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Molluscan shellfish resources of India - An overview

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ABSTRACT

Several groups of molluscan shellfish such as cephalopods comprising squids and cuttlefishes; bivalves like pearl oysters, edible oysters, mussels, clams and windowpane oyster; and gastropods represented by chank, top shell, turbo shell and a variety of ornamental species contribute to the marine fisheries of the country. This paper gives a synoptic picture of the available information about these resources, their distribution, exploitation, production and stock assessment. Suggestions for developing these resources are also given.

In recent times the molluscan shellfish are fast emerging as an important component in the marine fisheries of the country. Cephalopods are much sought after in the export trade. Their production trend is showing spectacular growth rate. The edible oysters, mussels and clams are nutritious sea foods with considerable export potential. The shells of several molluscs are in demand, either for ornamental purposes or for industrial use. The cephalopod fishery is regularly monitored in the country. The Governments of Tamil Nadu and Gujarat exercise control in organizing the pearl oyster fishery. At present no agency in the country regularly monitors the production of edible oysters, windowpane oysters, clams, mussels, etc. Nevertheless, surveys conducted, mostly by the Central Marine Fisheries Research Institute (CMFRI) at important production centres, have resulted in the collection of valuable data on these resources. Comprehensive information on the cephalopod fishery was brought out by Silas (1985). Alagarswami and Meiyappan (1989 a, b) discussed the prospects and R&D needs for developing the molluscan fisheries. Narasimham (1991) dealt on the status of clam fisheries. Recently CMFRI and Fishery Survey of India have assessed the cephalopod stocks of the country. This paper briefly gives the information on the marine molluscan fisheries of India. Also suggestions are given for developing these resources.

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CEPHALOPODS

Resources, distribution and exploitation

Cephalopods comprising squids, cuttlefishes and octopuses are exclusively marine molluscs which have emerged as a major and valuable resource in recent times due to the high demand in the export market. The fishery has witnessed a phenomenal increase in all the maritime states of India, leading to the export of 28 263 t of cephalopod products valued at Rs 902.8 million in 1992.

There are about 80 species of cephalopods. Of these about a dozen species contribute to the fishery. The cephalopod production in India which was less than 1 400 t in 1972 rose to 15 769 t in 1982 and reached an all-time high of 89 482 t in

1992 registering a 64-fold increase. Concurrent with this phenomenal growth in production, the contribution by cephalopods to all-India marine fish production which was 0.1% in the early seventies significantly rose to 4% in 1992.

Cephalopods are landed in all the maritime states of India. During 1988-1992 Kerala ranked first accounting for 37.17% of the cephalopod landings, followed by Maharashtra (28.98%), Tamil Nadu (13.88%) and Gujarat (13.65%) (Table 1). On the whole the west coast is more productive contributing to 85% of the cephalopod catch. The balance comes from the east coast.

Squids and cuttlefishes are the major groups contributing, respectively, to 52 and 48% of the cephalopod landing. Octopus are landed in negligible qualities, viz. 16 t/year. *Loligo duvauceli* Orbigny, *Sepia aculeata* Orbigny, and *Sepia pharaonis* Ehrenberg are the 3 main species contributing to 42, 22 and 20%, respectively, of cephalopod landings of the country.

The Indian squid *Loligo duvauceli* is landed all along the Indian coast. Kerala accounts for 38% of this species followed by Gujarat (22%) and Maharashtra (20%). Other squids of commercial importance but with restricted distribution are *Doryteuthis sibogae* Adam, *Doryteuthis singhalensis* (Ortmann), *Loligo uyii* Wakiya and Ishikawa, *Loliolus investigatoris* Goodrich and *Sepioteuthis lessoniana* Lesson. They contribute to about 6% of the total cephalopod landings.

Of the cuttlefish resources, *Sepia aculeata* and *Sepia pharaonis* are the major species. *Sepia aculeata*, commonly known as the needle cuttlefish, is found in the fishery of all maritime states except Gujarat. Maharashtra is the major producer accounting for 57% followed by Kerala contributing to 33%. *Sepia pharaonis*, known as the pharaoh cuttlefish, occurs throughout the Indian coast. The bulk of the production (44%) of the species comes from Maharashtra. Other cuttlefishes like *Sepia elliptica* Hoyle, *Sepia brevimana* Steenstrup, *Sepia prasadi* Winckworth and *Sepiella inermis* Orbigny together contribute to about 10% of the all-India cephalopod landings.

