Sustain Fish 2005
International Symposium
on
Improved SUSTAINability of FISH production systems and appropriate technologies for utilization

16 - 18 March, 2005, Cochin, India

Book of Abstracts

Jointly organised by

Cochin University of Science and Technology, Cochin

University Grants Commission, New Delhi

Co-sponsored by

Government of India
Ministry of Agriculture

Marine Products Export Development Authority

Government of India
Department of Biotechnology

NABARD
National Bank for Agricultural and Rural Development

Government of India
Dept. of Science & Technology/U. T of Lakshadweep

Council of Scientific and Industrial Research

Indian Council of Agricultural Research

Sustain Fish 2005, 16-18, March 2005, Cochin, India

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CULTURE POTENTIAL OF THE SAND LOBSTER *THENUS ORIENTALIS* (LUND)

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Lobsters have a complex and prolonged life cycle , which often involves several planktonic ("free floating") larval stages. Although reports of research conducted in different parts of the world indicate the amenability of lobsters to being cultured in closed systems, lobster aquaculture is still a virgin arena in India. Larval rearing of lobsters in captive conditions has always posed a problem owing to the complexity of their life cycle with delicate larval stages. The key bottleneck for lobster aquaculture is the hatchery-nursery phase. Like the spiny lobster, the sand lobster, represented by a single species in India's lobster fishery – ***Thenus orientalis*** (Lund, 1793), too has a complex and prolonged life cycle, though not as prolonged as in the case of the former. Complete larval development of the scyllarid lobster ***T. orientalis*** was achieved for the first time in India at the Kovalam Field Laboratory of CMFRI. There has been only one other earlier report of a similar achievement in ***T. orientalis*** from Australia. Sub-adult male and female ***T. orientalis*** collected from the wild matured and mated in captivity. Larvae (phyllosoma) were reared in treated seawater of salinity 37–39 ppt and pH 8-8.2 and fed on a combination of fresh clam meat and live zooplankton. The larval cycle is completed in 26 days and the larvae progress through four phyllosoma stages before settlement as the nisto, which is a non-feeding stage. The nisto later moulted into the juvenile stage and resumed feeding. When maintained on a diet of fresh clam meat the juveniles attained a growth of 35 g in 120 days. The study indicates the amenability of ***T. orientalis*** to being bred and reared in captivity. The relatively shorter duration of the larval phase will be of advantage in captive rearing of the sand lobster as compared to the spiny lobsters. In the light of decreased lobster catches from Indian waters and a high demand for this commodity in international seafood markets, lobster aquaculture will hold the key to augment lobster production and export.

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SOME ASPECTS OF REPRODUCTIVE BIOLOGY OF SKIPJACK TUNA OFF VISAKHAPATNAM, NORTH EAST COAST OF INDIA

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The oceanic skipjack *Katsuwonus pelamis* (Linnaeus, 1758) is the most important commercially exploited tuna species that affords greatest promise for the expansion of tuna fishing industry of Visakhapatnam (north east coast of Andhra Pradesh). For the rational exploitation of the fishery and to investigate the resource characteristics the study of life history traits, spawning habits and fecundity are very essential, about which very little is known from this region.

In the present study, some aspects of reproduction such as size at first maturity and gonadal developmental stages of male and female skipjack and fecundity are provided. Also the spawning of skipjack in Visakhapatnam waters with particular reference to the reproductive process is dealt with and ova diameter measurements have been used to demonstrate the developmental changes that take place in the female gonads during breeding season. Fecundity ranged between 1, 24,247 to 9, 08,013 in the specimens of size range 430 to 648 mm FL. The results of fecundity studies on skipjack from different regions of Indian waters are compared.

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THE FISHERY AND RESOURCE CHARACTERISTICS OF PENAEID SHRIMP ALONG CHENNAI COAST

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The average annual landings of penaeid shrimps along Chennai coast for the past five year period (200 -2004) was 2957t with a CUPE of 3.31Kg/hr. The catch was 2203t in 2000, which reached a maximum of 5394t in 2002 and decreased to 1488t in 2004. Penaeid shrimps contributed 11.94% to the total marine landings. Metapenaeus dobsoni (13.62%) dominated the catch, followed by Penaeus indicus (12.99%), metapenaeus monoceros (11.95%), Parapenaeopsis maxillipedp (9.99%), Trachypenaeus sedili (9.75%) and Metapeneopsis striudlans (7.03%). The other commercial species, Penaeus simisulcatus (4.71%) and P.Monodon (4.25%) contributed moderately to the catch. The peak landings was observed during June- September. Biological characteristics of three species, M.dobsoni, Pmaxillipedo and M. stridulans weree studied. The size of females of M.dobsoni ranged from 41-130mm and males from 41-120mm. The size range of females of p. maxillipedo ranged from 41 -115 mm and males from 41- 125mm. The size of frmales dominated the males in the case of M. dobsoni and P.maxillipedo and among M.stridulans, males ournumbered the females. The Penaeid shrimp fishery along Chennai coast is of a wide magnitude, supported by multiple species.

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FISHERY OF PENAEID SHRIMPS ALONG THE VERAVAL COAST (GUJARAT) STATE

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The present study presents an account of the trends in the catches of penaeid shrimps along the Veraval coast during the period 1990 – 2002 and the status of the resource in the state's fish production. The contribution of penaeid shrimps to the total landings fluctuated erratically from 3% to almost 30% with average annual contribution being 13%. Shrimps of the genera *Parapenaeopsis, Solenocera* and *Metapenaeus* formed the mainstay of the landings, forming 45%, 36% and 12% of the average annual penaeid shrimp landings. In 1992, *Parapenaeopsis* spp. formed 60% of the catches while by the year 2000, it had fallen back to less than 40% and was overtaken by *Solenocera* spp. (47%). *Metapenaeus* spp. which formed nearly 25% of the catch in 1990 formed only 10% of the catch in 2001.

The variation in species composition of the penaeid shrimp catch is clearly influenced by the increase in multi-day fishing operations beyond the coastal waters. Analysis of the species composition during 1990 – 2001 with that about a decade ago revealed that the contribution of *Solenocera crassicornis* increased from 6-9% to 8-46%. *S. choprai* and *Metapenaeopsis stridulans* are relatively new entrants to the fishery,

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contributing 0 to 41% and 0 to 6% during 1990 – 2001. The trend in the catches along Veraval coast are also reflected in the total penaeid shrimp landings in the state. Stock assessment studies for Gujarat (1994 – 1999) reveal that the catch of this resource has reached the MSY level of 42800 t. Estimation of stock for Parapenaeopsis spp. and *Solenocera* spp. showed that the average annual yield has almost reached the MSY. Reasons for declining catches and shifts in the species composition are issues of concern which need to be addressed immediately.

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STATUS OF SCIAENID FISH RESOURECES OF INDIA

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The average annual catch of sciaenids was 1.5 lakh which formed 5.9 % of the total marine fish landings in India. On the north west region, which accounts for more than 50 % of the sciaenid catches, peak landings were recorded during September-December. The trend of the sciaenid fishery at Veraval, Mumbai, Karwar, Calicut, Kochi, Tuticorin, Mandapam, Chennai, Kakinada and Visakhapatnam during 1998-2004 was analysed. The average annual catch was the lowest at Kochi (130 t) and highest at at Mumbai (8330 t). Trawlers accounted mainly with 94 % share of the catches followed by *dol* nets (5 %) and gillnets (1 %). The contribution of sciaenid resources to the marine fish catches have come down from 2 lakhs t (7.5 %) in 1998 to 1.1 lakhs t (4.5 %) in 2004. Around 25 species of sciaenids constitute the fishery. The dominant species is *Otolithes cuvieri* (20 %) which had the length composition of 90-359 mm in the fishery. The dominant modal size group of *O. cuvieri* had gradually come down from 215 mm in 1999 to 185 mm in 2004. The spawning season for the majority of sciaenid species was during monsoon and post-monsoon months. Sciaenids feed on crustaceans, especially prawns when young and show piscivorous tendency as they grew. The higher exploitation rates obtained for *O.cuvieri* from Gujarat and Maharashtra waters indicated that this species is exposed to higher fishing pressure by trawls and it is suggested that the fishing effort is to be maintained at the present level for sustaining the fishery.

