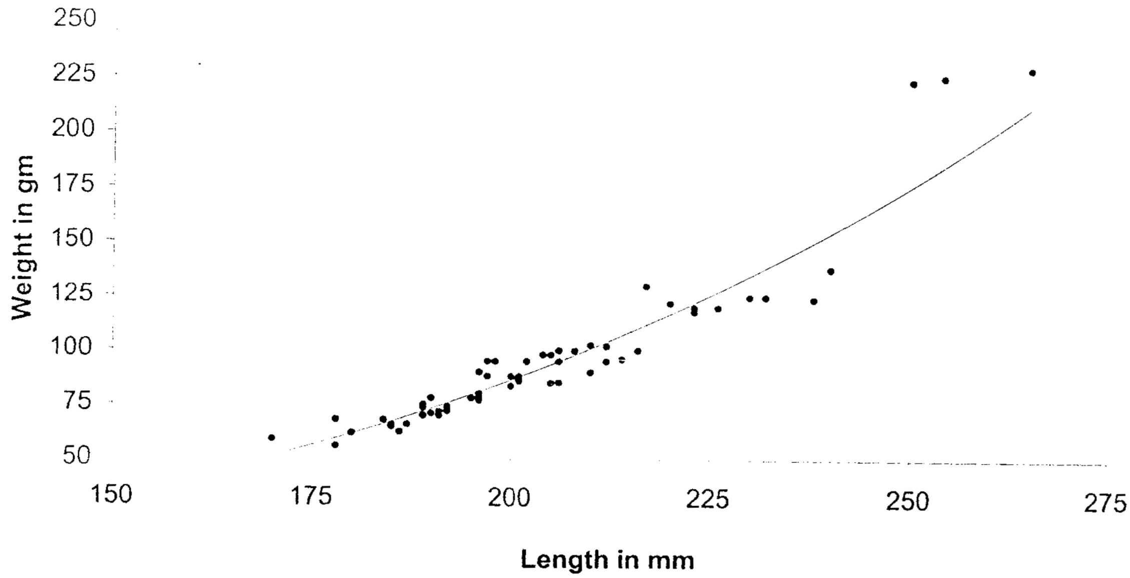


Fig: 5-2 Relation between Length & Weight
Priacanthus hamrur- Female.

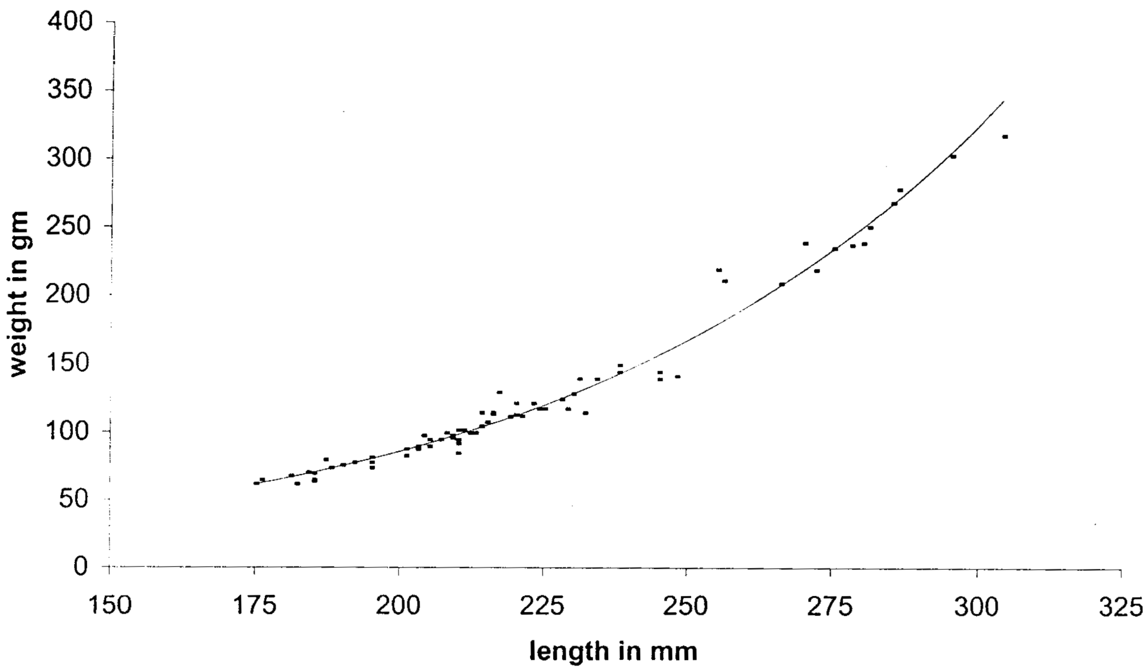


Fig: 5- 3 Relation between Length & Weight for *Priacanthus hamrur* (Pooled)

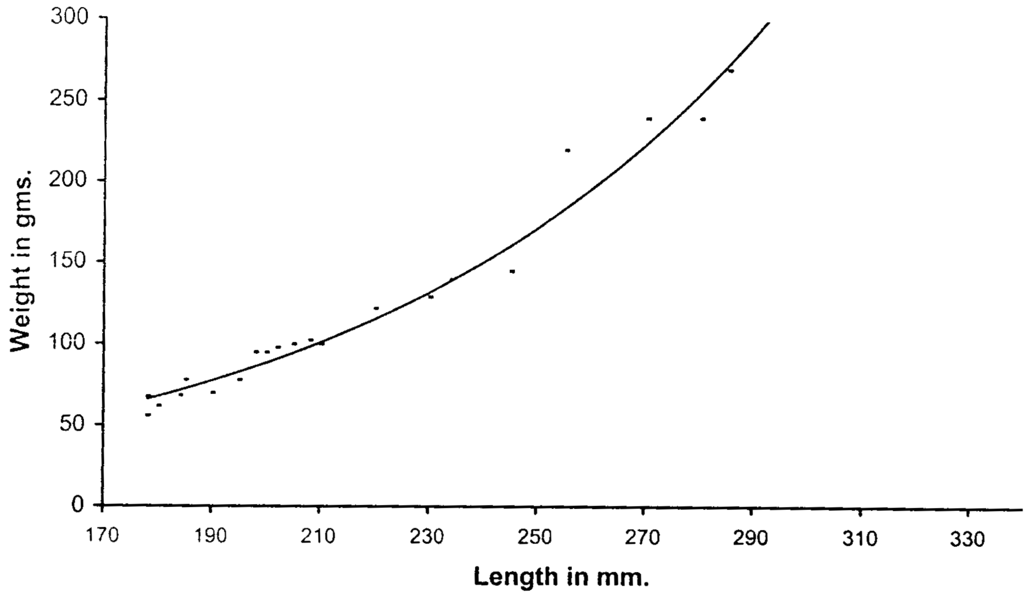


Fig: 5- 8 Relation between Length & Weight for *Pomadasys maculatus* (Pooled)

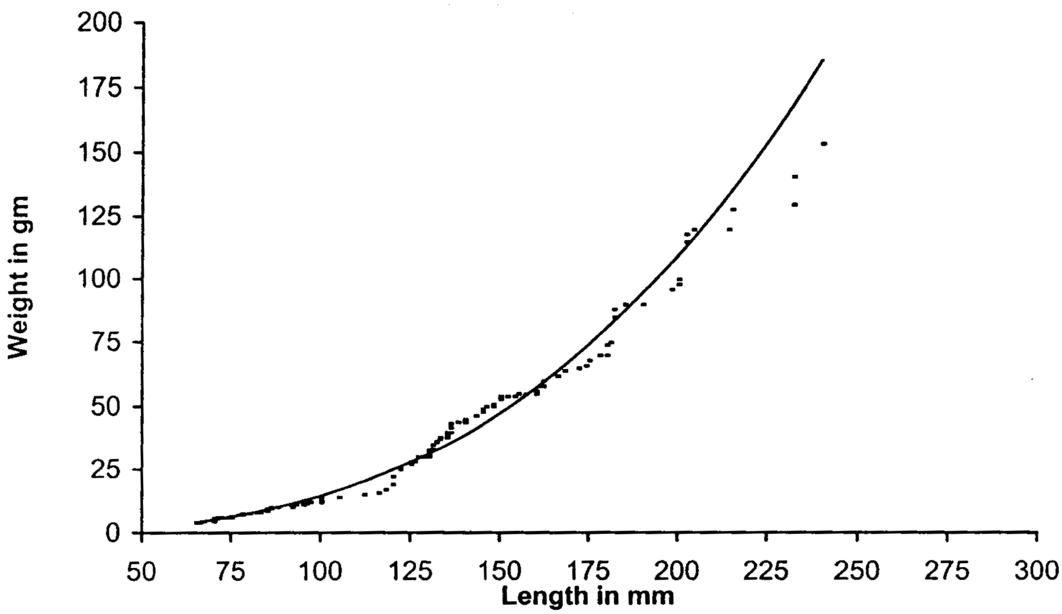


Fig:5-4 **Relation between Log L & Log W**
Priacanthus hamrur - Male

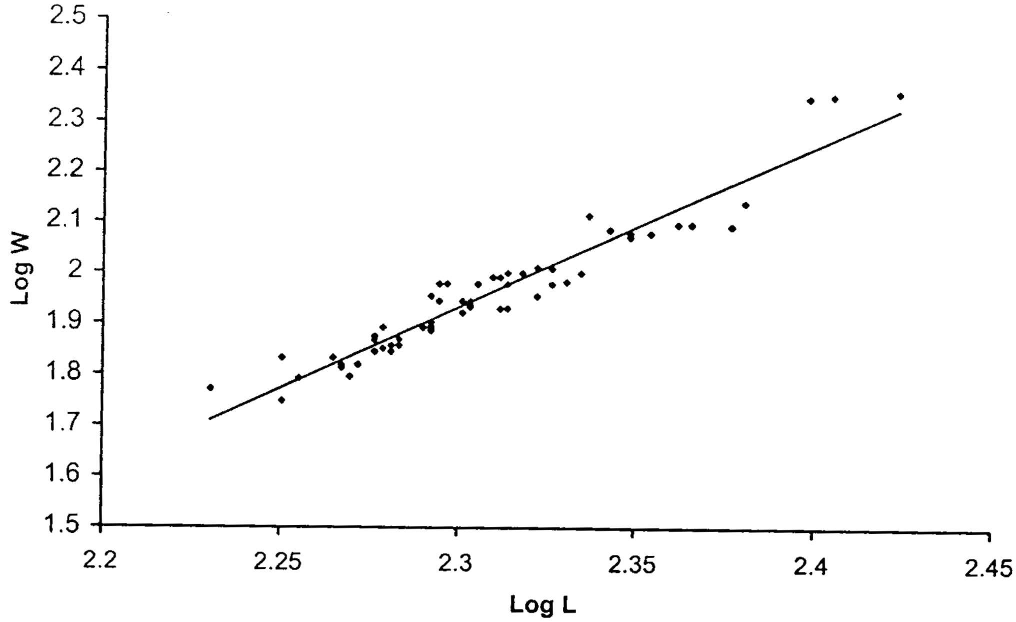


Fig :5 - 5 **Relation between log L& log W**
***Priacanthus hamrur* Female**

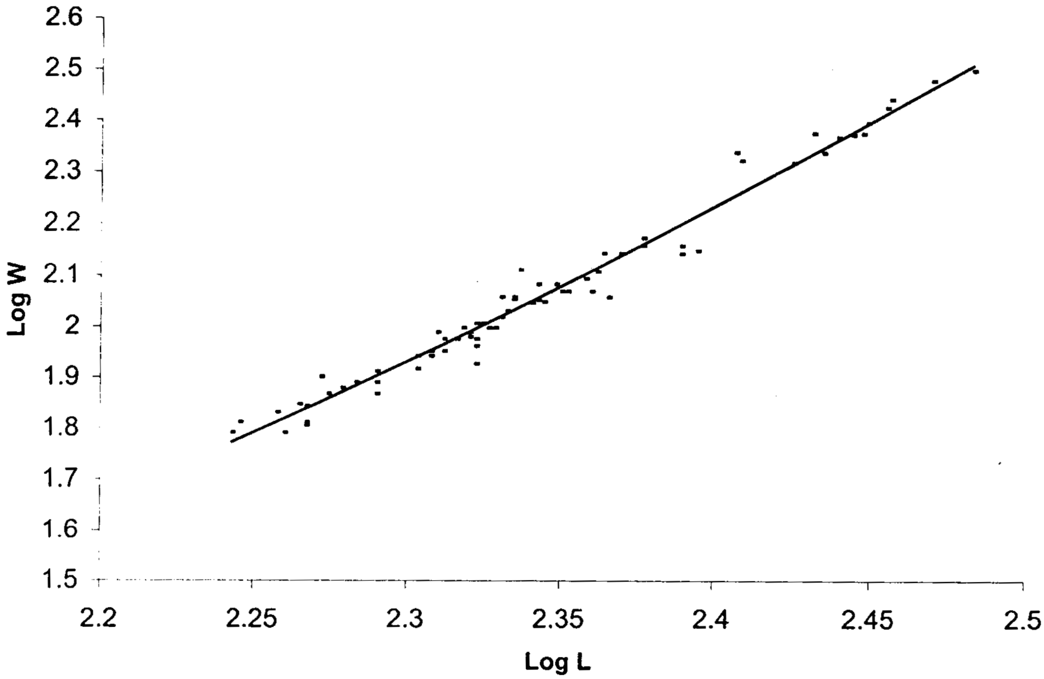


Fig:5- 6 Relation between Length & Weight for *Pomadasys maculatus* - Male.