Bulk of the cephalopod catch (87%) is landed by trawlers which operate within 50 m depth, except in West Bengal where there are no records of cephalopods in trawl

Table 1. State-wise produciton (in tonnes) of cephalopods during 1988 - 92

Year	WB	OR	AP	TN	PRY	KER	KAR	Goa	MAH	GUJ	Total
1988	7	38	545	4,192	26	15,155	1,953	389	13,346	2,859	38,510
1989	39	80	299	5,523	112	23,489	2,452	475	14,472	7,344	54,285
1990	81	13	988	7,434	101	24,206	2,287	123	15,605	5,399	56,237
1991	64	45	446	9,018	206	19,468	3,460	709	18,651	13,270	65,337
1992	122	60	667	16,004	193	30,625	2,121	1096	25,982	12,612	89,482
Annual average production	63	47	589	8,434	128	22,589	2,455	558	17,611	8,297	60,771
% - of all India cephalopod landing	0.10	0.08	0.97	13.88	0.21	37.17	4.04	0.92	28.98	13.65	

WB, West Bengal; OR, Orissa; AP, Andhra Pradesh; TN, Tamil Nadu; PRY, Pondicherry; KER, Kerala; KAR, Karnataka; MAH, Maharashtra; GUJ, Gujarat.

nets. The average catch per trawl unit per day was highest (96.9 kg) in Maharashtra and lowest (0.4 kg) in Orissa. The traditional gears like boat seine, shore seine, hook and line, fixed bag-net (*dol*) and drift net account for the rest of the cephalopod production. In Vizhinjam the entire production comes from the artisanal sector. A small portion of *Sepia pharaonis* catch from this area comes from the hand jigging operations which is exclusively targeted at this species.

On the east coast the third quarter of the calendar year is the most productive period for 3 major species, viz. *L.duvauceli*, *S. aculeata* and *S. pharaonis*. For *S. pharaonis* the second quarter was also equally productive in the east coast. On the other hand, along the west coast, the fourth quarter is the most productive. However for *L. duvauceli* the first quarter is equally productive.

Experimental fishing aimed at cephalopods

Cephalopods are mostly landed as by-catch in the bottom trawls throughout the world and the situation in India is no different. However, hand jigging targeted to catch cephalopods is also practised in Japan, the Philippines, Korea etc. Since 1945 automatic squid jigging from modern factory vessels of 300-500 GRT is in vogue in Japan to exploit the distant water cephalopod resources. In the Gulf of Thailand squids are fished by lowering the dip nets and attracting the squids with light.

Squid jigging experiments carried out in 1985 by the MPEDA, off Kerala coast yielded 102 squids/hour. Automatic squid jigging studies by the Fishery Survey of India (FSI) during 1988-1989 along the south-west coast gave an average catch of 6 squids/machine hour. Along the Gujarat coast hand jigging during 1990 yielded about 4 squids/hour (Nair *et al.* 1992). *L. duvauceli* is the dominant species forming 98-100% in these studies. The limited experimental studies conducted so far on squid jigging are not encouraging and the results are inconclusive.

Survey of cephalopod resources

In India operation of high-opening bottom trawls by the Bay of Bengal programme and the Central Institute of Fisheries Nautical Engineering Training along the Gujarat and Tamil Nadu coasts gave encouraging results with the cephalopod catches contributing up to 24.1% of the trawl catch (Swaminath and Vethabothagam 1987).

Depth-wise distribution of cephalopods by bottom trawl conducted by FSI have shown that the west coast is more productive than the east coast (Philip and Somavanshi 1991). Along the west coast good concentrations of squids have been observed at 0-50 m depth followed by 51-100 m and 101-202 m depth zones. However, cuttlefish are uniformly well distributed in the above 3 depth zones. Beyond this there is low concentration of both squids and cuttlefish. Along the east coast depth zones 0-50 m and 51-100 m showed relatively high density of squids. The cuttlefish occurred in comparatively high density in 51-100 m depth.

Joseph (1986) mentioned that the chartered vessels operating in 60 - 80 m depth reported good catches of cephalopods. These vessels have been fishing appreciable quantities of cephalopods ranging from 60 to 80% of the total catch declared by them. One of the chartered vessels obtained a catch rate of 106 kg/hr of cephalopods and a total catch of 120 t along the west coast.

