Biology and fishery of carangids with special emphasis on *Decapterus russelli* along the Malabar Coast

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By

Puduparambil Manojkumar

Department of Zoology, St. Joseph's College,
Devagiri, Calicut, Kerala, India
Pin : 673008

2003

Department of Zoology
St. Joseph's College

Devagiri, Calicut,
Kerala, India
PIN-673 008

Phone: 0495-2355901

Date: 16-9-2003

Dr. V.J.Zacharias,
M.Sc., P.hD,
Retired Professor of Zoology & Supervising Teacher

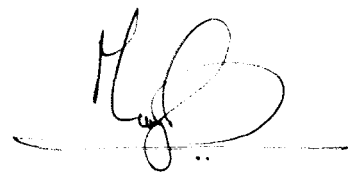
CERTIFICATE

This is to certify that this thesis entitled "Biology and fishery of carangids with special emphasis on *Decapterus russelli* along the Malabar coast" is an authentic record of the work carried out by Shri.Puduparambil Manojkumar, from September, 2000 to August, 2003 under my supervision and guidance in partial fulfillment of the degree of **Doctor of Philosophy** in the Faculty of Science of the University of Calicut. No part of this thesis has been presented for any other degree. I also certify that Shri.Puduparambil Manojkumar has passed the P.hD. Preliminary Qualifying Examination held in December, 2001.

V.J.Zacharias

Declaration

I do hereby declare that the thesis entitled "**Biology and fishery of carangids with special emphasis on *Decapterus russelli* along the Malabar Coast**" is original work and has not been published or submitted in part or full for any other degree, diploma or recognition.



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Contents

Chapter - 1

Introduction

The burgeoning world population has prompted mankind to exploit new and varied avenues for acquiring food. The sea is often seen as a vast and endless source of food for mankind. Man from time immemorial has exploited the fishery resources of the sea and the recent rapid strides in technology have enabled him to utilise the vast and deep expanses of the oceans effectively. The total annual world fish production is estimated as 92.86 million tonnes in 1999. Of this, production from marine fisheries alone accounted for 84.6 million tonnes (FAO, 1999). India ranks eighth in the total fish production in the world. With its long coastline of 8129 km and an extensive Exclusive Economic Zone of 2.02 million sq km, with an estimated fishery resources potential of 3.9 million tonnes (Anon, 1991), the importance of the marine fisheries sector in the national economy, food security and employment generation need not be overemphasised. In the 3651 fishing villages situated along the coastline, about one million people are employed full time in marine capture fisheries. The fishing sector dominated by small scale and semi industrial operations, support several ancillary industries such as boat building yards, processing plants etc (Devaraj and Vivekanandan, 1997).

Marine fisheries operations have grown from a subsistence level carried out almost exclusively by the traditional fishermen in the pre-independence days to that of a capital-intensive industry requiring close monitoring and management for their sustainability. In the course of the past over five decades of independence, the average annual marine fish production increased from six lakh tonnes in the fifties to the current level of 2.72 million tonnes in 2001 (CMFRI, 2002).

The mechanisation of indigenous artisanal fishing craft and the introduction of modern gear materials during fifties, introduction of synthetic gear materials during the sixties, advent of purse seining and the motorisation of artisanal craft in seventies and the

substantial growth of motorised artisanal craft operating ring-seines in eighties were some of the emphasising factors for the phenomenal growth of the fisheries sector. With an estimated per capita fish consumption of 11kg, the nation is expected to require 7.2 m.t of fish by 2020 A.D (Devaraj *et al.*, 1997).

Indian seafood has been able to make a mark for itself in the international market owing to its superior quality and innovative value-added products. During the year 1999-2000, India exported 3,43,031metric tonnes of seafood valued at Rs 5116.67 crores. The share of marine products in the total export earnings of the country was 3.14% during the year 1999-2000 (Anon, 2001). Marine capture fisheries thus constitute a highly productive sector as a valuable source of food and employment generation. In view of the important role played by the marine fishery resources in the socio-economic welfare of the nation, basic research on exploited fish stocks constitute a priority area in fisheries research and development.

Fishermen in many countries have found that the more heavily they fish the more their catches have declined (Cushing, 1968). Uncontrolled exploitation can lead even to the collapse of many fisheries. In order to avoid such possible adversities, scientific studies on fish population have become an essential prerequisite for sustained fishing operations.

It is well known that living populations are highly dynamic. The structure of a population changes markedly when it is continuously exploited. Hence, fish populations of commercial importance should be studied periodically if not continuously and their stock estimated from time to time taking into consideration all the variables that could influence the population. In modern times, the role of the scientists is not limited to study of these populations and drawing conclusions from there. They have to actively participate in policy decisions giving proper advice to concerned agencies so that the fishing industry is not hamstrung by serious resource depletion.

Stock assessment studies became a quantitative science in the 1950s. The notable contributions during this decade have been those of Chapman (1954), Schaefer (1954, 1957), Beverton and Holt (1959) and Ricker (1958).

Later on various authors, along with the progress of computer facilities, began to expand or remodel the available tools and techniques. Some of these important works are of Gulland (1964,1969, 1983), Allen (1966), Fox (1970) and Ricker (1975).

During the 80s, stock assessment studies of tropical resources gained momentum, some of the important contributions along these lines being Pauly (1979,1980a), Saila and Roedel (1980), Garcia and Le Reste (1981), Devaraj (1983), Munro (1983) and Sparre (1989).

There are a number of factors, which affect the abundance of fish stocks. Fishing is the only one that can be controlled to maintain the stocks in dynamic equilibrium. It is therefore important to assess whether the abundance or scarcity of stock is related to the intensity of fishing. In order to work out such a relationship, it has been the usual practice to calculate ''Catch Per Unit Effort'' (CPUE) since this provides the relative measure of abundance. It is in fact an index of abundance and level of exploitation of fishery resource (FAO, 1980). Therefore, catch and effort data are regarded as basic requirements for a primary resource assessment (Ricker, 1940; Banerji, 1971). Models deducing the state of a stock from historical record of catches and fishing efforts for solving the problems related to fishery management and have been attempted with various modifications by authors like Pella and Tomlinson (1969), Silliman (1971) and Ludwig and Hilborn (1983).

It was remarked by Roff (1983) that simple autoregressive model is consistently better at predicting both catch and CPUE. He contended that catch/effort data are generally too unreliable to detect anything except major fluctuations in population size. He therefore suggested that catch and effort data be used by adopting strategies, designed to track the population fluctuations. Schnute (1985) presented a general theory for the

catch-effort analysis, which is conceptually identical to the model identification problem described by Box and Jenkins (1970) in the context of time series analysis.

For a realistic assessment, of fishery resources, in most of the countries, fishery scientists of various organisations need a breakdown of the total catch by species or by a group of closely related species. One of the reasons behind this is that only some of the species are of commercial importance. "FAO species identification sheets for fishery purposes" (Fisher and Bianchi, 1984) are normally used as an aid to solve problems in species identification. Such categorization helps to study catch composition, which is very important.

Since the concept of fishing effort varies, it has become necessary to have a breakdown of the catch according to the types of efforts used. The need and types of classification of the gears are discussed by Banerji (1971,1974), Brander (1975) and FAO (1976). Since there is no single standard unit of fishing effort, it is usual to express total fishing effort by scaling the efforts of all other gears in terms of the dominant gear by dividing their gross catch by the catch/effort of the dominant gear. When two or more very different gears are in extensive use, it may not be possible to obtain a comparative measure of total effort (Ricker, 1975).

Different organisations, universities, etc have conducted marine fishery resource studies. In many cases the study was limited to particular group or species only. A few examples of such works are Joseph (1974), Joseph *et al.,* (1976), IOFC (1977), Diwedi and Devaraj (1983), Silas (1986), Sudarsan *et al.* (1987), Dalzell *et al.*, (1990), Kalita and Jaybalan (1990), Philip and Somvanshi (1991), Sivaprakasam (1991) and Panicker *et al.*, (1993).

The yield from a fish stock depends partly on the magnitude of the fishing effort. Obviously it also bears a dependency on the fishable stock. This is in fact determined by the strength of the recruitment to the fishable stock. When just catch and effort type of assessment is taken into consideration, it does not consider the age structure of the catch. When the age at first capture varies, it can alter not only the quality of the catch with

reference to the size but can also the quantity. If the age at first capture is altered, it will change the magnitude of recruitment to the fishable stock. This is on account of the operation of natural mortality during the pre-recruitment phase. When the growth rate and the fishable life span of the fish are considered, it can be clearly seen that the yield is dependent on these as well.

The Maximum Sustainable Yield (MSY) from a fish stock is function of parameters like recruitment, age at first capture, natural mortality, rate of growth and the fishable life span of the fish. Stock assessment studies therefore aims at forming different models linking yield to the various parameters. The two parameters fishing mortality and age at first capture are actually under human control. The estimates of other parameters can be obtained initially from the data on commercial catch and other biological data collected. Once estimates of all these parameters are obtained, then the Maximum Sustainable Yield (MSY), yield curves etc. can be worked out.

There has been a spurt of developments in marine fisheries research throughout India, over the past decade. The importance of studying tropical fishery resources and the need for their stock assessments has been advocated widely. Central Marine Fisheries Research Institute and Fishery Survey of India have been able to conduct training courses and workshops under the auspices of the FAO/DANIDA project. The main purposes of these were to impress the scientists, the need for studying resources and advise them to take up stock assessment studies in the wake of problems related to increased effort and likely over-exploitation of the resources (FSI, 1989; Venema and van Zalinge, 1989).

Kerala, the southwest region of India, has a coastline of about 590 km with about 220 landing centers (Jacob et al., 1987). With about 10 % of the Indian coastline (main land) Kerala occupies the foremost position in marine fish production in India, accounting for catch approximately ranging from 18.4 to 30.9% of total landing in India during the period 1985-93 as recorded in CMFRI publication (Anon, 1995).

Northern part of Kerala including four coastal districts such as Malappuram, Calicut, Kannur and Kasargode is called Malabar which has a coastal length of 260 Km.

Of these four districts, Calicut is the most important based on this district maximum fishing activities are going on in the Malabar region due to nearness of city markets and the marketing outlets.

Fishes of the family Carangidae popularly called scads, horse mackerels, jacks, leather jackets, pampanos, rainbow runner etc. are small to medium sized fishes living up to a depth of 80 m, but their abundance is more in the in shallow waters. They constitute an important group of marine resource contributing to the fisheries along the Indo-West Pacific region being exploited by bottom trawls, shore-seines, gillnets, ring-seines, bag nets, etc. Some species occur in dense schools offering great potential for commercial exploitation. Some of these fishes are highly esteemed table fishes and are consumed in fresh condition. The total carangids landing in India have been estimated at 117588 t in 2001 (CMFRI, 2002).

While reviewing the publications, it was found that carangids are the least studied marine resources in this region, so any information on the status of the resource of carangids from Malabar region will be much useful to the industry. The main objective of this study is to assess the fishing pressure on these resources by different fishing crafts and gears and to trace the possible management measures for sustaining the fishery on a continual basis. Carangids were selected for the present study because they form a major and regularly fishable group, which in turn contribute to substantial fishery at Malabar region. As far as the gears are concerned, trawls, gill nets, ring seines and hooks and line are the major gears. It was observed that carangids accounted for good part of the total fishery with decapterids sharing a high portion of the total carangid representation. Among carangids, major fishery was that of *Decapterus russelli* obtained in sufficient quantities throughout the year. *Decapterus macrosoma* and *Carangoides malabaricus* came next in importance. *Decapterus russelli* is found in the fishery through out the year in the trawls and during monsoon season also good quantity of this species is found in the ring seine. In the above context, it was decided to study the biology and population characteristics of *Decapterus russelli.*

Chapter-2

Review of Literature

Day (1865) has given the identifying characters of the carangids from Malabar. After the establishment of Central Marine Fisheries Research Institute in 1947, the investigations on the marine fisheries became more intensive and contributions by many workers threw light on various aspects. The UNDP/ FAO Pelagic Fisheries Project in 70's and made valuable contributions to this field.

Published accounts on age and growth of carangid species are very few. Tandon (1962 c) studied on *Selaroides leptolepis* based on length frequency analysis. Kagwade (1968 a) observed that *Caranx kalla* from Calicut area, attains a length of 82, 132 and 137 mm at the end of 1 st, 2nd and 3rd year respectively. Sreenivasan (1978 b & 1982) studied the growth of *Megalaspis cordyla* and *Decapterus dayi* respectively from Vizhinjam and estimated the growth parameters. Murty (1991) estimated the growth and mortality parameters of *Decapterus russelli* from Kakinada and Reuben *et al.,* (1992) on a number of species of carangids from different regions along the Indian coast. Kasim and Hamsa (1994) estimated the growth parameters of *Caranx leptolepis* and *Caranx carangus* from Tuticorin.

The earliest study on the length–weight relationship of a carangid species from Indian waters was that of Tandon (1961b) on *Selaroides leptolepis*. The studies on *Decapterus dayi* by Sreenivasan (1981a) from Vizhinjam showed that 'b' values of males and females did not vary significantly, but pooled value for both the sexes was significantly different from that of the intermediates. The estimate by Murty (1991) was slightly higher compared to the observations of Sreenivasan (1981a) and Reuben *et al.,* (1992). In *Atropus atropus* the 'b' value calculated by Reuben *et al.,* (1992) for the northwest coast was slightly higher than that observed by Raje (1994) from Veraval. In *Caranx carangus* the studies by Reuben *et al.,* (1992) and Kasim and Hamsa (1994) showed that the estimates of 'b' was almost identical and was less than 3. The length weight relationship of *Alepes kalla* and *Atule mate* was studied by Reuben *et al.,* (1992).

Using the data collected from the Vizhinjam area from 1971-74, Sreenivasan (1979, 1981b, 1982) studied length-weight relationship, age and growth, feeding biology and maturity and spawning of *Decapterus dayi.*

The studies conducted on food and feeding reveal that carangids are generally pelagic carnivores feeding mainly on fishes and crustaceans. The account by Kuthalingam (1955) on the feeding habits of *Caranx djedaba* from Madras coast is the first of the kind on carangid species. According to Sivakami (1990), *Alepes djedaba* had lower stomach volume during breeding period and the fish within a length range of 150-199 mm and 240-319 mm showed preference for young fish while those in the 200-239 mm range relished ostracods and other crustaceans. According to Vekataramanan (1960) crustaceans formed the major food of the species.

According to Kuthalingam (1959) *Megalaspis cordyla* is a carnivore. Sreenivasan (1978b) observed that the intensity of feeding decreased with the advancement of maturity and it was higher during night. Basheeruddin and Nayar (1962) reported that *Decapterus russelli* is a pelagic carnivore and feeds mainly on crustaceans. While discussing the fisheries and biology of the horse mackerel, Chacko and Mathew (1954) made some observations on the biology of *Decapterus russelli.* According to Tandon (1960b), *Selaroides leptolepis* is a carnivore feeding on crustaceans, fishes, algae and diatoms. Meenakshisundaram and Gnanamuthu (1968) also noticed that *Anchoviella* spp. is the preferred food of *Caranx sexfasciatus.* According to Kuthalingam (1959), this fish feeds throughout its life on planktonic crustacean though they also feed on numerous clupeoid larvae. Basheeruddin and Nayar (1962) also observed the juveniles of *Selar mate* feeds mainly on crustaceans. The feeding Habits of *Alectis indicus*, *Carangoides armatus*, *Caranx malabaricus*, *Caranx carangus*, *Chorinemus tolu* and *Trachinotus blochii* were studied by Basheeruddin and Nayar (1962). According to Reuben (1968) *Caranx malabaricus* along Visakapatnam is a carnivore and column feeder. Hamsa and Kasim (1989) noticed that the food of adult *Caranx carangus* above 150 mm is fish followed by Crustaceans. A detailed study on the food of *Caranx kalla* by Kagwade (1967) revealed that the adult of this species is a plankton feeder. Similar behaviour was

observed in *Atropus atropus* by Raje (1994) along Veraval coast. According to Vekataramanan (1960) prawns and copepods comprised the main food of *Caranx kalla.*

Kagwade (1968 b) made observations on the size at first maturity of *Caranx kalla* and later by Reuben *et al.*, (1992). The size at maturity of *Megalaspis cordyla* was studied by Sreenivasan (1978b). Murty (1991) and Reuben *et al.*, (1992) studied the size at first maturity of *Decapterus russelli* and reported a slow growth rate. Work on size at first maturity of *Selaroides leptolepis* was carried out by Tandon (1961a) and Reuben *et al.*, (1992).

Reuben *et al.*, (1992), Raje (1994) worked on the spawning season of *Atropus atropus.* Tandon (1962a,b,c) and Reuben *et al.*, (1992) reported the spawning season of *Selaroides leptolepis* from Indian waters. The work on the spawning season of *Megalaspis cordyla* was carried out by Sreenivasan (1978b), Bapat and Prasad (1952), Premalatha (1993) and Sivakami (1995). Sreenivasan (1981b) observed a prolonged breeding season for *Decapterus dayi* at Vizhinjam, but at Kakinada, Murty (1991) noticed that the fish spawns twice a season and expressed the view that this species spawns at night and Reuben *et al.*, (1992) also observed the release of eggs in two spurts. Kagwade (1968 b) reported short spawning seasons and females dominated the catch of *Caranx kalla.* Sivakami (1990) worked on the breeding season of *Alepes djedaba* from Cochin and Reuben *et al.*, (1992) on the same species from the east coast.

The fecundity of few species of carangids such as *Selar leptolepis* (Tandon, 1962 a), *Caranx kalla* (Kagwade, 1968 b), *Megalaspis cordyla* (Sreenivasan, 1978b, Sivakami, 1995), *Decapterus dayi* (Sreenivasan, 1981b) and *Atropus atropus* (Raje, 1994) were studied from different parts along the Indian coast.

The eggs, larvae and juvenile stages of some carangid species from Indian water have been described by earlier workers. The species studied are *Caranx kalla* (Bapat and Prasad, 1952), *Megalaspis cordyla* (Kuthalingam, 1959 and Premalatha, 1988), *Caranx mate* (Kuthalingam, 1959), *Caranx malabaricus*, *Caranx carangus* (Rao and Girijavallabhan, 1973), *Alectis ciliaris*, *Alectis indicus* and *Atropus atropus* (Premalatha,

1991). Bapat (1955) collected young ones of *Selar leptolepis*, which schools around large medusa. Kuthalingam (1959) collected larvae from plankton and reared them to the identifiable size. Bapat and Prasad (1952) studied the development stages of *Caranx kalla* from Bombay waters. Chidambaram (1943) studied the eggs of Horse mackerel found along with plankton collected from the Malabar region. Hamsa *et al.,* (1989) have carried out some work on the morphometric relationship and food and feeding in *Caranx carangus* from Tuticorin waters. Jones (1960) reported a preliminary note on the fishery of young *Selaroides leptolepis*. Literature clearly shows that detailed studies on *Decapterus spp.* in the Indian region are not as much as in other geographical areas. Reports on the presence of this species in the Indian coasts were made by Day (1985), Misra (1962) and Rao (1966). Though taxonomic confusion about this species persisted all these time, a reliable record from India, at that time, was given by Nekrasov (1969). Some observations about this species, from the west coast of India, were made by Dmitrenko and Fursa (1969) and Anon (1976 a,b). Shameen (1988) made biometric studies of *Decapterus russelli* along the Andhra coast.

Information on the migrations of carangid species is scanty. Rao *et al.,* (1977) observed that species of horse mackerel are fast swimmers. Meenakshisundaram and Gnanamuthu (1968) observed the shoreward migration of *Caranx sexfasciatus*. Bapat *et al.,* (1982) has reported the migration of *Decapterus russelli* to deeper waters. Shoreward migration of schools of *Selar crumenophthalmus* has been reported by Nair and Pillai (1987) from Vizhinjam

Studies on the population dynamics and stock assessment of carangid species are very few and are limited. Murty (1991) studied population dynamics of *Decapterus russelli* in trawling grounds of Kakinada. Special attention was given by the author for studying the stock assessment of this species. Reuben *et al.,* (1992) studied the fishery, biology and stock assessment of 8 species of carangids namely *Megalaspis cordyla*, *Decapterus russelli*, *Caranx carangus*, *Selar leptolepis*, *Atropus atropus*, *Caranx kalla*, and *Alepes djedaba* and *Atule mate*; Kasim and Hamsa (1994) on *Caranx leptolepis* and *Caranx carangus* from the Indian seas. In their work, the authors provided state-wise landing and species-wise analysis. Furthermore, growth and mortality estimates as well

as coast-wise MSY estimates were also given to supplement other informations. The mortality parameters of *Caranx leptolepis* and *Caranx carangus* of the Tuticorin area were estimated respectively by Kasim and Hamsa (1994).

Banerji (1973) assessed the stock of carangids in Indian waters and stated that the fishing intensity in all the states was exerting pressure on the coastal stocks of carangids. Rao *et al.*, (1977) studied the stock of horse mackerel. Sivakami *et al.*, (1996) estimated the potential yield of carangids along the Indian EEZ.

Review of literature revealed that investigations on different species of carangids especially scads were conducted abroad mainly in the continents of Africa and Asia. Most of the studies carried out in Africa were in the Mozambique. The studies in Asia covered a rather extensive geographic part including the Philippines, Indonesia, Malaysia, Thailand, and Pakistan.

Studies by Saetre and Paula e Silva (1979), Brinca *et al.*, (1983) and Gjosaeter and Sousa (1983) provided considerable information not only on the taxonomy of *Decapterus russelli* and *Decapterus macrosoma* but also on growth, sex ratio, reproduction and parameter estimation of these species in the Mozambique. Borges *et al.*, (1984) while investigating the scad and mackerel resources in the Mozambique region made a detailed study of the biology and aspects like catch rate, catch composition and yield estimation of *Decapterus russelli* and *Decapterus macrosoma.* Gislasan and Sousa (1985) studied the percentage composition and growth curve based on otolith reading of *Decapterus russelli.* Sousa and Gjosaeter (1987a) studied growth parameters of some commercially exploited fishes including *Decapterus russelli* and *Decapterus macrosoma.* Sousa and Gjosaeter (1987b) studied the reproduction, age and growth of *Decapterus macrosoma.* Silva and Sousa (1988) estimated average biomass, total mortality, fishing mortality, asymptotic length and growth coefficient of these two species from Sofala Bank and Boa Paz in Mozambique. Sousa (1988) particularly pointed out the source of bias in estimating growth and mortality parameters especially in a fish like *Decapterus russelli*, which migrates between the two main fishing ground of Sofala Bank and Boa Paz. The author initiated an alternative method called the

"Matched Sample Method". Gislason and Sousa (1989) in their stock assessment studies of scad and mackerel at Sofala Bank and Boa Paz dealt with *Decapterus russelli* and *Decapterus macrosoma* as well.

Studies on the round scad fishery were pioneered in the Philippines as early as in 1956 (Tiews 1958). Tiews *et al.,* (1970) studied the biology of *Decapterus russelli* and *Decapterus macrosoma* and gave valuable information on their distribution, spawning time, fecundity, food and feeding, sex ratio, size composition and growth rate of these two species. Following these, Ronquillo (1974) made a review of the round scad fishery of the Philippines. The decline of major fisheries resources in the Philippines during the period 1980-84 was noticed by some authors, which made Corpuz *et al.*, (1985) to work on the population parameters of commercially important fishes including *Decapterus russelli* and *Decapterus macrosoma*, in these areas. Through such studies, it became evident that in the absence of rational fisheries management and well defined fisheries policies, there was over exploitation and consequent decline in resources. Using ELEFAN method, length-frequency samples were analysed by them to estimate $L\infty$ and K. Estimations of Z, M, F, exploitation rate, recruitment pattern and selection pattern were also undertaken. Dalzell and Ganaden (1987) presented a review of the fisheries of small pelagic fishes in the Philippines. Under this, the analysis of round scad *Decapterus russelli* as well as *Decapterus macrosoma* was also included. Jabat and Dalzell (1988) analysed catch, effort and length-frequency data from ring net fishery. Small pelagics such as *Selar crumenophthalmus* and *Decapterus russelli* also formed part of the analysis. Ingles and Pauly (1984) brought out an atlas of growth, mortality and recruitment of Philippine fishes, which became a useful reference guide in stock assessment studies.

A joint programme was taken by Indonesia, Malaysia and Thailand to study the mackerel and scad resources of the Malacca Straits. This was initiated under the project 'Marine fishery resources management in the Bay of Bengal'. The technical report BOBP/UNDP/FAO (1987) summarised the result of the investigations. Catch, effort, biology, growth and mortality studies of many species formed part of the investigations. *Decapterus macrosoma* and *Decapterus russelli* were also treated in the study.

As part of the studies from Indonesia, Atmadja (1988) studied growth and mortality of round scad *Decapterus macrosoma* in the Java Sea. Soriano *et al.,* (1988) analysised morhometrics of *Decapterus russelli,* while Widodo (1988) studied population biology of this species in the same area. Maturity and spawning of *Decapterus macrosoma* were worked out by Widodo (1991) from the Java Sea. Chullasorn and Yusukswad (1978) studied the fishery, biology and parameter estimation of *Decapterus spp.* in the Gulf of Thailand. $L\infty$, K, Z, M and F values of *Decapterus russelli* were estimated form Pakistani waters by Iqbal (1992) as part of the application of the length based fish stock assessment method.

Although information available from previous research work in the Indian region can offer valuable indications, there has not been any recent attempt to evaluate fishery of carangids along the Malabar region in the context of mechanised and motorised fishing, except an account on the unusual fishery of *Decapterus russelli* by Yohannan *et al.*, (1987). The present study was undertaken to fill this need. Relative abundance of carangids in the landings in this area throughout the year and their great demand from consumers make these fishes economically important forms. Consequently, it has become imperative that these resources should be protected from over exploitation and their spawning grounds are ecologically preserved from unwanted incursions of man and machines.

Chapter-3

Material and methods

3.1. Introduction

The area of present study is shown in Fig 3. 1. Regular observations and collection of detailed fishery and biological data were made from five major fish landing centers such as Beypore, Puthiappa, Chombala, Puthiangadi and Vellayil along the Malabar area. Most of the vessels operating based at these centres conduct fishing in the entire Malabar area. Beypore was the southernmost and Chombala was the northernmost centre of observation. Trawlers operate based at Puthiappa and Beypore. During monsoon, other gears also land their catches at these harbors. At Vellayil and Puthyangadi, mainly ring seines and gill nets land their catch during non-monsoon months when the surf is relatively calm. At Chombala ring seines and gill nets and occasionally trawlers land their catches. The area of fishing of all the gears is the same. The changes in the landing centers occur depending upon the number of crafts landing at one centre and the quantity of fish landed to avoid any possible glut or reduction of price. Usually the fishermen out at sea contact their agents at shore over mobile phone and fix their places of landing to get better price for their catches. Hence, to get an overall picture of the fishery, observations were made in all these centers and the data collected were pooled. Other landing centres in the Malabar area was visited occasionally mainly to know if there are any major differences from the centers of regular observations.

3.2. Catch and effort

The data on catch, effort, species composition and biology were collected from five major fish landing centers such as Beypore, Puthiappa, Chombala, Puthiangadi and Vellayil by stratified random sampling technique. Each landing center was visited once in a week. The carangids along the Malabar coast are landed mainly by trawlers, ring seiners, out board gill-netters, non-mechanised gill-netters and hooks and liners. Boat seines were also in operation, but due to very poor performance their place is now occupied by the out board ring seines. Trawlers contribute majority of the landings of

carangids in Malabar. The contribution of ring seines and gill nets is comparatively poor. In the trawlers, the carangids are landed through out the year. Gill nets land only large species of carangids in minor quantities. Ring seines land only smaller varieties of carangids such as *Decapterus russelli* and other *Decapterus* spp. in small quantities mainly in the monsoon season.

The study was conducted based on data collected over a period of twenty-four months from September, 2000 to August, 2002 from the major landing centers along the Malabar coast. On each sampling day, the units to be sampled were selected following Alagaraja (1984). From each of the vessels sampled, information was collected on

a) The area of the operation - by enquiry

b) The depth of fishing - by enquiry

c) Mesh size of the net - by direct observation

d) The total carangid catch - by observation

"FAO species identification sheets for fishery purposes"(Fischer and Bianchi, 1984) was used as an aid to solve the problem of species identification.

The catch of different species on a particular day was estimated after ascertaining the total number of units landed on a particular day from each gear type observed at random and raised to the total catch of the day by a particular gear as given below:

$$\frac{\text{Total catch of the observed units}}{\text{No. of observed units}} \times \text{Total units operated}$$

The catch and effort of the night landing also were collected by detailed enquiries with the fishermen and related sources. The total catch and effort of different gears and species composition in the days of observation were raised to get the monthly figure as given below:

$$\frac{\text{Total catch/effort of a gear in the observed days}}{\text{No. of days of observation}} \times \text{No. of days in a month}$$

The monthly catch thus estimated is then summed up to get the annual figures.

In order to study the relationship between effort and catch, CPUE (catch per unit effort or catch rate) was calculated on monthly basis. The catch-CPUE relationship was also analysed in order to understand the variability and seasonality. This relationship was taken up in respect of each gear for each species and groups. From the estimated monthly effort (number of units) and catch, CPUE was calculated as

CPUE= catch/effort

The average monthly CPUE of different species was calculated by dividing average monthly catch by average effort. The average monthly percentage composition different species of carangids estimated from the average catch.

3.3. Length frequency distribution

Sampling of the catch for length frequency distribution studies of *Decapterus russelli* was made at least once a week, depending upon the availability from one or more of the landing centers mainly from trawlers. A minimum of 50 fishes from a boat's catch was measured in the field using a measuring board. The length of the fish referred to hereafter is the total length from the tip of the snout to the tip of the upper lobe of the caudal fin in mm unless otherwise mentioned. If any distinctly different size group was landed by another unit, 50 fishes from that unit also were measured. The catch percentages of these distinct size groups were estimated visually. The idea was not to mix different broods in one sample as far as possible. A sample of 25-30 fishes was taken to the laboratory for detailed study.

The length measurements were grouped in to 10 mm length intervals, the frequencies were summed up to get the total frequency in each length intervals of 10 mm.

Length frequencies were then raised to correspond to the weight of the catch assessed for the day. This was done by multiplying the frequencies with a multiplication factor (Mf) calculated for the day as

$$Mf = \frac{\text{Weight of the catch}}{\text{Weight of the sample}}$$

These raised frequencies corresponding to each of the length groups on the sampling days in a month were then added up to get the monthly figure. These figures were again raised to get the corresponding frequencies with respect to the estimated total landing of a month. This was done by multiplying with a factor (Mf_1) calculated as

$$Mf_1 = A/B$$

Where, A = sum of the estimated catch landed on all the fixed sampling days of the month.

B= Sum of the catch observed on the days when samples were collected.

These length frequency data actually formed the basis for further analysis and estimation of parameters.

3. 4. Estimation of growth parameters

The length frequency was analysed using the FISAT programme (FAO-ICLARM STOCK Assessment Tools). This is a modified version of the ELEFAN programmes developed by Pauly and David (1981) and Pauly (1987). Since an element of subjectivity is involved when growth curves are fitted by eye, ' FISAT' method of growth parameter estimation has been applied. This method allow one to perform the analysis in 3 stages

1. Restructuring of length frequency samples in order to facilitate the identification of peaks and trough in frequency polygons of each sample.
2. A large number of alternative runs are performed modifying the growth parameters and starting points.

3. Comparing the results from different runs by calculating the ratio of Explained sum of peaks (ESP) to Available sum of peaks (ASP) and allowing to select best of growth parameters.

FISAT works with seasonalised VBGF also (Picher and Macdonald, 1973 and Cloern and Nichols, 1978), which can be advantageously used when any species show oscillations of growth are expected.

The September, 2000 – August, 2002 data were pooled and manipulated to January– December for easy estimation of growth parameters in the FISAT programme.

3.4.1. Methods for estimation of mortality parameters

The reduction in number in a cohort is caused by fishing activity and due to all other causes like predation, disease and death due to old age. The later is called as natural mortality and the former as fishing mortality. The combination of both the factors gives the total mortality.

3.4.1.1. Fishing mortality (F)

Wetherall *et al.*, (1987) discussing Powel (1979) suggested method of estimating Loo and Z/K by relating L^- with L^1 using the regression equation $L^- - L^1 = a+b*L^1$, where L^1 is the lower limit of the length interval which is taken as that length at which all fish of that length or longer are under full exploitation. L^- is the mean length of fish of length L^1 and above.

From the values of regression coefficients 'a' and 'b' we get,

$Z/K = -(1+b)/b$ and $Loo = -(a/b)$

Where, Z is total mortality, L_∞ is the length at infinity and K is annual growth coefficient.

3.4.1.2. Total Mortality (Z)

1. The Jones and van Zalinge cumulated catch curve method of estimating Z

Based on the length composition data, Jones and van Zalinge (1981) suggested the cumulated catch curve equation, which is given as $\ln(C_{Li,\infty}) = a + b \cdot \ln(L_\infty - L_i)$ where $C_{Li,\infty}$ is the cumulative catch (computed from the highest length class with non-zero catch) corresponding to length class i, and L_i is the lower limit of length class i. The slope b is an estimate of Z/K.

2. The linearised catch curve based on length composition data

This model described by Pauly (1983b, 1984 a and b) was also used in the present study for the estimation of Z.

$$\ln(N) = a + b \cdot t$$

Where, N is the number of fish in (pseudo) cohorts "sliced" by means of successive growth curves, t' the relative age of the fish in that pseudocohort, while b, with sign changed, provides an estimate of Z.

3.4.1.4. Estimation of Natural Mortality (M)

After regression analysis of M (per year) on K (per year), L_∞ (cm) and T (mean annual temperature at the surface in ^{0}C) by referring to the data collected from 175 fish stocks, Pauly (1980b) estimated at the empirical relationship as

$$\ln(M) = -0.0152 - 0.279 \ln(L_\infty) + 0.6543 \ln(K) + 0.463 \ln(T)$$

This was employed in the present study for the estimation of M. The average annual temperature (28^{0}C) estimated by Seshappa and Jayaraman (1956) was used for the estimation of natural mortality.

3.4.2. Yield Per Recruit

The yield per recruit model (Beverton and Holt, 1959) was used for estimation of yield per recruit, Y/R was calculated in the form suggested by Gulland (1969)

3.3.3. Length weight relationship

Length-weight relationship was attempted following Le Cren (1951). The logarithmic form of the general equation $W = a L^b$ is $\log W = a + b \log L$. Here, 'W' represents weight in gram and 'L' the total length in mm and 'a' and 'b' are constants.

3.3.4. Recruitment pattern

Using a set of length frequency data and growth parameter values, recruitment patterns were derived as described by Pauly (1982). The t_o estimated by Balasubramanian Natarajan (2000) was used for this purpose.

For estimation of growth, mortality, recruitment patterns and Y/R the computer programmes of Sparre (1987) and Gayanilo *et al.,* (1996) were used.

3.5. Maturation and spawning

Hjort (1911) described seven distinct stages of maturity for the herrings of the Eastern North Sea and Iceland waters. This classification was subsequently followed by a number of workers (Graham, 1924; Hickling and Rutenberg, 1936 and Hickling, 1930).

For determining the stages of maturity, the standard recognized by the International Council for the Exploration of the Seas was adopted (Wood, 1930 and Lovern and Wood (1937). To find out the stages of development of gonads the fish

were cut open on ocular side, the colour, size and extensions of gonads in body cavity were examined. A small portion of each gonad was teased on a slide and was examined under compound microscope to determine the stage of maturity of each fish and then the gonads were preserved in 5 % formalin for further studies.

For maturity and spawning the following factors were considered.

1. The trend of occurrence of different stages during different months.
2. Occurrences of spent individuals.
3. Gonadosomatic index.
4. 'K' values
5. 'Kn' values

3.5.1. Ova diameter studies

Spawning periodicities were determined by ova diameter measurements of intra ovarian eggs with occulometer in different stages of development. The procedure followed by Clark (1934) was adopted for the present study.

To find out if there was any difference in the process of development of ova in different areas and in left and right lobe of ovary, samples from anterior, middle and posterior part of each lobe of ovary was taken and diameter of one thousand ova from each portion was measured under microscope fitted with an occulometer. The values of one micro division of occulometer used as calibrated with a stage micrometer and it was found that one micro division corresponds to 0.0196 mm. The ova diameter measurements were grouped into 3 micro-division cell (md) intervals. The percentage frequency of each group was calculated and graphs were drawn. The graphs thus obtained from the sample of different places of left and right lobe of ovary did not show any difference. Hence, for final assessment of each stage of maturity, one sample from the central portion of left lobe of ovary was taken and diameter of 1000 ova was measured.

3.5.2. Gonadosomatic Index

For the study of gonadosomatic index, ovaries of 628 fishes at different stages of maturity distributed over 24 months from September 2000 to August 2002 were weighed in an electronic balance accurate to 4^{th} decimal. Maturity cycle was studied following the seasonal changes in the weight of gonad by estimating the Gonadosomatic Index following Qasim (1973)

GSI= W/TW x 100

Where, GSI = Gonadosomatic Index
W = Weight of the gonad
TW = The total weight of the fish.

Ganado Somatic Index was calculated for females only.

Relative condition factor (Kn) values were estimated following Le Cren (1951). Only adult fish of both sexes were considered for this study.

3.5.3. Fecundity

50 females specimens in the penultimate stage of maturity were studied to find out the fecundity and its relationship with the total length and weight of the fish.

Ovaries, which were persevered in 5 % formalin for fecundity studies, were taken out from the formalin, excess formalin was removed by slightly pressing ovaries between two filter papers. The ovaries were kept under fan for 5 minutes to allow further evaporation of formalin. The entire ovary was weighed first on an electronic monopan balance then a small portion from central part of the left lobe of ovary was removed from individual fish and was measured to an accuracy of 0.1g. All the ova in the portion of ovary were counted and fecundity was estimated by the formula

$$F = \frac{\text{Total weight of ovary}}{\text{Weight of sample}} \times \text{Number of ova}$$

Where, F= fecundity

The relationship between fecundity and total length and weight of fish were determined by the method of least squares.

3.5.4. Size at first maturity

All the females and males collected from September, 2000 to August 2002 were considered to obtain size at first maturity level. The data for two years were pooled to one year. These were arranged in 10 mm length groups and the percentage of mature specimens (IV maturity sage and above) in each size group was calculated. The data were analysed in relation to different maturity stage and the percentage of occurrence of individual in each maturity stage was graphically plotted according to length groups. The size at which 50 % of the fish were mature was considered as the size at first maturity.

3.5.5. Sex ratio

Specimens above 120 mm only were considered for studying the sex ratio. A total of 2003 males and 2157 females were examined. In order to have a general idea of proportions in which sex are represented the number of females of each month was divided with the number of males of each month.

3.6. Food and feeding habits

Various methods are in vogue the study of food of fishes. Pillai (1952) in critical review of the various methods used for analysis of food of fishes emphasised that the

method used for any fish should suit its diet and is of the opinion that the volumetric methods are the most accurate for studying the food and feeding of carnivorous fishes.

The volumetric method as described by Pillay (1952) was used for the analysis of food of *Decapterus russelli.* Since, the *Decapterus russelli* is found to be highly carnivorous the determination of volume of each item of food was easily made by the displacement method. For this purpose, a narrow measuring cylinder was taken and filled up with water to a certain mark. The food item was then immersed in the water and the new level of water was noted. The differences in the two readings gave the volume of particular food item. Then the percentage volume of each food item was determined from the total volume of all the stomach contents. The percentage occurrence of different items of food in different months from various localities was determined by summing the total volume of all items from which the percentage occurrence of each item was calculated

The degree of fullness of the stomach was noted in relation to length of fish before the stomach was actually opened to ascertain the condition of feed in various months. A stomach was designated 'full' when it was completely full with food, appearing very thin and in some extreme cases even transparent. It was considered '3/4" when it was in a partly collapsed condition, in which case it was usually thick. Similarly, they were classified '1/2' full and '1/4' full' depending on the relative fullness and the space occupied by the stomach was termed 'little' when the contents occupied less than one-fourth the capacity of the stomach. Those stomachs, which were termed 'empty', contained practically nothing in them. In such cases, the wall of the stomach was shrunk and thick with conspicuous inner folds. From the total number of fish examined in a month, the percentage occurrence of 'full', '3/4' full', '1/2 full', '1/4 full, 'little' and empty' stomachs was estimated. The fishes with gorged stomachs due to over feeding were classified as 'Gorged'

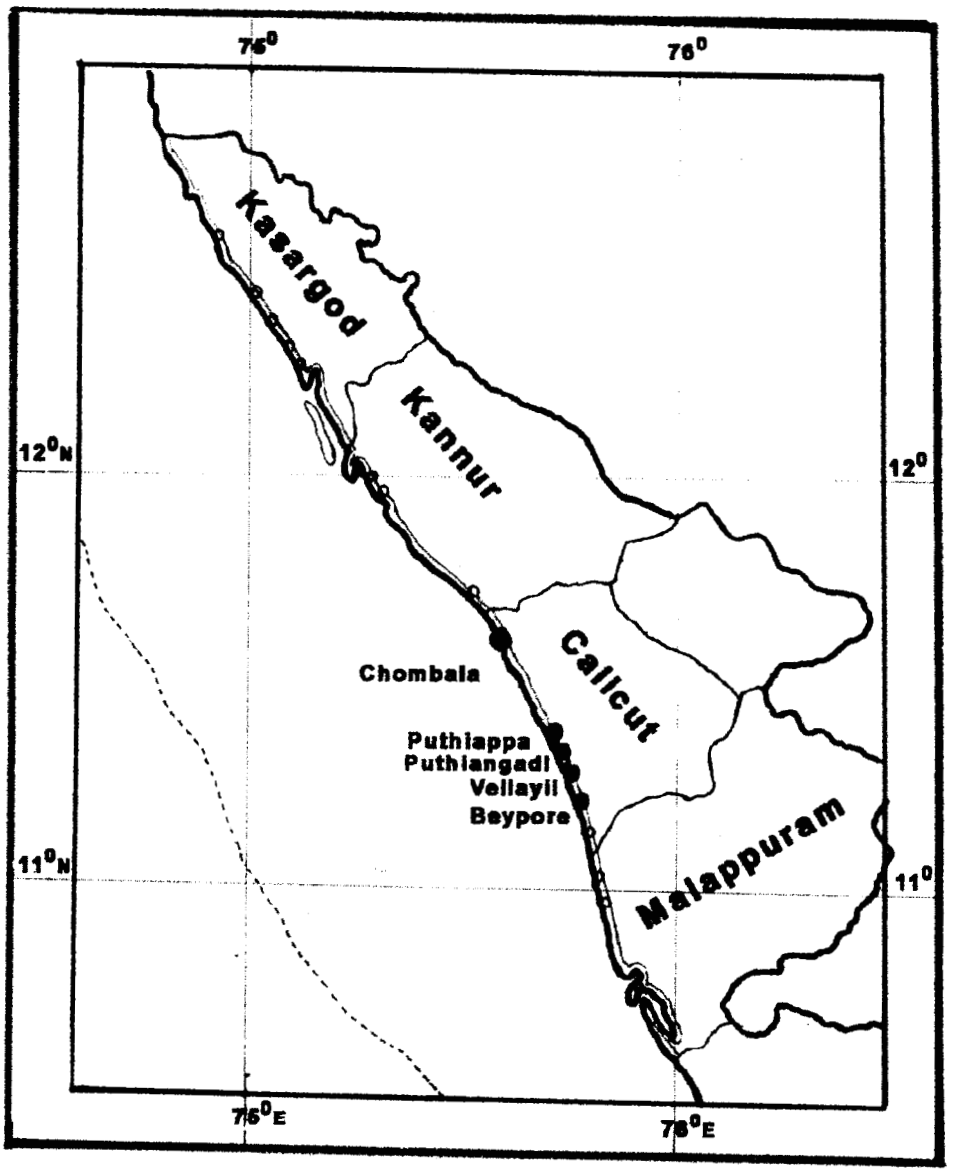
The components of the stomach contents were usually identified up to generic level and up to species level whenever possible, depending on the stage of digestion. It should be pointed out here that due to different states of digestion, it was not always

possible to identify the individual 'fishes' in the stomach contents. It was thought advisable to treat them separately under each genus as far as they could be identified, for better qualitative picture of the diet.

During the study, period considerable amount of digested material was encountered in the stomach of the fishes. This item was considered as gut content and not a food item.

Decapterus russlli samples were collected fortnightly from the trawlers and ring seiners operating at Puthiappa, Beypore and other nearby landing centers during September 2000 to August 2002. The samples were brought to the laboratory and washed. The fishes were then dissected to the study the stomach condition and content. The condition of feeding was ascertained as explained earlier and the stomach content were analysed by the volumetric method of Pillay (1952). A total of 4160 specimens were examined for food and feeding studies

Fig. 3.1. Area of the present study



Chapter-4

Craft and Gear

4.1. Introduction

The importance of fish as a source of cheap and nutritious food was recognised and the establishment of a department to develop the fisheries was initiated in 1899 under the Madras Province that was holding the administrative control of the Malabar area. In 1905, Sir .F. A. Nicholson was deputed to investigate the fishing industry and he in his first report to the Madras government he indicated the presence of vast shoal of pelagic fishes along this area. The crafts and gears used at that time was small and the fishermen spent most of their time and energy rowing to the fishing grounds and back. He recommended larger boats, which can go farther and do fishing for a longer time with carrier boats, which can take their catch quickly to the shore, while the larger boats could continue fishing. However, the improvements that Nicholson recommended in crafts and gears were not implemented to the indigenous fishery of Malabar area until the introduction of larger boats and nets by the end of 1980. For unloading the catches easily carrier boats became very common. The new modification with powerful outboard engines minimised the time in reaching the fishing ground and searching for shoals. The early sixties witnessed an important technological development, in gear, the shift from cotton to nylon nets. By mid sixties individual entrepreneurs entered the scene, paving way for a fast development of trawl fishery in coastal waters. The commercial purse seining started during late seventies and the process of large motorisation of country crafts begun in the early eighties. Fishing spread to deeper areas. Most of the recommendations by Nicholson in 1915 were effected these developments in relation to carangid fishery are briefly presented in this chapter.

The details of the crafts and gears used along the Malabar area were given by Govindan (1916), Hornell (1938), Rao (1970) and Yohannan and Balasubramanian (1989 and 1991).

4.2. Craft

4.2.1. Traditional fishing Craft

Dug out canoes were the only crafts employed in the indigenous fishery of Malabar are prior to 1985. The dug out canoes were constructed by scooping out of a single log of wood. Aini (*Artrocarpus hirsuta*) was considered the best wood for this purpose. Mainly two sizes of canoes were in use. Bigger canoes had a length of 9.8 m costing Rs 250-400 in 1916 (Govindan, 1916). Smaller canoes of length 6.4 to 8 m costing from Rs 60-250 were also in use. The larger canoes were mainly used in the operation of boat seines with 6-7 persons. The smaller ones were in use for operating gill nets, cast nets etc., with a crew of 6-7 persons. Rao (1970) has given a detailed description of such canoes.

In Malappuram district, some plank built boats have been in use exclusively in an area between Kootai and Vadakkekadappurm in Malappuram district. These boats made of planks of Aini have a length of 9.5 m. These planks are fixed using copper nails and these boats are mainly used in the operation of boats seines in this area since a very long time (Plate 4.2.1).

In the other areas of Malabar coast, dug out canoes continued to dominate till 1984-85 period, when out board engines were introduced in the indigenous fishing industry (Yohannan and Balasubramanian, 1989 and 1991). It was the introduction of out boat engines to the canoes was a great revolution in the indigenous fishing industry. It provided enough speed and thereby increased efficiency, while labour was considerably reduced. To start with, the out board engines of 7.5 H.P. were fitted to the dug out canoes. Here, human labour power is substituted by mechanised power for propulsion. The engine is fixed to a bracket fitted on the starboard side of the craft. Most of the engines used in the earlier periods were Yamaha make. The fuel is kerosene oil, while petrol used for starting. The engine is removed from the craft as soon as it returns to the shore and fishermen carry the same to home where the engine is washed and decarbonised. The fishermen enjoyed the newly acquired speed and welcomed

motorisation. By 1990, most of the country crafts of Malabar area were fitted with outboard engines.

In the mean time, due to prohibitive cost of wood, the dug out canoe became very costly. In 1986, plank built boats were introduced. These flat-bottomed boats with transom stern, where the out board engines can be fitted conveniently and more efficiently, became very popular. Later the plank built boats was coated with fiberglass for safety and durability (Plate 4.2.2). Then came the boats made of marine plywood coated with fiberglass which in 1992 was costing Rs 50000/- This kind of boats with a length of 8.5 m, width of 1.55 m and depth of 80 cm became popular among the fishermen. The FRP boats are widely in use along the Malabar area and the cost of the boat with a length of 8.5 to 20 m in 2003 ranged between 1.25 lakhs to 5 lakhs. These boats are fitted with outboard engines of 40 H. P. A 25 HP outboard engine in 1993 was costing around Rs 80000/-, which consumed around 30 litres of kerosene and 3 litres of petrol for a day's operation. Another important event in the indigenous fishery of Malabar was the introduction of ring nets in 1988 (Sivadas and Balasubramanian, 1989). As the net was large and heavy and needed more than 25 men for its operation, larger boats were needed. Kettuvallams were introduced in the area of this purpose. These large plank build boats had an overall length up to 20 m with a width up to 1.5 m. The plank build boats were fixed with coir ropes. These boats needed more powerful engines. It started with two 25 HP engines which became 3 later on. Then two 40 HP engines and one 25 HP engines were used. Some even used three 40 HP engines which in 2003 was costing around five lakhs. For a days trip all the three engines together require around 150 litres of kerosene and 2 liters of petrol. Recent trend in the revolution of FRP boat is the usage of inboard engine of 90 HP in the craft. Another engine of 40 HP is also kept to meet the need in the case of engine failure.

4.2.2. Mechanised fishing crafts

Trawlers use trawl net as fishing gear and are provided with marine engine of sufficient power to tow the net with the boat at appropriate speed. Trawl winches are fitted on the deck of these boats to operate the trawl net. Trawlers are operated along the

Malabar area based at Puthiappa, Beypore, Kannur and Ponnani. Stern trawlers are the most common mechanised fishing craft operated along the Malabar Coast (Plate 4.2.3). In these vessels warp are led from blocks to the aft deck and over the stern. Towing blocks on small vessels are attached to the stern gallows and in larger vessels to a gantry. On stern trawlers, the wheelhouse is usually situated in the forward part. Medium sized and large stern trawlers are often fitted with a stern ramp on which the trawl is hauled on to the deck. The trawl, which is placed transversally behind the wheelhouse. Split winches are used on medium and large trawlers. On small vessels the fish, hold is situated at amidships and on medium sized and large trawlers in the forward part of the vessel.

The size of the trawlers ranged between 32' and 58' in this area. The trawlers constructed from wood are commonly used for fishing operation in Malabar region. The cost of mechanised trawlers of 32 'to 58' varied between Rs 6, 00,000 and Rs 22,00,000 in 2003. For increasing the fuel efficiency, most of the mechanised fishing vessels are conducting multi day fishing operation of 6-7 days to save the fuel charges. The large trawlers conduct fishing voyages of 6–7 days while the small trawlers conduct the fishing for 1-2 days.

Mechanised gill-netters and purse seiners are not in operation along the Malabar region.

4.3. Gear

Hornell (1938) had given details of the gear employed in the fishery of the Malabar area. Boat seines were the most important gear. Boat seines, gill nets and hook and lines were the important gear for exploitation of the carangids. The boat seines were made of cotton and hemp twine with a mesh size varying from 15 mm at the cod end to 35 mm at the mouth. By 1965-68, the synthetic twines were used for fabrication of nets, it replaced the cotton and hemp twines. Pattenkolli is a product of this important change. It is a boat seine made of nylon twine. As the mesh size was smaller, it was equally effective in the carangid fishery.

In the mean time, nylon twine was also used for making the gill nets, which is an important gear for carangid fishery since very long time. Rao (1970) gave the details of the gill net made earlier with cotton twines. Introduction of ring nets in the Malabar area is a major event in the history of fishing gear. This was equally important as the introduction of outboard engines in 1985. By 1991, the operation of boat seines was very much restricted for exploitation of fishes in the Malabar region including carangids.

4.3.1. Trawl net

At present, the trawl net is the most important gear employed in the Malabar area. Its operation starts in August and the fishing operations continue until the State Government imposes the ban on trawling at the onset of monsoon season.

The trawl that has become the most commonly used net in the fishing trade is primarily a bag net (Fig. 4.3.1). It is believed that it evolved from the dredge nets used in the clam and oyster fisheries. The earliest trawls, therefore, had a rigid rectangular frame to which the bag was attached at one side and the towing ropes, on the other. They were primarily used for bottom dwelling fish like flat fishes. The vertical opening of the net is achieved through the floats attached to the head rope of the net. The horizontal stretch of the net was achieved by interposing on the two ropes, which are known as "otter board". These are rectangular board, either wooden or metal, to which the rope from the net and the towing rope from the boat are attached that the principle of parallelogram of forces acts upon them and when they are towed they fly apart in the water and thus help to keep the mouth of the net stretched. The use of the otter boards gave the name of otter trawl to these nets. Naturally, these modifications and improvements led to bigger-sized nets. The manual hauling of the net as was done with the beam trawl was not possible especially with the introduction of the heavy otter boards. Thus, mechanisation was introduced in the form of strong winches, etc. The recent development in the trawling is the stern trawling where a sloping platform extends from the body to the stern end of the ship ending level with the sea surface. This enables huge, present day trawl nets to be dragged right into the body of the ship. Whatever was

the method used for keeping the mouth of the trawl vertically open, it was found effective in catching fish only a few meter above the sea bottom. The depth of the trawl can be adjusted by varying the speed of the towing and also by adjusting the length of the warp- the longer the warp, the deeper we the net would go, and shorter it was, the higher it would rise, thus doing away with the gadgets like depressors, etc. The adjustments of the depth at which the net was to be operated was only a hit and run chance till the developments of the eco-sounder-oscillator which, was fitted on the bridge of the ship shows the depth at which the net is being operated as well as density and the depth of the shoal. The diagrammatic representation of two different types of trawling operation is given in Fig. 4.3.2 and Fig. 4.3.3. Depending upon the number of days of operation by trawlers, these gears are classified into Multi Day Trawl Net (MDTN) and Mini Trawl Net (MTN). Multi Day Trawl Net is operated by the large trawlers, which go for voyage fishing of 6-7 days duration while the Mini Trawl Net is operated by the small trawlers, which conduct fishing operations of 1-2 days duration. The cost of the gear in Calicut in 2003 varied between Rs 15,000 and Rs 30,000 depending upon the size of the gear.

4.3.2. Ring seine

This is a kind of purse seine locally known as Ringuvala or Ranivala. In Kannur area it is known as Kuduvala' and in Kasargode as "Ranivala". It has an average length of 540 meter and a depth of 80 m. The major portion of the net is made of 1/3 nylon thread with a mesh size of 18-20 mm. The edges of the nets are made of meshes of 50 mm size to which the head rope and the foot rope are attached. The central portion of the net is made strong using 2/3 nylon thread to hold fast when heavy catch is hauled to the boat. This portion of the net extends to a length of about 35 m. In some nets, the ends are also made strong. The cost of the gear in 2003 varied between Rs 2,50,000 and Rs 4,00,000.

Plastic floats are attached to the head rope at regular intervals of 15-30 cm depending on the capacity of the float. Another piece of net with meshes of 50 mm is attached to the foot rope. Lead weights are attached to this net at intervals of 45 cm. The weight of the sinkers varies according to the depth at which the net is to be operated. The

foot rope to which the main net and the small bottom piece of the net are attached is generally called by the fishermen as 'changala' which means the chain. The rings are normally made of brass. In some of the southern centers, plated steel rings were tried, but discarded later. Normally 3-4 rings are used per fathom of the net. Each ring weighs roughly 500 gms. A rope runs through the rings, which is the purse line. Usually one carrier boat also accompanies a ring net boat for carrying the catch to shore quickly while the unit continues fishing. Boats made of marine plywood coated with fiberglass with an overall length of around 9 m, width of 1.6 m and depth 90 cm are used for this purpose. A 25 HP engine is fitted to this unit. Now a days private carrier boat operators make this facility to the ring net operators, who do not own a carrier boat. They are normally given a percentage of the proceeds of the fish sales. A ring net unit goes for fishing with manpower ranging from 25 to 35. The number of persons depends upon the length of the craft used. The largest craft can accommodate up to 35 crews. As their number increased, hauling the net has become easier and quicker. There will be a minimum of 3 persons in the carrier boat.

With two engines of 40 HP, the units reach the fishing ground quickly. This gear is used to catch the shoaling pelagic fishes. The carangids are caught in this gear as a by-catch or accidentally. At the sight of the fish shoal of sufficient density, one person (kutty) jumps into the sea with one end of the net and he should be a good swimmer. Some units provide a life jacket for Kutty for easy floating. The boat encircles the shoal very quickly paving the net. Kutty will alert the to frighten the shoal into the net. After the shoal is encircled, the kutty is taken into the boat, along with the end of the net. Now the shoal is trapped in the huge well of net. The purse line is pulled to the boat slowly making the circle smaller (Plate 4.3.2). Finally, the catch is taken into the carrier boat, which rushed to the shore while the ring net unit goes in search of another shoal. Normally in a good season, the unit will continue fishing from morning till evening. Carangids are caught in ring seine in bulk quantities during the monsoon months. Ring net is operated from crafts fitted with out board engines and this unit is called Out Board Ring Seine (OBRS).

4.3.4. Gill nets

Gill net is a highly selective and passive gear of all fishing methods of the Malabar region. The simplicity of its design, construction, operation and its low energy requirement make the gear very popular in all the sectors. The gear is a vertical wall of netting, which is kept erect in water by means of floats and sinkers. The gear is mostly rectangular in shape whose upper end is mounted to a float line (Head Rope) and the lower end to a sinker line (Foot Rope) (Fig 4.3.4). The nets are operated in the surface, column or bottom layers of the water column in coastal and deep sea. Gill nets are used for capture of medium and large carangids and other pelagic fishes. When operated for such larger varieties in the deeper areas of the sea the nets extend to several kilometers.

The fact that separates gill nets from all other types of fishing is that in gill nets the mesh of the net serves the dual function of selecting the fish to be caught and catching it. The capture of fish in gill nets depends on the net construction, its dimensions, and shape of the fish body. The gill net is made up of monofilament net pieces, each 35 m to 50 m long and 8 m to 12 m broad. Normally 20 to 40 such pieces are joined together depending upon the targeted species caught to make a single net. The mesh size varies between 35 mm to 152 mm. Floats are attached to the head rope and stone, baked clay or lead sinkers to the foot rope. Some times the sinkers will be tied to the foot rope with ropes of 1 m length to keep the net 1 m above bottom to avoid mud and unwanted debris when the net is operated in the bottom.

Net repairs are made regularly when they are entangled in rocks and torn and the fishermen do it themselves. The engine and the boat need repairs after one or two year which is very costly. The engine and boat usually go as carrier boats for ring net units. The gill nets are used throughout the year for fishing operations with less intensity during the peak monsoon months. The costs of a gill net unit in the Malabar region vary between Rs 1,60,000 and 2,40,000 depending upon the size of the unit. The gill net units usually go for fishing in the after noon, reach the fishing area by sunset and set their net at the bottom as per the informations they received from the trawlers. Generally, the area will have a depth of more than 30 m. The net is allowed to set across the current and in

the path of fish migration. The method of operation varies with fishing condition, depth, area of operation and the species to be caught. Gill nets are operated mainly as bottom set, or surface net and as drift net. The soaking time of the net varies from 1 to 6 hours for drift nets and 12 to 24 hours for set nets. In set gill nets, both the ends of the gears are secured to bottom by means of sinkers or anchors. In drift nets, one end is tied to the boat and the other end with marker buoy and weights. The nets are shot mostly from the side and sometimes from the stern of the vessel. Hauling is generally done by the side of the vessel by puling the float line or head rope; the nets are cleared out and stored in the shooting position. While hauling, the anchor and the net are pulled over from the boat.

Gill nets are operated from crafts fitted with or without out board engines. When it is operated from crafts fitted with out board engines, it is called Out Board Gill Nets (OBGN) and when it is operated from crafts without out board engine, that unit is called Non-mechanised Gill Net (NMGN).

Crafts normally used at present is a boat made of marine ply wood, coated with fiberglass, of size 9 x 1.6 x 0.8 m. 25 HP outboard engines give the necessary sailing power. A few old dug out canoes are also used in the fishery now. Nevertheless, out board engines are used in most of the cases.

4. 3. 5. Other gears: Hooks and line (H & L) are also engaged in fishing operations for catching the carangids.

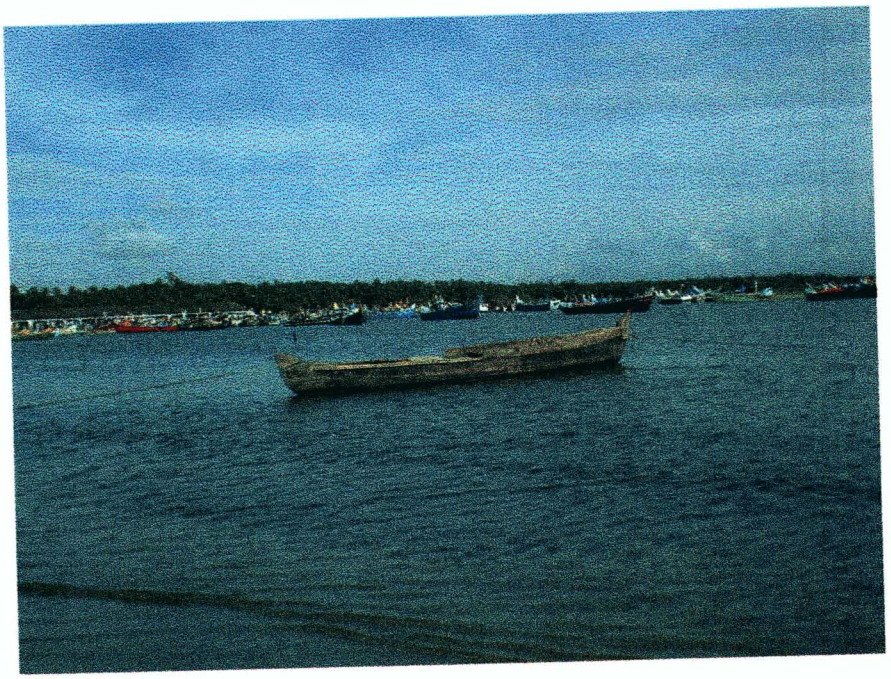


Plate 4.2.1. Traditional fishing craft operated along the Malabar coast

Plate 4.2.2. FRP boat operated along the Malabar coast

Plate 4.2.3. Mechanised trawler operated along the Malabar coast

Fig. 4.3.1. Trawl Net

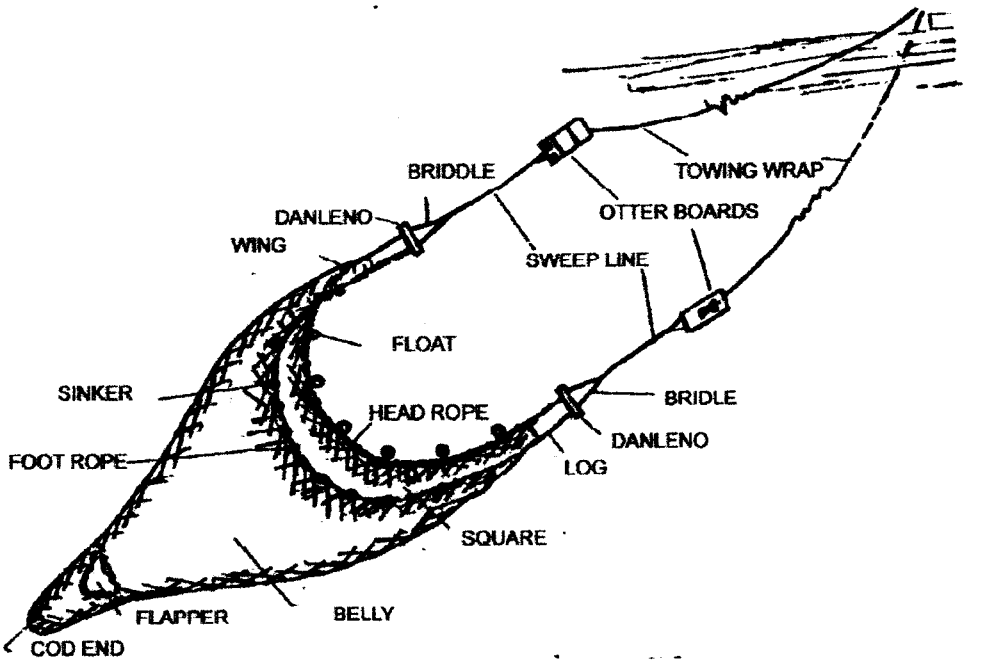


Fig. 4.3.2. Diagrammatic representation of bottom trawling

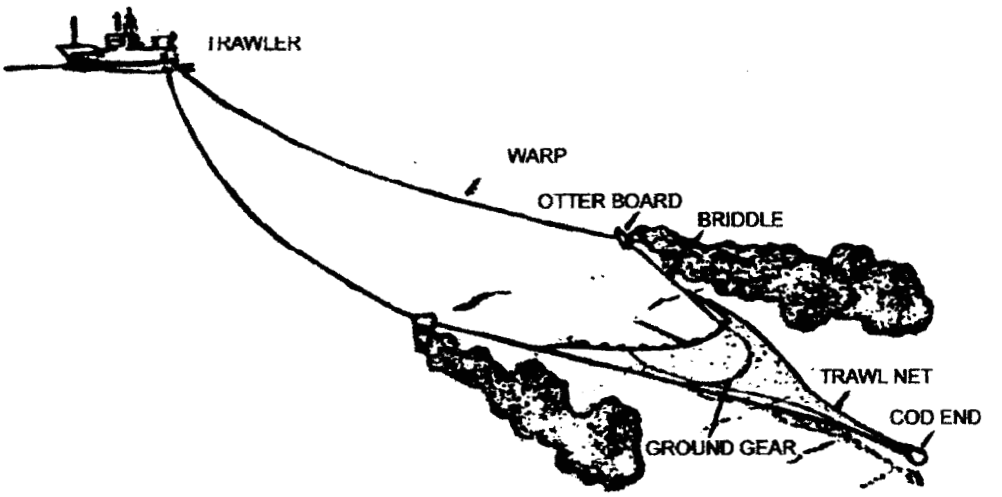


Fig. 4. 3.3. Diagrammatic representation of pelagic trawling

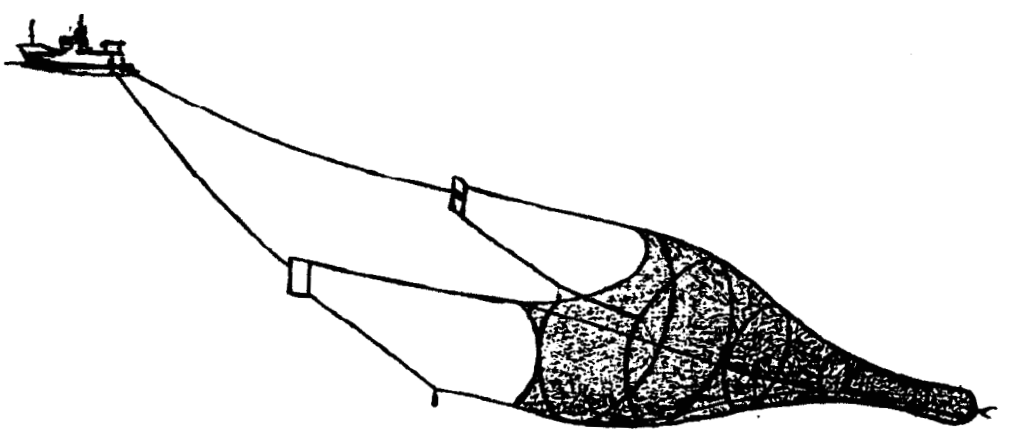
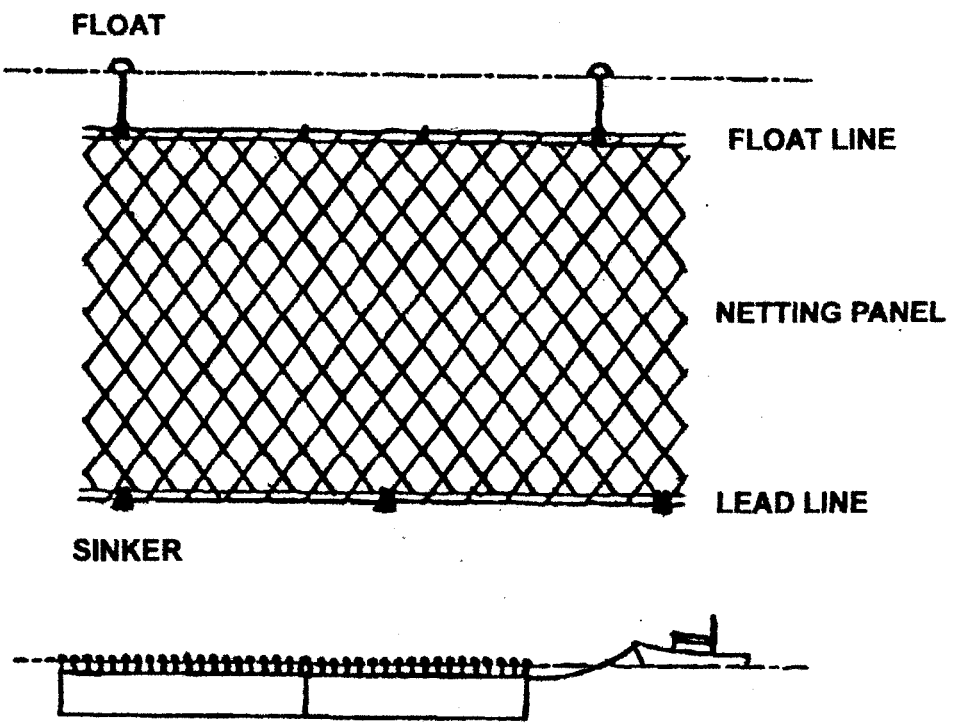


Plate 4.3.2. A view of ring seine operation

Fig. 4.3.4. Gill net



Chapter – 5

Fishery of Carangids

5.1. Introduction

One of the most outstanding characteristics of marine resources is the violent and usually unpredictable fluctuation of the catch. Looking through the history of fisheries of countries with long fishing tradition, one often finds reference to periods of successful fishing, alternating with periods, when the fishery apparently failed altogether. This aspect is of interest not only to the scientists, but also to the fishermen because of its economic impact. The fluctuating nature of any fishery is due to many parameters. It is well known that there is dependent or independent is rather well known. The dynamics of a fishery emerge only by analysing the catch statistics of the concerned fishery. The cardinal factors relevant to the scientific investigation are total catch of the resource, its composition in respect of different species, gear used, species wise catch details and monthly fluctuation of catch per unit effort in respect of the species. Carangids are caught by diverse types of gears, the complete analysis of the catch statistics is quite laborious. An attempt is made in this chapter to give a comprehensive account of the present status of the carangid fishery with special emphasis on *Decapterus russelli.*

The carangids are widely distributed in the Indo-Pacific region and their importance in the Indian fishery is highly significant, as they constitute nearly 7 % of the annual marine fish landings in India. The carangids are represented by 140 species under 25 genera. They occur abundantly in shallow waters up to 80 m depth along both the coasts supporting fisheries almost round the year particularly along states of Kerala, Karnataka, Tamil Nadu and Andra Pradesh. The commercial fishery is supported mainly by *Decapterus russelli*, *Decapterus macrosoma*, *Megalaspis cordyla*, *Alepes djedaba*, *Alepes melanoptera*, *Atule mate*, *Caranx kalla*, *Carangoides malabaricus*, *Carangoides caeruleopinnatus*, *Carangoides fulvoguttatus*, *Caranx melampygus*, *Caranx sexfasciatus*, *Seriolina nigrofasciata*, *Scomberoides* spp., other *Caranx* spp. and *Uraspis* spp.

