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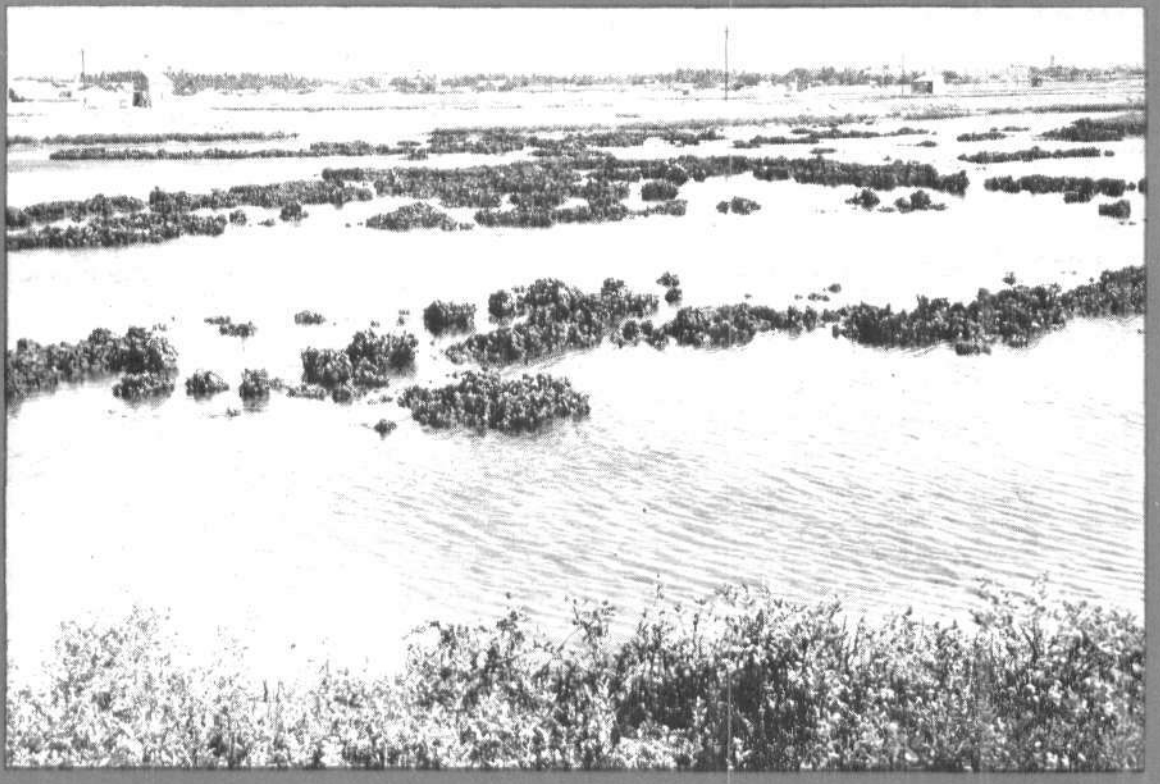

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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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MOLLUSCAN FISHERIES OF INDIA

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Introduction

Molluscs form valuable fisheries in various parts of the coasts of India providing shellfish as food and as source of lime, pearls and decorative shells, as constituents of medicinal preparations etc. The commercially important molluscs of the country consist of oysters, mussels, clams, ark shells, pearl oysters and other bivalve molluscs, the sacred chank *(Xancus pyrum)*, *Trochus niloticus*, *Turbo marmoratus* and some other gastropods and cephalopods including squids, cuttlefishes and octopods. The available resources are exploited at numerous places all along the coasts of the country using a variety of fishing methods but the total production is not high compared to several other countries of the world. However, in recent years following an increase in the fishing effort and greater awareness of the resources, there has been a steady rise in molluscan production. The Central Marine Fisheries Research Institute has recognized the importance of molluscs as valuable fishery resource and conducted several studies on the identity, distribution and biological characteristics of the resources and the trends in production of some of the major species. Very recently researches have been carried out on the culture of oysters, mussels, and clams as well as pearl culture, and culture methods have been developed which would be useful in adopting mariculture practices. In this article, the present status of exploitation of molluscan resources in the country and the progress made in researches on the culture of bivalve molluscs are presented and the possibilities for better utilization of the resources by proper exploitation are emphasized.

