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POTENTIAL AND PROSPECTS OF MARICULTURE IN INDIA

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Aquaculture is an activity primarily originated in Asian countries from time immemorial. During the past 50 years, aquaculture practices have spread to all continents showing faster growth rate. Aquaculture continues to be the fastest growing food production sector in the world even now and accounts for more than 50% of the total fish production. The world aquaculture production has shown phenomenal growth rate with 1 million tonnes in 1950 to 51.7 million tonnes in 2006 with a value of US\$ 78.8 billion indicating a growth rate of 7 percent. This growth rate is observed in 50 year period centered around Asia-Pacific region, particularly China which accounts for 67 percent of global aquaculture production. The major components of global aquaculture are fish, crustacea, molluscs and other aquatic

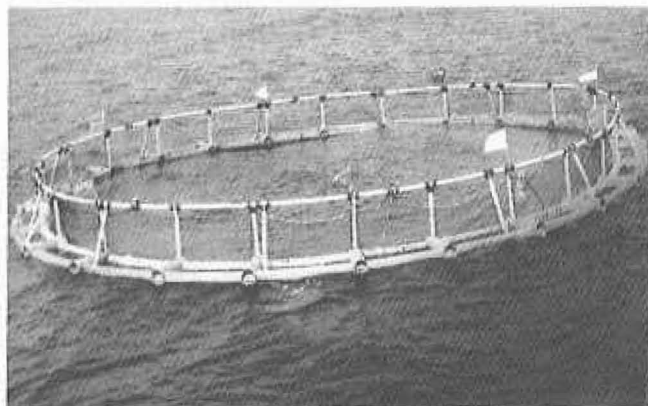
animals with total production of 3.6 percent in 1970 to 36 percent in 2007. The per capita supply of these animals increased from 0.7 Kg in 1970 to 7.8 Kg in 2006. The contribution of these animals by aquaculture comes mainly from freshwater, marine and brackish water. Aquaculture offer immense potential for employment in time coastal and rural areas and directly or indirectly influence the livelihoods of millions of people. Estimate in 2006 shows that 43.5 million people are directly engaged partly or full time in production of fish either in capture or in aquaculture and another 4 million people are occasionally engaged in fishery related activities. In recent years the employment opportunities in fisheries sector is increasing steadily especially in aquaculture sector. The estimated fish farmers globally is

around 9 million people (FAO, 2009).

In India growing fishes in ponds and water bodies was a traditional farming practice from time immemorial. The shrimp and fin fish farming in brackish water and paddy fields is an age old traditional practice in West Bengal, Kerala and Karnataka with little remuneration and least management with stocking of seeds from native species. With the introduction of scientific farming, like many southeastern countries, in India also, the shrimp farming has been initiated as a major aquaculture activity in most of the maritime states and intensification of shrimp farming started with adoption of new technologies in the last decade. Due to lack of better management practices both for shrimp hatcheries and farming, out break of diseases started in 1994 with mass mortality, crop production loss and several farms and hatcheries were closed or abandoned in the coastal region. The Central Marine Fisheries Research Institute, Kochi and few Agriculture Universities in maritime states have developed various mariculture technologies over the past 55 years. The technologies of marine prawn farming, crab farming, pearl oyster farming, edible oyster farming, mussel farming, seaweed farming, clam farming, sea-cucumber culture, lobster culture, grouper culture, ornamental fish culture and hatchery techniques for seed production of crustaceans and molluscs were developed and upgraded by researchers during the past 37 years. These technologies were

tested for its techno-economic viability in different parts of the country. Shrimp farming, shrimp hatchery, mussel, edible oyster, crab, lobster and seaweed farming have become popular and commercial production has been initiated. At present India stand second in aquaculture production with maximum production of freshwater fishes followed by shrimps.

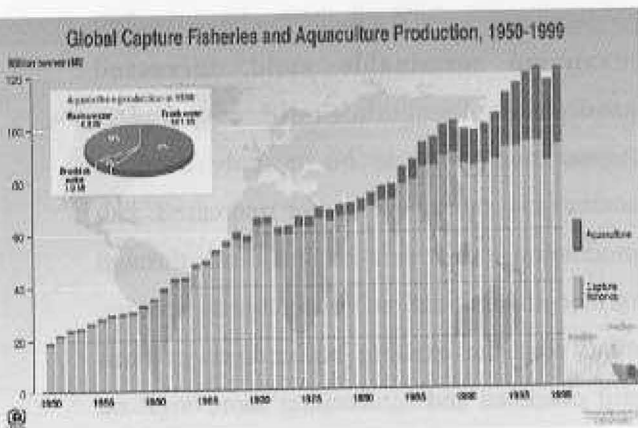
Aquaculture is expanding in all regions of the world and the global demand for fish is increasing every year. Since the supply from wild is stagnating for years together and most of the potential resources in the sea have reached maximum sustainable yield, increased production from the wild is remote. Aquaculture seems to be the only alternate source in coming years for increased fish production. This can be achieved through further diversification, using more species, modifying the existing aquaculture systems and practices and by keeping more vigil on enforcement of regulations and better management practices.