Carangids are exploited using mechanised, motorised and non-mechanised vessels of different types and sizes ranging from dug out canoes to large trawlers, plank build boats and many sorts of canoes without inboard or out board engines. Almost all types of gears such as trawl net, gill net, hooks and line, boat seine, shore seine, ring seine, purse seine are employed for the exploitation of this resource. Fish trawls, shrimp trawls, ring seine and hooks and line are the most effective gears used for fishing different types of carangids.

Published information on the fishery of carangids from India is scanty. Most of the works on carangids are about the biology of different species from various parts of the country. The pioneering work on the fishery of carangids was carried out by Banerji (1973) who assessed the stock of carangids in Indian waters and stated that the fishing intensity in all the states was exerting pressure on the coastal stocks of carangids. Rao *et al.*, (1977) studied the stock of horse mackerel. Sivakami *et al.*, (1996) estimated the potential yield of carangids along the Indian EEZ. Gopakumar *et al.*, (1991) studied the fishery of mackerel scad, *Decapterus macarellus* from Vizhinjam. Kasim and Hamsa (1994) studied the carangid fishery of Tuticorin. Reuben *et al.*, (1992) described the fishery of carangids in Indian waters. Nair (2000) reviewed the status of carangid fishery in India.

Carangids are a multispecies group caught by diverse types of gears in the Malabar area. An attempt is made in this chapter to give a comprehensive account of the present status of the carangid fishery with special emphasis on *Decapterus russelli* based on the observations made on the fishery at Puthiappa, Beypore, Vellayil, Puthiangadi and Chombala in the Malabar region.

5.2. Annual Fish Landing

Annual total fish landings in the study area during 2000-01 were 63214 t and in 2001-02, the total annual landing was 74715 t. The annual average catch for the two-year period was 68965 t (Table 5.1).

The landings were by Multi Day Trawl Net (MDTN), Mini Trawl Net (MTN), Hooks and Line (H & L), Out Board Rings Seines (OBRS), Outboard Gill Nets (OBGN) and Non-Mechanised Gill Nets (NMGN) in both years. Maximum landing in the year 2000-01 was contributed by MDTN (28131 t), followed by MTN (19833 t), OBRS (10206 t), H & L (2671 t), OBGN (1683 t) and NMGN (690 t) (Table 5.2.1).

In the year 2001-02, the annual marine landing was 74715 t. The landing showed an increase of 11501 t (18.19 %). The contribution of MDTN, MTN, H & L, OBRS, OBGN and NMGN was respectively 39727 t, 19707 t, 1918 t, 10914 t, 1754 t and 695 t (Table 5.2.2).

The average total marine landing was 68965 t. The contribution by MDTN was 33929 t followed by MTN (19770 t), OBRS (10560 t), H & L (2295 t), OBGN (1719 t), NMGN (693 t) (Table 5.2.3).

5.3. Annual landing of carangids

Carangids constituted 4575 t (7.23 %) of the total fish landing in 2000-01. Among carangids, the scads contributed 1747 t followed by, trevallys (889 t), jacks (725 t), other carangids (602 t), horse mackerel (570 t) and leather jackets (42 t) (Table 5.3).

In the year, 2001-02 carangids contributed 5455 t forming 7.30 % of the marine landing. The catch showed an increase of 880 t (19.23 %) when compared to the corresponding period of the previous year.

The average total carangid catch during this period was 5015 t of which, horse mackerel formed 590 t, and scads, leather jackets, and trevallys, jacks and other carangids contributed respectively 2630 t, 80 t, 806 t, 514 t and 396 t.

5.4. Gear wise landing of carangids

The carangids were landed by Multi Day Trawl Net (MDTN), Mini Trawl Net (MTN), Hooks and Line (H & L), Out Board Ring Seines (OBRS), Out Board Gill Nets (OBGN) and Non Mechanised Gill Nets (NMGN) at Calicut. Out of the total landings of

carangids in 2000-01, 2222 t carangids were landed by MDTN, which formed 48.56 % of the carangids landed. The carangids caught by MTN, H & L, OBRS, OBGN and NMGN were 919 t (20.08 %), 582 t (12.72 %), 515 t (11.21 %), 158 t (3.45 %), and 179 t (3.98 %) respectively (Table 5.2.1).

In the year 2001-02, the landing of carangids by MDTN was 3486 t against the 2222 t during 2000-01. The landing of carangids by MTN was 982 t, this showed a marginal increase of 63. t (6.85 %). The landing of carangids by H & L was only 229 t as against the 582 t of previous year, showing a decrease of 353 t. The catch of carangids by OBRS was 568 t showing an increase of 55 t (10.72 %) when compared to the landing of carangids in 2000-01. Carangids formed 115 t of OBGN catch showing a decrease of 43 t (27.21 %) as against the landing of carangids in 2000-02 by OBGN. The landing by NMGN was 75 t as against the 179 t of the previous year (Table 5.2.2).

The year wise landings by different fishing gears indicate that in general there was an increase in the landing of carangids. However, the landing by H & L, OBGN and NMGN showed a decline in 2001-02.

The annual effort by all fishing gears pooled was 97972 units in 2000-01, which was reduced to 72824 units in 2001-02. The effort showed a decline of 25148 units (25.66 %). The reduction in the effort was noticed in the case of MDTN by 766 units (5.31 %) and MTN by 4975 units (24.72 %). The effort expended by H & L, OBRS and OBGN was declines by 6908 units (54.47 %), 7772 (31.99 %) and 3157 (19.87 %) units respectively. The effort of NMGN also showed a decline by 1415 units (14.24 %). Thus, the increase in landing of carangids is mainly due to better landings by multiday and mini trawlers.

The average landing of carangids by MDTN, MTN, H & L, OBRS, OBGN and NMGN was 2852 t (56.88 %), 951 t (18.95 %), 406 t (8.09 %), 542 t (10.80 %), 137 t (2.73 %), and 127 t (2.53 %) respectively (Table 5.2.3).

The average data for the two years indicate that scads were the major component of carangids landed in the study area forming 52.44 %, of the total carangid landings,

followed by trevallys (16.07 %), horse mackerel (11.76.%), jacks (10.25 %), other carangids (7.90 %) and leather jackets (1.58 %) Fig (5.4.1).

5.5. Gear wise Analysis of Catch

5.5.1. Multi Day Trawl Net (MDTN).

It can be seen that in 2000-01 the MDTN effort varied from 784 units in June to 2145 units in October. The annual catch by this gear varied between 569 t (February) and 4275 t (June). The catch of the carangids ranged between 59 t (September) and 351 t (October) (Table 5.5.1.1).

In the year 2001-02 the annual effort expended by multi day trawlers was 13657 units and the range of effort expended was between 730 units (August) and 1857 units (April). The monthly total catch of trawlers was between 77 t (March) and 12834 t (May). The contribution by carangids also showed wide fluctuation during this period and it varied between 16 t (February) and 1870 t (May) (Table 5.5.1.2).

The average for the two-year period 2000-01 to 2001-02 showed that the monthly effort ranged between 966 units (February) and 1702 units (April). The annual composition of carangids was 2854 t and the catch ranged between 39 t (September) and 1065 t (May). In the MDTN, the composition of *Decapterus russelli*, *Decapterus macrosoma*, *Megalaspis cordyla*, *Carangoides malabaricus* and *Caranx kalla* was highest during the study period (Table 5.5.1.3).

5.5.2. Mini Trawl Net (MTN)

The effort of mini trawlers for the period 2000-01 was 20122 units. The range of effort expended was between 7 units (September) and 4358 units (February). The landing of carangids in the mini trawl ranged between 12 t (August) to 302 t (March) (Table 5.5.2.1).

The total effort expended by mini trawlers during the period was 2001-02 15147 units and the monthly effort ranged between 6 units (September) and 2952 units (December).

In the year 2001-02, the annual landing by mini trawlers ranged between 5 t (September) and 4524 t (March). The monthly carangid landing ranged between 9 t (June) and 316 t (May). However, the carangids were not found in the fishery of mini trawlers in September (Table 5.5.2.2).

The average monthly effort expended by mini trawlers during the two year ranged between 7 units (September) and 2908 units (February). The average marine landing by mini trawlers ranged between 5 t (September) and 4087 t (March) and the average annual catch for the two-year period was 19770 t. *Decapterus russelli, Megalaspis cordyla, Carangoides malabaricus* and *Caranx melampygus* were the dominant carangids landed in MTN. Peak landings were observed during February to May (Table 5.5.2.3).

5.5.3. Hooks and Line (H & L)

Among the different units, the effort expended by this unit is comparatively higher in 2000-01 but the landings were not significantly higher. The number of units operated varied between 76 in February and 4275 units in September. The total fish catch by hook and line was highest in September (995 t) and lowest in January (12 t). The landing of carangids was highest in September forming 293 t. The annual catch of non-carangids was 2089 t (Table 5.5.3.1).

In 2001-02, the total effort ranged between 71 units (February) and 1560 units (November). The total fish catch by hook and lines ranged between 12 t (January) and 334 t (August). The carangid landings ranged between 1 t in October and December to a maximum of 110 t in September. Good landings were also observed in July (17 t) and August (84 t). The annual composition of carangids for this period was 229 t. The annual catch of non-carangids was 1689 t (Table 5.5.3.2).

The average effort for the two years shows that, it varied between 73 (March) and 2334 (September) units. High effort was recorded during September-December and April-August. The landing of carangids in the H & L ranged between 1 t (December) and 199 t (September) and the annual catch was 406 t. The total fish landings ranged between 12 t (January) and 587 t (September) and the annual total was 2295 t. The average catch of non-carangids for this period was 1889 t. *Carangoides malabaricus*, *Carangoides fulvoguttatus*, *Megalaspis cordyla, Carangoides caeruleopinnatus* were the dominant species caught and scads were negligible. The landing of carangids was more during July to September (Table 5.5.3.3).

5.5.4. Out Board Ring Seines (OBRS)

The ring seines were operated throughout the year and their peak operation was observed during April - May and October – November months. The effort ranged between 868 units (March) and 4115 units (April) in 2000-01. The total landing by ring seines showed wide fluctuation during this year between 58 t (November) and 2978 t (March). Peak landings were observed during January to March. The contribution of carangids in the ring seine landing was negligible. The carangids landing ranged between 3 t (July) and 146 t (March). Peak landings of carangids were observed during January - March and the annual catch of carangid landing was 515 t. The total marine landing by this gear was 10206 t and the catch of non-carangids was 9691 t (Table 5.5.4.1).

During 2001-02, the monthly effort expended by ring seines ranged between 258 units (May) and 2832 units (December). The total fish catch by ring seines was between 64 t (October) and 3692 t (March). Highest landings of carangids were observed in July (185 t) and lowest in October (4 t). The catch of non-carangids was 10346 t (Table 4.5.4.2).

The average monthly effort of OBRS during study period was between 864 units (September) and 2492 units (April) and the annual landing of non-carangids was 10018 t. The monthly contribution of carangids in the OBRS was between 3 t (August) and 133 t

(January), and the annual average catch for the two-year period was 542 t. *Decapterus russelli*, *Carangoides malabaricus*, *Uraspis helvola* and *Caranx kalla* dominated the landing for this gear. January to May, and July was the peak landing period (Table 5.5.4.3).

4.5.5. Out Board Gill Nets (OBGN)

In 2000-01, the monthly effort expended by OBGN varied from 625 units (November) to 2090 units (December). The monthly fish catch by this unit ranged from 54 t (July) to 211 t (April). The carangids were not available to this gear during October to December. Highest landing of carangids was observed between January and April. Among carangids, scads and leather jackets were not landed through this gear. The trevallys formed 67 t. The contribution of horse mackerel, jacks and other carangids were 32 t, 33 t and 26 t respectively. The catch of non-carangids was 1525 t during this period (Table 5.5.5.1).

The annual total fishing effort for OBGN during 2001-02 was 12730 units and the monthly effort varied between 334 units (May) and 1766 units (October). High effort was expended in October and during January to March. The monthly fish catch ranged between 57 t (September) and 219 t (December). October to June was months that are more productive for OBGN and during this period OBGN units landed maximum quantities of fishes. The monthly landings of carangids were negligible which varied between 1 t (April) and 28 t (January and February) and the total carangids landed by this gear were 115 t. Peak landings were observed during January to March and in May. The non-carangids formed 1639 t of the total landings by OBGN in 2001-02 (Table 5.5.5.2).

The average monthly effort expended by OBGN during the two-year period ranged between 601 units (May) and 1792 units (January) and annual average landing by this gear was 1719 t. The monthly catch ranged between 60 t (September) and 205 t (April). The monthly average landings of carangids in OBGN ranged between 3 t (September and November) and 30 t (January). The annual catch of non-carangids was 1582 t. *Carangoides malabaricus, Megalaspis cordyla*, and *Uraspis helvola* were the

dominant species found in the fishery of OBGN. January to May was the peak period of landing for OBGN (Table 5.5.5.3).

5.6.6. Non-Mechanised Gill Nets (NMGN)

The total effort expended by NMGN for 2000-01 was 9930 units. The monthly effort varied between 425 units (December) and 1540 units (June). Higher effort was observed in January, May and June. The monthly landing by OBGN units ranged between 12 t (April) and 230 t (October) and the annual catch was 690 t. Carangids were absent in the landing in September, April, July and August and the total catch during other months was 179 t. Highest landing was observed during October (152 t) and lowest in May (1 t). The non-carangids accounted for 511 t of the annual marine landings by this gear (Table 5.5.6.1).

In 2001-02, the annual effort expended by NMGN was 8515 units and the monthly effort varied between 184 units (May) and 1336 units (July). The fish landing by NMGN ranged between 11 t (April) and 205 t (October). Peak landings were observed during September – October and July. Highest landing of carangids was observed in October (35 t) and during other months it was below 10 t. Carangids were absent in the fishery during September, April, July and August. The composition of non-carangids was 620 t for this period (Table 5.5.6.2).

The average monthly effort expended by NMGN during the two year ranged between 442 units (December) and 1145 units (July). The monthly total landings ranged between 12 t (April) and 218 t (October) and the annual catch was 693 t. Carangids formed 127 t with the monthly landings ranging from 2 t (April and June) and 94 t (October). The catch of non-carangids was 566 t. The landing by NMGN mainly consisted of *Carangoides malabaricus, Uraspis helvola* and other large species of trevallys in small quantities. October- March was the peak season for carangids in the NMGN (Table 5.5.6.3).

5.6. Species composition of carangids in different fishing gears

5.6.1. *Decapterus russelli* (Plate 5.6.1)

In 2000-01, the composition of *Decapterus russelli* by the MDTN was 50.09 % and the monthly composition ranged between 23.73 % (September) and 70.82 % (October). In the MTN, the monthly composition of *Decapterus russelli* was between 1.75 % (August) and 48.01 % (March) and the annual percentage composition was 25.68 %. In the OBRS, also marginal quantity (0.39 %) of *Decapterus russelli* was recorded during this year. In all the other gears, the catch of *Decapterus russelli* was not noticed (Fig 5.6.1.1)

The monthly percentage composition of *Decapterus russelli* during 2001-02 ranged between 20.34 % (June) and 68.42 % (May) and the annual composition was 42.86 % in the MDTN. As compared to the previous year the composition of this species showed a marginal decrease from 50.09 % in 2000-01 to 42.86 % in 2001-02. The composition of *Decapterus russelli* for the year 2001-02 in MTN was 21.79 %. The monthly composition of *Decapterus russelli* ranged between 0.62 % (June) and 85.71 % (August). *Decapterus russelli* was absent in the MTN during September, November, April and July. In the OBRS, it formed as a major component in 2001-02 with a composition of 63.56 % of the total carangids landed. The monthly composition ranged between 40.00 % (November) and 100.00 % (January and February). It was absent in the fishery during September, October, December, April, June and August. In other gears, this species was not observed (Fig 5.6.1.2)

The average for the two-year period indicated that composition of *Decapterus russelli* in the MDTN, MTN and OBRS was respectively 45.69 %, 23.65 % and 33. 76 %. It was absent in H & L, OBGN and NMGN. This is the commonly occurring species along the Malabar region. Bulk of the catch comes from MDTN, MTN and OBRS (Fig 5.6.1.3)

5.6.2. *Decapterus macrosoma* (Plate 5.6.2)

Decapterus macrosoma was present in the MDTN catch in 2000-01 with a monthly composition ranging from 4.92 % (October and November) and 39.24 % (December) and the annual composition for this period was 8.82 %. In the MTN, the composition of this species was only 0.87 % for the whole year and was present in the catch only for two months. In other gears, *Decapterus macrosoma* was not observed during this period (Fig 5.6.2.1)

In 2001-02, the annual composition of this species in the MDTN was 29.15 % and much higher than the previous year. This was in contrast to the *Decapterus russelli* landing. In the case of MTN, the annual composition of this species was 1.12 %, showing a marginal improvement in the landing compared to the previous year. The landing of *Decapterus macrosoma* was observed only for three months, in January, March and May. In OBRS, this species formed 2.46 % and the catch was observed only in July. *Decapterus macrosoma* was not present in the landings of other gears (Fig 5.6.2.2)

The average for the two-year period show that the composition of *Decapterus macrosoma* in the MDTN, MTN and OBRS was 21.23 %, 0.99 % and 1.27 % respectively. MDTN is the most suitable gear for catching *Decapterus macrosoma* and only marginal quantities of this species is landed in MTN and OBRS. Peak landing was observed in May (Fig 5.6.2.3)

5.6.3. *Alepes djedaba* (Plate 5.6.3)

The composition of this species in the MDTN was negligible forming 0.50 %, for the year 2000-01 and the monthly composition ranged between 1.33 % (December) and 0.66 % (November) by MDTN. In the MTN also the composition of *Alepes djedaba* was negligible and it formed only 0.65 % of the carangid landing. The landing was observed only in March. In H & L, this species was observed for one month in July and the composition was 0.34 %. This species could not be observed in other gears during 2000-01 (Fig 5.6.3.1).

During 2001-02, the composition of *Alepes djedaba* in MDTN was slightly higher than the previous year forming 2.75 % as compared to the 0.50 % of previous year. Monthly composition ranging from 3.99 % (October) to 7.28 % (December) was recorded during this year and *Alepes djedaba* was found in the fishery for four months. In the MTN, this species found only in May with a percentage composition of 0.63 %. Higher quantity of this species was landed during September and June in 2001-02 by H & L forming 3.93 % of carangid landing by this gear. In OBRS, OBGN and NMGN this species was not observed during this period (Fig 5.6.3.2).

The average percentage composition of this species in MDTN, MTN, and H & L indicate that it formed 1.89 %, 0.43 % and 1.47 % respectively. Higher landing of *Alepes djedaba* was noticed in September. In the MDTN, it was found during October – December and May in marginal quantities (Fig 5.6.3.3).

5.6.4. *Alepes melanoptera* (Plate 5.6.4)

This species was found only in negligible quantities in MDTN in 2000-01 forming 0.77 % of the carangid landing. This was landed only in four months during this year. In the MTN the composition of *Alepes melanoptera* was 0.76 % of carangid landing and was observed only in March. The H & L contributed 0.86 % of *Alepes melanoptera* during this period and it was observed in the month of July. In other gears, this species was not observed (Fig 5.6.4.1).

In 2001-02, the composition of *Alepes melanoptera* in the MDTN was 0.57 % of the carangid landing. It was found in the fishery in negligible quantities during October and November. The percentage composition of this species in MTN was 0.20 during 2001-02 and was found in the fishery in May. In the H & L the composition of *A. melanoptera* was observed for two months and the annual composition was 3.06 % of the carangids landed by this gear. OBRS also caught 0.70 % of this species during this period and the landing was observed during the month of July. 5.22 % of carangid landed by NMGN was represented by *Alepes melanoptera* and the landings were observed only during the month of November. NMGN also contributed 8.0% of this

species to the total carangid landings and the landing was recorded only in the month of November (Fig 5 6.4.2).

The average for this species for the two-year period 2000-01 and 2001-02 indicated that the composition of *Alepes melanoptera* in the MDTN, MTN, H & L, OBRS, OBGN and NMGN was 0.70 %, 0.52 %, 1.72 %, 0.37 %, 2.18 % and 2.36 % respectively. This was one of the species landed by all gears, though not observed in the fishery throughout the year (Fig 5.6.4.3).

5.6.5. *Alepes vari* (Plate 5.6.5)

This species was present in negligible quantities (0.77 %) in the MDTN during the year 2000-01. It was observed during October to December and April. In the MTN also, it was present in the month of March and formed 0.76 % of carangid landing. This species was not landed by other gears during this period (Fig 5.6.5.1).

A reduction in the percentage composition of *Alepes vari* from 0.77 % to 0.29 % was noticed during this period in the landings of carangids by MDTN. In the MTN also a reduction in the percentage of *Alepes vari* was noticed and it was decreased to 0.41 % from 0.76 % of the previous year and this species was observed only in May during the period 2001-02. The composition of this species was 3.49 % in the H & L and was found only during November and August. In OBRS *Alepes vari* was found in the catch in July and the composition was 0.88 % of the carangid landings. In other gears *Alepes vari* was not at all observed during 2001-02 (Fig 5.6.5.2).

The average compositions of *Alepes vari* for the year two-year period in MDTN, MTN, H & L, and OBRS was 0.49 %, 0.63 %, 0.98 % and 0.55 %. In the MDTN *Alepes vari* was observed during October- December and April and in MTN, this species was observed in March and May. November and August was the peak season for H & L while in OBRS the peak occurrence was in July (Fig 4.6.5.3).

5.6.6. *Atule mate* (Plate 5.6.6)

Atule mate was present in the catches of MDTN for only two months in October (1.64 %) and April (1.75 %) and the annual percentage composition of this species was 0.41 in the year 2000-01. In MTN, the composition of this species in the catch was 1.96 % and was observed only in March and in all other gears this species was not observed (Fig 5.6.6.1).

In 2001-02 also the composition of *Atule mate* in the catches of MDTN was negligible (0.34 %) and was observed only in December. In MTN, it was recorded in May (1.58 %) and August (14.29 %), and the annual composition was 0.71 %. The annual composition of this species in the OBRS was 0.70 % and was found only in July. Its landing was not recorded in other gears during this period (Fig 5.6.6.2).

The average compositions of *Atule mate* for the two-year period in the MDTN, MTN and OBRS were 0.39 %, 1.31 % and 0.37 % respectively. The fishery was observed in October, December and April in MDTN, while in the MTN it was seen for two months in marginal quantities. In all other gears, this species was absent (Fig 5.6.6.3).

5.6.7. *Caranx kalla* (Plate 5.6.7)

Among scads, *Caranx kalla* was one of the important species landed in moderately good quantities. During the year 2000-01, it was found in five months in the catches of MDTN and the annual composition was 2.97 %. In the MTN, also the composition was almost same but the landing by this gear was found only for three months and in other gears, *Caranx kalla* could not be observed (Fig 5.6.7.1).

A marginal decrease in the percentage composition of *Caranx kalla* was noticed in the fishery of MDTN in the year 2001-02 from 2.97 % of previous year to 2.24 % and the fishery was observed only in April and May. When compared to the MDTN, the catch composition of *Caranx kalla* was very high in MTN during this year forming 7.94 % of carangid landing. Unlike the previous year, the landings were observed for seven

months in MTN. The composition of *Caranx kalla* in OBRS was 41.98 % in March and 5.95 % in July and the annual composition was 7. 92 %. In other gears, this species was not at all recorded (Fig 5.6.7.2).

The average annual composition of *Caranx kalla* in MDTN, MTN, and OBRS was 2.52 %, 5.57 % and 4.24 % respectively during the study period. This was a dominant species observed in trawlers and OBRS. In the MDTN, it was observed during October-December and April - June while in the MTN in November and January - June with dominance in January to March. In OBRS, maximum landing was observed in March (Fig 5.6.7.3).

5.6.8. *Carangoides ferdau* (Plate 5.6.8)

The percentage composition of *Carangoides ferdau* in the MDTN in 2000-01 was 0.86 % and it was found in the fishery in marginal quantities for four months during this period. In H & L, it occurred only in September and annual composition was 0.34 % of the carangid landing. This species was not recorded in other gears (Fig 5.6.8.1).

In 2001-02, this species was recorded in the fishery only during five months forming 0.52 % of the carangid catch by MDTN. Unlike in the previous year this species was found in MTN in small quantities for seven months and the annual percentage composition was 2.34 %. The composition of this species in the H & L during this period was slightly higher than the 2000-01 period with the annual composition of 2.62 %. This species was found in the fishery only in September and August in H & L. NMGN contributed 2.67 % of this species during 2001-02 and this species was noticed in the catch only in October. In all other gears, the fishery of *Carangoides ferdau* was not observed (Fig 5.6.8.2).

The annual average percentage of *Carangoides ferdau* during the two years in MDTN, MTN, H & L and NMGN 0.67 %, 1.36 %, 0.98 % and 0.76 % respectively. In the MDTN, the fishery was observed during September- May in marginal quantities while in the MTN it was seen from November to May. In H & L the fishery of

Carangoides ferdau was noticed in September and August while in NMGN it was found only in October (Fig 5.6.8.3).

5.6.9. *Carangoides malabaricus* (Plate 5.6.9)

Among trevallys landed, *Carangoides malabaricus* was a dominant species found in most of the gears. In 2000-01, the percentage composition of this species in the landing by MDTN was 4.46 and was present in the carangid fishery in all the months, except in April, with the composition ranging from 0.33 % (November) to 24.05 % (August). In mini trawl net also, it was found during four months and the annual composition was 6.09 %. Highest landing was observed in August (66.67 %). With an annual composition of 20.45 %, it was the second important species landed in the H & L. Highest landing of this species was recorded in the month of September (28.67 %) and its fishery was observed only for six months during this period in H & L. In OBRS, *Carangoides malabaricus* was found for eight months with catch ranging from 1.37 % (March) and 55.56 % (October) and the annual composition was 13. 01 %. The catch of this species in the OBGN was the highest of the carangid landings with a percentage composition of 26.58 % for this period and the monthly percentage composition ranging between 12.90 % (January) and 85.71 % (May). *Carangoides malabaricus* was found in the landing by NMGN for four months and the annual percentage composition was 10.06 % (Fig 5.6.9.1).

In 2001-02, *Carangoides malabaricus* was found to occur in MDTN landings for ten months starting from October to June and the annual composition was 2.63 %. In the MTN, the composition of *Carangoides malabaricus* was 21.28 % and was found in the catch within the range of 10.00 % (June)- 14.71 % (December). *Carangoides malabaricus* ranked first among trevallys landed by H & L with a percentage composition of 16.59 %. The landing was found only for three with catch percentage ranging from 10.00 % (June) to 28.57 % (August). In OBRS, the catch of this species was recorded for five months with a percentage range of 5.26 % (March) to 50.00 % (December) and the annual percentage composition was 3.35 %. The composition of *Carangoides malabaricus* was within the range of 21.05 % (May) and 100.00 %

(August) in OBGN and the species was found only for five months during this period. The annual composition of this species was found to be 22.11 % in OBGN. Highest percentage composition of *Carangoides malabaricus* was observed in the landings by NMGN with a monthly composition ranging from 11.43 % (October) to 100.00 % (February, March May and June) and the annual percentage composition was found to be 40.00 (Fig 5.6.9.2).

The average composition of *Carangoides malabaricus* in the MDTN, MTN, H & L, OBRS and NMGN was 3.36 %, 14.17 %, 19.21 %, 7.98 %, 24.81 % and 18.89 % respectively. *Carangoides malabaricus* was the dominant species of carangids found in NMGN, OBGN, H & L, MTN and OBRS. The fishery of this species was observed through out the year in most of the gears (Fig 5.6.9.3).

5.6.10. *Carangoides caeruleopinnatus* (Plate 5.6.10)

The landings of this species by MDTN were observed for seven months during 2000-01 by MDTN and the annual composition for this period was 2.03 %. In the H & L, this species was available for four months with highest landing in June (50.00 %) and the composition for this period was 6.87 %. In OBRS, its composition was 0.58 % in the fishery. This species was available in the fishery by OBGN for four months with a percentage contribution ranging from 2.63 % (April) to 21.21 % (March) and the annual composition during 2000-01 was 8.23 %. This species was not landed in the MTN and NMGN during this period (Fig 5.6.10.1).

In 2001-02, this fishery for *Carangoides caeruleopinnatus* was observed for two months with the contribution ranging from 0.78 % (May) and 0.87 % (December) and the annual composition for this period in MDTN was 0.52 %. In the MTN, this species was found for five months in negligible quantity with the percentage contribution ranging from 1.14 % (January) to 11.00 % (July) and the annual composition was 2.14 %. This species appeared in the fishery of H & L for three months with a composition ranging from 5.95 % (August) and 12.73 % (September) and the annual composition was 8.30 %. In OBRS, the composition was 1.06 % for the period 2001-02 and this species landed

during two months with the percentage contribution ranging from 2.63 % (May) to 22.22 % (April). In NMGN, it was seen only in October and December with a composition of 5.71 % and 22.22 % respectively and the annual percentage composition of this species in the carangid fishery by this gear was 5.33 %. In other gears, it was not noticed during this period (Fig 5.6.10.2).

The average for the two years indicate that in the MDTN, MTN, H & L, OBRS, OBGN and NMGN the percentage composition of this species was 1.13 %, 1.17 %, 7.37 %, 0.92 %, 5.11 % and 1.53 % respectively (Fig 5.6.10.3).

5.6.11. *Carangoides fulvoguttatus* (Plate 5.6.11)

In MTN, fishery of *Carangoides fulvoguttatus* was observed for four months with the monthly percentage contribution ranging from 5.41 % (December) to 17.24 % (November) and the annual composition was 1.52 % in 2000-01. In the H & L, it formed a dominant species with the monthly composition ranging from 5.12 % (September) to 43.55 % (July and August) and the annual composition was 21.13 %. OBGN fishery was observed in January with 8.06 %. In the fishery by NMGN, also this species was found only for one month in January with a contribution of 12.90 %. This species was not observed in MDTN and NMGN during this period (Fig 5.6.11.1).

In 2001-02, *Carangoides fulvoguttatus* was observed in the catch of MDTN for two months in marginal quantities and the contribution was 0.26 %. This species was observed in MTN for three months with monthly percentage composition ranging from 0.63 % (May) to 10.41 % (December) and an annual composition of 1.12 %. The monthly composition of *Carangoides fulvoguttatus* ranged between 4.76 % (August) to 12.00 % (June) in the carangids landed in the H & L with an annual catch composition of 3.93 %. In NMGN, this species was observed in October with a percentage of 4.00 %. This species was not seen in the fishery of OBRS and OBGN during this period (Fig 5.6.11.2).

The averages for 2000-01 and 2001-02 show that the highest composition of *Carangoides fulvoguttatus* was observed in the landings by H & L (16.25 %) and in MDTN, MTN, OBRS, OBGN and NMGN and the percentage composition was 0.18 %, 1.36 %, 0.92 %, 1.45 % and 1.53 % respectively. Peak landings were observed during July – September (Fig 5.6.11.3).

5.6.12. *Caranx melampygus* (Plate 5.6.12)

During 2000-01, *Caranx melampygus* was observed in MTN for four months with the percentage contribution ranging from 10.00 % (June) to 39.13 % (May) with an annual composition of 9.03 %. This species also was found for four months in H & L within the contribution range of 5.12 % (September) to 2.58 % (May) and annual composition was 8.08 %. In OBGN, this species was found only in one month with a percentage composition of 12.90 %. In all other gears, this species was absent during this period (Fig 5.6.12.1).

In 2001-02, the percentage composition of this species in the landing by MDTN was 0.23 %. The composition of *Caranx melampygus* in MTN ranged from 0.95 % (May) to 4.25 % (March) with annual composition of 1.53 %, which was far less than the landing by MTN in the previous year. A marginal decrease in the percentage composition by H & L was noticed during this period from 8.08 % to 7.42 % and the monthly composition ranged between 7.27 % (September) and 13.00 % (August). The annual percentage composition in the OBGN and NMGN was 1.74 % and 6.67 % respectively and was found only for one month in both the gears (Fig 5.6.12.2).

The average for the two years indicate that it was found in the fishery of MDTN, MTN, H & L, OBGN and NMGN and their percentage composition was respectively 0.14 %, 5.18 %, 8.12 %, 2.17 %, and 2.36 %. The species was absent in OBRS during this period. Highest catch of this species was noticed in April-May and August – September (Fig 5.6.12.3).

5.6.13. *Caranx sexfasciatus* (Plate 5.6.13)

Caranx sexfasciatus was not observed in the fishery of MDTN, MTN, OBRS, and NMGN during 2000-01. However, in H & L, it was found during three months with the percentage contribution ranging from 3.23 % (August) to 9.22 % (September) and an annual composition of 7.04 %. In OBGN, it was found only in January with a composition of 6.45 % (Fig 5.6.13.1).

In 2001-02, this species was found in the catch of MDTN within the contribution range of 0.11 % (May) to 0.69 % (December) and an annual composition of 0.17 %. It was observed for two months in the fishery by MTN with a composition of 2.84 % (March) and 4.55 % (December) and an annual composition of 0.81 %. In the H & L catches, the *Caranx sexfasciatus* occurred for three months within the contribution range of 2.38 % (August) and 16.38 % (September) and an annual percentage composition of 8.73 %. *Caranx sexfasciatus* was found in the fishery only one month during 2001-02. In OBGN and NMGN, the annual composition of *Caranx sexfasciatus* was 3.45 % and 5.33 % respectively (Fig 5.6.13.2).

The average for the two years indicated that the percentage composition of *Caranx sexfasciatus* in the MDTN, MTN, H & L, OBGN and NMGN was 0.11 %, 0.42 %, 6.88 %, 2.17 % and 1.57 % respectively. Highest catch was noticed in May (Fig 5.6.13.3).

5.6.14. *Seriolina nigrofasciata* (Plate 5.6.14)

Being a large species, the composition of *Seriolina nigrofasciata* in the H & L was high and was observed for three months within the contribution range of 3.23 % (August) to 9.22 % (September) during the year 2000-01 and an annual percentage composition of 7.04 %. In OBGN, it occurred only in January with an annual composition of 1.27 %. In other gears, this species was not observed during this period (Fig 5.6.14.1).

In 2001-02 in the MDTN, it was found in negligible quantities forming 0.32 % (May) to 1.39 % (December) with an annual percentage composition of 0.46 %. In MTN, also this species was observed only during three months within the contribution range of 2.84 % (March) and 15.00 % (July) and an annual composition of 1.53 %. With a composition of 10.04 %, the annual percentage composition of *Seriolina nigrofasciata* was highest in the landings by H & L though was found only in two months. In the fishery by OBRS, also marginal quantity of *Seriolina nigrofasciata* was landed only in one month with an annual composition of 0.35 %. OBGN and NMGN contributed 9.57 % and 5.33 % respectively of *Seriolina nigrofasciata* for the year 2001-02 (Fig 5.6.14.2).

The average for the two years shows that the composition of this species in MDTN, MTN, H & L, OBRS, OBGN and NMGN was 0.28 %, 0.84 %, 7.88 %, 0.18 %, 5.10 %, and 1.57 % respectively. Peak landings in H & L were noticed in August-September months. In the OBGN, highest catch was recorded in February while in NMGN it was in October. In the trawl nets, the landing was noticed for a few months in marginal quantities. Peak landing was noticed in September (Fig 5.6.14.3).

5.6.15. *Megalaspis cordyla* (Plate 5.6.15)

This was an important species of carangid found in the MDTN catch in 2000-01 with an annul catch composition of 11.25 %. The monthly composition of this species ranged between 0.66 % (October) and 76.92 % (June). In the MTN, the catch was found only for five months during this period within the contribution range of 6.62 % (March) and 65.79 % (April) and annual composition was higher than the contribution by MDTN. In the H & L, also this species was found for three months with a monthly composition ranging from 4.44 % (September) to 12.90 % (August) and the annual composition was 7.04. The monthly composition varied between 16.00 % (June) and 65.12 % (January) and the annual landing was 20.27 % of the carangid landing by the OBRS. In the OBGN, also the percentage composition of *Megalaspis cordyla* was close to landing by OBRS with an annual contribution of 20.25 % and the monthly

composition was above 30 % during all three months. The landing of *Megalaspis cordyla* by NMGN was not recorded during this period (Fig 5.6.15.1).

In 2001-02, the percentage composition of *Megalaspis cordyla* in the landing by MDTN was 9.04 % and the species was noticed during nine months in this period. In the fishery by MTN, the species composition was slightly higher than that in MDTN with a contribution of 13.34 %. The species was observed during six months in this gear. The percentage composition of this species in the landing of carangids by H & L was between 10.91 % (September) and 100 % (July) with an annual composition of 20.96 %. *Megalaspis cordyla* was found during six months within the contribution range of 13.33 % (November) and 86.84 % (May) in OBRS and the annual composition was 14.61 %. Highest contribution of this species was recorded in OBGN with a percentage composition of 28.70 % and the monthly composition was between 35.71 % (January and February) and 65.20 % (March). In NMGN, this species was not observed (Fig 5.6.15.2).

The average for the two years shows that the *Megalaspis cordyla* formed a good component in MDTN, MTN, H & L, OBRS and OBGN with percentage composition of 9.96 %, 14.46 %, 10.84 %, 17.34 % and 24.08 % respectively. In NMGN this species was not observed. Highest percentage composition of *Megalaspis cordyla* was observed during January- March in OBGN. In the OBRS, peak catch was noticed in January and May. In H & L fishery, this species was noticed from July to September months only with a contribution ranging from 6.44 % (September) to 19.48 % (July). In the MTN, the species was noticed from January to June, but in the MDTN, the landings were noticed during most of the months with a peak from January to March (Fig 5.6.15.3).

5.6.16. *Scomberoides commersonnianus* (Plate 5.6.16)

Among leather jackets, *Scomberoides commersonnianus* was one of the species found in the MDTN catch in small quantities with contribution ranging from 0.34 % (April) to 4.91 % (October) and for the period 2000-01 annual composition was 0.81 % of the carangid landings. In the MTN, it occurred in the catch only for one month in

February and formed 0.11 % of the annual landing in carangids. In other gears, this species was not found in the landing (Fig 5.6.16.1).

In the year, 2001-02 monthly contributions of *Scomberoides commersonnianus* in the catch was between 1.07 % (April) and 3.39 % (June) in MDTN and the annual composition was 2.09 %. The composition of this species in the catch by MDTN showed an increase of more than 1 % when compared to that of previous period. In the MTN, this species was found only in January and the annual composition was 0.10 %. In H & L, OBRS, OBGN and NMGN this species was not recorded (Fig 5.6.16.2).

The average annual composition of *Scomberoides commersonnianus* during the two-year period in the MDTN and MTN and was 1.61 % and 0.11 % respectively. (Fig 5.6.16.3)

5.6.17. *Scomberoides tol* (Plate 5.6.17)

Among leather jackets, *Scomberoides tol* was the second species found in the MDTN fishery with the monthly composition ranging from 2.60 % (February) to 22 % (July) in 2000-01 and the annual percentage composition in the carangid landing was 1.04 %. In other gears, this species was not observed during this period (Fig 5.6.17.1).

Scomberoides tol formed 1.26 % of MDTN catch in 2001.02 with the monthly catch contribution ranging from 1.18 % (May) to 7.31 % (October). In other gears, this species was not recorded (Fig 4.6.17.2).

The average data for the two years indicate that the fishery of this species is not prominent in Malabar region. It occurred rarely in the catch of multi day trawlers. In other gears this species was not observed. The average composition of *Scomberoides tol* in MDTN was 1.19 % (Fig 5.6.17.3).

5.6.18. *Uraspis helvola* (Plate 5.6.18)

Among jacks, *Uraspis helvola* was the only carangid species found in all gears in reasonably good quantity throughout the year. In the MDTN, it occurred almost throughout the year with the percentage ranging from 1.69 (September) to 28.42 (March) and the annual composition for the year 2000-01 was 8.24 %. In MTN, this species was observed for nine months with the percentage contribution ranging from 0.11 (October) to 51.59 and the annual percentage (23.83 %) was much higher than that of the MDTN. In the H & L, *Uraspis helvola* was observed for three months ranging in contribution from 1.47 % (July) to 11.11 % (May) and the annual percentage composition was 4.12 %. *Uraspis helvola* was one of the major components of OBRS during 2000-01 forming 51.07 % of the carangids landed by this gear with the monthly composition ranging from 9.09 % (May) to 84.93 % (March) and was present in the fishery almost throughout the year. Highest percentage of this species was found during the month of January to March. In OBGN, *Uraspis helvola* was found with the contribution ranging from 6.06 % (March) to 33.33 % (September) and the composition among carangids for this period was 20.89 %. The peak landings were observed in September (33.33%) and April (55.29 %). This species was observed in NMGN only for three months in small quantities with an annual composition of 1.68 % for this period (Fig 5.6.18.1).

During the period 2001-02, *Uraspis helvola* was observed in the fishery of MDTN for eleven months with the composition ranging from 1.35 % (October) to 25 % (February) annual average being 3.04 %. The monthly contribution of this species ranged between 3.80 % (May) and 48.92 % (April) in MTN showing a decrease in the annual composition to 17.52 % when compared to that of the same period of last year. In the H & L, also the annual composition of this species has shown a decline from 4.12 % to 1.31 % during this period and the monthly contribution ranged between 1.82 % (September) and 11.11 % (May). The composition of *Uraspis helvola* in the carangid landing by OBRS was negligible during this period (2.04 %) showing a decrease of 49.03 % against the landing in the previous year (51.07 %). In OBGN, the landing was observed for three months ranging in contribution from 10.53 % (May) to 1.77 % (May) and the annual contribution was 3.48 %. Unlike the other gears, the NMGN catches

showed an increase in the landings of *Uraspis helvola* during 2001-02 with monthly contribution ranging from 5.71 % (October) to 28.5 % (January) 2.67 % (Fig 5.6.18.2).

The analysis of the data for two-year period indicated that *Uraspis helvola* formed an important component of the carangid landings by most of the gears except NMGN, but in 2001-02, the landing of this species in most of the gears showed a major decline. In NMGN, the landing showed considerable increase in 2001-02. The average for the two years indicate that in the MDTN, MTN, H & L, OBRS, OBGN and NMGN the percentage composition of *Uraspis helvola* was 5.08 %, 20.60 %, 3.44 %, 25.28 %, 13.86 % and 4.58 % respectively. November to May was the peak period with good quantities landed by MTN and OBRS (Fig 5.6.18.3).

5.6.19. Other carangids

The average annual composition of other carangids in MDTN, MTN, H & L, OBRS, OBGN and NMGN for this period was respectively 3.71 %, 8.01 %, 15.27 %, 7.19 %, 20.45 % and 66.92 % of the carangid landings (Fig 5.6.19.1, Fig 5.6.19.2 and Fig 5.6.19.3).

5.7. Gear wise Catch Per Unit Effort (CPUE)

5.7.1. Multi Day Trawl Nets (MDTN)

The CPUE of scads in MDTN for the year 2000-01 was 99.08 kg and the month wise CPUE fluctuated between 11.79 kg (September) and 276.79 kg (June). Highest catch rate was recorded for *Decapterus russelli* (77.17 kg) and *Decapterus macrosoma* (13.59 kg). The monthly CPUE of *Decapterus russelli* ranged between 11.79 kg (September) and 252.56 kg (June). In the case of *Decapterus macrosoma,* high catch rate was observed in December and May to June. The annual CPUE of *Alepes djedaba, Alepes melanoptera, Alepes vari* and *Atule mate* was negligible and was 0.76 kg, 1.18 kg, 1.18 kg and 0.62 kg respectively. The annual CPUE of *Caranx kalla* was 4.58 kg and the peak CPUE was recorded in the months of October-December and April.

Among trevallys the monthly, catch rate of *Carangoides malabaricus* ranged between 0.64 kg (November) and 16.96 Kg (May) and the annual CPUE was 6.86 kg for the year 2000-01. The yearly CPUE of *Carangoides ferdau* and *Carangoides malabaricus* was 1.32 kg and 3.12 kg respectively. The annual CPUE for trevallys was 11.30 kg and the monthly CPUE ranged between 3.19 kg (November) and 23.09 kg (February) in 2000-01.

The CPUE of horse mackerel, *Megalaspis cordyla*, ranged between 0.93 kg (October) and 59.00 kg (January) in 2000-01 with an annual value of 17.3 kg. High catch rates were recorded during the months of September and January - March 2000-01

CPUE of jacks ranged between 0.69 kg (August) and 40.06 kg (December) and the annual CPUE was 12.69 kg. High catch rate was observed during November-December and March during 2000-01. High CPUE for leather jackets were recorded during the months of October and November and the annual CPUE was 2.84 kg. The CPUE of other carangids was 10.82 kg for 2000-01 (Table 5.7.1.1).

During the period 2001-02 the annual CPUE of scads, trevallys, horse mackerel, leather jacks and other carangids were 199.60 kg, 12.23 kg, 23.07 kg, 8.57 kg, 7.76 kg and 4.03 kg respectively.

The monthwise catch rate of scads fluctuated between 9.62 kg (June) to 983. 62 kg (May). Among scads *Decapterus russelli* had the highest annual catch rate of 109.39, kg followed by *Decapterus macrosoma* (74.39 kg), *Alepes djedaba* (7.03 kg), *Caranx kalla* (5.71 kg), *Alepes melanoptera* (1.46 kg), *Atule mate* (0.88 kg) and *Alepes vari* (0.73 kg). High catch rate for *Decapterus russelli* was observed during October - December and May and in the case of *Decapterus macrosoma* it was in May. The higher CPUE for *Caranx kalla* was recorded in April- May. For other species the CPUE was negligible in 2001-02.

Among trevallys, highest annual catch rate was observed for *Carangoides malabaricus* (6.74 kg) during this year also. The monthly catch rate of *Carangoides malabaricus* varied between 1.08 kg and 15.12 kg and highest CPUE was observed

during May (15.12 kg). The CPUE of other species of carangids was negligible. The monthly CPUE of trevallys ranged between 2.43 kg (September) and 37.18 kg (May) and the annual CPUE was 12.23 kg.

The monthly CPUE of horse mackerel ranged between 1.48 kg (March) and 90.74 kg (May) with an annual value of 23.07 kg. High catch rates were noticed during October-December, and April-May months.

High CPUE of leather jackets were observed during the months of October (24.06 kg) and May (51.67 kg) and for jacks in December (49.49 kg) in 2001-02. The annual CPUE of leather jackets and jacks was 8.57 kg and 7.76 kg respectively. The high catch rate for other carangids was noticed only in January (8.38 kg) and May (12.03 kg) and the annual CPUE was 4.03 kg for the period 2001-02 (Table 5.7.1.2).

The average for the two-year period indicated that the annual CPUE of scads, trevallys, horse mackerel, leather jackets, jacks and other carangids were 147.97 kg, 11.75 kg, 20.12 kg, 5.63 kg, 10.29 kg and 7.51 kg respectively. Two peaks were observed for scads, the primary peak during October-December and the secondary peak during April – June and this is coupled with the highest CPUE of *Decapterus russelli*, the important species of scads. The high catch rate of trevallys was during December, February and May-June and the CPUE for *Carangoides malabaricus* was the highest among this group with the highest peak in February and May. Three peaks were observed in the case of horse mackerel, the primary peak in September, secondary peak in December-March and tertiary peak in May. Highest CPUE for leather jackets were observed in October. Peak landings of jacks were recorded for in December. The high catch rate of other carangids was seen in November-December and June (Table 5.7.1.3).

5.7.2. Mini Trawl Net (MTN)

Highest annual CPUE in MTN was of scads at 15.36 kg followed by jacks (10.88 kg), trevallys (7.60 kg), horse mackerel (7.11 kg), other carangids (4.67 kg) and leather jackets (0.05 kg) during 2000-01. The scads were recorded in higher catch rates during

March-May and August. Among scads, highest CPUE was of *Decapterus russelli*, with the monthly range between 0.79 kg (April) and 222.22 kg (August) and annual CPUE at 11.73 kg. Highest CPUE for *Decapterus macrosoma* was observed in May (2.13 kg) with an annual average of 0.40 kg. The highest CPUE of *Alepes djedaba, Alepes melanoptera, Alepes vari and Atule mate* was recorded in March and of *Alepes* vari, *Alepes* melanoptera and *Caranx kalla* in May in 2000-01.

CPUE of trevallys ranged between 2.26 kg (June) to 1111.11 kg in August. Highest catch rate of 888.89 kg and 222.2 kg was recorded for *Carangoides malabaricus* and *Carangoides fulvoguttatus* respectively in August. In the case of *Caranx melampygus,* CPUE was highest in May and the annual CPUE was 4.12 kg for the period 2000-01. Two peaks in CPUE of horse mackerel was recorded, the primary peak in April (29.45 kg) and the secondary peak in June (13.56 kg). The catch rate of leather jackets was negligible with 0.23 kg in February and the annual CPUE was 0.05 kg. The annual peak catch rate of jacks was observed in December (9.15 kg), secondary peak in February (18.59 kg) and tertiary peak in May (17.08 kg) with the annual CPUE of 10.88 kg. The range of CPUE for other carangids was between 4.02 kg (November) and 24.03 kg (December) and the annual CPUE was 4.67 kg (Table 5.7.2.1).

In the year 2001-02, the CPUE in general has shown an increase when compared to the 2000-01 period. The range of CPUE for scads was between 1.59 kg (April) and 1400 kg (August). The number of MTN operated during August was very low. The catch constituted mainly by *Decapterus russelli*, and the highest CPUE was recorded in August. The range of CPUE of *Decapterus russelli* fluctuated between 0.69 kg (February) and 1200 kg (August). High CPUE was recorded in May and August. The CPUE of *Decapterus macrosoma* was highest in March (2.85 kg) and the annual catch rate was 0.73 kg. The annual CPUE for *Alepes djedaba* and *Alepes melanoptera* was 0.13 kg each and for *Alepes vari* and *Atule mate* was 0.26 kg and 0.46 kg respectively. Only one peak in the CPUE of *Caranx kalla* was observed in January to March and the annual CPUE for this period was 5.15 kg. The CPUE of scads showed improvement over the previous period.

The CPUE of trevallys for this period ranged between 2.17 kg and 46.67 kg and the peak catch rates were recorded during February-May. Among trevallys, the highest catch rate was recorded for *Carangoides malabaricus* within the range of 2.17 kg (October) and 35.89 kg (April) and the annual average was 13.80 kg. Highest CPUE was recorded during the months of February-May. The monthly CPUE variation of *Carangoides ferdau*, *Carangoides malabaricus*, *Carangoides fulvoguttatus*, *Caranx melampygus*, *Caranx sexfasciatus* and *Seriolina nigrofasciata* was negligible and the annual CPUE of these species was 1.52 kg, 1.39 kg, 0.73 kg, 0.99 kg, 0.53 kg, and 0.99 kg respectively for the year 2001-02.

The CPUE of horse mackerel was high during January to March and May. The annual CPUE was 8.65 kg in 2001-02.

The CPUE of jacks fluctuated between 2.17 kg (October) and 54.23 kg (April) and the annual CPUE was 11.36 kg. High CPUE was recorded in February and April in 2001-02.

The annual CPUE of leather jackets and other carangids was 0.07 kg and 3.83 kg respectively. Peak CPUE for other carangids was noticed in February (10.98 kg) and April (12.76 kg) during 2001-02 (Table 5.7.2.2).

The averages for the two-year period indicated that among carangids, the CPUE (17.78 kg) of scads was the highest followed by trevallys (12.90 kg), jacks (11.11 kg), horse mackerel (7.77 kg) and other carangids (4.31 kg). The CPUE of scads was high during March, May and August. The range of CPUE of trevallys was between 0.93 kg (June), and 500 kg (August) and the highest CPUE was recorded during August and May. In the case of horse mackerel, high values were recorded in April and May with a CPUE of 21.04 kg and 17.14 kg respectively. The catch rates of leather jackets were negligible (0.06 kg). The CPUE of jacks was higher during the months of February to May and lowest in June. The highest CPUE for other carangids was observed in October (9.32 kg) (Table 5.7.2.3).

5.7.3. Hooks and Line (H & L)

The annual catch rate of scads in the H & L was poor during the period 2000-01 with 0.54 kg and the highest catch rate was recorded during July (5.61 kg). Among scads *Alepes melanoptera* realised the maximum CPUE of 4.01 kg in July and the annual CPUE of this species was 0.39 kg. The catch rate of trevallys was within the range of 0.62 kg (October) and 142.86 kg (August) and the annual CPUE was 31.58 kg. High catch rates were recorded during September and July –August months. Among trevallys, high catch rates of *Carangoides malabaricus* were recorded in the months of September (19.65 kg) and August (23.12 kg) and the lowest in October (0.62 kg). High catch rate of *Carangoides malabaricus*, *Carangoides fulvoguttatus*, *Caranx melampygus* and *Caranx sexfasciatus* were found in the months of August with 18.52 kg, 71.43 kg, 18.52 kg and 13.23 kg respectively and for *Seriolina nigrofasciata* it was in July (8.02 kg). The catch of trevallys in H & L was observed during September-October and May-August only and during other months it was absent in the catch. The catch rate for horse mackerel was highest in August (21.16 kg) and lowest in September (3.04 kg) and the annual catch rate was 3.23 kg. Highest catch rate of jacks was noticed in September (4.68kg) and lowest in July (1.60 kg) and the annual CPUE was 1.89 kg. For other carangids, high CPUE was realised in September (21.29 kg) and May (11.00kg) and the annual catch rate was 7.90 kg (Table 5.7.3.1).

In the year 2001-02, the annual CPUE for scads, trevallys, horse mackerel, jacks, and other carangids were 4.16 kg, 22.87 kg, 8.31 kg, 0.52kg, and 3.81 kg respectively. The highest catch rate for scads was recorded in September with 22.90 kg and lowest in November (3 .85 kg). Highest catch rate of *Alepes djedaba* was recorded in September (22.90 kg) and the annual CPUE was 1.56 kg. For *Alepes melanoptera* and *Alepes vari* the annual CPUE was 1.21 kg and 1.39 kg respectively. The highest catch rate of trevallys was noticed in September (208.65 kg) and lowest in May (4.47 kg) and the annual CPUE was 22.87 kg. For all trevallys highest CPUE was recorded in September. In the case of horse mackerel, CPUE was at its peak in July (77.98 kg) and minimum in August (15.15 kg). Jacks also realised higher catch rate in September (5.09 kg) and minimum in May (2.24 kg). For other carangids higher catch rates were recorded

in September (12.72 kg) and May (13.42 kg) and lowest in November (0.64 kg) (Table 5.7.3.2).

The averages of CPUE for different carangids show that the highest CPUE was recorded for trevallys (28.88 kg) followed by other carangids (6.63 kg), horse mackerel (4.26 kg) and jacks (1.44 kg). High CPUE of trevallys was recorded in the month of September and July-August. July-August was the peak period of availability for horse mackerel in the H & L while jacks and other carangids had the peak period in September with a CPUE of 4.71 kg and 20. 57 kg respectively (Table 5.7.3.3).

5.7.4. Out Board Ring Seiners (OBRS)

The scads and leather jackets were not caught in 2000-01 by OBRS. The annual CPUE of jacks was the highest (10.52 kg) followed by, horse mackerel (4.21 kg), trevallys (3.24 kg) and other carangids (2.64 kg). Among trevallys the catch rate of *Carangoides malabaricus* was highest during February (35.89 kg) and lowest in April (0.49 kg) and the annual CPUE was 2.68 kg. The annual CPUE of *Carangoides caeruleopinnatus* and *Carangoides fulvoguttatus* was 0.12 kg and 0.40 kg respectively. The horse mackerel was abundant in January with a CPUE of 82.03 kg and lowest in October (0.99 kg). Highest CPUE of jacks was in March (142.86 kg) and the lowest in November (0.60 kg). The range of CPUE for other carangids was between 0.55 kg (June) and 23.04 kg (March) (Table 5.7.4.1).

In 2001-02, scads were available in the fishery in reasonable good quantities and the CPUE was the highest among the carangids with 25.47 kg followed by horse mackerel (4.88 kg), trevallys (1.59 kg), other carangids (0.82 kg) and jacks (0.65 kg). Two peaks were recorded in the CPUE of scads, one in January (151.96 kg) and the second one in July (83.37 kg). Among scads, *Decapterus russelli* was caught with highest CPUE in January (151.96 kg) and July (66.25 kg) and the annual CPUE of 21.23 kg. Except for *Caranx kalla,* the CPUE of all other species of scads were highest in July. In the case of *Caranx kalla,* highest CPUE was realised in the month of March (21.42 kg). For horse mackerel, the peak catch rate was recorded in May (255.81 kg) and lowest

in November (1.00 kg). The CPUE for other carangids was highest in September (19.54 kg) and May (7.75 kg) and lowest in November (1.00 kg) (Table 5.7.4.2).

The averages of the two years in OBRS indicated that highest CPUE of carangids was recorded for scads (10.43 kg) followed by jacks (6.57 kg), horse mackerel (4.48 kg), trevallys (2.57 kg) and other carangids (1.92 kg). High CPUE of scads was recorded during January-March and July. Among scads, highest CPUE was recorded for *Decapterus russelli* (8.71 kg). The annual CPUE of trevallys ranged between 0.54 kg (November) and 23.09 kg (February) and *Carangoides malabaricus* had highest CPUE of 2.06 kg among trevallys. The range of CPUE of horse mackerel was between 1.02 kg (October) and 43.75 kg (January) and peak catch rates were recorded during January and May. Highest catch rate of jacks were recorded during January and March (Table 5.7.4.3).

5.7.5. Out Board Gill Netters (OBGN)

Scads and leather jackets were not observed in the catch by OBGN. The annual catch rate of trevallys was (4.22 kg), this was followed by jacks (2.08 kg), horse mackerel (2.01 kg) and other carangids (1.64 kg) in the year 2000-01. Among trevallys the CPUE was highest in January (9,75 kg) and lowest in September (1.11 kg). Highest catch rate was recorded for *Carangoides malabaricus* with the CPUE ranging from 1.11 kg (September) to 6.91 kg (May) and the average of 2.64 kg. The CPUE of *Carangoides caeruleopinnatus* ranged between 0.74 kg (April) and 3.53 kg (March). The catch of all other species of trevallys was observed only in January. The horse mackerel showed almost same CPUE of around 6 Kg during January to March. Highest catch rate of jacks was noticed in April (15.45 kg) and lowest in January (0.54 kg). As in the case of jacks, the highest catch rate for other carangids was noticed in April (7.36 kg) and lowest in January (0.54 kg) (Table 5.7.5.1).

Unlike in 2000-01, the scads were available in the OBGN in 2001-02 in marginal quantities with an annual CPUE of 0.47 kg. The annual CPUE of trevallys was 3.30 kg with monthly variation ranging from 2.03 kg (July) and 44.91 kg (May). The highest

CPUE *Carangoides malabaricus* was 11.98 kg (May) and lowest 2.03 kg (July) and the annual CPUE was 1.96 kg. The monthly catch rate of *Caranx melampygus*, *Caranx sexfasciatus* and *Seriolina nigrofasciata* was highest in May and their annual catch rate was 0.16 kg, 0.31 kg and 0.86 kg respectively. Horse mackerel was found only from December to February with the catch rate ranging from 5.76 kg to 9.11 kg and the annual catch rate was 2.59 kg. The catch rate of jacks was highest in May (5.59 kg) and lowest in July (1.01 kg) and the annual catch rate was 0.31 kg. For other carangids, the peak catch rate was in January (10.37 kg) and lowest in April (1.80 kg) and the annual value was 2.20 kg (Table 5.7.5.2).

The averages for the study period indicated that among carangids the highest catch rate was recorded for trevallys (3.93 kg) followed by horse mackerel (2.27 kg), other carangids (2.00 kg), jacks (1.38 kg) and scads (0.21 kg). Peak catch rates of trevallys was recorded in the months of February (7.41 kg) and May (17.47 kg) and lowest in July (2.26 kg). *Carangoides malabaricus* being the principal species of trevallys caught in OBGN had higher CPUE. The CPUE of horse mackerel was almost uniform for the period of its occurrence from January to March. For jacks and other carangids, the peak catch rate was recorded in April (Table 5.7.5.3).