Molluscan Resources and Fisheries

Oysters

Oysters are one of the most valuable among molluscs found along Indian coasts and are widely distributed in estuaries, creeks, backwaters, bays and harbours wherever rocky or other hard substratum is found. Several species of oysters have been reported from India of which four viz., *Crassostrea madrasensis*, *C. gryphoides*, *C. discoidea* and *Saccostrea cucullata* form beds and are of economic importance (Nayar, 1980). *C. madrasensis* has extensive distribution, occurring in Sonapur backwaters in Orissa, Pulicat Lake, Ennore, Killai backwaters, Karangad, Athankarai, Pinnakayal and Tuticorin (Fig. 1) on the east coast and in Vembanad Lake, Cochin, Beypore and Tellicherry in Kerala and

Fig. 1. Natural oyster bed of *Crassostrea madrasensis* at Tuticorin.

several estuaries of Karnataka on the southwest coast. The oysters at Sonapur are fished regularly for converting the shells into poultry feed (Alagarswami and Narasimham, 1973). Small sized oysters from Pulicat Lake were previously grown to marketable size in the shallow parts of the Lake and sold to meet the requirements of a few hotels in Madras city. Now oysters are occasionally collected from natural beds and supplied when there is demand. Along Cochin coast and in Mulki, Udayavara, Coondapur and villages bordering Kali river, oysters are collected for domestic consumption or sold at Rs. 3–4/- per 100 nos. thus forming a sustenance fishery. Oysters are collected by dislodging them with a strong knife or a chisel. The shells of this species are also used in the manufacture of calcium carbide.

In *Crassostrea madrasensis* of Adyar estuary a main spawning season extending from October to December and usually a second season from March–April have been observed (Rao, 1951). *C. madrasensis* spawns twice in a year during April–May and August–September at Tuticorin and grows to a size of 90 mm at the end of one year when meat forms 8–10% of total weight (Mahadevan, Nayar and Muthiah, 1980). *C. gryphoides* occurs along the Maharashtra and Goa coasts and is fished in fair quantities at a number of places such as Bombay, Alibag, Ratnagiri, Malvan, Ratnagiri Ribander, Siolim and Curca. *C. gryphoides* spawns between July and September in Kelwa waters and grows to a maximum size of only 48 mm at the end of one year (Durve and Bal, 1962). In the creeks of Gulf of Kutch, Port Okha, Dwarka and Porbunder in Gujarat the disc oyster *Crassostrea discoidea* occurring in muddy bottom is fished for its meat. In Poshetra *Crassostrea cristagalli* is exploited for meat but this species is a small sized one and fetches a price of Rs. 3/- per 100 nos. *Saccostrea cucullata* commonly known as the rock oyster due to its occurrence on rocky substratum is found on both east and west coasts but is more common on the west coast. This species grows well in marine environment and fisherfolk collect it from sandstone or granite boulders in the intertidal zone.

Mussels

Mussels are an important molluscan fishery resource in India. These are found in the coastal waters on rocky substratum up to a depth of 10 m and are fished at low tides using a knife. Of the two species (the green mussel *Perna viridis* and the brown mussel *Perna indica)*, the green mussel occurs at a number of places on Indian coasts and forms thick beds at Quilon, Alleppey, Cochin, Malabar coast, Karwar, Goa, Malvan, Ratnagiri and in Gulf of Kutch. In these areas the green mussels are regularly exploited for the meat which is relished very much. The green mussel resources are particularly abundant on the rocky coasts from Calicut to Tellicherry where there is an active fishery. On the east coast small beds of green mussels occur only at a few places viz., Visakhapatnam, Kakinada and Madras. *Perna viridis* attains a length of 92 mm at the end of one year at Kakinada and its breeding period is prolonged extending from December to July (Narasimham, 1980a). Unlike the green mussel, the brown mussel *Perna indica* has a limited distribution from Varkalai near Quilon on southwest coast to Cape Comorin with good fisheries at Varkalai, Kovalam, Vizhinjam, Poovar, Muttom and Colachel. The brown mussel grows to a size of 35–36 mm in a year on Vizhinjam coast and breeds from May to September (Appukuttan and Nair, 1980).