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FISHERY OF MALABAR SOLE *CYNOGLOSSUS MACROSTOMUS* NORMAN OFF COCHIN, KERALA STATE

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Among flatfishes occurring along the west coast, the Malabar sole *Cynoglossus macrostomus* form a major trawl fishery along the coastal region from Mulki in Karnataka to Kollam in Kerala. Though there is no targeted fishery for the Malabar sole, it is obtained as a by-catch in shrimp trawls. With the increase in targeted fishery for shrimps, this species is also being heavily fished. Market demand for fresh flatfishes is only in the Malabar area; towards south Kerala, the fish is being dried and sold through consumer markets. The fish costs Rs. 40/kg in fresh and Rs. 50/ kg in dried condition. Decayed fish from multiday shrimp fishing vessels is being dried and sold as ingredient for poultry feed at Rs. 20/kg.

Flatfish landings increased from an estimated 58 t in 2000 to 299 t in 2002, an increase of 241 t in two years, but declined to the earlier level of 65 t in 2003 and 61 t in 2004 at Cochin. Fourteen species of flatfishes were recorded in the fishery. Of these, *C. macrostomus* dominated the landings contributing over 65 %, followed by *C. macrolepidotus* with 18 %. The peak spawning season was August-September. The optimum length of exploitation was 124 mm. Annual growth coefficient (K) and L_∞ were 0.79 and 212.5 mm, respectively. . The resource is being

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exploited at a level (E = 0.78) higher than the optimum (E_{max} = 0.458); this value along with the high F value shows that this species is being heavily exploited and there is need for reducing the trawl effort.

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SOME OBSERVATIONS ON THE FISHERY OF THE WHITEFISH *LACTARIUS LACTARIUS* OFF GUJARAT COAST

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The whitefish, *Lactarius lactarius* is landed by trawl nets and gill nets operating in the coastal waters of Gujarat, particularly Saurashtra. The catch of this resource has undergone a dramatic change over the last three decades, with its percentage contribution to the average annual fish landing in Gujarat declining from about 2.5% in 1975-'79 to less than 0.3% in 1990 – '99. Among the top twenty-five contributors to the annual fish landings in the state during 1975 – '99, *L. lactarius* ranked 8th in 1975 – '79, 10th in 1980 – 89, 20th in 1990 – '94 and 24th in 1995 – '99. Veraval fish landing centre accounts for 35 – 40% of the state's average annual production of *L. lactarius*. The trends noticed in the state's landings are reflected in the landings of this resource at Veraval, where it fell from 5115 t in 1984 (7.4% of the total fish landing at the centre) to a mere 62 t in 2001 (0.04% of the total fish landing). The catch per unit effort fell drastically from 115 kg in 1984 to 1.2 kg in 2001; the catch per unit haul fell from 25 kg in 1985 to 0.1 kg in 2001 and the catch per unit hour fell from 8.4 kg in 1985 to 0.04 kg in 2001. Stock assessment for the resource along the Veraval coast indicates that the present level of exploitation is more than double the optimal effort that would have yielded sustainable catch and any further increase in effort may prove to be disastrous for the sustenance of this resource.

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ind.m-2) respectively. Amongst amphipods, 2725 individuals belonging to 13 species, Hyale sp.2 frequently encountered followed by H. hololuluensis. A total of 21 species of decapods comprising shapping shrimp, Alpheus sp. (1 sp.), anamuran crabs (2 spp.) branchyuran crabs (16 spp.) and megalapa larvae (2 spp.) were recorded during the study period. Leptochelia rapax of tanaidacea was recorded during August 1988. A sea spider belonging to pycnogonida was also reported. A total of 4 species of insects and 2 larvae of ceratopogonidae and collumbollidae were also reported. Arthropods were more in the pre- and post-monsoon periods and comparatively less in the south west monsoon months. Two species of sea urchins (Echinus sp., Lytechinus sp.) and three species of brittle stars (Ophiomusium sp., Ophiactis sp., Ophiothrix sp.) were reported. Biodiversity changed with season. The biodiversity of rocky shore sporadically colonized the entire bare rocky intertidal area soon after the south west monsoon season (June-September) and reached its climax prior to the onset of the next south west monsoon. The biodiversity experienced the catastrophic mortality during the peak of the south west monsoon, during which the entire mussel bed was lost. The green mussel population and the south west monsoon were responsible for regulating the biodiversity of green mussel bed at the study area. Temporal distribution of barnacles, isopods, amphipods, decapods, other arthropods and echinodermata was followed. Species diversity index and equitability (evenness) index were determined. The data was subjected to multivariate statistical analysis and the results are discussed.

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MARINE ALGAL BIODIVERSITY OF MAHARASTRA COAST

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Maharastra Coast is about 563 Km having sandy/rocky intertidal area. Four sites supporting good algal vegetation along the Maharastra coast are: Malvan, Ratnagiri, Shrivardhan and Coloba (Mumbai). In the present study, these stations were surveyed for algal biodiversity and biomass distribution. The biodiversity index and similarity index of algal vegetation was calculated for these stations using the data form these studies. Changes in the biodiversity have been estimated since 1980's to 2004-5. The above study revealed that Malvan, Ratnagiri, Shrivardhan and Coloba (Mumbai) harbour about 70, 65, 29 and 69 macro algal species respectively.

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IMPACT OF ALTERED RIVER FLOW ON THE BIOGEOCHEMISTRY AND PRODUCTIVITY OF THE SEAS ALONG THE EAST AND WEST COASTS OF INDIA

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Studies have been carried out to assess the impact of altered river flow on the nutrient and productivity profile of coastal waters from west coast (Veraval, Mangalore and Cochin) and east coast of India (Vishakhapatnam). Monthly samples were collected for two years (2001- 2003), from six rivers covering the west coast (Bhadar, Netravathi, Sharavathi, Nethravathi, Mahe, Periyar) and three rivers covering the east coast (Godavari, Sarada, *Gosthani*) for studying water quality parameters, physico-chemical parameters, primary & secondary production, heavy metal contamination and sediment characteristics.

The silicate content recorded from the riverine stations varied from 15.45 m Mol/m3 in Periyar River to 48.46 m Mol/m3 in Sharavathi River, from the estuarine stations varied from 10.24 m Mol/m3 in Periyar to 27.84 m Mol/m3 in Godavari and from the

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marine stations varied from 3.78 m Mol/m3 in Nethravathi to 18.14 m Mol/m3 in Sarada. The Chl *a* values recorded from the riverine stations varied from 0.07 mg/m3 in Netravathi River to 6.02 mg/m3 in Godavari River. River born material flux, nutrient discharge and sediment transport into the coastal seas are found to be directly linked to the quantum and timing of freshwater discharge. Annually all the nine rivers together discharged 627 t of nitrate, 769 t phosphate and 21,167 t silicate into the coastal waters, facilitating high productivity. They have also discharged 10,45,213 t of suspended solids, 2.17 x 107 t dissolved solids, 76 t ammonia and 44 t chlorophyll a pigments into the coastal seas every year.

