CMFRI

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Lecture Notes

Part 1

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केंद्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

STATUS OF CRUSTACEAN FISHERY RESOURCES

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Introduction

From the economic and industrial point of view, edible marine crustaceans consisting of shrimps, lobsters are the most important constituents of the commercial fish landings in the country. Major portion of the landings was exported in various product forms. Investigations on resources and biology of shrimps, lobsters and other important crustaceans were initiated at the CMFRI in 1947 and since then, valuable data had been collected. Information on catch and effort, composition of landings, species-wise details on age and growth, food and feeding, maturation and spawning, migration and population characteristics for shrimps, lobsters and crabs were collected from fish landing centers along the Indian coast. This voluminous database has provided a strong foundation for assessment of edible crustacean stock, so as to suggest appropriate regulatory measures for effective management of these resources. A comprehensive account on the fishery and biological characteristics on edible crustaceans, and management options for their optimum exploitation based on the research carried out by CMFRI is presented here.

Production Trend

The estimated average annual landings of edible crustaceans of India during the last 21 years (1985-2005) amounted to 0.31 million tonnes. The catch varied between 0.21 million tonnes (1985) and 0.43 million tonnes (1998). Penaeid shrimps (56.8%), non-penaeid shrimps (32.9%), crabs (9.6%) and lobsters (0.7%) constituted the edible crustacean landings in order of abundance during 1985-2005.

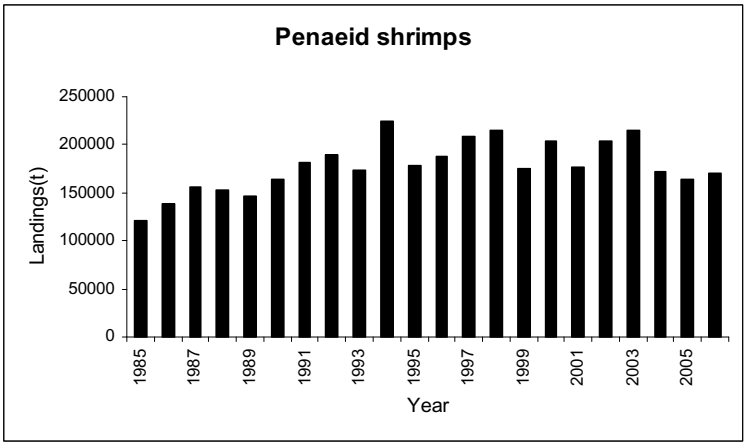
Craft, gear and fishing operations

Trawl net is the most effective gear to exploit demersal resources. Mostly medium sized vessels (overall length: 38'-48') operate trawl net from inshore to deep-sea grounds, mainly targeting shrimps while crabs and lobsters are caught as bycatch. Cod-end mesh size of the trawl net measures between 18 and 20 mm in most of the maritime states. However, in Gujarat from 1989, cod-end mesh of trawl was reduced to 10-15 mm, to exploit non-penaeid shrimps, mainly *Acetes* spp. on a large scale. From mid-eighties, most of the trawl units switched over to multiday fishing operation up to 80-100 m to exploit mid-shelf grounds, combining both day and night fishing, which also saved fuel cost. During 1999, some of the trawlers with higher engine power, with modification of winches and addition of wire ropes (up to 1,800 m) started operating in deep-sea grounds in depth range of 175-450 m off Kerala and South Kanara coast, to fish for deep-sea shrimps and lobsters. The traditional *dol* nets are operated mainly along the northwest coast and West Bengal coast to fish non-penaeid shrimps and smaller varieties of penaeid shrimps. *Minitrawl* and *thalluvalai* (smaller version of shrimp trawl) are operated by indigenous plank-built and wooden small crafts in near-shore waters (4-9 m depth range) along the Kerala and Tuticorin-Pamban (Tamil Nadu) coast, respectively, to catch mainly shrimps. Trammel net along Vizhinjam-Manakudy coast, bottom-set gillnet and disco-net along the southeast coast are operated regularly for exploitation of shrimps, lobsters and crabs.

Penaeid shrimp fishery

Penaeid shrimp constitute the backbone of seafood export industry as the major foreign exchange earner as well as a source of livelihood for millions of fish workers. Frozen shrimps contribute about 70% of the total export value of our country and the share of capture fisheries is about 59% by volume. Penaeid shrimp landings showed more than fivefold increase between 1960 (32,000 t) and 2005 (1,65,000 t).