Global aquaculture production, and status of mariculture.

The world aquaculture production steadily increased during the last 10 years with 28.6 million tonnes in 1997 to 51.65 million tonnes in 2006. In 2006 China contributed 67 percent of total aquaculture production of animals and 72 percent of aquatic plants. The total aquaculture production of China stands first with 67 percent of total quantity and 49 percent by value. Asia and Pacific region accounted for 89 percent by quantity and 77

production since 2000 (11.6%) compared with 6.5% and 5.4% respectively for freshwater and marine environment. In 2006 freshwater fish production was 27.8 million tonnes against the total aquaculture production of 51.65 (more than 50%) followed by molluscan production of 14.1 million tonnes (27%) and crustacean production of 4.5 million tonnes. The details of aquatic production by culture in 10 countries with total global production from 1997 to 2006 are given in table I. The production continues to differ from region to region. In the Asia and Pacific region aquaculture production from China, South Asia and most of the South East Asia consists of cyprinoid fishes, where as the rest of East Asia produces high value marine fishes. America and Caribbea produces large quantity of shrimp and salmon dominates in Chile. Channel cat fish is dominant in North America. While Atlantic and Pacific salmon are dominant fishes in Canada. China produces 77% of carps and 82% of oysters. 81% of shrimp and prawn come from China, Thailand, Vietnam, Indonesia and India. Norway and Chile produces 33 and 31 percent of cultured salmons respectively. The world aquatic plant production by culture is 15.1 million tonnes in 2006. China contributed 72% of aquatic plants followed by Philippines. Indonesia, the Republic of Korea, and Japan. Integrated multitrophic aquaculture and organic aquaculture have also on the rise for commercial production.



Source: The State of World Fisheries and Aquaculture 2000, Food and Agriculture Organisation of the United Nations (FAO).

percent by value. Maximum aquaculture production of fish, crustaceans and molluscs continues to come from inland waters (61%). Freshwater environment contribute 58% marine environment 34% and brackish water production 8% in 2006. Marine production is from high value finfishes and low priced mussels and oysters. Brackishwater production mainly consists of high value crustaceans and finfishes with highest growth rate in quantity of

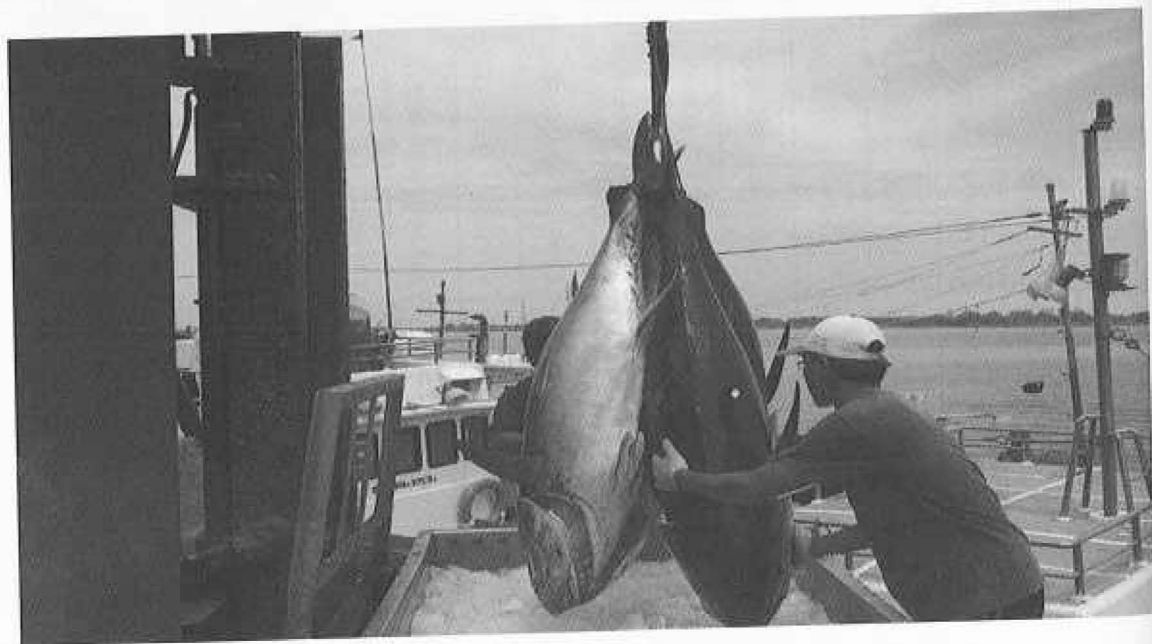
Table I
Total Global aquaculture production of fish crustaceans, molluscs etc.
by 10 major countries From 1997 to 2006