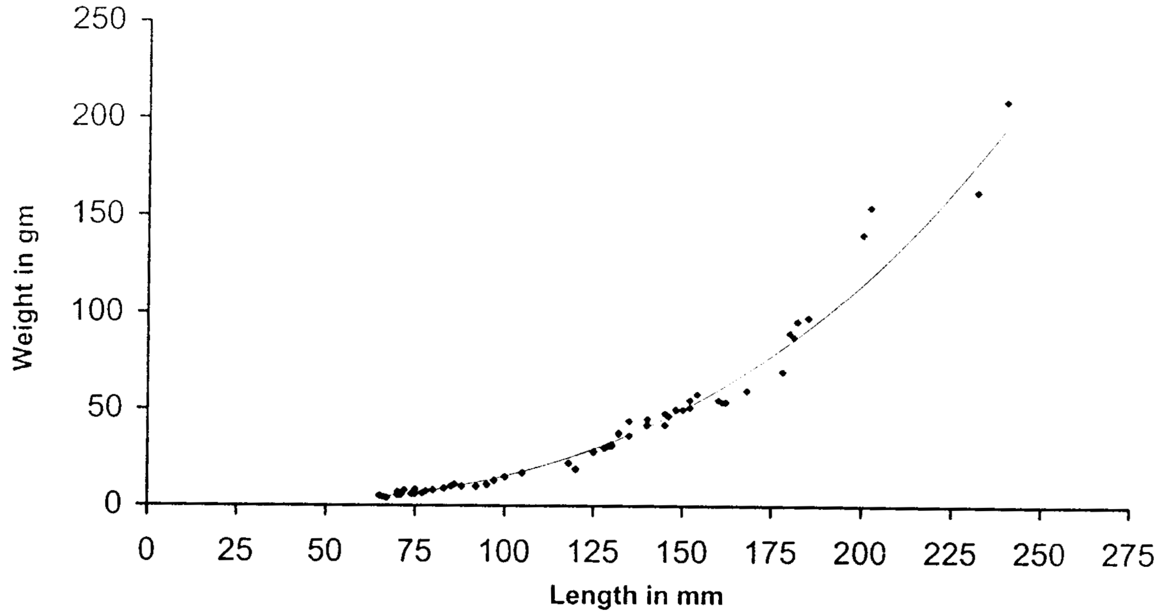


Fig : 5- 7 **Relation between Length & Weight for Pomadasys maculatus- Female.**

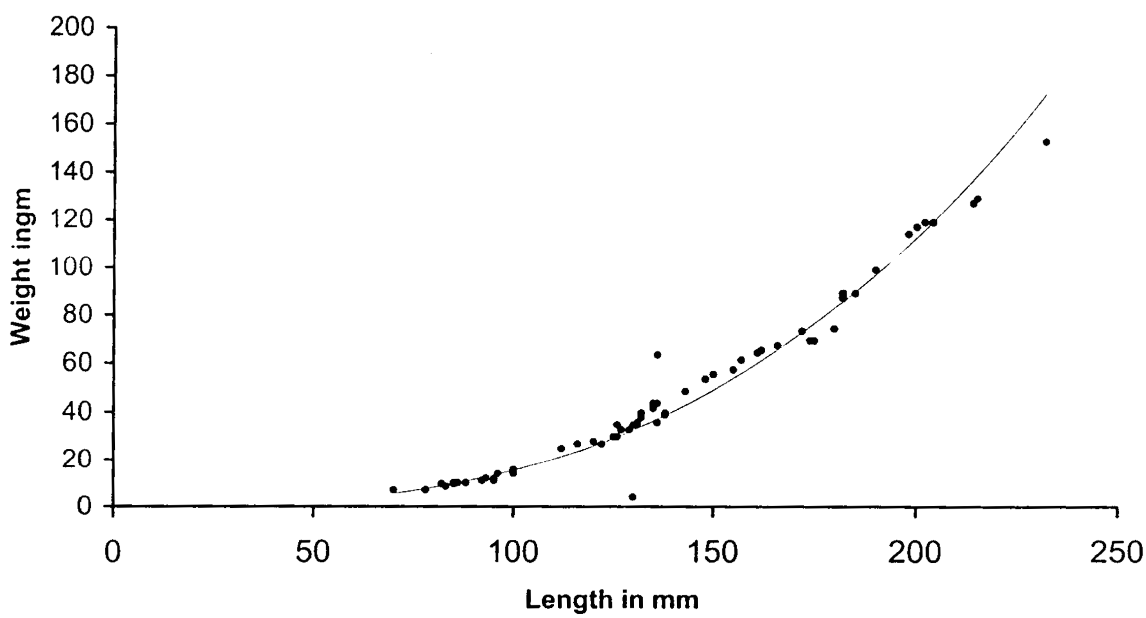


Fig:5-9 Relation between Log L and Log W
Pomadasys maculatus - Male

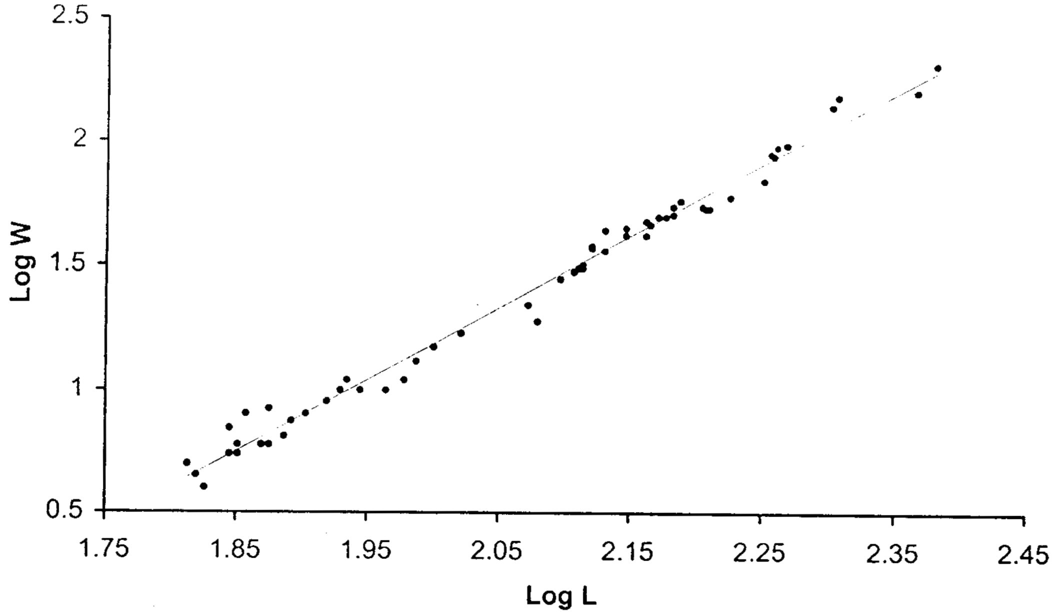


Fig:5-10 **Relation between log L and log W**
***Pomadasys maculatus* - Female**

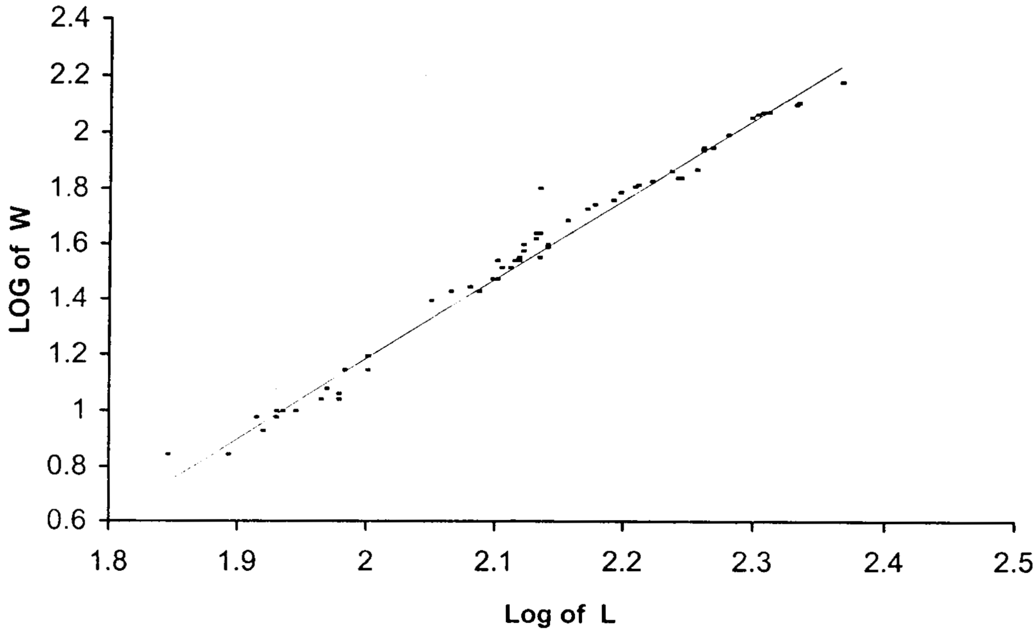


Fig : 5-11 Relation between length and Kn value
Priacanthus hamrur Male

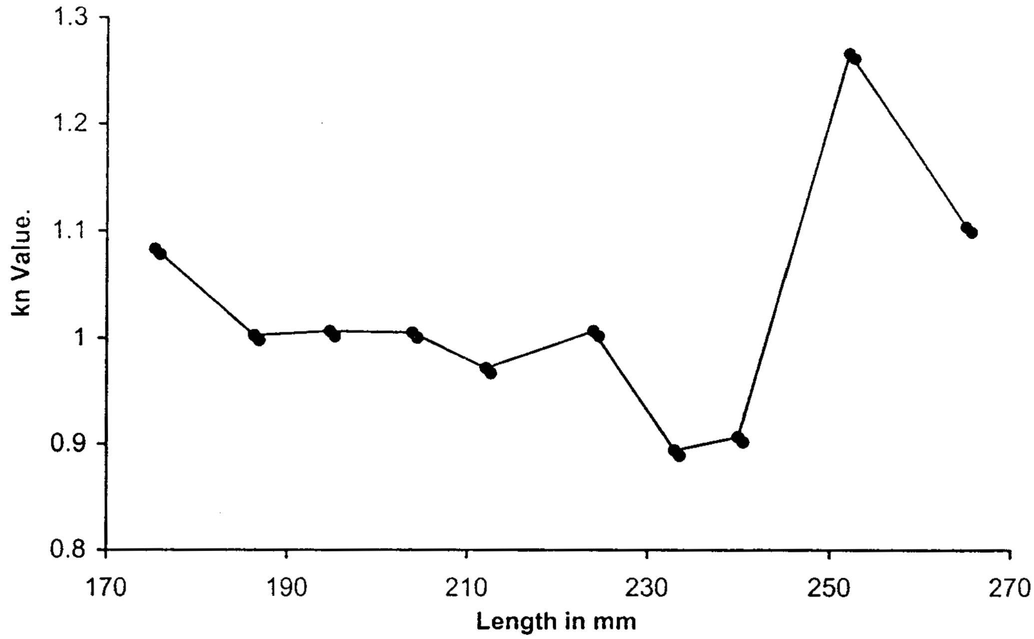
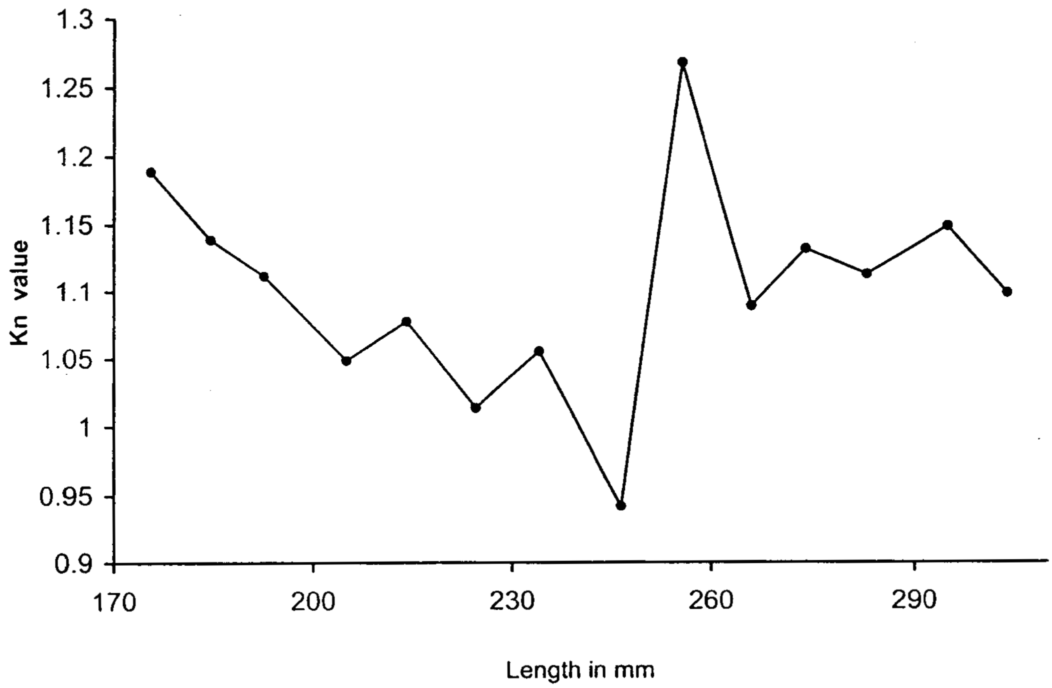