Fig. 1. Estimated annual landing of penaeid shrimps in India



Penaeid shrimps contributed 7.5% to the all-India marine fish production in 2005. Penaeid shrimp contribution in the edible crustacean landings of the country during the last 21 years (1985-2005) was 56.8%. The all India penaeid shrimp landings varied between 1,21,673 t (1985) and 2,24,620 t (1994) with an average annual landings of 1,78,534 t during 1985-2005. (Fig.1). Wide variations in shrimp landings between years may be due to influence of environmental factors and recruitment success. About 76% of penaeid shrimp catch was landed along the west coast of the country. Maharashtra (28.1%), Kerala (26.7%), Gujarat (14.6%), Tamilnadu (11.3%), Andhra Pradesh (7.9%) and Karnataka (5.1%) were the important maritime states, which contributed to the penaeid shrimp fishery of the country during 1985-2005.

Species composition

Some of the important penaeid shrimps that support commercial fisheries along the Indian seas are *Fenneropenaeus indicus* (Indian White prawn), *Penaeus semisulcatus* (Green tiger prawn), *P. monodon* (Giant tiger prawn), *F. merguiensis* (Banana prawn), *Marsupenaeus japonicus* (Kuruma prawn), *P. penicillatus* (Red-tail prawn), *Metapenaeus dobsoni* (Flower-tail prawn), *M. monoceros* (Speckled prawn), *M. affinis* (Jinga prawn), *M. kutchensis* (Giner shrimp), *M. brevicornis* (Yellow prawn), *Parapenaeopsis stylifera* (Kiddi prawn), *P. hardwickii* (Spear prawn), *P. sculptilis* (Rainbow prawn), *P. uncta* (Uncta prawn), *Trachysalambria curvirostris* (Rough prawn), *Metapenaeopsis stridulans* (Fiddler shrimp), *Parapenaeus longipes* (Flaming prawn), *Solenocera crassicornis* (Coastal mud prawn) and *S. choprai* (Coastal mud prawn). Conventional resources such as *P. stylifera*, *M. dobsoni*, *M. monoceros*, *F. indicus* and *S. crassicornis* were major constituents of penaeid fishery during 1995-2005 along the west coast. With the extension of trawling operations and night fishing, non-conventional resources such as *T. curvirostris, M. stridulans, S. choprai, Melicertus canaliculatus* and *M. japonicus* were added to fishery. *P. stylifera* dominated the fishery at all centres. However, *S. crassicornis* had emerged as a prime contributor to the fishery in Gujarat and Maharashtra. Along North Kanara, Calicut and Kochi coasts, *M. dobsoni* and *P. stylifera* together contributed about 90% of the catch. At Sakthikulangara, *P. stylifera* (60%) dominated the catch followed by *M. dobsoni, M. monoceros* and *F. indicus.* At Mangalore-Malpe coast, *M. monoceros*, *M. dobsoni*, *T. curvirostris* and *S. choprai* were main components of the fishery. *S. choprai* has emerged as a major constituent of shrimp fishery along Mangalore-Malpe coast in the past 3-4 years. Along the southeast coast, *P. semisulcatus* dominated the shrimp fishery at Tuticorin and formed an important contributor at Mandapam region along with *M. stridulans* and *Megokris granulosus.* At Chennai, *M. dobsoni*, *F. indicus* and *M. monoceros* were major species observed in shrimp landings. Along the Andhra Pradesh coast, *M. monoceros*, *M. dobsoni*, *M. brevicornis* and *Solenocera* spp. were main contributors to penaeid shrimp fishery. *Metapenaeopsis*

andamanensis, *Aristeus alcocki*, *Penaeopsis jerryi*, and *S. hextii* contributed to about 20-40% of deep-sea shrimp landings along the southwest coast during 1999-2005.

Biology

Among commercial species contributing to penaeid fishery, *Penaeus semisulcatus*, *Fenneropenaeus indicus* and *P. monodon* are larger in size and grow to a total length (TL) of 250, 270 and 300 mm, respectively. *M. monoceros* and *M. affinis* grow to a length of about 190-210 mm. Length ranges of smaller species such as *P. stylifera*, *M. dobsoni* and *S. crassicornis* are 46-145, 31-115 and 55-125 mm TL, respectively. *A. alcocki,* popularly known as red ring, is the most sought-after deep-sea shrimp by exporters. Available in the depth range of 350-500 m off south Kerala coast and Mangalore, the species measures between 81 and 185 mm TL. *M. andamanensis* is the dominant species in deep-sea shrimp catch with length range of 71-130 mm TL. Penaeid shrimps are heterosexual and females are generally larger than males. Growth rate varies in different species at different phases of life depending on the habitat and environment. Penaeids feed mainly on animal food items and decomposing organic matter. They have high fecundity and number of eggs varies between species, mainly in proportion to size of females and ovary weight. The fecundity was estimated as 7.3 lakh at 200 mm TL for *F. indicus*, 3.9 lakh at 163 mm TL for *Metapenaeus monoceros*, 1.6 lakh at 120 mm TL for *M. dobsoni* and 1.01 lakh at 102 mm TL for *Solenocera crassicornis*. Even though spawners are available throughout the year, there are species-wise peak spawning periods, which may vary between years mainly due to environmental factors. Life span of penaeid shrimp is about 2 years and mainly 0-year group contributes to shrimp fishery.