Countries	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
World total	28606108	30485721	33378496	35475103	37954378	40391695	42673878	45921837	48489670	51653329
China	19315623	20795367	22789887	24580671	26050101	27767251	28886199	30614968	32415523	34429122
India	1864322	1908485	2134814	1942204	2119839	2187189	2312971	2794636	2961978	3123135
Vietnam	322378	338920	3988468	498517	588098	703041	935702	1198617	1437300	1657727
Thailand	539817	594579	693762	738155	814121	954696	1064409	1259983	1304213	1385801
Indonesia	662547	629797	749269	788500	864276	914071	996659	1045051	1197109	1292899
Bangladesh	485864	574812	593202	657120	712640	786604	856956	914752	882091	892049
Chile	272346	293044	274216	391587	566096	545655	563435	665421	698214	802410
Japan	806534	766812	759262	762824	799946	826715	823873	776421	746221	733891
Norway	367617	410757	475932	491329	510748	551295	584423	636802	661811	708780
Philippines	327147	312505	352563	393863	434661	443537	459615	512220	557251	623369

Indian scenario

Fish production in India by capture is estimated as 3855467 t and by culture 3123136t in 2006, against the total world production of 92 millions and 51.7 million tonnes respectively. (FAO, 2009). Recent data indicate that the total marine production is 2.88 mt (2007) and the total fish production reached 7.02 million tonnes in India. The nearshore waters of India all along 8060 km coastline support good fishery contributing 90% of total marine fish production. The backwaters also afford good fishery besides traditional culture fisheries in some of the coastal states. India has 9 million hectare of inshore waters of less than 18 m depth and 1.7 million hectare of brackishwaters in the adjoining coastal areas. Though there were attempts to evolve techniques for culture of milk fish, shrimp and pearl production in early 70's by the Central Marine Fisheries Research

Institute (CMFRI) and Dept. of Fisheries, Tamilnadu, concerted efforts for developing sea farming technologies were initiated by CMFRI in late seventees especially for pearl oyster farming and pearl production, shrimp farming and hatchery seed production of shrimps, oyster farming, mussel farming and lobster culture. Later, the bivalve hatchery technology for pearl oyster, mussel, edible oyster, clams, sea cucumber were developed and some of these technologies were upgraded and refined to suit Indian ecosystems, which are characterized by frequent changes in environmental conditions predominantly due to monsoon. Commercialization of marine and coastal farming started in 80's itself with thrust in shrimp farming, which attracted export demand. The candidate species, both marine and brackishwater used for farming in India are listed in table 2.



