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PROSPECTS AND PROBLEMS OF MANAGEMENT AND DEVELOPMENT OF THE MARINE MOLLUSCAN RESOURCES (OTHER THAN CEPHALOPODS) IN INDIA

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ABSTRACT

Typical of tropics, India has a large variety of molluscan resources in the coastal waters and in the estuaries and backwaters. The clam resources consisting of species of *Meretrix*, *Katelysia*, *Paphia*, *Anadara*, *Villorita* and others have been exploited by the fisherfolk from time immemorial for food as also for their shells. Subsoil deposits of shells form a major resource in some of the estuaries and backwaters. The sea mussel *Perna* forms a moderate resource which is under intense exploitation in certain regions. Oyster resources *(crassostrea)* are not extensive but collected here and there. Windowpane oyster *Placenta* is restricted in its distribution but is well exploited. The pearl oyster resource has been unproductive since the early sixties. The gastropod resources consist mainly of *Xancus*, *Turbo* and *Trochus*, which are confined to certain regions and are heavily exploited Other ornamental gastropods used in shellcraft industry are thinly spread out. Deepsea molluscan resources, if any, are not known except *Pirula*.

Owing to manmade changes including pollution, the distribution and abundance of the molluscan resources, especially those in the estuaries and backwaters, have changed and will be subject to further change, if left unchecked The level of exploitation has also advanced from subsistence to mechanised operation, though on a small scale, on certain resources for industrial uses. During the last five years export of frozen clam meat has increased. Some of the molluscs are emerging as source material for bioactive substances. Taking an overall view of these changes and their probable effects on the resources, the future of the molluscan resources, which were once considered substantial, does not appear to be encouraging, unless management and conservation measures are evolved and implemented. Many States have considered the shells as a mineral resource and are operating them under leasing/licensing arrangements.

Based on the available data on exploitation of shellfish resources, an attempt has been made to estimate the all-India production of molluscs which approximates to about 70,000 t per annum (excluding cephalopods). The paper lays stress on adopting a national policy on management and development of the shellfish resources and bringing them under the mainstream of fisheries development programmes. Resource inventory, environmental monitoring, depuration of shellfish, transplantation, sea-ranching market research and screening for bioactive substances are indicated as future research and development needs. Management measures required are outlined as legislation on shellfisheries, holistic review of leasing policies of State Governments and control on export of clams and ornamental molluscs.

INTRODUCTION

India has a wide variety of molluscan resources (Hornell, 1951). The cephalopods share a common environment with the dominant marine finfish species and, therefore, are caught in fishing gears operated for the pelagic, midwater and demersal resources. Management and development problems concerning cephalopods are in common with those of finfish

resources. The bivalves and gastropods are the sedentary groups of molluscs which generally form the basis of subsistence fisheries in the coastal waters, estuaries and backwaters and the management and development problems are different and distinct. The present paper concerns itself with these sedentary resources. Culture of molluscs is excluded from its purview.

Useful faunistic information on marine bivalves and gastropods of India has been published (Hornell, 1951). Also accounts on the fishery for these molluscs have been given by several workers (Rao, 1958; Alagarswami and Narasimham, 1973; Jones and Alagarswami, 1973; Mahadevan and Nayar, 1973; Narasimham, 1973; CMFRI, 1974; Rasalam and Sebastian, 1980) Basic biology relating to age, growth, food and reproductive cycle has also been worked out for several species of importance (Abraham, 1953; Nayar, 1955; Rao and Nayar, 1956; Johi, 1963; Ranade, 1964; Alagarswami, 1966; Narasimham, 1968). Some estimates of production for a few areas are seen in the published literature (Silas et al., 1982). A few spot surveys of molluscan resources have been carried out at different times (Alagarswami and Narasimham, 1973; Jones and Alagarswami, 1973; Narasimam *et al*, 1984; Nayar *et al*, 1984]. What has been lacking is an overall picture of the magnitude of the marine molluscan resources of the country and, as a result, production of molluscs goes unaccounted in the marine fish production estimates of the country. In order to develop a national strategy for management and development of molluscan resources such information is necessary. The paper, for the first time, makes an attempt to arrive at an all-India eatimate despite an inadequate data base, with the expectation that this will motivate efforts in future to correct and refine the estimates at the State as well as national levels. Specific R & D needs and management problems of molluscan resources have been discussed.