Stock assessment

Estimation of stock for individual penaeid species to find out maximum sustainable yield for its judicious exploitation had been carried out by different research workers based on the data on the fishery and population characteristics of the species collected from different fish landing centers. The study showed that average annual yield of all commercial species such as *F. indicus, P. semisulcatus, M. dobsoni. M. monoceros* and *P. stylifera* had reached the Maximum Sustainable Yield. The yield per recruit analysis further confirmed that there may not be any significant improvement in the yield with increase in fishing effort.

Management options

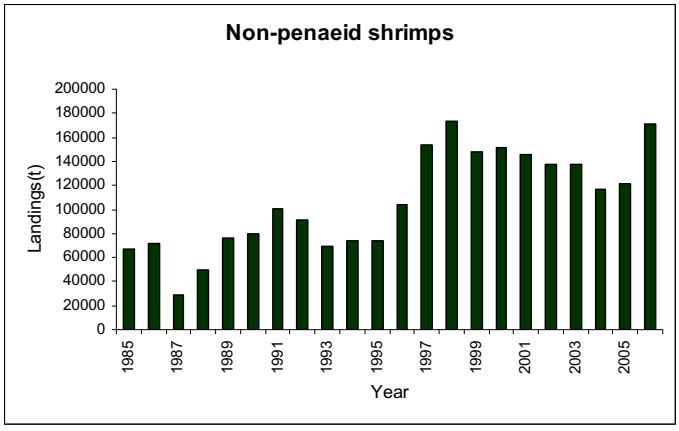
Detailed study on the population dynamics and stock assessment of commercial shrimps has shown that the average annual yield of most of the species has reached the MSY level. It was observed that increase in fishing effort would not result in substantial improvement in penaeid shrimp yield, and further, economical viability was also lacking. Reduction in number of fishing vessels being operated as well as fishing hours, along with increase in cod-end mesh size of shrimp trawl, to at least 25 mm, are the possible management measures which can be effectively implemented to get a sustainable yield of penaeid shrimp resource. Estuaries and backwaters are nursery grounds for important penaeid species such as *M. dobsoni*, *M. monoceros* and *F. indicus*. Large-scale destruction of juveniles of these species in this environment is due to indiscriminate fishing mainly by stakenets. Similarly, destruction of juveniles (*P. stylifera* and *M. dobsoni*) in near-shore waters along the Kerala coast by mini trawl operation, and capture of juvenile green tiger shrimp by *thalluvalai* along Tuticorin-Pamban coast, are regularly carried out. Such fishing operations should be slowly phased out with co-operation of fishers, government and exporters.

Juvenile shrimp fishing in estuaries, backwaters and near-shore coastal regions is to be banned for sustenance of the coastal shrimp fishery. Marine fishing regulations have earmarked areas of fishing operations for different gears and vessels and this should be strictly enforced. At present inshore fishing grounds have been fully exploited and diversification of fishing to exploit oceanic resources has to be encouraged by offering suitable subsidy for modification of crafts and gears.

Non-penaeid shrimp fishery

The estimated average annual landings during 1985-2005 amounted to 1,03,396 t which formed 32.9% of the total edible crustacean landings of India. Maximum landings (1,73,950 t) of non-penaeid shrimps was recorded in 1998 and the minimum (29295 t) in 1987 (Fig. 2). This resource is characteristic of the northwest coast, which accounts for 87% of the total non-penaeid shrimp production of the country. The important states, which contributed to the non-penaeid fishery of the country during 1985-2005, were Gujarat (47.7 %), Maharashtra (39.3%), West Bengal (6.2%), Kerala (2.6%), Andhra Pradesh (2.2%) and Tamilnadu (1.1%). Along the Maharashtra coast, traditionally used bag nets locally known as *dol* nets exploit the resource.