5.7.6. Non-Mechanised Gill Netters (NMGN)

In NMGN, scads, horse mackerel and leather jackets were not available for the year 2000-01. The annual catch rate of other carangids was 15.91 kg, followed by trevallys (1.81 kg) and jacks (0.30 kg). Among trevallys, *Carangoides malabaricus* was the only species found in the catch and its CPUE ranged between 4.01 kg (January) and 11.76 kg (December). The catch rate of jacks was highest in December (2.35 kg). The highest CPUE of other carangids was found in October (159.66 kg) in 2000-01. (Table 5.7.6.1)

Unlike in 2000-01, scads were present in the landings of NMGN in 2001-02, but horse mackerel and leather jackets were absent. Highest annual CPUE was recorded for trevallys (6.11 kg), followed by other carangids (1.29 kg) and jacks and scads 0.70 %

each. Among trevallys CPUE of *Carangoides malabaricus* was within the range of 4.56 kg (October) and 21.74 kg (May) and the annual composition was 3.52 kg. The species such as *Carangoides ferdau, Carangoides fulvoguttatus, Caranx melampygus, Caranx sexfasciatus* and *Seriolina nigrofasciata* were present only in October and their catch rate was 2.28 kg, 3.42 kg, 5.69 kg, 4.56 kg, and 4.56 kg respectively. The highest CPUE of *Carangoides malabaricus* was noticed in December (4.37 kg) and lowest in October (2.28 kg). The CPUE of jacks was within 2.26 kg (October) and 2.32 kg (January) and the jacks were available for only three months in the carangid landing. The highest CPUE of other carangids were noticed in October (10.25 kg) and lowest in December (4.37 kg) Table 5.7.6.2.

The averages for 2000-01 and 2001-02 show that the highest CPUE was noticed for other carangids (9.21 kg) followed by trevallys (3.79 kg), jacks (0.54 kg) and scads (0.33 kg). Peak CPUE of trevallys was recorded in October (14.04 kg), December (13.57 kg), and March (7.24 kg). The highest CPUE of jacks and other carangids was realised in November (1.48 kg) and October (94.15 kg) (Table 5.7.6.3).

5.8. Carangid catch in the Malabar area

The monthly carangid catch in different districts in Malabar area estimated by Central Marine Fisheries Research Institute during 2000-01 and 2001-02 is given in Table 5.8.1 and Table 5.8.2. The average for the two-year period indicate that highest landing of carangids was in Calicut (5770 t), followed by Malappuram (409 t), Kannur (170 t) and Kasaragod (123 t) (Table 5.8.3). Carangids constituted 5.62 % of the total marine catch of Calicut district and along the Malabar region it formed 3.25 % (Fig 5.8.1).

5.9. CONCLUSION

The present analysis of the fishery data of the carangids in this area shows fluctuation with reference to catch, catch rate, gear wise species composition and seasonality. The importance of carangid fishery in the marine fishery sector of this area is an indicted by its significant catch of the total fish landing forming 7.20 %.

The gear wise average of the catch indicates that Multi Day Trawl Nets landed 56.92 % of the carangids followed by Mini Trawl Nets (18.95%). Thus the trawl landing of carangids alone was 75.87 % of the landing. The composition of Hooks and Line, Out Board Ring Seines, Out Board Gill Nets and Non-Mechanised Gill Nets were 8.09 %, 10.78 %, 2.73 % and 2.53% respectively.

The scads were the major component of carangids landed along the Malabar area forming 52.44 %, of the total carangid landings, followed by trevallys (16.07 %), horse mackerel (11.76.%), jacks (10.25 %), other carangids (7.90 %) and leather jackets (1.58 %).

18 species of carangids were found in the fishery. Based on the annul yields of respective categories it was seen that *Decapterus russelli* formed 34.07 %, followed by *Decapterus macrosoma* 12.44 %, *Megalaspis cordyla* (11.76 %), *Uraspis helvola* (10.25 %), *Carangoides malabaricus* (8.19 %), and the remaining 23.3 % was contributed by *Alepes djedaba, Alepes melanoptera, Alepes vari, Atule mate, Carangoides ferdau, Carangoides caeruleopinnatus, Carangoides fulvoguttatus, Caranx melampygus, Caranx sexfasciatus, Scomberoides commersonnianus, Scomberoides tol* and other carangids. *Decapterus russelli, Decapterus macrosoma, Megalaspis cordyla* and *Carangoides malabaricus* were the dominant species found in the trawl catches. *Carangoides malabaricus, Carangoides fulvoguttatus* and *Megalaspis cordyla* were the important species of carangids found in the hooks and lines. *Decapterus russelli, Carangoides malabaricus, Uraspis helvola* and *Caranx kalla* dominated the ring seine catches, while in the gill nets *Caranx melampygus* and *Uraspis helvola* were the dominant species of carangids landed.

The catch and catch rates of carangids were higher in Multi Day Trawl Nets and Mini Trawl Nets. The catch rate of *Decapterus russelli, Carangoides malabaricus, Megalaspis cordyla* and *Uraspis helvola* was higher in the trawl nets. Higher catch rate was recorded for *Carangoides malabaricus, Carangoides fulvoguttatus* in the Hooks and Line. In the ring seines higher catch rate was recorded for scads and they were available in good quantities during monsoon season. Trevallys had the higher catch rate in the gill

nets after the monsoon season. Mechanisation and Motorisation of the traditional crafts in the area can be considered as one of the chief factors responsible for higher catch as well as good catch rates of carangids.

From the present study its is quite evident that the carangids form one of the important components of the marine fishery resources in the Malabar region on account of their continuous availability and appreciable catch rates. Even though carangids are represented by a variety of species, the abundant among them is *Decapterus russelli*, *Decapterus macrosoma*, *Megalaspis cordyla*, *Carangoides malabaricus*, *Caranx kalla* and *Uraspis helvola*. The landings of large species of carangids are seasonal, but they are highly relished table fishes, hence they have very good economic importance. The landing of *Decapterus russelli* in appreciable quantities throughout the year makes this as the most important component of the carangid fishery in the Malabar region.

Table 5.1. Monthwise marine landing (t) during 2000-01 and 2001-02

Months	2000-01	2001-02	Average
Sep	3462	2454	2958
Oct	5599	4755	5177
Nov	4184	5291	4738
Dec	5339	6757	6048
Jan	6973	6553	6763
Feb	6840	6425	6633
Mar	7492	8631	8062
Aprl	6186	7601	6894
May	6198	15376	10787
Jun	7141	6560	6851
July	345	539	442
Aug	3455	3773	3614
Total	**63214**	**74715**	68965

Table 5.2.1. Gearwise annual landing (t) of different groups of carangids during 2000-01

Gear/Groups	MDTN	MTN	H & L	OBRS	OBGN	NMGN	Total
Horse mackerel	250	143	41	104	32	0	570
Scads	1429	309	7	2	0	0	1747
Leather jackets	41	1	0	0	0	0	42
Trevallys	163	153	408	80	67	18	889
Jacks	183	219	24	263	33	3	725
Other carangids	156	94	102	66	26	158	602
Carangids total	2222	919	582	515	158	179	4575
Total	28131	19833	2671	10206	1683	690	63214
Effort (Units)	14423	20122	12918	24692	15887	9930	97972

Table 5.2.2. Gearwise annual landing (t) of different groups of carangids during 2001-02

Gear/Groups	MDTN	MTN	H & L	OBRS	OBGN	NMGN	Total
Horse mackerel	315	131	48	83	33	0	610
Scads	2726	318	24	433	6	6	3513
Leather jackets	117	1	0	0	0	0	118
Trevallys	167	302	132	27	42	52	722
Jacks	106	172	3	11	4	6	302
Other carangids	55	58	22	14	30	11	190
Carangids total	3486	982	229	568	115	75	5455
Total	39727	19707	1918	10914	1754	695	74715
Effort (Units)	13657	15147	5773	17003	12730	8515	72824

Table 5.2.3. Gearwise average annual landing (t) of different groups of carngids during 2000-01 and 2001-02

Gear/Groups	MDTN	MTN	H & L	OBRS	OBGN	NMGN	Total
Horse mackerel	283	137	45	94	33	0	590
Scads	2078	313	16	218	3	3	2630
Leather jackets	79	1	0	0	0	0	80
Trevallys	165	228	270	54	55	35	806
Jacks	145	196	14	137	19	5	514
Other carangids	106	76	62	40	28	85	396
Carangids total	2852	951	406	542	137	127	5015
Total	33929	19770	2295	10560	1719	693	68965
Effort(Units)	14040	17635	9346	20848	14309	9223	85398

Table 5.3. Annual marine catch (t) and composition of different groups of carangids during 2000-01 and 2001-02

Group/Year	2000-01	2001-02	Average
Horse mackerel	570	610	590
Scads	1747	3513	2630
Leather jackets	42	118	80
Trevallys	889	722	806
Jacks	725	302	514
Other carangids	602	190	396
Carangids total	4575	5455	5015
Total	63214	74715	68965
Non-carangids	58639	69250	63945
Effort(Units)	97972	72824	85398

Fig. 5.4.1. Average composition of different groups of carangids during 2000-01 and 2001-02

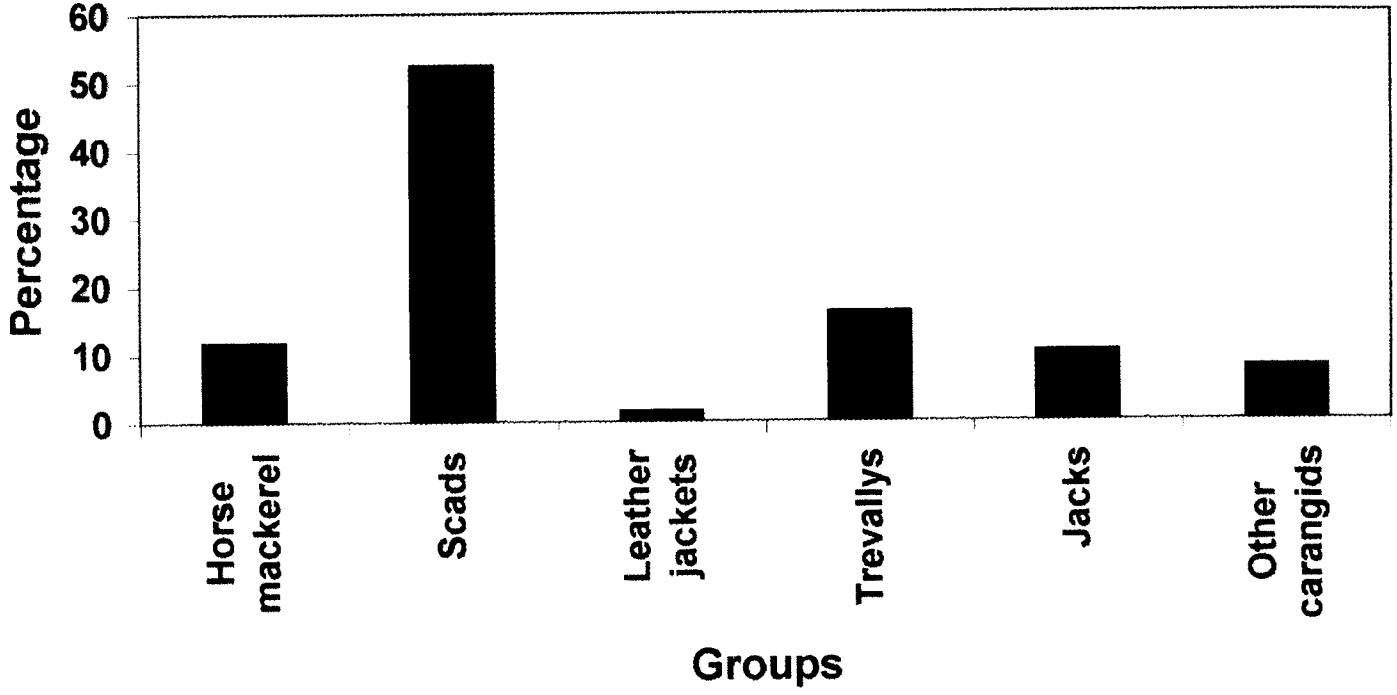


Table 5.5.1.1. Monthwise landing (t) of carangids in MDTN during 2000-01

Month/species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	1187	2145	1567	1348	1017	996	1093	1547	1297	784	0	1442	14423
Scads													
D. russelli	14	216	150	188	-	-	-	181	166	198	-	-	1113
D. macrosoma	-	15	15	58	-	-	-	15	45	17	-	31	196
A. djedaba	-	4	2	5	-	-	-	-	-	-	-	-	11
A. melanoptera	-	2	6	7	-	-	-	2	-	-	-	-	17
A. vari	-	2	8	5	-	-	-	2	-	-	-	-	17
A. mate	-	5	-	-	-	-	-	4	-	-	-	-	9
C. kalla	-	18	17	9	-	-	-	20	-	2	-	-	66
Scads total	**14**	**262**	**198**	**272**	-	-	-	**224**	**211**	**217**	-	**31**	**1429**
Trevallys													
C. ferdau	4	2	2	-	2	9	-	-	-	-	-	-	19
C. malabaricus	8	5	1	4	2	14	10	10	22	4	-	19	99
C. caeruleopinnatus	-	10	2	2	1	-	-	12	5	13	-	-	45
C. fulvoguttatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys total	**12**	**17**	**5**	**6**	**5**	**23**	**10**	**22**	**27**	**17**	-	**19**	**163**
Horse mackerel													
M. codyla	31	2	2	2	60	46	53	-	-	30	-	24	250
Horse mackerel total	31	**2**	**2**	**2**	**60**	**46**	**53**	-	-	**30**	-	**24**	**250**
Leather jackets													
S . commersonnianus	-	15	-	-	-	-	-	1	2	-	-	-	18
S. tol	-	-	19	-	-	2	-	2	-	-	-	-	23
Leather jackets total	-	15	19	-	-	2	-	3	2	-	-	-	**41**
Jacks													
U. helvola	1	4	50	54	8	2	27	12	12	12	-	1	183
Jacks total	1	4	50	54	8	2	27	12	12	12	-	1	183
Other carangids	1	5	34	42	5	4	2	27	8	25	-	3	156
Carangids total	59	305	308	376	78	77	95	288	260	289	-	79	2222
Non Carangids	2060	3385	2702	3540	502	492	529	2721	3453	3986	-	2523	25909
Total catch	2143	3736	3010	3870	580	569	624	3009	3713	4275	-	2602	28131

Table 5.5.1.2. Monthwise landing (t) of carangids in MDTN during 2001-02

Months/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	824	1247	1547	1374	955	936	1353	1857	1587	1247	0	730	13657
Scads													
D. russelli	13	180	214	315	-	-	-	124	615	12	-	21	1494
D. macrosoma	-	14	12	54	-	-	-	14	922	-	-	-	1016
A. djedaba	-	12	24	42	-	-	-	18	-	-	-	-	96
A. melanoptera	-	17	3	-	-	-	-	-	-	-	-	-	20
A. vari	-	10	-	-	-	-	-	-	-	-	-	-	10
A. mate	-	-	-	12	-	-	-	-	-	-	-	-	12
C. kalla	-	-	-		-	-	-	54	24	-	-	-	78
Scads total	**13**	**233**	**253**	**423**	**-**	**-**	**-**	**210**	**1561**	**12**	**-**	**21**	**2726**
Trevallys													
C.f erdau	-	-	2	2	-	-	3	6	5	-	-	-	18
C. malabaricus	-	5	6	19	8	5	7	2	24	14	-	-	92
C. caeruleopinnatus	-	-	-	5	-	-	-	-	13	-	-	-	18
C. fulvoguttatus	-	-	-	4	-	-	-	-	5	-	-	-	9
C. melampygus	-	-	-	4	-	-	-	-	4	-	-	-	8
C. sexfasciatus	-	-	-	4	-	-	-	-	2	-	-	-	6
S. nigrofasciata	-	-	2	8	-	-	-	-	6	-	-	-	16
Trevallys total	**2**	**5**	**10**	**46**	**8**	**5**	**10**	**8**	**59**	**14**	**-**	**-**	**167**
Horse mackerel													
M. codyla	-	27	28	40	2	2	2	56	144	14	-	-	315
Horse mackerel total	-	**27**	**28**	**40**	**2**	**2**	**2**	**56**	**144**	**14**	-	-	**315**
Leather jackets	-										-	-	
S . commersonnianus	-	8	-	-	-	-	-	3	60	2	-	-	73
S. tol	-	22	-	-	-	-	-	-	22	-	-	-	44
Leather jackets total	-	**30**	-	-	-	-	-	**3**	**82**	**2**	-	-	**117**
Jacks													
U. helvola	2	4	4	68	2	4	2	2	12	2	-	4	106
Jacks total	**2**	**4**	**4**	**68**	**2**	**4**	**2**	**2**	**12**	**2**	-	**4**	**106**
Other carangids	2	2	2	-	8	5	5	2	12	15	-	2	55
Carangids total	**19**	**299**	**297**	**577**	**20**	**16**	**19**	**281**	**1858**	**44**	**-**	**27**	**3486**
Non Carangids	1952	45352	3315	4531	525	518	58	4292	41944	3917	-	34759	36241
Total catch	**1971**	**3325**	**3612**	**5108**	**545**	**534**	**77**	**4573**	**12884**	**3976**	**-**	**3122**	**39727**

Table 5.5.1.3. Monthwise average landing (t) of carangids in MDTN during 2000-01 and 2001-02

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	1006	1696	1557	1361	986	966	1223	1702	1442	1015.5	0	1086	14040
Scads													
D. russelli	14	198	182	252	-	-	-	153	391	105	-	11	1304
D. macrosoma	-	15	14	56	-	-	-	15	484	9	-	16	606
A. djedaba	-	8	13	24	-	-	-	9	-	-	-	-	54
A. melanoptera	-	10	5	4	-	-	-	1	-	-	-	-	19
A. vari	-	6	4	3	-	-	-	1	-	-	-	-	14
A. mate	-	3	-	6	-	-	-	2	-	-	-	-	11
C. kalla	-	9	9	5	-	-	-	37	12	1	-	-	72
Scads total	**14**	**248**	**226**	**348**	**-**	**-**	**-**	**217**	**886**	**115**	**-**	**26**	**2079**
Trevallys													
C. ferdau	2	1	2	1	1	5	2	3	3	-	-	-	19
C. malabaricus	5	5	4	12	5	10	9	6	23	9	-	10	96
C. caeruleopinnatus	-	5	1	4	1	-	-	6	9	7	-	-	32
C. fulvoguttatus	-	-	-	2	-	-	-	-	3	-	-	-	5
C. melampygus	-	-	-	2	-	-	-	-	2	-	-	-	4
C. sexfasciatus	-	-	-	2	-	-	-	-	1	-	-	-	3
S. nigrofasciata	-	-	1	4	-	-	-	-	3	-	-	-	8
Trevallys total	**7**	**11**	**8**	**26**	**7**	**14**	**10**	**15**	**41**	**16**	**-**	**10**	**165**
Horse mackerel													
M. codyla	16	15	15	21	31	24	27	28	72	22	-	12	283
Horse mackerel total	**16**	**15**	**15**	**21**	**31**	**24**	**27**	**28**	**72**	**22**	**-**	**12**	**283**
Leather jackets													
S. commersonnianus	-	11	-	-	-	-	-	2	31	1	-	-	45
S. tol	-	11	10	-	-	1	-	1	11	-	-	-	34
Leather jackets total	**-**	**22**	**10**	**-**	**-**	**1**	**-**	**3**	**42**	**1**	**-**	**-**	**79**
Jacks													
U. helvola	2	4	26	61	5	3	15	7	12	7	-	3	145
Jacks total	**2**	**4**	**26**	**61**	**5**	**3**	**15**	**7**	**12**	**7**	**-**	**3**	**145**
Other carangids	2	**4**	**16**	**21**	**7**	**5**	**4**	**14**	**10**	**20**	**-**	**3**	**106**
Carangids total	**41**	**304**	**301**	**477**	**50**	**47**	**57**	**284**	**1063**	**181**	**-**	**52**	**2854**
Non carangids	2018	3228	3009	4013	514	505	295	3507	7234	3946	-	2810	31075
Total catch	**2059**	**3532**	**3310**	**4490**	**564**	**552**	**351**	**3791**	**8297**	**4127**	**-**	**2862**	**33929**

Table 5.5.2.1. Monthwise landing (t) of carangids in MTN during 2000-01

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	7	1654	1740	874	2587	4358	3587	2547	1874	885	0	9	20122
Scads													
D. russelli	-	6	5	6	18	10	145	2	40	2	-	2	236
D. macrosoma	-	-	-	-	-	-	4	-	4	-	-	-	8
A. djedaba	-	-	-	-	-	-	6	-	-	-	-	-	6
A. melanoptera	-	-	-	-	-	-	7	-	-	-	-	-	7
A. vari	-	-	-	-	-	-	7	-	-	-	-	-	7
A. mate	-	-	-	-	-	-	18	-	-	-	-	-	18
C. kalla	-	-	-	-	-	7	12	-	8	-	-	-	27
Scads total	**-**	**6**	**5**	**6**	**18**	**17**	**199**	**2**	**52**	**2**	**-**	**2**	**309**
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	-	-	-	-	6	19	23	-	-	-	-	8	56
C. caeruleopinnatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. fulvoguttatus	-	5	5	2	-	-	-	-	-	-	-	2	14
C. melampygus	-	-	-	-	-	-	2	25	54	2	-	-	83
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys total	**-**	**5**	**5**	**2**	**6**	**19**	**25**	**25**	**54**	**2**	**-**	**10**	**153**
Horse mackerel													
M. codyla	-	-	-	-	18	18	20	75	-	12	-	-	143
Horse mackerel total	**-**	**-**	**-**	**-**	**18**	**18**	**20**	**75**	**-**	**12**	**-**	**-**	**143**
Leather jackets							-						
S . commersonnianus	-	-	-	-	-	1	-	-	-	-	-	-	1
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
Jacks													
U. helvola	-	4	12	8	8	81	58	12	32	4	-	-	219
Jacks total	**-**	**4**	**12**	**8**	**8**	**81**	**58**	**12**	**32**	**4**	**-**	**-**	**219**
Other carangids	**-**	**21**	**7**	**21**	**24**	**21**	**-**	**-**	**-**	**-**	**-**	**-**	**94**
Carangids total	-	**36**	**29**	**37**	**74**	**157**	**302**	**114**	**138**	**20**	-	**12**	**919**
Non-carangids	5	844	680	874	3323	3170	3347	2337	1732	2134	-	468	18914
Total catch	5	880	709	911	3397	3327	3649	2451	1870	2154	-	480	19833

Table 5.5.2.2. Monthwise landing (t) of carangids in MTN during 2001-02

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	July	Aug	Annual
Effort	6	922	2088	2952	1587	1457	1754	1254	1860	1257	0	10	15147
Scads													
D. russelli	-	5	-	7	10	1	25		152	2	-	12	214
D. macrosoma	-	-	-	-	1		5		5	-	-	-	11
A. djedaba	-	-	-	-	-	-	-	-	2	-	-	-	2
A. melanoptera	-	-	-	-	-	-	-	-	2	-	-	-	2
A. vari	-	-	-	-	-	-	-	-	4	-	-	-	4
A. mate	-	-	-	-	-	-	-	-	5	-	-	2	7
C. kalla	-	-	6	-	26	15	17	2	10	2	-	-	78
Scads total	**-**	**5**	**6**	**7**	**37**	**16**	**47**	**2**	**180**	**4**	**-**	**14**	**318**
Trevallys													
C. ferdau	-	-	7	4	1	5	2	2	2	-	-	-	23
C. malabaricus	-	2	5	25	-	45	42	45	45	-	-	-	209
C. caeruleopinnatus	-	-	-	5	1	12	-	1	2	-	-	-	21
C. fulvoguttatus	-	-	-	7	2	-	-	-	2	-	-	-	11
C. melampygus	-	-	-	4	2	-	6	-	3	-	-	-	15
C. sexfasciatus	-	-	-	-	4	-	4	-	-	-	-	-	8
S. nigrofasciata	-	-	-	-	5	6	4	-	-	-	-	-	15
TrevallysTotal	**-**	**2**	**12**	**45**	**15**	**68**	**58**	**48**	**54**	**-**	**-**	**-**	**302**
Horse mackerel													
M. codyla	-	-	-	-	17	17	24	5	64	4	-	-	131
Horse mackerel total	**-**	**-**	**-**	**-**	**17**	**17**	**24**	**5**	**64**	**5**	**-**	**-**	**131**
Leather jackets													
S . commersonnianus	-	-	-	-	1	-	-	-	-	-	-	-	1
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
Jacks													
U. helvola	-	2	10	5	18	45	12	68	12	-	-	-	172
Jacks total	**-**	**2**	**10**	**5**	**18**	**45**	**12**	**68**	**12**	**-**	**-**	**-**	**172**
Other carangids	**-**	**3**	**6**	**10**	**-**	**16**	**-**	**16**	**7**	**-**	**-**	**-**	**58**
Carangids total	**-**	**12**	**34**	**67**	**88**	**162**	**141**	**139**	**316**	**9**	**-**	**14**	**982**
Non-carangids	5	771	816	1135	3105	2965	4383	2164	1385	1994	-	3	18726
Total catch	**5**	**783**	**850**	**1202**	**3193**	**3127**	**4524**	**2303**	**1701**	**2003**	**-**	**17**	**19707**

Table 5.5.2.3. Monthwise average landing (t) of carangids in MTN during 2000-01 and 2001-02

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	7	1288	1914	1913	2087	2908	2671	1901	1867	1071	0	10	17635
Scads													
D. russelli	-	5	3	7	14	6	84	1	96	2	-	7	225
D. macrosoma	-	-	-	-	1	-	4	-	5	-	-	-	10
A. djedaba	-	-	-	-	-	-	3	-	1	-	-	-	4
A. melanoptera	-	-	-	-	-	-	4	-	1	-	-	-	5
A. vari	-	-	-	-	-	-	4	-	2	-	-	-	6
A. mate	-	-	-	-	-	-	9	-	3	-	-	1	13
C. kalla	-	-	3	-	13	11	15	1	9	1	-	-	53
Scads total	-	**5**	**6**	**7**	**28**	**17**	**122**	**2**	**116**	**3**	-	**8**	**314**
Trevallys													
C. ferdau	-	-	4	2	1	3	1	1	1	-	-	-	13
C. malabaricus	-	1	3	13	3	32	33	23	23	-	-	4	135
C. caeruleopinnatus	-	-	-	3	1	6	-	1	1	-	-	-	11
C. fulvoguttatus	-	3	3	5	1	-	-	-	1	-	-	1	13
C. melampygus	-	-	-	2	1	-	4	13	29	1	-	-	49
C. sexfasciatus	-	-	-	-	2	-	2	-	-	-	-	-	4
S. nigrofasciata	-	-	-	-	3	3	2	-	-	-	-	-	8
Trevallys total	-	**4**	**9**	**24**	**11**	**44**	**42**	**37**	**54**	**1**	-	**5**	**228**
Horse mackerel													
M. codyla	-	-	-	-	18	18	22	40	32	8	-	-	137
Horse mackerel total	-	-	-	-	**18**	**18**	**22**	**40**	**32**	**8**	-	-	**137**
Leather jackets													
S . commersonnianus	-	-	-	-	1	1	-	-	-	-	-	-	2
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	**1**	**1**	-	-	-	-	-	-	**2**
Jacks													
U. helvola	-	3	11	7	13	63	35	40	22	2	-	-	196
Jacks total	-	**3**	**11**	**7**	**13**	**63**	**35**	**40**	**22**	**2**	-	-	**196**
Other carangids	-	**12**	**7**	**16**	**12**	**19**	**0**	**8**	**4**	-	-	-	**76**
Carangids total	-	**24**	**32**	**52**	**81**	**160**	**222**	**127**	**227**	**15**	-	**13**	**982**
Non-carangids	5	808	748	1005	3214	3068	3865	2251	1559	2064	-	236	18725
Total catch	5	832	780	1057	3295	3228	4087	2378	1786	2079	-	249	19707

Table 5.5.3.1. Monthwise landing (t) of carangids in H & L during 2000-01

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	4275	1614	1300	1672	77	76	83	503	818	497	1247	756	12918
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	2	-	2
A. melanoptera	-	-	-	-	-	-	-	-	-	-	5	-	5
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**7**	**0**	**7**
Trevallys													
C. ferdau	2	-	-	-	-	-	-	-	-	-	-	-	2
C. malabaricus	84	1	-	-	-	-	-	-	3	4	15	12	119
C. caeruleopinnatus	8	-	-	-	-	-	-	-	-	4	14	14	40
C. fulvoguttatus	15	-	-	-	-	-	-	-	-	-	54	54	123
C. melampygus	15	-	-	-	-	-	-	-	4	-	14	14	47
C. sexfasciatus	18	-	-	-	-	-	-	-	-	-	8	10	36
S. nigrofasciata	27	-	-	-	-	-	-	-	-	-	10	4	41
Trevallys total	**169**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**7**	**8**	**115**	**108**	**408**
Horse mackerel													
M. codyla	13	-	-	-	-	-	-	-	-	-	12	16	41
Horse mackerel total	13	-	-	-	-	-	-	-	-	-	12	16	41
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Jacks													
U. helvola	20	-	-	-	-	-	-	-	2	-	2	0	24
Jacks total	**20**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**0**	**24**
Other carangids	91	-	1	1	-	-	-	-	9	-	-	-	102
Carangids total	**293**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**18**	**8**	**136**	**124**	**582**
Non carangids	702	520	253	263	12	21	14	86	109	99	-	-	2089
Total catch	995	521	254	264	12	21	14	86	127	107	**136**	**134**	**2671**

Table 5.5.3.2. Monthwise landing (t) of carangids in H & L during 2001-02

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	393	358	1560	507	72	71	102	702	447	89	218	1254	5773
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	9	-	-	-	-	-	-	-	-	-	-	-	9
A. melanoptera	-	-	2	-	-	-	-	-	-	-	-	5	7
A. vari	-	-	4	-	-	-	-	-	-	-	-	4	8
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Sacds Total	**9**	-	**6**	-	-	-	-	-	-	-	-	**9**	**24**
Trevallys													
C. ferdau	4	-	-	-	-	-	-	-	-	-	-	2	6
C. malabaricus	12	-	-	-	-	-	-	-	-	-	-	24	38
C. caeruleopinnatus	14	-	-	-	-	-	-	-	-	-	-	5	19
C. fulvoguttatus	5	-	-	-	-	-	-	-	-	-	-	4	9
C. melampygus	8	-	-	-	-	-	-	-	-	-	-	9	17
C. sexfasciatus	18	-	-	-	-	-	-	-	-	-	-	2	20
S. nigrofasciata	21	-	-	-	-	-	-	-	-	-	-	2	23
Trevallys total	**82**	-	-	-	-	-	-	-	**2**	-	-	**48**	**132**
Horse mackerel													
M. codyla	12	-	-	-	-	-	-	-	-	-	17	19	48
Horse mackerel total	**12**	-	-	-	-	-	-	-	-	-	**17**	**19**	**48**
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jacketsTotal	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	2	-	-	-	-	-	-	-	1	-	-	-	3
Jacks total	**2**	-	-	-	-	-	-	-	**1**	-	-	-	**3**
Other carangids	**5**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**6**	**-**	**-**	**8**	**22**
Carangids total	**110**	**1**	**7**	**1**	**-**	**-**	**-**	**-**	**9**	**-**	**17**	**84**	**229**
Non carangids	75	235	571	87	12	19	58	125	138	18	101	250	1689
Total catch	185	236	578	88	12	19	58	125	147	18	118	334	1918

Table 5.5.3.3. Monthwise average landing (t) of carangids in H & L during 2000-01 and 2001-02

Month/species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	2334	986	1430	1090	75	74	73	603	633	293	733	1005	9346
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	4	-	-	-	-	-	-	-	-	-	1	-	5
A. melanoptera	-	-	1	-	-	-	-	-	-	-	3	3	7
A. vari	-	-	2	-	-	-	-	-	-	-	-	2	4
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	4	-	3	-	-	-	-	-	-	-	4	5	16
Trevallys													
C. ferdau	3	-	-	-	-	-	-	-	-	-	-	1	4
C. malabaricus	46	1	-	-	-	-	-	-	3	2	8	18	78
C. caeruleopinnatus	11	-	-	-	-	-	-	-	-	2	7	10	30
C. fulvoguttatus	10	-	-	-	-	-	-	-	-	-	27	29	66
C. melampygus	12	-	-	-	-	-	-	-	2	-	7	12	33
C. sexfasciatus	18	-	-	-	-	-	-	-	-	-	4	6	28
S. nigrofasciata	24	-	-	-	-	-	-	-	-	-	5	3	32
Trevallys total	124	1	-	-	-	-	-	-	5	4	58	78	270
Horse mackerel													
M. codyla	12	-	-	-	-	-	-	-	-	-	15	17	44
Horse mackerel total	12	-	-	-	-	-	-	-	-	-	15	17	44
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	11	-	-	-	-	-	-	-	2	-	1	-	14
Jacks total	11	-	-	-	-	-	-	-	2	-	1	-	14
Other carangids	48	1	1	1	-	-	-	-	8	-	-	4	62
Carangids total	199	2	4	1	-	-	-	-	15	4	78	104	406
Non carangids	388	378	412	175	12	20	36	106	123	59	50	130	1889
Total catch	587	380	416	176	12	20	36	106	138	63	128	234	2295

Table 5.5.4.1. Monthwise landing (t) of carangids in OBRS during 2000-01

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	1421	2072	1669	2146	1024	1254	868	4115	3141	3616	1239	2127	24692
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	2	-	2
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	-	-	-
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	2	5	2	-	-	45	2	2	4	5	-	-	67
C. caeruleopinnatus	-	-	-	-	-	3	-	-	-	-	-	-	3
C. fulvoguttatus	-	-	-	-	-	10	-	-	-	-	-	-	10
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys total	**2**	**5**	**2**	**-**	**-**	**58**	**2**	**2**	**4**	**5**	**-**	**-**	**80**
Horse mackerel													
M. codyla	-	2	2	3	84	-	-	5	4	4	-	-	104
Horse mackerel total	**-**	2	2	3	84	**-**	**-**	5	4	4	**-**	**-**	**104**
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1	2	1	-	45	54	124	14	2	14	1	5	263
Jacks total	**1**	**2**	**1**	**-**	**45**	**54**	**124**	**14**	**2**	**14**	**1**	**5**	**263**
Other carangids	**1**	**-**	**3**	**8**	**-**	**12**	**20**	**8**	**12**	**2**	**-**	**-**	**66**
Carangids total	**4**	**9**	**8**	**11**	**129**	**124**	**146**	**29**	**22**	**25**	**3**	**5**	**515**
Non carangids	128	63	50	64	2644	2592	2832	388	291	341	112	186	9691
Total catch	**132**	**72**	**58**	**75**	**2773**	**2716**	**2978**	**417**	**313**	**366**	**115**	**191**	**10206**

Table 5.5.4.2. Monthwise landing (t) of carangids in OBRS during 2001-02

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	July	Aug	Annual
Effort	307	1844	2002	2832	895	1257	1587	868	258	863	2219	2071	17003
Scads													
D. russelli	-	-	6	-	136	25	47	-	-	-	147	-	361
D. macrosoma	-	-	-	-	-	-	-	-	-	-	14	-	14
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	4	-	4
A. vari	-	-	-	-	-	-	-	-	-	-	5	-	5
A. mate	-	-	-	-	-	-	-	-	-	-	4	-	4
C. kalla	-	-	-	-	-	-	34	-	-	-	11	-	45
Scads total	**-**	**-**	**6**	**-**	**136**	**25**	**81**	**-**	**-**	**-**	**185**	**-**	**433**
Trevallys							-						
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	2	-	-	6	-	-	-	6	4	1	-	-	19
C. caeruleopinnatus	-	-	-	-	-	-	-	4	2	-	-	-	6
C. fulvoguttatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C.melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	2	-	-	-	-	-	-	-	-	2
Trevallys total	**2**	**-**	**-**	**8**	**-**	**-**	**-**	**10**	**6**	**1**	**-**	**-**	**27**
Horse mackerel													
M. codyla	-	2	2	4	-	-	-	5	66	4	-	-	83
Horse mackerel total	-	2	2	4	-	-	-	5	66	4	-	-	83
Leather jackets							-						
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1	-	5	-	-	-	-	2	2	1	-	-	11
Jacks total	1	-	5	-	-	-	-	2	2	1	-	-	11
Other carangids	**6**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**	**-**	**14**
Carangids total	**9**	**4**	**15**	**12**	**136**	**25**	**81**	**18**	**76**	**7**	**185**	**-**	**568**
Non carangids	112	60	54	87	2470	2528	3611	373	407	333	119	192	10346
Total catch	**121**	**64**	**69**	**99**	**2606**	**2553**	**3692**	**391**	**483**	**340**	**304**	**192**	**10914**

Table 5.5.4.3. Monthwise average landing (t) of carangids in OBRS during 2000-01 and 2001-02

Month/species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	864	1958	1836	2489	959.5	1256	1228	2492	1700	2240	1729	2099	20848
Scads													
D. russelli	-	-	3	-	68	13	24	-	-	-	75	-	183
D. macrosoma	-	-	-	-	-	-	-	-	-	-	7	-	7
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	2	-	2
A. vari	-	-	-	-	-	-	-	-	-	-	3	-	3
A. mate	-	-	-	-	-	-	-	-	-	-	2	-	2
C. kalla	-	-	-	-	-	-	17	-	-	-	6	-	23
Scads total	**-**	**-**	**3**	**-**	**68**	**13**	**41**	**-**	**-**	**-**	**93**	**-**	**218**
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	2	3	1	3	-	21	1	4	4	3	-	-	43
C. caeruleopinnatus	-	-	-	-	-	2	-	2	1	-	-	-	5
C. fulvoguttatus	-	-	-	-	-	5	-	-	-	-	-	-	5
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	1	-	-	-	-	-	-	-	-	1
Trevallys total	**2**	**3**	**1**	**4**	**-**	**29**	**1**	**6**	**5**	**3**	**-**	**-**	**54**
Horse mackerel													
M. codyla	-	2	2	4	42	-	-	5	35	4	-	-	94
Horse mackerel total	**-**	**2**	**2**	**4**	**42**	**-**	**-**	**5**	**35**	**4**	**-**	**-**	**94**
Leather jacket													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1	1	3	-	23	27	62	8	2	2	1	3	137
Jacks total	**1**	**1**	**3**	-	**23**	**27**	**62**	**8**	**2**	**2**	**1**	**3**	**137**
Other carangids	**1**	**1**	**3**	**4**	**-**	**6**	**10**	**5**	**7**	**2**	**-**	**-**	**39**
Carangids total	**4**	**7**	**12**	**12**	**134**	**75**	**114**	**24**	**49**	**11**	**94**	**3**	**542**
Non carangids	120	62	52	76	2557	2560	3222	381	349	337	95	174	10018
Total catch	**124**	**68**	**64**	**87**	**2691**	**2632**	**3335**	**404**	**398**	**353**	**210**	**191**	10560

Table 5.5.5.1. Monthwise landing (t) of carangids in OBGN during 2000-01

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	897	1766	625	2090	1847	1809	1985	1359	868	985	782	874	15887
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	-	-	-
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
ScadsTotal	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	1	-	-	-	4	5	8	6	6	6	2	4	42
C. caeruleopinnatus	-	-	-	-	2	3	7	1	-	-	-	-	13
C. fulvoguttatus	-	-	-	-	4	-	-	-	-	-	-	-	4
C. melampygus	-	-	-	-	4	-	-	-	-	-	-	-	4
C. sexfasciatus	-	-	-	-	2	-	-	-	-	-	-	-	2
S. nigrofasciata	-	-	-	-	2	-	-	-	-	-	-	-	2
Trevallys total	**1**	**-**	**-**	**-**	**18**	**8**	**15**	**7**	**6**	**6**	**2**	**4**	**67**
Horse mackerel													
M. codyla	-	-	-	-	11	10	11	-	-	-	-	-	32
Horse mackerel total	**-**	**-**	**-**	**-**	**11**	**10**	**11**	**-**	**-**	**-**	**-**	**-**	**32**
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1	-	-	-	1	5	2	21	1	2	-	-	33
Jacks total	**1**	**-**	**-**	**-**	**1**	**5**	**2**	**21**	**1**	**2**	**-**	**-**	**33**
Other carangids	1	-	-	-	1	7	5	10	-	-	2	-	26
Carangids total	**3**	**-**	**-**	**-**	**31**	**30**	**33**	**38**	**7**	**8**	**4**	**4**	**168**
Non carangids	59	160	129	166	126	124	136	173	154	177	50	71	1525
Total catch	**62**	**160**	**129**	**166**	**157**	**154**	**169**	**211**	**161**	**185**	**54**	**75**	**1683**

Table 5.5.5.2. Monthwise landing (t) of carangids in OBGN during 2001-02

Month/species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	July	Aug	Annual
Effort	825	1766	850	758	1736	1700	1427	557	334	916	987	874	12730
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	6	-	-	-	-	-	-	-	-	-	6
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	**-**	**-**	**6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6**
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	2	-	-	-	-	12	-	-	4	-	2	5	25
C. caeruleopinnatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. fulvoguttatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. melampygus	-	-	-	-	-	-	-	-	2	-	-	-	2
C. sexfasciatus	-	-	-	-	-	-	-	-	4	-	-	-	4
S. nigrofasciata	-	-	-	-	-	6	-	-	5	-	-	-	11
Trevallys total	2	-	-	-	-	18	-	-	15	-	2	5	42
Horse mackerel													
M. codyla	-	-	-	-	10	10	13	-	-	-	-	-	33
Horse mackerel total	**-**	**-**	**-**	**-**	**10**	**10**	**13**	**-**	**-**	**-**	**-**	**-**	**33**
Leather jackets	-	-	-	-									
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1	-	-	-	-	-	-	-	2	-	1	-	4
Jacks total	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**	**4**
Other carangids	-	-	-	-	18	-	7	1	2	-	-	-	28
Carangids total	**3**	**-**	**6**	**-**	**28**	**28**	**20**	**1**	**19**	**-**	**3**	**5**	**115**
Non carangids	54	142	148	219	119	116	189	197	127	172	73	85	1639
Total catch	**57**	**142**	**154**	**219**	**147**	**144**	**209**	**198**	**146**	**172**	**76**	**90**	**1754**

Table 5.5.5.3. Monthwise average landing (t) of carangids in OBGN during 2000-01 and 2001-02

Month/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	861	1766	737.5	1424	1792	1755	1706	958	601	950.5	884.5	874	14309
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	3	-	-	-	-	-	-	-	-	-	3
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	-	-	**3**	-	-	-	-	-	-	-	-	-	**3**
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	2	-	-	-	2	9	4	3	5	3	2	5	35
C. caeruleopinnatus	-	-	-	-	1	2	4	1	-	-	-	-	8
C. fulvoguttatus	-	-	-	-	2	-	-	-	-	-	-	-	2
C. melampygus	-	-	-	-	2	-	-	-	1	-	-	-	3
C. sexfasciatus	-	-	-	-	1	-	-	-	2	-	-	-	3
S. nigrofasciata	-	-	-	-	1	3	-	-	3	-	-	-	7
Trevallys total	**2**	-	-	-	**9**	**13**	**8**	**4**	**11**	**3**	**2**	**5**	**57**
Horse mackerel													
M. codyla	-	-	-	-	11	10	12	-	-	-	-	-	33
Horse mackerel total	-	-	-	-	**11**	**10**	**12**	-	-	-	-	-	**33**
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1	-	-	-	1	3	1	11	2	1	1	-	19
Jacks total	**1**	-	-	-	**1**	**3**	**1**	**11**	**2**	**1**	**1**	-	**19**
Other carangids	1	-	-	-	10	4	6	6	1	-	1	-	28
Carangids total	**3**	-	**3**	-	**30**	**29**	**27**	**20**	**13**	**4**	**4**	**5**	**137**
Non carangids	57	151	139	193	123	120	163	185	141	175	62	78	1582
Total catch	**60**	**151**	**142**	**193**	**153**	**149**	**190**	**205**	**154**	**179**	**66**	**83**	**1719**

Table 5.5.6.1. Monthwise landing (t) of carangids in NMGN during 2000-01

Month/species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	784	952	461	425	1247	647	742	467	1024	1540	954	687	9930
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	-	-	-
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	-	-	-	5	5	-	4	4	-	-	-	-	18
C. caeruleopinnatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. fulvoguttatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys total	-	-	-	5	5	-	4	4	-	-	-	-	18
Horse mackerel													
M. codyla	-	-	-	-	-	-	-	-	-	-	-	-	-
Horse mackerel total	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets		-	-	-	-	-	-	-	-	-	-	-	-
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	-	-	-	1	-	1	1	-	-	-	-	-	3
Jacks total	-	-	-	1	-	1	1	-	-	-	-	-	3
Other carangids	-	152	2	1	-	-	-	-	1	2	-	-	158
Carangids total	-	152	2	7	5	1	5	4	1	2	-	-	179
Non carangids	125	78	22	24	35	38	38	8	13	52	54	24	511
Total catch	125	230	24	31	40	39	43	12	14	54	54	24	690

Table 5.5.6.2. Monthwise landing (t) of carangids in NMGN during 2001-02

Month/species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	July	Aug	Annual
Effort	871	758	886	458	863	824	640	438	184	432	1336	824	8515
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	6	-	-	-	-	-	-	-	-	-	6
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	**-**	**-**	**6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6**
Trevallys													
C. ferdau	-	2	-	-	-	-	-	-	-	-	-	-	2
C. malabaricus	-	4	-	5	5	4	6	-	4	2	-	-	30
C. caeruleopinnatus	-	2	-	2	-			-			-	-	4
C. fulvoguttatus	-	3	-	-	-	-	-	-	-	-	-	-	3
C. melampygus	-	5	-	-	-	-	-	-	-	-	-	-	5
C. sexfasciatus	-	4	-	-	-	-	-	-	-	-	-	-	4
S. nigrofasciata	-	4	-	-	-	-	-	-	-	-	-	-	4
Trevallys total	**-**	**24**	**-**	**7**	**5**	**4**	**6**	**0**	**4**	**2**	**0**	**-**	**52**
Horse mackerel													
M. codyla	-	-	-	-	-	-	-	-	-	-	-	-	-
Horse mackerel total	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jacket													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks	-												
U. helvola	-	2	2	-	2	-	-	-	-	-	-	-	6
Jacks total	**-**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6**
Other carangids	**-**	**9**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**11**
Carangids total	**-**	**35**	**8**	**9**	**7**	**4**	**6**	**-**	**4**	**2**	**-**	**-**	**75**
Non carangids	115	170	20	32	30	32	47	11	11	48	76	28	620
Total catch	**115**	**205**	**28**	**41**	**37**	**36**	**53**	**11**	**15**	**50**	**76**	**28**	**695**

Table 5.5.6.3. Monthwise average landing (t) of carangids in NMGN during 2000-01 and 2001-02

Month/species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Effort	828	855	674	442	1055	736	691	453	604	986	1145	756	9223
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	3	-	-	-	-	-	-	-	-	-	3
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	-	-	3	-	-	-	-	-	-	-	-	-	3
Trevallys													
C. ferdau	-	1	-	-	-	-	-	-	-	-	-	-	1
C. malabaricus	-	2	-	5	5	2	5	2	2	1	-	-	24
C. caeruleopinnatus	-	1	-	1	-	-	-	-	-	-	-	-	2
C. fulvoguttatus	-	2	-	-	-	-	-	-	-	-	-	-	2
C. melampygus	-	3	-	-	-	-	-	-	-	-	-	-	3
C. sexfasciatus	-	2	-	-	-	-	-	-	-	-	-	-	2
S. nigrofasciata	-	2	-	-	-	-	-	-	-	-	-	-	2
Trevallys total	-	12	-	6	5	2	5	2	2	1	-	-	35
Horse mackerel													
M. codyla	-	-	-	-	-	-	-	-	-	-	-	-	-
Horse mackerel total	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	-	1	1	1	1	1	1	-	-	-	-	-	6
Jacks total	-	1	1	1	1	1	1	-	-	-	-	-	6
Other carangids	-	81	1	2	-	-	-	-	1	1	-	-	86
Carangids total	-	95	5	9	6	3	6	2	3	2	-	-	127
Non carangids	120	124	21	28	33	35	43	10	12	50	65	26	566
Total catch	120	219	26	37	39	38	49	12	15	52	65	26	693

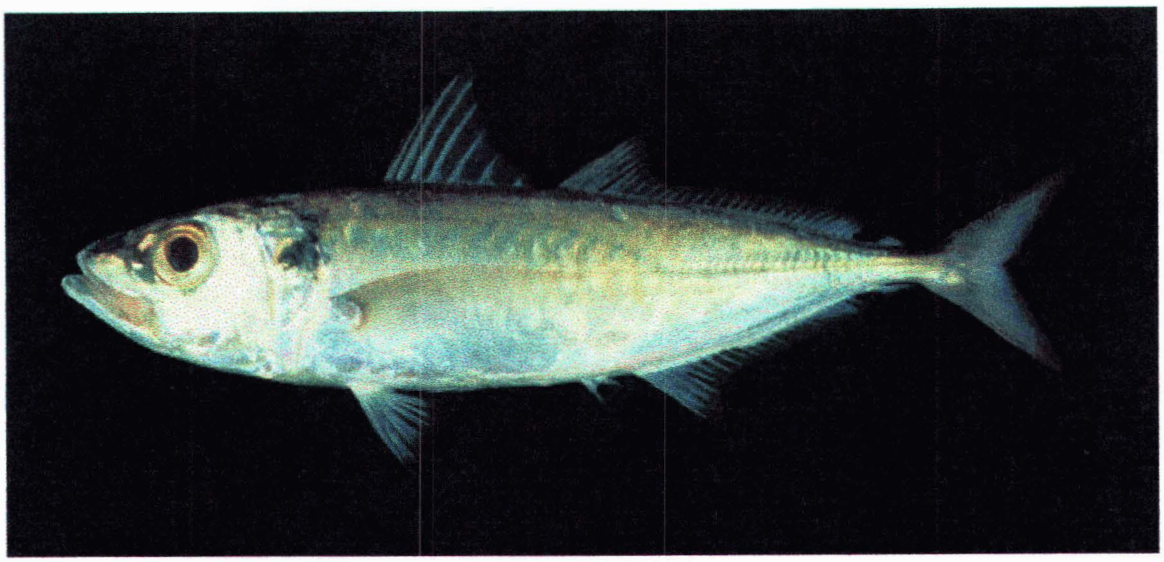


Plate 5.6.1. *Decapterus russelli* (Ruppell)

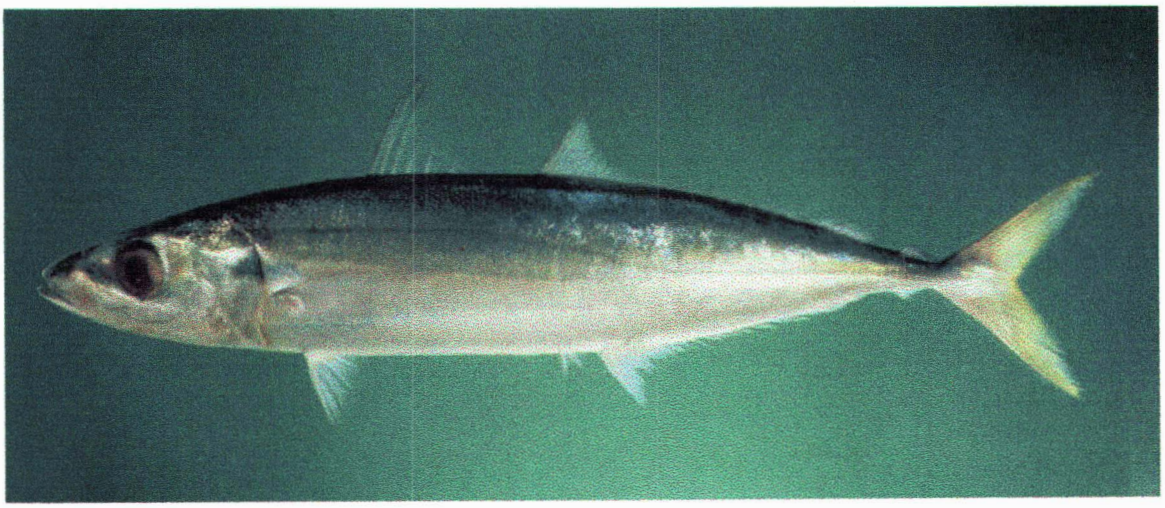


Plate 5.6.2. *Decapterus macrosoma* (Bleeker)

Plate 5.6.3. *Alepes djedaba* (Forsskal)

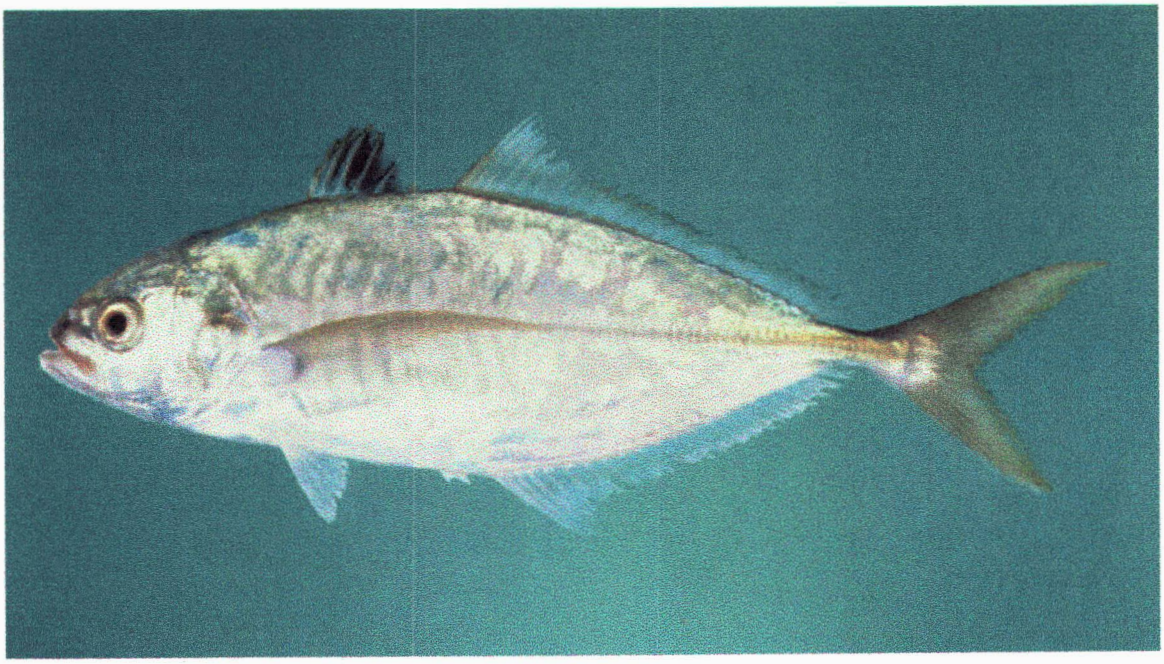


Plate 5.6.4. *Alepes melanoptera* (Swainson)

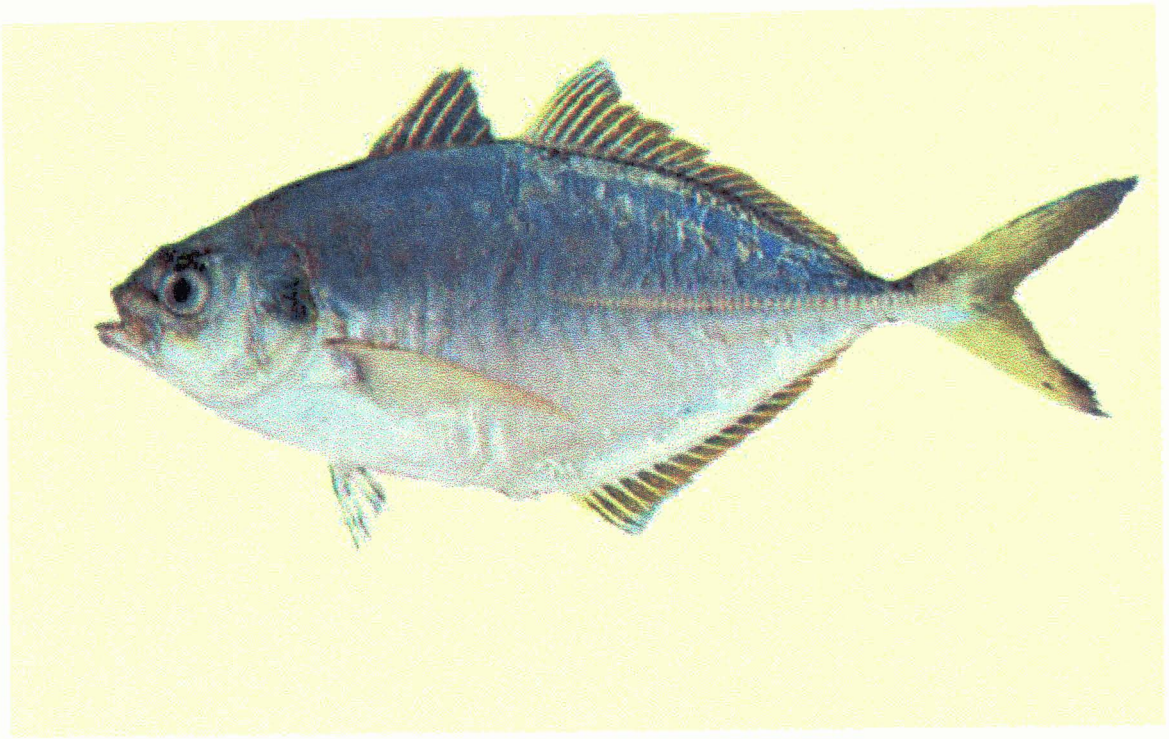


Plate 5.6.5. *Alepes vari* (Cuvier)

Plate 5.6.6. *Atule mate* (Cuvier)

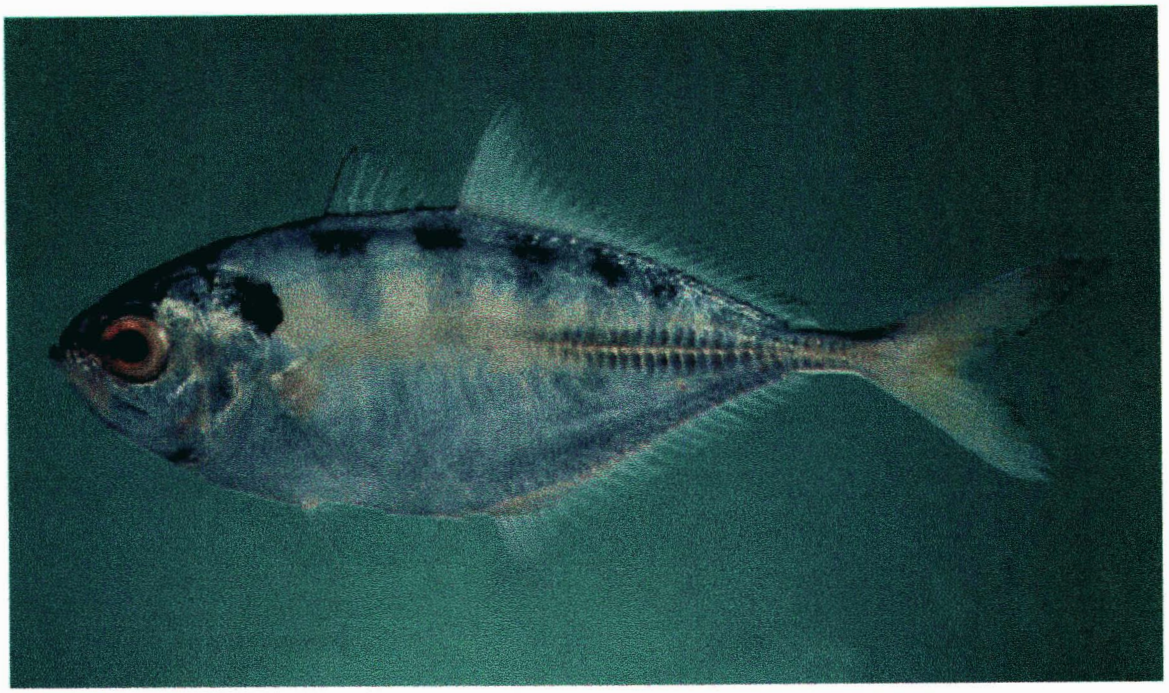


Plate 5.6.7. *Caranx kalla* (Cuvier)

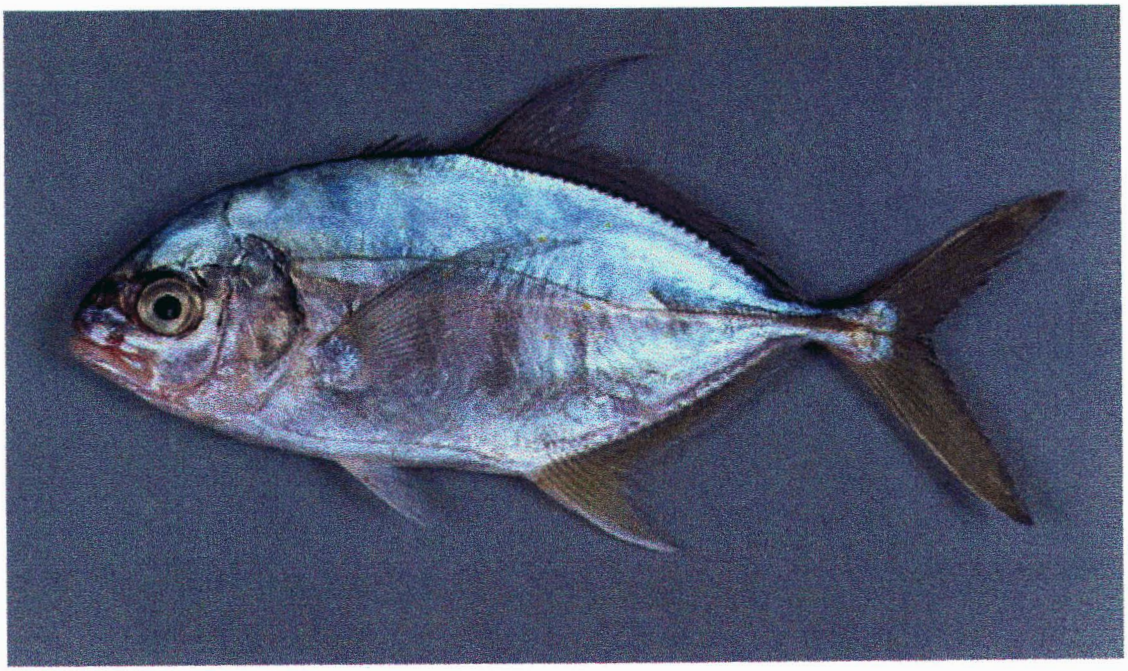


Plate 5.6.8. *Carangoides ferdau* (Forsskal)

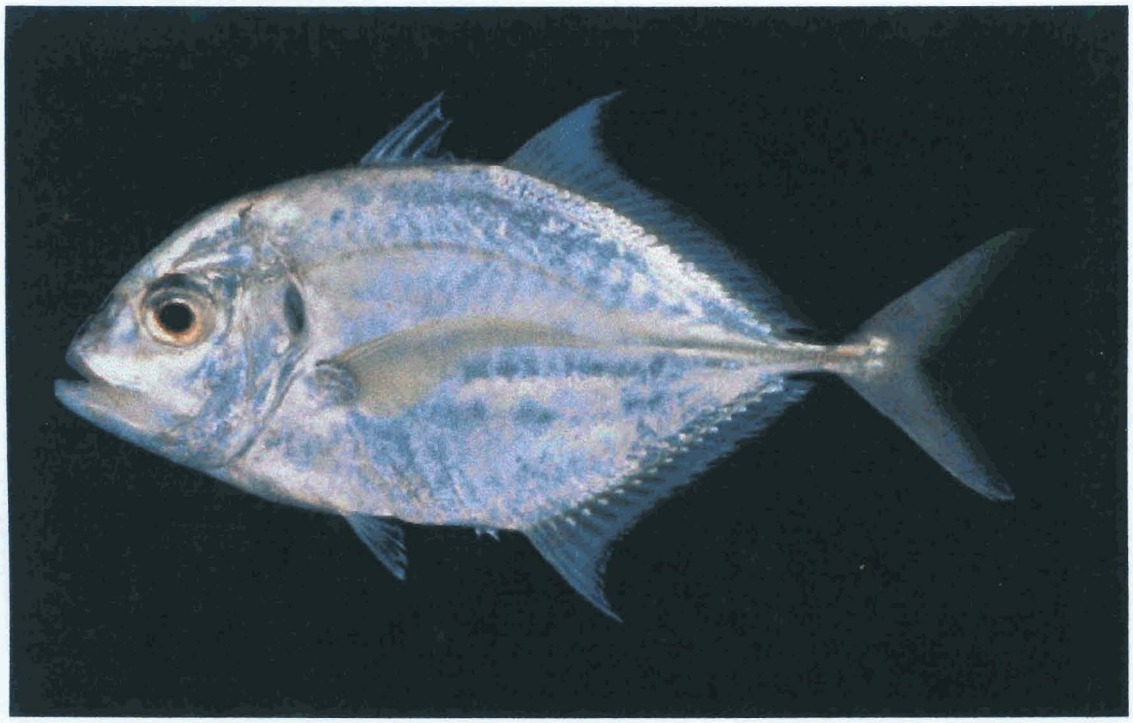


Plate 5.6.9. *Carangoides malabaricus* (Bloch & Schneider)

Plate 5.6.10. *Carangoides caeruleopinnatus* (Ruppell)

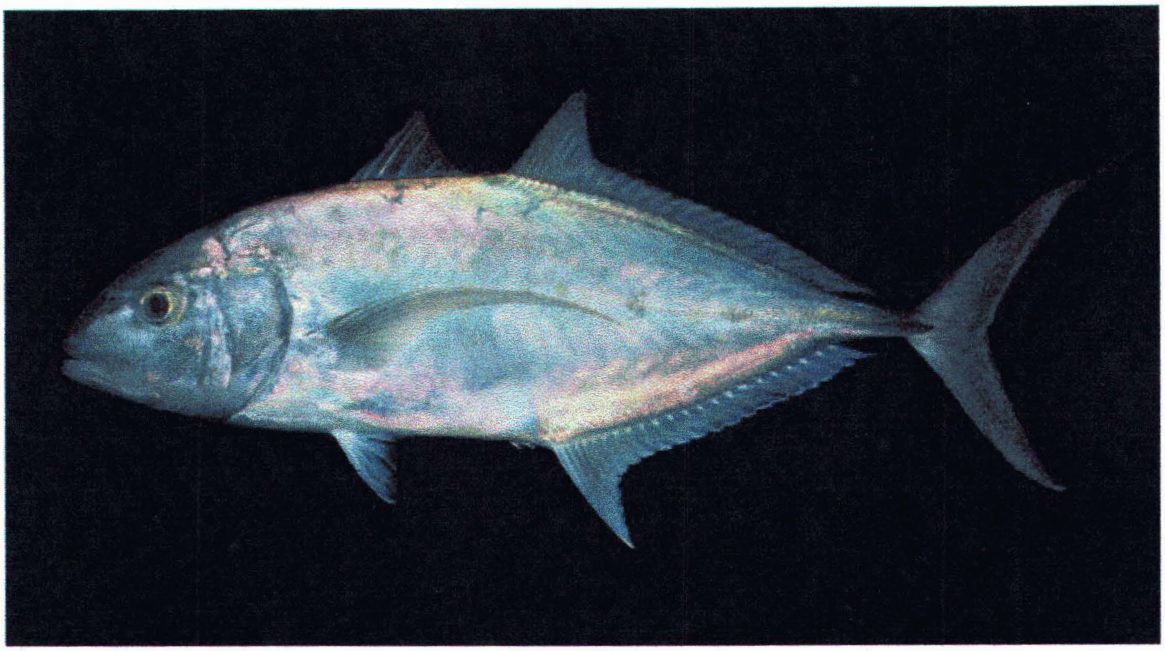


Plate 5.6.11. *Carangoides fulvoguttatus* (Forsskal)