MOLLUSCAN RESOURCES AND PRODUCTION

Clam resources

The clam resources are more dominant in the backwaters and estuaries than on the sandy beaches. Generally they are more abundant along the west coast than on the east coast. Among the bivalves, the clams are regularly fished and utilised because of the relatively simple method of collection by handpicking or using small canoes with scoop nets. Men, women and children are engaged in the collection. Among the molluscs the clam resources offer the greatest subsistence fishery potential to the coastal fishermen. The species exploited are several and the most important ones are *Villorita cyprinoides, Meretrix casta, M. meretrix, Katelysia opima, K. marmorata, Paphia malabarica* and *Anadara granosa*

Available production estimates are sketchy and limited to a few centres. These are generally based on enquiry. Some of the recent estimates (Silas *et al*, 1982; CMFRI, 1981-82; Narasimhsm, *et al*; 1984; Rao and Rao 1985; CMFRI, 1986) are given in Table 1. For the purpose of arriving at an estimate of exploited resources at all India level, certain reasonable approximations are made as follows:

State	Estimated clam production (t) (vide Table 1)	Approximate production (t)
Gujarat		—
Maharashtra	1,100	2,000
Goa	890	1,000
Karnataka	8,210	10,000
Kerala	32,340	35,000
Tamil Nadu & Pondicherry	730	1,000
Andhra Pradesh	2,700	3,000
Orissa	—	1,000
West Bengal	—	—
	45,970	53,000

For this purpose, considering the nature of coastline and reported resources, clam exploitation in Gujarat, West Bengal, Andaman & Nicobar Islands and Lakshadweep is considered as nil.

Oyster Resources

The oyster resources are distributed throughout the coastal areas in the estuaries, backwaters and creeks. The most important

TABLE 1

Estimated annual production of clams in the maritime States of India

Area	Species		Annual Production (t)
Maharashtra			
All estuaries	*Meretrix meretrix, Katelysis opima, K. marmorata* and *Paphia laterisulca*		1,100
		Sub-total	1,100
Goa			
All estuaries	*Meretrix casta* and *Villorita cyprinoides*		890
		Sub-total	890
Karnataka			
Netravati estuary	*M. casta*		230
	V. cyprinoides		150
Gurpur estuary	*Paphia malabarica*		640
	V. cyprinoides and *M. casta*		640
Mulki estuary	*M. casta* and *P. malabarica*		3,100
Udayavara estuary	*M. casta*		250
Swarna estuary	*V. cyprinoides* and *M. casta*		20
Sita estuary	*M. casta*		380
Coondapur estuary	*P. malabarica*		
	M. meretrix M. casta		
	V. cyprinoides and *K. opima*		640
Uppunda estuary	*P. malabarica K. opima*		
	M. casta and *M. meretrix*		160
Kalinadi	*M. meretrix P. malabarica*		
	V. cyprinoides		2,000
		Sub-total	8,210
Kerala			
Vembanad Lake	*V. cyprinoides*		21,900
Ashtamudi Lake	*K. opima*		5,440
	V. cyprinoides		5,000
		Sub-total	32,340
Tamilnadu			
Vellar estuary			730
		Sub-total	730
Andhra Pradesh			
Kakinada Bay	*Andhra granosa*		2,000
	M. meretrix		400
Godavari estuary	*M. meretrix*		300
		Sub-total	2,700
		TOTAL	45,970

species is *Crassostrea madrasensis* which has a wide distribution along the entire east coast and south-west coast. It is replaced by *C. gryphoides* in the north-west coast. *Saccostrea cucullata* occurs in the intertidal rocky areas throughout the mainland coast as well as in Andaman and Nicobar Islands and Lakshadweep The oyster beds are found in patches and except for an extensive bed at Ennore estuary in Tamil Nadu, they are small and dispresed in other regions.

Some estimates of standing stocks of oyster have been made for a few centres but production estimates are very sketchy. Oysters are collected at some centres near the cities of Bombay and Madras for supplying to hotels and at centres in Maharashtra, Goa, Karnataka and Kerala for local consumption. The exploitation estimates made are 100 t from Mulki, 75 t from Coondapur and 50 t from Sita estuaries in Karnataka totalling to 225 t, against the standing stocks of 244 t, 383 t and 91 t respectively (Rao and Rao, 1985). In the absence of any other data, conisdering the collection and consumption pattern indicated by Alagarswami and Narasimham (1973), the annual production of oysters in India would be of the order of 750-1000 tonnes whole weight.

Mussel Resources

Exploitation of the green mussel *Perna viridis* is confined to the northern Kerala coast from Calicut to Cannanore and the estimated annual production is about 2,900 t (Kuriakose *et al*, 1987). The brown mussel *(P. indica)* landings in the southern extremity of Kerala are about 600 t per annum (CMFRI 1983-84). Elsewhere along the Indian coast mussel production is negligible, although collected for local consumption in places such as Ratnagiri, Goa, Karwar and Cochin. Small mussel beds occurring along the east coast in Cuddalore, Pondicherry, Ennore, Kakinada and Chilka lake are not exploited. Thus the annual production of mussels in India would be around 3,500t.

Windowpane Oyster Resources

The present distribution of windowpane oyster *(Placenta placenta)* resource in commercially exploitable quantities is limited to the Gulf of Kutch, Kakinada Bay and Nauxim Bay (Zuari estuary in Goa) However, it is likely that this resource occurs in several other regions as well, though in smaller quantities.