Fig. 2. Estimated annual landing of non- penaeid shrimps in India



Reduction of cod-end mesh size of trawl net from 25 mm to 10-15 mm and fishing operation in coastal grounds coupled with development of fish meal industry at Veraval were responsible for enormous landings of this resource in Saurashtra region of Gujarat State. Owing to deep-sea shrimp fishing in Kerala from 1999, the non-penaeid shrimp catch increased and formed 3.6% of the all India non-penaeid landings (2000-2005). Similarly, fishing for deep-sea non-penaeids from Tuticorin and Chennai from the year 2000 resulted in the contribution of 1.3% of all India non-penaeid catch by Tamilnadu.

Species composition

The non-penaeid shrimp resource is multispecies, mainly supported by tiny species of genus *Acetes* (Paste shrimp), in addition to *Nematopalaemon tenuipes* (Spider prawn) and *Exhippolysmata ensirostris* (Hunter shrimp). There are 5 species of *Acetes* and among these, *A. indicus* and *A. johni* support commercially important fisheries from marine waters, and the rest are exploited on a low key from estuarine and nearshore coastal seas along both the northeast and northwest regions. Pandalid shrimps are the major contributors to deep-sea shrimp fishery, which consists mainly *Heterocarpus woodmasoni*, *H. gibbosus* and *Plesionika spinipes.*

Biology

Acetes indicus is an epipelagic planktonic shrimp, which forms large shoals in coastal waters. Generally, its size ranges from 8 to 38 mm TL, and males and females exhibit differential growth rates of 6.15 mm and 5.96 mm/month, respectively. Their fishable life span is about 3-6 months. The species breeds almost throughout the year in shallow coastal waters showing peak spawning activity during September-January. The females lay 4,300-10,300 eggs. The species mainly feeds on detritus consisting of fibrous and granular materials of phytoplankton and zooplankton origins.

Nematopalaemon tenuipes exhibits differential growth rates with males and females reaching 57 mm and 64 mm in total length at completion of 1 year. The life span of the species is slightly more than a

year. Being a caridean prawn, it carries yolky eggs attached to its pleopods for incubation. The fecundity varies from 242 to 3,648 eggs.

Exhippolysmata ensirostris, largest among the coastal non-penaeids, is a hermaphrodite. It is highly predaceous and feeds on paste shrimps, polychaetes and young ones of fish and shrimps. It attains 64.8 mm in 6 months and 92.8 mm TL at the end of 1 year, and its fishable life span is about 1 year. Being a continuous hermaphrodite, ovo-testis produce sperms as well as large yolky eggs when prawns attain 40-45mm size. The fecundity ranges from 476 to 13,260 eggs in individuals varying from 45 to 99 mm in total length. *E. ensirostris* breeds throughout the year with peaks during May-September and December-January.

In the deep-sea shrimp catch, the total length of *H. woodmasoni* and *H. gibbosus* range from 71-125 mm and 91-140 mm TL, respectively. Peak breeding season is from January-March. Fishery of *P. spinipes*, the dominant species among pandalids in the deep-sea shrimp catch, was supported by 71-120 mm length group. Berried females were observed throughout the year, indicating continuous breeding habit.

Management options

Stock assessment studies showed that MSY of non-penaeid shrimp is 64,685 tonnes in Maharashtra and 76,550 tonnes in Gujarat, together forming MSY of 1.41 lakh tonnes for entire northwest coast of India. To achieve this MSY, which is only 20% higher than the present annual average catch, the effort required would be more than double (1.3 times of the present level). Non-penaeid shrimps are not target species for either *dol* nets or trawlers, therefore, implementation of management measures is rather difficult. Being most important group of forage organisms along the northwest coast, the non-penaeid shrimps support huge biomass of economically important fishes such as Bombay-duck, sciaenids, polynemids, ribbonfishes, carangids, penaeid shrimps and cephalopods in the region. Therefore, one of the reasons for increase in abundance of non-penaeid shrimps leading to their increased catch in the region may be attributed to the removal of these predators by intensive trawling in Gujarat and Maharashtra that commenced in late eighties and nineties. It is evident that on account of their low commercial value but great significance in marine food chain of important food fishes of the region, large-scale exploitation of non-penaeid shrimp will not be economically feasible.

Heavy decline in the contribution of pandalids in the deep-sea shrimp catch, abundance of juveniles with less representation of berried females indicate that this resource is exploited more than optimal level. Unlike coastal species, deep-sea pandalids have biological limitations such as slow growth rate, less fecundity and long life-span. Hence, it is advisable to exploit this resource optimally by limiting effort in trawler units and fishing hours. Instead of concentrating on heavily exploited grounds such as Quilon Bank, the trawling should be done in new/under exploited deep-sea grounds for sustainable returns.