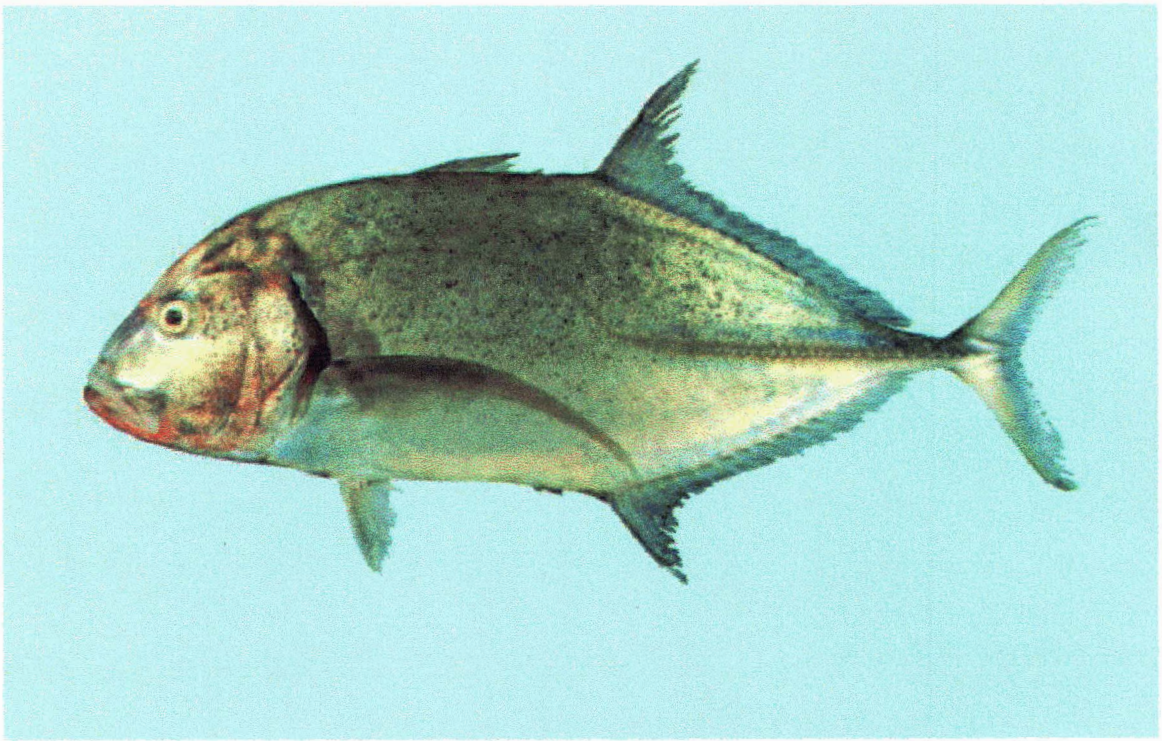


Plate 5.6.12. *Caranx melampygus* (Cuvier)

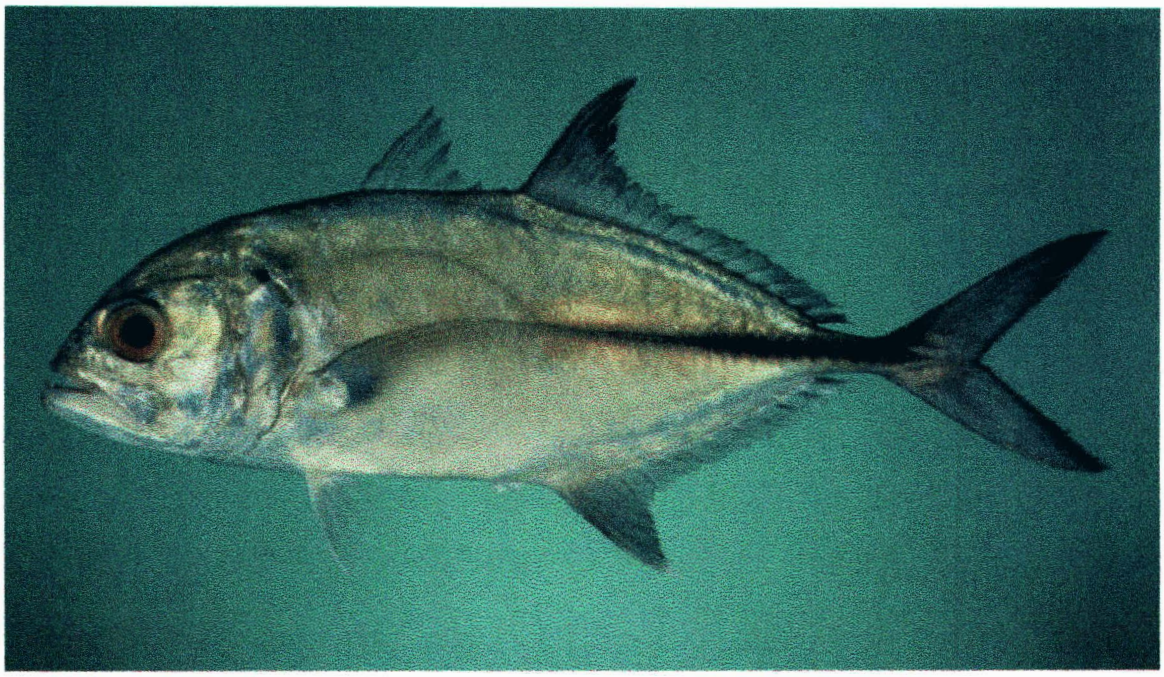


Plate 5.6.13. *Caranx sexfasciatus* (Quey & Gaimard)

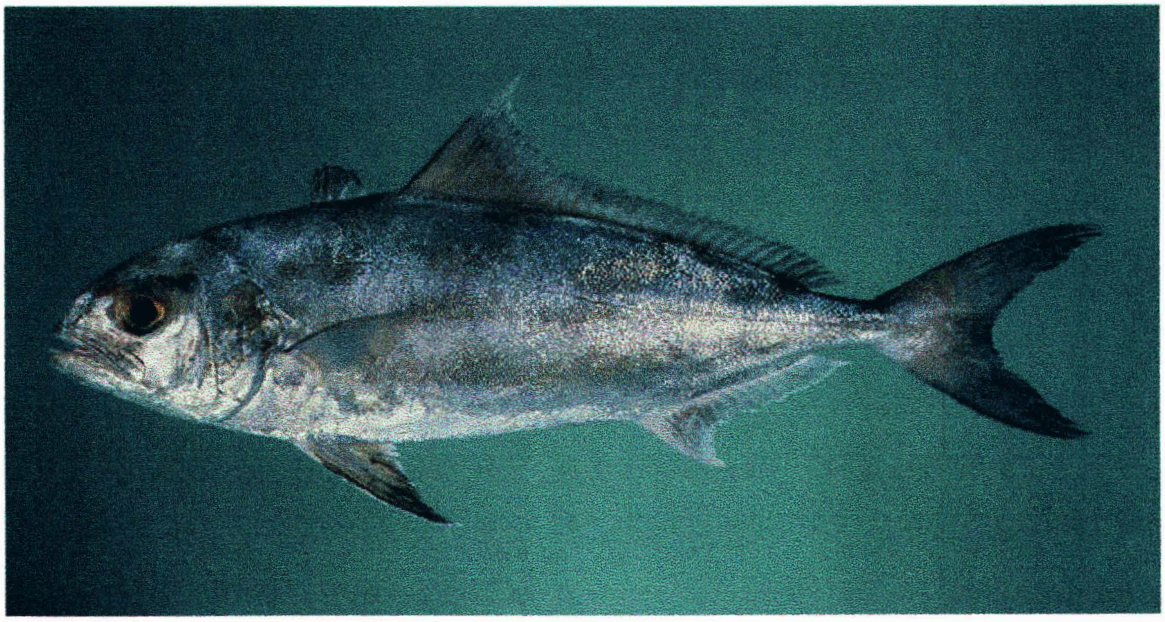


Plate 5.6.14. *Seriolina nigrofasciata* (Ruppell)

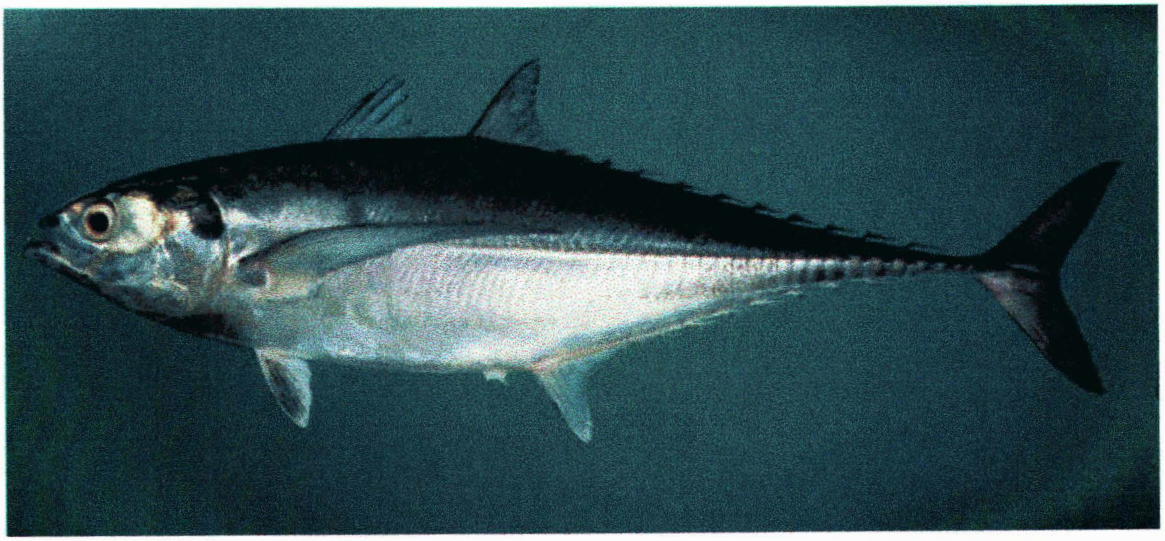


Plate 5.6.15. *Megalaspis cordyla* (Linnaeus)

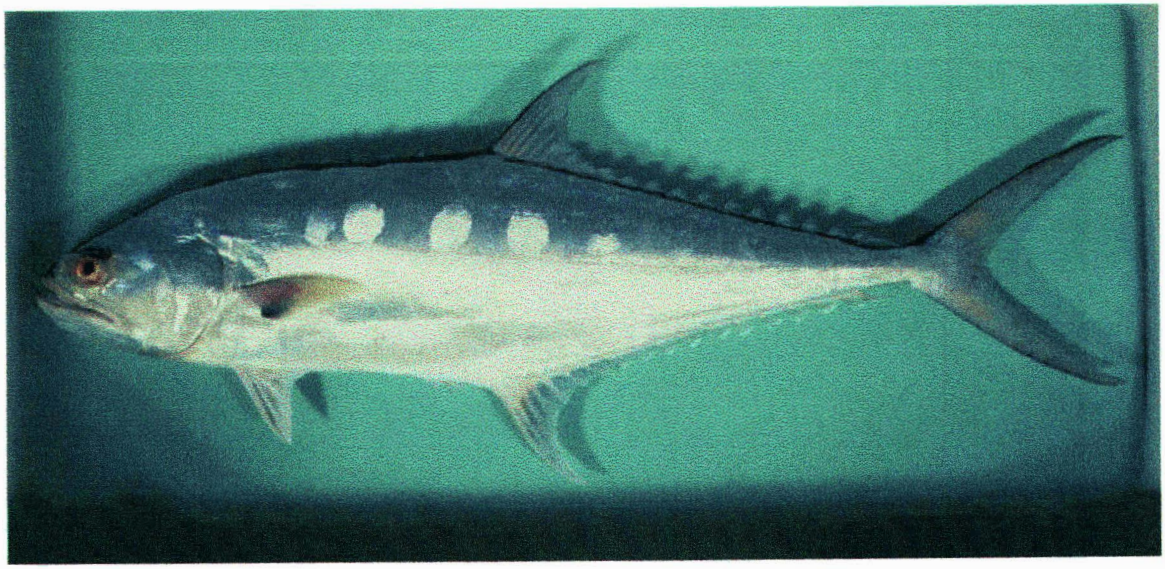


Plate 5.6.16. *Scomberoides commersonnianus* (Lacepede)

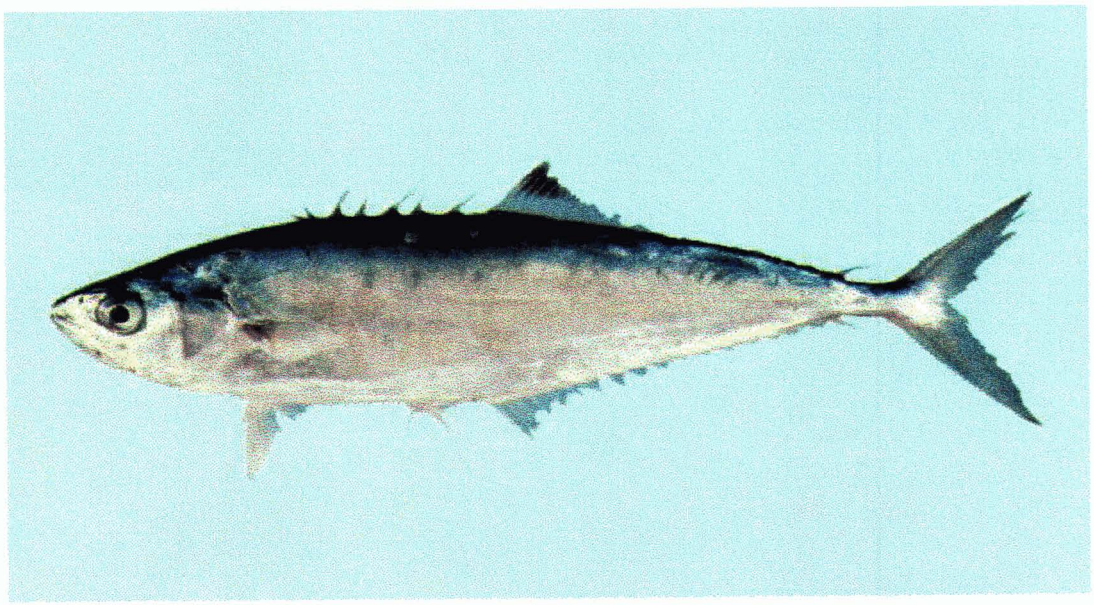


Plate 5.6.17. *Scomberoides tol* (Cuvier)

Plate 5.6.18. *Uraspis helvola* (Forster)

Fig. 5.6.1.1. Monthly percentage composition of *D. russelli* in different gears during 2000-01

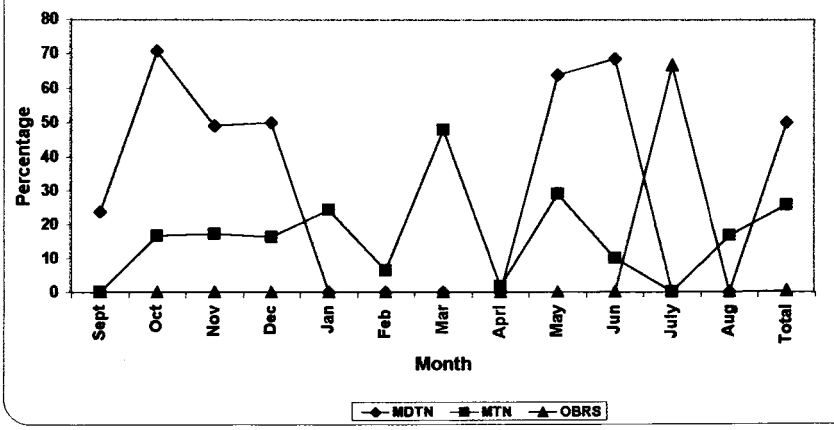


Fig. 5.6.1.2. Monthly percentage composition of *D. russelli* in different gears during 2000-02

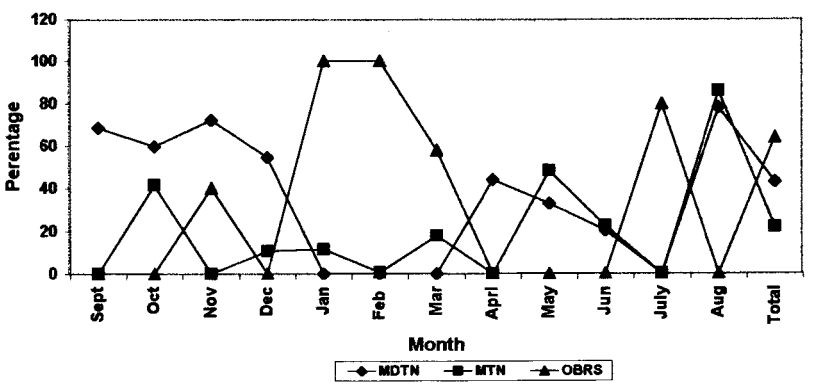


Fig. 5.6.1.3. Monthly average percentge composition of *D. russelli* in different gears during 2000-01 and 2001-02

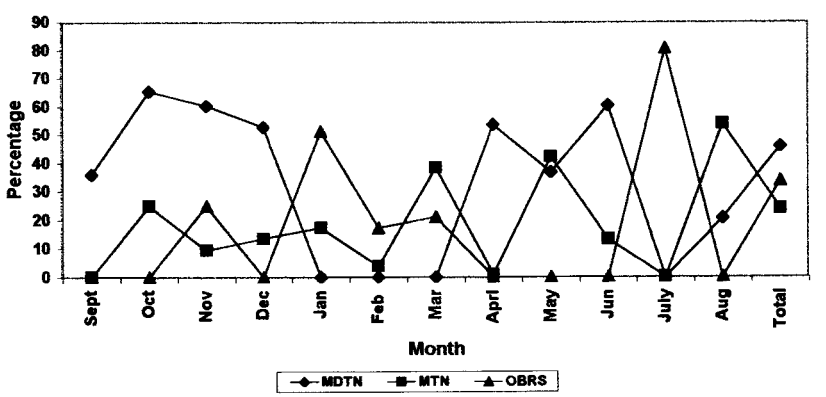


Fig. 5.6.2.1. Monthly percentage composition of *D. macrosoma* in different gears during 2000-01

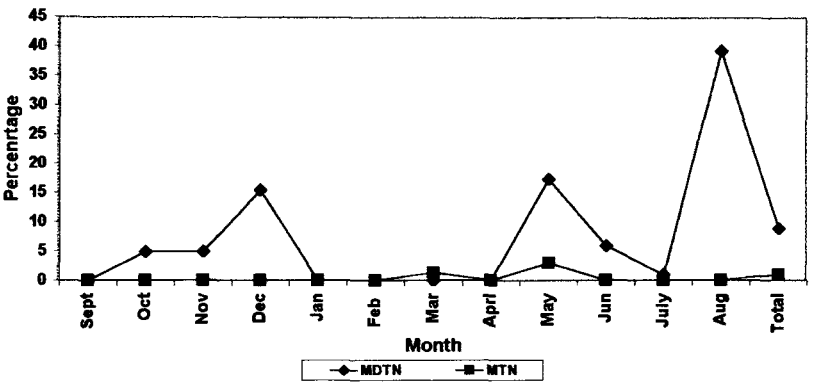


Fig. 5.6.2.2. Monthly percentage composition of *D. macrosoma* in different gears during 2001-02

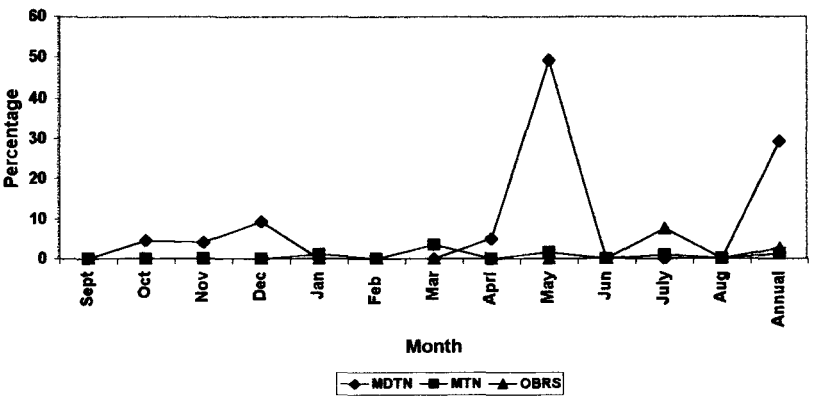


Fig. 5.6.2.3. Monthly average compositon of *D. macrosoma* in different gears during 2000-01 and 2001-02

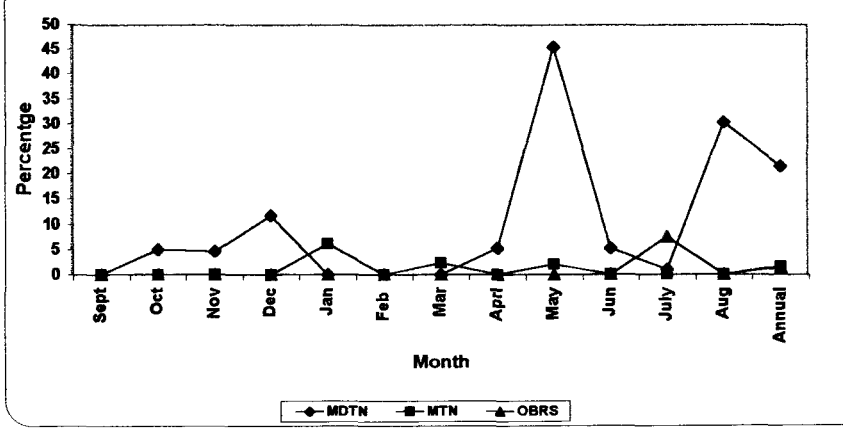


Fig. 5.6.3.1. Monthly percentage composition of *A. djedaba* in different gears during 2000-01

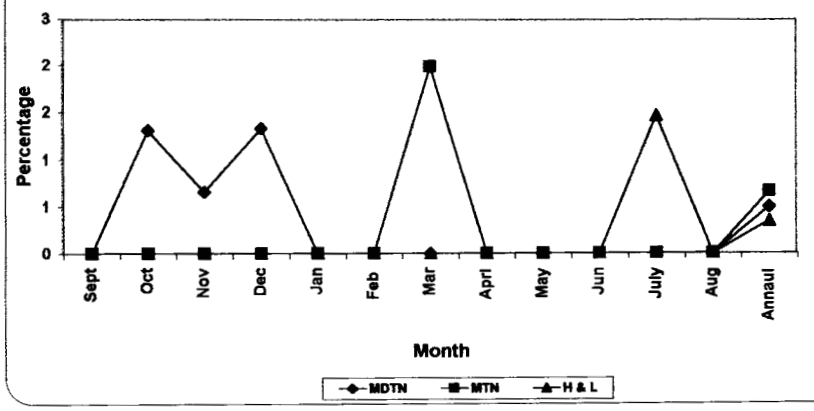


Fig. 5.6.3.2. Monthly percentage composition of *A. djedaba* in different gears during 2001-02

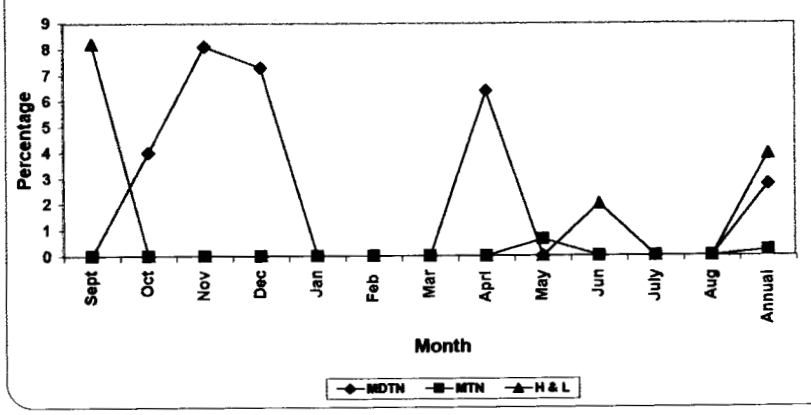


Fig. 5.6.3.3. Monthly percentage composition of *A. djedaba* in different gears during 2000-01 and 2001-02

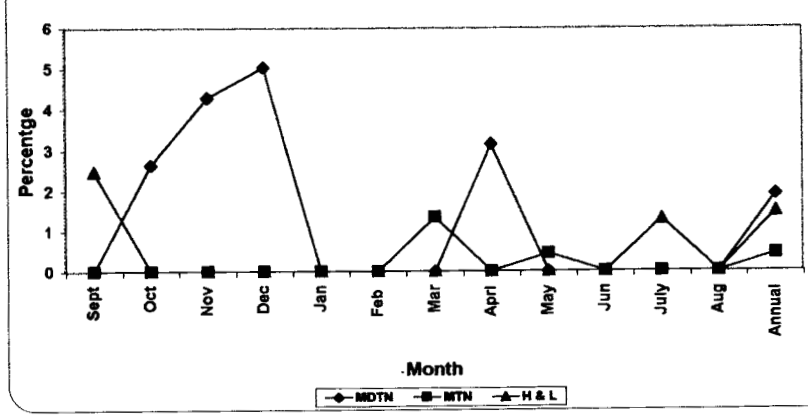


Fig. 5.6.4.1. Monthly percentage composition of *A. melanoptera* in different gears during 2000-01

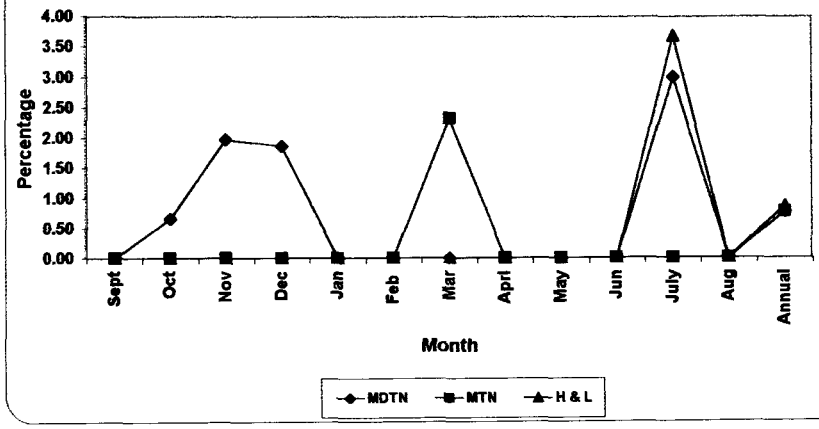


Fig. 5.6.4.2. Monthly percentage composition of *A. melanoptera* in different gears during 2001-02

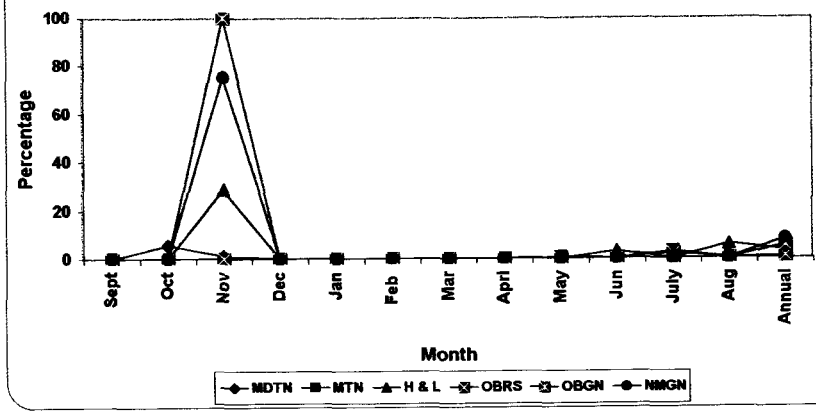


Fig. 5.6.4.3. Monthly average percentage composition of *A. melanoptera* in different gears during 2000-01 and 2001-02

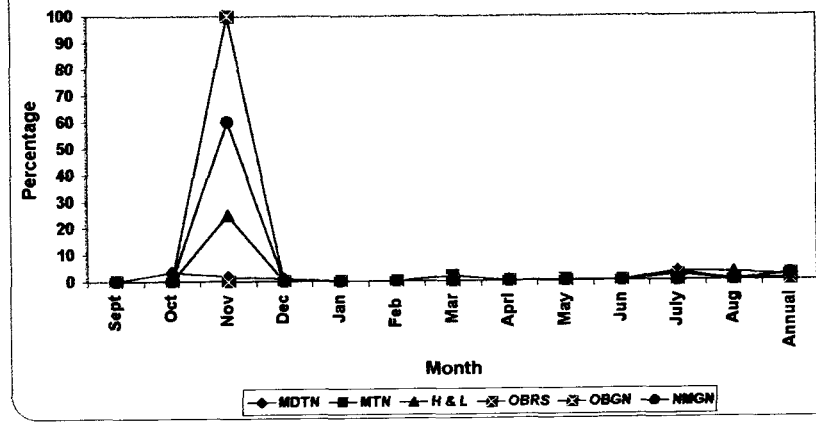


Fig. 5.6.5.1. Monthly percentage composition of *A. vari* in different gears during 2000-01

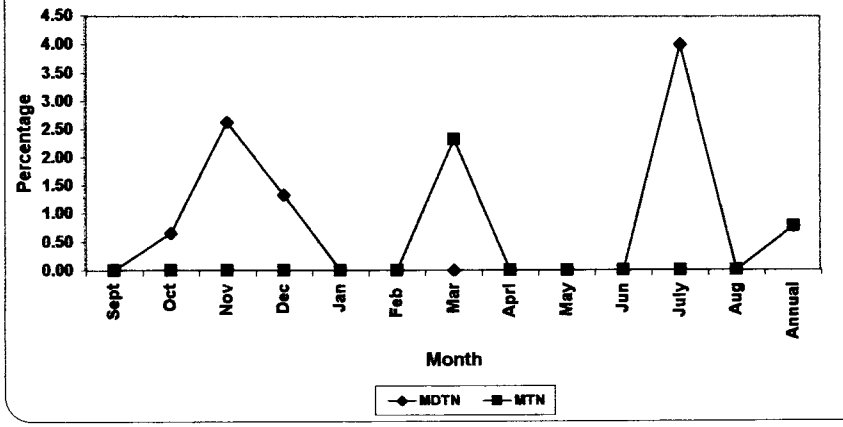


Fig. 5.6.5.2. Monthly percentage composition of *A. vari* in different gears during 2001-02

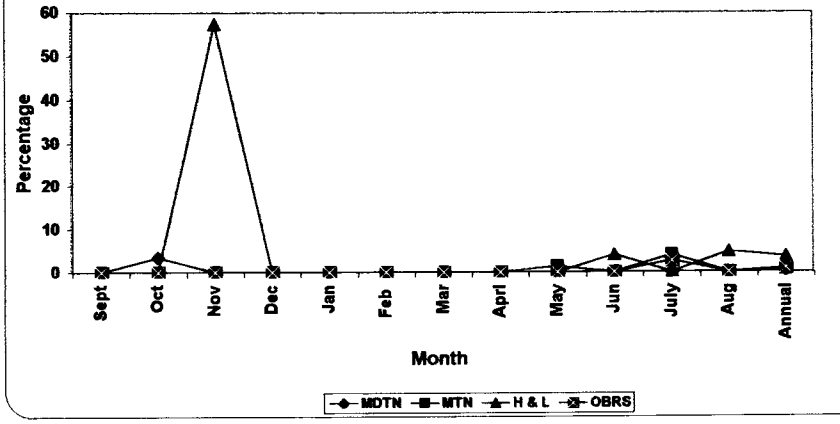
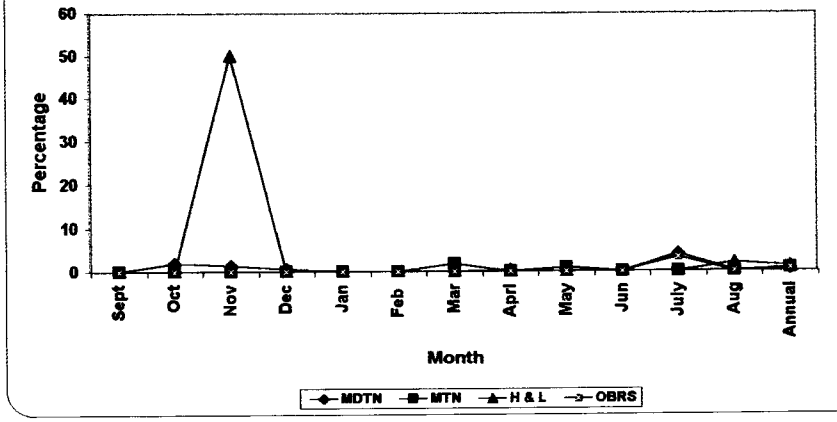


Fig. 5.6.5.3. Monthly average percentage composition of *A. vari* in different gears during 2000-01 and 2001-02



in different gears during 2000-01

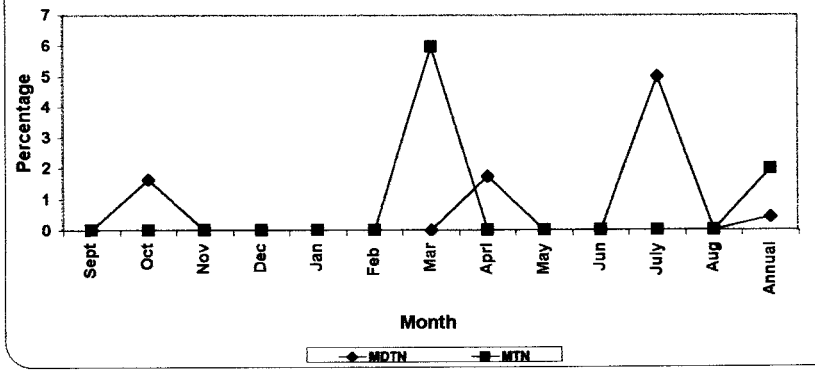


Fig. 5.6.6.2. Monthly percentage composition of *A. mate* in different gears during 2001-02

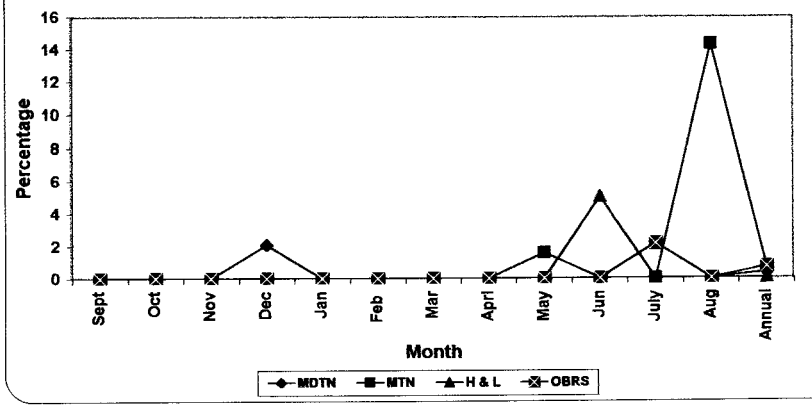


Fig. 5.6.6.3. Monthly average percentage composition of *A. mate* in different gears during 2000-01 and 2001-02

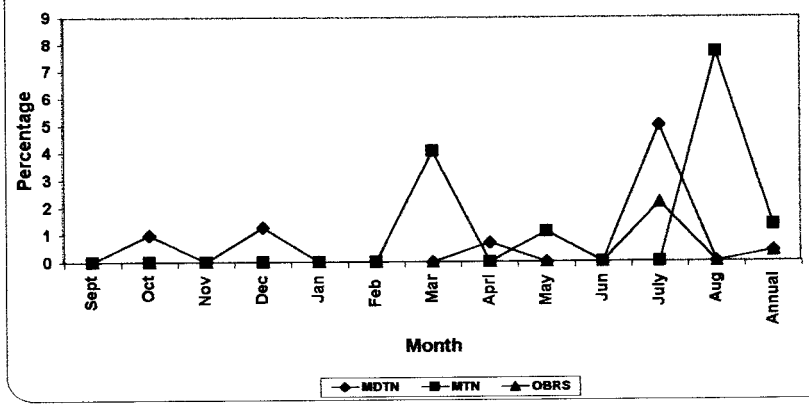


Fig. 5.6.7.1. Monthly percentage composition of *C. kalla* in different gears during 2000-01

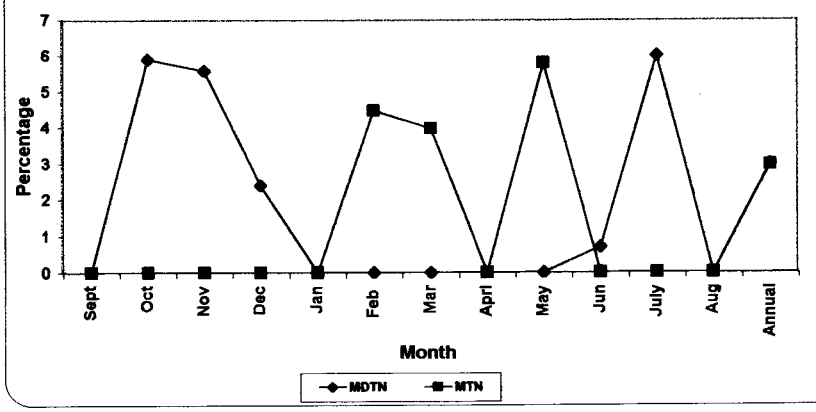


Fig. 5.6.7.2. Monthly percentage composition of *C. kalla* in different gears during 2001-02

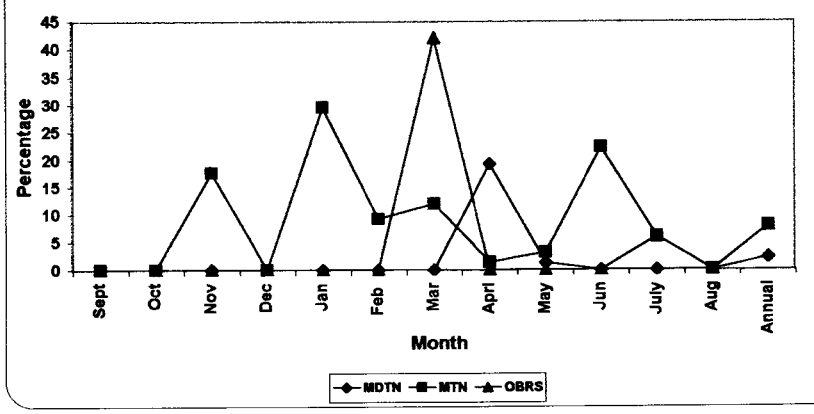


Fig. 5.6.7.3. Monthly average percentage composition of *C. kalla* in different gears during 2000-01 and 2001-02

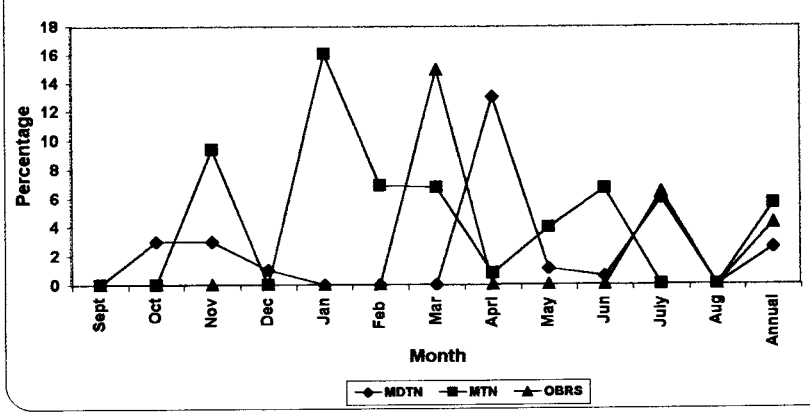


Fig. 5.6.8.1. Monthly percentage composition of *C. ferdau* in different gears during 2000-01

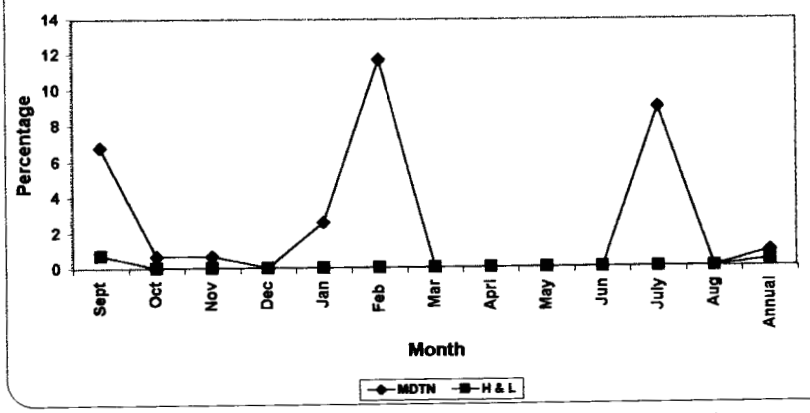


Fig. 5.6.8.2. Monthly percentage composition of *C. ferdau* in different gears during 2001-02

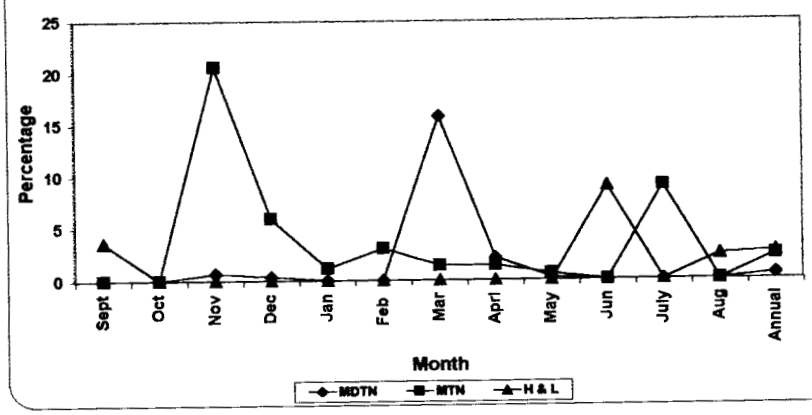


Fig. 5.6.8.3. Monthly average percentage composition of *C. ferdau* in different gears during 2000-01 and 2001-02

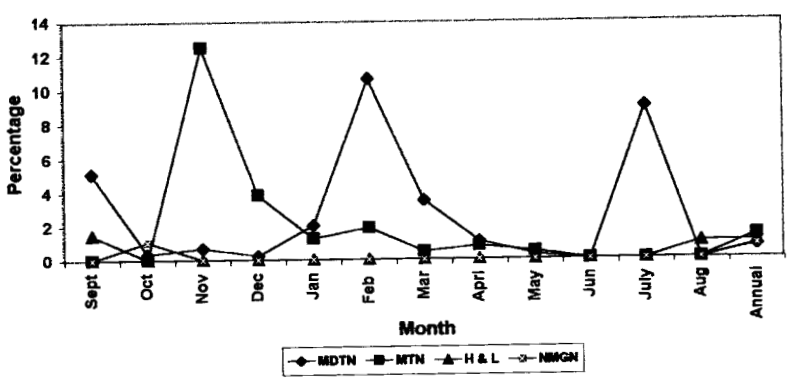


Fig. 5.6.9.1. Monthly percentage composition of *C. malabaricus* in different gears during 2000-01

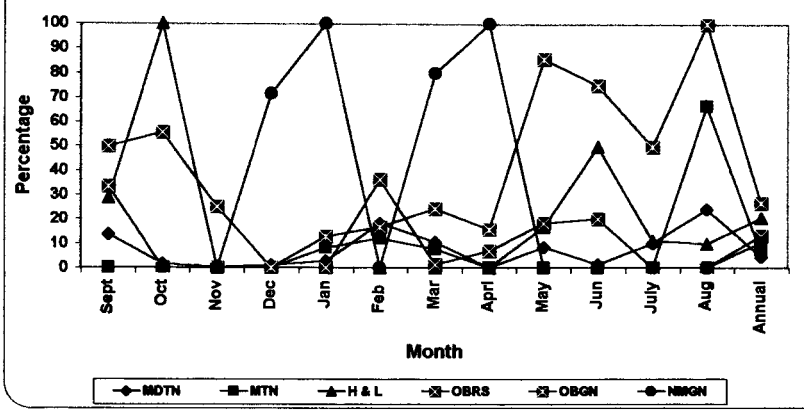


Fig. 5.6.9.2. Monthly percentage composition of *C. malabaricus* in different gears during 2001-02

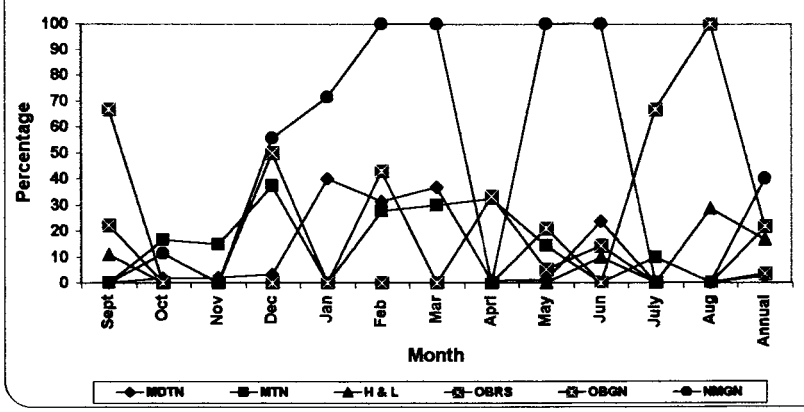


Fig. 5.6.9.3. Monthly average percentage composition of *C. malabaricus* in different gears during 2000-01 and 2001-02

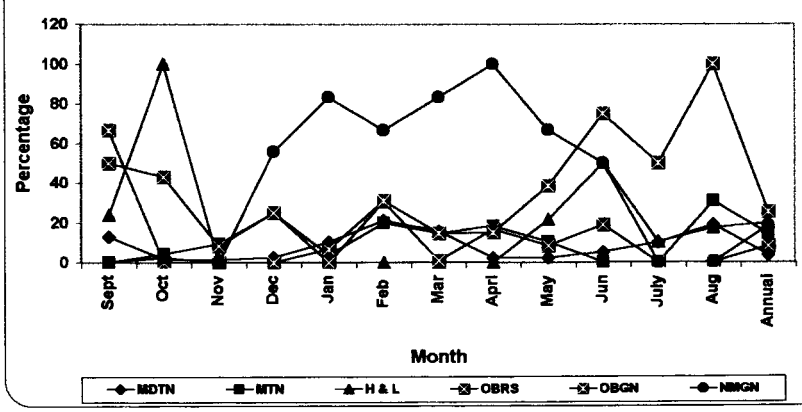


Fig. 5.6.10.1. Monthly percentage composition of *C. caeruleopinnatus* in different gears during 2000-01

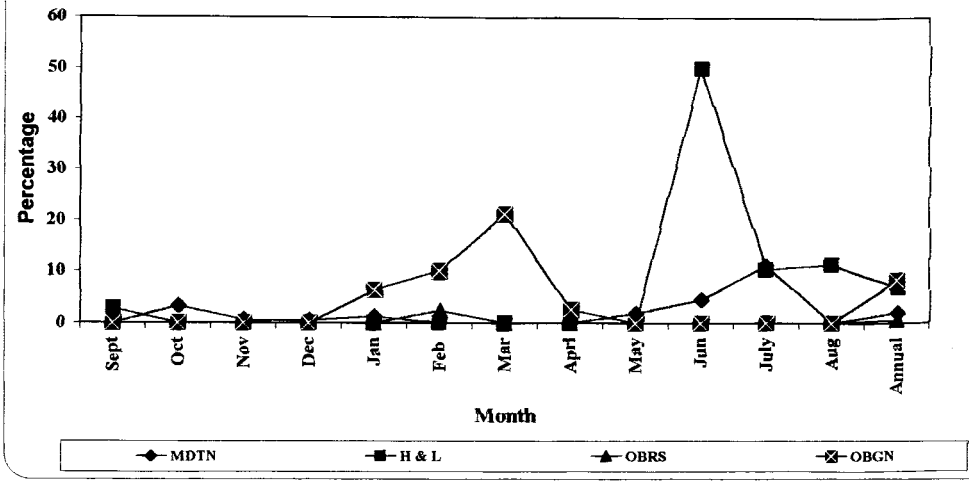


Fig. 5.6.10.2. Monthly percentage composition of *C. caeruleopinnatus* in different gears during 2001-02

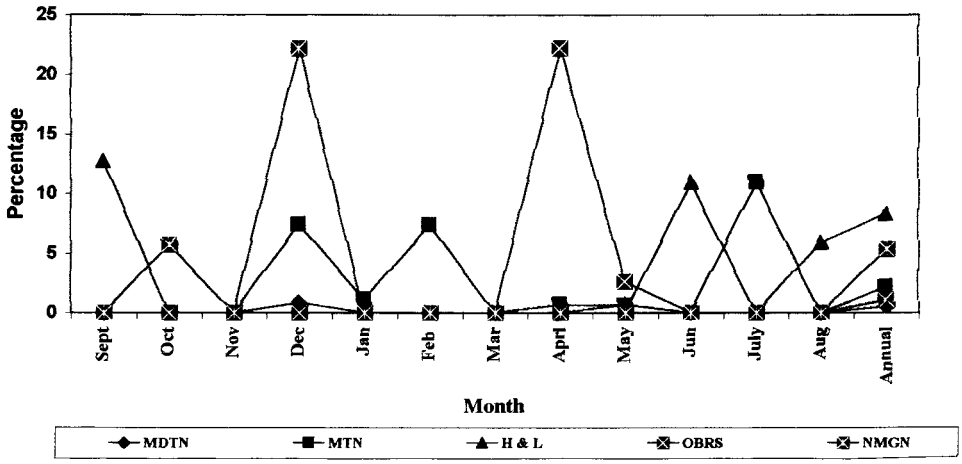


Fig. 5.6.10.3. Monthly average composition of *C. caeruleopinnatus* in different gears during 2000-01 and 2001-02

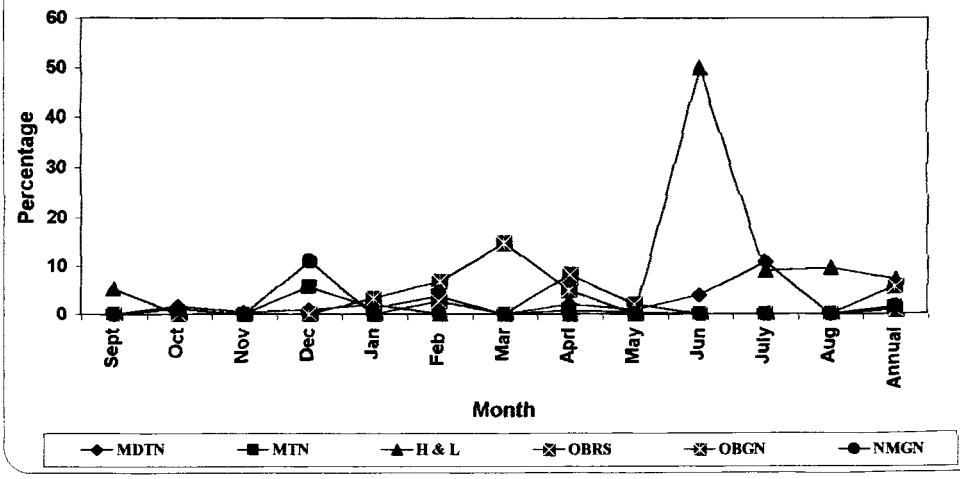


Fig. 5.6.11.1. Monthly percentage composition of *C. fulvoguttatus* in different gears during 2000-01

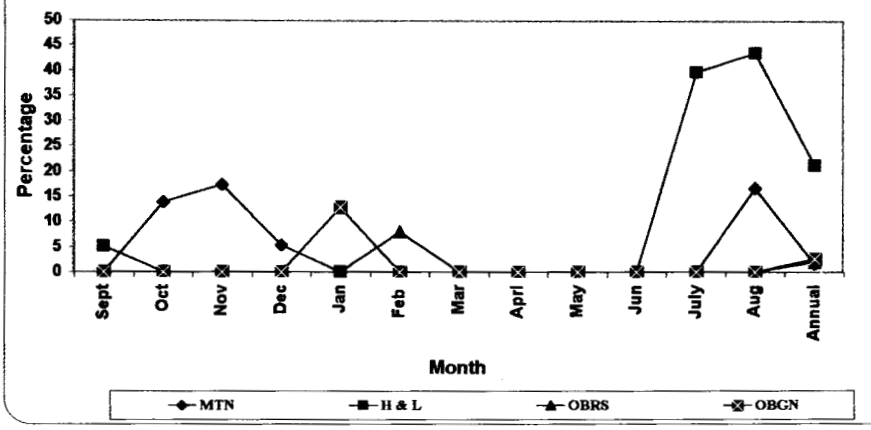


Fig. 5.6.11.2. Monthly percentage composition of *C. fulvoguttatus* in different gears during 2001-02

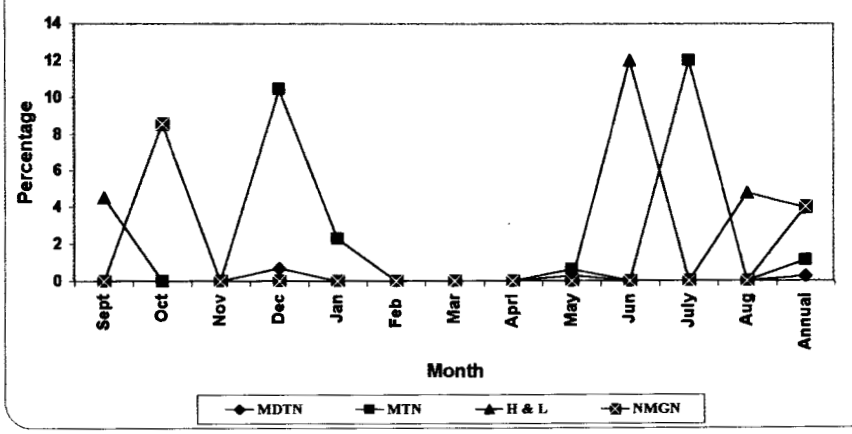


Fig. 5.6.11.3. Monthly average percentage composition of *C. fulvoguttatus* in different gears during 2000-01 and 2001-02

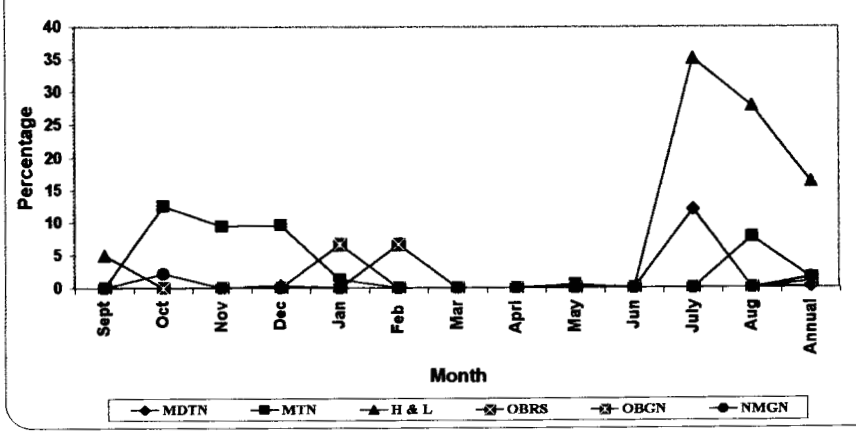


Fig. 5.6.12.1. Monthly percentage composition of *C. melampygus* in different gears during 2000-01

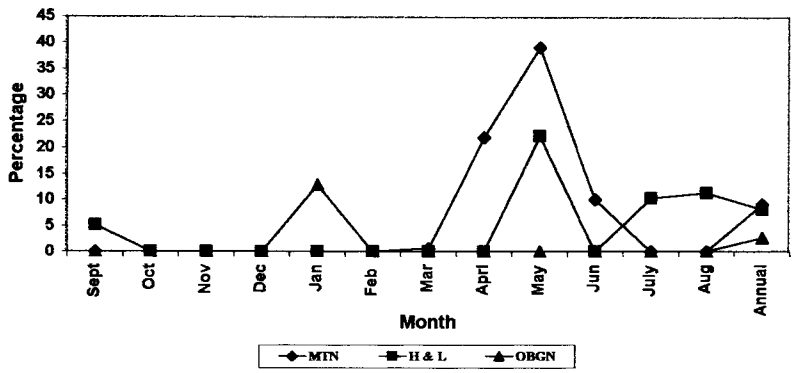


Fig. 5.6.12.2. Monthly percentage composition of *C. melampygus* in different gears during 2001-02

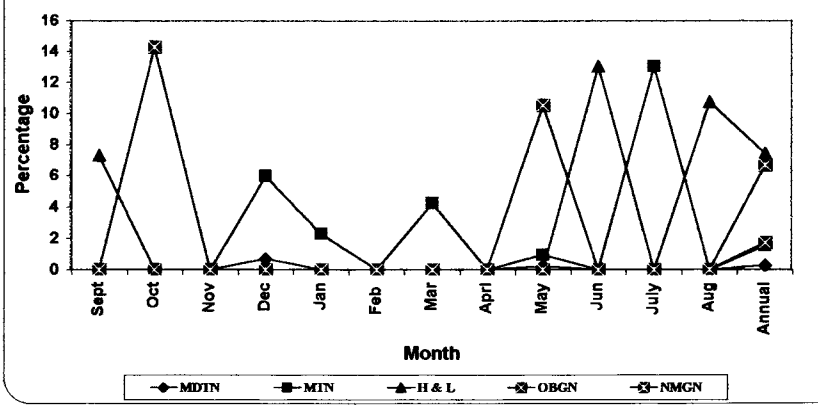


Fig. 5.6.12.3. Monthly average percentage composition of *C. melampygus* in different gears during 2000-01 and 2001-02

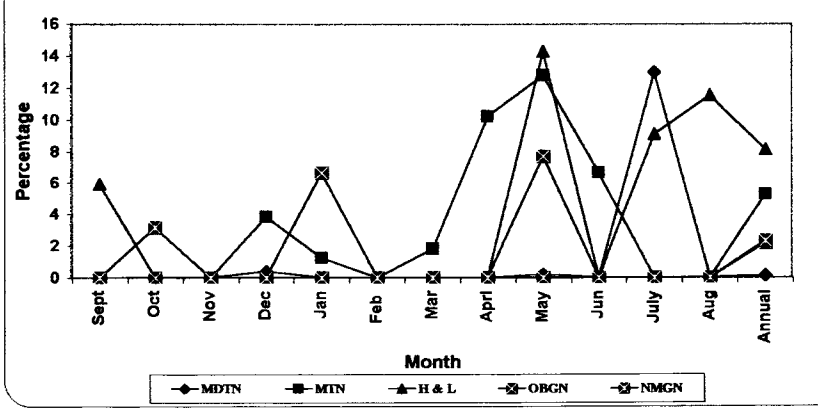


Fig. 5.6.13.1. Monthly percentage composition of *C. sexfasciatus* in different gears during 2000-01

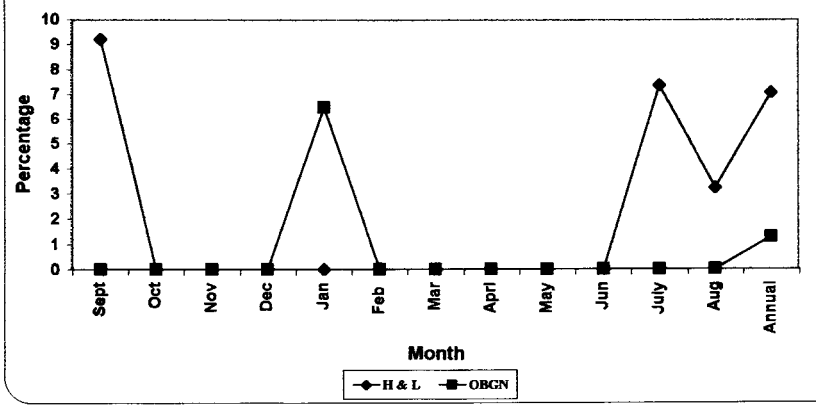


Fig. 5.6.13.2. Monthly percentage composition of *C. sexfasciatus* in different gears during 2001-02

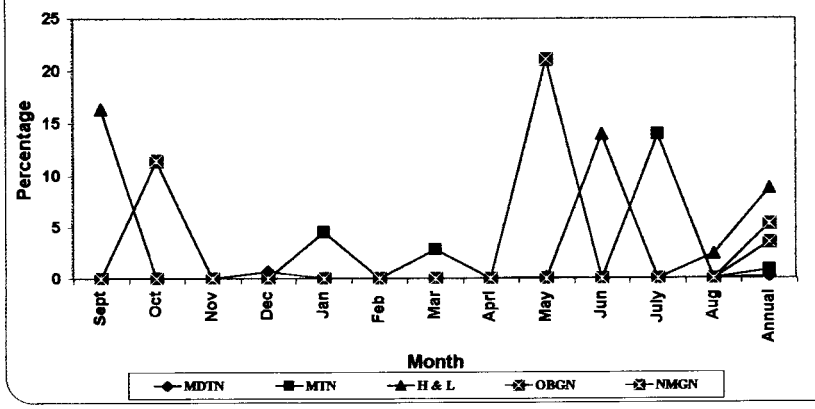


Fig. 5.6.13.3. Monthly average percentage composition of *C. sexfasciatus* in different gears during 2000-01 and 2001-02

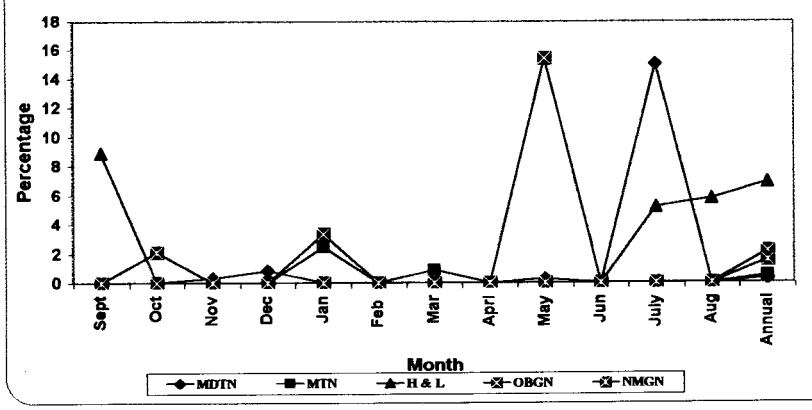


Fig. 5.6.14.1. Monthly percentage composition of *S. nigrofasciata* in different gears during 2000-01

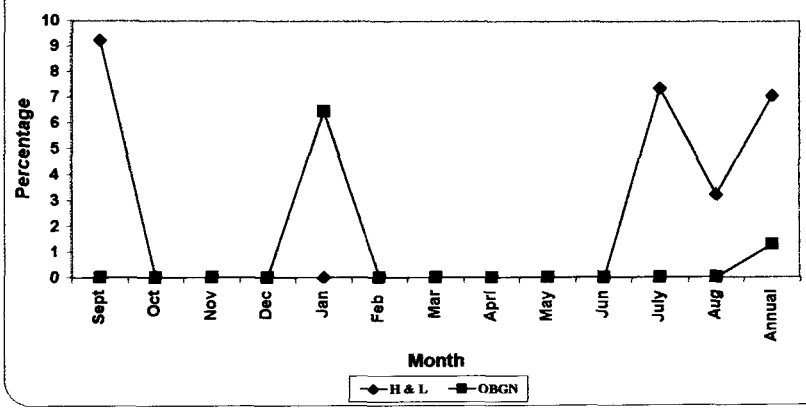


Fig. 5.6.14.2. Monthly percentage composition of *S. nigrofasciata* in different gears during 2001-02

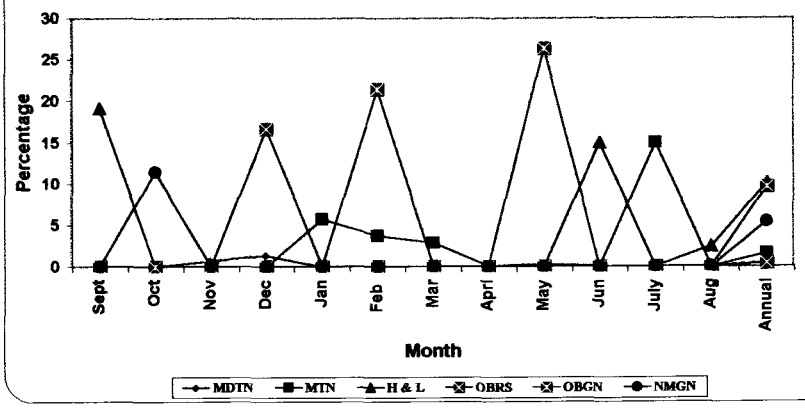


Fig. 5.6.14.3. Monthly average percentage composition of *S. nigrofasciata* in different gears during 2000-01 and 2001-02