Fig:5-12 Relation between Length and Kn value
***Priacanthus hamrur*- Female**



135

Fig:5-13 Relation between Length & Kn Value
Priacanthus hamrur - Poolded

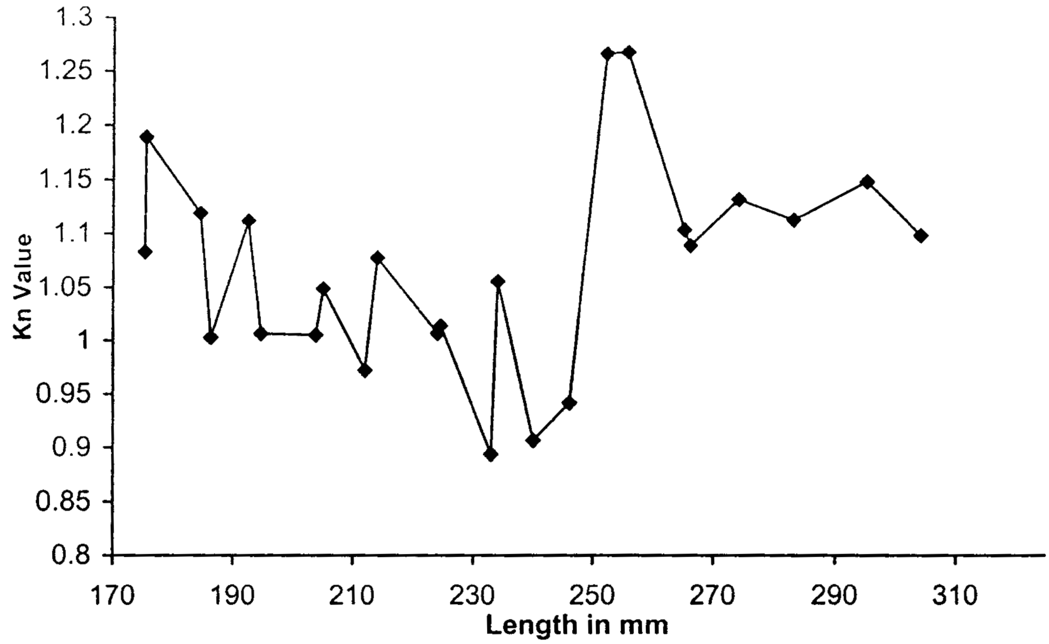


Fig:5-16 Relation between Length &Kn
***Pomadasys maculatus*- Pooled**

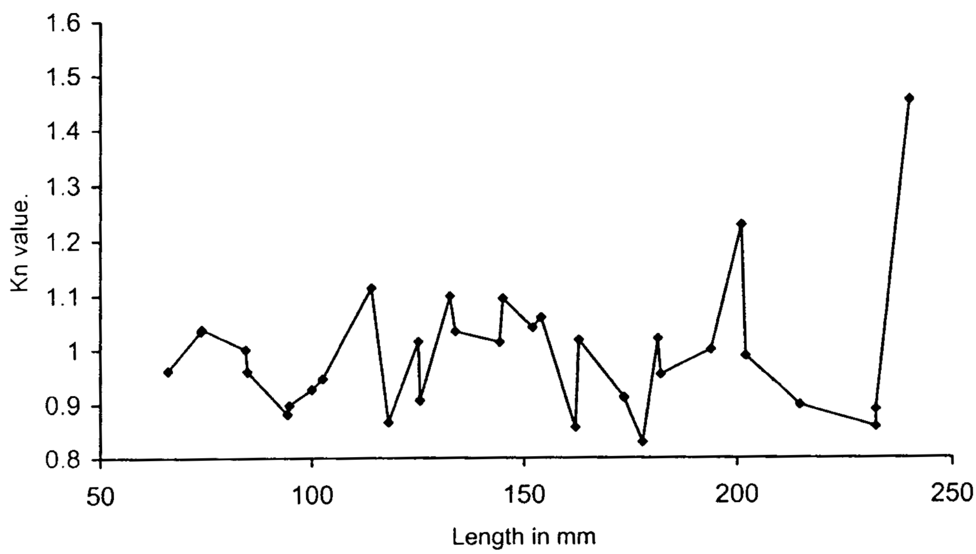


Fig :5-14 Relation between Length and Kn
Pomadasys maculatus - Male

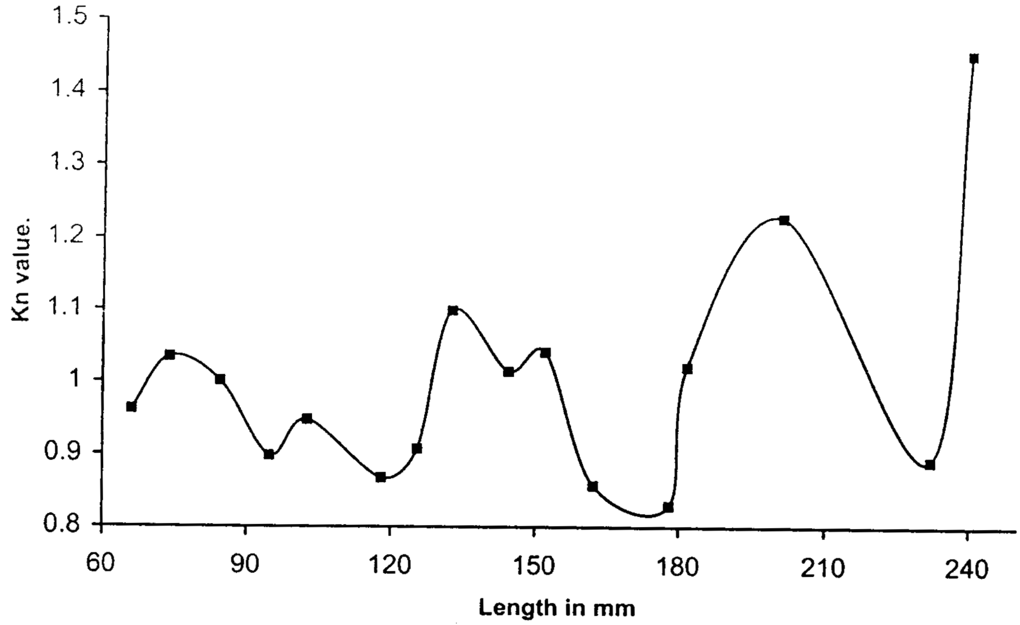


Fig:5-15 **Relation between length and Kn**
***Pomadasys maculatus* - Female**

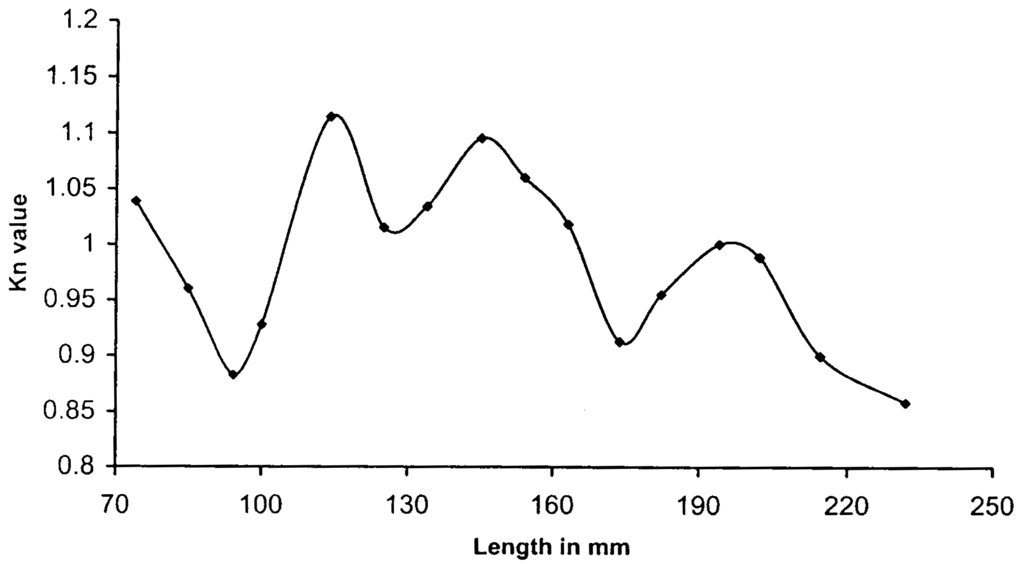


Fig :5-17. Relation betbween Month and Kn
Priacanths hamrur - Male

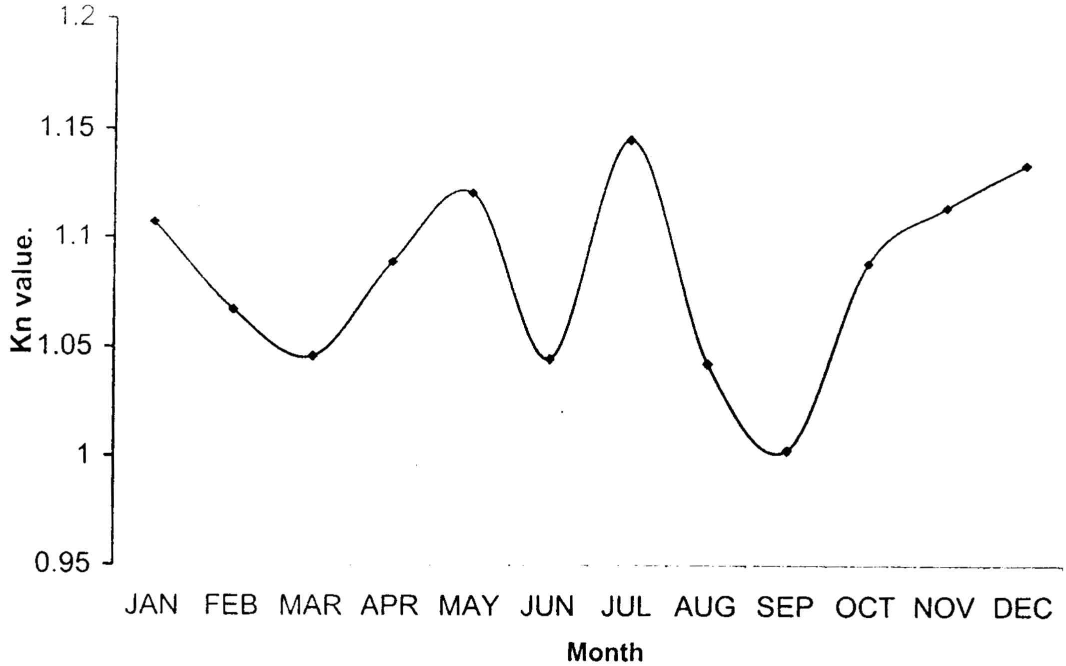


Fig:5-18 **Relation between Month and Kn**
Priacanths hamrur **- Female**

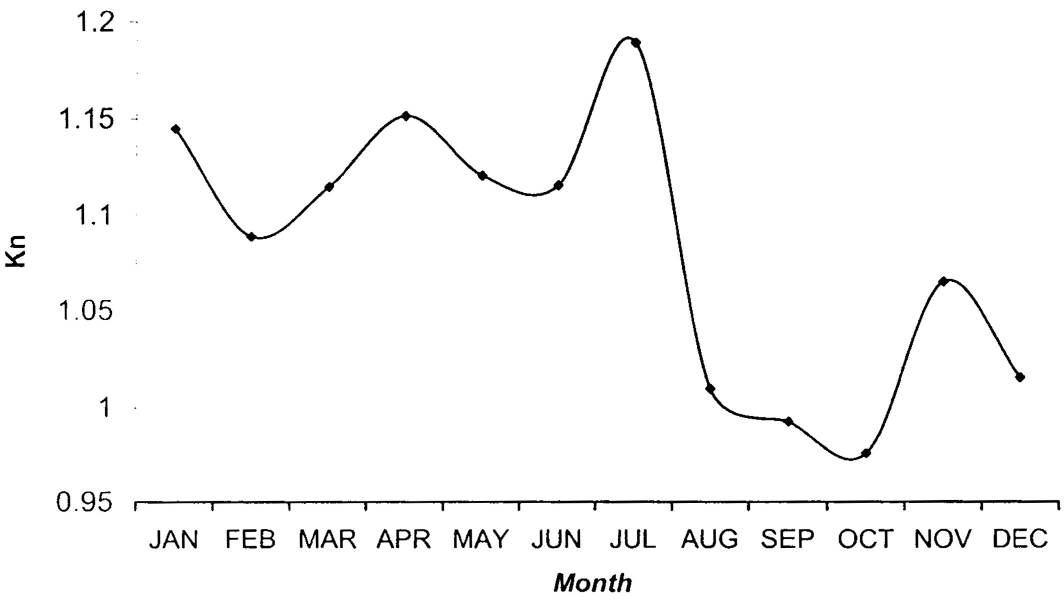


Fig:5-19 Relation between month and Kn
Pomadasys maculatus - Male

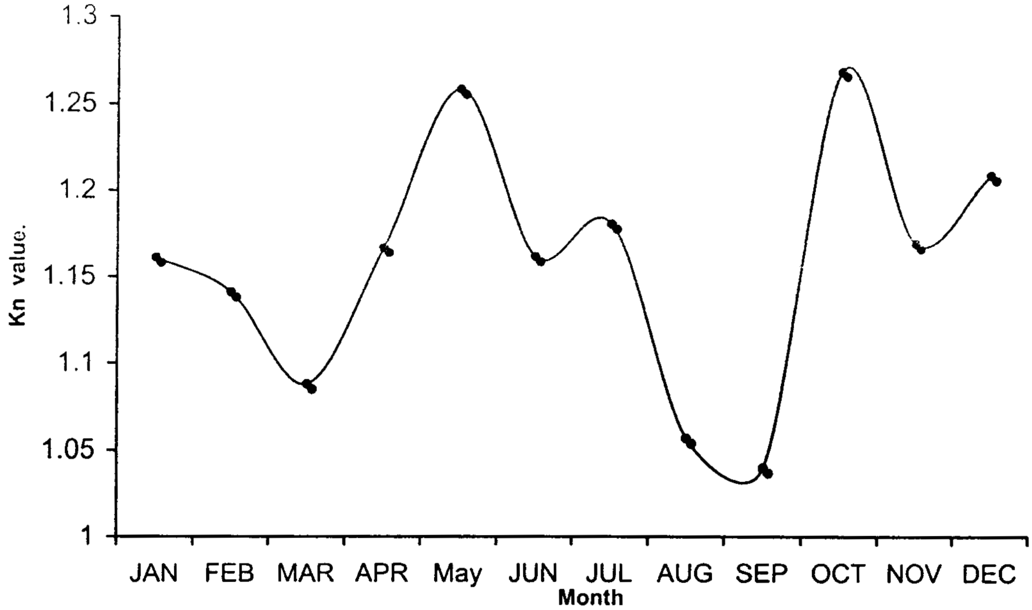


Fig.5-20 Relation between Month & Kn
Pomadasys maculatus-Female

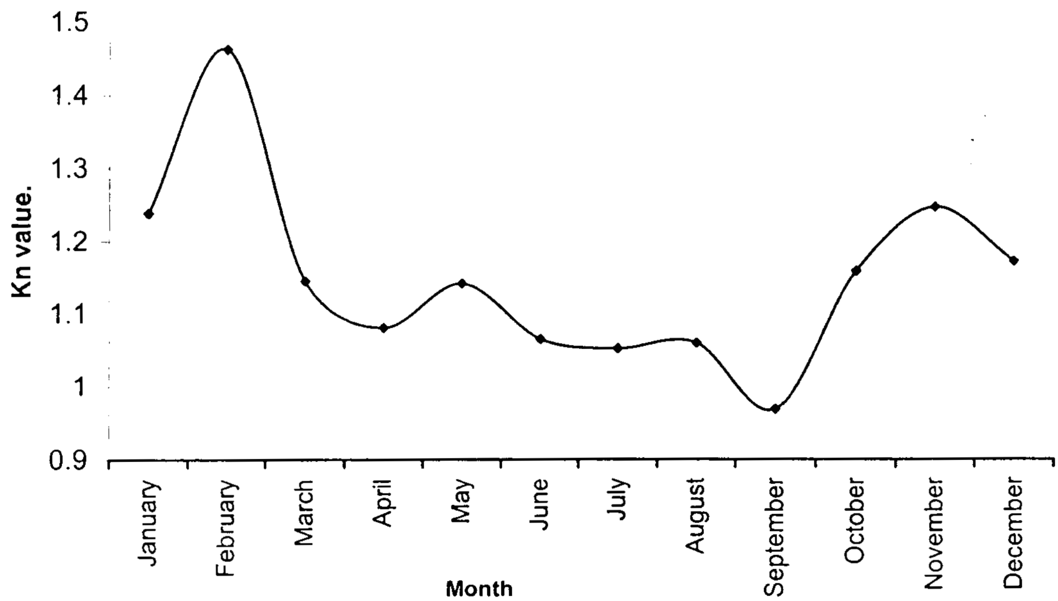


Fig:5-21 Relation between Month & Kn
Priacanthus hamrur- Pooled

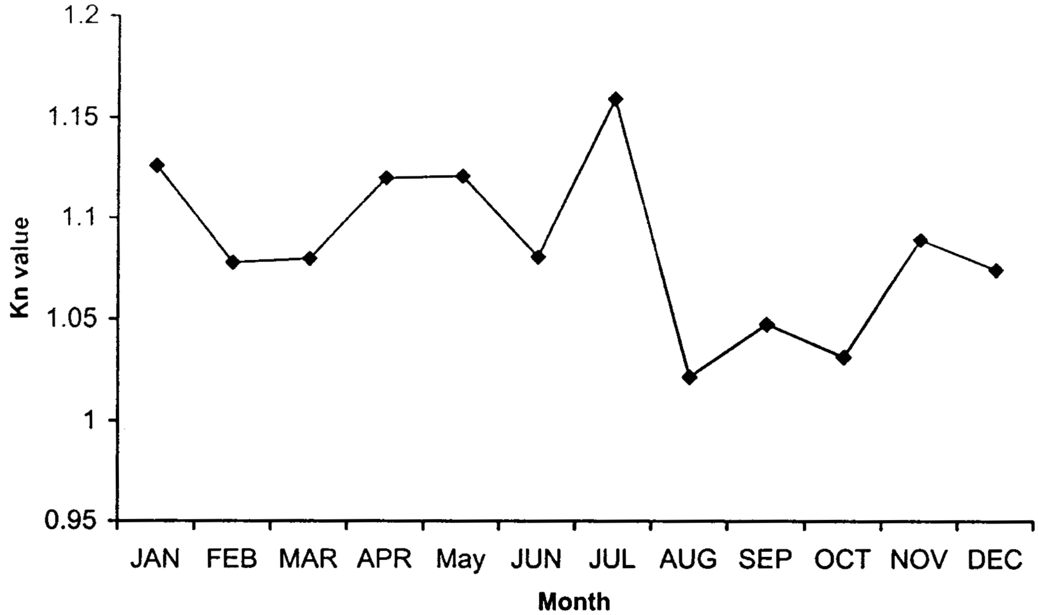
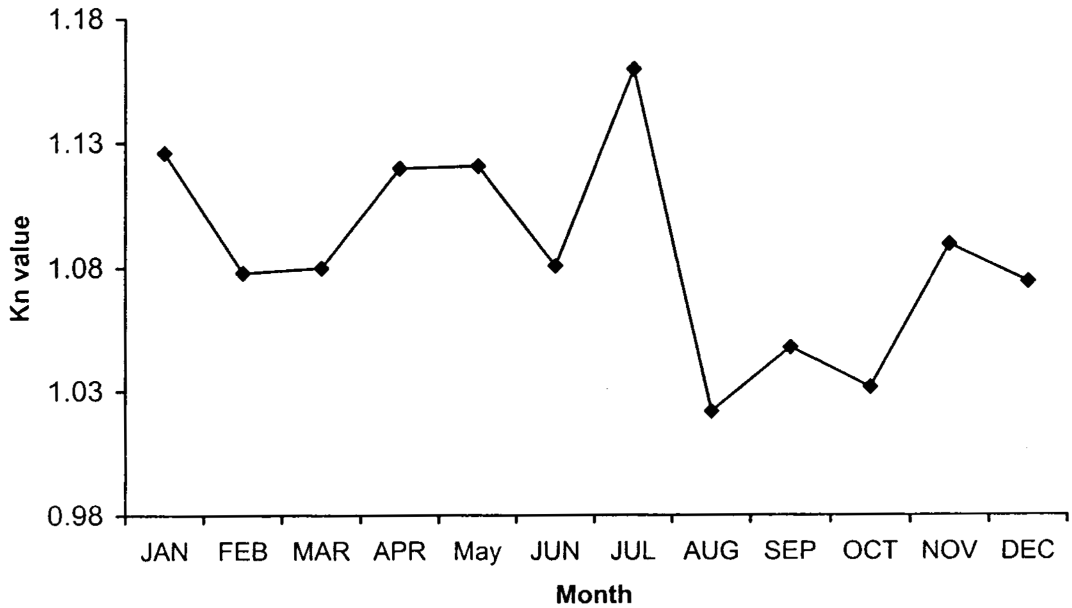


Fig: 5-22. Relation between Month & Kn
***Pomadasys maculatus*- Poolded**



CHAPTER - 6

REPRODUCTION

CHAPTER – 6

REPRODUCTION

INTRODUCTION

Reproduction, in fishes is the process by which species are perpetuated and by which, in combination with genetic change, characteristics for new species first appear. In studies of fisheries biology, it is important to determine the cycle of maturation and depletion of gonads. Determination of maturity stages finds primary application in providing basic knowledge on the reproductive biology of a stock. Information derived from these analysis is useful in ascertaining the age and size at which a fish attains sexual maturity, the time and place of spawning and duration of the cycle from the beginning of development of the ovary to the actual release of the eggs. In addition, to enable an estimation of fecundity, this information can be used to calculate the size of a stock and its reproductive potential. The age and size at sexual maturity is needed to assess the optimum age for first capture of a species and the time and place of spawning. All these studies are essentially meant for elucidating both the short and long-term variations in the production of fish broods, which are finally recruited in the population as exploitable stocks. Information relating to population stability and year class fluctuations can be obtained by undertaking studies on reproductive biology. Variations in the production from year to year may be due to these fluctuations.

The reproductive strategy relates to the general reproductive behaviour of the individuals, while the reproductive tactics are the variations in the general pattern, which the fish adopts in response to fluctuations in the environment. Reproductive traits include aspects such as size/age at fist maturity, size/age dependent fecundity, sex ratio, nature of gametes and timing of spawning season (Wooton, 1984). A study on these reproductive characters is

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essential in the determination of population stock, size from egg numbers, periodicity of strength of broods (year class recruitment), spawning time and place and sex composition of exploited stock. Reproductive parameters are of great value in fishery predictions and formations of management resources (Tessy, 1994).

The study of reproductive biology of fishes assume considerable importance not only to understand their reproductive potential in capture fisheries but also for the development and maintenance of fish brood stock (in hatchery operation). Knowledge in various aspects such as maturation process, environmental influences on maturation, egg production potential, is an essential prerequisite for successful brood stock development. This information is also essential for microlevel understanding of the physiological events taking place in the gonads as well as other related body structures during the different phases of gonadal maturation. Reproductive parameters such as size at first maturity, spawning frequency, fecundity and recruitment are important in fishery predictions.

Many scientists from different parts of the world had studied various aspects of reproductive characters of different fishes. Some of the important foreign contributions are by Foulton (1899) on the growth and maturation of ovarian eggs of teleostean fishes, Clark (1934) on the maturity and spawning of California sardine – *Sardina caerulea*, Hickling and Rutenberg (1936) on the spawning periods of hake, haddock, pilchard and other fishes, Dejong (1939) on the spawning habits of some fishes of Java sea, Dejong (1940) on the spawning periods of tropical fishes, Hickling (1940) on the fecundity of herring of southern north sea, June (1953) on the spawning of yellow fin tauna in Hawain waters, Bunag (1956) on the spawning habits of Philippine tauna, Bagenal (1957, 1963) about the breeding and fecundity of the long rough dab, *Hippoglossoidies platessoides*, Mac Greogor (1957) on the Pacific *Sardinops caerulea*, Otsu and Uchida (1959) on fauna spawning in the Marquesas islands and Tuamotu Archipelago. Rangarajan (1971) studied maturity and spawning of *Lutjanus kasmira* (Forsskal) from the Andaman sea, Macer (1974) on the reproductive biology of horse mackerel *Trachurus trachurus* in the north sea, Munro (1976) worked about mode of reproduction in goat fishes, Fox (1978) on the reproduction strategies of the bullhead in northern and southern England and Colin and Clavijo (1978) reported on the mass spawning of *Pseudopeneus maculatus*. Few aspects of reproductive biology of trigger fishes of North West Brazil were dealt by Ferreira de Menzes (1979), Hunter and Goldberg (1980) on the spawning and fecundity in northern anchovy – *Engraulis mordax*, Shapiro (1981, 1987) on the effect of environment in coral reef fishes William and Clark (1982) on the reproduction of Gold-spot herring, Fischer and Petersen (1987) on the evolution of several patterns in sea bass, Davis (1985) on *Lates calcarifer* in Van Diemen Gulf, Madan Mohan *et al* (1986) on the spawning biology of *Nemipterus delagoae*, Pillai *et al* (1987) on *Daseyllus aruanus*, Walsh (1987) found lunar periodicity in *Chaetodon multicinctus* Schaefer (1987) on black Skipjaik *Euthynnus lineatus*, Wijeyaratne and Costa (1988) on the fecundity and gonadal maturity of *Valamugil cunnesies* of Srilanka Robertson (1991) stated about variations in reproductive behaviour of fishes and Shamsul Hoda and Naeem Mulliah Qureshi (1992) studied on mullet.

In India also many workers studied the reproductive behaviour of many fishes. Some of the Indian contributions are by Seshappa and Bhimachar (1955) on *Cynoglossus semifasciatus*, Prabhu (1956) on the ova diameter measurements in fishes, Qasim and Qayyum (1961) on fresh water fishes, Sane (1963) on fresh water fishes, Rao (1963) on 'Ghol' *Pseudosciaena diacanthus*, Antony Raja (1967) on Indian oil sardine, Patnaik (1967) on the Indian salmon, James (1967) on ribbon fishes, Parulekar and Bal (1971) on *Bregmaceros* *clellandi*, Qasim (1973b) on some marine teleosts, Devaraj (1977) on the seer fishes, Dan (1977) on *Nemipterus japonicus* James and Baragi (1980) on ovaries as an indicator in fishes, Premalatha (1989) on Rock cods, Muthiah (1986) on *Euthynnus affinis*, Fischer and Petersen (1987) in the sea basses. Irene Fernandus and Devaraj (1989) on *Colia dusumieri* (Cuv & Val) Yohannan (1993) on the spawning of mackerel, Tessy (1994) on Epinephelus, Sivakami (1995) on the reproduction of carangid fish *Megalaspis cordyla*, Jayaprakash (1998) on Cynoglossus fishes and Devadoss (1998) on breeding and development in some batoid fishes.

Eventhough many works on reproductive biology had done, investigations on the reproductive biology of *Priacanthus* and *Pomadasys* specimens from Indian waters are very limited. Some of the foreign contributions about *Priacanthus* includes Chomjurai (1970) on *Priacanthus tayenus*, Wetchgaruun (1971) on *Priacanthus tayenus* of Thailand, Chantawong *et al* (1984) & Lester and Watson (1985) on *Priacanthus*, Ambak *et al* (1987) on *Priacanthus*, Liu *et al* (1992) on *Priacanthus macracanthus* in Tung Kang Waters and Tapia Garacia *et al* (1995) on *Priacanthus arenatus*. Some Indian contributions about *Priacanthus* are of Philip (1994) on Priacanthids and Rao (1984) on *Priacanthus macracanthus* and Premalatha (1997) on the fishery and biology of *Priacanthus hamrur*.

Foreign works on *Pomadasys* were conducted by AI-Ghais (1995) on *Pomadasys stridens*, Deacon and Hecht (1996) on *Pomadasys commersonnii*, Zhang Renzhai (1987) on *Pomadasys hasta*, Schultz (1991) on *Pomadasys maculatus* and de-Tarso-so-da-Cunha-Chaves (1998) on *Pomadasys corvinaeformis*. In India Deshmukh (1973) had done works on *Pomadayus hasta*.

Because of the limitations of works on the reproductive biology of *Priacanthus hamrur* and *Pomadasys maculatus* from Indian waters, a detailed study on this field is very essential. Since detailed studies on the reproductive biology of *Priacanthus hamrur* from central Kerala and *Pomadasys maculatus* from any part of India are not available, in this chapter, the reproductive biology of these two fishes from commercial catches of Central Kerala are dealt in detail and the results obtained are presented here.

MATERIALS AND METHODS

The fish samples for the study of reproductive biology of *Priacanthus hamrur* and *Pomadasys maculatus* were collected from the commercial catches of Munambum harbour during January 1997 to December 1998 (24 months). The fish samples were collected monthly and they were brought to the lab and freezed. After removing the moisture, the total length, standard length and weight of each individual fish was noted in fresh condition. The total length in mm and weight in gm were noted. Then the gonads were removed and weighed separately. It is generally assumed that gonadal weight depends on animal size and stage of gonadal development (de Valming *et al* 1982). The length of the ovaries and their colour was also noted in the fresh condition. Ovaries were then preserved in 5% formalin and this practice was followed during the course of the study. For classification of maturity stages, the International Council for the Exploitation of the Sea (ICES) scale was adopted. The fresh ovaries were examined macroscopically for studying the general external characteristics and the organization of the ovary. The ova diameter measurements were recorded to study the duration of frequency of spawning, as per the procedures described by Clark (1934), Hickling and Rutenberg (1936), Prabhu (1956), Rao (1963) and June (1953).

Ova Diameter Measurements

A stage ocular micrometer which gave a value 0.0143 mm for each micrometer division (md) was used to measure the diameter of the eggs. At the time of examination of eggs a drop of Guilson's fluid with double the amount of glacial acetic acid placed on the material, facilitated easier separation of intraovarian eggs. The method described by Clark (1934), June (1953) and others consists of a micrometer fixed in the eye piece of a monocular microscope and taking the diameter parallel to the horizontal guide line on the slide(in whatever axis the ovum lies) by moving the slide slowly, was followed. The parallel guidelines prevented duplication in measurements of the same ovum. The squares of the plankton counting chamber on which the ova were spread also were found to be helpful in avoiding duplicate measurements of the same ova. Antony Raja (1964) defined the diameter of the ovum as the distance between two parallel lines running along the two extremities of the ovum perpendicular to the guidelines. In the preliminary examination of distribution of ova diameter frequency from different parts of the ovary revealed that there was no difference in the size of ova from different parts of the gonad. So the eggs were always sampled from the middle portion of the ovary for further studies.

Gonado Somatic Index

Gonado somatic index (G.S.I) was estimated applying the method of June (1953). It is useful to explain the state of maturity and intensity of spawning year (James 1967). The weight of the fish and its gonad weight recorded for 2 full years were used towards the determination of the above index. If the gonads undergo regular seasonal change during the year which is accompanied by large changes in weight, then seasonal analyzing would indicate the peak spawning activity. Monthly mean index values were calculated using the formulae

$$G.S.I = \frac{\text{Weight of gonad}}{\text{Weight of fish}} \times 100$$

Length at First Maturity

For this purpose individuals examined for their maturity stages throughout two years. The average size at first maturity was determined by plotting the percentage of fish from stage II onwards against the length. Maturity curves were drawn to the scatter plots so as to estimate the length at which 50% fishes mature.

Sex Ratio

The sex ratio distribution was studied to test whether the observed sex ratio in each month and individual length group differs significantly from the expected ratio, the chi -square test applied to check the sex ratio.

$$\text{Chi-square} = (0 - E)^2 / E$$

E = expected number of males and females in each month

O = observed number of males and female in each month.

There is no much significance for the difference of sex ratio against 1:1 cannot be considered in the present study. This is because of the limited number of fishes collected.

Fecundity

For the purpose of fecundity estimation, mature ovaries were weighed in a monopan electronic balance and then a small portion of the ovary was separated and weighed to the nearest 0.001 gm. The sampled portion was placed on a microslide and ova were teased out and these ova were then transferred to a measuring cylinder containing a known volume of water and the total number of ova in the sample was counted. The fecundity was estimated by employing the formula.

$$F = (n/v)V$$

where n = number of ova in the subsample; V = volume to which the total number of ova is made up and 'v' volume of subsample. The relationship between fecundity and different variable like fish length, fish weight and ovary weight was worked out by the least square method.

$$F = ax^b$$

where F = fecundity, x = fish length or fish weight or ovary weight, a = constant and b = regression coefficient. The exponential relationship was transformed into a straight-line relationship based on logarithms by the following equations.

$$\text{Log fecundity} = \log a + b \log x$$

OBSERVATIONS

Reproductive Organs of *Priacanthus hamrur* & *Pomadasys maculatus*

The gonads of *Priacanthus hamrur* were seem to be lying in the posterior part of the abdominal cavity and are attached to the dorsal wall of the abdominal cavity by a thin membrane - mesarchium or mesovarium. The ovaries are paired symmetrical organs lying ventral to the air bladder. They were more or less triangular in out line (Plate 6.1). The posterior side of the ovary was broader than anterior side. The two lobes of the ovary seemed to be detached through out its length and interconnected before opening to the exterior by a common genital aperture. The ovaries were visible in fishes of 80–100 mm lengths. Ovary was cream coloured in the early stages. Proceeding to maturity the colour changed from cream to pinkish yellow, golden yellow, orange or red. When the ovary advanced to maturation the blood vessels of the surface of the ovary became very conspicuous.

In *Pomadasys maculatus* also, the gonads were lying in the abdominal cavity and are attached to the dorsal wall of cavity by the mesarchium or mesovarium. Here also the ovaries were paired symmetrical organs and were more or less triangular in out line (Plate 6.2). The two lobes of the ovary were free through out its length; but they were connected before opening to the exterior. The ovaries were visible in fishes of 40–60 mm lengths. In earlier stages the ovary was white coloured. At the time of maturity the colour changed from white to cream, yellow, golden yellow and light orange.

RESULTS

Five maturity stages were identified in both *Priacanthus hamrur* and *Pomadasys maculatus*. In *Priacanthus hamrur* the stage 1 represents the immature state. Ovaries were very small and the colour was light cream. The length of the ovary measured about 20–30 mm and the average ova diameter was 175 microns. The stage II of *Priacanthus hamrur* represents the maturing state, with a yellow coloured ovary. The average length of the ovary was 30–50 mm and the average ova diameter was 275 microns. Stage III of *Priacanthus hamrur* represents the mature stage with bright yellow coloured ovary. The average length of the ovary was between 30–60 mm. and the average ova diameter was 325 microns. Stage IV of *Priacanthus hamrur* represents the ripe state with golden yellow coloured ovary. The average ovary length was 50–70 mm and the average ova diameter was 375 microns. The stage V of *Priacanthus hamrur* represents the spent state. The colour of the ovary was faded or shrunk or collapsed (Fig. 6.1 & 6.2). The length was more or less similar to stage III and IV. The highest length group i.e. 340–360 mm and 360–380 mm length groups contained 100% mature females (Table 6.1). But these two length groups were represented by only 6 fishes each. The bulk of the population in this species was supported by the fishes of the middle length groups.