	Groups	Species	Environment	Type of farming	Areas suitable for aquaculture			
I	Fish fishes	<i>Eptnephelus taurina</i>	Marine	Floating cages, open, cages, earthen ponds.	Gulf of Kutch, Malwan, Palk bay, Andaman and Nicobar, Lakshadweep			
	Food fishes	<i>E.malabrica</i>						
	Groupers							
	Cobia	<i>Rachicentrus canadum</i>	Marine/brackish water		East and west coast of India			
	Sea Bass	<i>Lates calcalfer</i>			East and west coast of India			
	Mulletts	<i>Mugil cephalus, Liza-parsia</i>	Brackish water		Karnataka/ Kerala Tamilnadu/ Andrapradesh, Tamil Nadu, Kerala			
	Milk fish.	<i>Chanos chanos</i>	Brackish water					
	Omnamental fishes	<i>Amphiprion sebae, A.percula,</i>	Marine		Tanks/ Ponds.	Gujarat, Lakshadweep, Kerala, Tamilnadu, Andaman and Nicobar		
	clown fishes	<i>A.ocellatus</i>						
	Damsel fishes	<i>Neopomacentrus nemurus</i> <i>N.filamentosus, Dasyllus trimaculatus, Pomacentrus caeruleus, Chromis viridis</i> <i>P. puvo</i>						
Marine Angel fish	<i>Centropyge loriculus</i>							
Neon goby	<i>Goblosoma oceanops</i>							
Royal gramme	<i>Gramma loreto</i>							
Cardinal fish	<i>Pterapogon kauderni</i>							
Sea horse	<i>Hippocampus kuda</i>							
II	Crustaceans	<i>Penaeus indicus</i>		Marine / brackish water			Ponds/ paddy fields/ Tanks	East and west coast of India and Andaman.
	Shrimps	<i>P. monodos</i>						
		<i>P.japonicus</i>						
		<i>P. merguensis</i>	Marine					
		<i>P.semisulcatus</i>						
	Crabs	<i>Squilla serrata</i>	Brackish water. Paddy field	Cage/ pond	East and west coast of India, Andaman			
		<i>Squilla tranquilbaricus</i>						
		<i>Portunus pelagicus</i>						
	Spiny Lobsters	<i>Panulirus homarus P. ornatus</i> <i>P. polyphagus, P. versicolor</i>	Marine		East and west coast of India Andaman			
	Slipper lobster	<i>Theraps orientalis</i>		Tanks	North West and south East and west coast			
III	Molluscs	<i>Perna viridis, P.indica</i>	Marine/ estuarine	Raft/ pole culture/ Rack/ Longline	Maharashtra, Goa, Karnataka, Kerala, Tamilnadu, Andaman Island, Gujarat			
	Mussels							
	Edible oyster	<i>Crassostrea madrasensis</i>	Marine/ Estuarine	Rack and ren	Gujarat, Maharashtra, Karnataka, Tamilnadu, AP, Andaman			
		<i>C. gryphoides.</i> <i>C. rivalaris</i>	Marine	Relaying	Kerala, Karnataka, Goa, Maharashtra, Tamil Nadu, Andhra Pradesh			
	Clams	<i>Paphia malabarica Meretric, meretric, M.casta. Villorita cyprinoides</i>	Marine Estuarine					
	Pearl oyster	<i>Pinctada fucata</i> <i>P.margaritifera</i>		Raft/ Rack / onshore tanks	AP, Tamilnadu, Andaman, Kerala, Andhra Pradesh, Gujarat			
IV	Echinoderm		Marine	Cages	Tamilnadu			
	Sea cucumber	<i>Holothuria scabra</i>		Cement tanks	Andaman & Nicobar Islands			
V	Seaweeds	<i>Kappaphycus alvarezii</i> <i>Gracilaria edulis</i>		Rack / Raft /net bag	Tamilnadu, Gujarat.			

Status of Mari culture / brackish water culture in India.

Finfishes



1. Groupers

Grouper farming has been initiated in India in floating cages, open cages and earthen ponds in Tamil Nadu and Kerala. *Epiniphelus tauvina* and *E.malabarica* are two species used for culture and the initial experiments done by CMFRI and Marine Product Export Development Authority (MPEDA) are encouraging. Major constraints for large scale commercial culture of groupers is the shortage of sufficient quantity of fish seed. Hatchery production of seed is the only option for successful farming of groupers in India.

2. Seabass



Small-scale operation of commercial production of seabass (*Lates calcalifer*) has been launched by MPEDA in India in recent years. The hatchery production of the seabass seed is also been achieved by MPEDA with technologies developed for brood stock maintenance, larval raring, nursery and growout. Production of seabass by pond and cage culture is being practiced now in Tamilnadu, Andhra Pradesh and Kerala.

3. Cobia

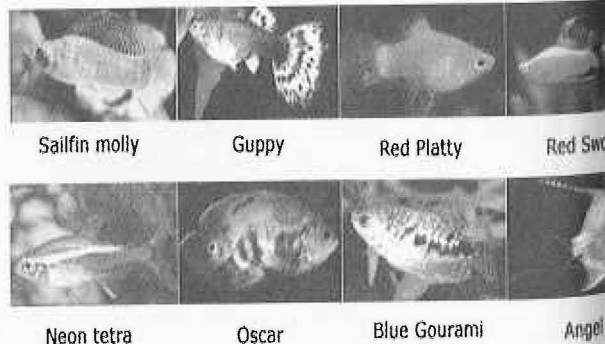


Cobia culture (*Rachicentrus canadum*) is a recent activity initiated by MPEDA in India.

The culture activities are in its infant stage and the large-scale commercial production through hatchery technology for seed production has to be achieved.