Generally, freshwater diversions have reduced the discharge of nutrients such as nitrate, nitrite and silicate, and dissolved oxygen content in the coastal waters consisting of river mouth, estuary and sea, while enhanced the concentration of suspended solids (TSS), TDS, N:P ratio and Si:P ratio. Correlation study with river discharge (runoff) shows that water salinity, pH and TDS values reduced with increase in water discharge, while dissolved oxygen content, nutrients, chlorophyll *a* and total chlorophyll pigments increased with water discharge in the study areas.

Analysis using the historic catch data (1969 – 2003) showed declining trends in the catch of *River system Dependent Fish Groups* such as Penaeid Prawns, Hilsa, Threadfins, Mullets and Rockcods and Snappers from the east and west coast of India. Study revealed that in all river basins, from a holistic perspective, one does not see any 'surplus' water, because every drop performs some ecological service all the time.

Marine Fisheries in Gujarat – An Overview

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The estimated marine fish potential of Gujarat in 1996 was 0.57 million t, which is about 17% of the all-India potential. With a shelf area of 1,64,000 km^2 and over 2,00,000 km^2 of EEZ, the waters off Gujarat offer scope for exploitation of several types of finfish and shellfish resources by both traditional and mechanized sectors. The development of marine fisheries in Gujarat can be traced to the pre-independence era, when traditional fishing methods were practised in the creeks and coastal waters primarily for subsistence and to meet the demands in some local markets. The importance of marine fisheries, however, rose to the forefront only in the 1950s, following the initiation of experimental trawl surveys in the grounds off Dwarka and Kutch. With the establishment of these areas as lucrative fishing grounds for several resources, a mechanization boom set in, followed by targeted trawling for shrimps towards the late 1960s. Developments in the traditional sector took place simultaneously, with the introduction of mechanized boats and synthetic gear materials and technological inputs. The fishing industry of Gujarat today has a fishing fleet of over 24,000 mechanised and non-mechanised crafts. The gears operated include trawl nets, dol nets, gill nets, hooks and lines, cast nets, stake nets, bag nets, drag nets, fence nets and trap nets. The major resources exploited along the Gujarat coast include ribbonfishes, croakers, Bombay duck, shrimps, cephalopods, perches, seerfishes, threadfin breams, lizardfishes, flatfishes, catfishes, elasmobranchs, crabs, lobsters, clupeids, carangids, threadfins, pomfrets, mudskippers, oysters, chanks and seaweeds. Along the coastline there are about 44 fishing harbours, extending between the minor landing centres of Koteswar in Kutch and Ummergaon in the south. The total marine fish catch of Gujarat has increased from less than 0.1 million t in 1971 to 0.62 million t in 2000. The state has also made great strides in processing and export of fish and fish byproducts. The need of the hour is to utilize the resources in a judicious manner so as to conserve the resources and ensure productivity for generations to follow.

Key words : Marine fisheries, fisheries development, Gujarat

The state of Gujarat, with about 20% of the country's coastline and over 2,00,000 km^2 of Exclusive Economic Zone ranks first among the Indian states with regard to all-India marine fish production. About 33% (1,64,000 km^2) of the total continental shelf area of the country lies along the Gujarat coast. The width of the Indian continental shelf is greatest off Gujarat. 64,800 km^2 of

Junagadh and Porbandar districts together account for more than 50% of the state's marine fish production. Valsad, Navsari and Kutch contribute to about 25%. (Fig. 1) The fishing harbour at Veraval in Junagadh district was developed in the year 1956 and was commissioned in 1962. Mangrol (Junagadh district) and Porbandar (Porbandar district) fishing harbours are next only to Veraval in terms of contribution to the marine fish landings along the coast of Gujarat. Mangrol fishing harbour was developed under the World Bank Project and was commissioned in 1985. The fishing harbour at Porbandar was commissioned in 1991.

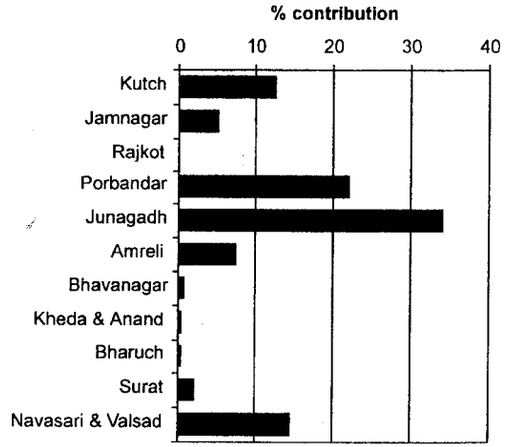

Fig. 1. Percentage contribution to marine fish production by different maritime districts of Gujarat

Trends in marine fish production

With the initiation of commercial trawling in the waters off Gujarat, the state established a niche for itself among the marine fish producing states in India. The rich diversity of resources and innovative developments in fishing technology helped the state to become one of the leading producers of marine fish in the country. The advances made by the state in this sector is evident from the fact that its marine fish production increased from less than 0.1 million t in 1971 to about 0.62 million t in 2000 (Fig. 2). The catch reached a peak of about 0.7 million t in 1998. However, developments in fishing methods, increase in intensity of fishing and targeting of specific resources of high economic value have created an impact on the fishery output, and over the years, the quality of the catches has changed considerably.

The variations in percentage contribution of different resources to the total fish catch clearly identifies the resources which are on the declining side and those which hold promise for the future (Fig. 3). While some groups like lobsters

(*Panulirus polyphagus*), whitefish (*Lactarius lactarius*), eels (*Congresox talabanoides*) and larger penaeid shrimps (*Penaeus semisulcatus, P. merguiensis P. monodon, Metapenaeus monoceros, M. kutchensis,* etc.) are fast declining, the groups that are steadily shrinking include pomfrets (*Pampus argenteus, Parastromateus niger*), threadfins (*Polynemus indicus* and *P. sextarius*), large sharks (*Carcarhinus limbatus, C. melanopterus, C. leucas, Galeocerdo cuvieri, Sphyrna mokarran, S. lewini, S. zygaena*, etc.), other penaeid shrimps (*Parapenaeopsis stylifera, P. hardwickii, Solenocera crassicornis, S. choprai*, etc.), clupeids like *Hilsa* spp., larger croakers like *ghol* (*Protonibea diacanthus*) and *koth* (*Otolithoides biaurites*), large perches (*Epinephelus malabaricus, E. tauvina*, etc.) and mullets (*Liza parsia, L. vaigiensis*). On the other hand, the fishery is being supported well (quantitatively) by resources like non-penaeid shrimps (*Acetes* spp., *Nematopalaemon tenuipes* and *Exhippolysmata ensirostris*), smaller croakers (*Johnieops sina, J. vogleri, J. dussumieri, Johnius glaucus, Johnius* spp., *Otolithes cuvieri, O. ruber,* etc), clupeids (*Tenualosa ilisha, T. toli, Hilsa* spp., etc.), carangids (*Megalaspis cordyla, Alepes djedaba, Decapterus russellii*, etc), cephalopods (*Loligo duvauceli, Sepia elliptica*), Bombay duck (*Harpodon nehereus*), ribbonfishes (*Trichiurus lepturus*), seerfishes (*Scomberomorus commerson, S. guttatus*), threadfin breams (*Nemipterus mesoprion, N. japonicus*), lizardfishes (*Saurida tumbil, S. undosquamis*) and flatfishes (*Cynoglossus macrostomus, C. macrolepidotus*, etc.)