In the case of *Pomadasys maculatus* stage I represents the immature state with very small and thin flesh coloured ovary. The average length of the ovary was about 20–30 mm and the average ova diameter was 210 microns and stage II in *Pomadasys maculatus* represents the maturing state with light yellow coloured ovary. The average ovary length measured about 25–45 mm and the average ova diameter was 290 microns. The stage III of *Pomadasys maculatus* represents the mature state with golden yellow coloured ovary. The average ovary length was about 35–60 mm and the average ova diameter was 330 microns. Stage IV of *Pomadasys maculatus* represents the ripe state with golden coloured ovary. The average ovary length was about 40–70 mm and the average ova diameter was 350 microns. Stage V in *Pomadasys maculatus* represents spent stage with shrunken ovary carrying the ova with oil globules and the length seemed to be reduced (Fig. 6.3 & 6.4). In *Pomadasys maculatus* the highest length group, i.e. 220–240 mm, 240–260 mm and 260–280 mm provide 100% mature females (Table 6.2). But very few fishes represent these length groups. The 220–240 mm group represented by only 8 female fishes. The 240–260 mm length group represented by only 2 female fishes and 260–280 mm represented by only 4 female fishes. Here also the fishes of the middle length group, i.e. between 140–220 mm, represent the bulk of the population. The percentage occurrence of different stages of maturity of *Priacanthus hamrur* and *Pomadasys maculatus* during the period 1997 and 1998 are represented in Table 6.3 & 6.4.

Length at First Maturity

In the case of fishes, maturity occurs at different sizes. All the fishes do not mature at the same length. Some workers considered the earliest length at which the maturity was attained to be the minimum size of maturity. But due to the limited number of fishes collected, this may not give the true picture of a population and hence for population studies the minimum size at first maturity is considered at 50% level.

A total of about 200 specimens of various length groups from both fishes had examined to find out the length at first maturity. In *Priacanthus hamrur* 208 female specimens were grouped into 20 mm class interval. The immature fishes may form one group and the other fishes form another group. From these, the number of immature and mature fishes in each size group and the percentage occurrence of maturing females were determined. The average size at first maturity was determined by plotting the percentage of fishes against the length group. Maturity curves were drawn to the scatter plots, so as to estimate the length at which 50% of the fishes mature. The length at which 50% of the female fishes attain maturity in *Priacanthus hamrur* was calculated as 198 mm (Fig. 6.5).

In *Pomadasys maculatus* 160 females of various length groups were grouped into 20 mm class interval. Maturity curves were drawn so as estimate the length at which 50% of the females attain maturity. In *Pomadasys maculatus* it is calculated as 135 mm (Fig. 6.6).

Ova Diameter

The duration and frequency of spawning in fishes were understood by ova diameter studies. The maximum ova diameter obtained in *Priacanthus hamrur* was 375 microns, in March 1997. The study of progression of ova diameter through months revealed that the maximum ova diameters were obtained in 2 peaks in a year - one is March–August and the other is November–December (Table 6.5). These 2 peaks represent the peaks of spawning in a year. After the 1st peak, the ova diameter suddenly falls to a lowest value during September–October. Then again the ova diameter rapidly increases as the second peak during November-December (Fig. 6.7). So this result indicates the existence of 2 spawning seasons for *Priacanthus hamrur*, one March–August and other November–December.

In *Pomadasys maculatus* the maximum ova diameter observation was 414 microns and it was noticed during May 1998 (Table 6.6). The study of the progression of ova diameter in this specimen revealed that there are 2 peaks in a year, One is March–May and the other is September–December (Fig. 6.8). This result clearly indicates that these 2 peaks of ova diameter represent two peaks of spawning because after the first peak the ova diameter suddenly decreased to a very lower level during both the years (1997 and 1998). The average ova diameter measurements of various stages of both *Priacanthus hamrur* and *Pomadasys maculatus* during the period of two years are represented in (Table 6.9 & 6.10).

Distribution of Ova in the Ovary

In order to get an idea regarding the distribution of ova in the different regions of the ovary of *Priacanthus hamrur* and *Pomadasys maculatus*, samples from anterior, middle and posterior regions of the right and left lobes of mature ovaries of the fishes were cut out and teased on a plankton counting chamber and ova diameter measurements of nearly 50 ova from each region was noted separately. The study indicated a similar pattern in the distribution of maturing and mature ova in both lobes of the ovary. In the left lobe of the ovary, the distribution pattern of ova was found to be uniform and comparable to that of right ovary. Thus, it was clear that the distribution of the ova and their diameter in the regions of both the lobes of ovaries were uniform in both *Priacanthus hamrur* and *Pomadasys maculatus*.

Fecundity

Knowledge on the fecundity is important in the determination of spawning potential of fish stocks and fishery management. The fecundity study helps in comparing different stocks and the relationship between fecundity and length or fecundity and weight of fish. It is useful in estimating the fecundity of known length and weight of fish. The fecundity of a fish is defined as the number of ova in the ovary of a female fish prior to spawning. In broad terms it can be considered as the number of eggs produced by an individual during its lifetime. Studies on fecundity play a key role in fish stock management.

Fecundity of *Priacanthus hamrur*

To study the absolute fecundity of *Priacanthus hamrur,* 24 samples were selected and their fecundity was found to range from 52,996 to 1,52,112 eggs (Table 6.11). ~~Fecundity was studied and it was found that~~ the maximum fecundity in *Priacanthus hamrur* was 1,52,112 for a female fish of length 340 mm, weight 373 gm and ovary weight 17.73 gm. The overall average fecundity of *Priacanthus hamrur* per gram body weight and per 0.1 gm ovary weight was 408 and 845 respectively. The higher fecundity values were observed in female fishes of middle length classes, ranging between 255–290 mm. The fecundity tends to increase along with the increase in body weight and ovary weight in *Priacanthus hamrur*.

Relation between fecundity and total length

To find out this relationship, the absolute fecundity estimated for the 24 fishes was plotted against their total lengths (Fig. 6.9). The relationship was calculated by the Least square method. The logarithmic values based on the formula

$$\text{Log } F = a + b \text{ Log } L$$

$$\text{Log } F = 0.790744 + 1.72388 \text{ Log } L \ (r = 0.684831)$$

Relation between fecundity and total weight

Here also, fecundity of the 24 fishes was plotted against the total weight of these fishes (Fig. 6.10). A regression line was fitted to the data, which gave a linear relationship according to the formula

$$\text{Log } F = 3.552668 + 0.611797 \text{ Log } W \ (r = 0.7245)$$

Relation between fecundity and ovary weight

For this study, fecundity of the 24 fishes was plotted against their ovary weight (Fig. 6.11). A regression line was fitted using the formula

$$\text{Log } F = 3.552668 + 0.611797 \text{ Log } OW \ (r = 0.962641)$$

Fecundity of *Pomadasys maculatus*

. In *Pomadasys maculatus*, the maximum fecundity was 52,410 for a female fish of length 188 mm, weight 90 gm and ovary weight 6 gm.(Table 6.12) The average fecundity of Pomadasys maculatus per gram body weight was 582 and per 0.1 gm ovary weight was 874. The fecundity tends to increase along with an increase in total body weight and ovary weight. The higher fecundity values were observed in female fishes ranging to middle length classes, especially the length groups between 150–190 mm. Here also, the fecundity tends to increase along with the increase of body weight and ovary weight.

Relation between fecundity and total length

Here also, fecundity of the 24 fishes was plotted against their total length (Fig. 6.12). The scatter diagram showed a linear relationship according to the formula

$$\text{Log } F = 0.44590 + 1.7841 \text{ Log } L \ (r = 0.842833)$$

Relation between fecundity and weight

The scatter diagram on the fecundity and total weight relationship of *Pomadasys maculatus* gave a linear relationship (Fig. 6.13). The regression of fecundity of total weight W can be expressed as

$$\text{Log } F = 3.2991 + 0.61704 \text{ Log } W \ (r = 0.81507)$$

Relation between fecundity and ovary weight

For this study of relationship fecundity of the 24 fishes were plotted against their respective ovary weights, which gave a linear relationship (Fig. 6.14) between the variables according to the formula.

$$\text{Log } F = 3.8762 + 1.0904 \text{ Log } OW \ (r = 0.94273)$$

Gonado Somatic Index

Nicklosky (1963) states that the effect of fish size on gonadal weight is defined by expressing gonadal weight as a percentage of body weight. The gonado somatic index value for a period of 24 months during 1997 and 1998 are presented (Table 6.13). The maximum average gonado somatic index observed in *Priacanthus hamrur* was 6.83, during August 1997. During this period the percentage of mature and ripe fishes were very high when compared to other groups. Lowest values of G.S.I. noted in October was 0.73. The study of G.S.I. through months clearly indicates that there were two peaks in an year one was March–August and the other was November-December (Fig. 15). These 2 peaks represented the peaks of spawning in an year. After the first peak G.S.I. came down towards the zero level and then again G.S.I. value increased to the second peak during both the years. From these observations it is clear that the increase of ovary weight is associated with the progress of maturity of the ovary.

In *Pomadasys maculatus* the maximum G.S.I. value observed was 4.76 during September 1997 (Table 6.14). Lowest value of G.S.I. noted in July

1997 was 0.55. The study of progression of G.S.I through months during 1997 and 1998 in this species revealed that there were 2 peaks in an year. One was March–May and the other was September–January. After the first peak the G.S.I. value came towards the zero level during July and then again increased towards the 2nd peak (Fig. 6.16). de Vlaming *et al* (1982) assumed that gonadal weight depends on animal size and stage of gonadal development. The result clearly indicated the presence of 2 spawning seasons for *Pomadasys maculatus*, one was March–May and the other was September–January.

Spawning Season

The percentage occurrence of ovaries in different stages of maturity based on the pooled data for 2 years is presented (Table 6.3 & 6.4). Similarly percentage occurrence of gonads in different stages of maturity in various length groups is presented (Table 6.1 & 6.2). According to Clark (1934) and Prabhu (1956) the multiplicity of modes in the frequency curve of ova diameters from mature fish can indicate the spawning periodicity.

Both these species, *Priacanthus hamrur* and *Pomadasys maculatus* enjoy 2 spawning seasons in an year. The spawning season can be determined by considering the months in which ova diameter and G.S.I. come to the maximum value. In Priacanthus *hamrur* the ova diameter in every year comes to the maximum value during March–August and November–December. The G.S.I. values also reached the maximum level during March–August and November–December in *Priacanthus hamrur.* So March–August and November–December are considered to be the two spawning seasons of *Priacanthus hamrur*. March–August represented the outbreak of South West monsoon and November–December represented the last quarter of North East Monsoon. So the effect of the monsoon is found predominant in the breeding biology of Priacanthus *hamrur.*

In *Pomadasys maculatus* the ova diameter measurements reached the highest value during March–May and September–December. The G.S.I. values reached maximum during March–May and September–January. So, it is estimated that the species *Pomadasys maculatus* also ~~enjoyed~~ two spawning seasons in a year March–May and September-January. March–May represented the onset of the South West monsoon or in certain years the pre South West monsoon period. September–January clearly represented the duration of North East monsoon in a year. It was very interesting to note that the first ovulation period (March–May) of *Pomadasys maculatus* indicated the early arrival of the South West monsoon along the coast of Kerala. So, this may be also considered to be a factor that helps us for the prediction of the South West monsoon in Kerala. This finding may help our weather forecast programmes. So the first ovulation period in *Pomadasys maculatus* can be taken as a dependable factor for the prediction of South West monsoon.

Sex Ratio

Sex ratio studies proved that the male: female ratio in both *Priacanthus hamrur* and *Pomadasys maculatus* agreed with 1:1 pattern (Fig. 6.17 & 6.18). The variation from this 1:1 pattern was found insignificant in both these species. Anyhow, very slight variation was noted from this 1:1 pattern in both species. Considering the slight variations it was found that females slightly outnumber the males. In *Priacanthus hamrur* the real observed data showed that the sex ratio between male and female was 1: 1.118 (Table 6.15). The overall sex ratio was in favour of females in many other fishes as in *Priacanthus hamrur*. The sex ratio during different months varied from year to year. The chi-square value showed that deviation observed from the expected ratio for the pooled data was only 0.614 and this deviation was considered to be non-significant at 5% table X^2 value for 1 degree of freedom (Table 6.17), as only more than 5% deviation (3.841) was considered and taken as significant.

Eventhough the ratio was insignificant for the pooled data, in certain months like February and April 1997 the ratio was significant. The females presented were double the number of males. Similarly in February and November 1998 males were double the number of females. But in other months slight variations noticed were non-significant

In *Pomadasys maculatus* the general sex ratio obtained approximately agreed with 1:1 pattern. The actual sex ratio obtained for the entire period was 1:1.026 (Table 6.16). Here also the male: female ratio was in agreement with hypothetical ratio 1:1. Chi-square value showed that in the pooled data, the deviation from the expected 1:1 pattern was only 0.025. This deviation was also non-significant at 5% table X^2 value for 1 degree of freedom (Table 6.18). In certain months like January, June and December 1997 female dominance was noticed. But in 1998 during February, March, August and October male dominance noticed. But these variations cannot be considered because of the limited sample size.

The average sex ratio in *Priacanthus hamrur* 1:1.118 and in *Pomadasys maculatus* it was 1:1.026. Slight dominance of females was seen in both fishes. But these variations are non-significant at 5% table X^2 value for 1 degree of freedom in both fishes (Table 6.17 & 6.18). This may be due to limited number of fishes collected. In the case of limited sample size the significant difference of sex ratio against 1:1 cannot be considered as a general case.

Sexual Dimorphism

Sexual dimorphism in both fishes had studied. A clear sexual dimorphism was noticed in both fishes – *Priacanthus hamrur* and *Pomadasys maculatus*. In both groups females were larger and heavier than the males of the same age group.

In *Priacanthus hamrur* the lateral line was arched downward in front end of the body in male specimens. This hook like downward bend of the lateral line in front end was not so conspicuous in females. The lateral line in female specimen is less arched in front (Fig. 6.19 & 6.20). The soft ray in the posterior half of dorsal fin are more filamentous and protrude out from the upper margin of the fin in female specimens. While the soft rays in the posterior half of the dorsal fin were less filamentous in male specimens and these do not protrude out from the upper margin of the fin. Dorsal anterior profile of the head had a downward slope in female. But this downward slope was absent in male. The opercular spine was sharply marked in male. But it was feeble in female specimen. The inter-orbital space was wide in female (1.76 cm). But it was less wide in male (1.28 cm). The female dominated in all dimensions of the body (Tessy & Inasu, 1998 a). A comparative study on morphological measurements in female and males were done and represented in Table 6.19.

In *Pomadasys maculatus* also a clear sexual dimorphism was noticed. Females were larger and heavier than the males of the same age group. The anterior dorsal part of the upper jaw in female was broader than that in the male (Fig. 6.21 & 6.22). The width of the anterior rim of the operculum in female was broader than that of the male. The inter-orbital space and eye diameter of the female was larger than the males. Dorsal fin in female was more filamentous and protruding. The black basal spot present on the edge of the dorsal fin in male was more prominent than that in the female (Tessy & Inasu, 1998 b). The black blotches on the lateral side of the body are more clearly imprinted in males than in females. The females dominate the males in all morphological measurements (Table 6.20).

DISCUSSION

Reproductive biology of many species of *Priacanthus* and *Pomadasys* were done by many foreign workers. But information regarding the breeding behaviour of *Priacanthus hamrur* and *Pomadasys maculatus* from Indian waters are very much limited. The reproductive cycle is reflected by pronounced variations in gonaldal size.

Ambak *et al* (1987) observed the breeding seasons of *Priacanthus tayenus* and *Priacanthus macracanthus* in Malaysian waters. They observed that these two species of fishes were spawning throughout the year in Malaysian waters. Rao (1984) conducted experiments on the spawning periodicity; length at first maturity and some biological information on *Priacanthus macracanthus* from North East coast of India. Tapia-garcia (1995) reported about the reproduction of *Priacanthus arenatus*. Ambak *et al* (1987) studied the sexuality, sex ratio and fecundity of big eye (*Priacanthus*). Similarly some works had noticed on the foreign species of *Pomadasys*. de-Tarso-do-cunha-chaves (1998) made a study on the reproductive and biometrical analysis of 1629 individuals of *Pomadasys corvinaeformis*. Al-ghais (1995) found in 1775 *Pomadasys stridens* (Forskaal) of United Arab Emirates reefs, that the pre-spawning and spawning months (November to March) exhibited the highest and Post-spawning (April to July) exhibited the lowest values for coefficient of condition 'K'. He also remarked that females were maturing earlier than males. Connell (1996) found that spotted grunter *Pomadasys commersonnii* were laying pelagic eggs in the St. Lucia estuary. Hussian *et al* (1992) used the length and weight data to estimate regression. Fantodji (1990) studied about the gonadotropic cells in the pituitary of *Pomadasys jubelini* and suggested that the gonadotropic hormone produced is immunologically related with several previously studied fish gonadotropins. Zhang-Renzhai (1987) studied the development of fertilized eggs and larvae of spotted grunt, *Pomadasys hasta*.

In many fishes ovary contains multimodal batches of eggs representing different stages of maturity. Murthy (1984) discovered in *Nemipterus japonicus,* multimodal batches of eggs. Contrary to this, in the present study it was found that in both *Priacanthus hamrur* and *Pomadasys maculatus* were having a unimodal distribution of developing ova. Philip (1994) got the same pattern of ova distribution in *Priacanthus hamrur*.

Based on the study of ova diameter measurement color of the ovary, size of ovary in relation to body cavity and microbiological analysis, ovaries were classified into 5 maturity stages. The classification of maturity stages was based as per the scale described by Antony Raja (1966). While reviewing overall implication of the problems related to the quantification of maturity stages in fishes of tropical waters, Qasim (1973b) proposed that the classification of gonads should be limited to about 5 maturity stages. James and Baragi (1980) opined that in the majority of the marine fishes from tropical waters maturation is a continuous process resulting in the occurrence of mature fishes through out the year.

In the present study of *Priacanthus hamrur*, gonads of the immature state were very small and colour was light cream and the diameter of the ova was about 175 microns. But when the ovary passes to the second stage the colour became yellow and diameter reached about 275 microns. In stage III ovaries became bright yellow coloured and the diameter increased to 325 microns and in stage IV i.e. ripe state color of the ovary became golden yellow and the ova diameter reached about 375 microns. In the V^th^ stage i.e. spent state, the ovary became faded or shrunk and larger than the developing virgin ovary. Devaraj (1987) named it as an intermediate ovary in the case of *Scomberomorus* specimen.

In *Pomadasys maculatus* also gonads of the immature state were small, light in colour and ova diameter reached 210 micron. In the second state (maturing stage) the ovary was light yellow in appearance and ova diameter was 290 microns. In the stage III (mature) the ovary became golden yellow with an ova diameter of 330 microns and in stage IV the ripe ovary became golden yellow with an average diameter of 350 microns. In the spent stage, the ovaries became shrunk and ova present were having oil globules.

Based on the type of spawning Hiekling and Rutenberg (1936) and De Jong (1939) divided the teleost fishes into 4 different groups. These groups are spawning once a year during short and definite period, specimen spawn only once but over a long period, specimens spawn twice in a season and specimens spawn intermittently over a long period. Eventhough specimens with ripe ovaries are seen through out the year in tropical waters, majority of the individuals may spawn with in a short and definite period .Rao (1984) noticed in *Priacanthus macracanthus* that ova in the ovary having different stages of maturity are characterized by unimodal distribution and therefore remarked that the spawning period of the fish is not a prolonged one. Ambak *et al* (1987) noticed that *Priacanthus tayenus* and *Priacanthus macracanthus* spawned throughout the year in Malaysian waters. Philip (1994) observed in *Priacanthus hamrur* of Vishakapattanam area that spawning occurs during November–February in the first year of observation and during October–March during the second year. Premalatha (1997) reported that in *Priacanthus hamrur*, March–April is the breeding season. This is in agreement with the first spawning period of the present study.