Lobsters

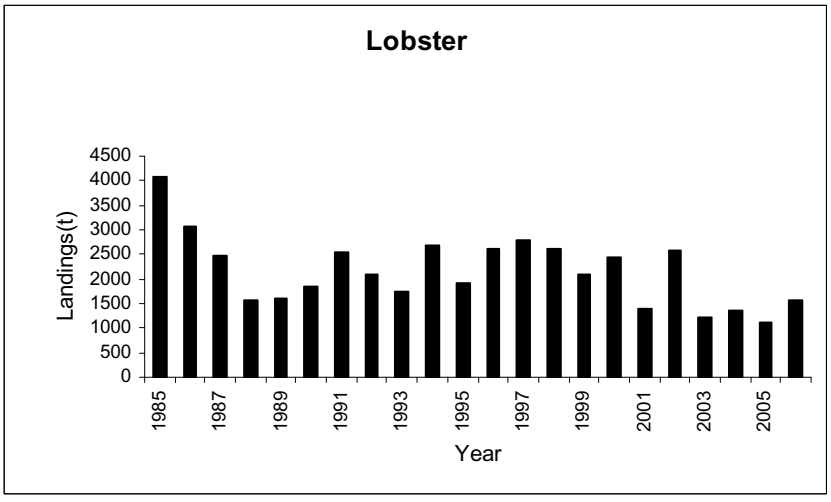
Lobsters are one of the highly priced crustaceans in India and are in great demand as a delicacy in the internal market and as a foreign exchange earner in export market. Fishing of lobsters from Indian seas by traditional fishermen is known since 1950s. The fishery, which has remained as a subsistence fishery until 1957 flourished into a commercial fishery is the importance of this resource as a potential foreign exchange earner was realized. During 1900s and 1970s, Kanyakumari District in Tamilnadu on the Southwest coast of India was the most productive lobster fishing region in the country. Major lobster fishing grounds were located off Colachel, Muttom and Kanyakumari. Traps and anchor hooks were the main gears used for lobster fishing, which were gradually replaced by gill net and trammel nets. Systematic data on lobster fishery is available from 1958 onwards. Intensive exploitation resulted in declining catches and by 1978, Maharashtra and Gujarat became the leading lobster producing States in the country. They are widely distributed along the entire coast of the country with maximum landings from the northwest coast, followed by the southeast and southwest coasts.

Twenty-five species of lobsters have been so far reported from Indian coast of which only 5 species are commercially harvested. The lobster fishery along the northwest coast comprising of Gujarat and Maharashtra, is constituted by the palinurid spiny lobster *Panulirus polyphagus* and the scyllarid *Thenus orientalis.* Both species are landed by trawl nets. These two species dominated lobster fisheries till the early 1990s in the country, contributing to nearly three-quarters of the total landing. However, the slipper lobster fishery in Maharashtra witnessed collapse by 1994 and has showed no sign of recovery so far. *P. homarus* is the dominant species in the shallow water lobster fishery along the southwest coast. Small quantities of *P. versicolor* and *P. ornatus* are also landed occasionally. The major landing centres are at Colachel, Khadiyapatnam, and Enayam where indigenous gears such as gillnet, trammel-net and traps are used. Colachel and Muttom in Kanyakumari district were the major lobster landing centres during 1960s and 1970s. Small scale lobster fishery also exists in few villages south of Kollam. The lobster fishery along the southwest coast is dominated by the deep-sea lobster *Puerulus sewelli*, the fishing ground of which is located off Quilon in Kerala State, at depths ranging from 150 m to 400 m. *T.* orientalis began to appear in the trawl fishery and Kollam from 2004 onwards. The major species exploited along the southeast coast of India are *P. homarus* and *P. ornatus*, landed mainly by gill-nets and trammel nets along the southern region and *P. homarus* and *T. orientalis* by trawlers as by-catch along the northern region of Tamilnadu. The occurrence of deepsea lobster *Linuparus somniosus* was reported from Andaman and Nicobar Islands. Other emerging species in the fishery are *Nephropsis stuwarti* at Mangalore and *Palinustus waguensis* at Chennai.