M.T. Murena during the exploratory survey of the north-west coast landed 1 015 kg of cephalopods comprising 761 kg from demersal trawl and 254 from the pelagic trawl which formed 0.2% of the total fish catch (Bapat *et al.* 1982).

Survey of the oceanic waters of EEZ by R.V. Varuna, R.V. Shoyo Maru and FORV Sagar Sampada brought to light about the dense congregations of the oceanic squid *Symplectoteuthis oualaniensis*. However detailed information about the magnitude of this resource is lacking.

Potential yield of cephalopods

George *et al.* (1977) and Joseph (1986) have estimated a potential of 1 80 000 t of cephalopods for Indian EEZ. Chikuni (1983) estimated the cephalopod potential of Bay of Bengal at 50 000-1 00 000 t and for eastern Arabian sea at 1 00 000-1 50 000 t. Silas (1985) estimated the potential harvest of cephalopods by 2000 A D by small neritic sector at 50 000 t and oceanic sector at 25 000-50 000 t. Since the above article was published the inshore production of cephalopods as by-catch reached 43 000 t in 1986 and peaked to 89 482 t in 1992. Alagarswami and Meiyappan (1989a) considered the negative potential projected above as an under-estimate. Philip and Somavanshi (1991) estimated the maximum sustainable yield of squids and cuttlefish from the continental shelf and slope at 49 100 t. The potential yield estimate by these authors is considerably low and they have stated that this could be mainly due to the operational limitation of larger vessels in shallow waters, where the density of the resource is generally high. In the 0 - 50 m depth the potential yield of cephalopods is estimated at 49 634 t (Anonymous 1991). Sudarshan *et al.* (1990) estimated the potential cephalopod yield from 50 - 300 m depth at 20 600 t.

The stock assessment papers presented in this volume on the basis of data collected during 1984-88 from bottom trawls operated at 50 m depth (Meiyappan *et al.* 1993, Nair *et al.* 1993, Rao *et al.* 1993) indicated that in the case of *L. duvauceli* the present level of exploitation is optimum along the east and west coasts of India. However, in the case of *S. pharaonis* and *S. aculeata* the present effort is optimum along the east coast whereas along the west coast there is scope for increasing effort to step up production in the present trawling grounds. Thus for all the 3 species the present level of exploitation has no adverse effect on the stocks. However, the requirement of increasing effort in the present fishing grounds along west coast to increase the production of *S. pharaonis* and *S. aculeata* needs an overall view of all the species exploited in the mixed fishery. This is because an increase in effort to get increased yield of one or a few species, can result in drastic reduction in the yield of other species, some of which may have greater economic value. Thus these studies can be considered as reflecting the current status of the exploited cephalopod stocks.

The cephalopod production in the presently exploited grounds has reached an all time high of 89 482 t in 1992. This is significantly higher than the potential yield estimates for this zone indicated by several authors. This higher production may be, as reports indicate, partly due to the extension of the trawl fishing beyond 50 m depth zone. The potential yield estimates made by several authors, based on bottom trawl operation, have not considered the availability of cephalopods in the columnar, pelagic and oceanic waters. Hence there is need to make an assessment of cephalopods by considering these aspects. Nevertheless, it is generally agreed that, as of now, the cephalopods are exploited at or close to the optimum level in the present fishing grounds and there is vast untapped resource in the rest of the EEZ.

Suggestions for the development of cephalopod resources

It is generally agreed that the cephalopods constitute potentially an important resource in the EEZ of India and concerted efforts on the lines suggested below are needed to realize the potential.

1. Systematic exploratory surveys are required for assessing the cephalopod resources in the deeper neritic and oceanic waters of EEZ.
2. Fishing techniques exclusively to harvest cephalopods are yet to be developed in India. The results of a few squid jigging experiments conducted are inconclusive. Joint ventures with foreign collaboration need to be considered.
3. While estimating potential yield of cephalopods, the resources available in the columnar, surface and oceanic waters need to be considered.
4. Wide gaps exist in our knowledge on the biology of exploited cephalopod species, particularly in the spawning behaviour. For example it is not known whether semelparity (i.e. high post-spawning mortality) exists in the commercial cephalopods of India. Very little is known about the biology of oceanic squids. Such information is necessary for commercial exploitation and management of species.
5. Concurrent with the development of strategies for resource exploitation, post-harvest technologies including product development for non-conventional species need consideration.