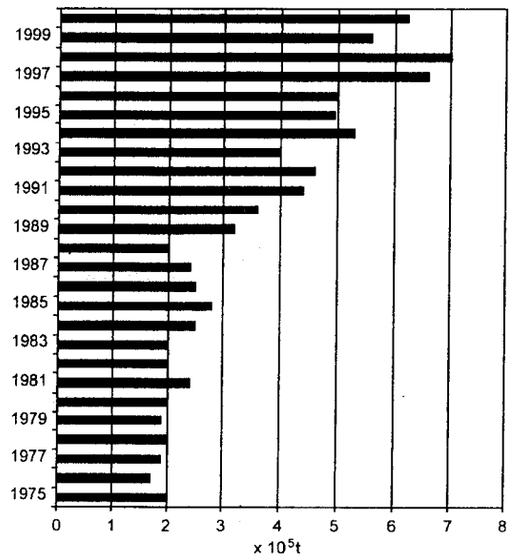

Fig. 2. Marine fish production in Gujarat during 1975-2000

Gujarat's continental shelf lies in the depth range of 0-50 m, offering scope for exploitation of several types of finfish and shellfish resources by both traditional and mechanized fishing. The annual marine fishery potential of the state is estimated at 0.57 million t (CMFRI, 1997), which is about 17% of the all-India potential.

Thirteen out of the twenty-one revenue districts in the state are coastal. There are more than 213 fishing villages spread along the coast, with about as many landing centres. The state has 44 fishing harbours extending between the minor landing centres of Koteswar in Kutch and Ummergaon in the south. Twelve of these harbours are medium ones and rest are minor ones. The total fishermen population of the state exceeds 0.45 million, out of which around 0.16 million people are actively engaged in fishing and related activities (Anon, 2002).

Marine fishing fleet in Gujarat

Experimental trawling off Dwarka and Kutch conducted in the 1950s indicated that these grounds are lucrative fishing grounds for different demersal resources like pomfrets, threadfins and large sciaenids. With the formation of the State of Gujarat in 1960, the Government initiated technological and infrastructural developments towards the growth of marine fisheries in the state. A mechanization boom set in, followed by targeted trawling for shrimps towards the late 1960s. Developments in the traditional fishing sector took place simultaneously, with motorized boats being operated for the first time in Jaleswar. Nylon ropes and twines, which received half-hearted acceptance initially, soon became an integral part of fishing activities in the state by the early 1970s. Fisheries development in the state has never looked back since then. Several other seafaring communities like the Kharvas and the Kolis also took up fishing as an occupation. With increasing fish production, the state also made great strides in processing and export of fish and fish products. Veraval became the main centre of the marine fishing industry of Gujarat.

The marine fishing industry of Gujarat has a fleet of over 24,000 fishing vessels, of which 65% are mechanized. Table 1 shows the growth of the state's marine fishing fleet from 1980-81 to 1997-98. At present, more than 70% of the mechanized boats are trawlers. The trawlers undertake either single-day or multi-day fishing operations. In the early years of trawling in the state, almost all the boats conducted single-day fishing. Towards early 1980s, some boats conducted 2-3 day fishing. Later, with reduction in the catches of high-value penaeid shrimps and increased demand for cephalopods and demersal finfish resources like threadfin breams and other perches, trawlers extended operations to deeper waters and the number of fishing days per trip gradually

increased to 5-7 days. In 1999, more than 50% of the trawlers conducted multi-day fishing. Single-day operations are done in the depth range of 20-50 m, mostly exploiting ribbonfishes, croakers, crustaceans, squids, etc. Multi-day operations are carried out in deeper waters (20-100 m) and the catches are chiefly comprised of ribbonfishes, croakers, threadfin breams, cephalopods and non-penaeid shrimps.

Table 1. Category-wise break-up of Gujarat's marine fishing fleet

Category of fishing boats	1980-81	1985-86	1990-91	1994-95	1997-98
Trawlers	1781	1919	2814	4634	6390
IBM Gill netters	622	956	1946	3110	3275
OBM FRP boats	0	0	1044	2545	3551
OBM wooden boats	843	1673	1834	1814	1854
Dol netters	213	310	498	545	628
Total Mechanized boats	3459	4858	8140	12648	15698
Total Non-mechanized boats	6023	8018	8677	8370	8918
Grand total	9482	12876	16817	21018	24616

Other fishing gears operated by the mechanized and non-mechanized sectors include *dol* nets, gill nets and hooks and lines, apart from stake nets, drag nets, cast nets, fence nets and trap nets, which are operated by the artisanal fishermen. *Dol* nets are fixed bag nets operated in the coastal waters up to 20 m depth. This gear is employed for the targeted fishery of Bombay duck (*Harpodon nehereus*). Gill nets operated along the coast are drift gill nets and bottom set gill nets for targeted fishery of specific resources. These nets are operated from boats fitted with outboard motors (OBMs), mostly conducting single-day fishing and from boats with inboard engines (IBMs).

The marine fish catch of the state consisted of mainly ribbonfishes, croakers, Bombay duck, cephalopods, shrimps, seerfishes, tunas, perches, threadfin breams, lizardfishes, flatfishes, elasmobranchs, mullets, carangids, clupeids, crabs, lobsters, catfishes and mudskippers. The major centres for trawling operations are Veraval, Porbandar, Mangrol, Okha, Jakhau, Mundra, Rupen, Kotada, Ummergaon, Ummersad and Diu/Vanakbara. Jaffrabad, Navabandar and Rajpara are the major *dol* net centres while Seemar, Goghla, Mundra and Tima are minor centres. The major gill net centres are Veraval, Porbandar, Mangrol, Muldwaraka, Dhamlej, Sutrapada, Hirakot, Madhavpur, Madhvad, Rupen, Salaya, Jakhau, Chorwad, Jaleswar, Miani, Navabandar, Seemar, Mangrol, Bhavnagar, Mahuva and Gogha. Stake nets are operated in Bhavnagar district. Fence nets are operated in the Gulf of Kutch, Little Rann of Kutch, Jamnagar district, Bhavnagar and Gulf of Cambay.

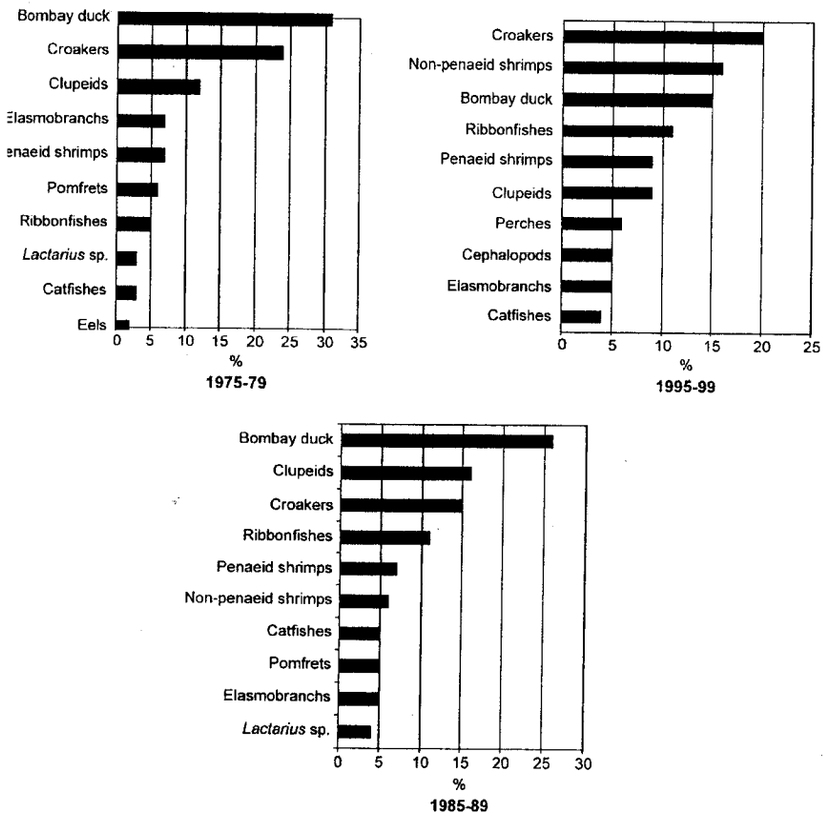

Fig. 3. Top ten contributors to the marine fish production of Gujarat, during 1975-79, 1985-89 and 1995-99