Production trends

In India, annual lobster landings increased from 800 t in 1968 to 3,000 t in 1975, and attained a peak of 4,075 t in 1985. However, the landings declined thereafter, averaging 2,200 t for about 15 years. The catches further decreased to 1371 t in 2004 and further to 1117 t in 2005 (Fig. 3). Gujarat contributed 38.9% of total lobster landings in the country. The state showed a decline in landing from 1,226 t in 1995 to 182 t in 2003. Maharashtra contributed to 27.6% of total catch, the maximum annual landing being, 1,132 t in 1996. The contribution of Tamilnadu and Kerala was 15.5 % and 14.6% respectively. In Maharashtra, the commercial fishery for *T. orientalis* was initiated in 1978, with a catch of 1.5 t. The landing reached a maximum of 375 t in 1982. Subsequently the catches fluctuated around 250 t and reached another peak (334 t) in 1986. But, thereafter the catches declined rapidly, landing only 2.2 t in 1994. As a consequence, the fishery collapsed and the species is yet to contribute to the fishery.

Fig. 3. Estimated annual landing of lobsters along the Indian coast



The estimated maximum total length that may attain by *P. homarus* is 320 mm, *P. polyphagus* 450 mm and *P. ornatus* 500 mm total length. Growth rate in both sexes is identical in juveniles but vary in adults. In females of *P. polyphagus,* 50% of lobsters attained sexual maturity at 175 mm TL. Though the species breeds throughout the year, maximum number of females in *berry* is observed during August-October and recruitment of juveniles measuring <100 mm (<50 g) generally takes place during December-January. In spiny lobsters, fecundity ranges from 50,000 to 1,000,000 depending upon the species and the weight of the lobster. Eggs are attached to endopodites of the pleopods and after incubation for 25-30 days, phyllosoma larvae hatch out and are carried to offshore areas by water currents. The final stage of phyllosoma larvae metamorphoses into puerulii, which swim towards inshore areas for settlement. In *T. orientalis*, sexual maturity is attained at 124 mm TL. Extended spawning has been observed from September to April with high incidence of berried and spent females from November to January. In this species fecundity is low and larval phase is short. After final metamorphosis, the post-larvae (nisto) settle in inshore areas. *P. sewelli* ranges in size (TL) from 76 mm to 190 mm in males and from 71 mm to 205 mm in females. Occurrence of maximum number of immature females in January and smaller size-classes during December-January indicate entry of young ones into the fishery during these months.

Maximum landing of lobsters is reported from the northwest region where *P. polyphagus* dominates the fishery. The size ranged from 75 mm to 385 mm TL, those between 160 mm and 230 mm forming mainstay of the fishery in 1998-2002. From the length composition of the 2 sexes of *P. polyphagus*, the total mortality coefficient (Z), natural mortality coefficient (M), exploitation rate (U) and E_{max} were estimated. The Z for 5-year period for males was 1.9 and for females 1.63. With the mean seawater temperature at 28°C, M for males and females was 0.53 and 0.6 respectively. The relative yield/recruit (Y/R) analysis indicated that yield could be maximized when the exploitation ratios were 0.46 and 0.53 for males and females respectively. However, the present exploitation ratios are 0.65 for males and 0.63 for females, which may not sustain future stock.

Management

Lobsters form only 0.14% of the total fish landed by the trawlers in Mumbai. Therefore, optimizing the trawling effort for spiny lobster alone is not wise. Observing closed season during peak breeding months (August-September) for the trawler is also not possible as fishing by mechanised boats in the Maharashtra State is banned during monsoon (10th June to 15th August). Therefore, the only management option left is to return the egg bearing females back to the sea, at least during August-September so that the spawning stock is protected. Heavy recruitment of the juvenile lobsters (40-160 g) takes place in December-February and these undersized lobsters do not fetch remunerative price to the fishermen, and therefore they can also be returned to the sea. These options are possible if it is legalized to catch lobsters only above the size at maturity (205 mm in total length or 220 g size) and returning the egg bearing females back to the sea. *P. polyphagus* is a hardy species which remain alive for 1-2 hours after it is brought on board by the trawl net. Hence releasing back the undersized and berried lobsters is recommended. This will protect not only the new recruits but spawning stock as well ensuring future recruitment process.

At Veraval, the drastic decline in lobster fishery from 271 t in 1999 to 22 t in 2002 (81.2 % decline) is of serious concern. Intensive exploitation of juveniles of *P.polyphgus* from the inshore reef area by gill nets is to be banned if the lobster fishery is to sustain. Legal ban on fishing of juveniles by the gear is to be enforced at State Government. As there is no stock of the sand lobster left in the sea off Mumbai, total conservation of the remaining residual population by returning it to the sea and legal ban on landing of the species are the only options until the stock is revived.