In Gulf of Kutch it is distributed from Sachana to Okha, with heaviest concentration in Pindara Bay (Varghese, 1976; Sarvaiya, 1982; Pota and Patel, 1987) The standing crop estimates at Goomara, Poshetra and Raida were 90 lakhs, 12 lakhs and 1 lakh oysters Varghese (1976) estimated an annual production of 45,00,000 oysters for a season of 5 months. The fishery used to be leased out for a term of 3 years upto 1978. But subsequently, the term of lease has been reduced to annual basis and, as reported by Pota and Patel (1987) the fishery is continuous throughout the year currently yielding about 50,00,000 oysters per month. At an average weight of 70 g per oyster (12 cm size) the annual production of windowpane oyster is calculated to be about 4,200 tonnes. The pearls collected are sold for pharmaceutical uses in indigenous system Varghese (1976) estimated the pearl yield at 2 g per 800 oysters. At current production of about 600 lakh oysters per annum, the annual production of pearls from this fishery can be estimated to be 150kg. The shells which from about 85% of whole weight of the oyster *i. e.* an estimated 3,570 t per annum, go for industrial uses.

Kakinada Bay is another rich ground with an estimated stock of about 8,945 t of windowpane oyster and about 43,348 t of shells of dead oysters (Murthy and Narasimham, 1979). More recent estimate of standing stock was 12,420 t (Narasimham *et al*, 1984) The annual production by the fishery is about 5,000 t. The pearl yield of windowpane oyster in the fishery will be about 98 kg at an estimated yield rate of 1 kg of pearls per 51 t of oysters (Murty and Narasimham, 1979). While small quantities of shells (right valve) are exported, the bulk is used in the production of shell-lime. The meat is not utilised at present.

The windowpane oyster resource of Nauxim Bay in Goa is relatively small. According to

Achuthankutty *et al.* (1979), about 8,000-10,000 oysters are fished per day thoughout the year except during the monsoon season. At an average of 160 days of active fishing per year, the above production would amount to about 100 t/annum. About 35% of the population is reported to contain pearls. However, the oysters are collected for the meat which is consumed locally and for the shells. The pearls are not collected from the oysters.

From the estimates made as above, the windowpane oyster production in India from the three areas would amount to about 9,300 t/annum. The yield of seed pearls would be around 250 kg/annum which is used entirely in the pharmaceutical preparations of medicines under the Indian systems.

Pearl Oyster Resources

The pearl oyster *Pinctada fucata* populations in the Gulf of Mannar and Gulf of Kutch are highly fluctuating. During the present century the Gulf of Mannar resources yielded pearl fisheries in 1908, 1914, 1926-28 series and 1955-61 series. Except for the above 12 years, the natural beds were not productive during the remaining 75 years upto now. The most successful series of 1955-61 fishery yielded an average annual production of 109 lakh oysters, with the minimum of 11.75 lakhs in 1957 and a maximum of 214.77 lakhs in 1958. Taking the weight of 45 g for a three-year old oyster (fishery minimum), the average annual production during the above period was 488 t.

The resource in the Gulf of Kutch is of a much smaller magnitude yielding to fishery every two or three years upto 1967 but failed thereafter. Between 1950 and 1967 there have been only 7 fisheries with an average production of about 19,000 oysters amounting to 0.86 t per fishery.

By reason of their high fluctuations with a very low productive cycle, the pearl oyster resource may be considered more a bonus than a regular resource at present.

Chank Resources

The sacred chank *Xancus pyrum* has been exploited from time immemorial. The major resources occur in the Gulf of Mannar, particularly along the Ramanathapuram – Tirunelveli coast. Chanks are also caught along Thanjavur-South Arcot - Chinglepet coast. The coastal region of Kerala from Quilon to Trivandrum has moderate chank beds The Gulf of Kutch has a limited resource. About 90% of the production comes from skin-diving and the rest as incidental catches in the bottom trawl nets and gillnets. Aimed hook & line fishing for chanks is conducted at Vizhinjam. Some production comes from Andaman and Nicobar Islands. There is some fluctuation in the landings in all the regions. The production in numbers is averaged for the recent years as follows:

Tamil Nadu:

Tirunelveli coast	—	8,77,000
Ramanathapuram coast	—	3,00,000
Thanjavur-South Arcot-Chinglepet coast	—	40,000
	Sub-total	12,17,000
Kerala:		
Quilon-Vizhinjam coast	—	22,000
Gujarat		
Gulf of Kutch	—	12,000
Andaman & Nicobar	—	5,000
	Total	12,56,000

The minimum legal size for capture is 64mm maximum shell diameter in Tamil Nadu and the weight would be about 350 g. However, larger chanks weighing upto more than a kg are landed in good numbers. It is estimated that annual chank production in India will be about 1250 tonnes.