During the period 1990–1999, pelagic resources contributed to 36.7% of the annual average catch, demersal resources contributed 34.4% and crustaceans and cephalopods formed 21.7 and 4.2%, respectively (Fig. 4). The major demersal resources include croakers, perches, elasmobranches, catfishes (*Arius sona, A. tenuispinis, A. thalassinus* and *A. dussumieri*), pomfrets, flatfishes, threadfins, eels, and lizardfishes (Fig. 5). The major pelagic resources include Bombay duck, ribbonfishes, clupeids, carangids, seerfishes and tunas (*Thunnus tonggol, T. albacares, Katsuwonus pelamis, Euthynnus affinis* and *Auxis thazard*) (Fig. 6). The crustacean catches are composed of non-penaeid shrimps, penaeid shrimps, crabs (*Charybdis hoplites, C. leucifera, Thalamita crenata, Portunus pelagicus*, etc), stomatopods (*Oratosquilla nepa*) and lobsters (Fig. 7). Cephalopod catches are chiefly composed of squids and cuttlefishes.

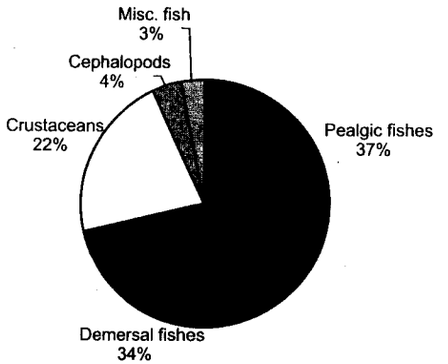

Fig. 4. Category-wise percentage composition of marine fish landings in Gujarat

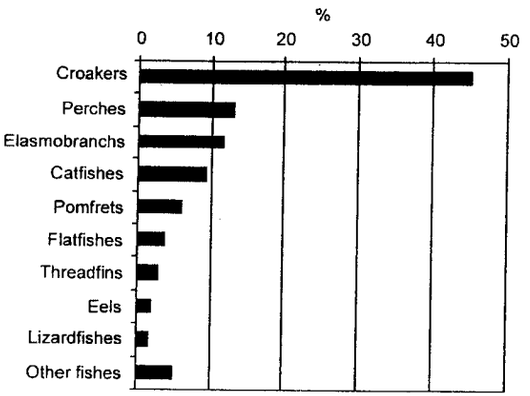

Fig. 5. Major demersal fishery resources of Gujarat

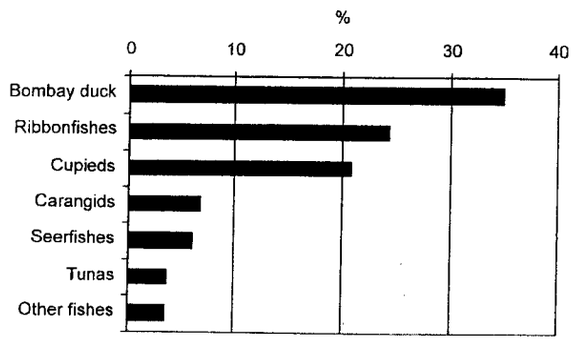

Fig. 6. Major pelagic fishery resources of Gujarat

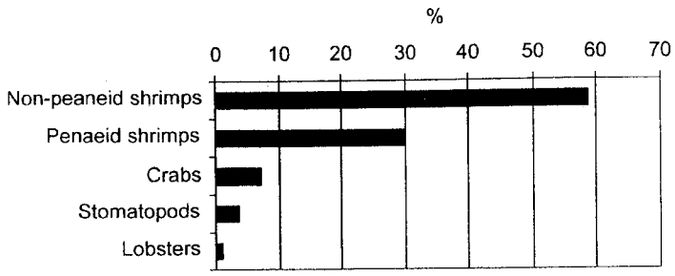

Fig. 7. Major crustacean fishery resources of Gujarat

The major contributors to the marine fish landings of the state, comprising about 75% of the total landings, are of comparatively low economic value. Bombay duck forms the mainstay of the *dol* net fishery. The fish is dried in bulk and are mostly sold in the domestic markets. In the early years of fishery development in Gujarat, croakers, especially the large-sized *ghol* and *koth* were an important commodity fished from this coast. However, over the years, these larger resources have practically dwindled and the major part of the catch of croakers is composed of small sized species which fetch low value. Non-penaeid shrimp which used to be a major contributor to *dol* net catches, has now become a major component of trawl net catches also. The bulk of the catch is composed of *Acetes* spp., which has relatively low commercial value. Trawler operators often bring this resource as a bycatch and its stale condition makes it good only for fishmeal plants.

Conservation of fishery resources

Sustainable development is defined by FAO as "the management and conservation of natural resources and the orientation of technological and institutional changes in such a way as to ensure the attainment and continued satisfaction of human needs for the present and future generations". In the context of marine fisheries management it involves the resolution of relatively complex situations which arise out of the renewable and common property nature of the fishery resource.

As has been the general trend in the capture fishery scenario in India, the marine capture fishery production in Gujarat reached the peak production in the late nineties. This has been solely due to the uncontrolled expansion in the number of large and efficient fishing vessels, especially the trawlers. This has resulted in the average catch per boat per year coming down from about 150 t to less than 40 t in the late nineties. Studies conducted by CMFRI on the resource characteristics of some of the major exploited marine fish stocks

of the state such as Bombay duck, white pomfrets, perches, small sciaenids, penaeid prawns and lobsters, have shown that most of these resources are either already or on the verge of being over-exploited. Studies conducted by the Institute in the eighties itself have emphasized the need for regulation of fishing effort to save the industry from disaster (Balan *et al.*, 1987). Under these circumstances, there is an urgent need for effective control on the number and capacity of the fishing boats in the coastal waters of the state.

There has been a progressive reduction in the codend mesh size of trawl nets and the mesh sizes of other indigenous gears like *dol* nets and gill nets, the consequence of which is the reduction in length at first capture of the exploited stocks. This in turn can cause recruitment overfishing and collapse of fisheries over a period of years (Alagaraja, 1989). The studies conducted by CMFRI have shown that the small codend mesh size of bottom trawls cause mortality of juveniles and sub-adults of commercial species in large quantities. So action should be initiated for arriving at a consensus for enforcing mesh size regulations, taking into consideration the multi-species nature of the exploited fish stocks.

Closure of certain areas in the sea for fishing and banning of fishing in certain seasons are some of the well-known methods in vogue in the management of the exploited fishery resources. Closure of selected trawling grounds has been employed to protect fish on spawning grounds. Most species in Indian waters with the exception of a few in which seasonal breeding has been clearly established, are continuous breeders (James, 1992). So the implementation of a closed season along Gujarat coast mostly serves the purpose of a reduction in fishing effort rather than protecting the spawning stocks (Devaraj *et al.*, 1998).

The impact of bottom trawling has been investigated and appropriate strategies have been evolved to reduce bottom trawling in the coastal waters and to reduce bycatch, in many developed nations. It has also become imperative to develop eco-friendly fishing gears so that the physical disturbance on macrobenthos due to bottom trawling can be reduced.

As has been indicated earlier, more than 75% of the fish catch of the state is composed of low value species, which are sun dried, or block frozen and exported mostly to China and Southeast Asian countries. Value addition, therefore, has a major role to play in sustaining the fishing industry of Gujarat.