Along the southwest coast, closure of fishery during the peak breeding months of November will protect the spawning stock temporarily and this may allow the actively breeding population to release the larvae. There is no data on the level of spawning stock required to sustain the fishery. Ban on operation of trammel net on the entire southwest and southeast coast will prevent exploitation of the recruiting juveniles,

which constitute nearly 50% of the trammel net catch. At Tuticorin, the gill net fishery of *P. ornatus* juveniles may be detrimental to the stock though the extent of negative impact was not assessed. However, the declining catch and catch rate in the gill nets and trawl nets between 1993 and 2002 is an indication of the instability of the stock. *P. homarus* being an inshore fishery and with restricted movement is the most vulnerable lobster resource as the spawning females and the juveniles are fished from the same fishing ground.

Spiny lobster fishery is an open access fishery and any restrictions imposed on fishing will be desisted by the fishermen. Apart from legal implementation of fishing regulations, education and creation of awareness among the various stakeholders on negative impact of fishing and marketing egg bearing lobsters and juveniles may bring a subtle change in the mindset. Establishment of artificial habitats, lobster sanctuaries / reserves in identified locations.

A participatory management project initiated by CMFRI and funded by MPEDA is making slow progress in changing the mindset of fishermen and traders and may inculcate the sense of responsible fishing and trade. Village level meeting, distribution of educative posters, stickers and pamphlets, video film shows, 'V' notching and releasing of egg bearing lobsters involving the fishermen and distribution of lobster traps to wean the fishermen away from using the destructive fishing methods are some of the activities implemented under the programme. Enforcement of minimum legal size for export is a positive step from the Ministry of Commerce and Industry, Government of India. However, implementation of a minimum legal size for fishing, closure of fishery during peak spawning in the southern rock lobster fishery and ban on trammel nets are regulatory measures to be implemented by State Governments. Lobster fishing being a socio-economic activity involving the local fishermen any regulatory measure shall consider the socioeconomic viewpoint so that the fishermen are not adversely affected.

Minimum Legal Size for export of lobsters from India *

Species	Live /Chilled / frozen	Whole cooked	Tail
Panulirus polyphagus	300 g	250 g	90 g
P. homarus	200 g	170 g	50 g
P. ornatus	500 g	425 g	150 g
Thenus orientalis	150 g	-	45 g

* Notification No. 16 (RE 2003)/2002-07 dated 17 July, 2003, Ministry of Commerce and Industry, Government of India.

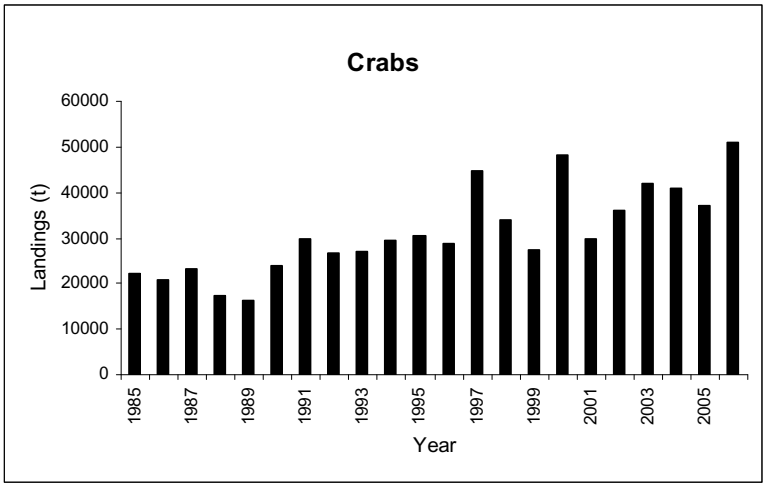
Marine Crabs

Marine crabs, one of the seafood items in great demand, formed about 11% of the edible crustacean landing in the year 2005. Although about 700 species of brachyuran crabs have been reported from the Indian waters, the Family Portunidae contributes maximum to the commercially important crab fishery of the country. The fishery for edible crabs in the coastal waters is predominated by the Cross crab, *Charybdis feriatus*, the Spotted crab *Portunus sanguinolentus* and the Reticulate crab *P. pelagicus. C. lucifera* is emerging as a fishery of importance in Andhra Pradesh and Kerala and is slowly becoming popular as an edible item. Crabs are caught as by-catch and more than 80% of the total landing is by trawlers. Indigenous gears such as gill nets and traps are also used in selected areas targeting individual species, especially *P. pelagicus*. Crabs are usually caught from a depth of about 10 m to 60 m. Trawlers occasionally go up to 80 m during the post-monsoon months, along the southwest coast. It is the recent advances in fishing technology that has enabled fishermen to venture into deeper waters engaging themselves in multi-day fishing. This has resulted in increased landing of edible crabs, especially *C. feriatus*.