4. Ornamental fishes

Much attention was not been given till recently for this rich resource of marine ornamental fishes available in the coastal areas of India. The research work done by CMFRI for the past few years on the development of hatchery technology for seed production of clown fishes, damsel fishes and seahorse have fully succeeded. Recently the institute has made a detailed survey of the availability of marine ornamental fishes in Lakshadweep waters. As the demand for marine aquarium fishes is increasing within the country and for export, the overexploitation of wild stock is going on in most of the areas. To replenish the stock as well as to meet the demand, culture of important species of marine ornamental fishes in India is highly necessary. Gujarat, Lakshadweep, Kerala, Tamil Nadu and Andaman & Nicobar are the suitable areas for marine ornamental fish production in India.



II Crustaceans.

The total shrimp production in India in 2007 was 341105t together for penaeid and non penaeid shrimps. During the year 2007-08 1,06,165 mt was produced by culture in an area of 1,22,078.80 ha in India. The principal cultured organism on commercial operation are penaeid shrimps especially *Penaeus monodon*, giant tiger prawn followed by *P.indicus*, Indian white prawn, *P.merгуiensis*, banana prawn and *P.semisulcatus*, green tiger prawn. With the introduction of scientific shrimp farming in the country in early seventies the production of shrimp both in east and west coasts showed a phenomenal growth. The yield in traditional method always ranged from 600 to 750 kg/ ha and with the introduction of modern scientific methods it has even reached 2000kg/ ha. Package of practice of scientific shrimp farming method are classified as extensive, semi-intensive and intensive. With the popularization of these methods in India, the stocking density was increased and also technical input from S.E.Asian countries for seed production and farming were introduced for higher rate of production. Meanwhile the disease problems struck the shrimp farming industry in India from 1993-94. During 1993-94 the uncontrolled spread of diseases in the hatcheries and farms due to manmade environmental degradation have forced to close down numerous hatcheries and farms. After the outbreak of disease,

farmers started practicing high intensive/intensive system in a limited scale in almost all regions of India. Many adopted low stocking densities and the number of crops / year were reduced. Farmers used all sorts of chemotherapeutants in a desperate attempt to control mortalities without regard to the potential health hazards. This has also lead to a lot of management problems. With the intensification of farming, hatchery production of shrimp seed also faced problems of microbial diseases due to lack of proper scientific management. In India there are more than 214 shrimp hatchery for shrimp seed production with maximum number of units in Andhra Pradesh followed by Tamilnadu, Pondicherry, Karnataka and Goa. There are number of government and private PCR- labs in India with maximum in Andra Pradesh. Table 3 shows the state-wise details of shrimp farming in India during 2007-08 period. Shrimp farming is done in Andra Pradesh, West Bengal, Orissa, Kerala, Tamilnadu, Karnataka, Gujarat, Maharashtra and Goa.



State	Area developed (WSA) (ha)	Area under culture (ha)	Production (MT)	Productivity (MT/ha/Yr)
West Bengal	51549.00	48236.00	28000.00	0.58
Orissa	13843.00	6286.00	5410.00	0.86
Andrapradesh	70144.00	50396.00	56557.00	1.12
Tamil Nadu	6161.33	2729.70	3437.74	1.26
Kerala	12434.23	7597.86	5902.57	0.78
Karnataka	3697.00	3577.00	2119.00	0.59
Goa	867.00	840.00	643.00	0.77
Maharashtra	1231.42	756.40	946.37	1.25
Gujarat	2005.93	1659.84	3148.90	1.90
Total	162,042.91	122078.80	106164.98	0.87

Source- MPEDA annual report 2007-08

2. Crab farming.

The total crab production in India was 40,377t (2007). In India 3 species are used for crab farming, *Portunus pelagicus* from marine habitat and two species *Scylla serrata* and *S.tranquebarica* from estuarine/ back water habitat. The culture practice for crab have began in India when the country started exporting live crabs in small quantities to south east Asian countries. In 1987-88 period the exported quantity was just 36 tonnes and as the demand increased it rose to 3000t in 1995-96. the important areas where crab farming is practiced are maritime states of Karnataka, Kerala, Tamilnadu, Andhra Pradesh and Orissa. Seed crabs are collected from the wild and



being stocked in cages and ponds for further growout operation. Fattening of crabs (water crabs) is also done in many places. Moulded crabs are collected and stocked for a period of 30 to 45 days for fattening and harvest. Crab culture is more remunerative and profitable than shrimp farming especially when fattening is taken up.