In the present study it was found that *Priacanthus hamrur* ~~was having~~ two spawning seasons, based on the maximum ova diameter and G.S.I values obtained. According to Nickolskii (1963) G.S.I of fishes is widely used as an index of gonadal activity and as an index for spawning preparations. When assessing gonadal activity, animals of different sizes are frequently sampled and it is generally assumed that gonadal weight depends on animal size and stage of gonadal development (de Vlaming *et al* 1982). The gonado somatic index is used as a criterion for determining the duration and intensity of spawning in fishes (June 1953 and Thomas 1969). During the developments of gonads the G.S.I. increases, gradually and declines at the commencement of spawning. This statement was in agreement with the present study. The two seasons for spawning were considered to be March–August and November–December. Since these two seasons were connected with the southwest monsoon and northeast monsoon, these seasons were predominant in the reproductive biology of *Priacanthus hamrur*.

In the case of *Pomadasys maculatus* also, the present study revealed that changes in the ratio of gonad size to body weight could be considered as an alternate method of assessing gonadal development. From the study of the ova diameter measurements and G.S.I values it was found that *Pomadasys maculatus* also enjoy two spawning seasons in a year i.e. March–May and September–January. But *Pomadasys* hasta exhibited single restricted spawning period during October–December (Desmukh, 1973). Since these two spawning periods were connected with south west monsoon and north east monsoon, the first ovilation period (March–May) of *Pomadasys maculatus* points out the early arrival of south west monsoon which can be considered as a factor for the prediction of the south west monsoon in Kerala.

Qasim (1973a) reported that spawning in marine teleosts mainly occurring during pre-monsoon months (February–May) whereas, along the west coast the same is taking place during monsoon (June–September) and post monsoon. In the present study also reproduction of *Priacanthus hamrur* and

Pomadasys maculatus was correlated with the monsoon periods. Rao (1984) observed that the peak spawning season for *Priacanthus macracanthus* in the North east coast is during November–February which is in agreement with the 2^{nd} spawning season of *Priacanthus hamrur* November–December. Lester and Watson (1985) observed that in *Priacanthus tayenus* of Hong Kong waters, spawning noticed only for a short period i.e. in June–July. But in *Priacanthus macracanthus* Lester and Watson (1985) noted that spawning occurred throughout the summer with 2 peaks one in May–June and the second in September. Nugroho & Rustam (1983) found that in *Priacanthus macracanthus* of Java waters spawning takes place during February–April and September - November. In the gulf of Thailand, Chomjurai (1970) observed that in *Priacanthus tayenus* spawning noticed all round the year with peak spawning during January to March. In *Priacanthus tayenus* of Andaman Sea spawning occurred in October to April so it was clear that spawning in different specie of *Priacanthus* is occurring at different periods. This may be due to changes in the environmental condition, nutrition and area dependent. In the present study it was noticed that both *Priacanthus hamrur* and *Pomadasys maculatus* were having two spawning seasons based on the ova diameter and gonads somatic index. In the study of the reproduction of *Pomadasys stridens* Al-ghais (1995) found that the pre-spawning and spawning months were November to March, which was in contrast with the present study of *Pomadasys maculatus*. This may be due to the difference in the species level and area.

In this study it was found that the size at which 50% female fish matures in *Priacanthus hamrur* was found to be 198 mm. Premalatha (1997) found that the size at first maturity of *Priacanthus hamrur* was 175 mm in males and 190 mm in females, which is almost similar with the present study. The size at which a specimen becomes mature is a rather constant proportion of the final length or asymptotic length. In *Priacanthus tayenus* of gulf of Thailand, Chomjurai (1970) observed the size at maturity was at 140 mm. Chanta Wong *et al* (1984) reported the maturity size was at 150 mm in *Priacanthus tayenus* of Andaman Sea. Philip (1994) noted that the size at maturity in *Priacanthus hamrur* of Vishakapatanam area at 123.5 mm in males and 126.5 mm in females. Though the present study indicated that female *Priacanthus hamrur* attained 50% maturity at higher length groups, when compared with other specimens the age at first maturity is well comparable with other specimens.

The size at 50% maturity in *Pomadasys maculatus* was found to be 135 mm in females. Al-ghais (1995) observed that in *Pomadasys stridens*, females were maturing earlier. The minimum length of fully mature fish was 110 mm. Deshmukh (1973) found in *Pomadasys hasta* the minimum size of maturity to be 41 mm. In the present study it is evident that females of *Pomadasys maculatus* and *Priacanthus hamrur* attains sexual maturity at a length group which is more or less in agreement with other findings.

In the sex ratio study it was found that both *Priacanthus hamrur* and *Pomadasys maculatus* agreed with general 1:1 pattern. The sex ratio distribution in different month or seasons may help in estimating stock size by fecundity method. Sex composition in a fish population might be affected by many factors like (1) segregation of sexes through periods of the year including segregation resulting from sex differences in age and size at maturity, (2) year selectivity in relation to sex differences in morphology and in physiological activity and (3) differences in natural and fishing mortality between the sexes. The sex, which exhibits a faster growth rate, will be less affected by predation and this would influence the sex ratio. In a population both intra and interspecific competition for food & space many also affect the sex ratio. It appears survival is a function of length (Qasim, 1966). Test of variance of homogeneity of sex ratio showed x^2 values were not significant at 1% level in both the years. Al-ghais (1995) found in *Pomadasys stridens* the female to male sex ratio was 2.5:1. Here in the present study a comparison of the sex ratio based on pooled data of both species – *Priacanthus hamrur* and *Pomadasys maculatus* were made. The ratio was found to be 1:1.118 and 1:1.026. Slight dominance of females was seen in both species. However, the dominance of either sex during different months is probably due to the combined effect of differences in areas and depths of operation and the segregation of sexes at different depths or due to limited number of fishes collected during different months. Philip (1994) observed the pre-ponderance of females in the population of *Priacanthus hamrur.* Murty (1990) observed pre-dominance of males in smaller length groups and females in larger length groups of *Secutor insidiator.* Zacharia *et al* (1991) observed pre-dominance of females with a male to female ratio of 1:1.6 in *Priacanthus hamrur*, collected from the trawl catches at Mangalore.

Since the success or failure of a fish species largely depends on its spawning potential, the knowledge of fecundity becomes extremely important from the viewpoint of successful management and exploitation of its fishery. In broad terms, fecundity may be defined as the number of eggs produced by an individual during its life time. Fecundity can be affected by a number of factors. According to Simpson (1951) these factors are (1) the condition of fish when germinal epithelium is laid down during the first year of life, (2) the condition of fish either when the egg to be laid each year are separated from the mass of developing ova, and when the new primary oocytes are being formed each year. Fecundity is important in the determination of spawning potential of fish stocks and fishery management. In fishes, which spawn in batches, the estimation of fecundity is difficult (Qasim and Quyam, 1961). Fecundity varies in the same species in different periods or under different environmental conditions. Fecundity of *Priacanthus tayenus* from Hong Kong waters was estimated as 1,50,000 (Lester and Watson, 1985) and from Gulf of Thailand it was between 56,000 and

1,52,000 (Chomjurai, 1970 and Wetchagarun, 1971). Fecundity has been shown to increase as square of length of fish (Clark, 1934) or as cube of length (Simpson (1951), Bagenal (1957), Sarojini (1957) and Pillay (1958)) or more than the fourth power of length (Varghese 1976 & 1984). In the present study fecundity estimate have shown that there is a good correlation between total length size, total weight and gonad weight in both fishes. In both *Priacanthus hamrur* and *Pomadasys maculatus* the fecundity increased along with the increase of body weight & ovary weight. In majority of fishes fecundity increased with increase of body weight. From the observations it is pertinent to mention that high fecundity and large size of fish have a good biotic potential.

In the study of the sexual dimorphism it was noticed that in both groups a clear sexual dimorphism was noticed. Shapiro (1987) found that social environment has a control over the sex in the case of coral reef fishes. But no such influences were noticed in the present study. In both groups it was found that female were larger and heavier than the male of the same age group. From the study of the morphological characters such as total length, weight, head length, interorbital space etc female measurements were found to be greater than the male in both *Priacanthus hamrur* and *Pomadasys maculatus*.

6:1 Imature & Mature Ovaries *Priacanthus hamrur*

6.2 Imature & Mature Ovaries *Pomadasys maculatus*

Table 6.1: Percentage occurrence of immature & mature female *Pricanthus hamrur* of various length groups during the period 1997 January to 1998 December

No. of fishes	Length group	% of immature female	% of mature female
5	120-140	100	0
8	141-160	80	20
10	161-180	70	30
4	181-200	75	25
20	201-220	60	40
16	221-240	65	35
28	241-260	70	30
39	261-280	50	50
40	281-300	25	75
22	301-320	36.37	63.63
18	321-340	22.22	77.78
6	341-360	0	100
6	361-380	0	100

Table 6.2: Percentage occurrence of immature & mature female *Pomadasys maculatus* of various length groups during the period 1997 January to 1998 December

No. of fishes	Length group	% of immature female	% of mature female
8	80-100	100	0
0	101-120	0	0
6	121-140	80	20
28	141-160	75	25
36	161-180	70	30
76	181-200	75	25
30	201-220	60	40
8	221-240	65	35
2	241-260	70	30
4	261-280	0	100

Table 6.3: Percentage occurrence of female *Priacanthus hamrur* in different stages of maturity during the period from January 1997 to December 1998

Month	Percentage occurrence during various stage of maturity									
	1997					1998				
	I	II	III	IV	V	I	II	III	IV	V
January	37.5	62.5	0	0	0	33.33	50	0	0	16.67
February	62.5	37.5	0	0	0	25	75	0	0	0
March	25	25	25	25	0	50	25	25	0	0
April	40	20	20	20	0	50	25	25	0	0
May	25	25	50	0	0	0	20	60	20	0
June	20	20	20	40	0	0	0	50	50	0
July	0	25	50	25	0	0	0	20	60	20
August	0	20	20	60	0	0	25	25	50	0
September	100	0	0	0	0	75	0	0	0	25
October	100	0	0	0	0	100	0	0	0	0
November	25	50	0	0	25	33.33	33.33	0	0	33.34
December	20	20	20	20	20	25	0	25	50	0

Table 6.4: Percentage occurrence of female *Pomadasys maculatus* in different stages of maturity during the period from January 1997 to December 1998

Month	Percentage occurrence during various stage of maturity									
	1997					1998				
	I	II	III	IV	V	I	II	III	IV	V
January	20	60	20	0	0	33.33	66.67	0	0	0
February	25	75	0	0	0	0	100	0	0	0
March	25	50	25	0	0	0	66.67	33.33	0	0
April	25	25	25	25	0	0	0	66.67	33.33	0
May	25	50	25	0	0	0	66.67	33.33	0	0
June	83.33	0	0	0	16.67	39	50	0	0	11
July	64.66	0	0	0	33.34	66.34	0	0	0	33.67
August	60	0	0	0	40	50	0	0	0	50
September	0	20	20	60	0	0	16.67	16.67	66.64	0
October	0	80	20	0	0	0	60	40	0	0
November	0	50	50	0	0	0	100	0	0	0
December	0	80	20	0	0	0	50	50	0	0

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Table 6.5: Average ova diameter of various months during the period of 1997 & 98

Priacanthus hamrur

Year	Average ova diameter (Microns)											
	January	February	March	April	May	June	July	August	September	October	November	December
1997	271.70	284.28	366.08	337.48	353.93	314.60	325.33	314.60	128.70	100.10	314.60	282.43
1998	286.00	286.00	303.86	318.18	334.62	325.33	345.63	308.88	123.98	095.38	314.60	314.60

Table 6.6: Average ova diameter of various months during the period of 1997 & 98

Pomadasys maculatus

Year	Average ova diameter (Microns)											
	January	February	March	April	May	June	July	August	September	October	November	December
1997	294.60	303.16	307.45	325.33	314.60	262.11	233.52	274.56	328.90	343.20	332.48	320.32
1998	290.29	228.80	333.62	334.19	414.70	281.28	243.10	293.15	333.62	331.76	319.32	321.75

Table 6.7: The classification of maturity stage of female *Pricanthus hamrur*

Stage of maturity	Description of the intra ovarian ova	Mode of the largest group of ova in microns	Size range of the intra ovarian ova in microns
I	Immature (virgin)	151 – 200	50 – 250
II	Maturing	251 – 300	150 – 350
III	Mature	301 – 350	200 – 400
IV	Ripe	351 – 400	301 – 450
IV	Spent	301 – 400	351 – 400

Table 6.8: The classification of maturity stage of female *Pomadasys maculatus*

Stage of maturity	Description of the intra ovarian ova	Mode of the largest group of ova in microns	Size range of the intra ovarian ova in microns
I	Immature (virgin)	201 – 220	180 – 300
II	Maturing	281 – 300	281 – 360
III	Mature	321 – 340	301 – 360
IV	Ripe	341 – 360	320 – 380
IV	Spent	321 – 340	300 – 380

Table 6.9: Average percentage of ova diameter measurements of stages I, II, III, IV & V ovaries of *Priacanthus hamrur* during January 1997 to December 1998

Ova diameter	Percentage of frequency				
	Immature	Maturing	Mature	Ripe	Spent
50-100	13.60	0	0	0	20
101-150	23.68	0	0	0	15
151-200	52.20	0	0	0	5
201-250	7.89	46.43	6.67	0	0
251-300	2.63	42.86	5.56	4.16	0
301-350	0	10.71	50.00	35.00	40
351-400	0	0	26.67	50.00	15
401-450	0	0	11.10	6.67	5
451-500	0	0	0	4.17	0
Total no. of species	**76**	**56**	**32**	**48**	**6**

Table 6.10: Average percentage of ova diameter measurements of stages 1, 2, 3, 4 & 5 ovaries of *Pomadasys maculatus* during January 1997 to December 1998

Ova diameter	Percentage of frequency				
	Immature	Maturing	Mature	Ripe	Spent
180-200	36	0	0	0	18.00
201-220	20	0	0	0	10.57
221-240	24	0	0	0	0
241-260	0	0	0	0	0
261-280	12	0	0	0	0
281-300	8	40.27	0	0	8.57
301-320	0	26.00	18.80	13.75	15.00
321-340	0	13.73	79.00	20.00	42.86
341-360	0	20.00	2.20	60.00	5.00
361-380	0	0	0	6.25	0
Total no. of species	**50**	**30**	**74**	**32**	**14**

Tab:6.11 **Fecundity Of *Priacanthus hamrur***

S.No	Total length	Body wt:	ovary wt:	Fecundity	Stages Of Maturity
1	238	140	11.183	101600	IV
2	240.5	136	11.2	91417.5	IV
3	249.88	140	5.33	52996.25	II V
4	250.6	155	9.35	75510	III
5	256.8	200	14.5	111070	IV
6	258.56	198	7.152	70541	III
7	259.25	195	7.675	66287.5109	III
8	262	200	9.125	77367.5	IV
9	262.4	210	12.25	106616	IV
10	264.11	215	12	99214	IV
11	267.5	215	13.75	113625	IV
12	268.5	245	13.95	110810	IV
13	270	245	12.35	114602.5	IV
14	272.85	238	11.986	89414.29	IV
15	275	250	12.4	109408	IV
16	283	252	12	99865	IV
17	287.33	257	9.41	93214	V
18	288.75	275	13	110231	IV
19	290.8	300	13.1	109251	IV
20	291.5	305	12.525	108687.5	IV
21	315	325	13.488	117895	IV
22	321.67	330	14	127340	IV
23	332	340	15.77	142571	IV
24	340.25	372.5	17.725	152112	IV

Tab:6.12 Fecundity Of *Pomadasys maculatus*

Sl. No	total length	body weight	ovary weight	fecundity	Stages Of maturity
1	179.8	75	3.19	27602	IV
2	188	80	3.68	28708	IV
3	180	79	3	27700	V
4	174	75	3.2	27200	IV
5	203.5	130	4.28	33480	IV
6	96.94	15	1.75	10575	III
7	159.5	50	2.5	17033	III
8	177.6	75	3.1	26402	IV
9	187.8	82	5.89	52410	IV
10	180.2	78	4.29	34000	IV
11	185.5	80	3.917	31250	IV
12	195	120	3.467	29100	V
13	180.67	75	2.67	31203	III
14	134.8	35	2.66	20580	III
15	207.33	120	3.53	35433	IV
16	213.33	130	5.833	49800	IV
17	226.67	140	5.73	45163	IV
18	171	72	2	16166	III
19	179	75	3	26866	V
20	171	70	3.95	33900	IV
21	226.67	140	5.733	49943	IV
22	195	110	3.7	30996	IV
23	168.2	65	3.16	29204	V
24	182.5	80	3.45	31525	IV

Table 6.13: Monthly average of Gonado-somatic Index of Female *Priacanthus hamrur* during 1997 & 1998

Month	Rail fall (mm)		Surface temperature		G.S.I.		Pooled data
	1997	1998	1997	1998	1997	1998	
January	0	0	27.81	28.65	2.42	3.44	2.93
February	0	8	28.81	29.11	2.04	3.03	2.54
March	38	5	28.93	29.55	4.42	2.49	3.46
April	66	52	29.14	30.56	3.60	3.69	3.65
May	53	104	29.31	30.17	3.41	4.72	4.07
June	552	189	27.59	27.31	3.51	4.13	3.82
July	605	379	26.55	27.05	3.87	4.53	4.20
August	491	122	26.97	27.33	6.83	5.73	6.28
September	427	649	27.48	26.60	1.12	0.82	0.97
October	278	493	27.89	26.66	0.73	0.74	0.74
November	398	95	27.66	27.18	3.55	2.81	3.18
December	132	42	28.45	27.48	4.53	4.66	4.60

Table 6.14: Monthly average of Gonado-somatic Index of Female *Pomadasys maculatus* during 1997 & 1998

Month	Rail fall (mm)		Surface temperature		G.S.I.		Pooled data
	1997	1998	1997	1998	1997	1998	
January	0	0	27.81	28.65	4.20	4.49	4.35
February	0	8	28.81	29.11	2.14	2.49	2.32
March	38	5	28.93	29.55	2.40	2.55	2.48
April	66	52	29.14	30.56	3.99	4.48	4.24
May	53	104	29.31	30.17	2.94	2.88	2.91
June	552	189	27.59	27.31	1.04	1.82	1.43
July	605	379	26.55	27.05	0.55	0.93	0.74
August	491	122	26.97	27.33	0.94	0.57	0.76
September	427	649	27.48	26.60	4.76	4.27	4.52
October	278	493	27.89	26.66	2.85	3.24	3.05
November	398	95	27.66	27.18	3.29	2.85	3.07
December	132	42	28.45	27.48	2.99	2.86	2.93

Table 6.15: Monthly distributions of sexes in *Priacanthus hamrur* during the period from January 1997 to December 1998

Year	Month	Total No. of fishes	Males	Females	Ratio of males to females	Chi-square test	Remarks
1997	January	30	14	16	1 : 1.14	0.067	N.S.
	February	22	6	16	1 : 2.67	2.273	S.
	March	20	12	8	1 : 0.67	0.4	N.S.
	April	14	4	10	1 : 2.5	1.29	N.S.
	May	16	8	8	1 : 1	0	N.S.
	June	18	8	10	1 : 1.25	0.11	N.S.
	July	16	6	10	1 : 1.67	0.5	N.S.
	August	20	10	10	1 : 1	0	N.S.
	September	18	8	10	1 : 1.25	0.11	N.S.
	October	16	8	8	1 : 1	0	N.S.
	November	18	10	8	1 : 0.8	0.11	N.S.
	December	18	6	12	1 : 2	1.5	N.S.
	Total	**226**	**100**	**126**	**1 : 1.26**	**1.50**	N.S.
1998	January	16	6	10	1 : 1.67	0.5	N.S.
	February	16	10	6	1 : 0.6	0.5	N.S.
	March	16	8	8	1 : 1	0	N.S.
	April	18	10	8	1 : 0.8	0.11	N.S.
	May	14	6	8	1 : 1.3	0.14	N.S.
	June	16	8	8	1 : 1	0	N.S.
	July	14	8	6	1 : 0.75	0.14	N.S.
	August	12	6	6	1 : 1	0	N.S.
	September	10	6	4	1 : 0.67	0.2	N.S.
	October	10	4	6	1 : 1.5	0.2	N.S.
	November	12	8	4	1 : 0.5	0.66	N.S.
	December	14	6	8	1 : 1.33	0.14	N.S.
	Total	**168**	**86**	**82**	**1 : 0.953**	**0.048**	N.S.
Grand Total		**394**	**186**	**208**	**1 : 1.118**	**0.614**	

Table 6.16: Monthly distributions of sexes in *Pomadasys maculatus* during the period from January 1997 to December 1998

Year	Month	Total No. of fishes	Males	Females	Ratio of males to females	Chi-square test	Remarks
1997	January	16	6	10	1 : 1.67	0.5	N.S.
	February	18	10	8	1 : 0.8	0.11	N.S.
	March	16	8	8	1 : 1	0	N.S.
	April	15	7	8	1 : 1.14	0.033	N.S.
	May	20	10	10	1 : 1	0	N.S.
	June	18	6	12	1 : 2	0.056	N.S.
	July	9	4	5	1 : 1.25	0.5	N.S.
	August	20	9	11	1 : 1.22	0.1	N.S.
	September	16	10	6	1 : 0.6	0.5	N.S.
	October	19	9	10	1 : 1.11	0.026	N.S.
	November	13	8	5	1 : 0.63	0.35	N.S.
	December	16	6	10	1 : 1.67	0.5	N.S.
	Total	**196**	**93**	**103**	**1 : 1.108**	**0.26**	N.S.
1998	January	10	4	6	1 : 1.50	0.2	N.S.
	February	12	8	4	1 : 0.50	0.67	N.S.
	March	12	8	4	1 : 0.50	0.67	N.S.
	April	10	4	6	1 : 1.50	0.20	N.S.
	May	14	8	6	1 : 0.75	0.14	N.S.
	June	10	4	6	1 : 1.50	0.2	N.S.
	July	5	2	3	1 : 1.50	0.1	N.S.
	August	10	6	4	1 : 0.67	0.2	N.S.
	September	14	6	8	1 : 1.33	0.14	N.S.
	October	5	3	2	1 : 0.67	0.1	N.S.
	November	7	4	3	1 : 0.75	0.07	N.S.
	December	11	6	5	1 : 0.83	0.05	N.S.
	Total	**120**	**63**	**57**	**1 : 0.905**	**0.15**	N.S.
Grand total		**316**	**156**	**160**	**1 : 1.026**	**0.025**	

Table 6.17: Test of variance of homogenity of sea ratio in *Priacanthus hamrur* during 1997 & 1998

Year	Total No.	Male	Female	Observed sex ratio	X^2	5% Table	Remarks
1997	226	100	126	1 : 1.260	1.496	3.841	N.S.
1998	168	86	82	1 : 0.953	0.048	3.841	N.S.
Pooled data 97 & 98	394	186	208	1 : 1.118	0.614	3.841	N.S.