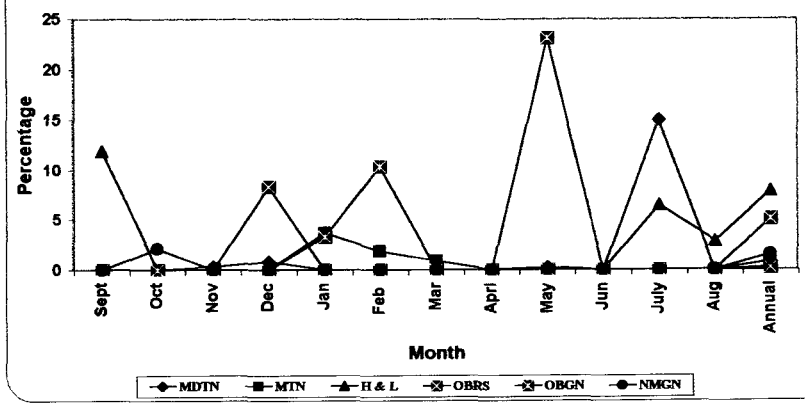


Fig. 5.6.15.1. Monthly percentage composition of *M. cordyla* in different gears during 2000-01

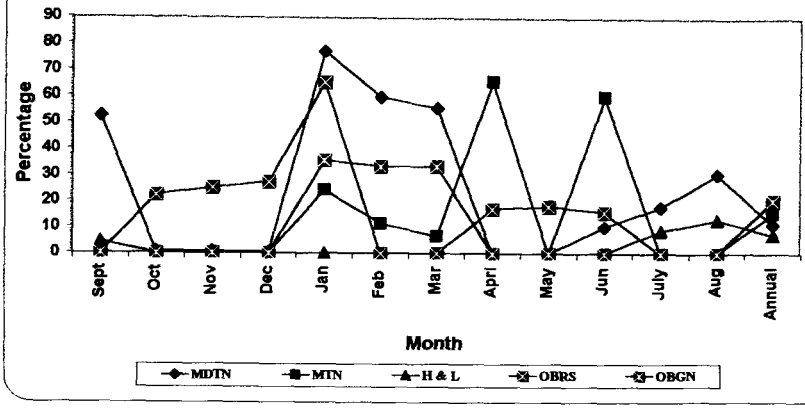


Fig. 5.6.15.2. Monthly percentage composition of M. *cordyla* in different gears during 2001-02

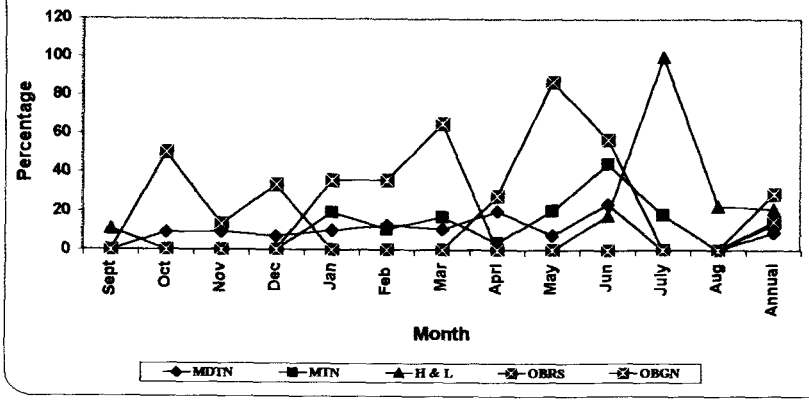


Fig. 5.6.15.3. Monthly average percentage composition of *M. cordyla* in different gears during 2000-01 and 2001-02

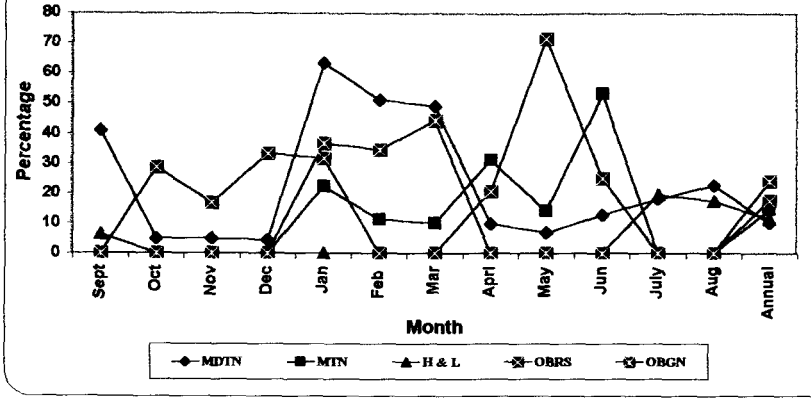


Fig. 5.6.16.1. Monthly percentage composition of *S. commersonnianus* in different gears during 2000-01

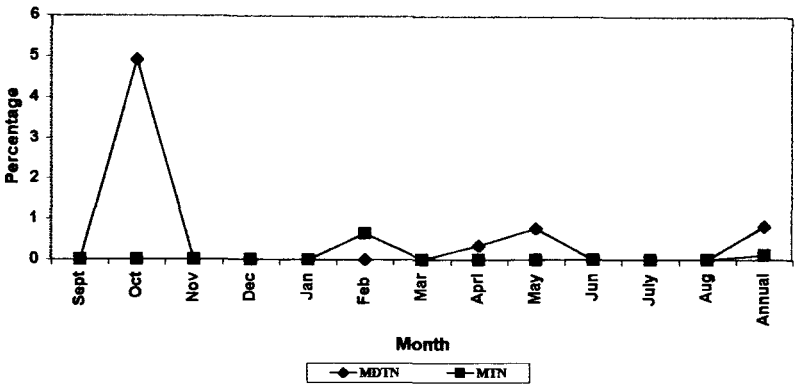


Fig. 5.6.16.2. Monthly percentage composition of *S. comersonnianus* in different gears during 2001-02

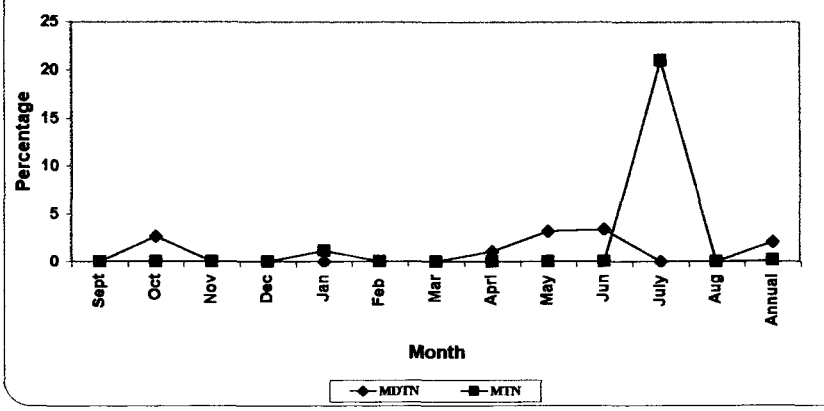


Fig. 5.6.16.3. Monthly average percentage composition of *S. commersonnianus* in different gears during 2000-01 and 2001-02

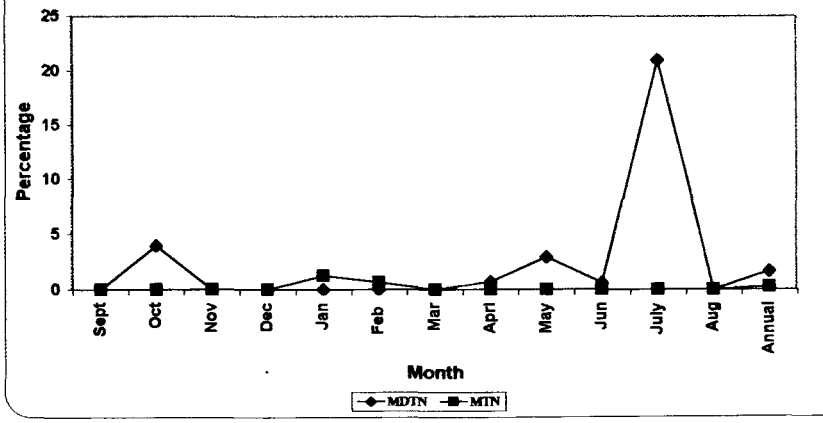


Fig. 5.6.17.1. Monthly percentage composition of *S. tol* in different gears during 2000-01

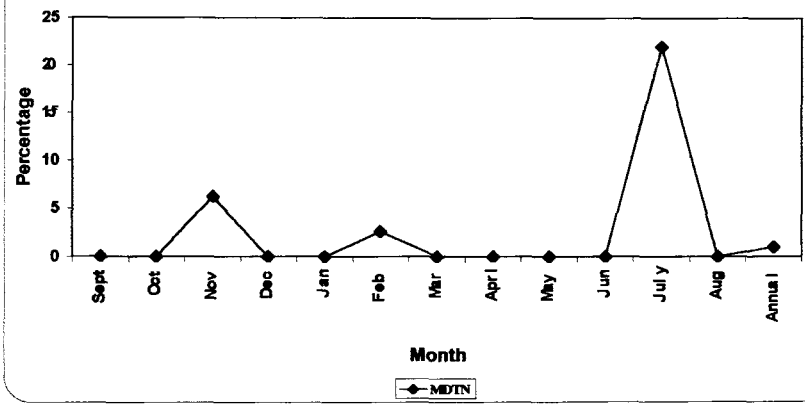


Fig. 5.6.17.2. Monthly percentage composition of *S. tol* in different gears during 2001-02

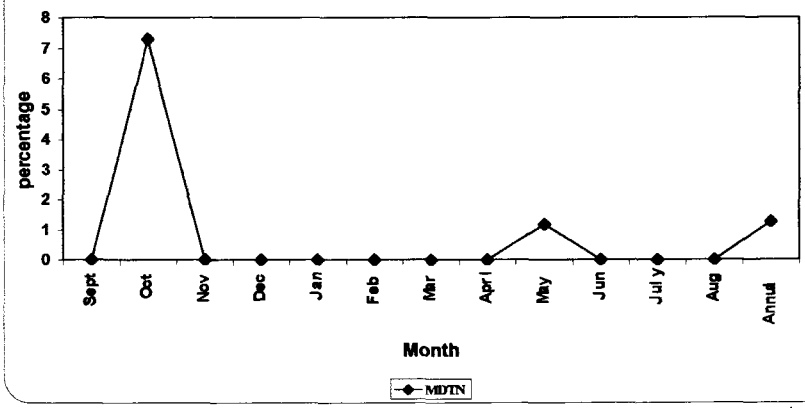


Fig. 5.6.17.3. Monthly average percentage composition of *S. tol* in different gears during 2000-01 and 2001-02

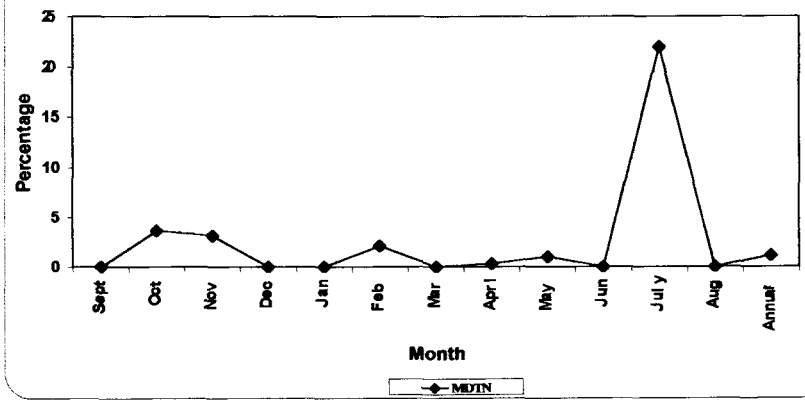


Fig. 5.6.18.1. Monthly percentage composition of *U. helvola* *in different gears during 2000-01*

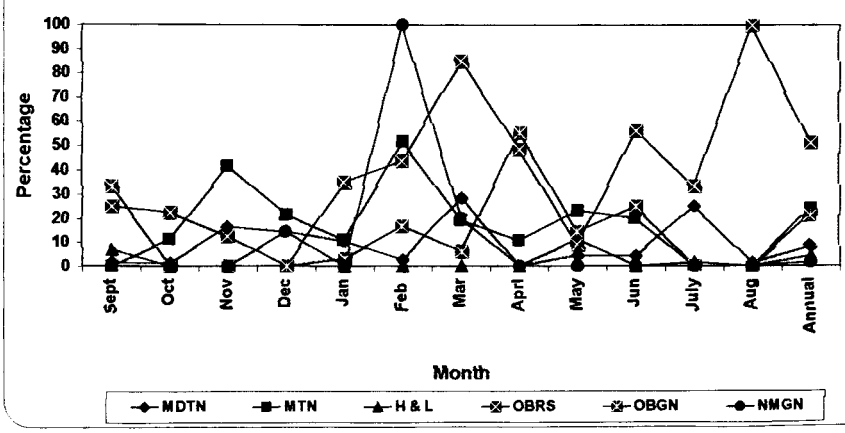


Fig. 5.6.18.2. Monthly percentage composition of *U. helvola* in different gears during 2001-02

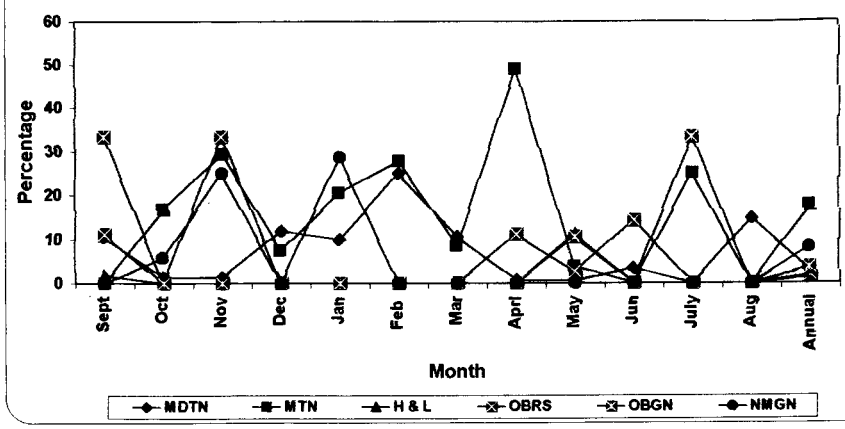


Fig. 5.6.18.3. Monthly average percentage composition of *U. helvola in different gears during 2000-01 and 2001-02*

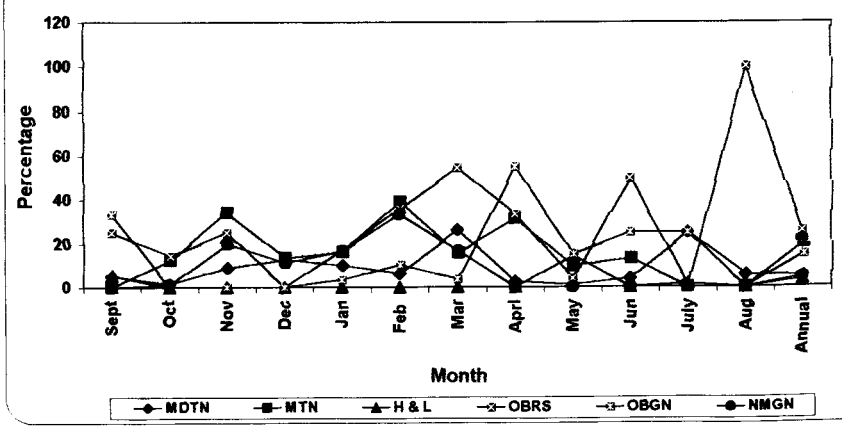


Fig. 5.6.19.1. Monthly percentage composition of other carangids in different gears during *2000-01*

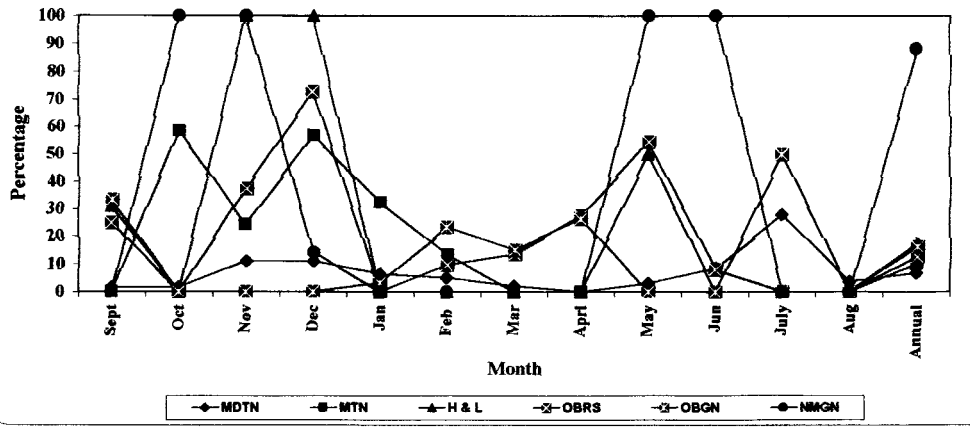


Fig. 5.6.19.2. Monthly percentage composition of other carangids in different gears during 2001-02

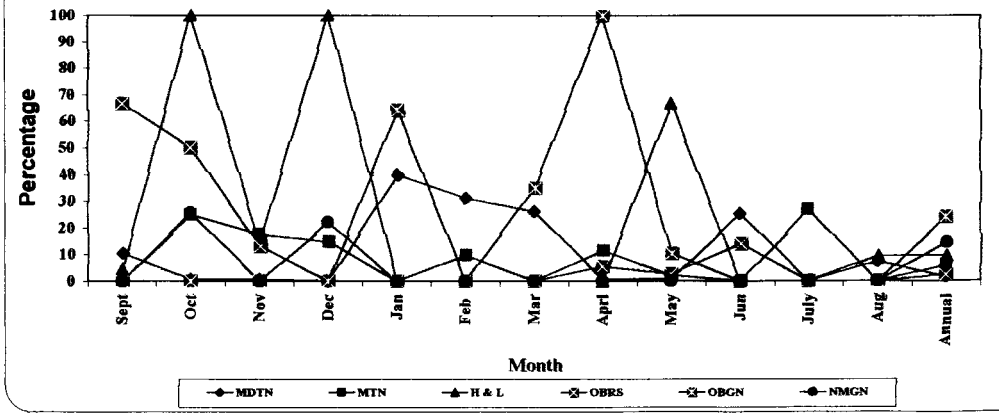


Fig. 5.6.19.3. Monthly percentage composition of other carangids in different gears during 2000-01 and 2001-02

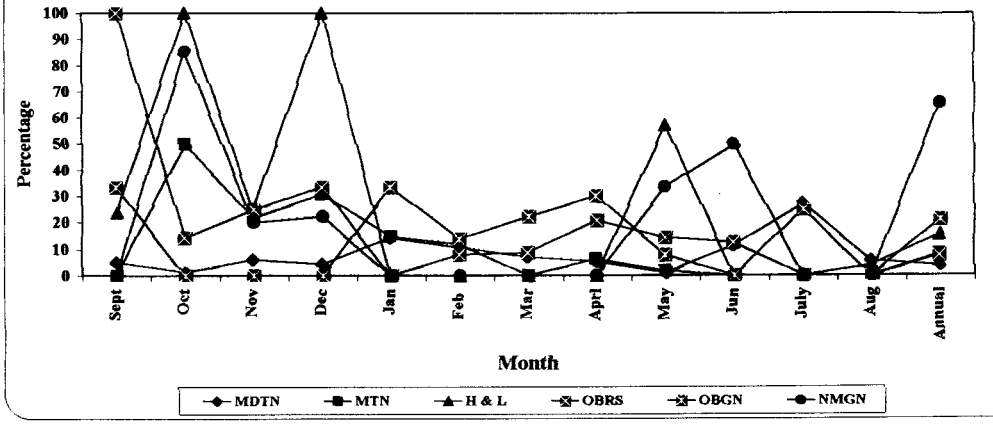


Table 5.7.1.1. Monthly CPUE (kg) of different species of carangids in MDTN during 2000-01

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	11.79	100.70	95.72	139.47	-	-	-	117.00	127.99	252.55	-	-	77.17
D. macrosoma	-	6.99	9.57	43.03	-	-	-	9.70	34.70	21.68	-	21.50	13.59
A. djedaba	-	1.86	1.28	3.71	-	-	-	-	-	-	-	-	0.76
A. melanoptera	-	0.93	3.83	5.19	-	-	-	1.29	-	-	-	-	1.18
A. vari	-	0.93	5.11	3.71	-	-	-	1.29	-	-	-	-	1.18
A. mate	-	2.33	-	-	-	-	-	2.59	-	-	-	-	0.62
C. kalla	-	8.39	10.85	6.68	-	-	-	12.93	-	2.55	-	-	4.58
Scads Total	**11.79**	**122.14**	**126.36**	**201.78**	**-**	**-**	**-**	**144.80**	**162.68**	**276.79**	**-**	**21.50**	**99.08**
Trevallys													
C. ferdau	3.37	0.93	1.28	-	1.97	9.04	-	-	-	-	-	-	1.32
C. malabaricus	6.74	2.33	0.64	2.97	1.97	14.06	9.15	6.46	16.96	5.10	-	13.18	6.86
C. caeruleopinnatus	-	4.66	1.28	1.48	0.98	-	-	7.76	3.86	16.58	-	-	3.12
C. fulvoguttatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C .sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys Total	**10.11**	**7.93**	**3.19**	**4.45**	**4.92**	**23.09**	**9.15**	**14.22**	**20.82**	**21.68**	**-**	**13.18**	**11.30**
Horse mackerel													
M. cordyla	26.12	0.93	1.28	1.48	59.00	46.18	48.49	-	-	38.27	-	16.64	17.33
Horse mackerel Total	**26.12**	**0.93**	**1.28**	**1.48**	**59.00**	**46.18**	**48.49**	**-**	**-**	**38.27**	**-**	**16.64**	**17.33**
Leather jackets													
S. commersonnianus	-	6.99	-	-	-	-	-	0.65	1.54	-	-	-	1.25
S. tol	-	-	12.13	-	-	2.01	-	1.29	0.00	-	-	-	1.59
Leather jackets Total	**-**	**6.99**	**12.13**	**-**	**-**	**2.01**	**-**	**1.94**	**1.54**	**-**	**-**	**-**	**2.84**
Jacks													
U. helvola	4.21	1.86	31.91	40.06	7.87	2.01	24.70	7.76	9.25	15.31	-	0.69	12.69
Jacks Total	**4.21**	**1.86**	**31.91**	**40.06**	**7.87**	**2.01**	**24.70**	**7.76**	**9.25**	**15.31**	**-**	**0.69**	**12.69**
Other carangids	**0.84**	**2.33**	**21.70**	**31.16**	**4.92**	**4.02**	**1.83**	**17.45**	**6.17**	**31.89**	**-**	**2.08**	**10.82**
Carangids total	**49.71**	**142.19**	**196.55**	**278.93**	**76.70**	**77.31**	**86.92**	**186.17**	**200.46**	**368.62**	**-**	**54.09**	**164.06**

Table 5.7.1.2. Monthly CPUE (kg) of different species of carangids in MDTN during 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	15.78	144.35	138.33	229.26	-	-	-	66.77	387.52	9.62	-	28.77	109.39
D. macrosoma	-	11.23	7.76	39.30	-	-	-	7.54	580.97	-	-	0.00	74.39
A. djedaba	-	9.62	15.51	30.57	-	-	-	9.69	-	-	-	-	7.03
A. melanoptera	-	13.63	1.94	0.00	-	-	-	-	-	-	-	-	1.46
A. vari	-	8.02	-	-	-	-	-	-	-	-	-	-	0.73
A. mate	-	-	-	8.73	-	-	-	-	-	-	-	-	0.88
C. kalla	-	0.00	0.00	0.00	-	-	-	29.08	15.12	-	-	-	5.71
Scads Total	**15.78**	**186.86**	**163.54**	**307.86**	**-**	**-**	**-**	**113.09**	**983.62**	**9.62**	**-**	**28.77**	**199.60**
Trevallys													
C.ferdau	-	-	1.29	1.46	-	-	2.22	3.23	3.15	-	-	-	1.32
C. malabaricus	2.43	4.01	3.88	13.83	8.38	5.34	5.17	1.08	15.12	11.23	-	-	6.74
C.caeruleopinnatus	-	-	-	3.64	-	-	-	-	8.19	-	-	-	1.32
C. fulvoguttatus	-	-	-	2.91	-	-	-	-	3.15	-	-	-	0.66
C. melampygus	-	-	-	2.91	-	-	-	-	2.52	-	-	-	0.59
C. sexfasciatus	-	-	-	2.91	-	-	-	-	1.26	-	-	-	0.44
S. nigrofasciata	-	-	1.29	5.82	-	-	-	-	3.78	-	-	-	1.17
Trevallys Total	**2.43**	**4.01**	**6.46**	**33.48**	**8.38**	**5.34**	**7.39**	**4.31**	**37.18**	**11.23**	**-**	**-**	**12.23**
Horse mackerel													
M. cordyla	-	21.65	18.10	29.11	2.09	2.14	1.48	30.16	90.74	11.23	-	-	23.07
Horse mackerel Total	-	21.65	18.10	29.11	2.09	2.14	1.48	30.16	90.74	11.23	-	-	23.07
Leather jackets											-	-	
S. commersonnianus	-	6.42	-	-	-	-	-	1.62	37.81	1.60	-	-	5.35
S. tol	-	17.64	-	-	-	-	-	-	13.86	-	-	-	3.22
Leaher jackets Total	**-**	**24.06**	**-**	**-**	**-**	**-**	**-**	**1.62**	**51.67**	**1.60**	**-**	**-**	**8.57**
Jacks													
U. helvola	2.43	3.21	2.59	49.49	2.09	4.27	1.48	1.08	7.56	1.60	-	5.48	7.76
Jacks Total	**2.43**	**3.21**	**2.59**	**49.49**	**2.09**	**4.27**	**1.48**	**1.08**	**7.56**	**1.60**	**-**	**5.48**	**7.76**
Other carangids	**2.43**	**1.60**	**1.29**	**-**	**8.38**	**5.34**	**3.70**	**1.08**	**7.56**	**12.03**	**-**	**2.74**	**4.03**
Carangids total	**23.06**	**241.38**	**191.98**	**419.94**	**20.94**	**17.09**	**14.04**	**151.32**	**1178.32**	**47.31**	**-**	**36.99**	**255.25**

Table 5.7.1.3. Average monthly CPUE (kg) of different species of carangids in MDTN during 2000-01 and 2001-02

Months/Species	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	13.42	116.75	116.89	184.79	-	-	-	89.60	270.80	103.35	-	9.67	92.84
D. macrosoma	-	8.55	8.66	41.16	-	-	-	8.52	335.30	8.37	-	14.27	43.16
A. djedaba	-	4.72	8.40	17.27	-	-	-	5.29	-	-	-	-	3.81
A. melanoptera	-	5.60	2.88	2.57	-	-	-	0.59	-	-	-	-	1.32
A. vari	-	3.54	2.57	1.84	-	-	-	0.59	-	-	-	-	0.96
A. mate	-	1.47	-	4.41	-	-	-	1.18	-	-	-	-	0.75
C. kalla	-	5.31	5.42	3.34	-	-	-	21.74	8.32	0.98	-	-	5.14
Scads Total	**13.42**	**145.93**	**144.83**	**255.33**	**-**	**-**	**-**	**127.61**	**614.42**	**112.70**	**-**	**23.94**	**147.97**
Trevallys													
C. ferdau	1.99	0.47	1.28	0.73	1.01	4.66	1.23	1.76	1.73	-	-	-	1.32
C. malabaricus	4.97	2.95	2.26	8.45	5.07	9.83	6.95	3.53	15.95	8.86	-	8.75	6.80
C.caeruleopinnatus	-	2.95	0.64	2.57	0.51	-	-	3.53	6.24	6.40	-	-	2.24
C. fulvoguttatus	-	-	-	1.46	-	-	-	-	1.73	-	-	-	0.32
C. melampygus	-	-	-	1.46	-	-	-	-	1.39	-	-	-	0.28
C. sexfasciatus	-	-	-	1.46	-	-	-	-	0.69	-	-	-	0.21
S. nigrofasciata	-	-	0.65	2.94	-	-	-	-	2.08	-	-	-	0.57
Trevallys Total	**6.96**	**6.49**	**4.83**	**19.10**	**6.59**	**14.49**	**8.18**	**8.81**	**29.82**	**15.26**	**-**	**8.75**	**11.76**
Horse mackerel													
M. cordyla	15.41	8.55	9.63	15.43	31.44	24.84	22.49	16.45	49.93	21.65	-	11.05	20.12
Horse mackerel Total	**15.41**	**8.55**	**9.63**	**15.43**	**31.44**	**24.84**	**22.49**	**16.45**	**49.93**	**21.65**	**-**	**11.05**	**20.12**
Leather jackets													
S. commersonnianus	-	6.78	-	-	-	-	-	1.18	21.50	0.98	-	-	3.24
S. tol	-	6.49	6.10	-	-	1.04	-	0.59	7.63	-	-	-	2.39
Leather jacketsTotal	**-**	**13.27**	**6.10**	**-**	**-**	**1.04**	**-**	**1.78**	**29.13**	**0.98**	**-**	**-**	**5.63**
Jacks													
U. helvola	1.49	2.36	17.34	44.82	5.07	3.11	11.86	4.11	8.32	6.89	-	2.30	10.29
Jacks Total	**1.49**	**2.36**	**17.34**	**44.82**	**5.07**	**3.11**	**11.86**	**4.11**	**8.32**	**6.89**	**-**	**2.30**	**10.29**
Other carangids	**1.49**	**2.06**	**11.56**	**15.43**	**6.59**	**4.66**	**2.86**	**8.52**	**6.93**	**19.69**	**-**	**2.30**	**7.51**
Carangids total	**38.77**	**178.66**	**194.27**	**350.11**	**49.70**	**48.14**	**46.61**	**167.16**	**738.63**	**171.26**	**-**	**48.80**	**203.28**

Table 5.7.2.1. Monthly CPUE (kg) of different species of carangids in MTN during 2000-01

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	3.63	2.87	6.86	6.96	2.29	40.42	0.79	21.34	2.26	-	222.22	11.73
D. macrosoma	-	-	-	-	-	-	1.12	-	2.13	-	-	-	0.40
A. djedaba	-	-	-	-	-	-	1.67	-	-	-	-	-	0.30
A. melanoptera	-	-	-	-	-	-	1.95	-	-	-	-	-	0.35
A. vari	-	-	-	-	-	-	1.95	-	-	-	-	-	0.35
A. mate	-	-	-	-	-	-	5.02	-	-	-	-	-	0.89
C. kalla	-	-	-	-	-	1.61	3.35	-	4.27	-	-	-	1.34
Scads total	**-**	**3.63**	**2.87**	**6.86**	**6.96**	**3.90**	**55.48**	**0.79**	**27.75**	**2.26**	**-**	**222.22**	**15.36**
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	-	-	-	-	2.32	4.36	6.41	-	-	-	-	888.89	2.78
C. caeruleopinnatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. fulvoguttatus	-	3.02	2.87	2.29	-	-	-	-	-	-	-	222.22	0.70
C. melampygus	-	-	-	-	-	-	0.56	9.82	28.82	2.26	-	-	4.12
C.sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys total	**-**	**3.02**	**2.87**	**2.29**	**2.32**	**4.36**	**6.97**	**9.82**	**28.82**	**2.26**	**-**	**1111.11**	**7.60**
Horse mackerel													
M. cordyla	-	-	-	-	6.96	4.13	5.58	29.45	0.00	13.56	-	-	7.11
Horse mackerel total	-	-	-	-	6.96	4.13	5.58	29.45	0.00	13.56	-	-	7.11
Leather jackets													
S. commersonnianus	-	-	-	-	-	0.23	-	-	-	-	-	-	0.05
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	**-**	**-**	**-**	**-**	**-**	**0.23**	**-**	**-**	**-**	**-**	**-**	**-**	**0.05**
Jacks							-						
U. helvola	-	2.42	6.90	9.15	3.09	18.59	16.17	4.71	17.08	4.52	-	-	10.88
Jacks total	**-**	**2.42**	**6.90**	**9.15**	**3.09**	**18.59**	**16.17**	**4.71**	**17.08**	**4.52**	**-**	**-**	**10.88**
Other carangids	-	**12.70**	**4.02**	**24.03**	**9.28**	**4.82**	**-**	**-**	**-**	**-**	**-**	**-**	**4.67**
Carangids total	-	21.77	16.67	42.33	28.60	35.80	84.19	44.76	73.64	22.60	-	1333.33	45.67

Table 5.7.2.2. Monthly CPUE (kg) of different species of carangids in MTN during 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	5.42	0.00	2.37	6.30	0.69	14.25	-	81.72	1.59	-	1200.00	14.13
D. macrosoma	-	-	-	-	0.63	0.00	2.85	-	2.69	-	-	-	0.73
A. djedaba	-	-	-	-	-	-	-	-	1.08	-	-	-	0.13
A. melanoptera	-	-	-	-	-	-	-	-	1.08	-	-	-	0.13
A. vari	-	-	-	-	-	-	-	-	2.15	-	-	-	0.26
A. mate	-	-	-	-	-	-	-	-	2.69	-	-	200.00	0.46
C. kalla	-	-	2.87	-	16.38	10.30	9.69	1.59	5.38	1.59	-	-	5.15
Scads Total	**-**	**5.42**	**2.87**	**2.37**	**23.31**	**10.98**	**26.80**	**1.59**	**96.77**	**3.18**	**-**	**1400.00**	**20.99**
Trevallys													
C. ferdau	-	-	3.35	1.36	0.63	3.43	1.14	1.59	1.08	-	-	-	1.52
C. malabaricus	-	2.17	2.39	8.47	0.00	30.89	23.95	35.89	24.19	-	-	-	13.80
C. caeruleopinnatus	-	-	-	1.69	0.63	8.24	0.00	0.80	1.08	-	-	-	1.39
C. fulvoguttatus	-	-	-	2.37	1.26	-	0.00	-	1.08	-	-	-	0.73
C. melampygus	-	-	-	1.36	1.26	-	3.42	-	1.61	-	-	-	0.99
C. sexfasciatus	-	-	-	-	2.52	-	2.28	-	-	-	-	-	0.53
S. nigrofasciatus	-	-	-	-	3.15	4.12	2.28	-	-	-	-	-	0.99
Trevallys total	**-**	**2.17**	**5.75**	**15.24**	**9.45**	**46.67**	**33.07**	**38.28**	**29.03**	**-**	**-**	**-**	**19.94**
Horse mackerel													
M. cordyla	-	-	-	-	10.71	11.67	13.68	3.99	34.41	3.18	-	-	8.65
Horse mackerel total	**-**	**-**	**-**	**-**	**10.71**	**11.67**	**13.68**	**3.99**	**33.87**	**3.98**	**-**	**-**	**8.65**
Leather jackets													
S. commersonnianus	-	-	-	-	0.63	-	-	-	-	-	-	-	0.07
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	**-**	**-**	**-**	**-**	**0.63**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.07**
Jacks													
U. helvola	-	2.17	4.79	1.69	11.34	30.89	6.84	54.23	6.45	-	-	-	11.36
Jacks total	**-**	**2.17**	**4.79**	**1.69**	**11.34**	**30.89**	**6.84**	**54.23**	**6.45**	**-**	**-**	**-**	**11.36**
Other carangids	**-**	**3.25**	**2.87**	**3.39**	**-**	**10.98**	**-**	**12.76**	**3.76**	**-**	**-**	**-**	**3.83**
Carangids total	**-**	**13.02**	**16.28**	**22.70**	**55.45**	**111.19**	**80.39**	**110.85**	**169.89**	**7.16**	**-**	**1400.00**	**64.83**

Table 5.7.2.3. Monthly average CPUE (kg) of different species of carangids in MTN during 2000-01 and 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apri	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	4.27	1.56	3.65	6.71	2.16	31.82	0.53	51.42	1.87	-	700.00	12.76
D. macrosoma	-	-	-	-	0.47	-	1.87	-	2.41	-	-	-	0.54
A. djedaba	-	-	-	-	-	-	1.12	-	0.54	-	-	-	0.22
A. melanoptera	-	-	-	-	-	-	1.49	-	0.54	-	-	-	0.26
A. vari	-	-	-	-	-	-	1.49	-	1.07	-	-	-	0.31
A. mate	-	-	-	-	-	-	3.37	-	1.34	-	-	100.00	0.71
Caranx kalla	-	-	1.56	-	6.23	3.78	5.43	0.53	4.82	0.93	-	-	2.98
Scads total	**-**	**4.27**	**3.13**	**3.65**	**13.18**	**5.84**	**46.69**	**1.06**	**62.14**	**2.80**	**-**	**800.00**	**17.78**
Trevallys													
C.ferdau	-	-	1.07	1.04	0.47	1.06	0.37	0.53	0.54	-	-	-	0.65
C. malabaricus	-	0.78	1.56	6.79	1.44	11.00	12.17	11.84	12.05	-	-	400.00	7.51
C.caeruleopinnatus	-	-	-	1.56	0.47	2.06	-	0.26	0.54	-	-	-	0.60
C. fulvoguttatus	-	2.32	1.56	2.61	0.48	-	-	-	0.54	-	-	100.00	0.71
C. melampygus	-	-	-	1.04	0.48	-	1.50	6.48	15.27	0.93	-	-	2.78
C.sexfasciatus	-	-	-	-	0.96	-	0.75	-	-	-	-	-	0.23
S.nigrofasciatus	-	-	-	-	1.46	1.03	0.75	-	-	-	-	-	0.43
Trevallys total	**-**	**3.10**	**4.70**	**12.64**	**5.27**	**15.13**	**15.54**	**19.20**	**28.92**	**0.93**	**-**	**500.00**	**12.90**
Horse mackerel													
M. cordyla	-	-	-	-	5.62	6.18	8.24	21.04	17.14	7.47	-	-	7.77
Horse mackerel total	**-**	**-**	**-**	**-**	**5.62**	**6.18**	**8.24**	**21.04**	**17.14**	**7.47**	**-**	**-**	**7.77**
Leather jackets	-												
S . commersonnianus	-	-	-	-	0.47	0.34	-	-	-	-	-	-	0.06
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	**-**	**-**	**-**	**-**	**0.47**	**0.34**	**-**	**-**	**-**	**-**	**-**	**-**	**0.06**
Jacks													
U. helvola	-	2.33	5.75	3.65	6.23	21.68	13.10	21.04	11.78	1.87	-	-	11.11
Jacks total	**-**	**2.33**	**5.75**	**3.65**	**6.23**	**21.68**	**13.10**	**21.04**	**11.78**	**1.87**	**-**	**-**	**11.11**
Other carangids	**-**	**9.32**	**3.65**	**8.36**	**5.75**	**6.36**	**-**	**4.21**	**1.87**	**2.26**	**-**	**-**	**4.31**
Carangids total	**-**	**18.63**	**16.71**	**27.18**	**38.81**	**55.02**	**83.11**	**66.54**	**121.69**	**14.00**	**-**	**1300.00**	**53.92**

Table 5.7.3.1. Monthly CPUE (kg) of different species of carangids in H & L during 2000-01

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	1.60	-	0.15
A. melanoptera	-	-	-	-	-	-	-	-	-	-	4.01	-	0.39
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	-	-	-	-	-	-	-	-	-	-	**5.61**	-	**0.54**
Trevallys													
C.ferdau	0.47	-	-	-	-	-	-	-	-	0.00	0.00	-	0.15
C. malabaricus	19.65	0.62	-	-	-	-	-	-	3.67	8.57	12.03	15.87	9.21
C.caeruleopinnatus	1.87	-	-	-	-	-	-	-	-	8.57	11.23	18.52	3.10
C. fulvoguttatus	3.51	-	-	-	-	-	-	-	-	-	43.30	71.43	9.52
C. melampygus	3.51	-	-	-	-	-	-	-	4.89	-	11.23	18.52	3.64
C.sexfasciatus	4.21	-	-	-	-	-	-	-	-	-	6.42	13.23	2.79
S. nigrofasciata	6.32	-	-	-	-	-	-	-	-	-	8.02	5.28	3.17
Trevallys total	**39.53**	**0.62**	-	-	-	-	-	-	**8.56**	**17.13**	**92.22**	**142.86**	**31.68**
Horse mackerel													
M. cordyla	3.04	-	-	-	-	-	-	-	-	-	9.62	21.16	3.17
Horse mackerel total	**3.04**	-	-	-	-	-	-	-	-	-	**9.62**	**21.16**	**3.17**
Leather jackets													
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	4.68	-	-	-	-	-	-	-	2.44	-	1.60	-	1.86
Jacks total	**4.68**	-	-	-	-	-	-	-	**2.44**	-	**1.60**	-	**1.86**
Other carangids	**21.29**	-	**0.77**	**0.60**	-	-	-	-	**11.00**	-	-	-	**7.90**
Carangids total	**68.64**	**0.62**	**0.77**	**0.60**	-	-	-	-	**22.00**	**17.13**	**109.06**	**164.02**	**45.06**

Table 5.7.3.2. Monthly CPUE (kg) of different speceis of carangids in H & L during 2001- 02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	22.90	-	-	-	-	-	-	-	-	-	-	-	1.56
A. melanoptera	-	-	1.28	-	-	-	-	-	-	-	-	3.99	1.21
A. vari	-	-	2.56	-	-	-	-	-	-	-	-	3.19	1.39
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	**22.90**	**-**	**3.85**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**7.18**	**4.16**
Trevallys													
C. ferdau	10.18	-	-	-	-	-	-	-	-	-	-	1.59	1.04
C. malabaricus	30.53	-	-	-	-	-	-	-	-	-	-	19.14	6.58
C.caeruleopinnatus	35.62	-	-	-	-	-	-	-	-	-	-	3.99	3.29
C. fulvoguttatus	12.72	-	-	-	-	-	-	-	-	-	-	3.19	2.94
C. melampygus	20.36	-	-	-	-	-	-	-	-	-	-	7.18	2.94
C.sexfasciatus	45.80	-	-	-	-	-	-	-	-	-	-	1.59	3.46
S. nigrofasciata	53.44	-	-	-	-	-	-	-	-	-	-	1.59	3.98
Trevallys total	**208.65**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4.47**	**-**	**-**	**38.28**	**22.87**
Horse mackerel													
M. cordyla	30.53	-	-	-	-	-	-	-	-	-	77.98	15.15	8.31
Horse mackerel total	**30.53**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**77.98**	**15.15**	**8.31**
Leather jackets	-	-	-	-	-	-	-	-	-	-	-	-	-
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks	-	-	-	-	-	-	-	-	-	-	-	-	-
U. helvola	5.09	-	-	-	-	-	-	-	2.24	-	-	-	0.52
Jacks total	**5.09**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.24**	**-**	**-**	**-**	**0.52**
Other carangids	**12.72**	**2.79**	**0.64**	**1.97**	**-**	**-**	**-**	**-**	**13.42**	**-**	**-**	**6.38**	**3.81**
Carangids total	**279.90**	**2.79**	**4.49**	**1.97**	**-**	**-**	**-**	**-**	**15.66**	**-**	**77.98**	**66.99**	**39.67**

Table 5.7.3.3. Monthly average CPUE (kg) of different species of carangids in H & L during 2000- 01 and 2001- 02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	2.14	-	-	-	-	-	-	-	-	-	1.36	-	0.64
A. melanoptera	-	-	0.70	-	-	-	-	-	-	-	4.09	2.98	0.64
A. vari	-	-	1.40	-	-	-	-	-	-	-	-	1.99	0.43
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	**2.14**	**-**	**2.10**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**5.45**	**4.97**	**1.71**
Trevallys													
C.ferdau	1.29		-	-	-	-	-	-	-	-	-	0.99	0.42
C. malabaricus	20.57	1.01	-	-	-	-	-	-	4.73	6.83	10.91	17.91	8.45
C.caeruleopinnatus	4.71	-	-	-	-	-	-	-	-	6.83	9.55	9.45	3.16
C. fulvoguttatus	4.28	-	-	-	-	-	-	-	-	-	36.83	28.86	7.06
C. melampygus	4.93	-	-	-	-	-	-	-	3.16	-	9.55	11.44	3.42
C. sexfasciatus	7.71	-	-	-	-	-	-	-	-	-	5.46	5.97	3.00
S. nigrofasciata	10.28	-	-	-	-	-	-	-	-	-	6.82	2.99	3.42
Trevallys total	**53.77**	**1.01**	**-**	**-**	**-**	**-**	**-**	**-**	**7.89**	**13.66**	**79.12**	**77.61**	**28.88**
Horse mackerel	-	-	-	-	-	-	-	-	-	-	-	-	-
M. cordyla	5.56	-	-	-	-	-	-	-	-	-	20.46	17.91	4.76
Horse mackerel total	**5.56**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**20.46**	**17.91**	**4.76**
Leather jackets	-	-	-	-	-	-	-	-	-	-	-	-	-
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks	-	-	-	-	-	-	-	-	-	-	-	-	-
U. helvola	4.71	-	-	-	-	-	-	-	3.16	-	1.36	-	1.44
Jacks total	**4.71**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3.16**	**-**	**1.36**	**-**	**1.44**
Other carangids	**20.57**	**1.01**	**0.70**	**0.92**	**-**	**-**	**-**	**-**	**12.63**	**-**	**-**	**3.98**	**6.63**
Carangids total	**86.33**	**1.01**	**2.80**	**0.92**	**-**	**-**	**-**	**-**	**22.11**	**13.65**	**105.04**	**103.48**	**43.44**

Table 5.7.4.1. Monthly CPUE (kg) of different species of carangids in OBRS during 2000-01

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	1.61	-	0.08
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	-	-	-
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.61**	**-**	**0.08**
Trevallys							-						
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	1.41	2.49	1.20	-	-	35.89	2.30	0.49	1.27	1.38	-	-	2.68
C. caeruleopinnatus	-	-	-	-	-	2.39	-	-	-	-	-	-	0.12
C. fulvoguttatus	-	-	-	-	-	7.97	-	-	-	-	-	-	0.40
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys total	**1.41**	**2.49**	**1.20**	**-**	**-**	**46.25**	**2.30**	**0.49**	**1.27**	**1.38**	**-**	**-**	**3.24**
Horse mackerel													
M. cordyla	-	0.99	1.20	1.40	82.03	-	-	1.22	1.27	1.11	-	-	4.21
Horse mackerel total	**-**	**0.99**	**1.20**	**1.40**	**82.03**	**-**	**-**	**1.22**	**1.27**	**1.11**	**-**	**-**	**4.21**
Leather jackets							-						
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	0.70	0.99	0.60	0.00	43.95	43.06	142.86	3.40	0.64	3.87	0.81	2.35	10.52
Jacks total	**0.70**	**0.99**	**0.60**	**0.00**	**43.95**	**43.06**	**142.86**	**3.40**	**0.64**	**3.87**	**0.81**	**2.35**	**10.52**
Other carangids	**0.70**	**-**	**1.80**	**3.73**	**-**	**9.67**	**23.04**	**1.94**	**3.82**	**0.66**	**-**	**-**	**2.64**
Carangids total	**2.81**	**4.34**	**4.79**	**5.13**	**125.98**	**98.88**	**168.20**	**7.05**	**7.00**	**6.91**	**2.42**	**2.35**	**20.86**

Table 5.7.4.2. Monthly CPUE (kg) of different species of carangids in OBRS during 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	3.00	-	151.96	19.89	29.62	-	-	-	66.25	-	21.23
D. macrosoma	-	-	-	-	-	-	-	-	-	-	6.31	-	0.82
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	1.80	-	0.24
A. vari	-	-	-	-	-	-	-	-	-	-	2.25	-	0.29
A. mate	-	-	-	-	-	-	-	-	-	-	1.80	-	0.24
Caranx kalla	-	-	-	-	-	-	21.42	-	-	-	4.96	-	2.65
Scads total	-	-	3.00	-	151.96	19.89	51.04	-	-	-	83.37	-	25.47
Trevallys													
C.ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	6.51	-	-	2.12	-	-	-	6.91	15.50	1.16	-	-	1.12
C.caeruleopinnatus	-	-	-	-	-	-	-	4.61	7.75	0.00	-	-	0.35
C. fulvoguttatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	0.71	-	-	-	-	-	-	-	-	0.12
Trevalys total	**6.51**	**-**	**-**	**2.82**	**-**	**-**	**-**	**11.52**	**23.26**	**1.16**	**-**	**-**	**1.59**
Horse mackerel													
M. cordyla	-	1.08	1.00	1.41	-	-	-	5.76	255.81	4.63	-	-	4.88
Horse mackerel total	**-**	**1.08**	**1.00**	**1.41**	**-**	**-**	**-**	**5.76**	**255.81**	**4.63**	**-**	**-**	**4.88**
Leather jackets													
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	3.26	-	2.50	-	-	-	-	2.30	7.75	1.16	-	-	0.65
Total	3.26	-	2.50	-	-	-	-	2.30	7.75	1.16	-	-	0.65
Other carangids	**19.54**	**1.08**	**1.00**	**-**	**-**	**-**	**-**	**1.15**	**7.75**	**1.16**	**-**	**-**	**0.82**
Carangids total	**29.32**	**2.17**	**7.49**	**4.24**	**151.96**	**19.89**	**51.04**	**20.74**	**294.67**	**8.11**	**83.37**		**33.41**

Table 5.7.4.3. Monthly average CPUE (kg) of different species of carangids in OBRS during 2000-01 and 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	1.63	-	70.83	9.95	19.14	-	-	-	43.37	-	8.71
D. macrosoma	-	-	-	-	-	-	-	-	-	-	4.05	-	0.34
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	1.16	-	0.10
A. vari	-	-	-	-	-	-	-	-	-	-	1.45	-	0.12
A. mate	-	-	-	-	-	-	-	-	-	-	1.16	-	0.10
C. kalla	-	-	-	-	-	-	13.84	-	-	-	3.18	-	1.08
Scads total	**-**	**-**	**1.63**	**-**	**70.83**	**9.95**	**32.98**	**-**	**-**	**-**	**54.08**	**-**	**10.43**
Trevallys													
C.ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	2.31	1.28	0.54	1.21	-	16.71	0.81	1.61	2.35	1.34	-	-	2.06
C.caeruleopinnatus	-	-	-	-	-	1.57	-	0.80	0.59	-	-	-	0.22
C. fulvoguttatus	-	-	-	-	-	3.98	-	-	-	-	-	-	0.24
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. nigrofasciata	-	-	-	0.40	-	-	-	-	-	-	-	-	0.05
Trevallys Total	**2.31**	**1.53**	**0.54**	**1.61**	**0.00**	**23.09**	**0.81**	**2.41**	**2.94**	**1.34**	**-**	**-**	**2.57**
Horse mackerel													
M. cordyla	-	1.02	1.09	1.41	43.75	-	-	2.01	20.59	1.79	-	-	4.48
Horse mackerel total	**-**	**1.02**	**1.09**	**1.41**	**43.75**	**-**	**-**	**2.01**	**20.59**	**1.79**	**-**	**-**	**4.48**
Leather jackets	-	-	-	-	-	-	-	-	-		-		-
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1.16	0.51	1.63	0.00	23.44	21.50	50.49	3.21	1.18	3.35	0.29	1.42	6.57
Jacks Total	1.16	0.51	1.63	0.00	23.44	21.50	50.49	3.21	1.18	3.35	0.29	1.42	6.57
Other carangids	**1.16**	**0.51**	**1.36**	**1.61**	**-**	**4.78**	**8.14**	**2.00**	**4.12**	**0.67**	**-**	**-**	**1.92**
Carangids total	4.62	3.57	6.53	4.82	138.54	59.71	92.43	9.63	28.82	7.14	53.78	1.42	25.99

Table 5.7.5.1. Monthly CPUE (kg) of different species of carangids in OBGN during 2000-01

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	-	-	-
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	1.11	-	-	-	2.17	2.76	4.03	4.42	6.91	6.09	2.56	4.58	2.64
C.caeruleopinnatus	-	-	-	-	1.08	1.66	3.53	0.74	-	-	-	-	0.82
C. fulvoguttatus	-	-	-	-	2.17	-	-	-	-	-	-	-	0.25
C. melampygus	-	-	-	-	2.17	-	-	-	-	-	-	-	0.25
C. sexfasciatus	-	-	-	-	1.08	-	-	-	-	-	-	-	0.13
S. nigrofasciata	-	-	-	-	1.08	-	-	-	-	-	-	-	0.13
Trevallys total	**1.11**	**-**	**-**	**-**	**9.75**	**4.42**	**7.56**	**5.15**	**6.91**	**6.09**	**2.56**	**4.58**	**4.22**
Horse mackerel													
M. cordyla	-	-	-	-	5.96	5.53	5.54	-	-	-	-	-	2.01
Horse mackerel total	-	-	-	-	5.96	**5.53**	**5.54**	**-**	**-**	**-**	**-**	**-**	**2.01**
Leather jackets													
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1.11	-	-	-	0.54	2.76	1.01	15.45	1.15	2.03	-	-	2.08
Jacks total	**1.11**	**-**	**-**	**-**	**0.54**	**2.76**	**1.01**	**15.45**	**1.15**	**2.03**	**-**	**-**	**2.08**
Other carangids	**1.11**	**-**	**-**	**-**	**0.54**	**3.87**	**2.52**	**7.36**	**-**	**-**	**2.56**	**-**	**1.64**
Carangids total	**3.34**	**-**	**-**	**-**	**16.78**	**16.58**	**16.62**	**27.96**	**8.06**	**8.12**	**5.12**	**4.58**	**9.95**

Table 5.7.5.2. Monthly CPUE (kg) of different species of carangids in OBGN during 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apri	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	7.06	-	-	-	-	-	-	-	-	-	0.47
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads Total	**-**	**-**	**7.06**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.47**
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	2.42	-	-	-	-	-	-	-	11.98	-	2.03	5.72	1.96
C.caeruleopinnatus	-	-	-	-	-	-	-	-	0.00	-	-	-	-
C. fulvoguttatus	-	-	-	-	-	-	-	-	0.00	-	-	-	-
C. melampygus	-	-	-	-	-	-	-	-	5.99	-	-	-	0.16
C. sexfasciatus	-	-	-	-	-	-	-	-	11.98	-	-	-	0.31
S. nigrofasciata	-	-	-	-	-	3.53	-	-	14.97	-	-	-	0.86
Trevallys total	**2.42**	**-**	**-**	**-**	**-**	**10.59**	**-**	**-**	**44.91**	**-**	**2.03**	**5.72**	**3.30**
Horse mackerel													
M. cordyla	-	-	-	-	5.76	5.88	9.11	-	-	-	-	-	2.59
Horse mackerel total	**-**	**-**	**-**	**-**	**5.76**	**5.88**	**9.11**	**-**	**-**	**-**	**-**	**-**	**2.59**
Leather jackets													
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1.21	-	-	-	-	-	-	-	5.99	-	1.01	-	0.31
Jacks total	**1.21**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**5.99**	**-**	**1.01**	**-**	**0.31**
Other carangids	**-**	**-**	**-**	**-**	**10.37**	**-**	**4.91**	**1.80**	**5.99**	**-**	**-**	**-**	**2.20**
Carangids total	**3.64**	**-**	**7.06**	**-**	**16.13**	**16.47**	**14.02**	**1.80**	**56.89**	**-**	**3.04**	**5.72**	**9.03**

Table 5.7.5.3. Monthly Average CPUE (kg) of different species of carangids in OBGN during 2000-01 and 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	4.07	-	-	-	-	-	-	-	-	-	0.21
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	-	-	**4.07**	-	-	-	-	-	-	-	-	-	**0.21**
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	2.32	-	-	-	1.12	5.12	2.34	3.13	8.32	3.15	2.26	5.15	2.41
C.caeruleopinnatus	-	-	-	-	0.56	1.13	2.34	1.04	-	-	-	-	0.45
C. fulvoguttatus	-	-	-	-	1.12	-	-	-	-	-	-	-	0.14
C. melampygus	-	-	-	-	1.12	-	-	-	1.66	-	-	-	0.21
C. sexfasciatus	-	-	-	-	0.56	-	-	-	3.33	-	-	-	0.21
S.nigrofasciata	-	-	-	-	0.56	1.71	-	-	4.16	-	-	-	0.45
Trevallys total	**2.32**	-	-	-	**5.02**	**7.41**	**4.68**	**4.17**	**17.47**	**3.15**	**2.26**	**5.15**	**3.93**
Horse mackerel													
M. cordyla	-	-	-	-	5.86	5.70	7.03	-	-	-	-	-	2.27
Horse mackerel total	-	-	-	-	**5.86**	**5.70**	**7.03**	-	-	-	-	-	**2.27**
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	1.16	-	-	-	0.28	1.42	0.59	11.48	3.53	1.05	1.13	-	1.38
Jacks total	**1.16**	-	-	-	**0.28**	**1.42**	**0.59**	**11.48**	**3.53**	**1.05**	**1.13**	-	**1.38**
Other carangids	**1.16**	-	-	-	**5.30**	**1.99**	**3.52**	**6.26**	**1.66**	-	**1.13**	-	**2.00**
Carangids total	**3.48**	-	**4.07**	-	**16.74**	**16.52**	**15.82**	**20.87**	**21.63**	**4.21**	**395.00**	**5.15**	**9.67**

Table 5.7.6.1. Monthly CPUE (kg) of different species of carangids in NMGN during 2000-01

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	-	-	-	-	-	-	-	-	-	-	-
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys													
C. ferdau	-	-	-	-	-	-	-	-	-	-	-	-	-
C. malabaricus	-	-	-	11.76	4.01	-	5.39	8.57	-	-	-	-	1.81
C.caeruleopinnatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. fulvoguttatus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. melampygus	-	-	-	-	-	-	-	-	-	-	-	-	-
C.sexfasciatus	-	-	-	-	-	-	-	-	-	-	-	-	-
S.nigrofasciata	-	-	-	-	-	-	-	-	-	-	-	-	-
Trevallys Total	-	-	-	**11.76**	**4.01**	-	**5.39**	**8.57**	-	-	-	-	**1.81**
Horse mackerel													
M. cordyla	-	-	-	-	-	-	-	-	-	-	-	-	-
Horse mackerel Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets													
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	-	-	-	2.35	-	1.55	1.35	-	-	-	-	-	0.30
Jacks Total	-	-	-	**2.35**	-	**1.55**	**1.35**	-	-	-	-	-	**0.30**
Other carangids	-	**159.66**	**4.34**	**2.35**	-	-	-	-	**0.98**	**1.30**	-	-	**15.91**
Carangids total	-	**159.66**	**4.34**	**16.47**	**4.01**	**1.55**	**6.74**	**8.57**	**0.98**	**1.30**	-	-	**18.03**

Table 5.7.6.2. Monthly CPUE (kg) of different species of carangids in NMGN during 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	6.77	-	-	-	-	-	-	-	-	-	0.70
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	-	-	**6.77**	-	-	-	-	-	-	-	-	-	**0.70**
Trevallys							-						
C. ferdau	-	2.64	-	-	-	-	-	-	-	-	-	-	0.23
C. malabaricus	-	5.28	-	10.92	5.79	4.85	9.38	-	21.74	4.63	-	-	3.52
C. caeruleopinnatus	-	2.64	-	4.37	-	-	-	-	-	-	-	-	0.47
C. fulvoguttatus	-	3.96	-	-	-	-	-	-	-	-	-	-	0.35
C. melampygus	-	5.28	-	-	-	-	-	-	-	-	-	-	0.59
C. sexfasciatus	-	5.28	-	-	-	-	-	-	-	-	-	-	0.47
S. nigrofasciatus	-	5.28	-	-	-	-	-	-	-	-	-	-	0.47
Trevallys total	-	**30.34**	-	**15.28**	**5.79**	**4.85**	**9.38**	-	**21.74**	**4.63**	-	-	**6.11**
Horse mackerel													
M. cordyla	-	-	-	-	-	-	-	-	-	-	-	-	-
Horse mackerel total	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jacket													
S. commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	-	2.64	2.26	-	2.32	-	-	-	-	-	-	-	0.70
Jacks total	-	**2.64**	**2.26**	-	**2.32**	-	-	-	-	-	-	-	**0.70**
Other carangids	-	**11.87**	-	**4.37**	-	-	-	-	-	-	-	-	**1.29**
Carangids total	-	**46.17**	**9.03**	**19.65**	**8.11**	**4.85**	**9.38**	-	**21.74**	**4.63**	-	-	**8.81**

Table 5.7.6.3. Monthly average CPUE (kg) of different species of carangids in NMGN during 2000-01 and 2001-02

Species/Months	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apri	May	Jun	July	Aug	Annual
Scads													
D. russelli	-	-	-	-	-	-	-	-	-	-	-	-	-
D. macrosoma	-	-	-	-	-	-	-	-	-	-	-	-	-
A. djedaba	-	-	-	-	-	-	-	-	-	-	-	-	-
A. melanoptera	-	-	4.45	-	-	-	-	-	-	-	-	-	0.33
A. vari	-	-	-	-	-	-	-	-	-	-	-	-	-
A. mate	-	-	-	-	-	-	-	-	-	-	-	-	-
C. kalla	-	-	-	-	-	-	-	-	-	-	-	-	-
Scads total	-	-	**4.45**	-	-	-	-	-	-	-	-	-	**0.33**
Trevallys													
C.ferdau	-	1.17	-	-	-	-	-	-	-	-	-	-	0.11
C. malabaricus	-	2.34	-	11.31	4.74	2.72	7.24	4.42	3.31	1.01	-	-	2.60
C.caeruleopinnatus	-	1.17	-	2.26	-	-	-	-	-	-	-	-	0.22
C. fulvoguttatus	-	1.75	-	-	-	-	-	-	-	-	-	-	0.22
C. melampygus	-	2.92	-	-	-	-	-	-	-	-	-	-	0.33
C. sexfasciatus	-	2.34	-	-	-	-	-	-	-	-	-	-	0.22
S. nigrofasciata	-	2.34	-	-	-	-	-	-	-	-	-	-	0.22
Trevallys total	-	**14.04**	-	**13.57**	**4.74**	**2.72**	**7.24**	**4.42**	**3.31**	**1.01**	-	**0.00**	**3.79**
Horse mackerel													
M. cordyla	-	-	-	-	-	-	-	-	-	-	-	-	-
Horse mackerel total	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather jackets													
S . commersonnianus	-	-	-	-	-	-	-	-	-	-	-	-	-
S. tol	-	-	-	-	-	-	-	-	-	-	-	-	-
Leather Jackets total	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacks													
U. helvola	-	1.17	1.48	1.13	0.95	1.35	1.44	-	-	-	-	-	0.54
Jacks total	-	**1.17**	**1.48**	**1.13**	**0.95**	**1.35**	**1.44**	-	-	-	-	-	**0.54**
Other carangids	-	**94.73**	**1.48**	**3.39**	-	-	-	-	**1.65**	**1.01**	-	-	**9.21**
Carangids total	-	**109.94**	**7.42**	**18.10**	**5.69**	**4.07**	**8.68**	**4.42**	**4.96**	**2.03**	-	-	**13.76**

Table 5.8.1. Districtwise catch (t) of carangids in the Malabar area during 2000-01

Month/Districts	Malappuram	Kozhikode*	Kannur	Kasargod	Total catch
September	17	215	1	28	261
October	28	185	42	12	267
November	20	468	28	16	532
December	76	412	74	11	573
January	5	464	5	0	474
February	2	387	9	0	398
March	7	287	7	1	302
April	77	648	0	0	725
May	44	614	0	0	658
June	42	875	0	0	917
July	25	248	0	16	289
August	42	548	0	22	612
Total	385	5351	166	106	6008
Total catch	48608	95457	33330	10894	188289

Table 5.8.2. Districtwise catch (t) of carangids in the Malabar area during 2001-02

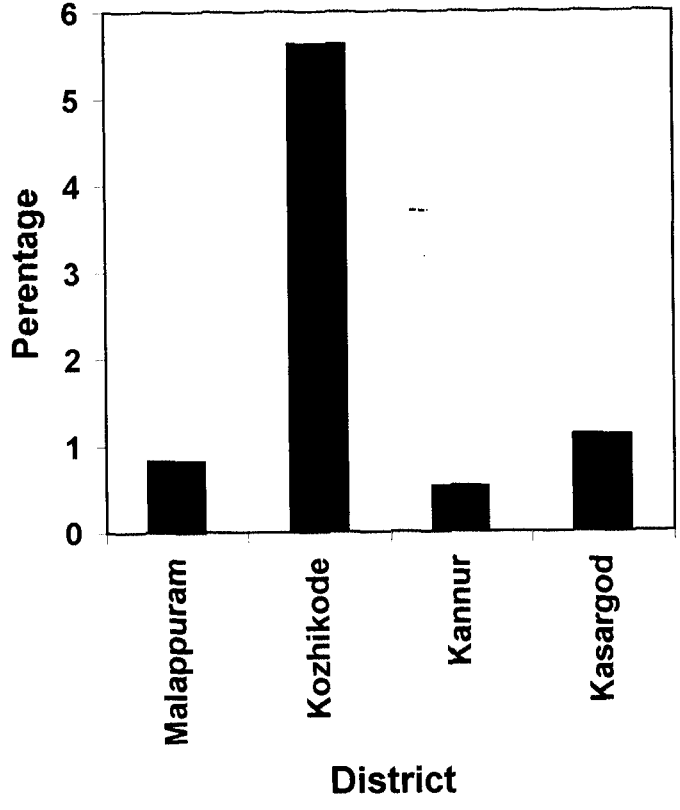
Month/Districts	Malappuram	Kozhikode*	Kannur	Kasargod	Total catch
September	19	278	2	35	334
October	31	245	38	18	332
November	22	308	27	22	379
December	86	389	87	14	576
January	4	387	3	2	396
February	8	465	10	0	483
March	14	320	6	2	342
April	85	719	0	1	805
May	42	798	0	0	840
June	49	798	0	0	847
July	32	612	0	22	666
August	40	428	0	24	492
Carangids Total	432	5747	173	140	6492
Total catch	51148	101987	31478	11248	195861

Table 5.8.3. Districtwise average catch (t) of carangids in the Malabar area during 2000-01 and 2001-02

Month/Districts	Malappuram	Kozhikode*	Kannur	Kasargod	Total catch
September	18	247	2	32	298
October	30	215	40	15	300
November	21	388	28	19	456
December	81	401	81	13	575
January	5	426	4	1	435
February	5	426	10	0	441
March	11	304	7	2	322
April	81	684	0	1	765
May	43	706	0	0	749
June	46	837	0	0	882
July	29	430	0	19	478
August	41	488	0	23	552
Carangids Total	409	5549	170	123	6250
Total catch	49878	98722	32404	11071	192075

* Calicut

Fig. 5.8.1. Average districtwise percentage composition of carangids to the total marine landing along the Malabar coast



Chapter-6

Food and Feeding Habits of *Decapterus russelli* (Ruppell)

5.1. Introduction

Study of food and feeding of fishes forms an important aspect of the biology of the fish. The distribution and fluctuation of the organisms that constitute the food of a species, influence the shoaling behavior, migration, growth, condition, the ecological niche it occupies in the sea, feeding adopted by the fish, its feeding behavior, and even the fishery. In view of this importance, considerable attention is being paid to this subject in recent years. In a competitive multispecies multi gear fishing as in the carangid fishery the study on food and feeding of fishes and their position in the food web becomes all the more significant in management of their stocks.