Trochus and Turbo Resources

The top-shell *Trochus niloticus* and turban-shell *Turbo marmoratus* form fishable beds in Andaman and Nicobar Islands. These resources were exploited clandestinely by shellfishing boats of other countries since 1926. After detailed studies on the two species made by Amirthalingam (1932) and Rao (1939), exploitation of the shellfishes was brought under the

control of the Administration, under the Andaman and Nicobar Islands Fisheries Regulation 1938 and rules were made under Notification of 1955. The Island territory was divided into 9 zones, namely Cape Price to Mayabunder, Cape Price to Austen Strait, Mayabunder to Long Island, Long Island to Shoal Bay, Shoal Bay to Chiriatapu, Chiriatapu to Port Mouat Ritchie's Archipelago, Nicobar Central group and Nicobar Southern group. The fishing rights for each zone are auctioned. The minimum legal size for collection is 9 cm for *T. niloticus* and 6.35 cm for *T. marmoratus*. The annual production ranges 400-600 t of *T. niloticus* and 100-150 t of *T. marmoratus* (Appukkuttan, 1977).

Ornamental Molluscs

Besides *Turbo* and *Trochus* from Andaman and Nicobar Islands and *Xancus* from mainland, several species of gastropod shells are available in the Indian waters. The Gulf of Mannar, Palk Bay, Gulf of Kutch, Andaman and Nicobar and Lakshadweep are some of the areas where rich resources of ornamental molluscs are available. The shells available are *Strombus, Chiragra, Cassis, Cypraea, Harpa, Conus, Cymbium, Oliva, Murex, Cymatium, Tibia, Babylonia, Fistularia, Fusinus, Umbonium* etc. As ornamental shells, these are invaluable. The shells are regularly collected, cleaned, polished and marketed locally in several coastal towns in the form of shellcraft articles and also exported. In 1981, the maximum of 1,256 t of sea shells valued at Rs. 32.6 lakhs were exported (MPEDA 1987). The annual average of exports during 1981-85 period was 333 t valued at Rs. 15.39 lakhs. The unit price of export value for the sea shells from 1981 through 1985 was Rs. 2.60, Rs. 11,90, Rs. 7.20, Rs. 31.00 and Rs. 13.00 per kg. Taking into consideration the export tonnage and domestic sales, total annual production of ornamental sea shells would be in the order of about 600 t.

Sub-soil Shell Deposits

The major sub-soil shell deposits along the Indian coast occur in Vembanad Lake, Pulicat Lake, and Coondapur and Swarna estuaries. Besides, minor deposits occur in several other places such as Athankarai, Kovalam backwaters, Pinnakayal and Valinokkam in Tamil Nadu and other estuaries in Karnataka. The production from Vembanad Lake includes about 53,000t collected by fishermen cooperative societies and about 95,000 t dredged by the factories for production of calcium carbide and white cement (CMFRI, 1986). Exploitation in Pulicat Lake is around 57,000 t (Thangavelu and Sanjeevaraj, 1987), in Kovalam backwaters about 3,000 t (Thangavelo *et al*. 1987) and in Coondapur and Swarna estuaries about 50,000 t (CMFRI, 1986). Production from all other areas may amount to 25,000 t. Thus, approximately 2,78,000 t of sub-soil shell deposits are "mined" and used for industrial and shell-lime making purposes.

Export of Molluscan Products

Besides cephalopods, small quantities of other molluscan products are exported from India. Clams *Katelysia opima, Villorita cyprinoides* and *paphia malabarica* form the main item which entered the export trade for the first time in 1981 and picked up on a continuous basis. The products and value of molluscs exported are given in Table 2.

It is worth noting that the average unit price for frozen clam meat per kg was Rs. 710 in 1981, Rs 21.30 in 1982, Rs. 12.50 in 1983, Rs. 14.00 in 1984 and Rs. 14.30 in 1985. The percentage of counts/grades exported in 1982-83 were 300/500-2.03%, 500/700-19.26%, 700/1,000-48.27%, 1,000/1500-27.96% and 1,500/3,000-2.48. The smaller sizes 700-3,000 counts/kg together form 78.71%. With the increase in quantity exported, much smaller clams, popularly termed 'baby clam' in the export trade, have been exploited increasingly.

Estimated annual production of molluscs

No attempt has been made so far to get a total estimate of production of molluscs in India. With the sketchy data available for a few of the species at some centres and making reasonable projections to fill up the gaps, an attempt has been made here for the first time to arrive at a total production figure. The estimate has several inadequacies but would appear as a reasonable approximation for using in development programmes. The estimates are given in Table 3.

TABLE 2

Quantity and value of molluscan products exported

		1981	1982	1983	1984	1985
Frozen clam	Q	15.6	397.4	608.6	1,085.8	436.8
	V	111.3	8.478.6	7,607.8	15,250.8	6,237.4
Canned clam	Q	10.1	—	—	—	18.0
	V	185.8	—	—	—	195 5
Clam meat pickle	Q	1.6	9.2	—	—	—
	V	28.2	61.4	—	—	—
Sea shells	Q	1,256.2	82.1	231.8	28.7	68.0
	V	3,260.7	981.3	1,677.3	889.4	886.8
Oyster shell powder	Q	0.2	10.0	550.0	654.2	200.0
	V	12.0	81.0	368.0	461.1	122.8

(Quantity in tonnes; Value in '000 rupees)

Source ; MPEDA

TABLE 3

Estimated approximate annual production of molluscs (other than Cephalopods) in India