The present annual catch has already exceeded the potential yield of 0.57 million t estimated for Gujarat (CMFRI, 1997). However, increased contribution by some of the resources like non-penaeid shrimps, threadfin breams, mackerels, sardines and carangids can pave the way for diversifying the fishery towards exploitation of new resources from both coastal and deeper waters using different

gears. The fishermen of Gujarat have already proved themselves to be highly innovative and adaptive to changes. There is also plenty of scope in the state for expanding its aquaculture industry by promoting open sea farming, coastal mariculture and ornamental fish culture.

In view of the present-day situation, the need of the hour is to maximize production from the vast resources of the state in a judicious and well managed fashion so as to conserve the resources and ensure productivity for generations to follow. This can be achieved by focusing research and commercial activities towards (i) fleet-size reduction, (ii) promotion of sustainable fishing activities through participatory rural development programmes, (iii) promotion of coastal mariculture and open sea farming, (iv) promotion of exploitation and utilization of non-conventional resources like seaweeds and gastropods, (v) promotion of marine aquarium industry, and (vi) conservation of resources through mesh size regulation, regulation of bottom trawling, regulation of fishing activities in identified breeding/nursery grounds, regulation of fishery of breeding adults and young juveniles, regulation of fishery of endangered/threatened species and promotion of sea ranching programmes for commercially important and cultivable species like shrimps and lobsters.

The authors wish to thank Dr. Mohan Joseph Modayil, Director, CMFRI, Cochin for the encouragement and for the opportunity given to publish this paper.

References

Alagaraja, K. (1989) A brief appraisal of marine fisheries in India, *Bull. Cent. Mar. Fish. Res. Inst.*, 44 (1), Central Marine Fisheries Research Institute, Cochin: 36-41.

Anon (2002) *Gujarat Fisheries Statistics: 1999–2000,* Commissionerate of Fisheries, Ahmedabad

Balan, K., Sivaraman, P., George, K.P. and Ramachandran M. (1987) An appraisal of the marine fisheries of Gujarat, *CMFRI Spl. Publ.* 38, Central Marine Fisheries Research Institute, Cochin: 51 p.

CMFRI (1997) Status of research in marine fisheries and mariculture, *CMFRI Spl. Publ.* 67, Central Marine Fisheries Research Institute, Cochin: 35 p.

Devaraj, M., Vivekanandan, E., Sathiadas, R. and Reghu, R. (1998) Techno-economic assessment of marine fish production, marketing and capacity utilization of processing plants in Gujarat, In: *Experience Sharing Workshop on Fisheries Sector Development for the State of Gujarat*, Govt. of Gujarat: 1-16

James, P.S.B.R. (1992) Impact of fishing along the west coast of India during southwest monsoon period on the finfish and shellfish resources and the associated management considerations, *CMFRI Bull.* 45, Central Marine Fisheries Research Institute, Cochin: 251-259

Problems and prospects for inland fishery development in Gujarat

There are several reasons for low production from the inland sector in Gujarat state. In Gujarat, majority of the districts have low rainfall and most of the ponds and reservoirs are seasonal, which affects long-term culture prospects. Fish seed stocking in ponds and reservoirs is inadequate and potential is not fully utilized. Poaching in large reservoirs is a major cause for low fish production. In many large reservoirs, harvesting is done before the fish attained marketable size. In many places religious taboos prevent fish harvesting. Another reason contributing to low aquaculture production is inadequate adoption of supplementary feeding practices. Insufficient training and low adoption of scientific culture practices also contribute to the low production from inland waters.

In order to enhance the inland fish production in Gujarat, there is need to increase grow-out areas for culture practices in each district, making full use of the available potential. There is also need for introducing fast growing species for culture. In the seasonal water tanks and reservoirs of Saurashtra and North Gujarat, yearling stocking could be useful. Scientific management of reservoirs with adequate stocking and controlled fishing could go a long way in improving production. Polyculture of giant freshwater prawn and fish is another approach which could be pursued for increasing production. Fisheries development of Sardar Sarovar Project need to be carefully planned and promoted in such a way as to maximize fish production from the reservoir proper and command areas.

Fishery of Marine Crustaceans in Gujarat

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Crustacean resources are well distributed along the Gujarat coast. Both the mechanized and the artisanal fishing sectors exploit these resources with a variety of resource-specific and area-specific gears. The artisanal sector operates in the coastal waters, up to a depth of 50 m, and in the numerous estuarine and saline creeks along the coastline. The gears employed are gill nets, stake nets, fence nets, trap nets, umbrella nets and drag nets. The mechanized sector operates in the coastal and offshore waters at depths of 20-100 m with trawl nets and *dol* nets. About 95% of the total crustacean landings in Gujarat are by the mechanized sector (80% by trawl nets and 15% by *dol* nets) and the rest by the artisanal sector. Crustaceans formed about 17% of the average annual marine fish catch of Gujarat during the period 1971-2000. An analysis of each five-year period within this time frame reveals that the percentage contribution of crustaceans to the total fish catch increased steadily from 7.4% in 1971-75 to 23.4% in 1996-2000. The percentage composition of the crustacean catches, however, showed a high degree of variation, with the contribution of penaeid shrimps steadily declining over the years and that of non-penaeid shrimp correspondingly increasing. The contribution of lobsters to the crustacean landings is marginal and has decreased from 8.2% in 1971-75 to less than 1% in 1996-2000, clearly indicating the fishing pressure on this resource. The percentage of crabs in the crustacean landings increased from about 1% in 1971-75 to about 34% in 1981-85 and has thenceforth been steadily declining. In the first two decades there was targeted effort towards the exploitation of crustaceans, especially penaeid shrimp and lobsters, by the trawl nets which accounted for the bulk of the crustacean catch. However, a gradual decline in the landings of these resources combined with the conversion of short-trip (1-2 days) operations to long-trip (5-7 days) operations with targeted fishing being done in deeper waters for cephalopods and the increase in the landings of non-penaeid shrimps in both trawl nets and *dol* nets, has now sidelined the status of the much-valued crustaceans to a bycatch. While the percentage contribution of crustaceans to the total fish catch has increased, the value of this catch has decreased and the state's marine fishery is now more or less economically sustained by targeted fishery of perches, cephalopods, ribbonfishes and sciaenids in the trawl sector and Bombay duck, catfishes, and ribbonfishes in the *dol* net sector.

Key words : Crustacean fishery resources, Gujarat

Crustaceans have always enjoyed a special position in the Indian fish trade, being in good demand in international markets. The world-wide demand for

crustaceans, fresh or frozen, has directed fishing activities towards targeted exploitation of this group.

The rich diversity of marine life along the Gujarat coast is reflected by the large number of crustacean resources (Table 1) which contribute to the marine fishery production of the state. The presence of crustacean resources (shrimps in particular) in the fishing grounds along the Gujarat coast was established towards the late 1960s and early trawl fishing activities for large demersal fishes were slowly directed towards exploitation of this group. Shrimp trawls soon became the mainstay of the state's harvesting sector. Increased fishing pressure has manifested as a marked reduction in crustacean landings all along the coast. This paper attempts to analyse the changes in the marine crustacean landings of the state, both in qualitative and quantitative terms, over a period of 30 years (1971 – 2000).

Crustacean fishery

A variety of gears are employed to exploit crustacean resources along the Gujarat coast. The exploitation methods are usually resource and area-specific. The traditional sector operates in the coastal waters, up to a depth of 50 m, and in the numerous estuarine and saline creeks dotting the coastline. The gears employed are gill nets, stake nets, fence nets, trap nets, umbrella nets and drag nets. The mechanized sector operates in the coastal and offshore waters at depths of 20-100 m. This sector operates trawl nets and *dol* nets. Crustacean fishery in Gujarat has been discussed by Chhapgar (1957), Jayaraman *et al.* (1959), Kagwade (1965), Bapat *et al.* (1982) and Rao & Kasim (1985).