Fig. 2. Fishing of the brown mussel *Perna indica* on Vizhinjam coast.

Clams

In terms of total production, clams are the foremost among the molluscan resources in India. They are distributed along both coasts but the resources along the west coast are very considerable as compared to those on the east coast. Clam fishing is generally done by hand picking or with scoop nets. In several estuaries of Maharashtra, Goa, Karnataka and Kerala on the west coast there are regular fisheries for different species of clams. *Meretrix casta, Katelysia opima* and *Paphia laterisulca* are the species caught from the estuaries and backwaters in Maharashtra. Two species of clams *M. meretrix* and *Villorita cyprinoides* support clam fisheries at Tiracol, Chapora, Sal, Mandovi, and Zuari estuaries in Goa (Alagarswami and Narasimham, 1973).

In Kali river in Utthara Kannada district, Karnataka there is a very good clam fishery of *Meretrix meretrix, Paphia malabarica* and *V. cyprinoides*; the annual clam production amounting to about 2,000 t (Nayar *et al.*, MS). Clam fishing is carried out in Kali river by hand picking or with a net which has a semi-circular mouth and is operated with leg. In the estuaries of Dakshina Kannada district, in contrast to Utthara Kannada district, *Meretrix casta* is generally the dominant clam species, the other species occurring in commercial catches including *M. meretrix, Paphia malabarica, V. cyprinoides* and *K. opima*. An estimated clam production of 79 to 128 t including mostly *Villorita cyprinoides* are fished annually from Netharavathi estuary at Mangalore (Rao, K. S., MS).

In Kali river and Coondapur estuary vast subfossil clam shell deposits are present and these are exploited on a large scale using dredges. The fishermen who fish live clams in the Kali river vehemently oppose the exploitation of shell deposits using the dredging equipment and they contend that along with shells live clams present in the area are caught in large quantities and destroyed.

There are extensive sub-fossil molluscan shell deposits largely comprising of clams in Vembanad Lake, the total resource of which has been estimated as 2–4 million tonnes. The annual estimated production of shells from the lake is 1,98,809 t of which live clams form 26,859 t (Rasalam and Sebastian, 1976). Fishing is carried out using a long handled spade as in the southern portions or with a drag net. Mechanical suction type dredgers are used by M/s. Travancore Cements Ltd. and Travancore Electro-Chemical Industries Ltd., which exploit large quantities of lime shells for the manufacture of cement and calcium carbide. Lime shells are used for a number of other purposes like preparing of morter and slaked lime, for neutralising acidic soil and in rayon and paper industries. Large quantities of sub-soil lime shell deposits occur in Kodungallore and Ashtamudi lakes, and Kadalundi and Korapuzha estuaries also in Kerala. *Villorita* spp. form 90% of clam resources of Vembanad Lake and their meat is sold and consumed in a large number of surrounding villages. There is a good fishery for *Katelysia opima* in Ashtamudi lake for exporting clam meat.

On the east coast in Bahundi river in Orissa live *Meretrix* sp. occur along with oysters and subfossil shell deposits are quarried annually. From Chilka Lake good quantities of shells of *Meretrix* spp. are mined every year (Alagarswami and Narasimham, 1973). *Meretrix meretrix* is common in Kakinada Bay and about 400 t of the clams are landed annually. On the southeast coast, beds of *Meretrix casta* occur in Vellar and Vaigai estuaries. The clam beds in Vellar estuary support a fairly good fishery with yearly production of about 210 t (Natarajan *et al.*, 1979). *M. casta* is found in Chilka and Pulicat lakes and Vaigai estuary. There is a regular fishery for live *M. casta* in Pulicat lake. *Katelysia opima* occurs only sporadically in the lake. Good quantities of subfossil molluscan deposits are present in the northern part of Pulicat lake which are regularly exploited (Thangavelu, personal communication). Large subfossil molluscan deposits of *M. casta* and some other species have been located recently in Vaigai estuary at Athankarai and they are being actively exploited since 1978 (Nayar *et al.*, MS).