1% (5%) Table X^2 value for 1 d.f.

Table 6.18: Test of variance of homogenity of sex ratio in *Pomadasys maculatus* during 1997 & 1998

Year	Total No.	Male	Female	Observed sea ratio	X^2	5% Table	Remarks
1997	196	93	103	1 : 1.108	0.255	3.841	N.S.
1998	120	63	57	1 : 0.950	0.150	3.841	N.S.
Pooled data 97 & 98	316	156	160	1 : 1.026	0.025	3.841	N.S.

1% (5%) Table X^2 value for 1 d.f.

Table 6.19: Sexual Features – *Priacanthus hamrur* comparison of morphological features in Males and Females

Sl. No.	Characters	Males	Females
1	Lateral line is more arched and curved like a hook in front	Yes	No
2	The dorsal anterior profile of the head has downward slope	No	Yes
3	Opercular spine is sharply marked	Yes	No
4	The soft rays of the posterior half of the dorsal fin are filamentous and project out from the fin	No	Yes
5	Inter orbital space	1.28 cm	1.76 cm
6	Average total length	20.57 cm	26.30 cm
7	Average head length	5.10 cm	6.13 cm
8	Average caudal peduncle length	6.26 cm	7.26 cm
9	Average maximum width	5.67 cm	7.26 cm
10	Average total weight	101.07 gm	215.8 gm

Table 6.20: Sexual Features – *Pomadasys maculatus* comparison of morphological features in Males and Females

Sl. No.	Characters	Males (cm)	Females (cm)
1	Males are small/ Females are large		
2	Average total length	15.56	16.93
3	Average head length	4.14	4.77
4	Caudal Peduncle length	4.75	5.17
5	Average total weight	52.5	81.72
6	Average inter orbital space	1.14	1.46
7	Average eye diameter	1.01	1.303
8	Average inter nostril gap	1	1.03

Fig. 6.1: Average percentage of ova diameter measurements of stages I, II, III, IV & V ovaries of *Priacanthus hamrur* during January 1997 to 1998

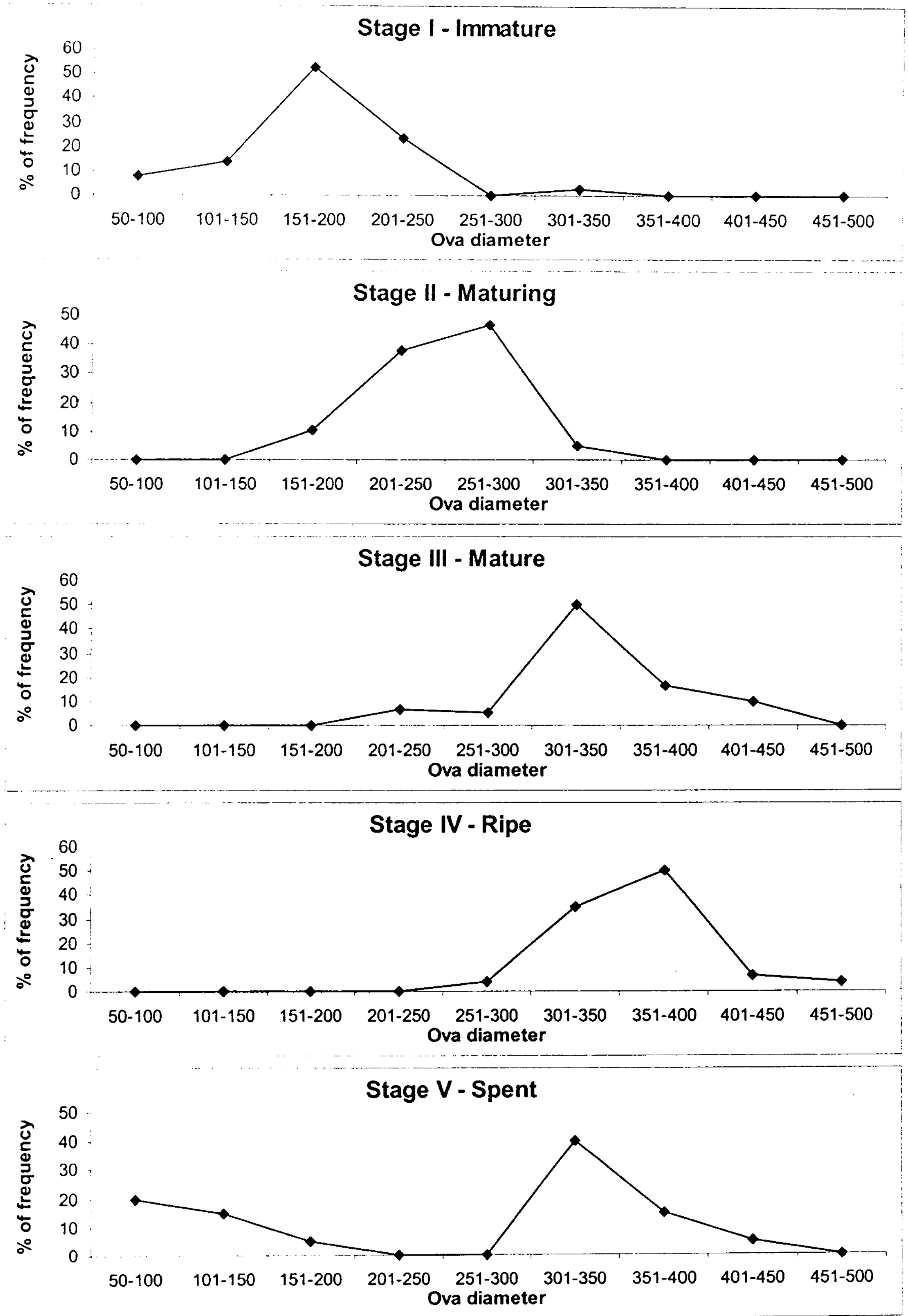
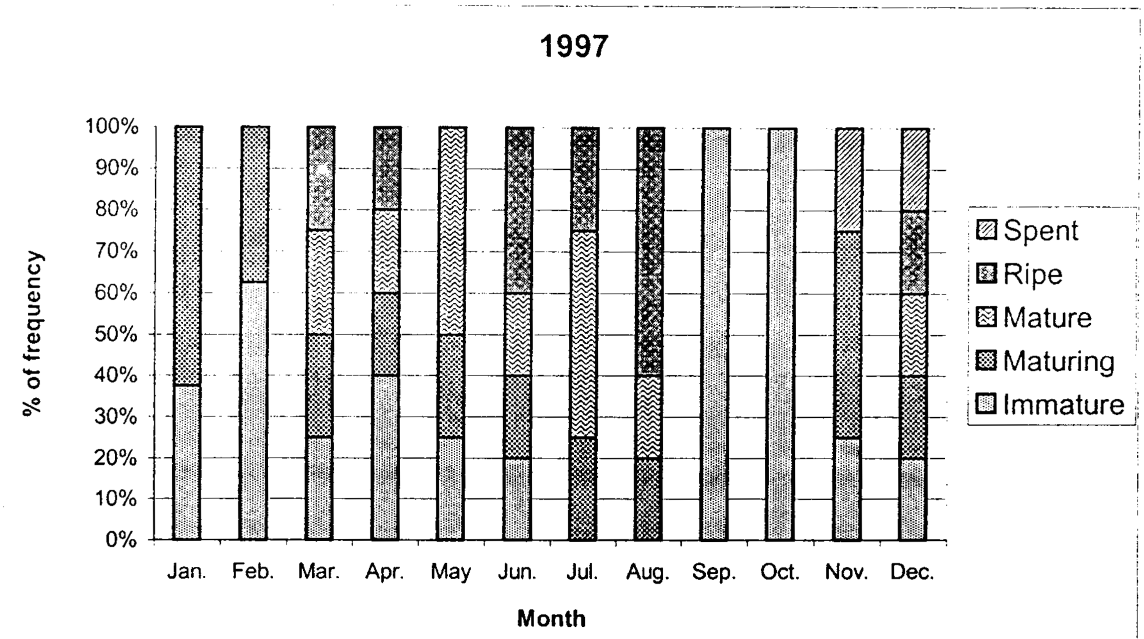


Fig. 6.2: Percentage occurrence of female *Priacanthus hamrur* in different stages of maturity during the period from January 1997 to December 1998



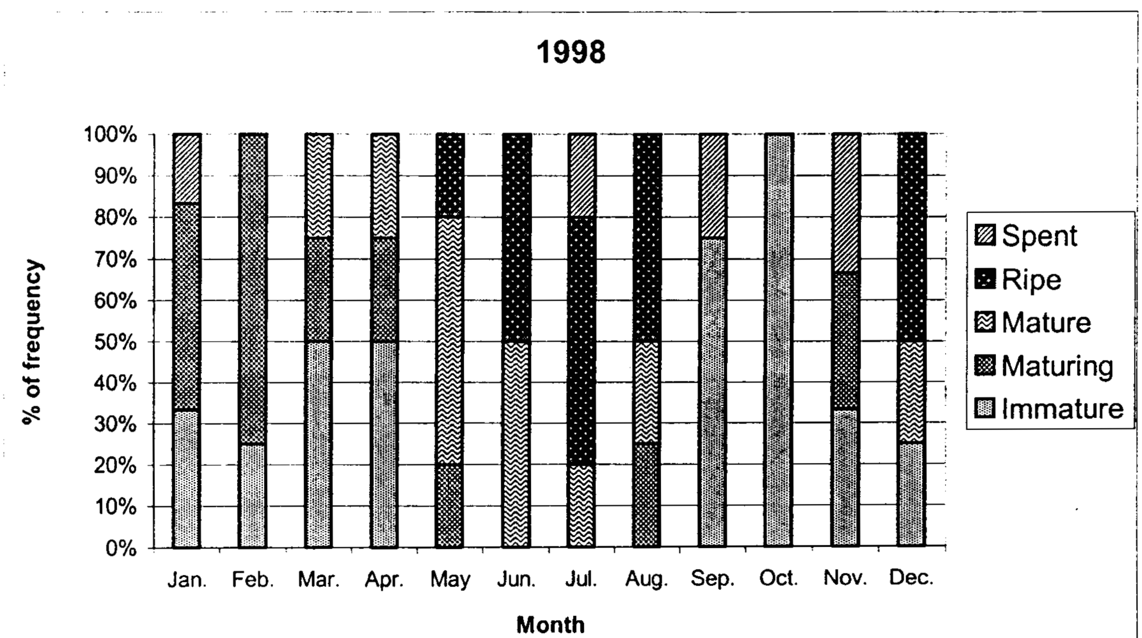


Fig. 6.3: Average percentage of ova diameter measurements of stages I, II, III, IV & V ovaries of *Pomadasys maculatus* during January 1997 to 1998

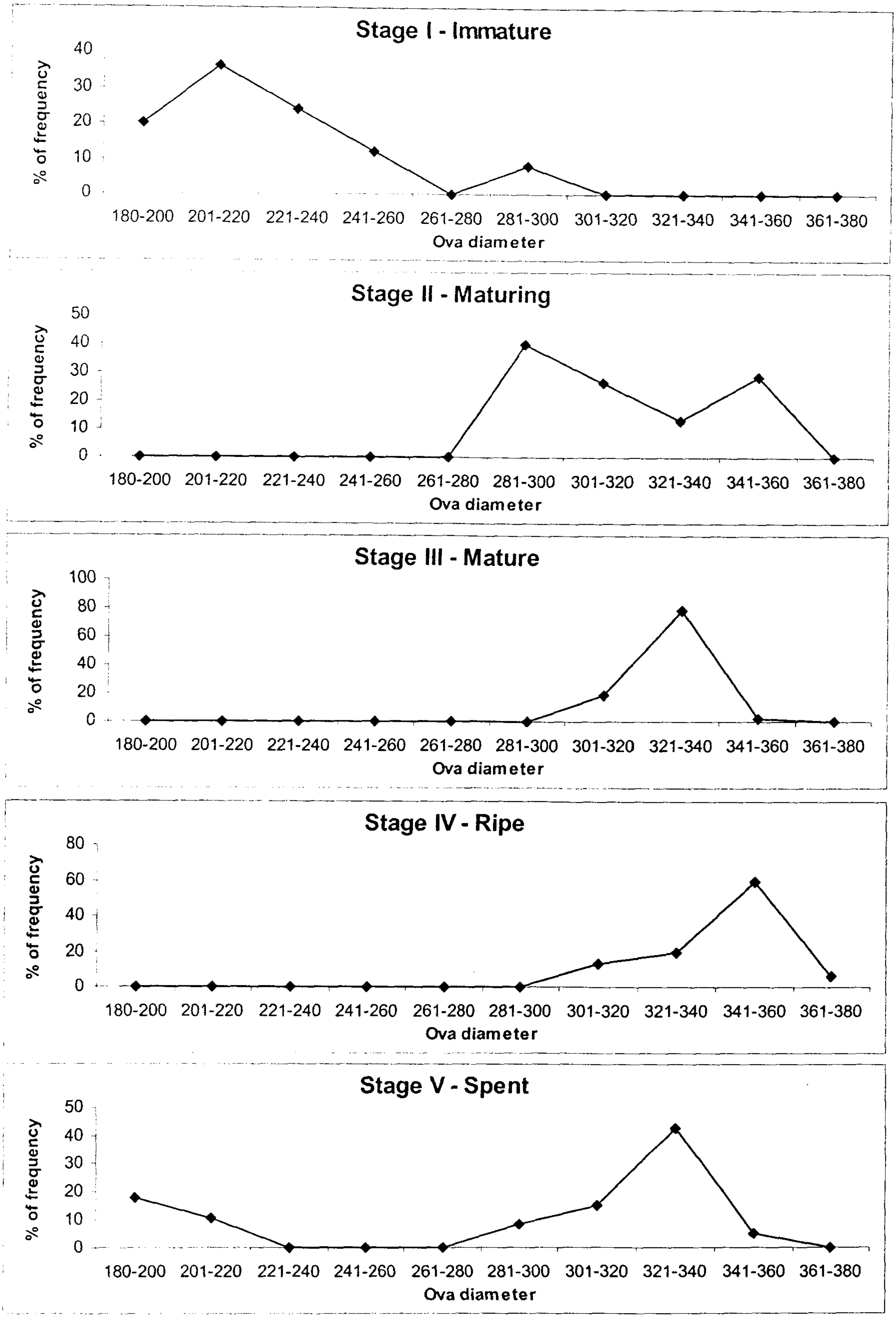
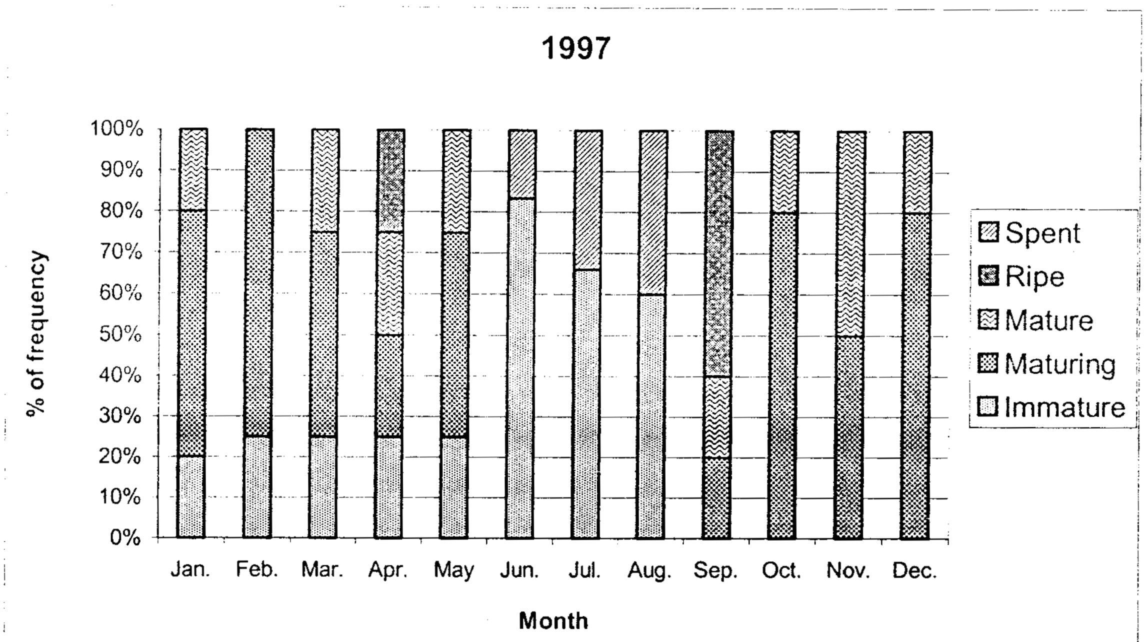


Fig. 6.4: Percentage occurrence of female *Pomadasys maculatus* in different stages of maturity during the period from January 1997 to December 1998



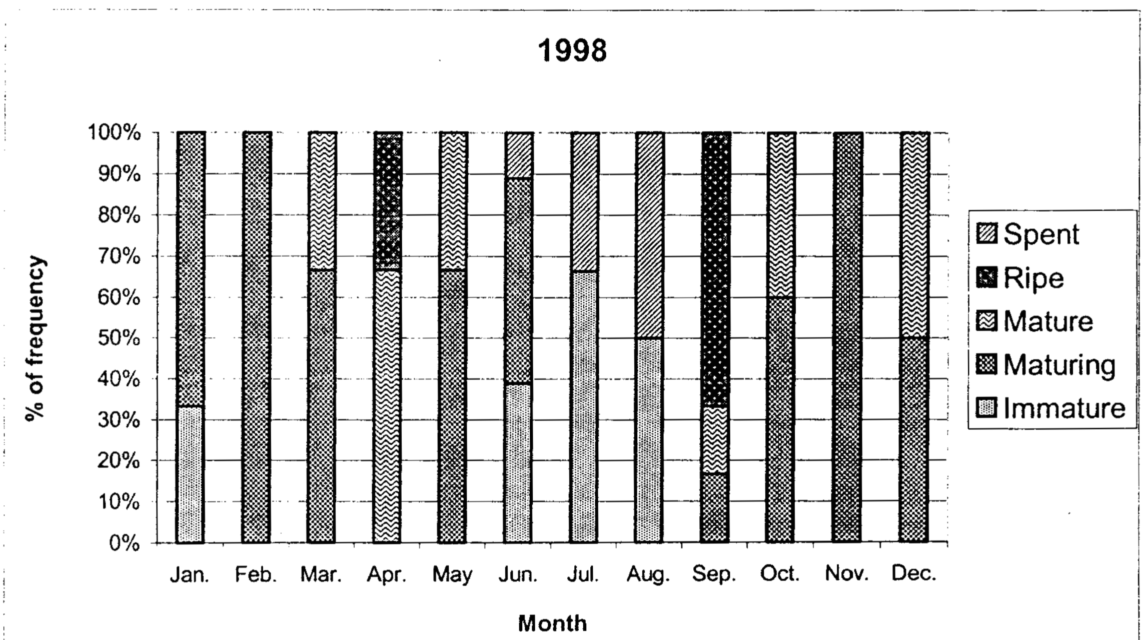


Fig. 6.5: Size at 50% Maturity in *Priacanthus hamrur* (Female)