Earlier works on this subject include those of Day (1882), Hederman and Corbin (1892) and Hornell and Nayadu (1924). Other significant studies include those of Scot (1902), Johnston (1906), Le Bour (1919), Hardy (1924), Neill (1938), Swynnerton and Worthingon (1940), Frost (1943), Hynes (1950) and Maitland (1965).

The pioneering work on the food and feeding of marine species (*Sardinella longiceps*) from India was done by Hornell and Nayadu (1924). Food and feeding habits of some other marine pelagic species were studied by Devanesan (1932), Chacko (1949), Bhimachar and George (1952), Datar (1954), Venkataraman (1960), Tandon (1960b), Kuthalingam (1961) and James (1967). Qasim (1972) reported on the dynamics of food and feeding habits of some of the marine fishes. The food and feeding habits of carangids in Indian waters have been studied by Kagwade, 1967 ; Reuben, 1968 ; Hamsa and Kasim ; 1989 and Shameen, 1992. Sivakami (1996) and Nair (2000) have recently reviewed the food and feeding of carangids of Indian coasts.

The food and feeding habits of a few *Decapterus* spp. have been studied in India and abroad. Outside India the studies have been mainly carried out in the South East Asian countries. Tang *et al.*, (1997) have reported from China; Tiews (1958) and Tiews *et al.*,

(1970 and 1975) from Philippines, Widodo (1988) and Atmaja (1988) from Indonesia. Devaraj *et al.*, (1997) have reviewed the work carried out on small pelagic resources in the South East Asian countries including India.

A few reports on the food and feeding of scads from Indian waters are also available. The earlier report was by Vekataramanan (1960) on the food contents of *Decapterus russelli* from Calicut waters followed by the report of Basheeruddin and Nayar (1962) from Madras. Sreenivasan (1979) reported the food and feeding habits of *Decapterus dayi* from Vizhinjam waters. Raje (1997) has studied the food contents of *Decapterus russelli* from Veraval waters. Reuben *et al.*, (1992) reported on the feeding habits of major carangids including *Decapterus russelli* from Indian coasts. Nair (2000), while reviewing the research work carried out so far on various aspects of carangid resources of India has given details of work done on food and feeding habits of *Decapterus* spp. from different parts of the country. In the present study the food and feeding habits of the *Decapterus russelli* caught in trawl and ring seines operating along the Malabar coast have been studied in detail.

6.2. Results

The 18 items of food components in the guts were grouped into 7 main groups. The total volume gained by each group of food was sized down to percentage and thus obtained the percentage composition of 7 groups of main food items. The groups are as follows.

1. Crustaceans: Consisting of prawns, *Acetes* spp. and other crustaceans that could not be identified which include the pieces of body parts of lobster, squilla, amphipods, crabs etc.
2. Fish: Consisting of different species of fishes.
3. Polycheates
4. Salpa
5. Detritus

6. Miscellaneous: Consisting of bivalves, gastropods, cheatoceros, ostracods, unidentified food materials and molluscs (cephalopods). Ostaracods have been included in miscellaneous food items due to its negligible contributions in food.
7. Digested matter. Unrecognisable, digested, gelatinous mass, a product of all ingested food, formed in the process of digestion and present in most of the guts, has been taken into consideration as content of the gut and not as food.

Estimation of number of stomachs in different degrees of fullness separately and sized down to percentage have determined intensity of feeding. Percentage composition of main food items, percentage of prevalence of each food item and intensity of feeding have been enumerated separately, in each case for males, females and males and females combined, month wise, length group wise, season wise (pre monsoon, monsoon, post monsoon), and according to the stages of maturity for females.

The food items encountered in the stomach of the fishes are recorded under 18 headings for determination of percentage of prevalence is as follows:

1. Prawns: *Penaeus indicus*, *Metapenaeus monoceros* and *M.brevicornis* and *Parapenaeopsis stylifera.*
2. Other crustaceans: The broken and destroyed pieces of crustaceans not digested but unidentifiable.
3. *Acetes* spp: Mainly *Acetes indicus.*
4. Lobsters: Pieces of lobsters in a few cases.
5. Squilla: *Squilla* spp
6. Fish: Mainly *Stolephorus* spp., *Lactarius lactarius*, silver bellies, eels, *Trypauchen vagina*, *Bregmaceros maclandi*, mullets, gobies, fish scales, fish bones and eye balls.
7. Polycheates: *Doiopatra* spp., *Onuphis* spp. and other unidentified polycheates.
8. Salpa: *Salpa* spp.
9. Bivalves: Minute bivalves
10. Gastropods: Minute gastropods
11. Amphipods: *Gamarus* spp and other amphipods

12. Crabs: Crabs and megalopa.
13. Detritus: Minute fragments of bivalves, gastropod shells and calcareous fragments of echinoderms.
14. Cheatoceros: Mainly found along with *Acetes indicus*.
15. Ostrcods: Observed in negligible quantities.
16. Unidentified: In few cases, pieces of flesh encountered, could not be identified.
17. Molluscs: Pieces of, *Sepia* spp. or *Loligo* spp. observed only in few cases.
18. Digested and semi digested matter has been taken into consideration as content of the gut, not as food.

6.2.1. Percentage composition of stomach contents

6.2.1.1. Males

1. Crustaceans

Year wise fluctuation in the feeding of crustaceans showed that highest feeding of crustaceans was observed in the month of September in both the years 2000-01 and 2001-02 forming 65.87% and 70.35% respectively (Table 6.1.1 and Table 6.1.2). Lowest feeding of crustaceans was observed in November in both the years. The average for the two-year period indicated the presence of crustacean food in gut fluctuated between 22.07 % and 68.11 %. Maximum crustacean intake was in September (68.11 %) and minimum (22.07 %) in November (Table 6.1.3). It was present in the gut throughout the year and the average intake of crustaceans during the two-year period was 52.34% (Fig 6.1.3).

2. Fishes

Year wise fluctuation in the feeding of fishes by male *Decapterus russelli* showed that in 2000-01 the quantity of fishes ranged between 5.68 % (March) and 48.21 % (November) and average intake of fish food item in the stomach was 19.65 % (Fig 6.1.1). In the year 2001-02 also highest volume of fish as food item was observed in the month of November (46.89 %) and lowest in March (4.90 %). The average volume of

fish in the stomach was 20.19% (Fig 6.1.2). The average for the years 2000-2001 and 2001-2002 indicated that the fish food fluctuated between 5.29 % and 47.55 %. Maximum (47.55 %) was observed in November and minimum (5.29 %) in March. The fish food was present in the gut throughout the period of investigation and the average intake during the study period was 19.92 % (Fig 6.1.3.).

3. Polycheates

Polycheates were not present in all the months. In 2000-01, the volume of this food item ranged between 1.65 % (June) and 15.12 % (December) and the average intake of this group was 4.31 %. In the year 2001-02, the volume of polycheates in the stomach ranged between 1.88 % (June) and 11.33 % (December) and the average intake of polycheates in the stomachs during this period was 3.83%.

The average for the two-year period of study showed that the volume of polycheates, in the stomach fluctuated from 1.77 % to 13.23 %. Maximum (13.23 %) was noticed in December, and minimum 1.77 % in June. Polycheates were absent in gut for five months in October, January, May, July and August.

5. Salpa

The quantity of salpa ranged between 1.21 % and 35.84 % in 2000-01 and average volume was 11.12 %. In 2001-02, the range of salpa in the stomach was between 0.62% and 36.11% and the average consumption of salpa during this period was 11.12 %. The average for the study period indicated that salpa as a component of the gut contents fluctuated from 0.92 % (November) to 35.98 % (April). It was absent during September, October, December and February. The average for the study period was 11.12 %.

5. Digested matter

Month wise fluctuation of digested matter in *Decapterus russelli* during 2000-2001 and 2001-2002 showed almost similar pattern. In the two-year period, the range of fluctuation was between 0.83 % and 35.91 %. Maximum amount of digested matter was

observed in the stomach in June (35.91 %) and minimum in April (0.83 %). In other months it varied between 1.70 % and 9.89 %. It was present in the gut throughout the period of investigation. The average composition of digested matter in the stomach was 8.23 %.

6. Detritus

The range of detritus in the stomach in the year 2000-01 was between 1.25 % (August) and 4.58 % (November) and the average intake of detritus during this period was 2.03 %. In the year 2001-02 the volume of detritus in the stomach ranged between 0.55 % (August) and 6.21 % (November) and on average they formed 2.25 %. Detritus was not present in all the months.

The averages for the study period indicated that the range of fluctuation was between 0.90 % (August) and 5.40 % (November). It was absent in October, May and June. The average contribution of detritus in the stomach during the study period was 2.14 %.

7. Miscellaneous

The intake of miscellaneous items by *Decapterus russelli* ranged between 0.68 % (March) and 17.59 % (August) in 2000-01 and the average volume was 2.17 %. In the year 2001-02 their volume ranged between 0.61 % (March) and 16.57 % (August) and on an average they formed 2.19 %.

The average intake of miscellaneous food items for both the years indicated that this item was not present all the months. Maximum 17.08 % was observed in August and minimum in February. Average for the study period was 2.18 %. Miscellaneous food items were absent during September-October, December-January and April-June.

6.2.1.2. Females

1. Crustaceans:

Crustaceans formed a major component in the food items of female *Decapterus russelli* and their intake ranged between 32.65 % (July) and 83.68 % (August) and on an average they formed 55.20 % of the food items in the year 2000-01 (Table 6.2.1 and Table 6.2.2). In 2000-2002, the range of crustaceans in the stomach was between 33.67 % (March) and 87.02 % (July) and the average composition of crustaceans in the stomach during the period was 56.60 % (Fig 6.2.1 and Fig 6.2.2).

The average for the years 2000-01 and 2001-02 showed that this most important group of food items fluctuated within the range of 33.67 % and 72.23 %. Crustaceans were present in the stomach throughout the year and their average composition during this period was 55.71 % in the stomachs of female *Decapterus russelli* (Table 6.2.3 and Fig 6.2.3).

2. Fishes

The intake of fish in the stomach in 2000-2001 ranged between 4.80 % (February) and 38.12 % (October) and the average consumption was 22.97 %. In the year 2001-02 the volume of fishes in the stomach ranged between 4.80 % (February) and 38.12 % (October) and the average composition of this item in the stomach was 22.26 %. This item was present in the stomach throughout the period. The averages for the study period indicated that the volume of fish as food item fluctuated from 4.81 % (February) to 37.94 % (October). The volume of fish was 22.33 % and it formed the second important food item of *Decapterus russelli* after crustaceans.

3. Polycheates

Polycheates were present in the stomach in all the months except in October, January and August and their volume in the food ranged between 1.54 % (November) to

16.54 % (May) with an average volume of 4.98 % during the year 2000-01. In 2001-02, the intake of polycheates ranged between 0.16 % (November) and 20.40 % (April) and the average was 4.57 %.

The average for the two-year study period showed that the polycheates composition ranged from 0.85 % (November) to 14.42 % (February). It was absent in October, January, and August. The average percentage for this period was found to be 4.78 %.

4. Salpa

Salpa was present in the stomach for ten months in 2000-01 and their volume in the stomach ranged between 0.51 % (December) to 18.54 % (July) and the average intake of salpa was 7.24 %. In 2001-02, the quantity of salpa present in the stomach was between 0.51 % (December) and 16.35 % (January) and the average for the year was 7.22 %.

The average for this period indicated that salpa occurred within the range of 0.51% (December) to 16.35% (January). It was absent in October and August. The average composition of salpa during study period was 7.23 %.

5. Detritus

Detritus was observed for nine months in 2000-01 and its volume ranged between 0.51 % (December) to 8.65 % (February) with an average composition of 2.04 %. In 2001-02 also it was observed for nine months within the range from 0.31 % (May) to 8.65 % (February) and the average volume was 1.65 %.

The average monthly data for the two-year study period showed that the volume of detritus was highest (8.65 %) in February, and lowest (0.19 %) in August. During October and July it was absent. The average intake for the entire period was 1.84 %

6. Digested matter

The volume of digested matter present in the stomach ranged between 1.18 % (June)) and 12.57 % (January) with an average of 6.38 % in 2000-01. In 2001-02, the composition of digested material ranged between 1.16% (May) and 15.55 % (June) and on an average it formed 6.57 %.

The average data for the study period showed that volume of digested gelatinous mass in the guts fluctuated between 1.95 % (February) and 12.57 % (January). The digested material was observed throughout the year. The average for this period indicated that the composition of digested material in the stomach was 6.36 %

7. Miscellaneous

In 2000-01, the range of volume miscellaneous item in the stomach was between 0.62 % (January) and 5.94 % (March) and the average in the stomach was 1.19 %. In 2001-02 the range was between 0.21 % (June) and 5.94 % (March) with the average consumption of 1.13 %.

Average data for the study period indicate that miscellaneous group of food components were present for eight months in the stomach of *Decapterus russelli*. Highest volume was observed in March (5.94%) and lowest 0.11 % in June. In, October, December May, and August, miscellaneous food items were absent in the gut contents. The average composition of miscellaneous food items in the stomach was 1.16 %.

6.2.3. Percentage composition of stomach contents of females in different stages of maturity

Crustaceans and fish occupied first and second position in the volume of gut contents of all the females in different stages of sexual maturity during the two-year period (Table 6.3.1 and Table 6.3.2).

Considerable year wise fluctuation in the composition of different food items were not observed for the two years, hence average data for the two years is presented in (Table 6.3.3).

In the case of females in I stage of maturity crustaceans and salpa held first and second position during 2000-01 and 2001-02 and the pooled data also indicate the same pattern. Third position was held by polycheates and fourth, fifth, sixth and seventh positions were occupied by fishes, digested matter, detritus and miscellaneous food items respectively.

In the stage II fishes, the crustaceans formed the dominant food item (56.21 %), followed by fishes (26.42 %), digested matter (11.12 %) and salpa (6.25 %) in the year 2000-01. In 2001-02 similar pattern of feeding was observed. The average for these two years indicate that in stage II, polycheates were absent in their stomach.

Crustaceans and fishes occupied first and second position in the volume of gut contents of the fishes of maturity stage III in both the years, and they preferred detritus and salpa as fourth and fifth food item in 2000-01. In 2001-02 detritus and salpa stood as the fourth and fifth preferred food item. Percentage of digested material occupied third position in the females during the entire period. The average data for the study period also indicate that first, second, third, fourth, fifth and places were occupied by crustaceans, fishes, digested material, detritus and salpa respectively.

In the case of stage IV fishes, again the crustaceans and fishes stood as the most preferred food items and third position was held by digested material in 2000-01 and 2001-02. Average percentage composition indicates that fourth, fifth and sixth places were held by polycheates, salpa and detritus food items respectively.

In V th stage females first two places were occupied by crustaceans and fishes third place by salpa in both the years. The average for the study period shows that third place was occupied by salpa and fourth, fifth, sixth and seventh respectively by digested matter, polycheates, detritus and miscellaneous items.

In the VI stage fishes as in the case of all other stages of females, crustaceans and fishes formed the first and second place in both 2000-01 and 2001-02. The average for the two years shows that crustaceans, fishes, salpa, polycheates, digested material, detritus and miscellaneous food items formed 50.40 %, 22.61 %, 10.70 %, 5.95 %, 4.79 %, 3.16 % and 2.38 % respectively.

The females in spent condition were not having detritus in their guts in 2000-01. The first, second and third positions were held by crustaceans, fishes and polycheates respectively during this period. Digested food material occupied fourth position, while salpa and miscellaneous took fifth and sixth position respectively in 2000-01. In 2001-02, miscellaneous group occupied fourth place and salpa was in the sixth place. The average data for the study period showed that digested matter, miscellaneous food items and salpa occupied fourth, fifth and sixth place respectively.

When considered as a whole, it can be seen that crustaceans and fishes constituted the maximum percentage of gut contents in the female fishes of all stages of maturity. It occupied first and second position in all stages of maturity in females. Crustaceans formed the major portion of the food to the fishes. The fishes contributed next to crustaceans and other food items only filled rest of the part of the stomach

6.2.4. Percentage composition of stomach contents of males and females during different seasons

Table 6.4.1 and Table 6.4.2 show the percentage composition of main groups of food items in different seasons, pre monsoon (December to May), monsoon (June to August), and post monsoon (September to November), for males and females.

1. Monsoon

During monsoon crustaceans and fishes were the main food items of males and females of *Decapterus russelli* for both the years. The averages for the two years indicate that, leaving aside digested food material, salpa, miscellaneous food items, detritus and polycheates were preferred by males during monsoon season after

crustaceans and fishes. In female also salpa was the third preferred food item and polycheates, detritus and miscellaneous food items formed the fourth, fifth and sixth important food item (Table 6.4.3).

2. Post monsoon

During post monsoon also crustaceans and fishes were the dominant food items found in the stomach of both males and females of *Decapterus russelli* in both the years.

The polycheates, detritus, miscellaneous food items and salpa were the other main food items of males in that order of preference in 2000-01. In 2001-02, salpa formed a good volume in the stomach and formed as the fourth preferred food item in the guts, which was followed by miscellaneous food items, detritus and polycheates in males. The average data for the two years indicate that salpa, miscellaneous food items, polycheates, detritus were in the order of food preference by male *Decapterus russelli* during post monsoon season. Digested material also formed 11.62 % of the stomach content.

Salpa, polycheates, detritus and miscellaneous food items were the food items preferred by females during 2000-01 as fourth, fifth, sixth and seventh. In 2001-02 again, salpa was fourth food item found in the stomach followed by detritus, miscellaneous food item and polycheates. The pooled data for the two years show that the order of food preference of female *Decapterus russelli* was crustaceans, fishes, salpa, polycheates, detritus and miscellaneous food items.

3. Pre-monsoon

In pre-monsoon period also crustaceans formed as the principal diet of males and females of *Decapterus russelli.* During 2000-01 and 2001-02 salpa was the second preferred food item of males, followed by fishes, polycheates, detritus and miscellaneous food items. Leaving aside digested food material, the averages for the two years show that the volume of crustaceans in the stomach of fishes was reduced and the percentage of polycheates and salpa was increased. The volume of digested material, detritus and

miscellaneous food items was minimum during premonsoon period in males compared to the monsoon and post monsoon months.

In the case of females also crustaceans were the principal food item found in the stomach forming first position during 2000-01. The salpa occupied the second important component in 2000-01. But in 2001-02, fishes again formed the second important food item in the stomachs of females of *Decapterus russelli.* The average data of females for 2000-01 and 2001-02 show that crustaceans were the dominant food item found in the stomach followed by fishes, salpa, polycheates, detritus and miscellaneous food item. An important observation during this period was the reduction in the intake of fishes and increase in the intake of polycheates and salpa by females of *Decapterus russelli.*

6.2.5. Percentage composition of stomach contents in 10mm Length groups

6.2. 5.1. Males

1. Crustaceans

In 2000-01, the intake of crustaceans in the stomach ranged between 27.88 % in 170-179 mm group and 100 % in 220-229 mm length group (Table 6.5.1). During 2001-02 the range of crustaceans in the stomach was between 6. 90 % in 240-249 mm and 100 % in 220-229 mm size group (Table 6.5.2). The average data for the study period show that crustaceans dominated over all other food items with a minimum volume of 6.90 % in 240-249 mm group and maximum 100% in 220-229 mm group. Up to a size of 220-229 mm crustaceans were the dominant food item present in the stomach and later the feeding habit was slowly changed to fishes (Table 6.5.3).

2. Fish

The range of fish as food component in the stomach in the year 2000-01 ranged from 6.85 % in the size group 140-149 mm to 100 % in 250-259 mm length group. In the

year 2001-02 also the similar trend was noticed. The fish slowly became ichthyophagus as it grows and fishes replaced the crustacean component to a great extent.

The average for the two-year period indicate that except in the length group of 120-129 mm, 130-139mm, 150-159 mm and 190-199 mm in all other length groups, fish food was observed as second preferred item with minimum volume of 5.75 % in 120-129 mm group and to a maximum of 100% in 250-259 mm length groups. The youngest group of 100-109 mm length was perhaps too small to hunt fishes as their food. Fish was absent in the stomach of the juveniles. The fishes of 240-249 mm group preferred salpa (74.14 %) in first place than fish.

3. Salpa

Salpa was available in the stomachs with a volume ranging from 2.82 % in 120-129 mm size group to 28.37 % in the 190-199 mm size group in the year 2000-01. In the year 2001-02 the range of salpa as food item was between 2.45 % in 140-149 mm size group and 74.14 % in the 240-249 mm size group.

The average for the study period indicated that this item of food was present in twelve length groups out of 16 length groups examined. Salpa was absent in 100-109 mm, 160-169 mm to 220 –229 mm and 250-259 mm length groups. The quantity of salpa intake ranged between 3.28 % in 210-219 mm and 74.14 % in 240-249 mm and it occupied third position as a food component of *Decapterus russelli*. In general as the fish grows the percentage of salpa intake was also found to be increasing.

4. Polycheates

The polycheates were present in the stomach of *Decapterus russelli* ranging from 120-129 mm to 200-209 mm length group in both the years. Fishes showed almost similar trend in the percentage of food composition for 2000-01 and 2001-02. In 2000-01, the percentage of polycheates was slightly higher than 2001-02 .The average data for the study period show that polycheates were present in the gut from 120-129 mm length

group to 200-209 mm and 240-249 mm length group. In 100-109 mm, 110-119mm, 210-219mm, 230-239mm and 250-259 mm length groups polycheates were absent.

The consumption of polycheates ranged between 1.66 % in 200-209 mm to 1.66 % in 240-249 mm and ranked as third and fifth preferred food item in different length groups. The average for the entire period shows that polycheates occupied fifth position in the stomach of male *Decapterus russelli.*

5. Detritus

Detritus intake was within the range from 0.54 % in 150-159 mm size group to 10.21 % in 140-149 mm length group in 2000-01. The range was between 0.86 % in 190-199 mm and 7.18 % in 100-109 mm size group in 2001-02. The average for the study period indicate that the volume of detritus in the stomach ranged between 0.43 % in 190-199 mm to 8.54 % in 100-109 mm length group. The percentage of detritus has shown a decreasing trend as the size of the fish increases. In 110-119 mm, 160-169 mm, 200-209 mm, 210-219 mm, 220-229 mm, 230-239 mm and 250-259 mm size group, no detritus food item was found in the stomach.

6. Digested matter

The occurrence of digested matter in the stomach for the period of study showed that it was present in the stomach in most of the length groups in both the years with little difference. The average for the study period show that in 100-109 mm, 130-139 mm, and 230-239 mm length group digested jelly like food material was present in considerable percentage. In youngest group of 100-109 mm, digested food material was as high as 30.22 %, second highest, next to crustaceans. With 16.78 % and 21.06 % respectively in 130-139 mm and 230-239 mm length group also, it occupied second highest. In all other size groups the volume of digested material ranged between 1.87 % (150-159 mm) and 9.19 % (140-149 mm). On an average the digested matter was the fourth item present in the stomach forming 8.21 %. When the total volume of all the length groups were taken into consideration digested material occupied fourth position.

7.Miscellaneous

Miscellaneous food items were present in the stomach of fishes with the size ranging between 100-109 mm to 190-199 mm in 2000-01 and in 2001-02 it was present from 120-129 mm to 190 – 199 mm with some exceptions. The fluctuation of the percentage composition of miscellaneous food items in the stomach was almost similar during both the years. The average percentage composition for the study period shows that it was present only in seven length groups. The intake of miscellaneous food items ranged between 0.55 % in 160-169 mm and 13.64 % in 150-159 mm size group and was absent in fishes bigger than 190-199 mm length group. The average composition of miscellaneous food items for the two years period indicate that it was the last preferred food item by *Decapterus russelli.*

6.2.5.2. Females

1.Crustaceans

Excluding digested matter, crustaceans formed a dominant food item in 2000-01. The quantity of crustaceans present in the stomach ranged between 10.03 % in 200-209 mm size group to 90.62 % in 90-99 mm size group (Table 6.6.1). In 2001-02, the intake of crustaceans ranged between 32.14 % in 200-209 mm size group to 99.75 % % in 90-99 mm size group (Table 6.6.2). The pooled data indicated that out of thirteen groups of 10 mm length classes of females of *Decapterus russelli* ranging from 90-100 mm to 210-219mm crustaceans, fishes and salpa were observed to dominate in first, second and third position respectively. Out of thirteen length groups crustaceans dominated as first preferred food item in 12 groups from a lowest volume of 21.09 % in 200-209 mm length group to highest volume 95.19 % in 90-99 mm length group. Crustaceans with a volume of 21.09 % were of second preference only in 200-209 mm length group (Table 6.6.3).

2.Fishes

The volume of fish diet ranged between 0.44 % in 100-109 mm size group to a maximum of 64.12% in 200-209 mm size groups in 2000-01. Fishes were not observed in the 90-99 mm size group. In 2001-02, the range of fish in the diet was between 2.54 % in 100-109 mm size group to 56.16 % in 200-209 mm size group. The contribution of fish in the diet was found increasing as the fish grows except in the size group 210-219 mm where the volume of fish intake was only 10.00 %. The pooled data indicate that fish diet ranged between 0.49 % in 100-109 mm and 60.14 % in 200-209 mm length group. Fishes were the least preferred item in 100-109 mm length group and absent in 90-99 mm length group.

3.Salpa

The range of salpa in the stomach was between 1.80 % in 130-139 mm size group and 18.23 % in 200-209 mm size group in 2000-01. Salpa was absent in 90-99 mm, 160-169 mm and 210-219 mm size groups. In 2001-02, the percentage occurrence of salpa in the stomach was between 2.32 % in the 210-219 mm size group to a maximum of 18.97 % in the 100-109 mm size group. Salpa was absent in 90-99 mm and 160-169 mm size groups. The average for the study period indicate that salpa occupied as third preferred item in six length groups in 100-109 mm, 120-129 mm, 150-159 mm, 170-179 mm, 190-199 mm and 200-209 mm length groups. Salpa got second preference in 100-109 mm length group with a volume of 21.15 %. Salpa was not found in the length groups of 90-109 mm and 160-169 mm. Salpa ranked third in the food item found in the stomach.

4.Polycheates

Polycheates were not present in all the size groups in both the years. The volume of polycheates in the stomach ranged between 0.07 % in 140-149 mm and 14.24 % in 210-219 mm in 2000-01 and in 2001-02 the range of polycheates in the stomach was between 1.85 % in 140-149 mm and 10.54 % in 170-179 mm. The average for the two years show that polycheates were preferred mostly as fifth items with little exceptions. Maximum volume it occupied was 11.06 % in 170-179-mm and minimum 1.13 % in

160-169 mm length group. In 110-119 mm and in 190-199 mm length groups it ranked as the fourth food item. This was present in eleven length groups and absent in two length groups viz smallest length group of 90-99 mm and largest length groups of 200-209 mm.

5.Detritus

Detritus was not present in all the length groups in both the years. Its quantity in the stomach ranged from 0.14 % in 130-139 mm length group to 11.02 % 100-109 mm size group in 2000-01. In 2001-02, the range of detritus in the stomach was between 1.18 % in 180-189 mm and 3.51 % in 210-219 mm length group. The average for the two-year period indicate that detritus was present in nine length groups with minimum volume of 1.16 % in 180-189 mm and 190-199 mm size group. Maximum volume (7.58 %) was observed in 100-109 mm length group. It was absent in 90-99 mm, 110-119 mm, 170-179 mm and 200-209 mm length groups. When considered as a whole, it occupied sixth place in females.

6.Digested matter

Digested matter was present in all the stomachs observed except in 210-219 mm length group and its percentage ranged between 1.76 % in 180-189 mm length group and 25.66 % in 140-149 mm size group in 2000-01. In 2001-02, it was between 0.25 % in 90-99 mm and a maximum of 18.98 % in 140-140 mm size group. Like the previous period, during this year also digested matter was not present in the stomach in the size group of 210-219 mm. The average consumption for the two year period show that out of thirteen length groups digested mater was present in twelve length groups. On the basis of total percentage of all length groups, digested material was fourth in position.

7.Miscellaneous

Miscellaneous food item fluctuated with a minimum of 0.25 % in 180-189 mm size group to a maximum of 4.12 % in 140-149 mm size group in 2000-01 and in 2001-02 the range of miscellaneous food item was between 0.87 % in 100-109 mm size group

to a maximum of 3.90 % in 140-149 mm size group. The average for the study period show that miscellaneous food items occupied a minimum of 0.18 % in 120-129 mm and maximum of 4.01 % in 140-149 mm size group. It was absent in smaller length group of 90-99 mm and in 190-199 mm and 210-219 mm length groups. In general with some exceptions in few length groups it occupied the seventh position.

6.2.7. Percentage composition of individual food items

Percentage of prevalence of seventeen types of food, namely *Acetes* spp., other crustaceans, (mysids, broken and unidentifiable parts of crustaceans animals), prawns (penaeid and non penaeid prawns), lobsters, squilla, fish (mainly, *Lactarius lactarius*, *Trypauchen vagina*, eels, silver bellies, *Mugil* spp., *Nemipterus japonicus*), polycheates, salpa, bivalves, gastropods, amphipods, crabs, detritus, cheatoceros, unidentified, molluscs, together with a considerable amount of digested matter (including semi-digested material) found in the guts of *Decapterus russelli* were calculated sex wise for each month, to obtain a clear idea about the preference of *Decapterus russelli* towards different food items occurred in their guts. In males ostracods were not found, where as in females due to presence of ostracods in their guts, number of food items became 18, excluding digested food materials.

1. Males

The percentage occurrence of individual food item for 2000-01 and 2001-02 is presented in Table 6.7.1 and Table 6.7.2. The average for the two-year period showed that the prawns had higher percentage occurrence in both the years (Fig 6.7.1, Fig 6.7.2 and Fig 6.7.3). The percentage occurrence of individual food items in the guts of the male fishes for the study period showed highest total intake of *prawns* (23.10 %), followed by fish (19.85 %), Salpa (11.12 %), crabs (9.95 %), other crustaceans (4.11 %), digested matter (8.23 %), *Acetes* spp. (9.06 %), squilla (2.98 %), amphipods (2.28 %), and detritus (2.14 %). The intake of lobster, bivalves, gastropods, unidentified food particles, cheatoceros and molluscs were only in fractions, below 1%, which is nominal. These showed that out of 17 items, leaving aside digested food matters, which was

present in every month from lowest occurrence of 0.83 % in April to highest occurrence 35.91 % in June. In the order of percentage occurrence, prawns, fish, crabs, other crustaceans, squilla, amphipods, and detritus were the main food items found in the stomach (Table 6.7.3).

The prawns and fishes were present throughout the year and *Acetes* spp. and crabs were throughout the year except July. Lobster with low occurrence of 3.03% was present only in March. Squilla was present from November to February and polycheates in September, November-December, February- April and June. Salpa was absent in September – October, December and February. Amphipods were present in September, November, February- March and July. Bivalves showed their presence only in November, February and August while the gastropods were available only in November and August. Detritus was absent in October, May and June. Some unidentified food items were present only in August, other molluscans in November, March and August. Cheatoceros was available in November and March.

2. Females

The percentage of individual food items for the year 2000-01 and 2001-02 are presented separately in Table 6.8.1 and Table 6.8.2 respectively. As in the case of males, the females had higher intake of prawns in the stomach followed by fishes in both the years (Fig 6.8.1, Fig 6.8.2 and Fig 6.8.3). 18 food items were observed in the stomach in both the years and for better analysis of the food composition the average for the study period was taken and presented in Table 6.8.3.

The average food composition for females in terms of percentage, leaving aside the digested material, which is present each month of the year, from a minimum occurrence of 1.92 % (February) to 12.57 % (January) shows the dominance of the prawns in most of the months.

The average volume of prawns, fish, crabs, salpa, other crustaceans, polycheates, and squilla observed were to be 26.69 %, 22.23 %, 8.36 %, 7.48 %, 8.21 %, 5.35 %, 4.98 % and 4.13 %, in a gradual diminishing order while amphipods and detritus

formed 3.33 % and 1.91 % respectively. Lobsters, gastropods, ostracods, unidentified food material, bivalves and other molluscans were observed to be less than 1 %. Prawns, fishes, and digested matter were present in the gut contents throughout the year. *Acetes* spp was absent in December, March and July. Other crustaceans were not found in October, November, March, June and July. Squilla was absent in September and March – May. Detritus was present in ten months and absent in the months of October and July. Ostracods and unidentified food particles occurred only in two months and chatoceros, and bivalves occurred only in two months and one month respectively while gastropods and lobsters were observed for one month in February and October and April respectively. Polycheates and salpa were absent in the gut contents in the month of October, January and August while salpa was not seen in the stomach in October and August. A comparison of the males and females shows that total percentage of occurrence of different food items in order of preference remained the same in both males and females. The fluctuation in the percentage occurrence of different food items was not seen between males and females except the presence of ostracods in females.

6.2.8. Feeding intensity.

1. Males

The month wise feeding intensity of males for the years 2000-01 and 2001-02 are presented in Table 6.9.1 and Table 6.9.2. It can be seen that, there was no wide variation in the intensity of feeding during the two years (Fig 6.9.1 and Fig 6.9.2). Hence, the data were pooled and presented in Table 6.9.3 for better interpretation.

Month wise average feeding intensity for the two year for male indicated that the fishes with gorged stomachs were observed in October (6.65 %), November (8.15 %), March (6.84 %), May (5.83 %) and August (16.32 %). Gorged stomachs were maximum during the month of August and minimum in May. Fishes with full stomachs were observed during all the months except in June. The range of fishes with full stomachs was between 9.61 % (September) and 56.89 % (January). Fishes with ¾ full stomachs were observed for ten months excluding June and December. The occurrence of fishes

with ½ full stomachs was observed between 5.20 % (November) and 36.61 % (October) and was present in all months except May. ¼ full stomachs were present in all the months except in October and the percentage ranged between 7.48 (November) and 47.13 (June). Fishes with trace stomachs were found in all the months and the percentage range of fishes with trace stomachs was between 3.47 (August) and 41.19 (June). Fishes with empty stomach was available for four months only within the range of 3.14 % (February) and 25.79 % (May). The average of different intensities feeding condition show that fishes with full stomachs formed 26.04 %, followed by trace stomachs (23.83 %), ¼ full stomachs (17.72 %), ½ full stomachs (15.66 %), ¾ full stomachs (8.42 %), gorged stomachs (3.65 %), and trace stomachs (3.67 %). The occurrences of different degrees of fullness for the entire period indicate that the intensity of feeding in male *Decapterus russelli* is very high (Fig 6.9.3).

8.2. Females

The month wise feeding condition of females for the year 2000-01 and 2001-02 are presented in the Table 6.10.1 and Table 6.10.2. The average of different degrees of fullness for the two years is presented in Fig 6.10.1 and Fig 6.10.2. It can be seen that the different degrees of feeding intensities were showed little difference between the two years hence, the average percentage occurrence of different degrees of fullness was taken for description of the various degrees of fullness for the study period and is presented in Table 6.10.3.

The fishes with gorged stomachs were present during the months of April (14.42 %), July (6.86 %), October (3.65 %), November (5.26 %), January (4.76 %) and March (6.66 %). The fishes with full stomachs ranged between 3.68 % (November) and 46.48% (October) and were present in all the months. The fishes with 3/4 full stomachs were present for seven months with percentage ranging from 2.81 (September) to 14.28 (January). ½ full stomachs were present during all the months under study within the range from 3.87 % (October) to 32.44 % (August). Like ½ full stomachs, ¼ full stomachs were also present in all the months in the range of 10.76 % (July) to 42.10 % (November). Fishes with trace stomachs were also present during all the months within

the range of 9.09 % (February) to 44.84 % (May). Fishes with empty stomachs formed less than 2 % in most of the months and their percentage of occurrence ranged between 0.51 (August) and 2.71 (September). The average for the period shows that fishes with full stomachs formed 26.04 % followed by 1/4 full stomachs (25.77 %), ½ full stomachs (16.02 %, Trace stomachs (22.23 %), ¾ full (5.18 %) and empty stomachs (1.30 %) (Fig 6.10.3).

Conclusion

The present study shows that the *Decapterus russelli* along the Malabar coast is a highly carnivorous fish, feeds mainly on crustaceans, fish, salpa and polycheates in that order of preference. There is not much fluctuation in the choice of food or intensity of feeding either sex wise or among different stages of maturity. *Decapterus russelli* does not feed on vegetative matter. Out of the crustaceans most dominant food item was penaeid prawns, *Acetes* spp., crabs, mysids, squilla and amphipods. Intake of crustaceans appeared to have relation with the size of the fish. As the fish grows, it was showing preference for fish as the principal diet. Higher intake of crustaceans was noticed in May, July and February and a fall in November is noticed in both sexes.

Fish food was absent in smallest size groups. Amongst the fishes *Stolephorus* spp. and *Lactarius lactarius* were the common food of *Decapterus russelli*. Other food fishes were eels, mullets, silver bellies and gobies. Salpa stood as the third food item in both males and females. Polycheates, detritus and miscellaneous groups of food items reached fourth fifth and sixth respectively. With increase in the size, the variety of the food items taken by the fish is narrowed, but the particle size of the food increased. The fish is a sight feeder, which is obvious from its feeding on motile animals. It feeds on animals dwelling in bottom or the column just above the bottom. With increase in size it shows an affinity towards the column feeding. No vegetative matter was seen in the stomach contents throughout the period of investigation. The feeding intensity was lowest in June in males and females in May. Highest feeding intensity was noticed in October for both males and females.

Table 6.1.1. Percentage composition of main group of food items in male *Decapterus russelli* during 2000-01

Months/ Food items	No of Specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
September	68	6.13	65.87	20.21	3.25	-	4.54	-
October	72	6.44	57.02	36.54	-	-	-	-
November	64	9.12	20.21	48.21	10.21	1.21	4.58	6.46
December	76	7.14	48.87	26.54	15.12	-	2.33	-
January	74	10.25	50.14	16.87	0	20.54	2.2	-
February	54	5.55	65.54	15.64	9.48	-	2.54	1.25
March	76	9.87	59.13	5.68	2.85	18.54	3.25	0.68
April	82	1.32	45.21	6.27	9.21	35.84	2.15	-
May	98	1.7	62.14	5.95	-	30.21	-	-
June	78	35.98	47.22	9.47	1.65	5.68	-	-
July	54	10.25	50.47	18.87	-	18.87	1.54	-
August	48	4.52	48.56	25.54	-	2.54	1.25	-

Table 6.1.2. Percentage composition of main group of food items in male *Decapterus russelli* during 2001-02

Months/ Food items	No of Specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
September	95	6.59	70.35	17.58	2.19	-	3.29	-
October	69	4.29	57.09	38.62	-	-	-	-
November	90	6.21	23.93	46.89	9	0.62	6.21	7.14
December	90	1.33	58.68	27.33	11.33	-	1.33	-
January	104	9.52	50.02	16.66	-	22.61	1.19	-
February	102	4.02	64.46	16.77	8.05	-	4.69	2.01
March	102	7.36	61.38	4.9	3.06	20.24	2.45	0.61
April	118	0.33	42.74	6.94	10.41	36.11	3.47	-
May	137	1.7	61.56	6.83	-	29.91	-	-
June	109	35.84	47.19	9.43	1.88	5.66	-	-
July	76	8.86	51.91	17.72	-	17.72	3.79	-
August	67	3.31	46.43	32.59	-	0.55	0.55	16.57

Fig. 6.1.1. Annual percentage composition of different food items in male *D. russelli* during 2000-01

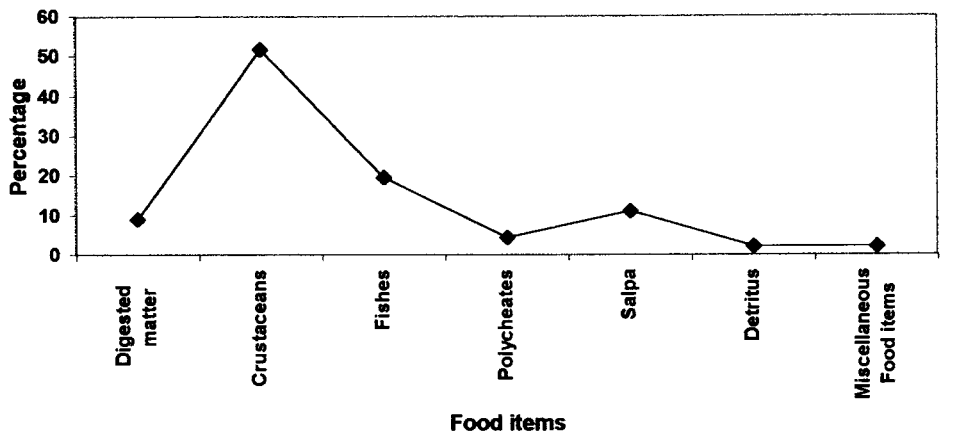


Fig. 6.1.2. Annual percentage composition of different food items in male *D. russelli* during 2001-02

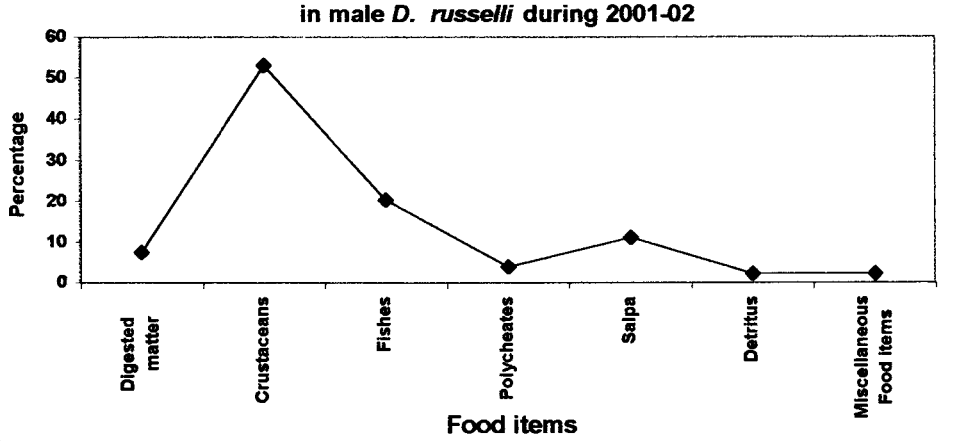


Fig. 6.1.3. Annual average percentage composition of different food items in male *D. russelli* during 2000-01 and 2001-02

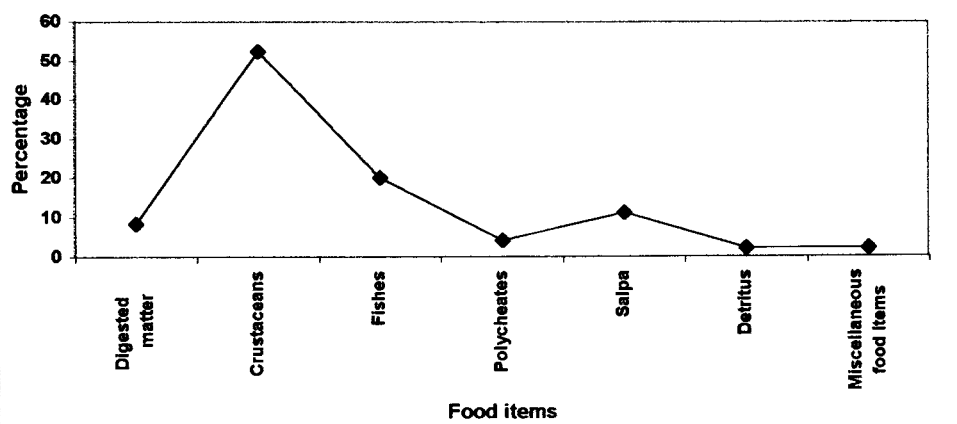


Table 6.1.3. Average percentage composition of main group of food items in male *Decapterus russelli* during 2000-01 and 2001-02

Months/ Food items	No of Specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
September	163	6.36	68.11	18.90	2.72	-	3.92	-
October	141	5.37	57.06	37.58	-	-	-	-
November	154	7.67	22.07	47.55	9.61	0.92	5.40	6.80
December	166	4.24	53.78	26.94	13.23	-	1.83	-
January	178	9.89	50.08	16.77	-	21.58	1.70	-
February	156	4.79	65.00	16.21	8.77	-	3.62	1.63
March	178	8.62	60.26	5.29	2.96	19.39	2.85	0.65
April	200	0.83	43.98	6.61	9.81	35.98	2.81	-
May	235	1.70	61.85	6.39	-	30.06	-	-
June	187	35.91	47.21	9.45	1.77	5.67	-	-
July	130	9.56	51.19	18.30	-	18.30	2.67	-
August	115	3.92	47.50	29.07	-	1.55	0.90	17.08

Table 6.2.1. Percentage composition of main group of food items in female *Decapterus russelli* during 2000-01

Months/ Food items	No of Specimens	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
September	76	7.9	45.83	32.2	4.51	5.64	2.36	1.56
October	74	3.21	58.67	38.12	-	-	-	-
November	87	12.25	69.79	10.21	1.54	1.25	2.55	2.41
December	74	2.56	54.89	33.84	7.69	0.51	0.51	-
January	67	12.57	53.49	13.83	-	16.35	3.14	0.62
February	51	1.92	62.53	4.8	14.42	5.76	8.65	1.92
March	87	2.97	33.67	37.62	5.94	12.87	0.99	5.94
April	57	6.20	54.12	24.37	4.87	6.05	2.60	1.78
May	112	6.21	45.56	18.54	16.54	10.54	2.61	-
June	64	1.18	62.95	15.21	2.54	15.47	2.65	-
July	44	10.25	32.65	30.21	6.54	18.54	-	1.81
August	38	6.54	83.68	9.78	-	-	-	-

Table 6.2.2. Percentage composition of main group of food items in female *Decapterus russelli* during 2001-02

Months/ Food items	No of Specimens	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
September	106	7.9	44.91	32.2	4.51	5.64	4.4	0.44
October	71	1.53	60.71	37.76	-	-	-	-
November	122	11.67	67.03	12.01	0.16	3.87	0.85	4.41
December	124	2.56	54.89	33.84	7.69	0.51	0.51	-
January	187	12.57	53.49	13.83	-	16.35	3.14	0.62
February	118	1.92	62.53	4.81	14.42	5.76	8.65	1.92
March	148	2.97	33.67	37.62	5.94	12.87	0.99	5.94
April	88	8.23	46.86	8.76	20.4	15.16	0.59	-
May	157	1.16	72.57	13.01	0.2	12.75	0.31	-
June	90	15.55	34.73	34.29	1.52	13.7	-	0.21
July	62	3.8	87.02	9.18	-	-	-	-
August	53	8.99	60.78	29.85	-	0	0.38	-

Fig. 6.2.1. Annual percentage composition of different food items in female *D. russelli* during 2000-01

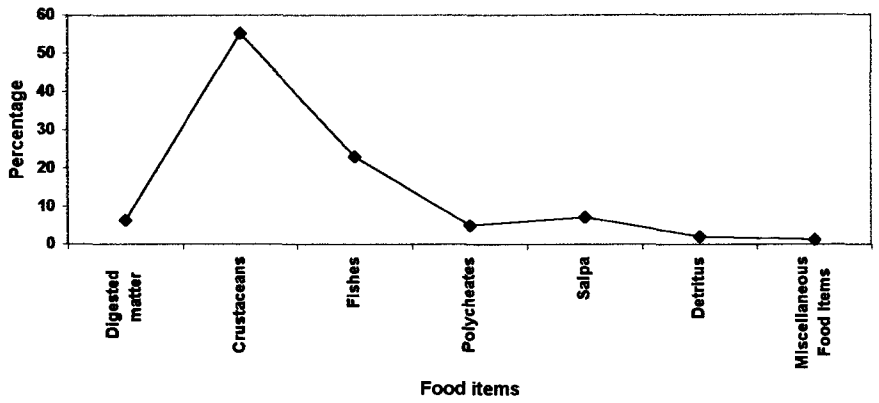


Fig. 6.2.2. Annual percentage composition of different food items in female *D. russelli* during 2001-02

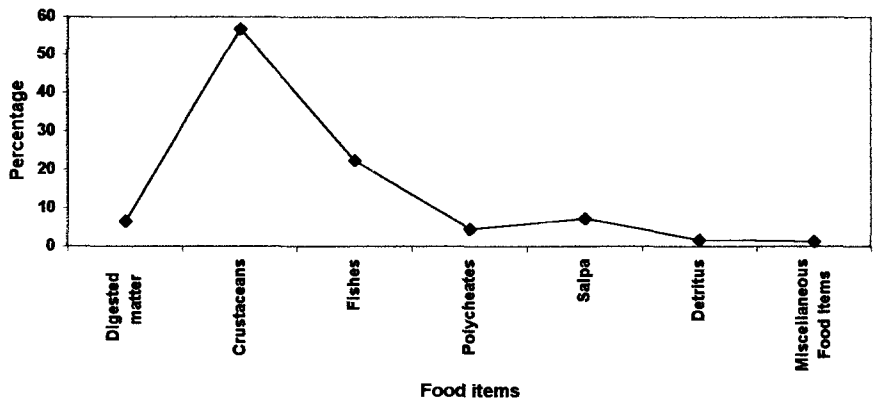


Fig. 6.2.3. Annual average percentage composition of different food items in female *D. russelli* during 2000-01 and 2001-02

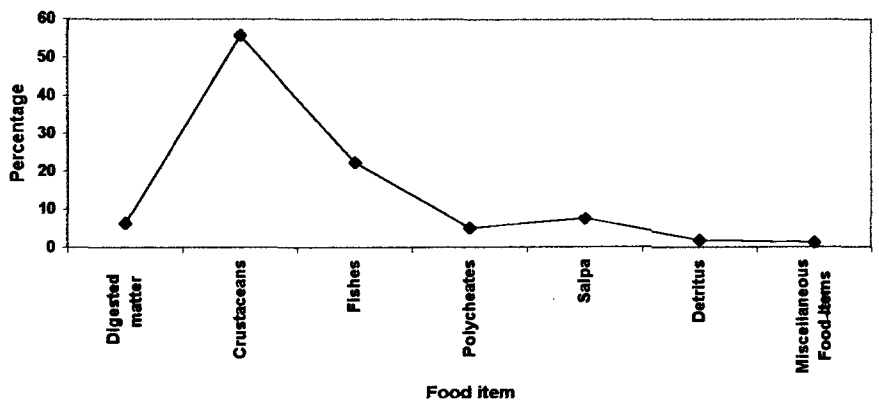


Table 6.2.3. Percentage composition of main group of food items in female *Decapterus russelli* during 2000-01 and 2001-02

Months/ Food items	No of Specimens	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
September	182	7.90	45.37	32.20	4.51	5.64	3.38	1.00
October	145	2.37	59.69	37.94	-	-	-	-
November	209	11.96	68.41	11.11	0.85	2.56	1.70	3.41
December	198	2.56	54.89	33.84	7.69	0.51	0.51	-
January	254	12.57	53.49	13.83	-	16.35	3.14	0.62
February	169	1.92	62.53	4.81	14.42	5.76	8.65	1.92
March	235	2.97	33.67	37.62	5.94	12.87	0.99	5.94
April	145	7.22	50.49	16.57	12.64	10.61	1.60	0.89
May	269	3.69	59.07	15.78	8.37	11.65	1.46	-
June	154	8.37	48.84	24.75	2.03	14.59	1.33	0.11
July	106	7.03	59.84	19.70	3.27	9.27	-	0.91
August	91	7.77	72.23	19.82	-	-	-	-

Table 6.3.1. Percentage composition of main group of food items in different stages in female *Decapterus russelli* during 2000-01

Stages/ Food items	No of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
Stage-I	88	0.48	47.34	15.21	10.64	20.88	2.47	2.98
Stage-II	107	11.12	56.21	26.42	-	6.25	-	-
Stage-III	131	10.21	65.12	20.52	-	2.14	2.01	-
Stage-IV	148	7.4	65.14	21.18	2.89	1.25	2.14	-
Stage-V	88	5.65	50.48	32.14	2.21	5.87	2.14	1.51
Stage -VI	131	6.59	45.39	20.15	6.98	12.14	5.54	3.21
Stage-VII	138	3.21	56.72	25.14	12.14	2.14	-	0.65

Table 6.3.2. Percentage composition of main group of food items in different stages in female *Decapterus russelli* during 2001-02

Months/ Food items	No of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
Stage-I	157	15.42	31.03	1.12	21.91	26.75	3.05	0.72
Stage-II	188	14.24	64.55	9.68	-	3.87	6.1	1.56
Stage-III	124	6.41	67.4	24.44	-	0.22	1.53	-
Stage-IV	187	4.44	74.54	19.98	0.77	0.21	0.06	-
Stage-V	285	0.59	43.49	45.86	0.27	9.05	0.05	0.69
Stage -VI	187	2.99	55.41	25.07	4.92	9.28	0.78	1.55
Stage - VII	198	1.91	59.76	29.68	4.1	1.14	-	3.41

Table 6.3.3. Average percentage composition of main group of food items in different stages in female *Decapterus russelli* during 2000-01 and 2001-02

Months/ Food items	No of Specimens ecxamined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
Stage-I	245	7.95	39.19	8.17	16.28	23.82	2.76	1.85
Stage-II	295	12.68	60.38	18.05	-	5.06	6.10	1.56
Stage-III	255	8.31	66.26	22.48	-	1.18	1.77	-
Stage-IV	335	5.92	69.84	20.58	1.83	0.73	1.10	-
Stage-V	373	3.12	46.99	39.00	1.24	7.46	1.10	1.10
Stage -VI	318	4.79	50.40	22.61	5.95	10.71	3.16	2.38
Stage - VII	336	2.56	58.24	27.41	8.12	1.64	-	2.03

Table 6.4.1. Percentage composition of main group of food items in *Decapterus russelli* in different seasons during 2000-01

Season/Food items	No of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
a. Males								
Monsoon	180	16.00	48.51	19.91	0.63	7.98	1.45	5.52
Post monsoon	204	7.23	47.70	34.99	4.49	0.40	3.04	2.15
Premonsoon	460	5.97	55.17	12.83	6.11	17.52	2.08	0.32
B. Females								
Monsoon	146	5.88	47.05	21.32	8.54	14.85	1.75	0.60
Post monsoon	237	7.79	58.10	26.84	2.02	2.30	1.64	1.32
Premonsoon	448	4.04	56.47	13.24	5.48	18.15	2.19	0.44

Table 6.4.2. Percentage composition of main group of food items in *Decapterus russelli* in different seasons during 2001-02

Season/ Food items	No of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
a. Males								
Monsoon	252	16.00	48.51	19.91	0.64	7.98	1.45	5.52
Post monsoon	254	16.00	48.51	19.91	0.63	7.98	1.45	5.52
Premonsoon	653	4.04	56.47	13.24	5.48	18.15	2.19	0.44
B. Females								
Monsoon	205	7.03	57.55	27.32	1.56	3.17	1.75	1.62
Post monsoon	299	7.03	57.55	27.32	1.56	3.17	1.75	1.62
Premonsoon	822	5.15	52.36	20.41	8.18	9.62	2.72	1.56

Table 6.4.3. Average percentage composition of main group of food items in *Decapterus russelli* in different season during 2000-01 and 2001-02

Season/ Food items	No of Specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous food items
a. males								
Monsoon	432	16.00	48.51	19.91	0.64	7.98	1.45	5.52
Post monsoon	458	11.62	48.11	27.45	2.56	4.19	2.25	3.84
Premonsoon	1113	5.01	55.82	13.03	5.80	17.84	2.14	0.38
b. Females								
Monsoon	351	6.46	52.30	24.32	5.05	9.01	1.75	1.11
Post monsoon	536	7.41	57.82	27.08	1.79	2.74	1.70	1.47
Premonsoon	1270	4.60	54.41	16.82	6.83	13.89	2.46	1.00

Table 6.5.1. Percentage composition of main group of food items in male *Decapterus russelli* in different length groups during 2000-01

Length groups in mm/ Food items	No.of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous Food items
100-109	25	19.12	60.45	-	-	-	9.89	10.54
110-119	28	20.75	59.74	-	-	19.51	-	-
120-129	30	26.21	60.15	-	5.14	2.82	2.14	3.54
130-139	32	14.12	49.54	7.12	3.14	20	3.54	2.54
140-149	38	10.25	40.25	6.85	9.12	23.32	10.21	0
150-159	57	2.48	50.21	8.12	8.35	13.7	0.54	16.6
160-169	58	5.98	58.18	15.12	19.67	-	-	1.05
170-179	51	8.98	27.88	36.54	10.24	12.54	3.82	-
180-189	85	5.62	58.21	22.48	5.66	5.44	2.35	0.24
190-199	68	1.25	48.83	16.54	4.87	28.37	-	0.14
200-209	74	5	68.45	13.71	2.72	10.12	-	-
210-219	102	-	65.04	28.41	-	6.55	-	-
220-229	98	-	100	-	-	-	-	-
230-239	48	24.54	28.54	31.94	-	14.98	-	-
240-249	45	-	-	-	-	-	-	-
250-259	5	-	-	100	-	-	-	-

Table 6.5.2. Percentage composition of main group of food items in male *Decapterus russelli* in different length groups during 2001-02

Length groups in mm/ Food items	No.of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous Food items
100-109	25	41.31	51.51	-	-	-	7.18	-
110-119	19	2.2	65.34	29.83	-	2.63	-	-
120-129	29	3.72	55.33	11.49	7.42	7.16	7	7.88
130-139	58	19.44	56.46	12.67	2.68	5.43	2.21	1.11
140-149	45	8.12	43.91	26.73	12.34	2.45	6.45	-
150-159	98	1.26	50.12	15.07	0.68	19.93	2.26	10.68
160-169	112	10.58	55.66	24.76	8.95	-	-	0.05
170-179	158	4.52	32.16	44.54	6.5	9.08	3.2	-
180-189	168	1.6	42.25	18.48	1.96	18.14	4.57	13
190-199	102	3.77	38.59	18.68	3.48	32.39	0.86	2.23
200-209	148	5	86.54	7.86	0.6	-	-	-
210-219	56	-	94.86	5.14	-	-	-	-
220-229	68	-	100	-	-	-	-	-
230-239	58	17.57	68.12	7.77	-	6.54	-	-
240-249	8	-	6.9	-	16.65	74.14	2.31	-
250-259	7	-	-	100	-	-	-	-

Table 6.5.3. Average percentage composition of main group of food items in male *Decapterus russelli* in different length groups during 2000-01 and 2001-02

Length groups in mm/ Food items	No.of Specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous Food items
100-109	50	30.22	55.98	-	-	-	8.54	5.27
110-119	47	11.48	62.54	14.92	-	11.07	-	-
120-129	59	14.97	57.74	5.75	6.28	4.99	4.57	5.71
130-139	90	16.78	53.00	9.90	2.91	12.72	2.88	1.83
140-149	83	9.19	42.08	16.79	10.73	12.89	8.33	-
150-159	155	1.87	50.17	11.60	4.52	16.82	1.40	13.64
160-169	170	8.28	56.92	19.94	14.31	-	-	0.55
170-179	209	6.75	30.02	40.54	8.37	10.81	3.51	-
180-189	253	3.61	53.12	20.48	3.81	11.79	2.13	5.21
190-199	170	2.51	43.71	17.61	4.18	30.38	-	1.19
200-209	222	5.00	77.50	10.79	1.66	5.06	-	-
210-219	158	-	79.95	16.78	-	3.28	-	-
220-229	166	-	100.00	-	-	-	-	-
230-239	106	21.06	48.33	19.86	-	10.76	-	-
240-249	53	-	6.90	-	16.65	74.14	2.31	-
250-259	12	-	-	100.00	-	-	-	-

Table 6.6.1. Percentage composition of main group of food items in female *Decapterus russelli* in different length groups during 2000-01

Length groups in mm/ Food items	No.of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous Food items
90-99	16	9.38	90.62	-	-	-	-	-
100-109	54	5.36	58.86	0.44	4.00	16.85	11.02	3.47
110-119	59	4.40	56.88	32.86	0.78	4.22	-	0.86
120-129	65	3.98	47.54	25.76	3.09	17.07	2.20	0.36
130-139	89	5.89	52.27	25.58	12.76	1.80	0.14	1.56
140-149	65	25.66	36.39	29.24	0.07	3.50	1.02	4.12
150-159	87	1.90	58.78	33.68	2.22	2.42	0.74	0.26
160-169	94	3.81	87.82	7.94	0.07	-	0.28	0.08
170-179	98	9.28	58.25	7.59	11.58	12.38	-	0.92
180-189	89	1.76	52.41	33.16	5.99	5.29	1.14	0.25
190-199	78	7.45	42.75	27.35	9.98	12.37	0.10	-
200-209	25	4.13	10.03	64.12	-	18.23	-	3.49
210-219	12	-	64.98	10.88	14.24	-	9.90	-

Table 6.6.2. Percentage composition of main group of food items in female *Decapterus russelli* in different length groups during 2001-02

Length groups in mm/ Food items	No.of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous Food items
90-99	28	0.25	99.75	-	-	-	-	-
100-109	56	12.54	64.54	0.54	-	18.97	2.54	0.87
110-119	57	12.54	52.04	23.75	5.95	2.74	-	2.98
120-129	89	8.04	52.08	20.14	8.45	9.44	1.85	-
130-139	151	9.98	56.68	20.14	4.64	3.58	2.54	2.44
140-149	188	18.98	41.21	22.54	1.85	8.98	2.54	3.90
150-159	129	6.24	47.76	25.14	6.54	10.24	2.54	1.54
160-169	178	2.55	78.14	12.54	2.19	-	2.54	2.04
170-179	158	5.22	52.11	19.11	10.54	13.02	-	-
180-189	120	0.12	39.13	45.12	7.17	6.33	1.18	0.95
190-199	85	5.21	40.21	34.21	7.90	10.25	2.22	-
200-209	62	3.55	32.14	56.16	-	8.15	-	-
210-219	25	-	80.00	10.00	4.17	2.32	3.51	-

Table 6.6.3. Average percentage composition of main group of food items in female *Decapterus russelli* in different length groups during 2000-01 and 2001-02

Length groups in mm/ Food items	No.of specimens examined	Digested matter	Crustaceans	Fishes	Polycheates	Salpa	Detritus	Miscellaneous Food items
90-99	44	4.82	95.19	-	-	-	-	-
100-109	110	7.48	58.95	0.49	1.18	21.15	7.58	3.17
110-119	116	8.47	54.46	28.31	3.37	3.48	-	1.92
120-129	154	6.01	49.81	22.95	5.77	13.26	2.03	0.18
130-139	240	7.94	54.48	22.86	8.70	2.69	1.34	2.00
140-149	253	22.32	38.80	25.89	0.96	6.24	1.78	4.01
150-159	216	4.07	53.27	29.41	4.38	6.33	1.64	0.90
160-169	272	3.18	82.98	10.24	1.13	-	1.41	1.06
170-179	256	7.25	55.18	13.35	11.06	12.70	-	0.46
180-189	209	0.94	45.77	39.14	6.58	5.81	1.16	0.60
190-199	163	6.33	41.48	30.78	8.94	11.31	1.16	-
200-209	87	3.84	21.09	60.14	-	13.19	-	1.75
210-219	37	-	72.49	10.44	9.21	1.16	6.71	-

Table 6.7.1. Percentage of prevalence of individual food items in male *Decapterus russelli* during 2000-01

Food items/ Months	September	October	November	December	January	February	March	April	May	June	July	August
Dig. matter	6.13	6.44	9.12	7.14	10.25	5.55	9.87	1.32	1.70	35.98	10.25	4.52
Prawns	39.40	27.16	0.04	8.43	9.66	29.96	32.96	25.80	15.03	34.03	38.33	25.75
Other crustaceans	7.69	-	-	3.25	-	7.80	2.84	6.91	-	-	12.14	6.35
Acetes spp.	3.40	27.24	6.55	6.58	8.00	8.52	6.04	6.25	13.78	6.24	-	10.25
Lobster	-	-	-	-	-	-	2.14	-	-	-	-	-
Squilla	-	-	5.26	10.24	11.24	8.71	-	-	-	-	-	-
Fish	20.21	36.54	48.21	26.54	15.12	15.64	5.68	6.27	5.95	9.47	18.87	25.54
Polycheates	3.25	-	10.21	15.12	-	9.48	2.85	9.21	-	1.65	-	-
Salpa	-	-	1.21	-	20.54	-	18.54	35.84	30.21	5.68	18.87	2.54
Bivalve	-	-	2.44	-	-	1.25	-	-	-	-	-	3.78
Gastropods	-	-	-	-	1.75	-	-	-	-	-	-	5.14
Amphipods	-	-	4.41	-	-	-	-	-	-	-	-	-
Crabs	15.38	2.62	1.54	20.37	21.24	10.55	12.12	6.25	33.33	6.95	-	6.21
Detritus	4.54	-	4.58	2.33	2.20	2.54	3.25	2.15	-	-	1.54	1.25
Cheatoceros	-	-	2.41	-	-	-	3.03	-	-	-	-	-
Unidentified food items	-	-	-	-	-	-	-	-	-	-	-	5.21
Molluscs	-	-	4.02	-	-	-	0.68	-	-	-	-	3.46

Table 6.7.2. Percentage of prevalence of individual food items in male *Decapterus russelli* during 2001-02

Food items/ Months	September	October	November	December	January	February	March	April	May	June	July	August
Dig. matter	6.59	4.29	6.21	1.33	9.52	4.02	7.36	0.33	1.70	35.84	8.86	3.31
Prawns	37.48	22.95	6.04	24.13	10.50	4.80	20.89	25.10	22.76	36.41	33.04	23.67
Other crustaceans	7.69	-	-	5.08	-	11.25	3.22	7.90	-	-	11.39	5.07
Acetes spp.	4.29	28.76	5.06	1.75	8.00	10.53	6.08	8.56	19.12	9.74	-	12.58
Lobster	-	-	-	-	-	-	3.92	-	-	-	-	-
Squilla	-	-	3.07	14.76	12.76	5.57	-	-	-	-	-	-
Fish	17.58	38.62	46.89	27.33	16.66	16.77	4.90	6.94	6.83	9.43	17.72	32.59
Polycheates	2.19	-	9.00	11.33	-	8.05	3.06	10.41	-	1.88	-	-
Salpa	-	-	0.62	-	22.61	-	20.24	36.11	29.91	5.66	17.72	0.55
Bivalve	-	-	3.14	-	-	2.01	-	-	-	-	-	6.30
Gastropods	-	-	1.92	-	1.75	-	-	-	-	-	-	6.15
Amphipods	5.51	-	1.46	-	-	23.81	12.12	-	-	-	7.48	-
Crabs	15.38	5.38	2.08	12.96	18.76	8.50	12.12	1.18	19.68	1.04	-	5.11
Detritus	3.29	-	6.21	1.33	1.19	4.69	2.45	3.47	-	-	3.79	0.55
Cheatoceros	-	-	6.22	-	-	-	3.03	-	-	-	-	-
Unidentified food items	-	-	-	-	-	-	-	-	-	-	-	0.05
Molluscs	-	-	2.08	-	-	-	0.61	-	-	-	-	4.07