Ark shells

In Kakinada Bay the ark shell *Anadara granosa* is abundant and supports a fishery (Fig. 3), the annual production amounting to 130 t. The ark shells fished from the bay are mostly used in the production of lime

Fig. 3. Fisherwomen engaged in fishing *Anadara granosa* in Kakinada bay.

and only small quantities are utilized as food or for export. There is much demand in Japan for this species. An economic method of culturing this species has been developed by CMFR Institute (Narasimham, 1980b). Efforts are necessary to culture the shellfish and export them *A. granosa* occurs in Vellar estuary and Venkatpur estuary also but only in small quantities.

Window-pane oysters

These bivalves belonging to the species *Placenta placenta* the shells of which are used for glazing windows and are also sources of shell lime and pearls used in medicine, enjoy wide distribution in Indian seas occurring in Gulf of Kutch, Bombay, Malabar coast, Tuticorin, Mandapam, Nagapattinam, Madras and Kakinada Bay. Of the several places, only in Kakinada Bay and Gulf of Kutch window-pane oysters form a resource. The total biomass of this shellfish in Kakinada Bay has been estimated to be 8,945 t, the dead oyster resources forming another 43,348 t and the annual landing is 400 t (Murthy, Narasimham and Venugopalam, 1979) indicating that production could be increased several times. Till recently window-pane oysters were only converted into lime or pearls present were collected and used in preparing medicine. At present the right valves of the oysters are exported to Hong Kong, Japan

and Korea. In addition the shell valves with iridescent lustre are used in the production of chandeliers. The meat of window pane oysters is edible. Therefore the possibilities of popularizing it as food in the country have to be explored.

Pearl oysters

In India there is a continous demand for pearls for use in the making of jewellery, which is largely met through import of cultured pearls from Japan, the pearl production from pearl oyster resources in the country being erratic. Most beautiful natural pearls have been collected from pearl oysters of the species *Pinctada fucata* collected in pearl fisheries off Tuticorin coast in Gulf of Mannar and to some extent from Gulf of Kutch since very early times. The pearl banks in the Gulf of Mannar are under the control of the Government of Tamil Nadu which conducts pearl fisheries (Fig. 4) when the pearl banks known as *Paars* are populated by pearl

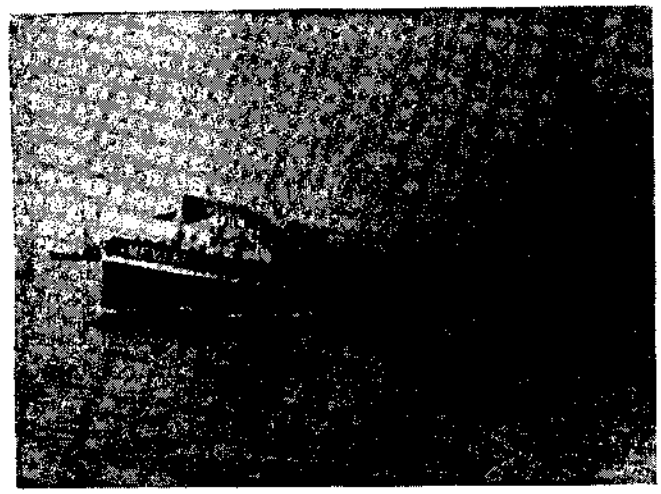

Fig. 4. Pearl oyster fishing boats being towed by mechanised vessel.

oysters in abundance. In the present century only fourteen pearl fisheries have been conducted the last being as far back as in 1961. Pearl oysters occur in Gulf of Kutch and support small fisheries, the annual production amounting to 30,000 to 77,000 pearl oysters (Mahadevan and Nayar, 1973). Settlement of *P. fucata* has been noticed in Vizhinjam coast recently. *Pinctada margaritifera* which also yields pearls of high quality occurs only sporadically in India.