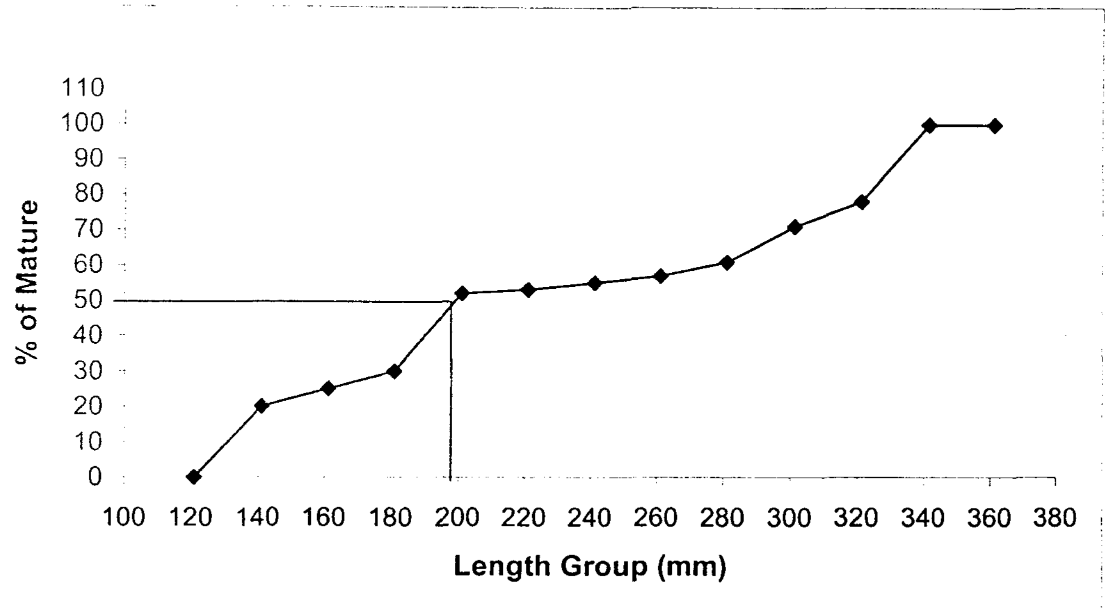


Fig. 6.6: Size at 50% Maturity in *Pomadasys maculatus* (Female)

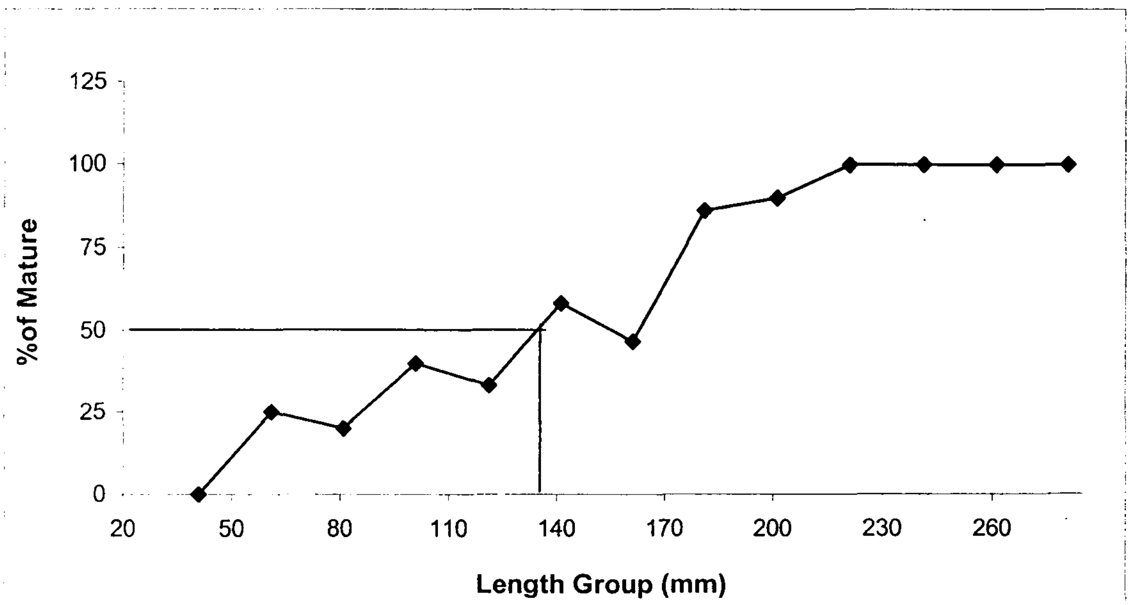


Fig. 6.7: Ova diameter of *P.*'*acanthus hamrur* of various months during the period of 1997 & 1998

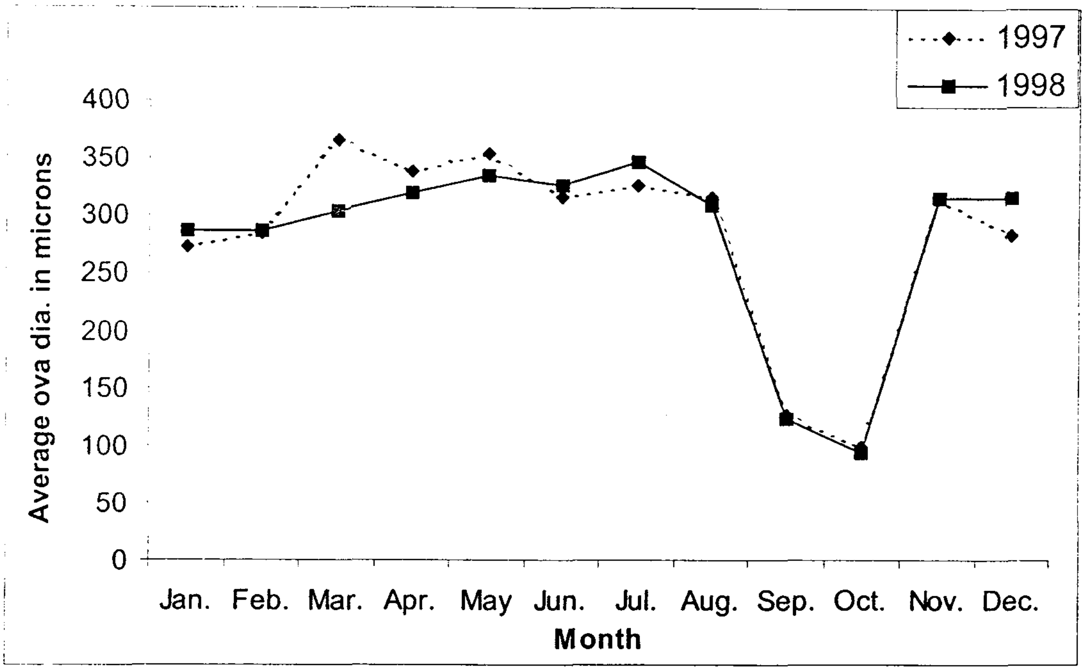


Fig. 6.8: Ova diameter of *Pomadasys maculatus* of various months during the period of 1997 & 1998

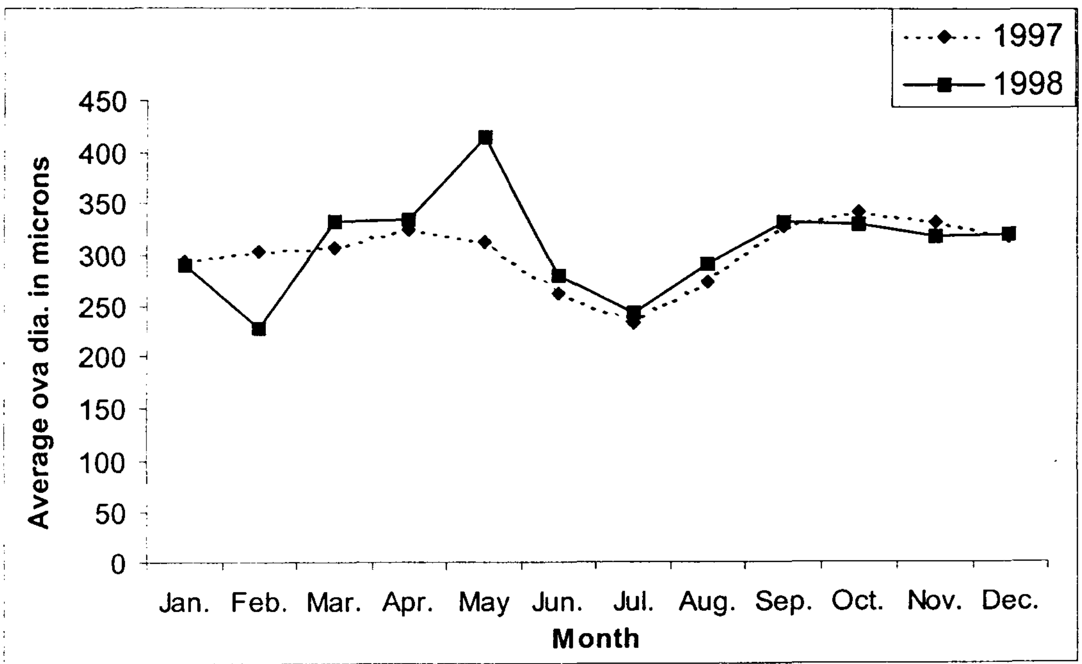


Fig.6.9 Relation between fish length&Fecundity for Priacanthus hamrur.

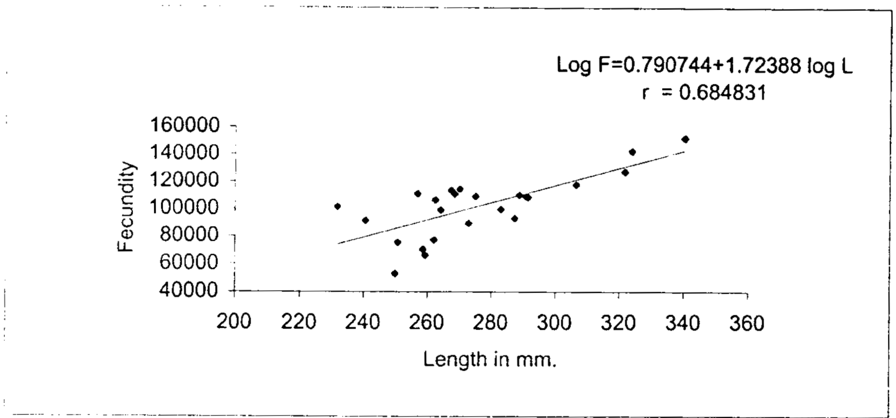


Fig.6.10 Relation between body weight&Fecundity for Priacanthus hamrur.

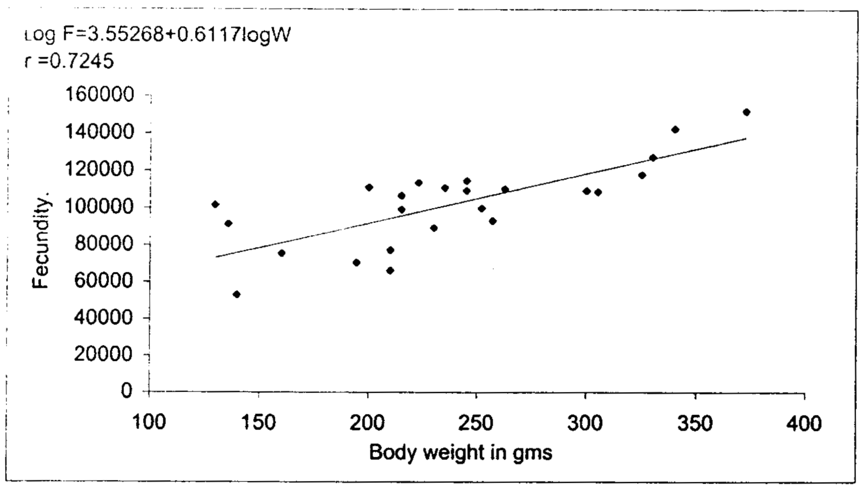


Fig.6.11 Relation between Ovary weight and Fecundity for Priacanthus hamrur.

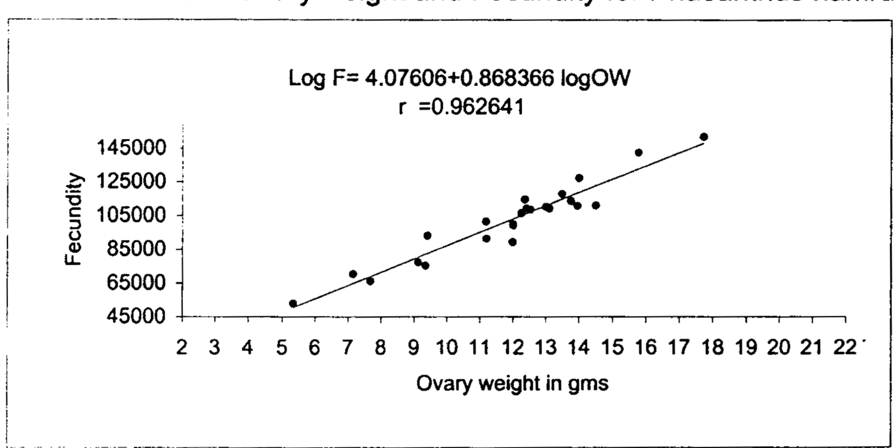


Fig. 6.12 Relation between fish length & fecundity for Pomadasys maculatus

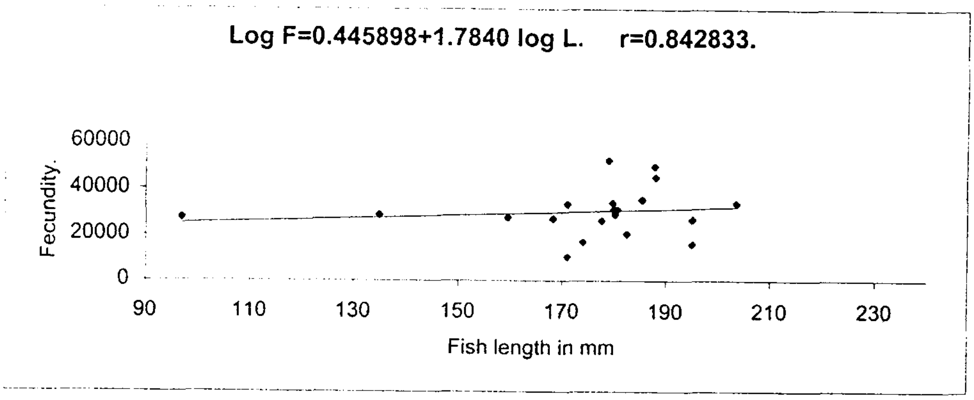


Fig. 6.13 Relation between body weight & fecundity for Pomadasys maculatus

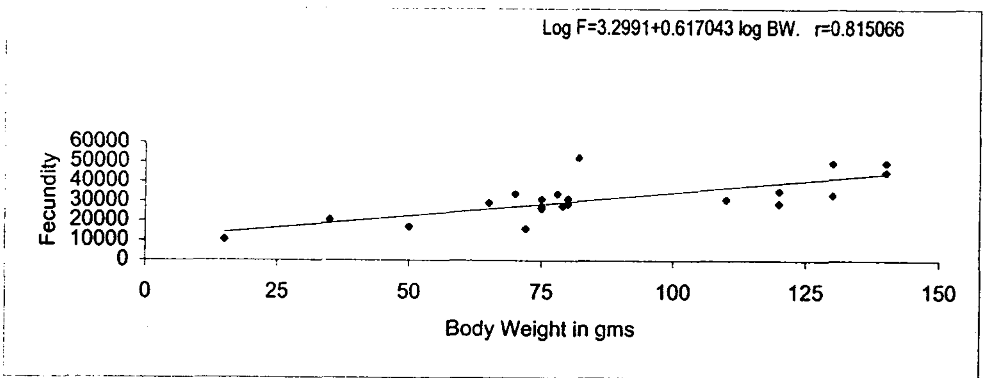


Fig. 6.14 Relation between ovary weight &fecundity for Pomadasys maculatus

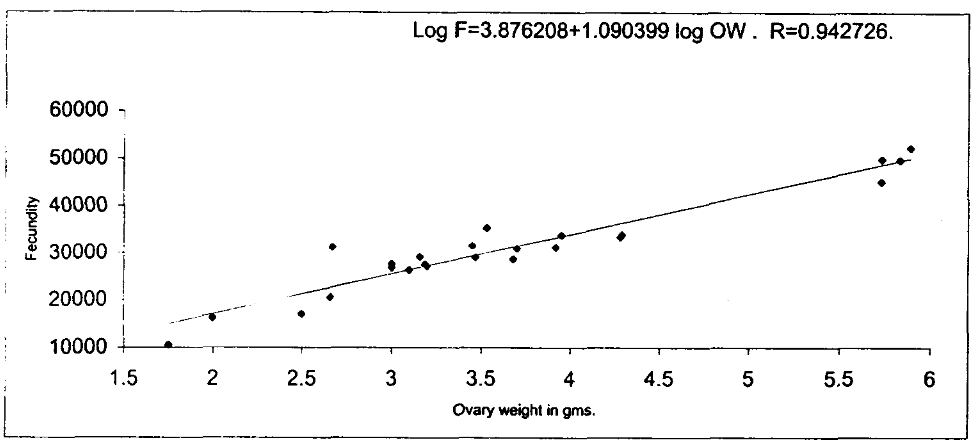


Fig. 6.15: Monthly average of Gonado-somatic index of female *Priacanthus hamrur*

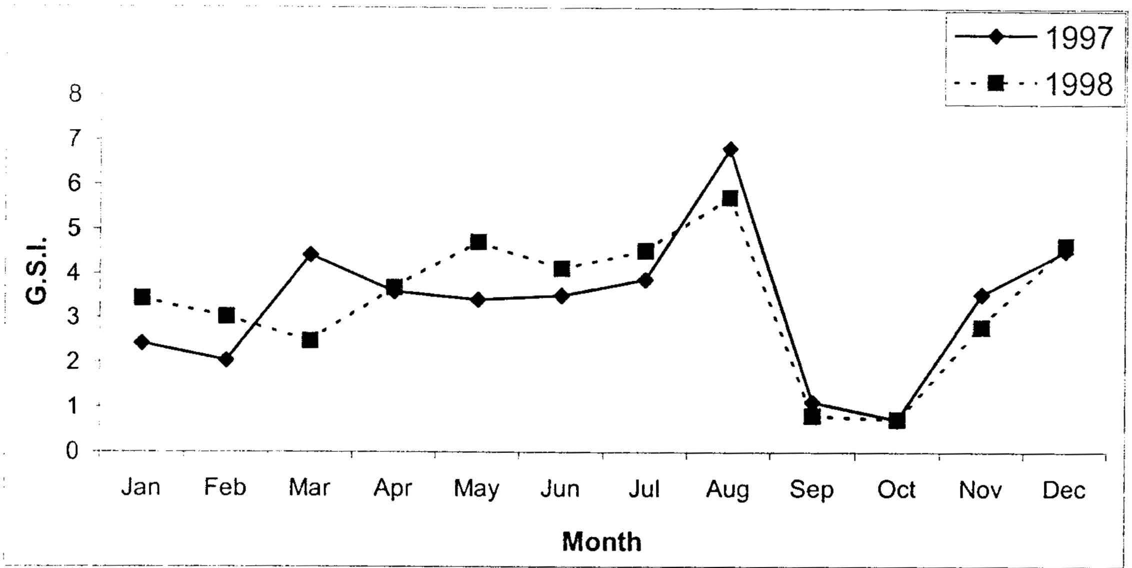


Fig. 6.16: Monthly average of Gonado-somatic index of female *Pomadasys maculatus*

