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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*, *Villoita* 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). For the purpose of arriving at an estimate of exploited resources at all India level, certain reasonable approximations are made as follows:

<table>
<thead>
<tr>
<th>State</th>
<th>Estimated clam production (t)</th>
<th>Approximate production (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gujarat</td>
<td>1,100</td>
<td>2,000</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>890</td>
<td>1,000</td>
</tr>
<tr>
<td>Karnataka</td>
<td>8,210</td>
<td>10,000</td>
</tr>
<tr>
<td>Kerala</td>
<td>32,340</td>
<td>35,000</td>
</tr>
<tr>
<td>Tamil Nadu &amp; Pondicherry</td>
<td>730</td>
<td>1,000</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>2,700</td>
<td>3,000</td>
</tr>
<tr>
<td>Orissa</td>
<td>—</td>
<td>1,000</td>
</tr>
<tr>
<td>West Bengal</td>
<td>45,970</td>
<td>53,000</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Area</th>
<th>Species</th>
<th>Annual Production (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maharashtra</td>
<td>Meretrix meretrix, Katelysis opima, K. marmorata and Paphia lateralisulca</td>
<td>1,100</td>
</tr>
<tr>
<td>Goa</td>
<td>Meretrix casta and Villorita cyprinoides</td>
<td>890</td>
</tr>
<tr>
<td>Karnataka</td>
<td>Netravati estuary: M. casta, V. cyprinoides</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>Gurpur estuary: Paphia malabarica</td>
<td>640</td>
</tr>
<tr>
<td></td>
<td>Mulki estuary: M. casta and P. malabarica</td>
<td>3,100</td>
</tr>
<tr>
<td></td>
<td>Udayavara estuary: M. casta</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>Swarna estuary: V. cyprinoides and M. casta</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Sita estuary: M. casta</td>
<td>380</td>
</tr>
<tr>
<td></td>
<td>Coondapur estuary: P. malabarica</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kerala</td>
<td>Vembanad Lake: V. cyprinoides</td>
<td>21,900</td>
</tr>
<tr>
<td></td>
<td>Ashtamudi Lake: K. opima</td>
<td>5,440</td>
</tr>
<tr>
<td></td>
<td>V. cyprinoides</td>
<td>5,000</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>Vellar estuary</td>
<td>730</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>Kakinada Bay: Andhra granosa</td>
<td>2,000</td>
</tr>
<tr>
<td></td>
<td>Godavari estuary: M. meretrix</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,700</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>45,970</td>
</tr>
</tbody>
</table>
The species is *Crassostrea madrasensis* which has a wide distribution along the entire east coast and south-west coast. It is replaced by *C. grypoides* 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 dispersed 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 51 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, considering 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 3,500 t.

**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 Nauzim 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, Posheta 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 until 1978. But subsequently, the term of lease has been reduced to an 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 150 kg. 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 96 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 Nauzim Bay in Goa is relatively small. According to
Achuthankutty et al. (1979), about 8,000-10,000 oysters are fished per day throughout 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 up to 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 up to 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 64 mm maximum shell diameter in Tamil Nadu and the weight would be about 350 g. However, larger chanks weighing up to more than 1 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 Mount 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*, *Chiagra*, *Cassis*, *Cypraea*, *Harpe*, *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 1981-83 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 Coonapur 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 53,000 t 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 (Thangavelu *et al.*, 1987) and in Coonapur 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 *Katalysia opima*, *Vilforta 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. 12.60 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**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen clam</td>
<td>15.6</td>
<td>397.4</td>
<td>608.6</td>
<td>1,068.8</td>
<td>436.8</td>
</tr>
<tr>
<td>Canned clam</td>
<td>111.3</td>
<td>8,478.6</td>
<td>7,507.8</td>
<td>15,250.8</td>
<td>6,237.4</td>
</tr>
<tr>
<td>Clam meat pickle</td>
<td>10.1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>18.0</td>
</tr>
<tr>
<td>Sea shells</td>
<td>1.6</td>
<td>9.2</td>
<td>231.8</td>
<td>28.7</td>
<td>68.0</td>
</tr>
<tr>
<td>Oyster shell powder</td>
<td>2.8</td>
<td>61.4</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>(Quantity in tonnes; Value in '000 rupees)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** MPEDA

### TABLE 3

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

<table>
<thead>
<tr>
<th>Resource</th>
<th>All-India annual production (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clams</td>
<td>63,0000</td>
</tr>
<tr>
<td>Oysters</td>
<td>750</td>
</tr>
<tr>
<td>Mussels</td>
<td>3,500</td>
</tr>
<tr>
<td>Windowpane oyster</td>
<td>9,300</td>
</tr>
<tr>
<td>Trochus and Turbo</td>
<td>600</td>
</tr>
<tr>
<td>Chanks</td>
<td>1,250</td>
</tr>
<tr>
<td>Ornamental molluscs</td>
<td>600</td>
</tr>
<tr>
<td><strong>Estimated total</strong></td>
<td>68,900</td>
</tr>
<tr>
<td><strong>Say</strong></td>
<td>70,000 tonnes</td>
</tr>
</tbody>
</table>

**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. Taking an average price of Rs 2,000/tonne of live bivalves and gastropods, the nominal landed value of 70,000 t would be Rs. 1.4 crores. If the average price of shells from sub-soil deposits is taken as Rs. 1,000/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.

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 Siles 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 parameters 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 led 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 beginning 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, 1983; 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 Family Turbinidae.
   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 Geastridium (Conus) geographus, tulip cone G. tulipa, Court cone Darloconus (Conus) sulicus, 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; Maeulotoxin from Octopus maeeulosus.

3. Other poisonous marine molluscs

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

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.

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, 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, hypertensive and hypotensive 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, management measures cannot 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 Shellfish 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 up to 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 available 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