Species composition

The chief resources that contribute to the total crustacean landings by various gears along the Gujarat coast are penaeid shrimps, non-penaeid shrimps, lobsters and crabs.

The bulk of the penaeid shrimp landings come from trawl net operations off Saurashtra and Gulf of Kutch. The major species contributing to the catches are *Parapenaeopsis stylifera, P. hardwickii, P. sculptilis, Parapenaeus longipes, Metapenaeus monoceros, M. kutchensis, M. affinis, M. brevicornis, Metapenaeopsis stridulans, Penaeus merguiensis, P. monodon, P. semisulcatus, P. japonicus, P. canaliculatus, P. latisulcatus, Solenocera crassicornis, S. choprai* and *Trachypenaeus curvirostris. Metapenaeus* spp., *Parapenaeus* spp. and *Solenocera* spp. contribute to nearly 90% of the total penaeid catch.

Table 1. Crustacean fishery resources of Gujarat

Scientific name	Vernacular name (Gujarati)
Penaeid shrimps	
Metapenaeus affinis	*Medium jinga; sonia*
M. brevicornis	*Medium jinga; sonia*
M. kutchensis	*Medium jinga; sonia*
M. monoceros	*Kapsi jinga*
Metapenaeopsis stridulans	*Dhebari*
Parapenaeus longipes	*Bhusi*
Parapenaeopsis hardwickii	*Kolmi; tiny*
P. sculptilis	*Patta kolmi*
P. stylifera	*Kolmi; tiny; jingi*
Penaeus indicus	*Jingi*
P. merguiensis	*White jumbo*
P. pencillatus	*White jumbo*
P. latisulcatus	*Patta jumbo*
P. japonicus	*Jinga*
P. monodon	*Tiger jumbo*
P. semisulcatus	*Patta jumbo; flower*
Trachypenaeus curvirostris	*Kolmi*
Solenocera choprai	*Lalkolmi; jogni*
S. crassicornis	*Lalkolmi; jogni*
Non-penaeid shrimp	
Acetes indicus	*Jawla; golbo*
A. johni	*Jawla; golbo*
Nematopalaemon tenuipes	*White kolmi*
Exhippolysmata ensirostris	*Dodi*
Lobsters	
Panulirus homarus	*Bhatiyo*
P. ornatus	*Bhatiyo*
P. polyphagus	*Titan; titi; jinga*
P. versicolor	*Patta valo*
Thenus orientalis	*Kaka*
Crabs	
Calappa lophas	*Karachala*
Matuta planipes	*Karachala*
Charybdis feriatus	*Karachala*
C. hoplites	*Karachala*
C. leucifera	*Karachala*
Portunus pelagicus	*Karachala; khekda; kurchal*
P. sanguinolentes	*Karachala*
Scylla serrata	*Karachala; lodun*
Thalamita crenata	*Karachala*
Atergatis spp.	*Karachala*
Macrophthalmus pectinipes	*Charola*
Stomatopods	
Oratosquilla nepa	*Vichi kanta*

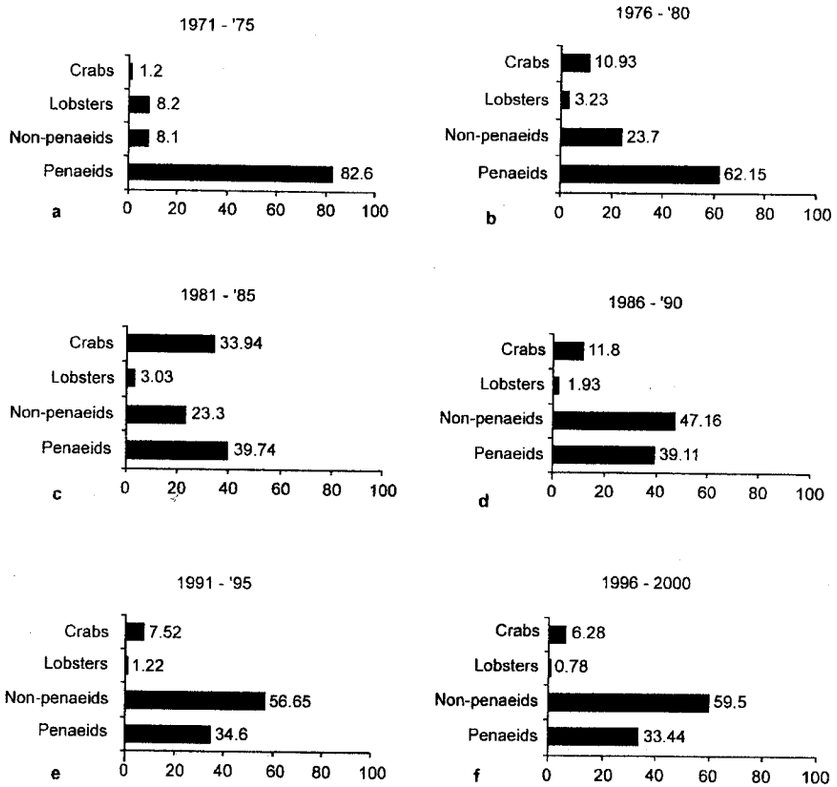

Fig. 2. Percentage composition of crustacean landings in Gujarat, during 1971-1975 to 1996-2000

based at Veraval to market the *P. pelagicus* caught by traditional fishermen in the Gulf of Kutch and the establishment of a meat extraction unit for processing soft-shelled crabs by a multi-national group at Dwarka showed promise and since then some attention has been directed towards exploiting *P. pelagicus* on a larger scale. The contribution of crabs to the total crustacean landings of the state increased from about 1% in 1971-75 to a peak of about 34% in 1981-85 and has thenceforth been declining steadily.

About 95% of the total crustacean landings in Gujarat are by the mechanized sector (80% by trawl nets and 15% by *dol* nets) and the rest by the traditional sector. The contribution of trawl net catches of crustaceans during 1980-89 ranged from 8-13% of the total fish catch of the state while *dol* net catches of crustaceans ranged from 0.6-2.6%. In 1990-99, trawl net catches of crustaceans

formed 13-18% and *dol* net catches of crustaceans formed 2.5-7.5% of the total marine fish catch of the state. Since trawl nets and *dol* nets together contribute maximum to the total crustacean landings from the waters off Gujarat, variations in the crustacean fishery can be best explained by comprehending the trends in fishery by these two gears. An analysis of the composition of the crustacean catches shows that the increase in contribution of crustaceans from trawl nets and *dol* nets to the total fish catch in the 1990s was mainly due to an increase in the catches of non-penaeid shrimp (90% of which is composed of *Acetes* spp.), especially in the trawl nets. Hence, even though catch statistics reflect an increase in crustacean landings, this increase is not reflected in the value of the catch since non-penaeids are of very low economical value. The percentage composition of the average annual crustacean landings by trawl nets and *dol* nets during the periods 1980-84 and 1995-99 (Fig. 3 & 4) reveal a significant change in the trawl net catches, with decline in the contribution of penaeid shrimp (37% to 27%), crabs (41% to 9%), stomatopods (13% to 5%) and lobsters (2% to 1%). The contribution of non-penaeid shrimp on the other hand showed a tremendous increase from 7% to 58%. The variation in the percentage composition of *dol* net crustacean catches during the same periods, though not as marked as in trawl net catches, reveals a similar trend – decline in the contribution of penaeid shrimps (20% to 15%) and stomatopods (2% to 1%), and increase in the contribution of non-penaeid shrimp (78% to 83%). Crabs increased slightly from 0.4% to 0.6% and lobsters increased marginally from 0.1% to 0.2%.