Resource	All-India annual production (t)
Clams	53,0000
Oysters	750
Mussels	3,500
Windowpane oyster	9,300
Trochus and *Turbo*	500
Chanks	1,250
Ornamental molluscs	600
Estimated total	68,900
Say	70,000 tonnes

MANAGEMENT AND DEVELOPMENT OF MOLLUSCAN FISHERIES

National policy

The overall fisheries policy of the country, as reflected in the main objective of fisheries development programmes, has been augmentation of fish production, increase in export earnings of marine products and welfare of traditional fishermen. In this context fish production has usually been considered as production of finfish and crustaceans and, more recently cephalopods. The development programmes have not touched, in the least, the other molluscan resources of bivalves and gastropods These resources have not been given any recognition except treating some of them, notably the chank, pearl oyster, windowpane oyster and the sub-soil shell deposits, as revenue-yielding items by the concerned State Governments and, for this reason, claiming State monopoly on the resources. The export sector has shown interest in exploitation of clams during the last five years purely from business motive.

These resources remain unaccounted even today, after four decades of planned development of fisheries in the country. The production estimates made at the National and State levels do not include these items, as no estimates are made by any agency. This situation arises from the fact that their exploitation is dispersed over wide areas in the estuaries and backwaters and production in subsistence fisheries cannot be estimated in the absence of a system to cover

such a situation. A deliberate attempt has been made in this paper, with all its inadequacies, to approximately estimate the production of the bivalves and gastropods landed in India which has given a figure of 70,000 tonnes per annum. Similarly, the estimated production of sub-soil deposits of shells has been arrived at 2,78,000 tonnes per annum. The number of persons directly engaged in the exploitation of these resources in various States/Union Territories will be around 20,000. Except for the hazardous job of diving and operation of the boats which are done by men, a good part of the production is accounted for by women and children. Talking an average price of Rs 2,000/tonne of live bivalves and gastrapods, the nominal landed value of 70,000 t would be Rs. 14 crores. If the average price of shells from sub-soil deposits is taken as Rs. 1000/tonne the value of 2,78,000 t of shells would be Rs. 2.78 crores. Thus the total landed value of the bivalves and gastropods can be put at Rs. 16.78 crores per annum.

The molluscs are put to varied uses. The meats of bivalves and gastropods have high nutritional value. But consumption is limited, due to its least popularity and restricted food habits of people. The traditional use of shells (clams and windowpane oyster) has been for shell-lime production in village kilns. But today the shells are in great demand in several industries and pressure on the resource is increasing. Being sedentary resources, greater demand will lead to indiscriminate exploitation limiting the chances of their survival and natural replenishment through reproduction and recruitment. Pollution and man-made changes can affect them more severely and lead to total destruction of beds.

In view of the facts presented above, there is need for a greater awareness at the National and State level recognising these sedentary molluscan resources as of considerable importance and to have an appropriate policy at the National and State levels to manage and develop the resources in a judicious manner by bringing them specifically under the mainstream of fisheries development programmes.

Research and development needs

Resource inventory

In spite of several years of fisheries research in the country, the information on the molluscan resources has remained fractional. Information available in various publications has been consolidated and given, along with the results of spot surveys, by Jones and Alagarswami (1973), Alagarswami and Narasimham (1973) and Silas *et al*, (1982). More recently, a better strategy was developed to bring out molluscan resources atlas for each maritime State. The one for Karnataka is under publication. It is realised that a single research organisation can not independently complete this task within a reasonable time frame. It should be a collaborative effort between the National and State organisations. The base-line resource information will require to be periodically updated taking into account recruitment and exploitation. Development organisations in the State will be better placed for this responsibility with technical assistance from National research organisations.

Environmental monitoring

The distribution and abundance of the shellfish are largely influenced by their environment. In a backwater or estuarine ecosystem, the environmental paramenters play a more decisive role than in an open bay or gulf ecosystem. The rainfall, the amount of freshwater discharge of the rivers, tidal amplitude, temperature and salinity changes, changes in hydrogen-ion concentration, composition of substratum, discharge of pollutants from city sewerage, agricultural fields and industries, and occurrence of obnoxious blooms of planktonic organisms all contribute to the quantity and quality of production of shellfish. Recent examples of how some of these factors affect the resources are the mass mortality of *Villorita cyprinoides* in a part of Vembanand Lake due to problems of acidity (pH 3.65-4.85) (Pillai *et al*., 1983) and instances of paralytic shellfish poisoning in clam *Meretrix casta* in Vayalur on Buckingham canal (Silas *et al*., 1982) and Arikad on Kumble estuary (Indrani *et al*., 1984) which had lead to death of some people. Strict

environmental monitoring is essential in beds from which the shellfish are exploited for human consumption.