The pearl oyster production in the various pearl fisheries varies very much due to wide fluctuations in the stocks of pearl oysters in the pearl banks. Natural populations of pearl oysters are influenced by a variety of factors like recruitment, presence of *Modiolus* as a pest, occurrence of predators like sea stars, sharks, rays and skates, strong currents, drifting sand and unauthorised fishing.

Maximum of 21.4 million pearl oysters which brought a revenue of Rs. 4,51,098/- to the State Government were obtained in 1958 pearl fisheries. The maximum income of Rs. 8,00,568/- was achieved in the fishery held in 1959 when 16.4 millions of oysters were fished. In the 1961 fishery the total harvest of pearl oysters fished was 15.4 millions which fetched an income of Rs. 2,88,860/-. Observations made recently on the pearl banks in the Gulf of Mannar have revealed the presence of pearl oysters in good numbers in some of the paars. The Central Marine Fisheries Research Instutute has achieved a major breakthrough by producing spherical cultured pearls in the pearl oyster *Pinctada fucata* (Alagarswami and Qasim, 1974).

Other Bivalves

There are also other bivalve molluscs of economic value like the razor shells *Solen* spp. in Ratnagiri coast (Rao *et al.*, 1962) and surf clams *Donax cuneatus, D. faba,* and *D. incarnatus* in various parts in the intertidal zone which are fished for their meat (Nayar, 1955, Alagarswami, 1966, Nayar and Mahadevan, 1974). *D. cuneatus* attains a size of 13–14 mm in one year and its spawning season extends from January to April in Palk Bay (Nayar, 1955). *D. faba* of Gulf of Mannar grows to sizes of 20 mm and 24 mm at the end of one year and two years respectively and spawns from November to June (Alagarswami, 1966). Other species like *Mesodesma glabratum* in sandy beaches, *Gafrarium* spp. in muddy habitat in Gulf of Mannar and the fan shells *Pinna bicolor* and *Atrina (Servatrina) pectinata pectinata* (Rao and Dorairaj, 1974) occurring in coastal waters of Mandapam area are bivalves which could be exploited.

Sacred chank

The sacred chank *Xancus pyrum* which occupies an important place in the lives of Hindus, being used in worship and in the manufacture of bangles worn by ladies in Bengal is distributed in the coastal waters of Tamil Nadu, Kerala and Gulf of Kutch in Gujarat. The major portion of the resources are distributed in Tamil Nadu where chanks occur in Tirunelveli, Kanyakumari, Ramanathapuram, Pudukottai, Thanjavur, South Arcot and Chingleput coasts. Chanks occur from shallow parts to depths of 20 m (Nayar and Mahadevan, 1973).

About 90% of the chank production is obtained by diving (Fig. 5) and the rest in nets or by fishermen wading in shallow waters. In Tamil Nadu chank

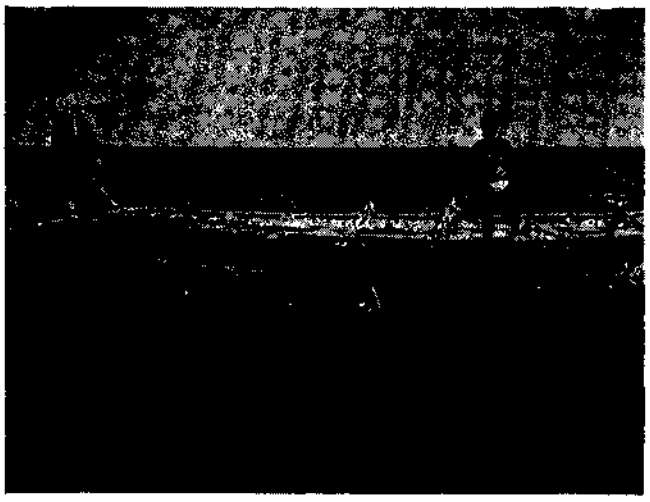

Fig. 5. Chank fishing by divers off Tuticorin coast.