Table 6.7.3. Average percentage of prevalence of individual food items in male *Decapterus russelli* during 2000-01 and 2001-02

Food items/ Months	September	October	November	December	January	February	March	April	May	June	July	August
Dig. matter	6.36	5.37	7.67	4.24	9.89	4.79	8.62	0.83	1.70	35.91	9.56	3.92
Prawns	38.44	25.06	3.04	16.28	10.08	17.38	26.93	25.45	18.90	35.22	35.69	24.71
Other crustaceans	7.69	-	-	4.17	-	9.53	3.03	7.41	-	-	11.77	5.71
Acetes spp.	3.85	28.00	5.81	4.17	8.00	9.52	6.06	7.41	16.45	7.99	-	11.42
Lobster	-	-	-	-	-	-	3.03	-	-	-	-	-
Squilla	-	-	4.17	12.50	12.00	7.14	-	-	-	-	-	-
Fish	18.90	37.58	47.55	26.94	15.89	16.21	5.29	6.61	6.39	9.45	18.30	29.07
Polycheates	2.72	-	9.61	13.23	-	8.77	2.96	9.81	-	1.77	-	-
Salpa	-	-	0.92	-	21.58	-	19.39	35.98	30.06	5.67	18.30	1.55
Bivalve	-	-	2.79	-	-	1.63	-	-	-	-	-	5.04
Gastropods	-	-	0.96	-	-	-	-	-	-	-	-	5.65
Amphipods	-	-	2.94	-	-	11.90	6.06	-	-	-	3.74	-
Crabs	15.38	4.00	1.81	16.67	20.00	9.53	12.12	3.72	26.51	4.00	-	5.66
Detritus	3.92	-	5.40	1.83	1.70	3.62	2.85	2.81	-	-	2.67	0.90
Cheatoceros	-	-	4.32	-	-	-	3.03	-	-	-	-	-
Unidentified food item	-	-	-	-	-	-	-	-	-	-	-	2.63
Molluscs	-	-	3.05	-	-	-	0.65	-	-	-	-	3.77

Fig. 6.7.1. Annual compositin of individual food items in male *D. russelli* during 2000-01

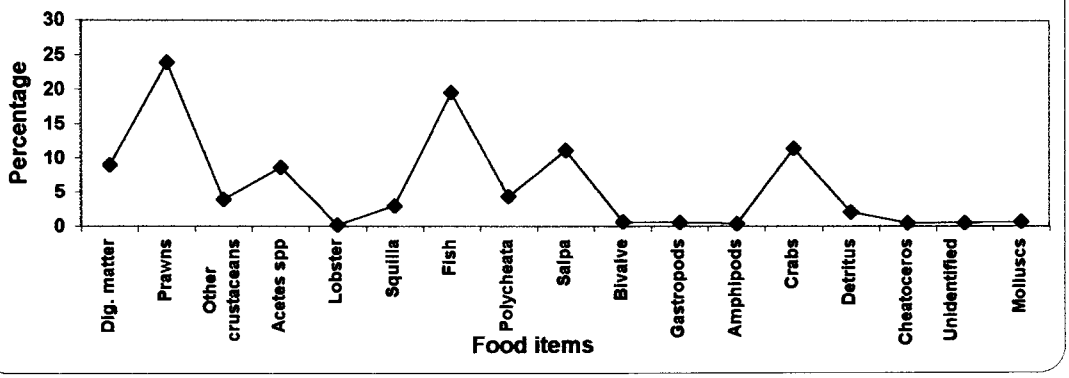


Fig. 6.7.2. Annual composition of different food items in male *D. russelli* during 2001-02

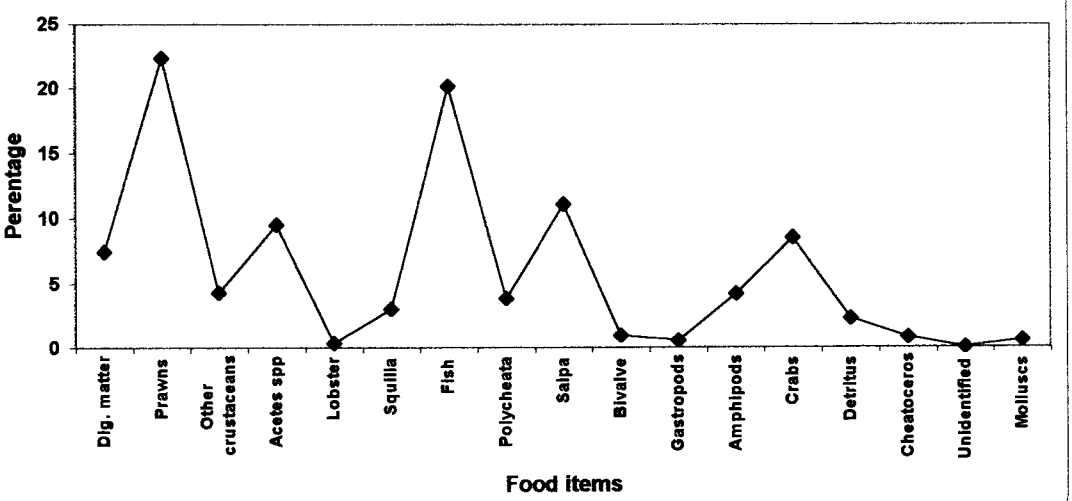


Fig. 6.7.3. Average annual composition of different food items in male *D. russelli* during 2000-01 and 2001-02

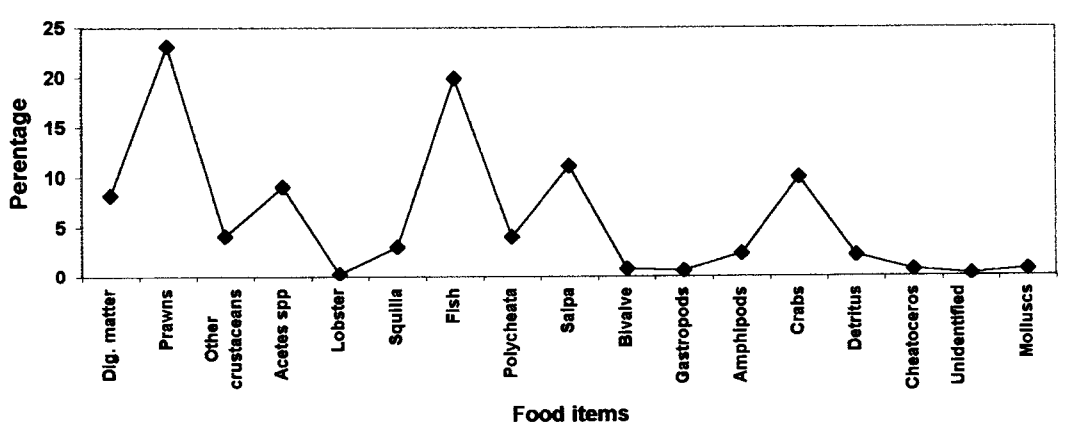


Table 6.8.1. Percentage of prevalence of individual food items in female *Decapterus russelli* during 2000-01

Food items/ Months	September	October	November	December	January	February	March	April	May	June	July	August
Dig. matter	7.90	3.21	12.25	2.56	12.57	1.92	2.97	6.21	1.18	10.25	6.54	9.05
Prawns	11.28	37.58	42.11	31.83	10.78	15.96	12.56	24.03	34.02	10.37	49.01	28.98
Other crustaceans	10.21	-	-	3.24	6.25	12.04	-	5.64	3.58	-	14.24	10.05
Acetes spp.	2.25	14.07	5.13	-	6.14	9.14	-	10.14	15.14	9.14	-	2.31
Lobster	-	2.04	-	-	-	-	-	3.24	-	-	-	-
Squilla	-	4.98	10.64	8.78	3.21	6.24	-	-	-	3.54	6.87	6.06
Fish	32.20	38.12	10.21	33.84	13.83	4.80	37.62	18.54	15.21	30.21	9.78	31.25
Polycheates	4.51	-	1.54	7.69	-	14.42	5.94	16.54	2.54	6.54	-	-
Salpa	5.64	-	1.25	0.51	16.35	5.76	12.87	10.54	15.47	18.54	-	-
Bivalve	2.01	-	-	-	-	-	-	-	-	-	-	-
Gastropods	-	-	-	-	-	1.92	-	-	-	-	-	-
Amphipods	7.63	-	-	-	4.12	6.17	5.64	-	-	-	9.24	5.24
Crabs	14.01	-	5.04	11.04	20.14	12.98	15.47	2.51	10.21	2.87	4.32	6.06
Detritus	2.36	-	2.55	0.51	3.14	8.65	0.99	2.61	2.65	-	-	1.00
Cheatoceros	-	-	6.87	-	-	-	-	-	-	-	-	-
Ostracods	-	-	-	-	2.85	-	-	-	-	6.73	-	-
Unidentified Food items	-	-	2.41	-	-	-	3.24	-	-	-	-	-
Molluscs	-	-	-	-	0.62	-	2.70	-	-	1.81	-	-

Table 6.8.2. Percentage of prevalence of individual food items in female *Decapterus russelli* during 2001-02

Food items/ Months	September	October	November	December	January	February	March	April	May	June	July	August
Dig. matter	7.88	1.53	11.67	2.56	12.57	1.92	2.97	8.23	1.16	15.55	3.80	8.99
Prawns	12.12	37.37	40.10	33.26	13.44	16.81	11.95	27.42	45.28	14.04	52.02	33.51
Other crustaceans	9.09	-	-	2.70	5.80	11.43	-	5.55	4.54	-	15.00	9.09
Acetes spp.	1.51	16.68	7.69	-	5.71	8.57	-	8.33	13.66	10.34	-	3.03
Lobster	-	3.33	-	-	-	-	-	2.78	-	-	-	-
Squilla	-	3.33	11.54	8.11	2.85	8.57	-	-	-	3.45	5.00	6.06
Fish	32.15	37.76	12.01	33.84	13.83	4.80	37.62	8.76	13.01	34.29	9.18	29.85
Polycheates	4.50	-	0.16	7.69	-	14.42	5.94	20.40	0.20	1.52	-	-
Salpa	5.64	-	3.87	0.51	16.35	5.76	12.87	15.16	12.75	13.70	-	-
Bivalve	0.65	-	-	-	-	-	-	-	-	-	-	-
Gastropods	-	-	-	-	-	1.92	-	-	-	-	-	-
Amphipods	16.04	-	-	-	2.85	5.71	4.33	-	-	-	10.00	3.03
Crabs	6.15	-	3.85	10.82	19.98	11.44	17.39	2.78	9.09	3.45	5.00	6.06
Detritus	4.27	-	0.85	0.51	3.14	8.65	0.99	0.59	0.31	-	-	0.38
Cheatoceros	-	-	3.85	-	-	-	-	-	-	-	-	-
Ostracods	-	-	-	-	2.86	-	-	-	-	3.45	-	-
Unidentified food items	-	-	3.85	-	-	-	4.34	-	-	-	-	-
Molluscs	-	-	0.56	-	0.62	-	1.60	-	-	0.21	-	-

Table 6.8.3. Average percentage of prevalence of individual food items in female *Decapterus russelli* during 2000-01 and 2001-02

Food items/ Months	September	October	November	December	January	February	March	April	May	June	July	August
Dig. matter	7.90	2.37	11.96	2.56	12.57	1.92	2.97	7.22	3.69	8.37	7.03	7.77
Prawns	11.60	37.48	41.11	32.55	12.11	16.39	12.26	29.78	30.94	27.31	25.02	43.73
Other crustaceans	9.65	-	-	2.97	6.03	11.74	-	5.60	4.06	-	14.62	9.57
Acetes spp.	1.88	15.38	6.41	-	5.93	8.86	-	9.24	14.40	9.74	-	2.67
Lobster	-	2.69	-	-	-	-	-	3.01	-	-	-	-
Squilla	-	4.16	11.09	8.45	3.03	7.41	-	-	-	3.50	5.94	6.06
Fish	32.20	37.94	11.11	33.84	13.83	4.80	37.62	16.57	15.78	24.75	19.70	19.82
Polycheates	4.51	-	0.85	7.69	-	14.42	5.94	12.64	8.37	2.03	3.27	-
Salpa	5.64	-	2.56	0.51	16.35	5.76	12.87	10.61	11.65	14.59	9.27	-
Bivalve	1.33	-	-	-	-	-	-	-	-	-	-	-
Gastropods	-	-	-	-	-	1.92	-	-	-	-	-	-
Amphipods	11.84	-	-	-	3.49	5.94	4.99	-	-	-	9.62	4.14
Crabs	10.08	-	4.45	10.93	20.06	12.21	16.43	2.65	9.65	3.16	4.66	6.06
Detritus	3.38	-	1.70	0.51	3.14	8.65	0.99	1.60	1.46	1.33	-	0.19
Cheatoceros	-	-	5.36	-	-	-	-	1.10	-	-	-	-
Ostracods	-	-	-	-	2.86	-	-	-	-	5.09	-	-
Unidentified Food items	-	-	3.13	-	-	-	3.79	-	-	-	-	-
Molluscs	-	-	-	-	0.62	-	2.15	-	-	0.14	0.87	-

Fig. 6.8.1. Annual composition of individual food items in female *D. russelli* during 2000-01

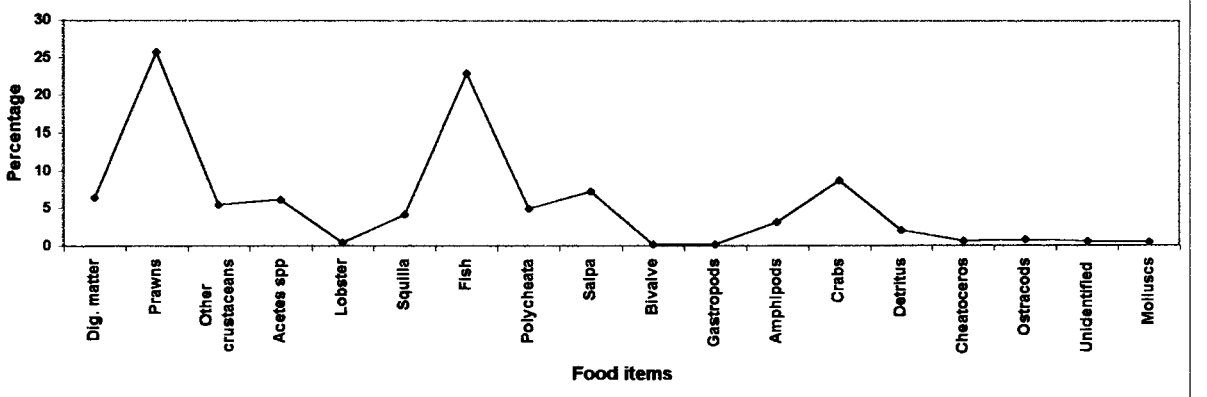


Fig. 6.8.2. Annual composition of individual food items in female *D. russelli* during 2001-02

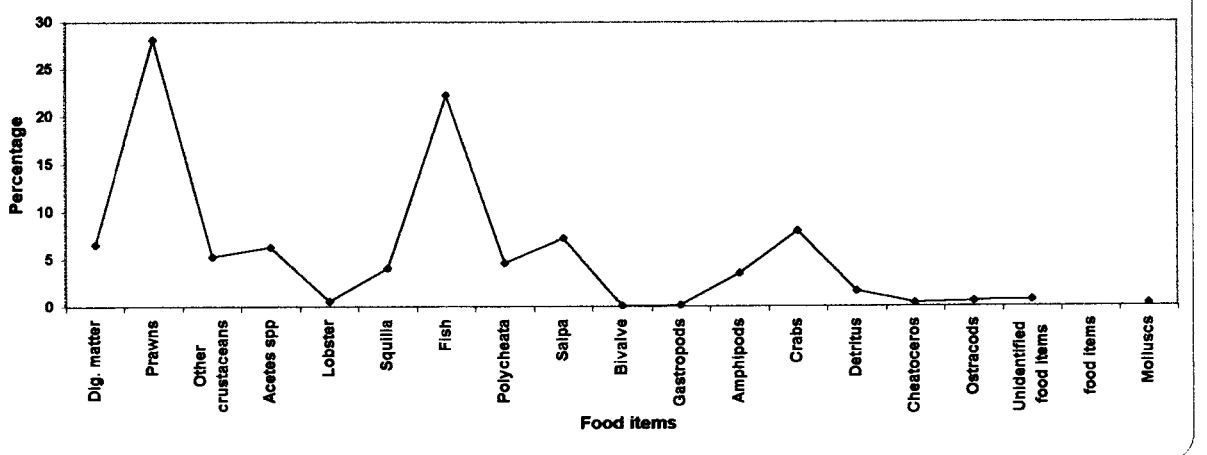


Fig. 6.8.3. Average composition of individual food items in female *D. russelli* during 2000-01 and 2001-02

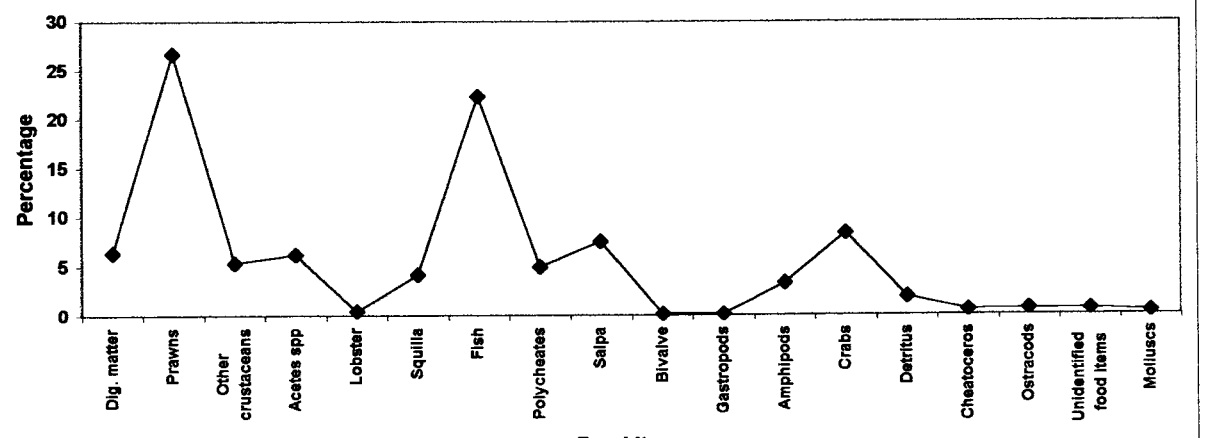


Table 6.9.1. Percentage occurrence of stomachs in various degrees of fullness in male *Decapterus russelli* during 2000-01

Months/Feeding condition	No of specimens examined	Gorged	Full	3/4 full	1/2 full	1/4 full	Trace	Empty
September	68	-	8.97	14.24	16.54	22.14	28.97	9.14
October	72	6.02	18.54	17.98	37.14	-	20.32	-
November	64	7.58	30.24	9.14	6.69	8.21	38.14	-
December	76	-	26.54	-	27.68	10.24	35.54	-
January	74	-	58.21	6.54	12.54	14.84	7.87	-
February	54	-	28.54	12.58	10.45	32.35	12.54	3.54
March	76	5.84	32.24	5.24	8.99	15.54	32.15	-
April	82	-	28.14	15.24	6.54	10.24	39.84	-
May	98	5.47	37.14	8.14	-	10.24	15.47	23.54
June	78	-	-	-	6.24	45.14	43.14	5.48
July	54	-	32.14	9.14	18.87	28.17	11.68	-
August	48	14.21	14.25	13.88	35.14	18.54	3.98	-

Table 6.9.2. Percentage occurrence of stomachs in various degrees of fullness in male *Decapterus russelli* during 2001-02

Months /Feeding condition	No of specimens examined	Gorged	Full	3/4 full	1/2 full	1/4 full	Trace	Empty
September	95	-	10.25	13.07	17.70	21.21	27.18	10.59
October	69	7.28	18.04	16.89	36.19	-	21.60	-
November	90	8.71	31.46	8.57	3.71	6.75	40.80	-
December	90	-	23.68	-	25.93	8.72	41.67	-
January	104	-	55.56	8.71	12.04	16.64	7.05	-
February	102	-	26.66	12.08	12.21	29.92	16.39	2.74
March	102	7.84	29.88	6.60	10.29	15.70	29.69	-
April	118	-	31.28	17.98	6.83	7.98	35.93	-
May	137	6.18	36.16	6.76	-	10.96	11.90	28.04
June	109	-	-	-	6.58	49.11	39.23	5.08
July	76	-	33.52	10.56	22.36	25.58	7.98	-
August	67	18.42	13.50	12.76	35.28	17.08	2.96	-

Table 6.9.3. Average percentage occurrence of stomachs in various degrees of fullness in male *Decapterus russelli* during 2000-01 and 2001-02

Months /Feeding condition	No of Specimens examined	Gorged	Full	3/4 full	1/2 full	1/4 full	Trace	Empty
September	163	-	9.61	13.66	17.12	21.68	28.08	9.87
October	141	6.65	18.29	17.44	36.67	-	20.96	-
November	154	8.15	30.85	8.86	5.20	7.48	39.47	-
December	166	-	25.11	-	26.81	9.48	38.61	-
January	178	-	56.89	7.63	12.29	15.74	7.46	-
February	156	-	27.60	12.33	11.33	31.14	14.47	3.14
March	178	6.84	31.06	5.92	9.64	15.62	30.92	-
April	200	-	29.71	16.61	6.69	9.11	37.89	-
May	235	5.83	36.65	7.45	-	10.60	13.69	25.79
June	187	-	-	-	6.41	47.13	41.19	5.28
July	130	-	32.83	9.85	20.62	26.88	9.83	-
August	115	16.32	13.88	13.32	35.21	17.81	3.47	-

Fig. 6.9.1. Annual feeding condition of male *D. russelli* during 2000-01

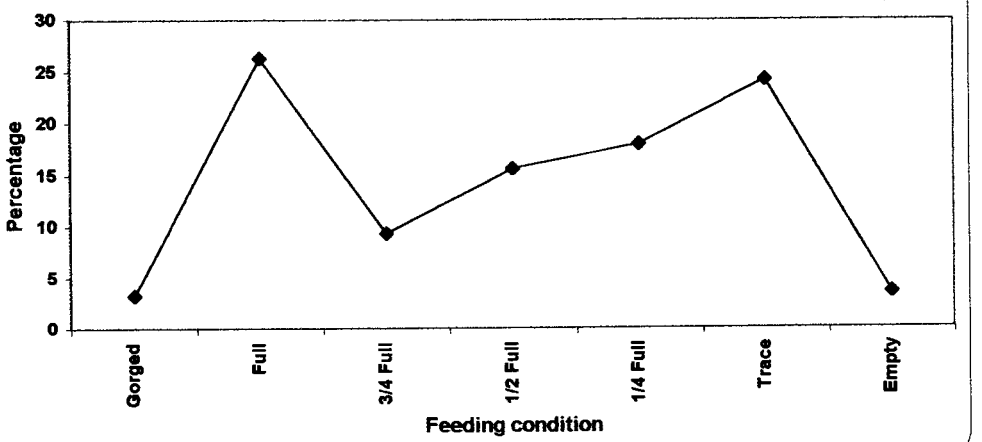


Fig. 6.9.2. Annual feeding condition of male *D. russelli* during 2001-02

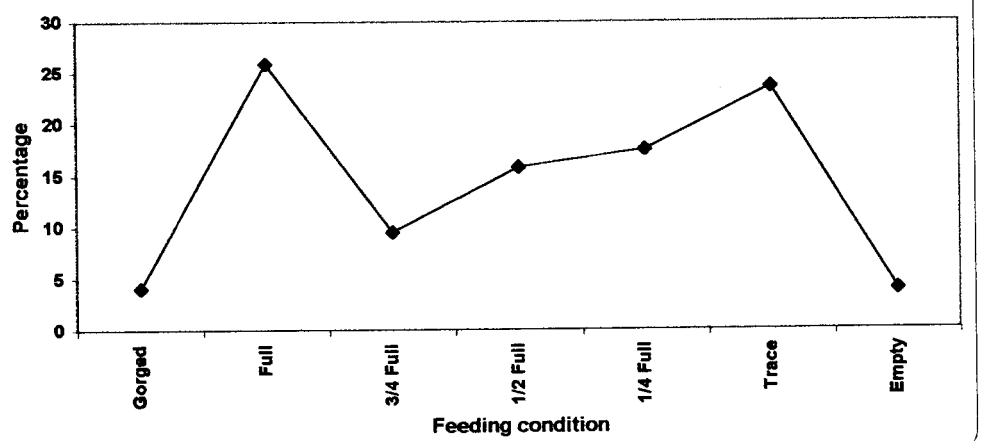


Fig. 6.9.3. Annual average feeding condition of male *D. russelli* during 2000-01 and 2001-02

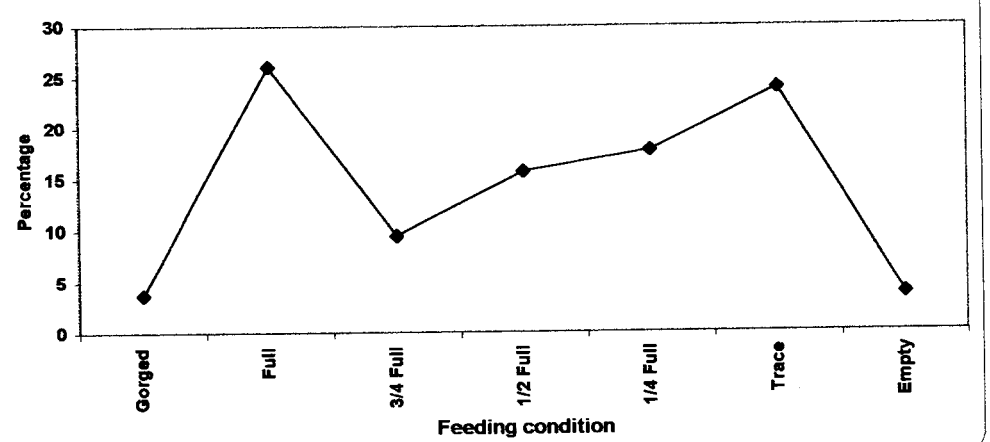


Table 6.10.1. Percentage occurrence of stomachs in various degrees of fullness in female *Decapterus russelli* during 2000-01

Months /Feeding condition	No of specimens examined	Gorged	Full	3/4 full	1/2 full	1/4 full	Trace	Empty
September	76	-	2.84	5.49	32.14	35.14	18.98	5.41
October	74	6.98	31.61	10.25	6.54	21.54	21.04	2.04
November	87	5.26	2.07	-	10.52	42.10	36.84	3.21
December	74	-	29.53	4.54	18.18	31.81	13.63	2.31
January	67	4.76	36.87	14.28	9.52	23.80	9.52	1.25
February	51	-	36.09	9.09	18.18	27.27	9.09	0.28
March	87	6.66	31.20	-	20.00	20.00	20.00	2.14
April	57	14.01	26.90	-	18.41	25.41	14.03	1.24
May	112	-	11.23	-	9.87	36.02	38.87	4.01
June	64	-	31.10	6.54	6.54	18.74	32.06	5.02
July	44	5.04	29.66	-	22.54	15.98	23.57	3.21
August	38	-	15.53	2.54	35.12	25.59	20.21	1.01

Table 6.10.2. Percentage occurrence of stomachs in various degrees of fullness in female *Decapterus russelli* during 2001-02

Months /Feeding condition	No of specimens examined	Gorged	Full	3/4 full	1/2 full	1/4 full	Trace	Empty
September	106	-	1.20	1.91	27.10	31.52	32.86	5.41
October	71	2.54	50.07	8.79	2.98	16.54	17.04	2.04
November	122	5.26	2.07	-	10.52	42.10	36.84	3.21
December	124	-	29.53	4.54	18.18	31.81	13.63	2.31
January	187	4.76	36.87	14.28	9.52	23.80	9.52	1.25
February	118	-	36.09	9.09	18.18	27.27	9.09	0.28
March	148	6.66	31.20	-	20.00	20.00	20.00	2.14
April	88	14.55	27.82	-	19.67	22.19	14.53	1.24
May	157	-	9.35	-	4.41	35.40	46.83	4.01
June	90	-	17.22	10.12	10.12	22.92	34.60	5.02
July	62	7.46	38.92	-	14.96	9.02	26.43	3.21
August	53	-	20.59	16.50	31.54	22.01	8.35	1.01

Table 6.10.3. Average percentage occurrence of stomachs in various degrees of fullness in female *Decapterus russelli* during 2000-01 and 2001-02

Months /Feeding condition	No of specimens examined	Gorged	Full	3/4 full	1/2 full	1/4 full	Trace	Empty
September	182	-	4.32	2.81	28.36	32.43	29.39	2.71
October	145	3.65	46.48	9.16	3.87	17.79	18.04	1.02
November	209	5.26	3.68	-	10.52	42.10	36.84	1.61
December	198	-	30.69	4.54	18.18	31.81	13.63	1.16
January	254	4.76	37.50	14.28	9.52	23.80	9.52	0.63
February	169	-	36.23	9.09	18.18	27.27	9.09	0.14
March	235	6.66	32.27	-	20.00	20.00	20.00	1.07
April	145	14.42	28.21	-	19.36	23.00	14.41	0.62
May	269	-	11.83	-	5.78	35.56	44.84	2.01
June	154	-	23.20	9.23	9.23	21.88	33.97	2.51
July	106	6.86	38.21	-	16.86	10.76	25.72	1.61
August	91	-	19.83	13.01	32.44	22.91	11.32	0.51

Fig. 6.10.1. Annual feeding condition of female *D. russelli* during 2000-01

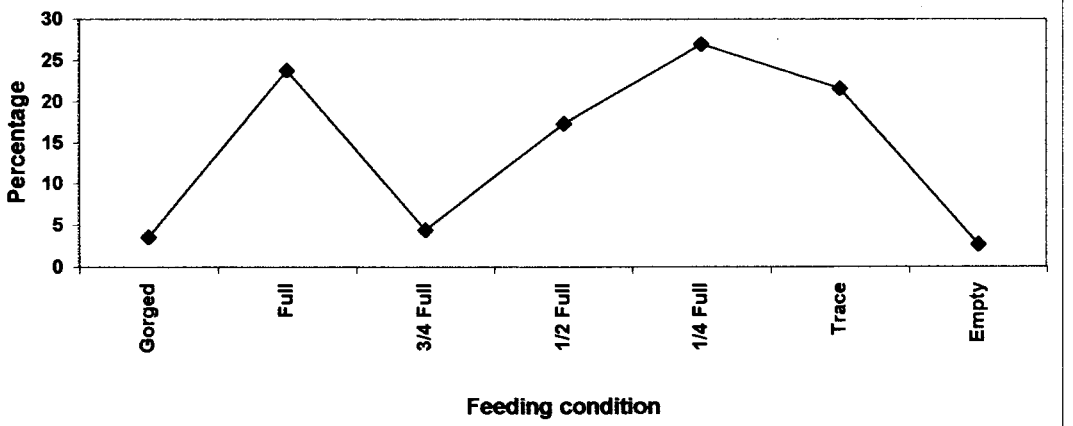


Fig. 6.10.2. Annual feeding condition of female *D. russelli* during 2001-02

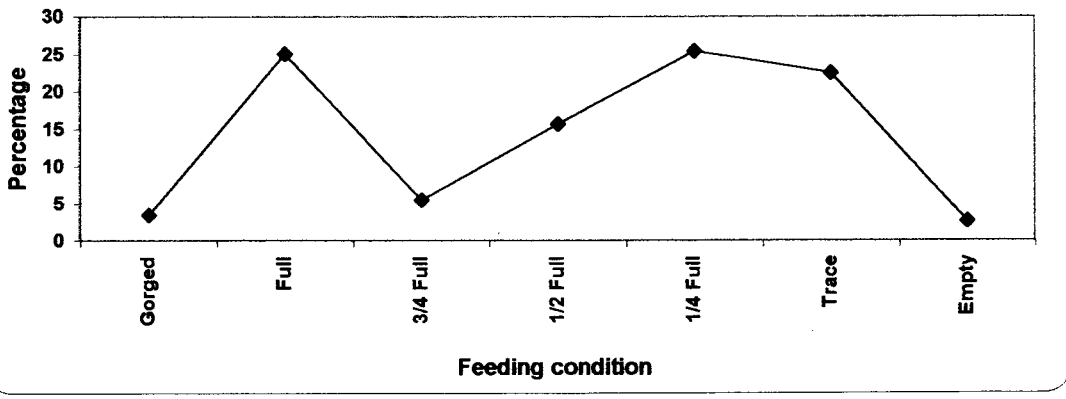
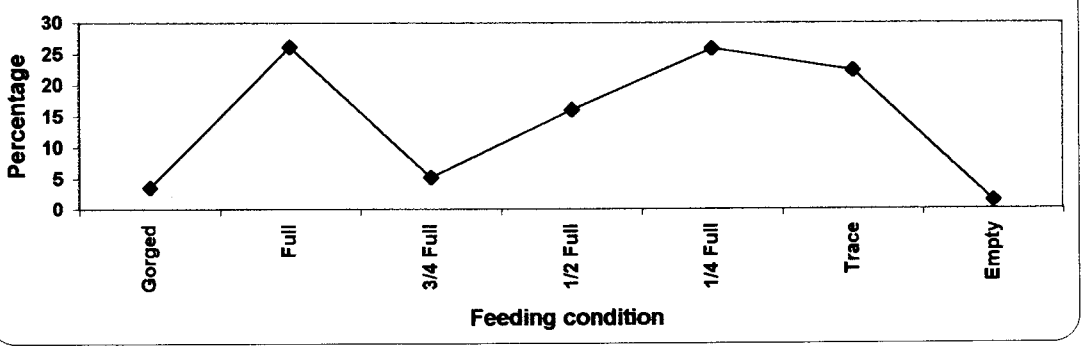


Fig. 6.10.3. Annual average feeding condition of female *D. russelli* during 2000-01 and 2001-02



Chapter – 7

Maturation and spawning of *Decapterus russelli* (Ruppell)

7.1. Introduction

Study of maturation and spawning of fish involves various aspects, such as the maturation process, the size at first maturity, maturation cycle, spawning season, fecundity etc. Studies on these aspects are aimed at understanding and predicting the changes the population is expected to undergo from time to time. These studies are also useful for the judicial management of the fishery.

The basic factor that supports new recruitment in any stock of fishery is the reproducing capacity of a fish that is determined by estimation of fecundity. Fecundity is the egg laying capacity of a fish, or in other words, fecundity is the number of eggs to be laid by a fish in the ensuing spawning season. As a very important aspect of fishery biology, knowledge of fecundity of fishes is one of the essentials to be known. The recruitment of a stock depends on the fecundity of that fish. The knowledge of fecundity of a fish is essential to assess the regiments potentiality of a particular fishery of a particular area and this helps in proper planning for its management and rational exploitation.

It is said that a mother fish never laments over the mortality of her offsprings. Except some aggressive predators and nest making fish, most of the fish have no parental care to compensate mortality, but they have high reproductive potential. Various internal and external factors such as heredity, racial differences, environmental conditions, photoperiodicity, availability of proper food, breeding ground, population density, weight of fish, eggs, size of ova, weight and length of ovary, disease, deformity, etc., influence fecundity of fish either individually or in combination. Generally, fecundity is expressed in relation to the body weight, ovary weight or the total length of fish. A comprehensive study on the reproductive biology of fish is often very useful for a better understanding of the annual regeneration of their stocks. The reproductive

parameters such as maturity, spawning periodicity, fecundity and recruitment are of great value in fishery predictions and formulation of management measures.

Being aquatic, many a times fishes do not tend themselves for direct observation. Their growth and survival are controlled by many natural factors. The growth and mortality of a fish to a large extend is influenced by its reproductive behavior. It is assumed that growth is able to take place when the rate of energy intake is more than sufficient to supply the energy needed for maintaining an organism at its existing size and according to its usual mode of existence. Given that a fish takes in more energy than it needs for maintenance, when considering the effect of deploying the energy in different ways, there would appear to be a choice in a evolutionary sense of whether to use a supply energy for growth, reproduction, laying down storage tissue, or for more energetic food gathering.

Where fertilization is external and eggs and parents do not tend young ones, the mortality rate is bound to the high. However, nature takes care of a reasonable degree of survival of these eggs by providing infinitely large number of eggs. In the tropic majority of fishes are known to spawn in batches or show a protracted spawning. Protracted spawning has once again a direct bearing on the growth and mortality factors of these fishes. As it is a continuous reproductive activity, the energy is continuously channeled in its direction and it involves a higher energy diversion, which is directly reflected on its size and early mortality. Protracted spawning, though assures a constant recruitment pattern gives a poor yield in terms of weight.

Following Clark (1937), considerable progress has been made on these studies through investigations by Sekharan (1958), Prabhu (1956), Chacko and Mathew (1954), Seshappa and Bhimachar (1955), Venkataraman (1956), Annigeri (1971) Rao (1965) Pradhan and Palekar (1956) and Kagwade (1968b). In this chapter, an attempt is made for assessing various parameters related to maturation and spawning of *Decapterus russelli* along the Malabar area.

7.2. Classification of maturity stages

Earlier workers have used different features of ovary as the basis for classification of maturity stages. Graham (1924) noted the colour as the basis, while Hjort (1911) and Bowers (1954) used the shape and size of the gonads in relation to the body cavity. Hickling and Rutenberg (1936) employed the ratio between the gonad weight and body weight and Clark (1934) used the ova diameter. Hjort (1911) described seven distinct stages of maturity for the herrings of the eastern North Sea and Iceland waters. This classification was subsequently followed by a number of workers (Graham, 1924; Hickling, 1930 and Hickling and Rutenberg, 1936).

In the present study the maturity stages were determined based on colour, relative size to the body cavity and shape of ovary and testis. Ova diameter measurements and extend of yolk formation in eggs were also taken into consideration during the classification of maturity stages of ovaries. The maturity stages described here more or less correspond to the scale adopted by ICES (Wood, 1930 and Lovern and Wood (1937).

The seasonal changes in the gonad of *Decapterus russelli* necessitated macroscopic observations every month and ovaries were examined for these studies during the period of investigation. Macroscopically gonads of *Decapterus russelli* are classified in to seven stages of maturity.

Stage I: Immature

Ovary: Thin, small and pink coloured. Ova not visible. When thrashed on a glass slide and observed under microscope minute, transparent, irregular shaped cells are visible. Nucleus not visible. Small transparent ova measuring up to 0.0588 mm or less. Ovary occupies 1/8 of the body cavity.

Testis: Thin, pale whitish in color. Occupies 1/8 of the body cavity. Milt absent

Stage II : Maturing

Ovary: Small, tubular: fills ¼ th of the body cavity: White in colour. Ova transparent larger than I stage ova. Ova ranges in size from 0.0588-0.1764 mm. Transparent eggs with clearly visible, nucleus present.

Testis: Pale, pinkish in colour. Slightly flattened; occupies 1/3 of the body cavity. Both lobes equal in size and milt absent

Sate III : Maturing

Ovary: Ovary occupies more than ½ of the body cavity, large tube like and massive, more turbid than II nd stage ovary. Surface of ovary smooth; ovarian wall thick and the eggs not visible through it; white in colour and elongate. Due to commencement of yolk deposition, the central region is translucent; eggs range in size from 0.1764-0.4704 mm; two sets of ova are seen, one set with clearly visible nucleus and the other with opaque and yoked ova.

Testis : Pale whitish in colour occupying ½ of the body cavity. Milt oozes by application of pressure. Groves appears on the margin.

Stage IV : Mature

Ovary : Cylindrical bright yellow in colour occupying ¾ of the body cavity; ovary wall thin and yellow yolked ova are seen through it; ova visible under microscope looks opaque ball like, without space in peripheral region; both transparent and yoked ova are present; their sizes range from 0.1764 - 0.6408 mm. Pure white in colour and much elongated. Right lobe slightly larger than the left and grooved.

Testis : Whitish occupying ¾ of the body cavity. Right lobe testis slightly longer than the left lobe.

Stage V: **Ripe**

Ovary: Bright yellow in colour, occupies almost full of the body cavity; eggs measuring from 0.1764-0.8232 mm, some eggs with oil globule are also present.

Testis: Fill the entire body cavity; whitish in colour. Milt released on application of pressure.

Stage: VI: **Running**

Ovary: Body cavity is wholly filled with the ovarian lobes; pale yellowish in colour; ovary wall thin; eggs extrude under slight pressure; large translucent ova with single oil globule (size ranging from 0.1453 to 0.1879 mm), opaque, yellow ova and also small transparent ova present; size of eggs range from 0.1764 to 1.0584 mm.

Testis: Whitish and massive structures and identical to previous stage but white flabby and milt oozes out. Size varies according to the advancement of spawning.

Stage VII **: Spent**

Ovary : Blood vessels stained and flaccid ovaries were assigned to this stage. Some ovaries occupy ¾ of the body cavity; eggs in them range in size from 0.01981 to 0.8232 mm; three types of ova were met with viz. transparent small ova, yoked opaque and few eggs with oil. Most of the large eggs are under disintegration with broken egg membrane and yolk oozing out. In some ovaries, only transparent and opaque eggs were present.

Testis : Blood shot and shrunken occupying ¾ of the body cavity or much smaller.

Stage IIR : Spent Recovering

Ovary: Small tubular; pale reddish or pinkish; eggs range in size from 0.0588 to 0.1764 mm.

Testis: Pale reddish, occupying less than 1/3 of the body cavity.

7.3. Ova diameter studies

The mature ovary of *Decapterus russelli* is a paired elongated organ; almost round in cross-section, attached to the dorsal wall of the body cavity by a mesentery, the mesoarium. The mature ovary occupies nearly the whole of the body cavity. Posteriorly the two lobes unite to form an oviduct opening to the exterior through the urogenital pore. Both the lobes are almost equal in length, but in a few specimens, the right ovary was found to be slightly larger. In a mature ovary, the blood vessel becomes very conspicuous imparting a blood-red hue to the ovary.

Ova diameter frequency of *Decapterus russelli* in different stages of maturity is given in Fig 7.3.1. Immature eggs ranging from 1 md to 3 md are present in all the stages of maturity and can be considered as general stock. In immature stage I, transparent ova with clearly visible nucleus are observed. In stage II also the ova diameter was slightly more than the I stage. In the stage III, some of the eggs drawn from general stock of the immature females were under the process of maturation. These eggs were deposited with yolk and become opaque. The maximum size of the eggs in this stage was 24 md. They increase in size further in next stage IV and form a separate stock with mode 25-27 md and the largest egg of this stage measured was 33 md. In stage V, the above group increases in size with a mode at 28-30 md and here the size of the eggs reaches up to 42 md. In stage VI, the yolk laden mature eggs increase very much in size, the first batch swells enormously to become large hyaline eggs with mode at 46-48 md and this batch represents the eggs to be spawned immediately. A single oil globule is clearly seen in the transparent eggs. The maximum size of the eggs noticed is 54 md. At the same time the second batch of eggs were also present with mode at 22-24 md. In

stage VII, the first batch spawned, while the second batch of eggs remain with very little representation. In II R, only general stock was observed.

7.4. Size at first maturity

To determine the size at first maturity in *Decapterus russelli*, the percentage occurrence of both male and female at various stages of maturity have been tabulated against their length group for the year 2000-01 and 2001-02 and the pooled data for the two-year is taken for calculating the size at first maturity.

The percentage occurrence of males in different stages of maturity for the year 2000-01 and 2001-02 are pooled and presented in Table 7.4.1. It would appear that males up to 90-99 mm were all immature. Maturing males appear in the fishery when they grow beyond 100 mm and attain maturity at 120-129 mm size. However, 50 % of the fishes were mature at 143 mm (Fig 7.4.1). Therefore, it can be concluded that the size at first maturity of males of *Decapterus russelli* is 143 mm.

The percentage occurrence of females of *Decapterus russelli* for the years 2000-01 and 2000-02 were pooled and presented in Table 7.4.2 for assessing the size at first maturity of females. The pooled data for the two years indicate that the females up to 110-119 were all immature. The maturing females started to appear in the fishery from 120-129 mm size group onwards and they were present in the fishery up to 210-219 mm. Maturation of females started from a size of 120-129 mm onwards. However, 50 % of them were mature only when they were at 155 mm (Fig 7.4.2). Therefore, it can be stated that the size at first maturity of females of *Decapterus russelli* along the Malabar coast is at 155 mm.

7.5. Spawning season

For determination of spawning season of *D. russelli*, mature females only were considered. An arbitrary classification of gonads into five stages namely immature, maturing (II and III), mature (IV & V), ripe (VI) and spent for the years 2000-01 and 2001-02 is presented in Table 7.5.1 and 7.5.2. It can be seen that there was apparently

not much differences in the monthwise occurrence of different stages of maturity. The combined data for the two years shows that immature gonads were present from July to February (Table 7.5.3). Females in the maturing stages were present from June to February. Mature females were present during all the months. Fishes with ripe ovary was present for 10 months from March to December. The spent fishes were also present during the same period and absent during January to February months. The presence of mature, ripe and spent gonads from March to December indicate prolonged spawning season for this fish. Enlarged jelly like ovaries and testes with oozing milt were observed from March to December indicating spawning season of the fish. Occurrence of limited number of spawners during spawning season may also indicate that fish may be spawning elsewhere. Fishes with spent gonads started appearing in March and were present until December.

The relative condition factor (Kn) values obtained during different months of the years 2000-01 and 2001-02 are given in Table 7.5.4. These values are mostly high and vary within a narrow range of 0.92 to 0.98 strengthening the earlier conclusion that this species has prolonged spawning season.

To confirm the spawning period of *Decapterus russelli* the gonadosomatic index have been calculated month wise and presented in Table 7.5.5. Fishes having a total length of 20 cm and above only were considered for the study. The average gonadosomatic values during 2000-2001 to 2001-2002 for males were between 0.75 and 3.85, where as those of females were between 1.01 and 4.93. The gonadosomatic index values for male showed maximum value in April during the years 2000-2001 and 2001-2002. The values showed a downward trend during the subsequent months except in December when a slight increase was evident, but again the decreasing trend was followed to reach the lowest value in December. In the case of females also the value showed a bimodal nature indicating two peak spawning periods. From March to December, gonadosomatic index values remained high representing the spawning season. The observations on the occurrence of spawning individuals in the fishery for a long period stood as the confirmatory evidence to the present results on the spawning season of *Decapterus russelli*. Based on the gonadosomatic index values and on the incidence of

spawning and spent fishes in the commercial catches it is evident that the spawning season of *Decapterus russelli* is prolonged and falls between March and December.

7.6. Fecundity

The reproductive potential of a population has considerable bearing on the fecundity in females. Fecundity estimates were made based on the eggs of gonads in stage V of maturity. 50 ovaries were examined from the fishes ranging in the size from 160-220 mm. A curvilinear relationship exists between the values of length, ovary weight and fecundity.

The fecundity of *Decapterus russelli* was found to vary from 33159-196392. The number of ova per gram ovary varied from 8270-28300 (average 19460). The parabolic equation between fecundity and fish length was estimated to be

$$F = 0.0060534\ L^{5.5952}$$

Coefficient of correlation r= 0.9891

The graphic expression of the equation is curvilinear indicating that fecundity increases at more rapid rate in relation to length (Fig.7.6.1).

The relationship between fecundity and fish weight was found to be

$$F = 0.0076913\ W^{3.7672}$$

7.7. Sex ratio

The number of males and females observed during different months for the year 2000-01 and 2001-02 has been presented in Table 7.7.1 and 7.7.2. It is seen from the Table that the distribution of males and females during different months fluctuated considerably. During the period 2000-01, the annual sex ratio between male and female was 1: 0.97. This shows marginal domination of males in the commercial catches.

Monthwise fluctuation in the sex ratio shows that females were dominating the catch during September, November, March and May and during all other months males dominated in the catches.

In the year 2001–02, a marginal domination of females was observed in the fishery. The month wise fluctuation in the sex ratio shows that unlike in the previous year female fishes have been dominated in most of the months. Males dominated the catch only during the months of April, June, July and August. The annual sex ratio for this year between male and female was 1: 1.14.

The pooled data for the two-year period is presented in Table 7.7.3. This shows the females dominated over males during seven months and during other five months, males dominated the catch. The annual average for the whole period shows that the sex ratio of 1: 1.07 indicating marginal domination of female population.

Conclusion

In the present study, *Decapterus russelli* was observed as a continuous breeder with spent forms appearing from March to December. Moreover, corresponding to the increasing trend in juveniles appearing from April with an increase in the spent forms from March onwards clearly suggests that the peak spawning period as March to May. Another fact, which is also discernible from the present study, is that of a likelihood of second spawning peak during September to October months. The size at first maturity is estimated, in present study, in respect of *Decapterus russelli* 143 mm for males and 155 mm for females. The fecundity of *Decapterus russelli* of size range studies was found to vary from 33159-196392. The fecundity was found to vary depending upon the size of the fish.

Fig. 7.3.1. Ova-diameter frequency in *D. russelli* in different stages of maturity

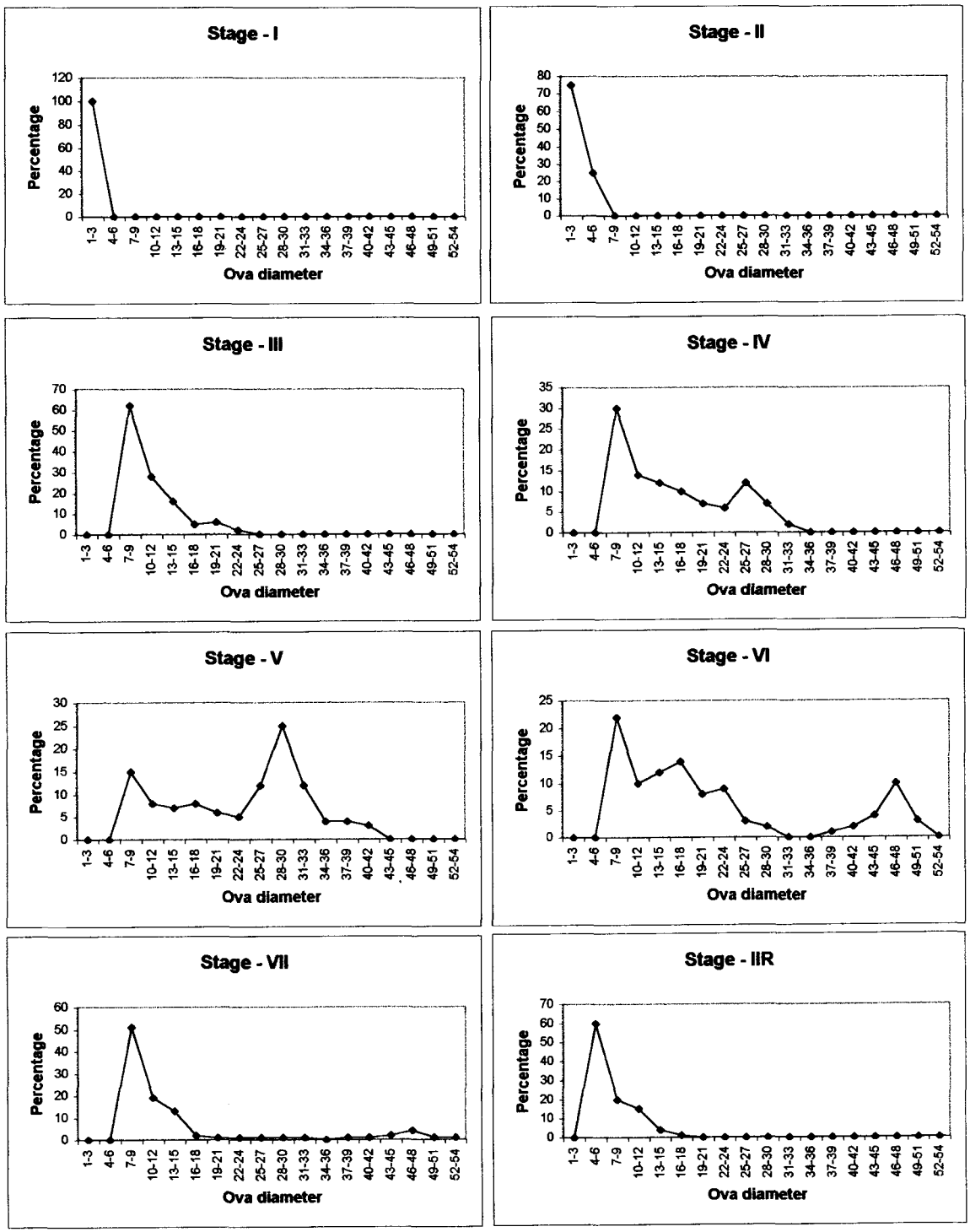


Table 7.4.1. Percentage occurrence of male *D. russelli* in different stages of maturity in different length groups during 2000-01 and 2001-02

Length group (mm	Number of fishes examined	Maturity stages							
		I	II	III	IV	V	VI	VII	IIR
90-99	12	100							
100-109	50	62.5	25	12.5					
110-119	47	69.7	30.3	0					
120-129	59	53.4	36.6	7.6	2.4				
130-139	90	13.6	38.1	28.8	13.14	6.36			
140-149	83	1.2	15.82	27.7	35.14	20.14	0	0	
150-159	155		4.6	20.14	33.14	19.84	12.14	10.14	
160-169	170			2.14	22.14	34.12	20.14	21.46	
170-179	209				30.74	36.14	12.14	20.98	
180-189	253				12.14	39.69	18.61	29.56	
190-199	170				8.31	23.12	28.18	40.39	
200-209	222				38	22.52	2.14	33.14	4.2
210-219	158					33.41	33.14	29.26	4.19
220-229	166					45.15	21.14	21.14	12.57

Table 7.4.2. Percentage occurrence of female *D. russelli* in different stages of maturity in different length groups during 2000- 01 and 2001-02

Length group (mm)	Number of fishes examined	Maturity stages							
		I	II	III	IV	V	VI	VII	IIR
90-99	44	100	0						
100-109	110	75	25	0					
110-119	116	63.3	36.7	0					
120-129	154	38.14	40.66	14.82	4.24	2.14			
130-139	240	4.99	35.14	35.14	22.59	2.14			
140-149	253	2.1	34.13	24.12	21.14	16.1	2.41		
150-159	216	5.45	30.12	13.6	7.59	20.12	23.12		
160-169	272	4.99	10.1	33.12	25.12	22.26	4.41		
170-179	256	2.1	2.4	7.28	17.7	16	2.41	52.11	
180-189	209		1.1	5.37	18.9	7.2	12.12	55.31	
190-199	163			3.09	32.67	5.2	12.24	45	1.8
200-209	87				16.54	7.8	22.24	51.72	1.7
210-219	37				24.68	8.8	10.14	56.33	0.05
220-229	87				12.12	13.4	10.13	62.21	2.14

Fig. 7.4.1. Size at first maturity of male *D. russelli*

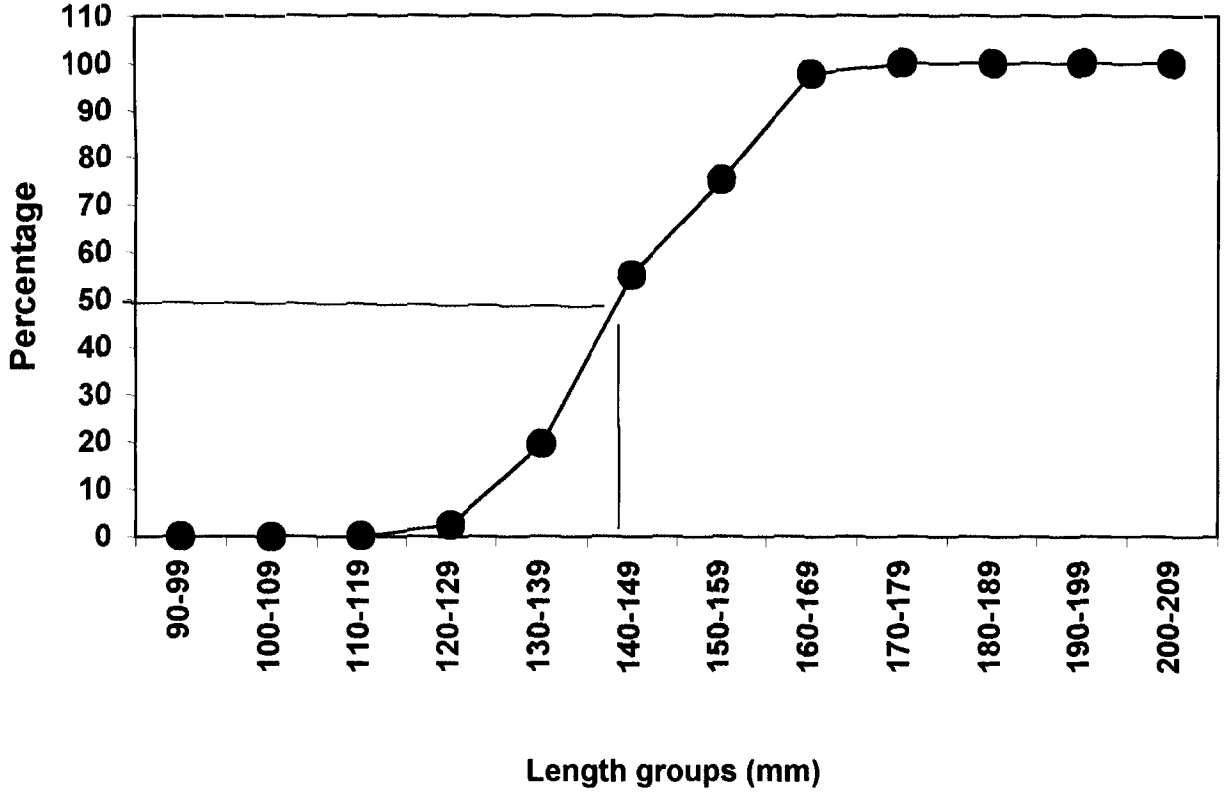


Fig.7.4.2. Size at first maturity of female *D. russelli*

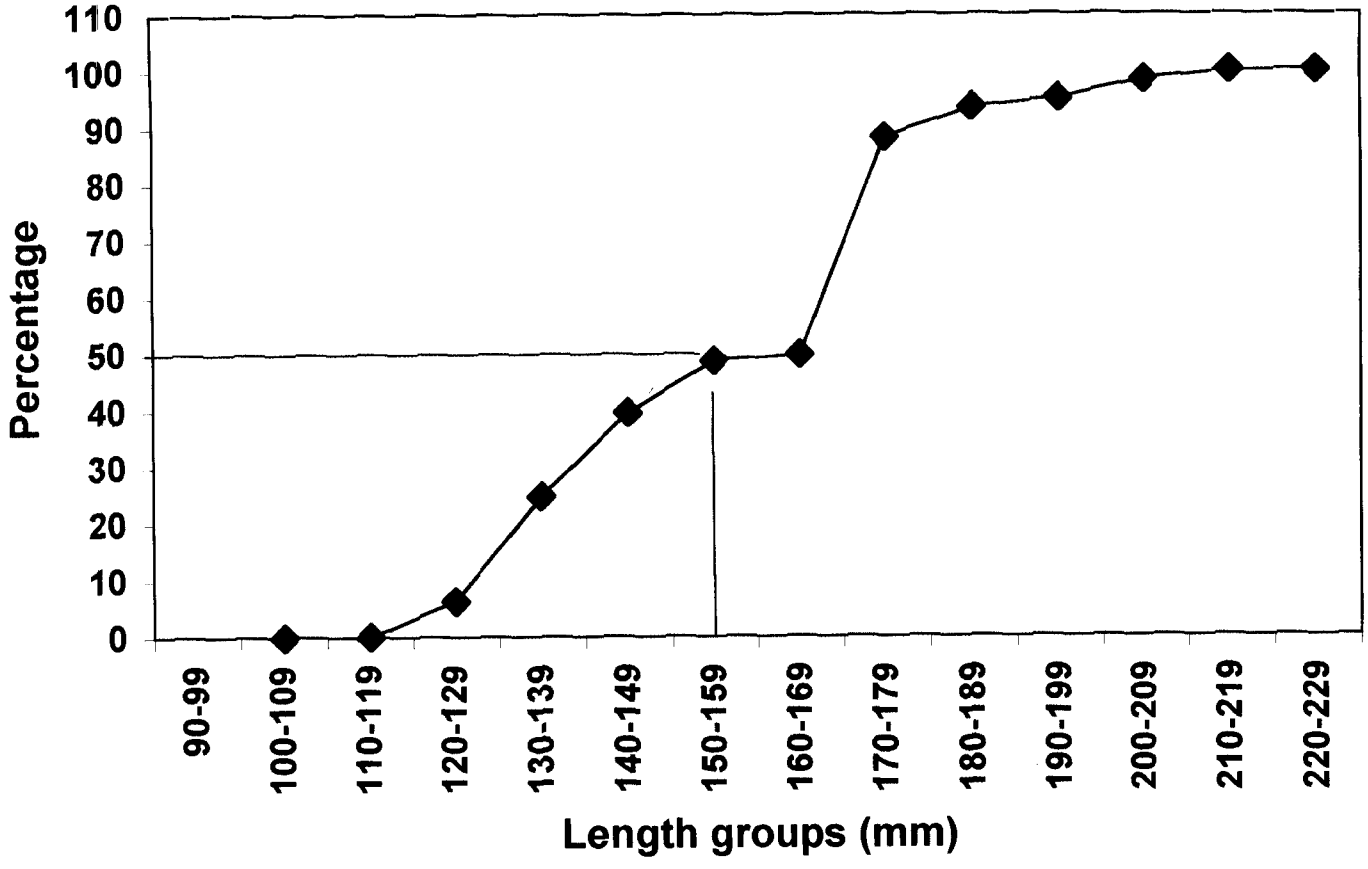


Table 7.5.1. Monthwise percentage occurrence of *D. russelli* with gonads in different stages of maturity during 2000-01

Month/ Stages of maturity	No. of specimens examined	Immature	Maturing	Mature	Ripe	Spent
September	76	12.54	28.14	36.01	12.85	10.46
October	74	39.98	22.15	14.54	21.14	2.19
November	87	28.31	41.08	19.21	8.54	2.86
December	74	42.42	38.12	13.21	4.21	2.04
January	67	2.1	9.76	88.14		
February	51	8.12	12.54	79.34		
March	87			42.14	37.14	20.72
April	57			18.12	23.28	58.6
May	112			42.21	28.24	29.55
June	64		26.21	30.45	16.21	27.13
July	44	18.01	12.65	31.98	32.05	5.31
August	38	17.14	14.15	34.12	22.14	12.45

Table 7.5.2. Monthwise percentage occurrence of *D. russelli* with gonads in different stages of maturity during 2001-02

Month/ Stages of maturity	No. of specimens examined	Immature	Maturing	Mature	Ripe	Spent
September	106	6.04	29.12	39.12	13.58	12.14
October	71	35.12	20.14	16.14	23.01	5.59
November	122	31.14	36.37	23.14	4.21	5.14
December	124	38.39	36.12	15.21	6.14	4.14
January	187	3.59	10.27	86.14		
February	118	8.12	12.54	79.34		
March	148			39.12	23.14	37.74
April	88			16.12	21.57	62.31
May	157			41.34	22.12	36.54
June	90		23.43	35.12	10.21	31.24
July	62	8.64	11.25	35.69	36.21	8.21
August	53	18.12	15.12	38.54	19.11	9.11

Table 7.5.3. Average percentage occurrence of *D. russelli* with gonads in different stages of maturity during 2000-01 and 2001-02

Month/ Stages of maturity	No. of specimens examined	Immature	Maturing	Mature	Ripe	Spent
September	182	9.29	28.63	37.57	13.22	11.30
October	145	37.55	21.15	15.34	22.08	3.89
November	209	29.73	38.73	21.18	6.38	4.00
December	198	40.41	37.12	14.21	5.18	3.09
January	254	2.85	10.02	87.14	-	-
February	169	8.12	12.54	79.34	-	-
March	235	-	-	40.63	30.14	29.23
April	145	-	-	17.12	22.43	60.46
May	269	-	-	41.78	25.18	33.05
June	154	-	24.82	32.79	13.21	29.19
July	106	13.33	11.95	33.84	34.13	6.76
August	91	17.63	14.64	36.33	20.63	10.78

Table 7.5.4. Kn Values of female *D. russelli* in different months during 2000-01 and 2001-02

Months	2000-01	2001-02	Average
September	0.95	0.96	0.96
October	0.96	0.95	0.96
November	0.96	0.94	0.95
December	0.92	0.93	0.93
January	0.93	0.94	0.94
February	0.94	0.94	0.94
March	0.97	0.98	0.98
April	0.97	0.98	0.98
May	0.92	0.96	0.94
June	0.93	0.95	0.94
July	0.92	0.93	0.93
August	0.94	0.94	0.94

Table 7.5.5. Monthly average gonadosomatic index of *D. russelli* in different months during 2000-01 to 2001-02

Month	Female		Average	Male		Average
	2000-01	2001-02		2000-01	2001-02	
September	4.19	4.32	4.26	2.79	2.21	2.50
October	3.32	3.18	3.25	2.89	2.02	2.46
November	2.54	2.48	2.51	1.97	2.11	2.04
December	2.11	1.81	1.96	0.51	0.98	0.75
January	0.81	1.21	1.01	0.92	1.24	1.08
February	1.12	2.31	1.72	1.23	0.81	1.02
March	4.49	5.21	4.85	3.05	2.34	2.70
April	4.95	4.91	4.93	3.71	3.98	3.85
May	3.61	4.21	3.91	2.89	3.72	3.31
June	3.64	4.03	3.84	2.86	2.34	2.60
July	3.14	4.52	3.83	2.94	2.53	2.74
August	3.45	3.56	3.51	3.05	2.01	2.53

Fig. 7.6.1. The relationship between length and fecundity of *D. russelli*

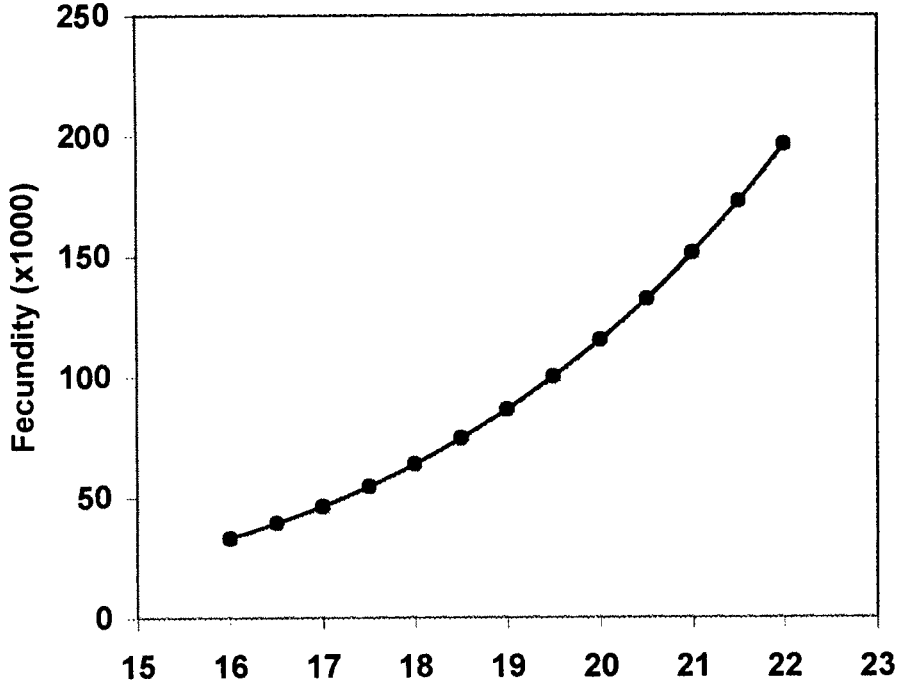


Table 7.7.1. Sex ratio between male and female of *D. russeli* during 2000- 2001

Months	No of males	No of females	Sex ratio M:F
September	68	76	1.12
October	72	74	1.02
November	64	87	1.36
December	76	74	0.97
January	74	67	0.91
February	54	51	0.94
March	76	87	1.14
April	82	57	0.70
May	98	112	1.14
June	78	64	0.82
July	54	44	0.81
August	48	38	0.79
Annual	844	831	0.98

Table 7.7.2. Sex ratio between male and female of *D. russeli* during 2001- 2002

Months	No of males	No of females	Sex ratio M:F
September	95	106	1.12
October	69	71	1.04
November	90	122	1.36
December	90	124	1.38
January	104	187	1.81
February	102	118	1.16
March	102	148	1.45
April	118	88	0.75
May	137	157	1.14
June	109	90	0.82
July	76	62	0.81
August	67	53	0.79
	1159	1325	1.14

Table 7.7.3. Average sex ratio between male and female of *D. russelli* during 2000-2001 and 2001- 2002

Months	No of males	No of females	Sex ratio M:F
September	163	182	1.12
October	141	145	1.03
November	154	209	1.36
December	166	198	1.19
January	178	254	1.43
February	156	169	1.08
March	178	235	1.32
April	200	145	0.73
May	235	269	1.14
June	187	154	0.82
July	130	106	0.81
August	115	91	0.79
Annual	2003	2156	1.07

Chapter-8

Estimation of Length-Weight Relationship, Growth, Mortality, Recruitment Patterns and Yield Per Recruitment of *Decapterus russelli* (Ruppell)

8.1. Introduction

Marine fisheries are based on stocks of wild populations inhabiting the sea. The success of capture fisheries depends on the state of these stocks. The purpose of study of fish population dynamics of exploited stocks is to offer scientific advice on the possible range of options for rational exploitation. By increasing the fishing effort, the yield can be increased to a certain level, but further increase in exploitation levels leads to reduction in the yield and if the effort is still further increased regardless of the reduction in total catch and catch rates, the stock under exploitation may collapse. Such a situation would arise if proper scientific advice on the maximum possible effort and safe gear and mesh levels that could be deployed to exploit the resources of a stock/stocks in a given geographic area, was not made available and even if made available, not implemented. Hence, the exploited stocks need to be maintained carefully and scientific advice rendered to the government and the industry on the range of measures required ensuring maximum economic and sustainable yield.