3. Lobster farming

Lobster landing in India in 2007 was 1539t. Lobsters are distributed all along Indian coast and the major fishing grounds are on the Northwest Maharashtra and Gujarat and south-west Kerala and south-east Tamilnadu in addition to Lakshadweep and Andaman and Nicobar. *Thenus orientalis*, the slipper lobster are usually caught mainly in the trawl catches off northwest and south-west coast of India. The important species which are being used for culture are *Panilurus, homarus, P. ornatus, P. polyphagus, and Thenus orientalis*. Though commercial lobster farming has not become popular so far, fattening of lobster is being practiced in Tamilnadu and Gujarat coast. Researches on hatchery production of lobster is progressing in CMFRI. Lobster culture programme was initiated to fatten the juveniles to marketable size in indoor tanks and cages in the southeast coast of India. The estimated landing of lobsters from wild in 1998 was 3000t whereas it came down to 1536 t in 2007 mainly due to over exploitation of brood stock and juveniles.

III. Molluscs

Bivalves

1. Mussel

Marine mussels form one of the most dominant cultivable species all over the world. This gives highest conversion of primary producers (phytoplankton) to human food and is the fast growing animal in column water with high rate of production. In India two species, green mussel *Perna viridis* and brown mussel, *P. indica* occur with wide distribution for the former in rocky intertidal areas in Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamilnadu, Andhra Pradesh, Orissa, and Andaman and Nicobar Islands. The technology



for mussel farming was developed by the Central Marine Fisheries Research Institute and in 1974-85 period it was field tested and from 1996 onwards farming activities were initiated as small-scale operation in the estuaries of northern Kerala. The initial production by culture in 1997 was only 2t and subsequent years showed phenomenal increase

in farming activities resulting in the production of 10600t in 2006 from estuaries of Kerala. Meanwhile, small-scale production of mussels have been achieved in Karnataka, Goa and Maharashtra with financial assistance from Govt. agencies and NABARD and NGO's. Methods of farming adopted are rack method, long-line method and raft culture. In estuaries the rack method was found most suitable and 100's of units are now operated in Kasargod and Kannur districts of Kerala. In most of the coastal districts of Kerala, mussel farming is done in the estuaries with great success and the Kerala government has given utmost importance for mussel farming in its 'Matsya Keralam' programme and BFFDA and ADAK activities.

2. Edible oyster

Edible oysters are one of the major group of bivalves used for farming throughout the world. They are considered to be a delicacy in Europe and there is growing demand for this



bivalve. Considering the oyster as a renewable resource, protein rich meat, the employment potential it offer for rural population, especially womenfolk, oyster farming is being taken up in many of the estuaries of Kerala, Karnataka, Goa, and Tamilnadu. The shorter period it takes in tropical waters for growout and harvest is an added advantage. In India initial farming activities were done in Tamilnadu in marine environment and later it has become more successful in the estuaries of Kerala. The production by culture in 1996 was only 2t where as it has increased to 800t in 2006. *Crassostrea madrasensis*, *C.gryphoides* and *C.rivularis* are the major species available in India and the first species is widely used for farming. The major methods of culture are bottom culture and off-bottom culture. The later is being practiced by rack and ren, raft and long line methods. Rack and ren method is now widely used in India in shallow waters. Government of Kerala, through Brackish Water Fish Farmers Development Agency (BFFDA) has promoted oyster farming in different estuaries of Kerala. Like mussel farming, oyster farming is also becoming a popular commercial activity in most of the estuaries in Kerala. The scope for further development in Kerala, Karnataka, Goa, Maharashtra, Gujarat, Tamilnadu, Andhra Pradesh and Orissa is bright. Mass scale seed production techniques and remote setting of edible oyster spat were also developed by CMFRI for commercialization of oyster farming.

3. Clam culture

The total annual clam production in India varies from 45000 t to 50000 t with species composition of *Paphia malabarica*, *Meretrix casta*, *M. meretrix*, *Villorita cyprinoides*, *Arca granosa* and *Mercia opima*. Clams are distributed in Maharashtra, Goa, Karnataka, Kerala, Tamilnadu and Andhra Pradesh with maximum production in Kerala followed by Karnataka. The technology for clam culture worldwide is relaying methods where clam seed is collected and relayed in suitable areas for further growth and subsequent harvest. At present relaying of *Paphia malabarica* and *Villorita cyprinoides* are done in certain parts of the country. (Kerala, Kanataka) as a traditional farming practice. The hatchery seed production technique of *P. malabarica*, *M. casta* and *V. cyprinoides* have been developed by CMFRI for mass scale seed production.