fishing is controlled by the State Government which permits fishing by issuing licences to fishermen. Fishing of chanks below the size of 57 mm is prohibited, the under-size ones being returned to the sea. The chank production is highest in Tirunelveli area off Tuticorin coast. The fishing season extends in the area from November to May and over 900 divers are engaged in the fishery. During 1972–78 the number of full size chanks fished per season off Turicorin coast varied between 18,768 and 5,58,996. In the recent years 1978–83 the chank landings per season along the coast have been much higher ranging between 7,78,132 and 10,54,940 with maximum number of chanks having been obtained in 1982–83 season (Table 1). Next in importance is the

Table 1. *Number of full size chanks fished off Tuticorin coast during* 1972–83

Season	Number of chanks fished
1972–73	3,72,106
1973–74	3,58,883
1974–75	5,58,996
1975–76	12,365
1976–77	18,768
1977–78	19,171
1978–79	9,55,893
1979–80	8,01,035
1980–81	7,78,132
1981–82	7,95,645
1982–83	10,54,940

Source: Department of Fisheries, Govt. of Tamilnadu.

Kannirajapuram–Ramanathapuram fishery with a yearly production of 3,00,000 chanks.

Another 40,000 chanks are fished along the coasts of Tanjavur, South Arcot and Chingleput districts. Chank production is much less in other areas being 17,000 chanks caught in trawl nets off Quilon coast and 6,000 obtained in hooks and lines off Vizhinjam. From the Gulf of Kutch, about 12,000 chanks are fished annually. A number of varieties of chanks are recognised based on shell characteristics, the main ones being the beautiful spindle shaped *acuta* and the squat form *obtusa*. The sacred chanks with sinistral shells known as *Valampuri* (Fig. 6) which are greatly esteemed are caught in very stray numbers and these fetch a price of Rs. 10,000/- or more depending on the size and quality of the shell. The sinistral chanks are auctioned by the Government of Tamil Nadu.

Fig. 6. A sinistral chank *Xancus pyrum*.

Fig. 7. *Trochus niloticus*.

Trochus and Turbo

Trochus niloticus and *Turbo marmoratus* (Figs. 7 & 8) form important local fisheries in Andaman and Nicobar

Fig. 8. *Turbo marmoratus.*

Islands, the annual production of the former amounting to 400-600 t and that of the latter 100-500 t (Appukuttan, 1977). In recent years a decrease in the catches of *T. marmoratus* is evident. There is very good demand for the beautiful shells of the two species with opalescent lustre, as a variety of utilitarian articles are made with them. The foot of the species is boiled, dried and consumed.

Other gastropods

Apart from the above species, there are other gastropods like *Turbo intercostalis*, *Oliva* sp., *Lambis lambis* and *Babylonia spirata* which occur in intertidal zone and littoral waters and could be utilized as food. Shells of *Tonna* spp., *Hemifusus* sp, *Cymbium melo*, *Umbonium vestiarium* and *Cyprea tigris* are collected and sold as such or made into handicraft articles. The cowries *Cypraea moneta* gathered from shallow coastal waters are used as dice. The early development of a number of prosobranch molluscs of Mandapam area has been studied by Natarajan (1957). Studies have been taken up by CMFR Institute at Mandapam camp to make some of the gastropods of economic importance breed in laboratory.