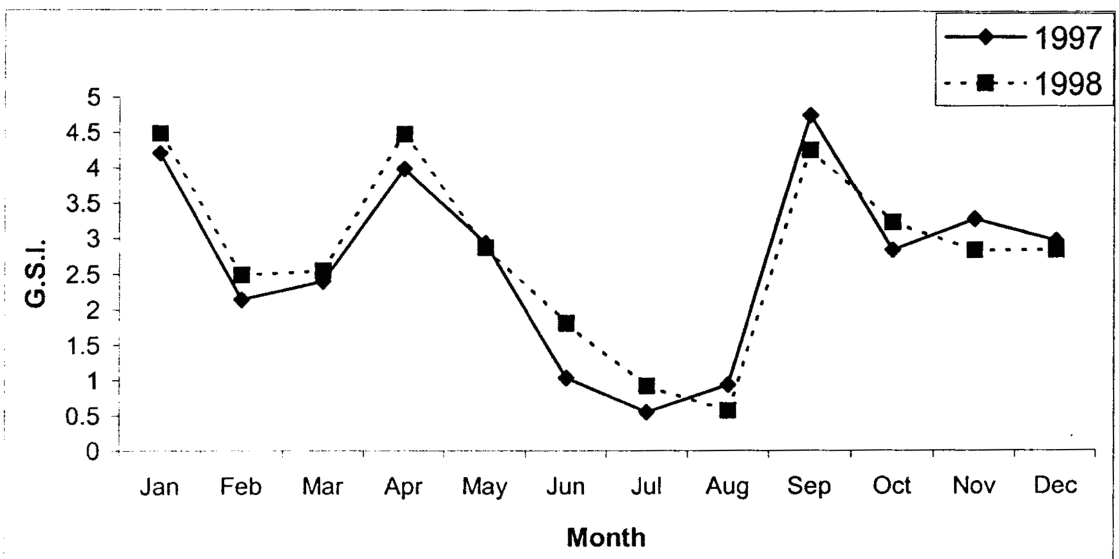


Fig. 6.17: Sex Ratio

Pooled data of 1997 & 1998

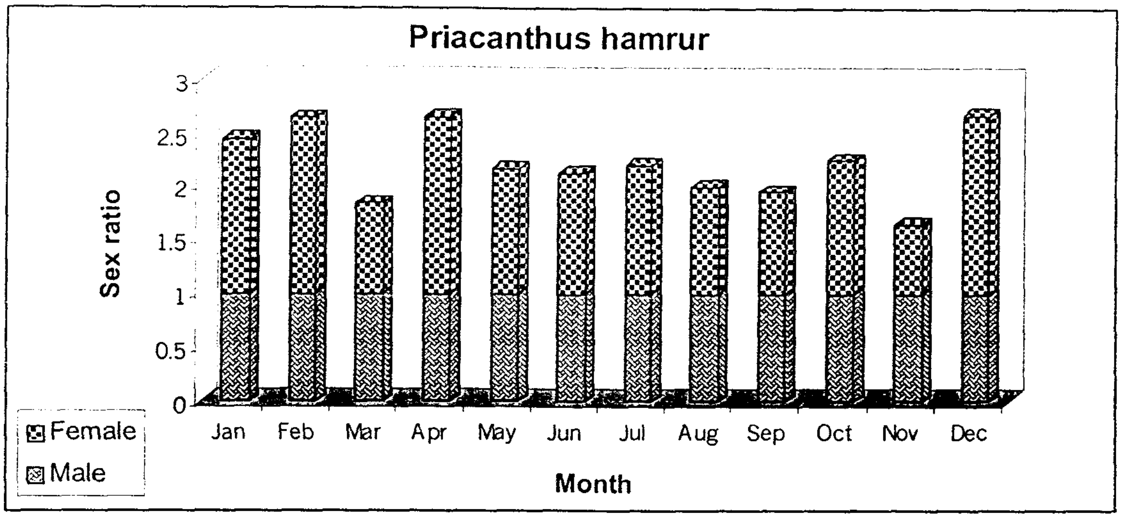
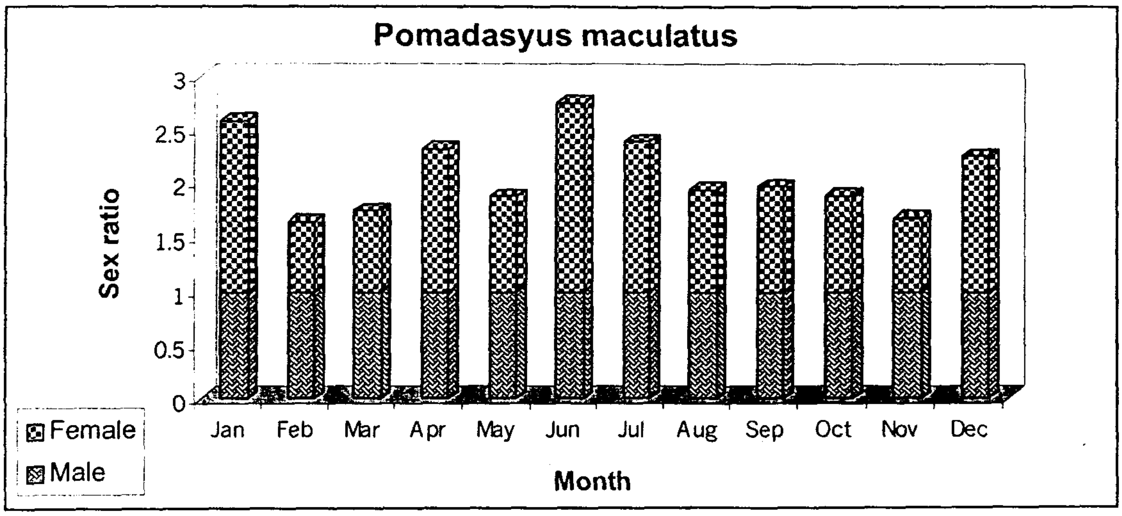


Fig. 6.18: Sex Ratio

Pooled data of 1997 & 1998



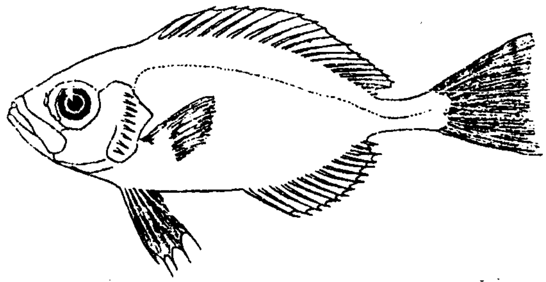


Fig:6.19. Priacanthus hamrur-Male

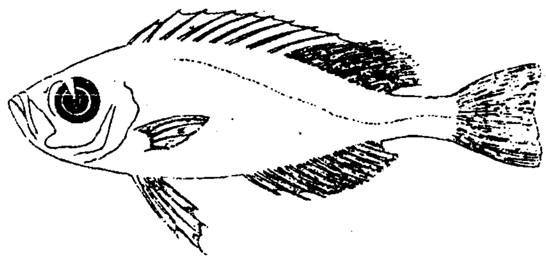


Fig:6.20. Priacanthus hamrur-Female

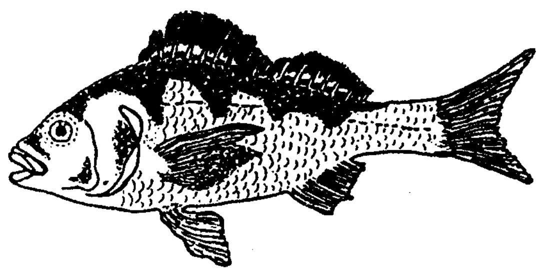


Fig:6.21. Pomadasys maculatus-Male

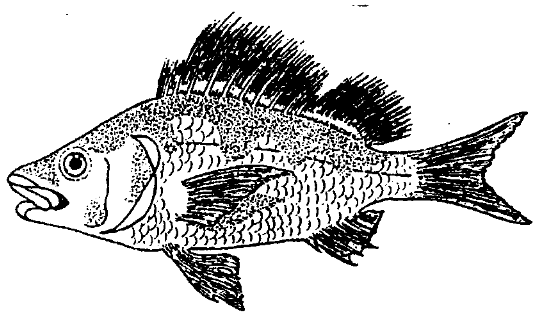


Fig:6.22. Pomadasys maculatus-Female

CHAPTER - 7

SUMMARY

CHAPTER – 7

SUMMARY

Coastal waters of Central Kerala support a great number of fish species. The present study deals with the systematics and bionomics of edible perches of Central Kerala. The first part of the thesis is concerned with the systematic part, which includes the taxonomy of edible perches occurring in Central Kerala. The second part consists of biology of two edible perches – *Priacanthus hamrur* and *Pomadasys maculatus*. From outside India, there have been several reports on these and related species of fishes. But very little attention has been paid to the comprehensive study of these species occurring in Indian waters. The present work was initiated in January 1996 with the object of contributing additional information to the existing knowledge of the biology and fishery of these important groups of commercial fishes. This thesis is mainly based on the study of samples of fishes collected from the commercial catches at various centres along the coast of Central Kerala. The main centres at which samples have been collected for systematics were Chavakkadu, Vadanappalli, Munambum and Cochi. For biological study of the two selected species – *Priacanthus hamrur* and *Pomadasys maculatus*, the collection was done mainly from Munambum harbour. During the period of study monthly samples of fish were collected regularly from the above places and the results of these investigations presented here are based on the analysis of these samples collected during January 1996 to December 1998 from commercial landings of trawlers. For the purpose of this study, total length, standard length and total weight were recorded. Scales, eye lens, stomach contents and gonad tissues were taken and preserved. The whole work is presented in 6 chapters.

See pages 19 and 20.

1. INTRODUCTION

The group perches constitute one of the important commercial fisheries of India. The first chapter consists of an account of perch landings and catch rates. It also gives an idea of the density of perch population in different parts of India. The highest landing of major perches is from the state of Tamil Nadu, 49.5% followed by Kerala. Along the Southwest and Southeast coasts, the peak fishing season is from December to April. The average annual production of major perches in the country during 1990–1998 periods has been estimated as 23,732 tons.

2. SYSTEMATICS

During the period 38 species of fishes of the group perches belonging to 11 different families were collected. The characters of the families and key to the respective genera and species of the collected fishes are given. The systematic position of all fishes got from the coast of Central Kerala has been reviewed. The morphometric and meristic characters of the species studied are also presented. Photos of all these fishes were also included in this chapter.

3. FOOD AND FEEDING HABITS

Regular Monthly samples of *Priacanthus hamrur* and *Pomadasys maculatus* for 24 months during the period 1997 January to 1998 December were collected and food analysis have done. The gut content analysis of *Priacanthus hamrur* and *Pomadasys maculatus* were done qualitatively and quantitatively. The food analysis of these 2 fishes revealed their preference for crustacean and fish diet. Both fishes are carnivorous. The food analysis of *Priacanthus hamrur* revealed that they were having a high preference towards prawns especially deep-sea prawns – *Solenocera*. Their percentage occurrence proved that these fishes are really a major threat to prawn fishery. The various food items in the order of abundance consisted of organisms like deep-sea prawns, prawn tissues, annelida bristles, invertebrate eggs, animal tissues, fat droplets, jelly pieces of coelenterates, tentacles of coelenterates etc. In *Pomadasys maculatus* the order of abundance of food items were animal tissues, fat droplets, crustacean fragment, annelida bristles and invertebrate eggs. The food items were analysed month wise separately for both males and females for a period of 24 months in the case of both fishes at Munambum. The results in both cases indicated no significant difference in food items, between males and females. The maximum feeding intensity in *Priacanthus hamrur* was during September. But in *Pomadasys maculatus* the maximum intensity was noted during 6 months of the year in a protracted manner. The active feeding condition is mainly based on the availability of the food items. In both the fishes, occurrence of food items influences the feeding of both immature and mature fishes.

In *Priacanthus hamrur* these observations undoubtedly prove that the length groups and size groups have a real influence in the nature of feeding and preference on the food items. But in *Pomadasys maculatus* the results proved that in general the length groups and size groups have no real influence in the nature of feeding and preference on food items.

Feeding rhythm was studied in both the fishes. The results of both fishes proved that there was no day night specification in the feeding mechanism. Medium and heavy stomachs were seen both during day and night periods. So, both these fishes are not diurnal or nocturnal.

4. AGE AND GROWTH

The age and growth of *Priacanthus hamrur* and *Pomadasys maculatus* was studied by the scales and eye lens method. Scales of both fishes were translucent to read the annual rings. The relationship between scale radius and fish length was found out. In *Priacanthus hamrur* the relationship was expressed as $L = a + b\ S_R$ where L = total length of the fish, S_R = scale radius, a & b are two constants. The mean fish length at capture (TL mm) worked out in *Priacanthus hamrur* for 1^{st} to 4^{th} growth rings on scales was 198 mm, 230 mm, 269 mm and 300 mm for males and 208 mm, 244 mm, 280 mm and 324 mm for females respectively. In *Pomadasys maculatus*, the mean fish length worked out for 1^{st} to 4^{th} growth rings on scales was 95 mm, 140 mm, 182 mm and 218 mm for males and 98 mm, 148 mm, 173 mm and 234 mm for females. The frequency distribution of growth checks in the males and females of both fishes were almost similar. Back calculation of fish length from scales was done by the Lee's formula in both fishes.

$$L_i = a + [(L_c - a)\ (S_i/S_R)]$$

where L_i = length at the time of annuusl formation, a= intercept, L_c = length at capture, S_i= Scale radius at the time of annulus formation, S_R = Scale radius at the time of capture.

In *Priacanthus hamrur*, the mean back calculated length for the first 4 years of life using scales in males were 185 mm, 225 mm, 260 mm and 296 mm respectively. In females the first 4 years of lengths were 201 mm, 245 mm, 283 mm and 320 mm. The back calculated length of both males and females were in agreement with the length of the fish obtained at the time of capture in the case of *Priacanthus hamrur*.

In *Pomadasys maculatus* also the mean back calculated lengths for the first 4 years of life was done and in males the length for the 4 years were 106 mm, 143 mm, 175 mm and 211 mm and in females the lengths were 116 mm, 157 mm, 192 mm and 208 mm. Growth increments in males and females of both fishes were calculated. Slight variations in the size of both sexes were noticed which supports the sexual dimorphism. The absolute growth curves derived from mean total body lengths and mean back calculated lengths from scales at each age group based on scale radius, illustrate a smooth curvilinear growth in males and females of both fishes. A close agreement was obtained between the mean standard length at capture of each age group and the mean back calculated standard lengths in the case of both fishes.

Eye lens technique was also used in the age determination of *Priacanthus hamrur* and *Pomadasys maculatus*. The relationship between the body length and eye lens weight, body length and eye lens diameter was established in males and females of both fishes and the result revealed linear relationship.

The average lens diameter for male *Priacanthus hamrur* in the years 1 to 4 was 4.28 mm, 14.45 mm, 5.45 mm and 6 mm and lens weight for 1 to 4 years 42.39 mg, 64.94 mg, 73.63 mg and 79.56 mg respectively. In females eye lens diameter in the four years was 4.38 mm, 4.40 mm, 5.83 mm and 6.27 mm and lens weight for 1 to 4 years was 51.60 mg, 66.21 mg, 73.73 mg and 81.16 mg respectively.

In male *Pomadasys maculatus* the average lens diameter for the years 1 to 4 years were 4.28 mm, 1.58 mm, 2.66 mm, 2.66 mm and 3.0 mm and lens weight for 1 to 4 years was 2.52 mg, 10.76 mg, 11.95 mg and 15.6 mg respectively. In females eye lens diameter in the 4 years was 4.38 mm, 4.40 mm, 5.83 mm and 6.27 mm and eye lens weight was 2.69 mg, 9.86 mg, 13.33 mg and 16.75 mg.

The relationship of eye lens weight and diameter with total length seemed to be isometric, i.e. eye lens diameter and eye lens weight increased with body length in both fishes. Eye lens weight and eye lens diameter of certain age groups showed overlapping in both fishes. This may be due to inadequate number of specimen collected and the presence of overlapping in lens weight also correlates with the development of sexual maturity.

5. LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR

The length-weight relationship in the *Priacanthus hamrur* and *Pomadasys maculatus* was determined using the parabolic formula $W = aL^b$. The value obtained for *Priacanthus hamrur* and *Pomadasys maculatus* were given.

The analysis of covariance revealed no significant difference between sexes in respect of both *Priacanthus hamrur* and *Pomadasys maculatus* and proved that the length weight relationship between males, females and pooled were statistically significant and highly associated. The significance of variation in the estimation of 'b' for this species from the expected value for ideal fish (3.0) was tested by the 't' test and the values were not significant. In *Pomadasys maculatus* the 'b' (exponential) value is slightly below 3, which would indicate lean pattern of growth. While in *Priacanthus hamrur* the exponential values were slightly above 3, thus showing stoutest pattern of growth. The growth is isometric in both the sexes of both species.

Relative Condition Factor

In both fishes the relative condition factor (Kn) was worked out separately for both males and females by using the length-weight relationship formulae. Kn = W/w. The Kn values of different size group give an idea about the variation in the condition of the fish during its growth. Fluctuations were noticed in the relative condition with increase in length of the fish. In males and females of both fishes at first an increase in Kn value was noticed along with the increase in length. After that a decrease in the value noticed which indicated spawning. Again the Kn value increased and reached the maximum followed by a decline in the value thereafter. Two peaks of Kn value were noticed in both males and females followed by a decrease indicating the 2 spawning seasons. The decrease in Kn value indicates spawning period. During spawning metabolic strain of the fishes will be increased which will lead to an abrupt fall in the condition factor. During different seasons, the changes in Kn values were more or less similar in both sexes indicating that the metabolic strain undergone by males as well as females was almost the same.

6. REPRODUCTION

Reproductive parameters are of great value in fishery predictions and formations of management resources. In both fishes the gonads were lying in the abdominal cavity and are attached to the dorsal wall of the abdominal cavity by a thin membrane. Female gonads alone were studied in detail. In both fishes ovaries are paired symmetrical organs lying ventral to the air bladder. They were more or less triangular in outline. The two lobes of the ovary seemed to be detached through out its length and interconnected before opening to the exterior by a common genital aperture. In *Priacanthus hamrur* the ovaries are closely visible in fishes of 80–100 mm lengths. In *Pomadasys maculatus* ovaries are seen in fishes of 40–60 mm lengths. The colour of the ripe ovary in *Priacanthus hamrur* is orange red and in *Pomadasys maculatus* golden yellow.

Five maturity stages were identified in both *Priacanthus hamrur* and *Pomadasys maculatus*. The stages are immature, maturing, mature, ripe and spent. The ova diameter of the different stages of *Priacanthus hamrur* was 175 md, 275 md, 325 md and 375 md respectively. In *Pomadasys maculatus* the ova diameter was in the order 210 md, 290 md, 330 md and 350 md. The ovaries of the ripe stage in both fishes seemed to be faded or shrunk.

To find out the length at first maturity, in both fishes the length at which 50% of the female fishes attain maturity was calculated. In *Priacanthus hamrur* it was found to be 198 mm and in *Pomadasys maculatus* it was 135 mm.

In order to get an idea regarding the distribution of ova in the different regions of the ovary of *Priacanthus hamrur* and *Pomadasys maculatus*, samples from anterior, middle and posterior regions of the right and left lobes of the mature ovaries of the fishes were taken and ova diameter was noted separately. From the study it was clear that the distribution of ova and their diameter was uniform in both fishes.

Fecundity was studied and it was found that the maximum fecundity in *Priacanthus hamrur* was 1,52,112 for a female fish of length 340 mm, weight 373 gm and ovary weight 17.73 gm. The overall average fecundity of *Priacanthus hamrur* per gram body weight and per 0.1 gm ovary weight was 408 and 845 respectively. In *Pomadasys maculatus* the maximum fecundity was 52,410 for a female fish of length 188 mm, weight 90 gm and ovary weight 6 gm. The average fecundity of Pomadasys maculatus per gram body weight was 582 and per 0.1 gm ovary weight was 874. Regression analysis has done to find out the relation between fecundity and length of fish, fecundity and weight of fish and fecundity and ovary weight of fish. In both fishes fecundity tends to increase along with the increase of body weight and ovary weight.

The gonado somatic index was calculated for 24 months. The maximum G.S.I. in *Priacanthus hamrur* was 6.83 in August 1997 and in *Pomadasys maculatus* it was 4.76 in September 1997. The study of G.S.I. throughout the months clearly indicates that in both fishes there were 2 peaks in a year, which represents the peaks of spawning seasons. In *Priacanthus hamrur* the two peaks are March–August and November–December. The 2 peaks of

G.S.I. in *Pomadasys maculatus* was March–May and September–January. So in both fishes 2 spawning seasons are noted in a year.

Sex ratio studies proved that the ratio in both *Priacanthus hamrur* and *Pomadasys maculatus* agreed with 1:1 pattern. The sex ratio during different months varied from year to year. The Chi-square value showed that, deviation observed from the expected ratio for the pooled data of both fishes were considered to be non-significant at 5% table for 1° of freedom.

Both fishes exhibited a clear sexual dimorphism. In both groups, females were bigger and heavier than the males of the same age group. In all morphological characters females were dominating males.

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