Depuration of shellfish

Today, shellfish are consumed as they are collected after cooking. The bivalves are notorious for their propensity for accumulation of pathogenic bacteria, heavy metals and other pollutants as also biotoxic substances. The PSP cases in India have been referred to above. Most of the regular shellfish consuming countries have adopted strict standards of hygiene on the shellfish marketed. However in India there is no awareness of this problem except for the experimental depuration done at the research institutes. There is need for bringing in minimum regulation on depuration of shellfish, however small the quantities are. The development agencies should provide the necessary minimum infrastructure and facilities at the collection or marketing centres. If shellfish food is to be popularised and promoted, a begining should be made to introduce depuration techniques even at this stage.

Transplantation

Transplantation of shellfish is a simple method of culture adopted for augmenting production and improving quality. This is based on the principles that seed grounds are not always the ideal grounds for growth and that the grow-out grounds are not always ideal for fattening of meat before marketing. In India although some experimental work has been done (Narasimham, 1980; Rao and Rao, 1983), this has not been pursued to provide the required data for practising transplantation on commercial basis. With regard to edible molluscs, this is an important aspect for research and extension.

Sea-ranching has potential benefits for the open sea resources such as pearl oyster, chank, *Turbo* and *Trochus*. But in these cases seed production has to be done in the hatcheries and the juveniles released into the natural beds at appropriate size. An attempt has been made on sea-ranching of oyster (Chellam *et al*, 1987). This is an area of research to be followed up and required technologies for production of seed, mode of ranching and monitoring have to be developed.

Popularisation and market research

Any development efforts on shellfish should be integrated with programmes on popularisation of molluscan meat as wholesome and nutritious protein food and also research on market potential. Trial marketing of oyster product carried out by the Integrated Fisheries Project of Government of India in certain parts of the country, has shown that the demand is high. There should be a product mix of other shellfish in the effort of trial marketing which should be done on a wider basis. Presently it appears to be a confidence crisis problem with regard to supply and demand. The natural resources themselves are not judiciously utilised as most clams landed in the country are marketed for the shells and rarely for the meat and the oyster resources are under-exploited or not exploited at several centres.

Bioactive substance

Many marine molluscs produce toxins or accumulate toxic substances. Hashimoto (1979) classified them as follows:

1. *Marine molluscs which cause food poisoning*
   a) Gastropods containing tetramine in salivary gland *e.g*, *Neptunea* of Family Buccinidae.
   b) Pyropheophorbide a in the digestive gland *e g*., abalones *Haliotis* spp.
   c) Ivory shell toxin in carnivorous *Babylonia japonica* (Family Buccinidae).
   d) Coral reef snails of FamilyTurbinidae.
   e) paralytic shellfish poisoning species *e.g*, several species of bivalves.
   f) Venerupin toxin from *Tapes japonica*.
   g) Bivalves infested with dinoflagellate *Gymnodinium breve*.
   h) Japanese clam *Callista brevisiphonata*.
   i) Giant clam *Tridacna maxima* from French Polynesia.
2. *Marine molluscs with toxic stings or bites*
   a) Stinging toxins in cone shells- *e. g*., geographer's cone *Gastridium (Conus) geographus*, tulip cone *G. tulipa*, Court cone *Darioconus* (*Conus*) *aulicus*, textile

cone *D. textile* and striated cone *Dendroconus (Conus) striatus*.

b) Salivary gland toxins in cephalopods- *e. g.*, Cephalotoxin from *Sepia* and *Octopus*; Eledorsin from Octopus Eledone; Maculotoxin from *Octopus maculosus*.

3. *Other poisonous marine molluscs*

a) Cholinesters in the hypobranchial glands of *Murex* spp., *Thais* and *Buccinium*.

b) Toxins from salivary glands of *Thais haemostoma*, and *Cassis tuberosa*.

c) Skin toxins from opisthobranchs *e.g.*, *Aplysia punctata*.

d) Toxins in midgut gland of *Aplysia depilans*.

Most of these molluscs, at generic or specific levels, are available in the Indian waters for future research on drugs from the sea. As stated by Hashimoto (1979), even if direct use of the toxins is not expected, these can be useful as a model for synthesis or improvement of other drugs. With a rich variety of species of molluscs in the tropical Indian waters, more serious attention should be paid to screen the marine molluscs for pharmacologically active substances, *e. g.*, "anticarcinogenic, antibiotic, growth promoting or inhibiting, haemolytic, analgetic, antispasmodic, hypotensive and hypertensive agents".

Management

In the recent years, some of the maritime States and Union Territories have legislated Marine Fishing Regulation Acts and others are in the process of legislating. Rules have been framed under the Act to regulate fishing in the sea. These Acts and Rules do not touch upon the shellfish. Unless the shellfish resources are brought under the purview of the Acts, mangement measures cannnot be introduced. It is for the Governments in the States to consider and bring the shellfish resources under the existing Act or make separate legislation. It may be noted that the *Trochus* and *Turbo* fishery is managed under the Andaman and Nicobar Islands Shellfishing Rules, 1955 under section 12 of the Andaman and Nicobar Islands Fisheries Regulation, 1938 (Regulation 1 of 1938).