Cephalopods

In India squids and cuttlefishes are mostly obtained as by-catch in trawl nets, shore sienes, boat seines, hooks and lines and stake nets operated for fish and prawns, trawl nets accounting for 59% of total cephalopod production. The country's cephalopod production was meagre till 1973 after which there has been a remarkable increase in the landings to meet the demand for exports (Silas *et al*, 1982). In recent years, the annual cephalopod production varied between 9,548 t (1981) and 15,931 t (1978) (Silas *et al*, 1982, FRAD, CMFRI, 1982). 41.94% of the total landings are caught on the west coast and the rest on the east coast. Kerala, Maharashtra and Gujarat are the states with high cephalopod production, the three states accounting together for 79% of the production during 1978–81 while Tamil Nadu ranks fourth in importance. The commercially imporatnt species of cephalopods of India are the squids *Loligo duvaucelli*, *Sepioteuthis lessoniana*, *Doryteuthis* sp., *Loliolus investigatoris* and the cuttlefishes *Sepia pharaonis*, *S. aculeata*, *S. breviamana*, *S. elliptica*, *S. prashadi* and *S. inermis*. There is an important local fishery for the squid *Sepioteuthis lessoniana* in Ramanathapuram district on southeast coast of India, which is exploited with a special type of shore seine *ola valai* (Rao, 1954). Octopods occur in sheltered crevices amidst rocks and coral stones at a number of places on the mainland and Lakshadweep and Andaman Islands. In Lakshadweep Islands they are fished by spearing, the annual production amounting to 13–20 t. A number of species of oceanic squids are known to be distributed in Indian ocean (Flippova, 1968) but their catch potential is to be assessed. Silas (1969) has pointed out that the oceanic squid *Symplectoteuthis oulaniensis* is common at high depths beyond 180 m off southwest coast of India. By carrying out exploratory fishing extensively on the continental shelf and oceanic parts and use of special gear like jigs, there is much scope for considerably increasing the country's cephalopod production. Squids and cuttlefishes are being exported in good quantities annually to several countries. The total cephalopod exports from India amounted to 3,028 t worth Rs. 75 millions in 1981.

General Considerations

Molluscan resources exist at innumerable places along the coasts of India and are exploited in varying degree of intensity forming valuable fisheries. The fisheries and biological aspects of the major species of molluscs of economic importance have been studied only at a few areas in the last few years. It is quite essential that these studies are intensified and extended to other areas which will help in taking steps to develop the fisheries. A big lacuna in the study of molluscan fisheries in India is the lack of detailed data on the production of the shellfishes such as oysters, clams, mussels, ark shells etc. At present such data is available only for pearl oysters, chanks and cephalopods. The

CMFR Institute has drawn up a programme to monitor the landings of the different groups of molluscs other than cephalopods. When this programme is implemented, we will have a clear idea of the status of the various molluscan fisheries of the country.

In the case of bivalve and gastropod resources, systematic resources surveys have to be conducted along the east and west coasts as well as the Andaman and Lakshadweep islands for assessing the standing stocks. A beginning has been made in this field and CMFRI has surveyed the molluscan resources of a number of estuaries and other brackish water systems in Kerala and Karnataka.

Bivalve molluscs such as oysters, mussels, clams, cockles and scallops are cultivated in shallow coastal waters on scientific lines in several advanced as well as developing countries of the world such as U.K., U.S.A., Canada, France, Spain, Holland, Germany, Australia, Japan, Philippines, Korea, and Taiwan to supplement production from exploitation of natural stocks. But unfortunately until recently no serious attempt has been made to adopt culture practices for bivalve molluscs in our country. In India where malnutrition is widespread, aquaculture of oysters, mussels, and clams can very much augment production from fishing natural beds and provide protein-rich sea food. Silas (1980) has stressed the importance of culture of edible molluscs as the production of biomass is high. The Central Marine Fisheries Research Institute has developed economic methods of oyster culture (Nayar and Mahadevan, 1980), mussel culture (Kuriakose, 1980) pearl culture (Alagarswami, 1980) and culture of *Anadara granosa* (Narasimham, 1980b). The culture of the bivalves could be carried out profitably in suitable littoral areas with the available technology as the materials required could be easily procured and farming conducted. During the last few years a very good demand has developed for the export of bivalve molluscs especially clams. Clams like *Katelysia opima, Meretrix* and *Villorita* have been collected from Ashtamudi and Vembanad lakes and over 510 t of clam meat worth Rs. 97,37,000 exported in 1982-83. Thus by improving the fishing methods and proper exploitation of the available molluscan resources it is possible for India to increase production substantially from the present level which will provide greater quantities of wholesome sea-food to meet internal demand and requirements of export industry. Besides the meat, the molluscan shells which are used in various ways bring substantial additional income.

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