BIVALVES

Pearl oysters

From Indian waters 6 species of pearl oysters have been reported and among them, *Pinctada fucata* (Gould) and *P. margaritifera* (Linnaeus) are of commercial value. The former is the most dominant and contributes to the pearl fisheries of the Gulf of Mannar and the Gulf of Kutch.

P. margaritifera is confined to the Andaman and Nicobar group of islands. In recent times a few specimens have been collected from the Gulf of Mannar. The natural pearls are collected from the pearl oysters of the Gulf of Mannar from time immemorial and were exported to Rome and Greece. Alagarswami (1991) updated the work on the pearl oysters of India.

In the Gulf of Mannar, between Kanyakumari and Rameswaram there are about 65 pearl banks known as 'paars'. The paars are located at a distance 12-20 km away from the coast, at 15 - 25 m depth. During 1663 to 1961, 38 pearl fisheries were conducted. In this century, pearl fishery was conducted in 1900, 1908, 1926 to 1928 and 1955 to 1961. Obviously the pearl fisheries are erratic and this is attributed to the decline of fishable quantities of pearl oysters in the pearl banks. Several suggestions have been advanced to explain the decline such as shifting of the sand by bottom currents, colonization of the pearl beds by *Modiolus*, overfishing, overcrowding, diseases and predation by gastropods, octopus, crabs, starfish and fishes.

The Tamil Nadu Government exercises monopoly over the pearl oysters and organizes pearl fishery. The divers hold their breath, descend to the bottom and pick the oysters by hand. The pearl fishing season is from February to May. Each dive lasts for a maximum of 90 sec.

The details of the 1956-61 series of pearl fisheries in the Gulf of Mannar are as follows :

Year	No. of oysters fished	Gross revenue
		(Rs)
1955	3508 967	146 000
1956	2129 058	45 454
1957	11175 214	168 807
1958	21476 514	474 067
1959	16428 298	874 000
1960	16175 839	215 267
1961	15360 928	288 860

SCUB diving was introduced in India in 1958 for the survey of pearl banks in the Gulf of Mannar under the auspices of FAO. The surveys conducted during 1975 to 1985 by the CMFRI showed revival of pearl oyster population in some of the paars, but the yield was not consistent except for 3 or 4 paars. Incursion of uneconomic pearl oyster species to the extent of 10.36% of population has been observed. Also the population was mostly composed of 0-year age group and these young oysters do not yield natural pearls.

The CMFRI developed the hatchery technology in 1981 for the production of pearl oyster spat. The techniques have been standardized, enabling mass production of spat in the Tuticorin hatchery. To enhance the natural stocks the Institute has embarked upon a sea ranching programme of hatchery that produced spat of *P. fucata* in the Gulf of Mannar. During 1985-90, a total of 1 025 300 spat of *P. fucata* have been sea ranched on 17 occasions. The average size of the spat ranged from 1.5 to 5.7 mm. The spat were placed in rectangular box-type cages of 90 cm × 60 cm × 15 cm size, covered with appropriate synthetic net webbing and the cages were lowered to the sea bed in Van Thivu Arupagam, Kurichan and Nagarai paars. Due to practical difficulties in locating the cages, monitoring of the ranched stock and its effect if any on the natural pearl oyster population could not be carried out.

In the Gulf of Kutch, there are about 42 important pearl oyster reefs known as *khaddas* in the intertidal zone at a distance ranging from 1 to 5 km from the coast line. The total area is about 24 000 ha from Sachana in the east to Ajad in the west. Between 1913 and 1967 during the south-west monsoon season 25 pearl fisheries were held. The oysters are hand-picked and the Gujarat Government which exercises monopoly over these resources paid paise 25 for every oyster collected during the 1966-67 fishery. From 1950 to 1967, the average number of oysters fished per season was about 17 000 and the last fishery held in 1966-67 yielded about 30 000 oysters. The highest value of pearls realized from the fishery was Rs 61 693 during 1943-44. Since 1968 there has been no improvement in the population structure of the pearl oyster beds although a few oysters could be gathered.