3. Peal Oysters

Out of 6 species of pearl oysters recorded from Indian coasts, two are used for pearl production in India. Farming of pearl oysters is done using *P. fucata* in Tamilnadu coast, Kerala and Gujarat. *P. margaritifera* found in Andaman waters is used for pearl production in recent years. Mass scale seed production for *P. fucata* has been developed for CMFRI for commercial production of seed of this species. There was an age old pearl fishery in India in Gulf of Mannar and Gulf of Kutch

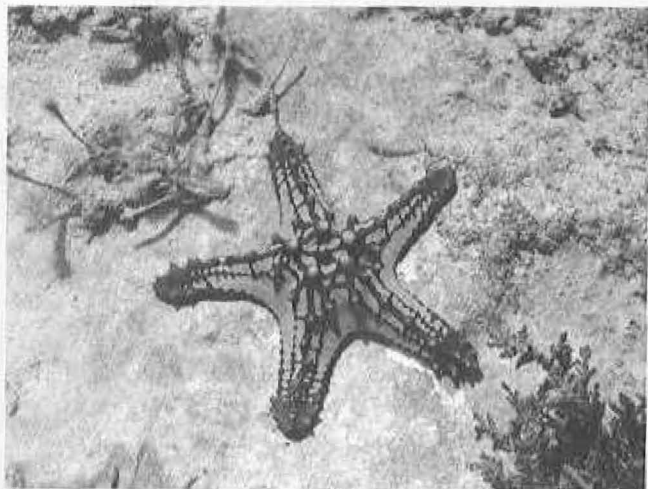
for years together. Due to environmental deterioration, manmade and climatic changes in the environment the pearl fishery has not revived after 1966 in both these areas. This has lead to the development of pearl production and subsequent hatchery production technology for pearl oysters in India by the Central Marine Fisheries Research Institute. The technique for pearl production in *P. fucata* was developed in 1973 and through farm trials and field tests, commercial pearl production was achieved in subsequent years. Govt. of Tamilnadu, Kerala, Gujarat and Lakshadweep have initiated pearl production, where as it did not take off as a viable commercial venture due to lack of interest among various entrepreneurs. The high capital input compared with shrimp farming, availability of protected areas for farming, longer gestation period in pearl production, the smaller size of pearls (4-6 mm) produced from *P. fucata* and lack of leasing policies by Govt. for farming areas in coastal waters are the major factors restricting commercial production of pearls in India. Meanwhile growout system for *P. margaritifera* is developed in Andaman and Nicobar island. At Visakapatnam on-shore pearl production was developed. At Tuticorin laboratory of CMFRI *in vitro* pearl production using tissue culture methods and colour pearl production were also initiated. Pearl oyster farming is done in bays or lagoons or protected areas in coastal waters, where environmental

condition are favourable for growth of oysters and pearl production. The method of farming are raft culture, rack culture, on bottom culture or the onshore tank culture. Commercial production of pearls is possible in Tamilnadu, Andhra Pradesh, Kerala, Gujarat, Lakshadweep and Andaman

IV Echinoderms

Sea cucumber

In seas around India atleast 200 species of sea cucumbers are distributed. In India they occur mainly in the Gulf of Mannar and Palk Bay, the Andaman and Nicobar islands and the Lakshadweep. They found in Gulf of Kutch and also along other parts of mainland of India, but many of them are not commercially important. Only 15 species are commercially important of which *Holothuria scabra* is the most important species. The processed sea cucumber *beach de mer* commands good price in the international markets especially in HongKong, Singapore and Taiwan. They



posses toxins, which have antifungal, antifumoral and anticancerous properties and find importance in bio medical research. The Central Marine Fisheries Research Institute has developed hatchery technology for seed production of *H. scabra* and the prospects for seacucumber farming is bright. Sea cucumbers are over exploited and hence the Govt. of Indian imposed ban on collection of this from wild and brought sea cucumber under schedule I of the Wild Life Protection act 1972 and strictly banned the collection in 2001. It is suggested that sea cucumber production in India can be augmented if we follow rational exploitation and also produce seed and culture them in farms to marketable size in cages or tanks.

V Sea weed culture

Along Indian coasts, seaweeds are abundant in rocky coasts or where coral growth or reefs found. Along Indian coast it occur in plenty on Tamilnadu and Gujarat coasts and also in Mumbai, Ratnagiri, Goa, Karwar, Vizhinjam, Varkala in west coast and Visakapatanam in Andhra Pradesh. Sea weeds are found to occur in Lakshadweep and Andaman and Nicobar islands., Sea weeds contains different vitamins, minerals, trace elements and proteins. Certain sea weeds are rich source of iodine. Sea weeds are utilized for production of different pharmaceutical products, manure, agar-agar production, used in textile production, carrageenan and algin production. Several





economically important species of seaweeds are cultivated in Asian countries especially China. In India, *Gracilaria edulis* and *Gelidiella acerosa* which are agar yielding are cultivated in Gulf of Mannar area. Recently carrageenan yielding *Kappaphycus alvarezii* is being introduced for seaweed farming in Tamilnadu. The cultivation of this seaweed has become a profitable small-scale operation in the southeast coast especially Kanyakumari, Thirunelveli and Ramnad coast. Rack culture and monofilament bag culture is usually practiced for seaweed production in India.