The Government of Tamil Nadu exercises monopoly on the pearl oyster and chank resources. Gujarat has a similar situation. Kerala has monopoly on the chank resource. The system in the three States is concerned with the revenue accruing from the resources without plans for management and development of the resources. Several States lease out the sub-soil shell deposit resources to private parties for a number of years mostly through the Department of Mines and Geology treating the shells as minerals. These leases do not protect the overlying live clam resources nor do they control the damages caused to the environment through dredging or mining Over a period of time, the danger to the resource will be cumulative. The pros and cons of leasing the beds for mining shells for industrial purposes should be examined holistically as the pressure for the raw material is increasing with industrial expansion.

Export of shellfish meat is recent. Clam meat of upto 3,000 count/kg is under export. The average price obtained is Rs. 14.30 per kg processed meat (1985 price). The export earning is about Rs. 64 lakhs (1985). The policy on export of clams would need to be re-examined if the clams are to be considered a source of nutrition availble cheap to the coastal rural population with potential for reaching also the interior markets through proper extension strategy. In the scheme of marine products exports of the present order of Rs. 450 crores, the contribution of Rs. 64 lakhs by the clam is insignificant. If further promotion of export of clam meat is to take place, there will be more pressure on these limited sedentary resources which provide subsistence to several thousand fishermen families. Areas of collection, season, species, quantity and size for export should be regulated until a policy is adopted on the shellfish resource management.

A similar evaluation of the export of ornamental shells from the country is also called for. The average export during 1981-85 period was 333 t valued at Rs. 15.39 lakhs. The ornamental mollusc resources have limited distribution and most of the species would take many years to reach commercial size. The species of gastropods have not been studied in any manner. The gastropods are slow to grow as compared to the bivalves which have a shorter life span.

Several species of gastropods are important as resource material for bioactive substances. Under these circumstances, it may not be prudent to continue to export the ornamental shells, until the resources are investigated in detail and their critical uses are ascertained.

REFERENCES

ABRAHAM, K. C. 1953. Observations on the biology of *Meretrix casta* (Chemnitz). *J. zool. Soc. India, 5:* 163-190.

ACHUTHANKUTTY, C. T., S. R. SREEKUMARAN NAIR AND M. MADHUPRATAP, 1979. Pearls of the window-pane oyster, *Placuna Placenta*, *Mahasagar Bull. natn. Inst. Oceanogr. 12* (3): 187-189.

ALAGARSWAMI, K. 1966. Studies on some aspects of biology of the wedge clam, *Donax faba* Gmelin from Mandapam coast in the Gulf of Mannar. *J. mar. biol. Ass. India. 8* (1): 56-76.

ALAGARSWAMI, K AND K. A. NARASIMHAM. 1973. Clam, cockle and oyster resources of the Indian coasts. *Proc. Symp. Living Resources of the seas around India, Special Publication,* CMFRI: 648-658.

AMIRTHALINGAM, C. 1932. Breeding of *Trochus* and preservation of the beds in the Andamans. *Curr. Sci., 1* (1): 31.

APPUKKUTTAN, K. K. 1977 *Trochus* and *Turbo* fishery in Andamans. *Seafood Export Journal, 9* (12): 21-25.

CHELLAM, A., S. DHARMARAJ AND A. C. C. VICTOR, 1987. Experimental sea-ranching of pearl oyster in the Gulf of Mannar. *Bull. cent. mar. Fish. Res. Inst., 39:* 90-91.

CMFRI, 1974. The commercial molluscs of of India. *Bull. cent. mar. Fish. Res. Inst., 25:* 170 pp.

CMFRI. Annual Report 1981-82: 167pp

CMFRI, Annual Report 1983-84: 114 pp.

CMFRI, 1986. The clam resources. R & D Series for marine fishery resources management. *Cent. mar. Fish. Res. Inst.* Cochin. 9 4 pp.

HASHIMOTO, Y. 1979. Marine toxins and other bioactive marine metabolites (English translation by S. Kondo *et. al.,*). *Japan Scientific Societies Press Tokyo,* 369 pp.

HORNELL, J. 1951. *Indian Molluscs. Bombay Nat. Hist. Society, Bombay,* 96 pp.

INDRANI, K. H. S. V. GOWDA, M. SUBBURAJ, M. N. VENUGOPAL AND I. KARUNASAGAR, 1984. Out break of paralytic shell fish poisoning in Mangalore west coast of India. *Curr. Science, 53* (5): 247-249.

JONES, S. AND K. ALAGARSWAMI 1973. Mussel fishery resources of India. *Proc. Symp. Living Resources of the seas around India, Special Publication* CMFRI: 641-647.

JOSHI, M. C. 1963. A study on clam *Katelysia marmorata* (Lam.), *Ph. D. Thesis* University of Bombay, 273 pp.

KURIAKOSE, P. S., M. P. SIVADASAN AND V. G. SUNRENDRANATHAN. 1987. Fishery resource of the green mussel *Perna viridis* along the west coast of India. National seminar on shellfish resources and farming held at Tuticorin, India, 19-21 January 1987. *Cent. mar. Fish. Res. Inst.* Cochin: Abstract No. 4.