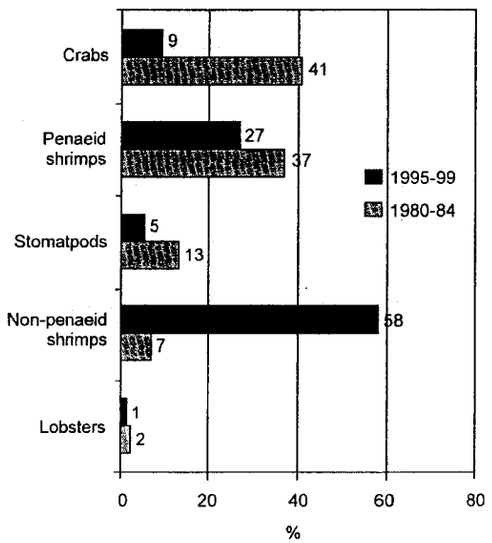

Fig. 3. Composition of crustaceans in trawl landings of Gujarat, during 1980-84 and 1995-99

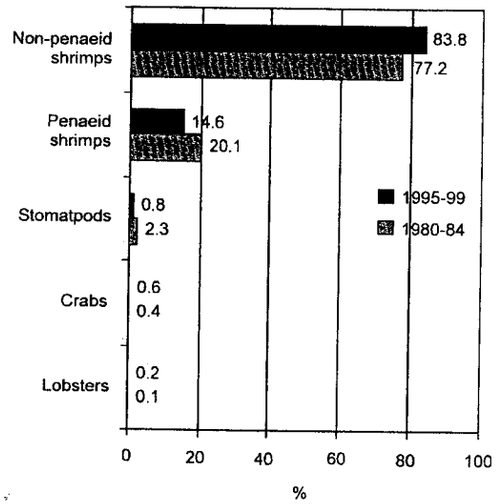

Fig. 4. Composition of crustaceans in *dol* net landings of Gujarat, during 1980-84 and 1995-99

Since the initiation of commercial shrimp trawling along the Gujarat coast in the 1960s, several significant changes have taken place in this operation, which include:

i. Diversion of fishing activities towards exploitation of cephalopods

ii. Expansion of trawl operations into deeper waters in the depth range of 80-100 m for exploiting cephalopods and demersal fishes like threadfin breams, lizardfishes and bull's eye

iii. Conversion of short-trip (1-2 days) operations to long trip (5-8 days) operations

iv. Reduction in codend mesh size

v. Multiple gear operation by trawlers.

These changes have affected the catches of crustaceans by trawl nets. Data available from 1994-1999 (CMFRI, 1997; 1998; 1999; 2000; 2001) reveal that only about 25% of the total trawl operations in 1994 were long-trip operations. By 1999, however, this percentage had increased to over 50%. During the period 1979-82, almost all the boats conducted single day fishing, at Veraval trawl landing centre (Rao & Kasim, 1985). Rao & Kasim (1985) found that non-penaeid shrimp formed about 29.3-39.9% of the annual shrimp catches during 1979-82. In the present study, it was found that non-penaeid shrimp formed about 70% (range: 68 – 72%) of the average annual shrimp landings during 1999-2002. From

the earlier comparison of percentage composition of crustacean landings by trawl nets and *dol* nets during the periods 1980-84 and 1995-99, it is evident that the increase in non-penaeid catches by trawl nets in 1995-99 far surpasses the increase in the landings of this resource by *dol* nets. The drastic change in the composition of the trawl net catches can be attributed to the increase in long-trip fishing operations. Incidentally, the increase in number of long-trip operations has also effected a change in the composition of the penaeid shrimp landings, with a decline in the contribution of *Parapenaeopsis* spp. and *Metapenaeus* spp. and a corresponding increase in the contribution of *Solenocera* spp. (Table 3).

Although the traditional sector contributes only a very low percentage of crustaceans to the total crustacean catch of the state, it can by no means be overlooked. Anthropogenic factors like industrial effluents and salt pan intrusions (especially in the Gulf of Kutch and adjoining creeks) are taking their toll on the traditional fisheries existing in these areas. This is evident from the decline in catches of *Metapenaeus kutchensis* during the monsoon fishery in the Little Rann of Kutch, and the catches of spiny lobsters from reefs adjoining the coastline, as compared to the 1970s. The traditional fishery of crabs in Bhavnagar and Gulf of Kutch, however, have not been much affected, since these fisheries are mostly operated to meet the demands of local domestic markets and the quantity exploited is usually restricted to the required levels. These fisheries are highly selective and the fishermen avoid capture of juveniles and berried crabs, thus ensuring the sustenance of the resource.

Table 3. Variation in composition of shrimp landings by trawlers based at Veraval during 1979-82 and 1999-2002

Major resources	% Contribution to annual shrimp catch	
	1979-82	1999-2002
Parapenaeopsis stylifera	20-30	8-12
P. hardwickii	4-10	0.6-0.3
Metapenaeus kutchensis	4-10	0.7-1
M. affinis	3-8	0.8-1
M. monoceros	2-8	0.3-0.8
Solenocera crassicornis	4-10	6-9
S. choprai	0	0.1-2.3
Non-penaeid shrimps	29.3-39.9	68-72

From the present analysis, it is evident that a shift in the nature of trawl fishing operations and grounds and intentional diversion of fishing activities for cephalopods and demersal fishes which are in demand for *surimi* plants, have

sidelined the importance of crustaceans, especially the penaeid shrimps. The increase in catches of non-penaeid shrimps (Fig. 3) helps in merely augmenting the quantum of the total marine catch of the state, and has no bearing on the economy of the industry. The fishermen themselves claim that the economy of fishing operations is now sustained by cephalopods, ribbonfishes and sciaenids in the trawl sector and catfishes, Bombay duck and ribbonfishes in the *dol* net sector.

The authors wish to thank Dr. Mohan Joseph Modayil, Director, CMFRI and Dr. E.V. Radhakrishnan, Head of Crustacean Fisheries Division, CMFRI for the encouragement given and for providing the opportunity to carry out the study.

References

Bapat, S.V., Deshmukh, V.M., Krishnamoorthi, B., Muthiah, C., Kagwade, P.V., Ramamritham, C.P., Mathew, K.J., Krishnapillai, S. and Mukundan, C. (1982) Fishery resources of the exclusive economic zone of the Northwest coast of India, *Bull. Centr. Mar. Fish. Res. Inst.* 33

CMFRI (1997) *Annual Report 1997*, Central Marine Fisheries Research Institute, Cochin

CMFRI (1998) *Annual Report 1998*, Central Marine Fisheries Research Institute, Cochin

CMFRI (1999) *Annual Report 1999*, Central Marine Fisheries Research Institute, Cochin

CMFRI (2000) *Annual Report 2000*, Central Marine Fisheries Research Institute, Cochin

CMFRI (2001) *Annual Report 2001*, Central Marine Fisheries Research Institute, Cochin

Chhapgar, B.F. (1957) *Marine Crabs of Bombay State*, Contribution No. 1, Taraporevala Marine Biological Station, Bombay

Jayaraman, R., Seshappa, G., Mohammed, K.H. and Bapat, S.V. (1959) Observations on the trawl fisheries of the Bombay and Saurashtra waters, 1949-50 to 1954-55, *Indian J. Fish.* VI (1): 58-144

Kagwade, P.V. (1965) Prawn catches by mechanized vessels in the trawling grounds of Bombay and Saurashtra, In: *Proc. Symposium on Crustacea* IV, p. 1348-1381, Marine Biol. Assn. of India, Cochin

Rao, G.S. and Kasim, H.M. (1985) On the commercial trawl fishery off Veraval during 1979-1982, *Indian J. Fish.* 32(3) : 296-308