Production trend

The total landing of marine crabs in India during 1985-2005 is presented in Fig. 4. The average catch per year was 30,325 t. The fishery showed a steady improvement from the year 1989 to 1997. Though there was a decline in the following years, the annual landing improved to 48,000 t in 2000, 42,000 t in 2003 and 41,000 t in 2004.

Fig.4. Estimated annual landing of crabs in India



Species composition

C. feriatus dominated the fishery for edible crabs at Veraval in Gujarat, the modal classes ranging from 56 mm to 75 mm carapace width. Inedible species were landed often in putrefied form and were used for production of fish meal or manure. In Mumbai waters also, *C. feriatus* predominated the fishery followed by *P. sanguinolentus* and *P. pelagicus*. Ring seines and hand trawls also landed crabs along the Malpe coast, during the southwest monsoon months. In Kerala, maximum landing was reported during January-May with very little landing in the 3rd quarter of the year. In *P. sanguinolentus* the size ranged generally from 70 mm to 150 mm (CW), with size groups between 90 mm-110 mm (CW) forming the mainstay of the fishery. At Vizhinjam in south Kerala, trammel nets were used from *Vallom* or *Catamaran* during the southwest monsoon months. Bottom-set gill nets were widely used along the coasts of Mandapam and Tharuvaikkulam landing large sized *P. pelagicus*. On the other hand, the trawl landings at Chennai and Visakhapatnam were dominated by *P. sanguinolentus* followed by *P. pelagicus* and *C. feriatus*. The landing of inedible crabs at Visakhapatnam was dominated by *C. callianassa.*

Stock assessment

In *P. sanguinolentus*, the mean monthly growth rates were 10.3 mm and 8.8 mm, attaining a carapace width of 124.1 mm and 112.5 mm on completion of one year, in males and females respectively. In *P. pelagicus*, the average monthly growth rates were 11.0 mm and 9.6 mm attaining a carapace width of 145.2 mm and 132.5 mm by the first year, in males and females respectively. It is indicated that the population of these crabs, exploited by different gears comprises mainly of the 0-year class, the 1-year-olds forming only about 10% or less. However, the gill nets, which are used at certain centres, during peak seasons of occurrence of crabs, land large proportion of the one-year-olds, possibly due to the larger mesh size. The status of the stocks along the Karnataka coast was assessed by Sukumaran and Neelakantan (1997). The maximum sustainable yield (MSY) estimated for *P. sanguinolentus* was 776 t (403 t for males and 373 t for females) and that for *P. pelagicus*, 567 t (275 t for males and 292 t for females) which are very close to the annual average yield of 771 t and 564 t, respectively.

Management

It is the multi-day or voyage fishing that has necessitated sorting of the catches at the sea itself, ensuring the limited facility of freezing and storage, for the priced catches only. Invariably, this leads to discard of the less important and less sought after varieties at the stage of sorting itself. Thus, varieties which attract lesser prices and juveniles which are not much in demand in the industry are discarded at the sea itself making it very difficult to quantify the discards and the juveniles getting caught. Crabs, when landed in a putrefied state as in Gujarat, get used for production of fish meal or manure. Analysis of the catch data of crabs over the years shows that there is no drastic decline or sign of over-exploitation of the stock. The slight improvement in the landings may be due to the facts that our fishermen venture into deeper waters engaging themselves in multi-day fishing and that conventional species like *C. feriatus* and *C. lucifera* are gaining popularity among consumers. However, it is essential to ascertain rational utilization of the crab resources as demand for this commodity in both the export and domestic markets of the country is on the increase.

The economic importance of crustaceans has always been on the increase due to the consumer demand in global market. This has resulted in increased fishing pressure and the consequent decline in catches of many valuable species. Detailed study on population dynamics and stock assessment of commercially important shrimps showed that the average annual yield of most of the commercial species has reached the MSY level. The management measures recommended based on scientific investigations are not fully enforced due to various reasons. Reduction in number of fishing vessels, ban on destructive gears, strict enforcement of closed fishing season, protection of nurseries, diversification of fishing operations and stakeholder participation in fisheries management are the measures suggested for continued sustainability of the crustacean resources.

Suggested reading

Mohan Joseph, M and Jayaprakash, A.A.(Eds.). 2003. *Status of Exploited Marine Fishery Resources of India*. Central Marine Fisheries Research Institute, Kochi.

Mohan Joseph, M and N.G. K. Pillai. (Eds.). 2007. *Status of Research on Marine Fishery Resources*. Central Marine Fisheries Research Institute, Kochi.