MAHADEVAN, S. AND K. NAGAPPAN NAIR. 1973. Pearl oyster resources of India. *Proc. Symp. Living resources of the seas around India, Special Publication.* CMFRI: 659-671.

MPEDA, 1987. Statistics of marine products exports 1985. *The Marine Products Export Development Authority,* Cochin: 263 pp.

MURTHY, V. S. AND K. A. NARASIMHAM 1979. Survey of windowpane oyster *(Placenta placenta)* resources

in the Kakinada Bay. *Indian J. fish. 26* (1&2): 125-132.

NARASIMHAM, K. A. 1968. Studies on some aspects of biology and fishery of the Cockle *Anadara granosa* (Linnaeus) from Kakinada Bay. *Proc. Symp. Mollusca. Mar. Biol. ASS. India*, pt. II: 407-417.

NARASIMHAM, K. A. 1973 On the molluscan fisheries of the Kakinada Bay *Indian J. fish., 20* (1): 209-213.

NARASIMHAM, K. A 1980 Culture of blood clam at Kakinada. *Mar. fish. Infor. Serv. T&E Ser., 23*: 7-9.

NARASIMHAM, K. A., G. S. D. SELVARAJ AND S. LALITHA DEVI. 1984. The molluscan resources and ecology of Kakinada Bay. *Mar. Fish. Infor. Serv. T&E Ser 59*: 1-16.

NAYAR, K. NAGAPPAN. 1955. Studies on the growth of the wedge clam *Donax (Latona) cuneatus*, Linnaeus. *Indian. J. Fish., 2*: 324-348.

NAYAR, K. NAGAPPAN, K. RAMADOSS C. T. RAJAN AND N SUNDARAM. 1984. Molluscan resources of Kali River estuarine system in Karnataka. *Mar. Fish. Infor. Serv. T&E Ser., 58*: 1-8.

PILLAI, V. K., A. G. PONNIAH, D. VINCENT AND I DAVIDRAJ. 1983. Acidity in Vembanad lake causes fish mortality. *Mar. Fish. Infor. Serv. T & E Ser. 53*: 8-15.

POTA, K. A. AND M. I. PATEL. 1987. Preliminary study on the fishery and biology of the window-pane oyster *Placenta placenta* Linn. in and around Poshitra, the Gulf of Kutch. National Seminar on shellfish resources and farming held at Tuticorin, India, 19-21 January 1987. *Cent. mar. Fish. Res. Inst*, Cochin, India. Abstract No. 36.

RANADE, M. R. 1964. Studies on the biology, ecology and physiology of the marine clams. *Ph. D. Thesis*. University of Bombay, 266 p.

RAO, K. SATYANARAYANA AND G. SYAD RAO, 1983. Experimental clam culture at Mulki, Dakshina Kannada. *Proc. Symp. Coastal Aquaculture*, MBAI, 2: 557-560.

RAO, H. S. 1939. Consolidated report on the shell fisheries in the Andamans during the year 1930-35. *Zool. Surv. India*, Calcutta: 133 pp.

RAO, G. SYDA AND K. SATYANARAYANA RAO. 1985. Survey of clam and oyster resources of some Karnataka estuaries. *Indian J. Fish.,32* (1): 74-89.

RAO, K. V. AND K. NAGAPPAN NAYAR, 1956, Rate of growth in spat and yearlings of the Indian backwater oyster *Ostrea madrasensis* (Preston) *Indian J. Fish. 9* (2) A: 542-579.

RAO, K VIRABHADRA. 1958. Molluscan Fisheries. In Fisheries of the West coast of India, Ed., by S. Jones: 55-59.

RASALAM, E. J. AND SEBASTIAN, 1980. The lime shell fisheries of the Vembanad lake, Kerala. *J mar. biol Ass. India, 18* (2) (1976). 323-355.

SARVAIYA R. T. 1982. Window pane oyster fishery of Pindhara Bay in the Gulf of Kutch. *Seafood Export Journal 14* (8): 25.28.

SILAS, E. G., K. ALAGARSWAMI, K. A. NARASIMHAM, K K. APPUKUTTAN AND P. MUTHIAH. 1982. Country report—India. *In*: F. B. Davy and M. Graham (Eds.), *Bivalve Culture in Asia and the Pacific* Proc. Workshop held in Singapore, 16-19 February 1982. International Development Centre, Ottawa: 34-43.

THANGAVELU, R. K RENGARAJAN AND P. POOVANNAN. 1987. An account on the sub-fossil shell deposits of Kovalam backwater. *Mar. Fish. Infor. Serv. T&E Ser. 73*: 5-6.

THANGAVELU, R. AND P. J. SANJEEVARAJ. 1987. Distribution of molluscan fauna in Pulicat lake. National Seminar on shellfish resources and farming held at Tuticorin, India 19-21 January 1987. *Cent. Mar. Fish. Res. Inst* Cochin: Abstract No. 14.

VARGHESE, M. A. 1976. Window pane oysters *(Placenta placenta* Linn) of the Gulf of Kutch. *Seafood Export Journal. 18* (5): 25-28.