Conclusion

Mariculture offer excellent opportunities for sea farming and associated activities of stock enhancement process as well it provide employment for the coastal population. Though India has started scientific mariculture practices very recently, shrimp farming, activities have advanced rapidly in the beginning and had a set back due to disease problems right from 1993- 94 period. India has initiated mariculture of molluscs and fin fishes

as small-scale operation and the production is increasing year by year. The per capita fish consumption in India is low with an average of 7 kg/ year compared with that of world average of 16.4 Kg/year in 2005, where as the average for Asia is 13.9 Kg/ year with maximum of 26.1 Kg/ year in China. The need for increased production is much felt to meet the higher rate of per capita consumption of fishes in India.

The shrimp aquaculture faced a serious threat from 1994 onwards due to the outbreak of diseases in most of the maritime states. Through the intervention of Government Departments, Research Institutions and other agencies, farming practices were suitably modified to face this problem. Some of the measures adopted to tackle the disease outbreak were adoption of suitable stocking density, scientific water management, PCR test for seed, regular monitoring of microbial diseases, treatment of effluent water in bio ponds, awareness programmes for shrimp farmers, rotational crop, bio-security for shrimp hatchery and selection of disease free brood stock and use of chemicals and Chemotheraputants. Introduction of seed of *Litopenaeus vannamei* which is disease free and fast growing is also suggested for increased production. However India stands second in aquaculture production in the world, bulk of which is contributed by freshwater fishes, scampi and shrimp. Compared with shrimp

farming , crab farming in India is in its infant stage. The major constraint are the availability of seed crab from wild which has drastically reduced and the hatchery production of seed has not yet been commercialized. Already there is pressure due to over exploitation of wild stock in most of the water bodies and protection of brood stock and nursery grounds are urgent need to conserve and replenish the wild stock. The lobster stock in the wild is decreasing due to over exploitations of brood stock and juveniles. The declaration of minimum legal size (MLS) for lobster export by Govt. of India in 2003 is a welcome sign in the conservation of this resource. The awareness programme launched by CMFRI in Gujarat and Tamilnadu coast helps in protection of the stock to certain extend. The scientific farming of lobster is highly essential to increase production of lobster in India.

Bivalve farming is ecofriendly and farming methods are suitable for easy adoption. The infrastructure requirements of farms are low cost materials and are available locally. Bivalve are filter feeders and there is no need of supplementary feed for these animals. Farming is seasonal with fast growth rate reaching harvestable size within 5 to 7 months. There is good demand for bivalves meat world over and the export possibilities for mussel, edible oyster and clam are bright in coming years. At present the low market demand in the internal market is a constraint. Appropriate awareness programmes are required to popularize bivalve farming technology in all maritime state. The

phenomenal growth of mussel farming in Kerala is a bright example and a roll model for commercialization of bivalve farming in other parts of India. Major constraints are lack of adequate seed supply, financial support from Govt. agencies and other financial institutions, lack of knowledge about the technologies for bivalve production and low export demand at present. Quality improvement of water bodies where bivalves are farmed is an urgent pre-requisite for exporting live bivalves to European Union, where there is good demand for bivalve meat. The sea cucumber and sea weed farmings are taken up as small-scale operations and further refinement of technologies for sea cucumber , food fishes and ornamental fishes are required for commercialization in India.

The coastal waters along the mainland and around Lakshadweep and Andaman and Nicobar provide immense potential for development of sea farming. It is well known now that aquaculture production has got a vital roll in satisfying the demand for fish required for human consumption world over and this can be achieved only through aquaculture production. It is assumed that the major problems facing mariculture development in India are primarily lack of knowledge about scientific farming technologies, availability of financial support for capital or fixed assets, availability of quality seed, feed and accessories. Added to that social issues such as Govt. policies, viz leasing policy, coastal zone development, pollution problems and interference of civil society also influence mariculture in India. Once we systematically tackle these problems, the mariculture / brackish water production of fish, crustaceans, molluscs and other animals will increase substantially in coming years.