The basic objective of fish stock assessment is to provide advice on the optimum exploitation of the living resources under investigation. The maximum effort level, which in the long term gives the highest yield, is indicated by F (MSY) and the corresponding yield is the MSY (Maximum Sustainable Yield). It is rather well known that the fundamental concept while describing the dynamics of an exploited marine resource is that the 'stock'. A stock is a subject of a species, which is considered as the basic taxonomic unit. Stocks are discrete groups of animals, which show little mixing with the adjacent groups. The population parameters or stock parameters remain constant over the distribution area of the stock. The growth parameters and mortality coefficients are the two fundamental stock parameters required for the identification of a stock. The former are the numerical values in an equation by which we can predict the body size of a

fish when it reaches a certain age and the latter are the rates at which the animals die either by fishing (fishing mortality) or by other causes such as predation, disease, etc. (natural mortality). The recruitment pattern as well as the size at first capture also play key role in regulating the exploitation of a fishery.

8.2. Length-weight relationship

According to Le Cren (1951), a knowledge on the length – weight relationship serves generally two purposes; first towards deriving or describing a mathematical relationship between length and weight so that one of the variables may be converted into the other; secondly to measure variations from the expected weight for length of individual fish or relevant groups of individual as indicators of fatness, general well being and gonad development etc. The length and weight of fishes may be determined with accuracy. Weight of the fish may be considered a function of the length. This relationship of the length and weight follows approximately the cube law. In order to find out the length weight relationship, it was decided to consider juveniles and adults together and represent a combined regression equation so that it can be applied for stock assessment studies uniformly. The length is considered in millimeter and weight in gram.

The length-weight relationship of *Decapterus russelli* is worked out as

$$W = 0.00000151\ L^{3.3612}$$

$$r = 0.9924$$

8.3. Growth parameters.

For estimation of growth and mortality parameters, the raised length frequencies corresponding to each month pooled over the years 2000-01 and 2001-02 is used (Table 8.1.) The restructured length frequency distribution and the line drawn along the modal values marks their growth line using the FISAT programme is given in Fig 8.1. It indicates that the juveniles start entering the fishery in June and it continues up to February.

The length frequency data analyses using the FISAT programme show a distinct brood originating in April. The figure 8.1 shows the growth curve of the brood originating in April and the fit is perfect. Analysis of recruitment patterns of this brood agrees this result. For further analysis the estimated growth parameters of this brood were taken. The values of L_{00}, K, C, WP and Rn values for this brood is as given below.

L_{00} : 271.2 mm
K : 1.220 y^{-1}
C : 0.700
WP : 0.160
Rn : 0.210

8.4. Mortality Parameters

Mortality in fish occurs because of natural causes as well as due to fishing. Death from any cause is unique event for the individual. The probability of death at any given age is a statistical property of the population as a whole that can be measured only by observation of many individuals.

8.4.1. Estimation of Total Mortality (Z)

The growth parameters of the April brood were used for estimation of total mortality (Z). The Z for April brood is estimated using the catch curve and Jones and van Zalinge Z plot are as follows:

1. Catch curve

The result of this analysis is depicted in the fig 8.2. The estimated Z using the growth parameters of April brood is 3.79 (y^{-1}) and the coefficient of correlation r = 0.960.

2. Jones and Van Zalinge Z Plot

In figure 8.3 the results of Z analysis using growth parameters are presented. The Z estimated by this method is 3.90 (y^{-1}), which is very close to the Z estimated by the catch curve method.

This brood would have been probably born in April and persisted until September to October of the succeeding year. These 16-17 months can be considered as the fishable life span of the *Decapterus russelli.*

8.4.2. Natural mortality (M)

The natural mortality (M) was estimated using the Pauly's empirical formula for an average temperature for 28° C. The value of temperature was found to be fluctuating between 27 and 29 C and hence, the mean temperature was taken as 28 °C (Seshappa and Jayaraman, 1956). The estimated natural mortality for the April brood was 1.13 (y^{-1}).

8.4.3. Fishing mortality (F)

Fishing mortality was estimated by subtracting the values of natural mortality (M) from the total mortality coefficient (Z). Z obtained form catch curve analysis was used for estimation of fishing mortality. The value of natural mortality obtained by Pauly's method was deducted from the total mortality obtained from the catch curve method and fishing mortality obtained was as follows.

$F = Z - M$

$M = 1.13$

$Z = 3.79$

$F = 2.66\ (y^{-1})$

8.5. Recruitment pattern

The recruitment pattern of *Decapterus russelli* was estimated and is presented in Fig 8.4. In the April brood two distinct peaks were observed. Maximum recruitment was observed between March and May and a second one in September-October. The maximum recruitment was during the March – May months with maximum production in April. In April, for the March – April Brood, the recruitment was 36.12 % while in March and May it was respectively 21.19 % and 11.63 %. The recruitment during

March-May alone was 68.54 %. During the second phase, highest recruitment was taken place in September (5.02 %) (Table 8.5.1).

From the above, it can be concluded that the peak recruitment of *Decapterus russelli* takes place in two phases. The primary recruitment takes place in March – May and the secondary recruitment in September-October months.

8.6. Length at First capture (Lc) and length at first recruitment (Lr)

The length at recruitment was taken as the smallest mid-length in the length frequency distribution and the length at first capture was obtained as the mid length of the first peak of length frequency distribution.

The length at first capture (Lc) and length at recruitment (Lr) of *Decapterus russelli* were taken as.

Lc = 145 mm

Lr = 55 mm

8.7. Yield per recruitment

Using the population parameters the yield per recruitment studies were made. Beverton and Holts yield recruitment model is diagrammatically represented in figure 8.8.1. From the figure it can be inferred that relative yield per recruit (Y/R) is maximum for an exploitation rate 0.69. The current exploitation rate (E) was estimated using the equation E=F/Z. The exploitation rate thus estimated is 0.71. The current exploitation rate is slightly higher than the optimum exploitation rate estimated by the Beverton and Holts method. This means that the current level of exploitation rate has crossed the exploitation rate at the MSY level. Hence, there is a need for reducing the present exploitation rate below 0.69 to reduce the fishing pressure on this resource to avoid the depletion of the stock of *Decapterus russelli.*

Conclusions

A living population is dynamic. Environment and exploitation cause persistent alteration in the fish stocks. Technological advancements in the craft and gear have increased their efficiency of exploitation resulting in increased fishing pressure on *Decapterus russelli* along the Malabar region. The growth, mortality and recruitment studies are of prime importance for the assessment and management of a fish stock since these parameters determine the quantum of catch that can be exploited year to year in a fishery.

The length frequency data analysis using the FISAT programme shows a distinct brood originating in April. The best fitting for this brood had growth line parameters as given below.

L_{00}: 271.2 mm, K : 1.22 y^{-1}, C: 0.700, WP : 0.160, Rn 0.210

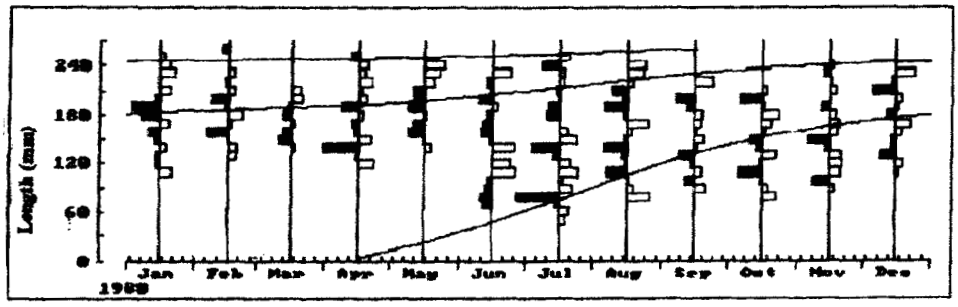
The total mortality (Z) estimated from the catch curve method was 3.76 y^{-1} and the Z estimated using Jones and van Zalinge method was very close to the Z estimated from catch curve. The natural mortality (M) estimated using the Pauly's empirical formula was 1.13 y^{-1}. Fishing mortality (F) estimated by subtracting the values of natural mortality (M) from the total mortality coefficient (Z) was 2.69 y^{-1}. Maximum recruitment was observed between March and May and another recruitment in September-October months. The current exploitation rate is slightly higher than the optimum exploitation rate. This means that the current level of exploitation rate has crossed the exploitation rate at the MSY level. Hence, there is a need for reducing the fishing pressure on this resource to avoid the depletion of the stock.

Table 8.1. Estimated monthly pooled catch in number in different length groups of *Decapterus russelli* for the period from September, 2000 to August, 2002

Gear: All Catch = 10^4 numbers

Length groups/ Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50	0						160.68					
60	0					16.44	336.96					
70	0					39.84	822.12					
80	0					38.4	2051.9	1.08		5.16		
90	0					30.6	280.08	45.72	19.2	41.16	1.2	
100	0					19.08	440.28	96.36	106.8	81.72	4.8	
110	1.32					1.08	15.72	253.8	61.68	159.24	1.2	7.8
120	5.52			9.96		1.68	65.04	194.64	115.7	91.56	1.68	9.12
130	9.72	4.32		97.08		0	72.48	216.12	147.1	18.84	2.88	26.88
140	12.36	8.76	26.28	265.92	23.76	7.92	144.96	308.28	75.36	67.56	8.76	19.68
150	25.68	25.56	81.84	40.92	60.12	113.52	13.56	137.88	41.4	56.04	14.4	18.6
160	49.32	43.56	65.04	138.36	118.2	186.36	60.96	81.36	41.4	28.16	4.56	8.83
170	26.56	21	37.92	110.26	126.4	206.2	107.28	4.06	30.96	10.56	3.84	3
180	92.64	0.48	47.64	64.456	93.48	196.56	193.08	53.52	30.96	1.92	4.08	8.76
190	103.32	29.52	27	107.28	161.2	122.76	200.28	92.04	63.48	11.88	7.56	6.12
200	56.64	46.56	6.36	21.96	109.3	212.52	147.24	57.36	76.08	31.44	6.12	5.76
210	17.28	14.76	3.24	26.88	92.28	112.68	116.28	66.84	40.8	7.92	4.32	12.12
220	16.2	27		2.52	24.24	113.16	61.2	19.56	2.4		4.68	6.36
230	2.04	6.24		5.28	6.6	11.4	41.28	5.16			5.66	0.48
240	1.68	0		1.32			86.4	0.98			3.24	
250	0.48	0		5.28			2.28				3.12	

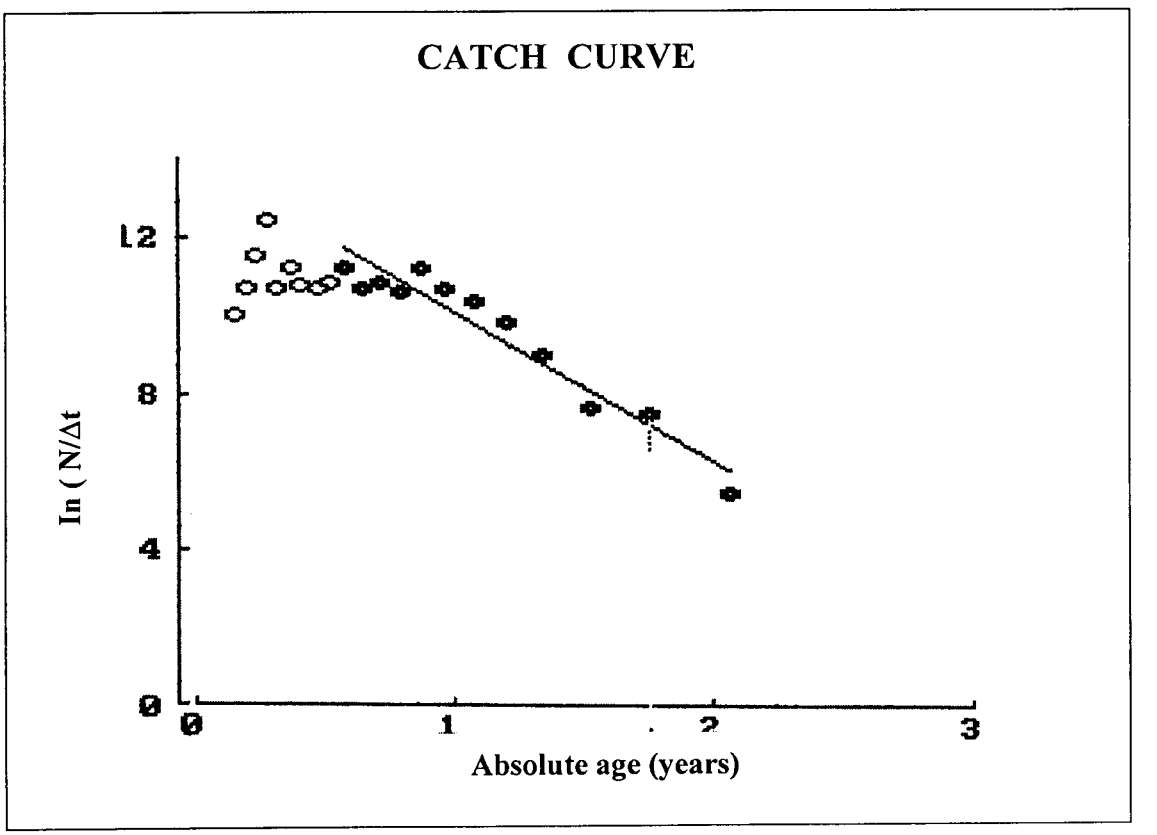
Fig. 8.1. Plot of FISAT analysis of *D. russelli*
(Pooled data)



Month

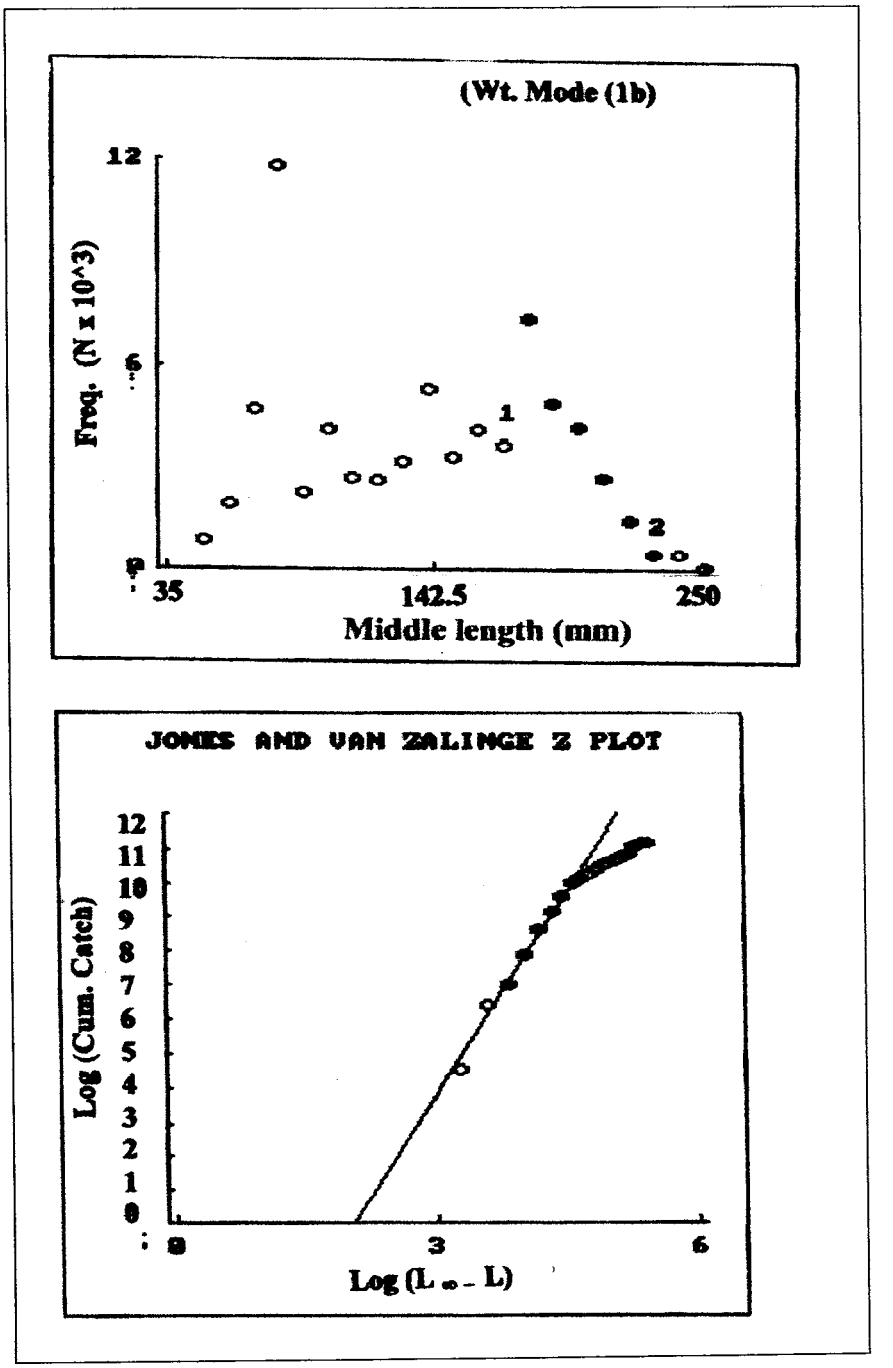
L_{00} = 271.2 mm, K= 1.22 y^{-1}, C= 0.700, WP = 0.160, Rn =0.210

Fig. 8.2. Catch curve analysis estimating total mortality (Z) of *D. russelli*



Estimated Z = 3. 79

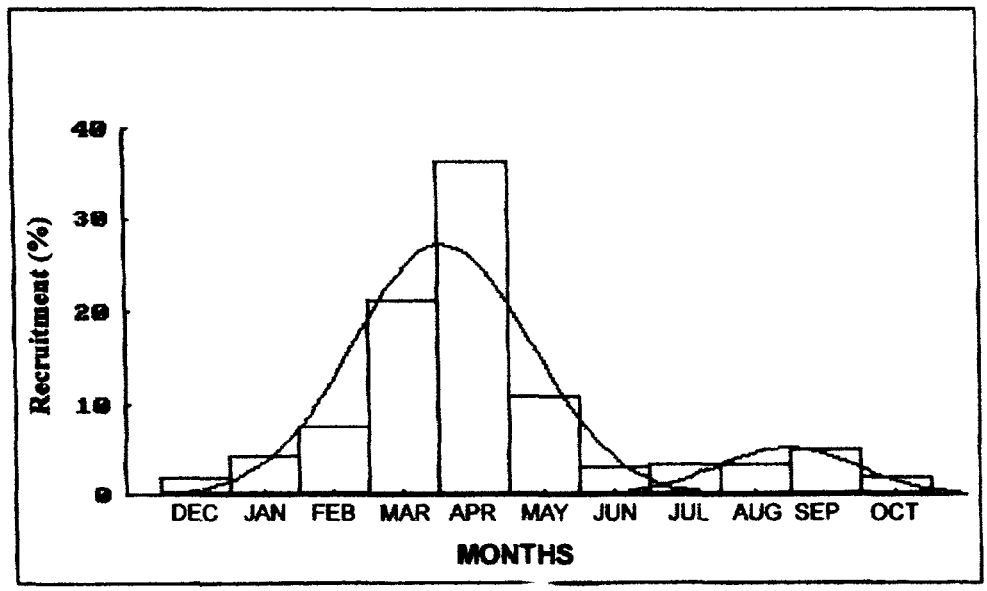
Fig. 8.3. Estimation of Z of *D. russelli* (Jones and Van Zalinge Plot)



Regression equation : Y = - 7.88 + (3.904) x X, r = 0.995

Estimate of Z = 3.904

Fig. 8.4. Recruitment pattern of *D. russelli*



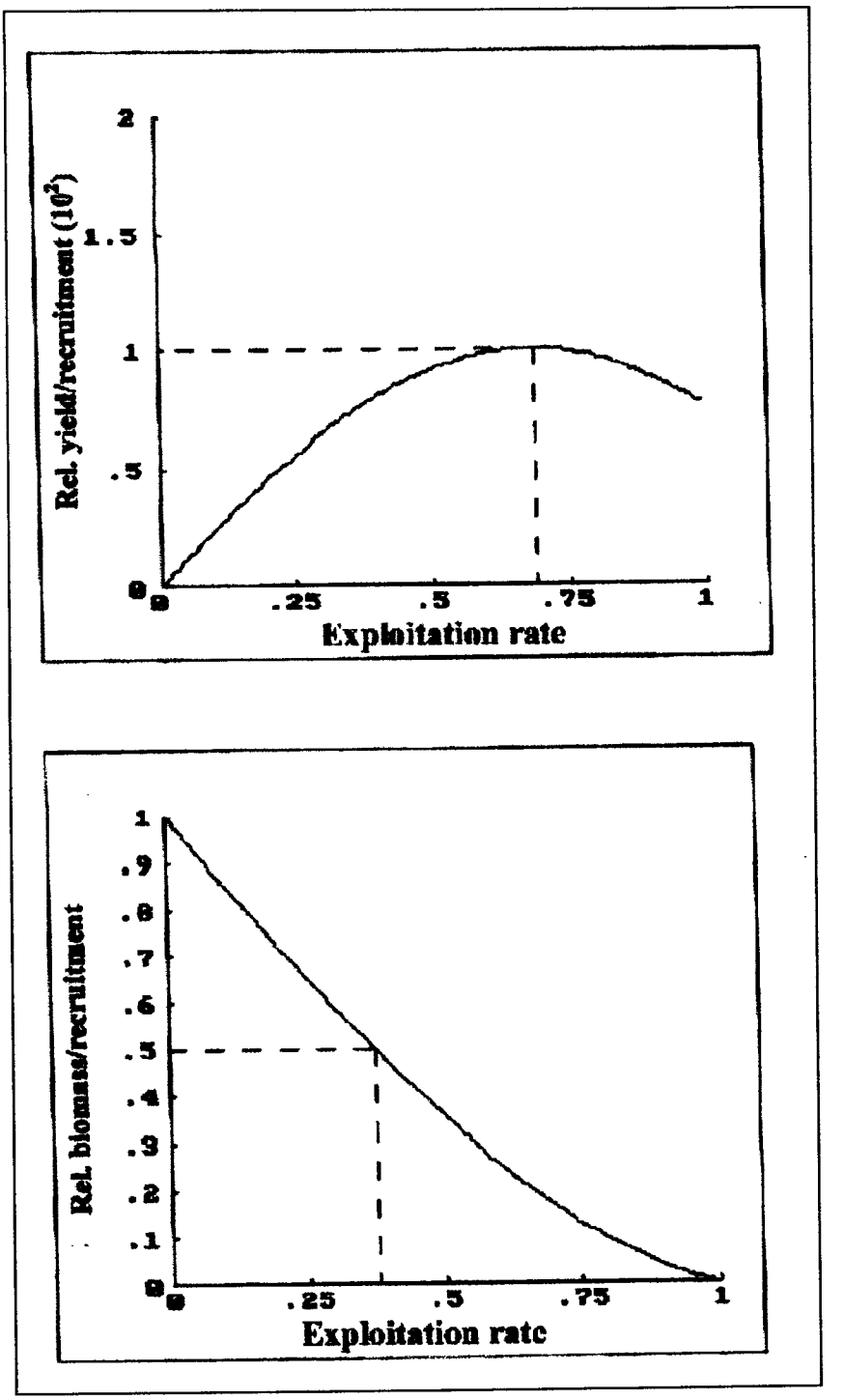
L_{oo} = 271.2 mm, K= 1.22 y^{-1}, C= 0.700, WP = 0.160, t_0 = - 0.01

1st Mean : 4.06, SD = 1.27 2nd Mean : 8.98, SD = 1.02

Table 8.5.1. Percentage of recruitment of *D. russelli*

Month	Percentage of recruitment
December	2.00
January	4.47
February	7.81
March	21.19
April	36.22
May	11.13
June	3.09
July	3.42
August	3.53
September	5.02
October	2.12
November	0.00

Fig. 8.8.1. Relative yield per recruitment of *D. russelli*



Emax : 0.69, Lc/L_{00} : 0.53, M/K : 0.93
E-1 : 0.65 E-0.5 : 0.37

Chapter – 9

Discussion

Carangids are caught along with other fishes in trawl nets, gillnets, hooks and line and ring seines in the coastal and offshore waters operated by mechanised and non-mechanised crafts. The carangid fisheries, constituted by a number of species and caught by diverse types of artisanal gears, exhibit species wise variation in its seasonal availability in catch and catch rates. Some species occur very rarely or only in stray catches while others contribute in a sizeable proportion to the total marine fishery.

Analysing the data collected from south west coast of India between 1981-1984, Premalatha (1993) observed two peak seasons for *Decapterus russelli*; September to January and April to May while studying samples collected between Quilon and Mangalore. According to that study, *Decapterus russelli* constituted only 16% of the carangids landed at Cochin. It is evidently much lower than the 34.07 % observed in the present analysis. Analyzing the catches in Palawan waters in Philippines Tiews *et al.*, (1970) reported that although, *Decapterus macrosoma* dominated the catches during the southwest monsoon period (June to October), it was *Decapterus russelli* that dominated the catches during the north east monsoon (December to March). However, Kasim (1986) indicated that *Atropus atropus* was the major species found in the trawl landings at Veraval along the north west coast of India forming 34.5 % of the trawl landing. This was followed by *Caranx* spp. (27.9 %), *Decapterus russelli* (15.70 %), *Chorinemus* spp. (12.90 %) and *Megalaspis cordyla* (8.90 %) and in the drift net *Megalaspis cordyla* (67.20 %) was the dominant species, followed by *Chorinemus* spp. (30.70 %) and *Caranx* spp. (2.10 %). This is slightly different from the observation made along Malabar region, this may be due to geographical difference between the far off fishing grounds off Gujarat and Malabar region. Sivakami *et al.*, (1996) discussed variation in the distribution and abundance of carangids. Their studies showed that carangids formed 19 % of the total trawl catch and reported more than 20 species of carangids. *Decapterus* spp. was the most dominant group, followed by species like *Atule mate*, *Selar crumenophthalmus*, *Carangoides malabaricus* etc. and they were abundant up to 80 m.

Ronquillo (1974) observed that although the *Decapterus russelli* is caught throughout the year in all the principal grounds in Philippines, marked variations were noted in the seasons in different in fishing grounds. The shift in the monsoon may be considered as a plausible explanation for the different trends observed in the study period as well as reported by the above author. The availability and abundance of other fishes in the same gears and the fishery independent factors such as rough weather and consequent reduction in the effort may play significant reduction in the changing trend of fishery of the species with respect to a particular gear. In the present study, 18 species of commercially important carangids were recorded besides half a dozen carangids, which are rarely seen in the commercial landings. Good catches of *Decapterus russelli* in the trawl landings relates closely to the observations made by Tiews *et al.,* (1970) and Sivakami *et al.,* (1996).

George *et al.,* (1976), Gopakumar *et al.,* (1986, 1995), Luther *et al.,* (1982) and Nair (1993) reported the predominance of *Decapterus russelli* at Vizhinjam along the Kerala coast. During the present study, *Decapterus russelli* accounted on an average 34.07 % of the carangid fishery. The dominance of *Decapterus russelli* is found in the landings of trawl nets throughout the year, except in July, the main season can be traced from October to December and March to June. The March to June season is closely related to the earlier reports of the previous authors. The present study shows that there are two peaks in the landings of *Decapterus russelli*, the primary peak in October to December and the secondary peak in March to June. The secondary peak almost agrees with that of previous studies from Kerala coast.

Decapterus russelli and *Decapterus macrosoma* were mainly caught in the Multi Day Trawl Net, Mini Trawl Net and Out Board Ring Seine and the former species alone contributed 46.69 %, 23.65 % and 33.76 % respectively in these gears. These species were absent in H & L, OBGN and NMGN. These are the commonly occurring species of carangids found in the fishery along the Malabar region.

Rueben *et al.,* (1992) reported two peaks in the landings of *Carangoides malabaricus*, the first peak in January and the second in June to September along the

east coast in Visakapatnam. The present study shows that the peak season for *Carangoides malabaricus* was between September and June. The average annual composition of *Carangoides malabaricus* to the carangid landing was 8.19 %.

Nair (1993), based on the data from 1979 to 1988, reported an annual catch of 14.4 % for *Atule mate* from Vizhinjam along the south west coast of India. However, the present study shows that the fishery of *Atule mate* was less than 1 % during the study period and the average composition was 0.60 %. Unlike Vizhinjam, the fishery of *Atule mate* was observed in the trawl nets and occasionally in the ring seines along the Malabar region.

During the same period, although he recorded an annual catch of 0.41 % of *Megalaspis cordyla* in the carangid catches, in the present study its presence in general was amounting to 11.76 %. Though this species contributed to the fishery in reasonable percentage during most of the months, it has to be remarked that their fishery is quite unstable. The season for this species is approximately between October and April. This almost agrees with observation of Nair (1993). Sivakami (1995) based on the observations on the trawl landings at Cochin found that *Megalaspis cordyla* is mainly caught in trawls, drift gill nets and purse seines and form 13.76 % of the carangid landing. Higher quantities of *Megalaspis cordyla* as high as 8.90 % is reported by Kasim (1986) in trawl landing which is very close to the observations made during the present study, while in the gill net it was 24.08 %, which is lower than the parentage reported by the same author from Gujarat coast. Seasonally, this species is caught during pre-monsoon and post monsoon in trawls, during post monsoon in drift gill nets and in purse seine only during September – October.

Reuben *et al.,* (1992) found February to May as the Season for *Alepes djedaba* along the Visakapatnam coast. The present study shows that October to December as the main season for *Alepes djedaba* in the trawl fishery and in the hooks and line they are found in September. *Alepes djedaba* was caught in Multi Day Trawl Net, Mini Trawl Net and Hooks and line and on an average it formed 1.62 %, 0.43 % and 1.47 % respectively in these gears. Higher landing of *Alepes djedaba* was noticed in September.

Three peaks in the landings of *Alepes kalla* were reported at Cochin in Kerala by Reuben *et al.,* (1992). The first peak was in January, second in June and the third in November. The present study shows that the abundance of *Caranx kalla* in the fishery from January to May showing some similarity in the peak landings of this species along the Malabar region as reported by earlier authors from different parts.

Many species of carangids, *Alepes vari*, *Carangoides ferdau*, *Carangoides caeruleopinnatus*, *Carangoides fulvoguttatus*, *Scomberoides commersonnianus* and *Scomberoides tol* were also contributed to the fishery. However, the trend seems to be highly fluctuating and seasonal. Other species of scads observed were *Alepes melanoptera*, *Alepes vari* and *Atule mate* and they are not seen in the fishery during all the months. Among trevallys *Carangoides malabaricus* was the dominant species found in the fishery during all the months and it dominated the landing of trevallys. Other species such was *Carangoides ferdau*, *Carangoides caeruleopinnatus*, *Carangoides fulvoguttatus*, *Caranx melampygus*, *Caranx sexfasciatus* and *Seriolina nigrofasciata* were present during most of the months in negligible quantities. Among jacks, *Uraspis helvola* was present throughout the year in moderately good quantities. Some species of *Alectis spp.*, *Atropus spp.*, *Elegatis spp.*, *Gnathodon* spp., and *Ulva* spp. were stray or rare in their representation. These carangids were included in the group other carangids. The various species in the above group did not provide any specific trend or seasonal abundance. Therefore, their effect on the main fishery could not be taken into account properly.

The annual total fish catch ranged from 63214 t in 2000-01 to 74606 t in 2001-02 with an average of 68910 t. The peak landings correspond to October to June. In the present study, the annual total carangids ranged between 4575 t (2000-01) to 5455 t (2001-02) with an average of 5015 t. Though detailed information about previous catch details of carangids from Malabar region is not available, Nair (1993) recorded the

monthly average range from 1979 to 1985 as 36 t to 164 t from Vizhinjam. Nair (1993) reported that Kerala is the major contributor to the carangid fishery in India and during 1956-1984 period nearly 38 % of the carangid landing in India was contributed by Kerala. Average annual composition of carangids to the total fish catch in the study area ranged between 7.23 % (2000-01) and 7.30 % (2001-02) and the average for the study period was 7.27 %.

Considering the gear wise production, the present study indicates that trawl net is the most important gear for catching carangids as the average total catch of multi day trawlers and mini trawlers were 2854 t and 951 t respectively out of the 5015 t of carangids landed. The next important gear is ring seine operated from out board fishing crafts. The analysis also reveals the gear specificity of *Decapterus russelli* and *Decapterus macrosoma.* The best gear for *Decapterus russelli* and *Decapterus macrosoma* is the large fish trawl operated by multi day trawlers or mini trawlers.

It is interesting to note that considerable quantities of carangids are caught in the motorised gears such as OBRS, H & L and NMGN. When the impact of motorisation is considered these gears are worth mentioning. It was noticed that *Decapterus russelli* forms a good fishery in the ring seines during monsoon season. The analysis thus confirms the beneficial impact of motorisation of the total fishery as well as fishery of carangids along the Malabar region. It was also reported by Nair (1993) that the motorisation period yielded higher quantities of carangids at Vizhinjam.

Fishing is only one of the factors, which affect the abundance of a fish stock. However, when this becomes a predominant factor, the abundance of stock naturally declines. It is therefore important to assess whether abundance or scarcity of stock is related to the intensity of fishing. In order to work out such a relationship, it has been the usual practice to calculate 'Catch Per Unit Effort' (CPUE) since this provides the relative measure of abundance. It is infact an index of abundance and level of exploitation of fishery resource (FAO, 1980). Therefore, catch and effort data are regarded as basic requirements for a primary resource assessment (Ricker, 1940; Banerji, 1971). Models deducing the state of a stock from historical record of catches and fishing efforts solving

the problems related to fishery management have been attempted with various modifications by authors like Pella and Tomlinson (1969), Silliman (1971) and Ludwig and Hilborn (1983).

As far as CPUE, which reflect the abundance in the fishery, is concerned, it generally fluctuated. It followed at the same trend of the catch throughout the year for individual species with respect to gears. Highest catch rate of carangids was observed during October-December and April – June and this is coupled with the highest CPUE of *Decapterus russelli*, the important species of scad landed among carangids. The highest catch rate for trevallys was during December, February and May-June and the CPUE for *Carangoides malabaricus* was the highest among this group with highest peak in February and May. Horse mackerel was landed in three peaks, the primary peak in September, secondary peak in December-March and tertiary peak in May. Highest catch rate for leather jackets was observed only in October. For jacks, peak landings were recorded in December. The highest catch rate of other carangids was seen in November-December and June. In the case of other species as well, peak catch rates were recorded during the same periods when catches also were high. A change worth noticing in the trawlers was the reduction in the effort expended by trawlers but higher landing, this was due to increase in the number of days of operation by the multi day trawlers for higher fuel efficiency.

The composition of main food items of *Decapterus russelli* of Malabar coast, in males and females studied separately revealed that crustaceans and fishes dominated as the first and second main food item. The crustaceans were found in all the length groups of males from 100-109 mm to 240-249 mm length groups, with variations in different groups, from a minimum volume of 3.45 % to 100%. Even though the percentage intake of this food item showed variations during different months, it appears to be the highly preferred food of the species.

Crustaceans were absent only in one length group (250-259 mm) in males. In females crustaceans were invariably present in the guts of all the length groups examined, with volume ranging up from 33.67 % to as high as 72.63 %. Intake of crustaceans

appeared to have relation with the size of fish. As the fish grows, it was showing preference for fish as the principal diet.

A rise in the intake of crustaceans in the month of May, July and February and a fall in November were observed in both the sexes. It is evident from the above that both males and females of *Decapterus russelli* prefer crustaceans as their food and feed heavily on them in similar pattern throughout the year.

Fish food was absent in the smallest length group of 90-99 mm in females. In 100-109 mm length group of females, only a very low volume of fish food was observed. In the higher length group (250-259 mm) 100 % of food observed was fishes. Males of 100-109 mm size group do not feed on fish and in 110-19 mm size group the volume of food was low (14.92 %). It was as high as 100 % in 250-259 mm length group. It appears from the above observations that after attaining a length of 100-109 mm *Decapterus russelli* develop the capacity to prey upon fishes and thereafter continues to take fish as their food. Juveniles of *Decapterus russelli* do not prey upon other small fishes, rather, they depend upon on tender, soft bodied, smaller crustaceans, like juveniles of prawns, *Acetes* spp., etc. As they grow up they start feeding on fishes.

Salpa was observed to be preferred both by males and females as third item of food. Salpa was found in the gut contents in males of length groups from 110-119 mm to 210-219 and 230-239 mm, with minimum value of 3.28 % in 210-219 mm to maximum value of 74.14 % in 240-249 mm. In females the salpa was minimum in 210-219 mm and maximum (21.15 %) in 110-119 mm size group indicating that the intake of salpa in females decreases as the fish grows, but in males this was just reverse. The month wise variations in the feeding of salpa indicate that maximum intake of salpa was in January- June period in both males and females. Salpa stood as third food item both in males and females. In none of the previous reports on *Decapterus russelli* salpa has been reported as one of the main food items. The reason may be the abundance of salpa in the Malabar region.

It was observed in month wise food habits that, the contribution of other main groups of food items was less than 5 % of the gut contents. Excluding digested matter, polycheates, detritus and miscellaneous groups of food items ranked fourth, fifth and sixth respectively.

Digested material occupied the minimum of 1.70 % to a maximum of 35.91 % in the gut contents of males. In females, this ranged from 1.92 % to 12.57 %. In both the cases highest percentage was observed in the smallest length group. The reason for encountering more digested material in the smallest fishes might be due to the higher metabolic activities of the fishes of that stage.

Decapterus russelli feeds mainly on crustaceans, fishes and salpa, in the similar order of preference irrespective of sex, maturity stage or season, though percentage volume may vary in the gut contents of different length groups. Young fishes do not consume fish. This may be due to their inability to capture live prey with their smaller mouth size. As they grow, the spectrum of food becomes narrow. In males above the size 190-199 mm, salpa, detritus and miscellaneous food items were absent. Salpa was found in small percentage in females up to the size of 210-219 mm, but miscellaneous food items were absent. It was also observed that with the increase in size of the *Decapterus russelli*, the size of the food particles in the stomach contents also increase and the fishes take bigger and motile animals. It appears that with the advancement of growth they shift a little towards the column feeding than the bottom feeding.

The percentage occurrence of main group of food items, though differed in various months of the year, the order of preference remained the same. During breeding period, intake of crustacean food diminished a little. The bulk of food being crustaceans and fishes, they were compensatory to each other. When fish diets were more, crustaceans were less and vice versa. Female fishes of different stages of maturity also showed the same order of preference except in stage I and in stage VI fishes. Stage I fishes and stage VI fishes preferred salpa and polycheates than teleost fishes.

Season wise intake of main groups of food items except in monsoon, differed in males and females. Both males and females took crustaceans, fishes, polycheates and salpa in monsoon in order of preference. In post monsoon, males preferred crustaceans, fishes, polycheates, salpa and detritus, but the females avoided polycheates. During pre monsoon males showed preference towards crustaceans, salpa, fishes and polycheates, but females preferred crustaceans, fishes, polycheates and detritus in that order of preference. Though there was not any pronounced difference in season wise feeding intensity, a gradual decrease was observed from post monsoon to pre monsoon to monsoon season. Feeding intensity was maximum in post monsoon and minimum in monsoon. Inter sex difference in feeding intensity was negligible.

Amongst the crustaceans, the most esteemed food of the *Decapterus russelli* was found to be prawns, *Acetes spp.* and crabs. Other crustacean foods were taken in low percentages.

Among the fishes, *Stolephorus* spp. and *Lactarius lactarius* were found to be most common food of this species. Other food fishes were eels, mullets, silver bellies and gobies. In a case, a fry of *Decapterus russelli* in the stomach was noticed indicating that this species is cannibalistic in nature.

Lowest average feeding intensity in males was in June and in females in May. Both males and females registered highest feeding intensity in the month of October. In general, the females maintained a slightly higher feeding intensity than males throughout the year. As observed by the previous workers, the present observations also revealed that, with the increase of the size, the variety of the food items taken by the fish is narrowed, but the particle size of the feed increases. The fish is perhaps a sight feeder, which is obvious from its feeding mainly on motile animals. It feeds on animals dwelling in bottom or the column just above the bottom. With the increase in size it shows an affinity towards the column feeding. Throughout the period of investigation no vegetative matter could be found in the gut contents.

Studies on *Decapterus russelli* from Indian waters indicated that they are carnivores feeding predominantly on crustaceans and fishes (Vekataramanan, 1960; Basheeruddin and Nayar, 1962; Sreenivasan, 1979; Sivakami, 1996; and Raje, 1997 and Nair, 2000). Devaraj *et al.*, (1997) reported that *Decapterus russelli* fed mainly on clupeids, diatoms, copepods and other crustaceans, Sreenivasan (1979) studied the feeding biology of *Decapterus dayi* (*russelli*) caught by hooks and line at Vizhinjam and concluded that *Decapterus dayi* is a pelagic carnivore subsisting on small fishes and zooplanktons; whereas *Decapterus russelli* landed by the trawlers at Veraval fed substantially on crustaceans, followed by fishes and molluscs (Raje, 1997). Such difference in feeding intensity as well as food composition in *Decapterus maruadsi* caught from different locations in China has been reported by Tang *et al.*, (1997).

Squids and cuttlefishes represented molluscan component in *Decapterus dayi* (Sreenivasan, 1979). Sivakami (1996) reviewed the food items of the fishes of the family carangidae and observed that the fishes belonging to the family carangidae are generally pelagic carnivores feeding mainly on crustaceans (penaeid prawns, *Acetes* spp., squilla, alima larva, megalopa, *Temora* spp., *Pontella* spp., *Labidocera* spp., *Lucifer* spp., zoea and mysis stages of prawns, juveniles crab, appendages of shrimps and ostracods), juveniles of fishes (*Stolephorus* spp., *Leiognathus* spp. and *Sardinella* spp.). Nair (2000) too in his review of the carangid resources of India has concluded that carangids are generally pelagic carnivores feeding mainly on crustaceans and fishes. The present study shows that the food of *Decapterus russelli* in Malabar region consists of penaeid prawns, *Acetes* spp., crabs, copepods, juveniles of prawns and amphipods. Fishes such as *Stolephorus* spp., *Lactarius lactarius* and silver bellies were the dominant fish diet. Food items such as polycheates, detritus etc. formed insignificant proportions of the food spectrum. Studies by Tiews *et al.*, (1975), on *Decapterus macrosoma* from Philippines waters showed that the crustaceans were dominant in the diet with higher percentage contribution of copepods, amphipods, megalopa larvae, cladocerans and zoea larvae.

From the present study, it is revealed that as the fish grow from young to adult there is a clear shift from crustaceans to fish in *Decapterus russelli*. Basheeruddin and Nayar (1962) and Sreenivasan (1979) observed similar trend in *Decapterus russelli*

where the planktonic crustaceans formed the total diet in smaller groups and it was replaced by fishes in higher size groups. Devaraj *et al.*, (1997) too have reported that juveniles of *Decapterus russelli* of 4-2 cm size from the Indian waters fed on *Acetes* spp., copepods and other crustaceans. Magnuson and Heltz (1971) have explained that the change in food pattern is dependent on the area of filtration formed by the gill apparatus. In smaller organisms gill rackers are closely set with small gaps in between and smaller organism only are sieved whereas in larger fishes with comparatively larger gaps in between the gill racker, larger organisms are retained. Moreover, Sreenivasan (1979) has concluded that the smaller fishes cannot move so swiftly to prey upon fast moving organisms and therefore need to rely on the planktons. With the increase in size, foraging is mainly on shoaling fishes like *Stolephorus* spp., *Leognathus* spp. and *Sardinella* spp. Sreenivasan (1979) also observed wide trend in trophic spectrum from 5 mm to 40 mm size groups of 1 to 23 items in 160-180 mm groups. This increase in the number of food items has an adaptive significance in utilizing the food available for survival whenever, the availability of preferred food items are limited. The preferential feeding on different food items in different size groups may be explained as avoiding direct competition and also because of the rich oil content available in the planktonic crustaceans which is essential for the developing gonad of the sub adult stage (Sivakami, 1996).

Sreenivasan (1981 b) indicated the prolonged spawning behavior of *Decapterus russelli* from the Vizhinjam area. Spawning extended from February to November with February and March as the peak season. However, in the present study *Decapterus russelli* was observed as a continuous breeder with spent fishes appearing from March - December. Moreover, the increasing trend in appearance of juveniles from April with an increase in the spent ones from April onwards clearly suggests that the peak spawning period as April to May. Another fact discernible from the present study is that of a likelihood of second spawning peak during September to October months. Delsman (1926), Tiews (1958) and Tiews *et al.,* (1975) also observed prolonged spawning period for *Decapterus* spp. from Java Sea and Manila Bay. Delsman (1926) reported that the spawning in *Decapterus* spp. takes place during night.

The size at first maturity estimated in the present study is 143 mm for males and 155 mm for females. Sreenivasan (1982) working on *Decapterus russelli* in Vizhinjam area concluded that it attains maturity at a fork length of 130 mm in the first year of life. Slightly different values regarding the size at maturity of *Decapterus russelli* were observed by Premalatha (1993) 140 mm; Murty (1991) 150 mm and Reuben *et al.*, (1992) 137 mm. In Mozambique, Brinca *et al.*, (1983) reported that male *Decapterus russelli* matured at a size between 12 and 13 cm, while it was between 13 and 14 cm for females. Pairoh and Ravi (1987) has reported higher values of size at first maturity in their studies made on the west coast of Thailand on *Decapterus russelli.* Chullasorn and Yusukswad (1978) reported a wide range of 16.1 to 23.0 cm size at first maturity in the study made in the Gulf of Thailand. The present observations are very close to the observations made by Sreenivasan (1982), Rueben *et al.*, (1992) and Premalatha (1993).

Sreenivasan (1981b) reported that males were generally dominant in the fishery. Premalatha (1993) also observed similar dominance of males in Cochin area. Quite in contrast to the above findings, Balasubramanian *et al.*, (2000) reported marginal dominance of females over males. He further concluded that though females dominated over males, almost a 1: 1 ratio is satisfied. Present study also shows a marginal domination of females over the males substantiating the findings of Balasubramanian *et al.*, (2000)

The relation between fecundity and length of fish was found to vary in different fishes. Clark (1934) using the method of least squares found that in the California sardine, *Sardina caerulea* the number of ova produced by individual sardines increased as the square of length. Farran (1938) found that it increased at a rate higher than the fourth power of its length and Hickling (1930) found that the fecundity of the herring increased at a rate greater than the third power of its length. Lehman (1953) found a correlation between length of fish and fecundity in the shad, *Alosa sapidissima* by the method of least squares. Tiews *et al.*, (1975) reported a fecundity of 28700 to 48,700 for *Decapterus russelli.* Sreenivasan (1981 b) found a linear relationship between the length of the fish, ovary weight and fecundity and there is a direct proportional increase in

fecundity with increase in length and weight in *Decapterus russelli*. The fecundity of *Decapterus russelli* of size 160-220 mm in the present study was found to vary from 33159-196392. This shows that the fecundity increases with the increase in the size of the fish supporting the earlier report of the relationship between the fecundity and length of the fish as reported by Tiews *et al.*, (1975) and Sreenivasan (1981 b).

Sreenivasan (1982) reported L_{∞} as 260 mm fork length (=280 mm total length from the conversion formula), K as 0.1858 y^{-1} and t_o as -0.05 y^{-1}. From Kakinada, Murty (1991) estimated L_{∞}, K and t_o values as 232. 3 mm total length, 1.08 y^{-1} and -0.08 y^{-1} for *Decapterus russelli*. Reuben *et al.*, (1992) estimated varying L_{∞} (221, 299 and 248 mm), K (0.71, 0.45 and 0.78 per year), M (1.35, 0.83, and 1.26), Z (2.83, 2.85 and 3.88) F (1.48, 2.02 and 2.68) and E (0.52, 0.71 and 0.68) along the east coast, north west coast and south west coast of India. While Jabat and Dalzell (1988) reported a very high L_{∞} value of 33.7 cm and low K value of 0.364 y^{-1} for *Decapterus russelli* from Philippines, Silva and Sousa (1988) in Mosambique (27.9 cm:0.56 $y^{-1)}$ and Widodo (1988) in Indonesia (28 cm; 0.9 y^{-1}) also observed values similar to that study. Iqbal (1992) while studying *Decapterus russelli* from Pakistan waters reported a very low L_{∞} value of 19.4 cm with the K value as 0.75 $y^{-1.}$ The result of the present study also shows some close similarity with the results of the growth parameters they have worked out.

Two recruitment seasons can be noted from the present analysis of *Decapterus russelli*. The former was a major season compared to the later. The second recruitment was for a short period. Various authors observed different types of recruitment patterns. Ingles and Pauly (1984) recorded two pulses for *Decapterus russelli* after studying the fishery in different parts of Philippines. They also reported different recruitment pulse from same area. Dalzell and Ganaden (1987) observed only one pulse of recruitment in both the species in their work in Philippine waters. Widodo (1988) observed only one pulse for *Decapterus russelli* in Indonesia. Atmaja (1988) reported similar single pulse for *Decapterus russelli* in the same area. Thus, close similarities were noted in some of the previous and current observations while some were slightly different.

Various methods were taken into consideration in this study for the estimation of Z, the total mortality. Catch curve analysis was mainly used to estimate Z by many authors quoted earlier in this chapter although no specific rationale was given for using that method in priority to other methods. Nevertheless, Z estimated by catch curve analysis was preferred for the estimation fishing mortality F.

In the present analysis the natural mortality, M obtained for *Decapterus russelli* was to 1.13 y^{-1}. According to Sparre and Venema (1992) as a rough generalization, for species with a high K value has high M. Similarly M is associated with low K. According to Beverton and Holt, (1959) K has been associated with the life span of the fish. Tanaka (1960), Holt (1965) and Saville (1977) established the relationship of longevity to mortality. Beverton and Holt (1959) also found that M/K values would normally range from 1.5 to 2.5. Rikhter and Effanov (1976) concluded that fish with a high M, mature early in life and thus compensating this high value by starting to produce earlier. Sparre and Venema (1992) reported that since most biological process goes faster at high temperatures within a limit, natural mortality could be related to the environmental temperature. All these above conclusion are more less in agreement with the findings arrived at in the course of present study. This is because for this species K values are high (1.22 y^{-1}), longevity is less than four years, maturity is attained within one year and temperature is normally high fluctuating around 28-29° C. M/K value is 0.93.

The current exploitation rate is slightly higher than the optimum exploitation rate estimated by the Beaverton and Holts method. This means that the present fishing is above the MSY level. Hence, there is a need for reducing the effort from the present level for sustaining the fishery of *Decapterus russelli* on a long time basis.

Chapter-10

Summary

It is well known that living resources are renewable in nature and are therefore required to be managed properly to ensure sustainable returns on a continual basis. Among marine living resources, different ethnic and commercial groups having different interests exploit the finfish and shellfish resources. This has already led to undesirable consequences like conflicts leading to governmental and political interventions. The overall picture of marine fisheries resource in India is such that most of the resources, particularly those resources in the inshore waters are subjected to the maximum exploitation. The demand for fish food and trade has been growing with increasing human population. The situation therefore warrants intervention at different levels so as to ensure sustainability of the resources, through improvement in employment generation and export in justice to the human population solely depending on fishing and related activities. For any management measures, the basic input is the scientific advice. This study is an attempt to understand the status of the fishery of carangids along the Malabar region and possible impact of the changed exploitation scenario, to propose management measures, if warranted, to protect this very important resource from decline and collapse.

The material and methods are explained in Chapter 3. The data on catch and effort in the carangid fishery from Multi Day Trawl Nets (MDTN), Mini Trawl Nets (MTN), Out Board Ring Seines (OBRS), Hooks and Line (H & L) Out Board Gill Nets (OBGN) and Non-Mechanised Gill Nets (NMGN) from different landing centres and the data on the length frequency distribution, maturation and spawning, food and feeding habits of *Decapterus russelli* collected from September, 2000 to August, 2002 along the Malabar area formed the basis of this study. The changes in the length frequency distribution of this fish in the commercial catches were monitored to get a clear picture of growth, mortality and recruitment of *Decapterus russelli* entering the fishery and changes in their availability to different gears. Studies on the maturation and spawning were carried out to understand the reproductive potential, spawning periodicity and size at first maturity.

A lot of information is available on the fishery and biology of various species of carangids from different parts of India and abroad, but the information on the fishery of carangids from Malabar area is negligible. This aspect is discussed in review of literature.

The changes took place in crafts and gears used in the fishery are explained in Chapter 4. The boat seines made of hemp or cotton fibers dominated the fishery till fifties, were phased out slowly by small meshed boat seines made of nylon twine by mid sixties. By seventies the trawlers were introduced for commercial fishing, this has made sweeping changes in the deep-sea fishing. By the end of eighties boat seines were disappeared and large ring nets of smaller meshes became the major gear. The primitive dug out canoes persisted until mid eighties disappeared by the introduction of out board engines, which gave immense speed to the indigenous fishing units. The dug out canoes were replaced by plank built boats during nineties. The large ring nets needed bigger boat. Three powerful out board engines were used for propulsion. By 2002, the out board engines were slowly replaced by inboard engines for ring seine operation. The size of the trawlers has reached 62 ' for conducting voyage fishing of 6-7 days duration. The gill nets and hooks and line are used for catching large carangids. Large boats, large nets, large storage facility and increase in the operation cost have made the fishing a capital-intensive enterprise.

The fishery of carangids is described in Chapter 5. The carangids are caught by diverse types of gears. The annual average landing of carangids was 7.27 % of the marine landing. Among carangids, the composition of scads, horse mackerel, leather jackets, trevallys, jacks and other carangids were 52.44 %, 11.76 %, 1.58 % 16.07 %, 10.25 % and 7.90 % respectively. The average composition of carangids by different gears indicates that the major share of the landing was by Multi Day Trawl Nets and Mini Trawl Nets, this was followed by Out Board Gill Nets, Non-Mechanised Gill Nets, Hooks and Line and Out Board Ring Seines. The annual effort of all gears was 97972 units in 2000-01, which was reduced to 72824 units in 2001-02. The effort showed a decline of 25. 66 %. The reduction in the effort was due to increase in the number of days per voyage trip by the MDTN from 5-6 days to 6-7 days duration in the year 2001-02.

As far as the species wise landing is concerned, *Decapterus russelli* was the dominant species found in the catches of Multi Day Trawl Nets, Mini Trawl Nets and Out Boards Ring seines. In the Multi Day Trawl Nets highest percentage of this species was observed in summer months, while in the Mini Trawl Nets highest volume of *Decapterus russelli* was recorded at the onset of trawling in August. In the ring seines, *Decapterus russelli* was observed in monsoon months. *Decapterus macrosoma* was the second important species of scads landed in the Malabar region. Multi Day Trawl Net was found to be the most suitable gear for this species as the landing of this species was highest in this gear forming 21.23 % of the carangid landing. Mini Trawl Net and Out Board Ring Seine are the other gears suitable for catching this species. In other gears, fishery of *Decapterus macrosoma* was not observed. Peak landing of this species was observed in summer months.

Alepes djedaba was another species of scad found in the fishery. Annual average landing of this species in the Multi Day Trawl Net, Mini Trawl Net and Hooks and Line was less than 2 % of the carangid landing. October – December and May was the peak season for the landing of *Alepes djedaba. Alepes melanoptera* and *Alepes vari* were occasionally seen in the fishery in marginal quantities. Among scads, *Caranx kalla* was one of the important species seen in the catches of carangids in moderately good quantities in Out Board Ring Seines and Trawlers. In the Multi Day Trawl Net, the peak period was observed during October–December and April–June, while in the Mini Trawl Net January to March was the peak period of abundance.

Among trevallys, *Carangoides malabaricus* was the dominant species found in all the gears. The fishery of this species was found throughout the year however, abundance of this species was found in the landing of Mini Trawl Net, Hooks and Line, Out Board Gill Nets and Non Mechanised Gill Nets. The fishery of *Carangoides caeruleopinnatus* was seen occasionally in the landings of Multiday Trawl Nets, Out Boards Gill Nets, Out Board Ring Seines, Hooks and Line and Non Mechanised Gill Nets. The highest percentage of this species was seen in Hooks and Line and Out Board Ring Seines during the summer months. *Caranx melampygus* was another species of trevallys found in the

fishery in marginal quantities in most of the gears. Highest catch of this species was noticed in April-May and August–September months. In the hooks and line, *Caranx sexfasciatus* formed 6.88 % of the carangids landing and the peak landing was noticed in May and in all other gears it formed marginal quantities. *Seriolina nigrofasciata* was another important species of carangid landed in hooks and line in higher quantities with peak landings in August-September months.

The fishery of *Megalaspis cordyla* was seen in most of the gears in good quantities. January – March was the best season for the fishery of horse mackerel. The fishery of leatherjackets was not prominent in Malabar region. Two species such as *Scomberoides commersonnianus* and *Scomberoides tol* were found in the fishery occasionally in marginal quantities. Among jacks, *Uraspis helvola* formed a good composition of carangid landing in Mini Trawl Nets, Out Board Ring Seines and Out Board Gill Nets. November- May was the peak season for jacks.

As far as the catch rates are concerned, in the Multi Day trawl Net the highest catch rates were recorded for scads, followed by horse mackerel, trevallys, jacks, other carangids and leather jackets. For scads, October-December and April–June was the peak period of landing and this was coupled with the highest landing of *Decapterus russelli.* December-February and May-June was the peak period for the landing trevallys. Highest landing of horse mackerel was observed in September, December–March and May. Highest catch rate of jacks was observed in December. November-December and June was the peak period for the landing of other carangids.

In Mini Trawl Net also scads had the highest catch rate followed by trevallys, jacks, horse mackerel and other carangids. Scads were landed in notable quantities during the summer months and at the onset of trawling in August. Highest catch rate for trevallys was noticed in August. Abundance of horse mackerel was recorded in the catch during summer months. The catch rate of other group of carangids was negligible.

Trevallys and other carangids realised good catch rate in hooks and line. September and July-August was the best season for carangids in hooks and line. Horse

mackerel and jacks had highest catch rate in September in hooks and line. In the Out Board Ring Seine high catch rate was recorded for trevallys in February, May and July. *Carangoides malabaricus* was the dominant species of trevallys found in the Out Board Gill Net. The catch rate of horse mackerel was uniform for the period of occurrence from January to March in Out Board Gill Net. In the Out Board Gill Net, trevallys realised the highest catch rate followed by horse mackerel. The peak landing of trevallys was observed in February and May in Non Mechanised Gill Net. The catch rate of jacks and scads were negligible forming less than 2 kg. In Out Board Gill Net, also trevallys had the highest catch rate in October, December and March.

It is interesting to note that considerable quantities of carangids are caught in the motorised gears. Carangids form good fishery in the ring seine during monsoon season. The present study thus confirms the beneficial impact of motorisation along the Malabar region.

The carangids fishery in the Malabar area shows fluctuations with reference to catch, catch rates, gear wise species composition and seasonality. The importance of carangid fishery in the marine fishery sector of Malabar area is indicated by its significant catch to the total fish landing. The catch and catch rates are higher in trawl nets, followed by ring seines and gill nets (Motorised). Even though carangids are represented by many species, the most abundant of them are *Decapterus russelli*, *Decapterus macrosoma*, *Megalaspis cordyla, Carangoides malabaricus* and *Uraspis helvola.* Other species are seasonal. However, *Decapterus russelli* is the single dominant species of carangids caught by the major gears in bulk quantities and this species emerge as the most important component of the carangid fishery with its continuous availability and appreciable catch rates.

The food and feeding habits of *Decapterus russelli* are studied in Chapter 6. Crustaceans and fishes formed the main food item in both males and females. The young fishes preferred crustacean, but in adults, fishes were the dominant food item in both sexes. Among fishes *Stolephorus* spp, *Lactarius lactarius*, eels, mullets, silver bellies and gobies were the common species encountered in the stomach. Among the

crustaceans, *Penaeus* spp., *Acetes* spp., crabs and other crustaceans were the major components. Salpa formed as the third important food item in both males and females. Maximum intake of salpa was noticed between January–June in both males and females. The other food items observed in the stomachs were polycheates, detritus and miscellaneous food items. The composition of these food items was minimum in most of the months. If digested food material kept aside, the order of polycheates, detritus food items was fourth, fifth and sixth respectively. The seasonal difference in the intake of food item was negligible.

The intensity of feeding was high in both males and females. Although there was not any pronounced difference noticed in season wise feeding intensity, a gradual decrease was observed from post monsoon to pre monsoon season. Feeding intensity was highest during monsoon months. Inter sex difference in feeding intensity was negligible.

Maturation and spawning of the fish is studied in Chapter 7. The relation between body length/weight of fish and weight of full gonad were estimated. Mature females were present in the fishery during all the months. Fishes with ripe ova and spent females were present from March – December indicating prolonged spawning period for the *Decapterus russelli*. The Relative condition factor (Kn) values also indicated that the species has prolonged spawning season. The peak spawning was noticed in April and a secondary peak was noticed in September. As far as sex ratio is concerned, the females marginally dominated the males in the commercial catches. The size at first maturity of males was estimated at 143 mm and in the case of females this was at 155 mm.

Study of growth parameters of *Decapterus russelli* supporting the fishery of Malabar are given in Chapter 8. The L_{00} and K was estimated using FISAT programme was L_{00} = 271.2 mm and K = 1.22 y^{-1} respectively. The natural Mortality (M) was estimated as 1.13 y^{-1}. Though various methods were applied in estimating Z, the estimated from catch curve analysis was considered for further analysis. The Z, F and E estimated in this study are Z = 4.79 y^{-1}, F = 2.66 y^{-1} and E = 0.71.

As far as the recruitment pattern is concerned, this analysis confirms two recruitment pulses for *Decapterus russelli*, the major pulse was recorded in April and the minor pulse in September. The current level of exploitation is slightly higher than the optimum level, hence there is a need for reducing the effort from the present level for sustaining the fishery of *Decapterus russelli* on a long-term basis.

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