Windowpane oyster

Among the commercially exploited bivalve molluscs in India the windowpane oyster *Placenta placenta* (Linnaeus) is next in importance to the clams in production. It occurs at several places in soft muddy bottom in shallow bays, estuaries and backwaters. Commercial exploitation is limited to the Gulf of Kutch, Nauxim bay (Goa) and Kakinada bay. The oysters are hand-picked at low tide without any diving aids and a plank-built boat may be used for transport.

In the Gulf of Kutch, Pindara bay is an important production centre. The annual yield is 60 million oysters (Pota and Patel 1988). In terms of weight at 70 g/oyster the production is calculated at 4 200 t (Alagarswami and Meiyappan 1989 b). The standing stock at Goomara, Poshetra and Raida have been estimated at 9,1.2 and 0.1 million windowpane oysters respectively (Varghese 1976). The natural pearls from the oysters are collected and used in indigenous pharmaceutical preparations. The shell accounts for 85% of whole weight and is used in lime-based industries and also in making curios.

The Nauxim bay in Goa supports a minor fishery, yielding 8 000 - 10 000 oysters/day, throughout the year except during the monsoon season (Achuthankutty *et al.* 1979). The annual production is estimated at 100 t. The oyster meat is consumed locally and pearls are not collected.

The windowpane oyster fishery of the Kakinada bay has been studied intensively (Narasimham 1987). It occurs in 40 km^2 area and the population density is low at 2-15 oysters/m^2. The annual production is about 5 000 t. The oysters are fished for their shell and neither the meat is consumed nor the pearls are extracted. The standing stock has been estimated at 12 420 t in 1983. Based on the data collected during 1978-81, Narasimham (1987) studied the population dynamics of *P. placenta* in the Kakinada bay. The parameters of the von Bertalanffy growth equation for length are estimated at L_∞ = 186.6 mm, K = 0.7802 per year and t_0 = — 0.3543 year. The natural (M), fishing (F) and total (Z) mortality rates have been estimated at 1.3, 2.7 and 4 respectively. The age at recruitment (tr), age at first capture (t_c) and fishable life-span are estimated at 0.12, 0.89 and 3.4 years respectively. The study on the yield in weight per recruit showed that at t_c at 0.89 year, the yield increases without reaching a maximum with increased F. Maximum yield can be obtained at t_c = 0.8 year which is close to the current value. It is recommended that the present t_c and F can be maintained with advantage. Also there is no danger of over-exploitation through recruitment overfishing even at higher levels of F since the length at first capture (116 mm) is much greater than the length at first maturity (53 mm).

Edible oysters

In Indian waters 6 species of edible oysters are found. Of these *Crassostrea madrasensis* (Preston), *C. rivularis* (Gould), *C. gryphoides* (Schlotheim) and *Saccostrea cucullata* (Born) are of commercial importance. *C. rivularis* occurs along the Gujarat and Maharashtra coasts and is exploited. *C. gryphoides* is distributed along the north Karnataka, Goa, Maharashtra and Gujarat coasts and is regularly exploited from several creeks and backwaters in Maharashtra. *S. cucullata* is found on rocky substrate in marine environment in shallow coastal and intertidal areas throughout the mainland coast of India and also in the Andaman and Lakshadweep islands. At Worli and Bandra near Bombay 8.75 ha beds of this species have an estimated standing stock of 335.2 t of oysters (Sundaram 1988).

C. madrasensis is the mainstay of oyster fisheries of India. Dense populations are found and exploited along the east coast of India. It is also exploited along the coasts of Kerala, Karnataka and Maharashtra. It inhabits backwaters, creeks, bays and lagoons from intertidal region to 17 m depth. Meat forms 5-10% of shell-on-weight.

A survey conducted by the CMFRI revealed that in 11 water bodies in Andhra Pradesh the standing stock of oysters (mostly *C. madrasensis*) was about 1 450 t, in Tamil Nadu (including Pondicherry) in 21 water bodies at about 23 000 t and in Kerala in 13 water bodies at about 4 000 t. (Satyanarayana Rao) personal communication). Information on the standing stock of oysters from other maritime states is not available. The current annual production of oysters is estimated at 2 000 t.

Based on the standing stock estimates of the oysters there is scope to step up the production of oysters several times. However, the demand for the oyster meat is stagnant as it is not conventionally eaten. Along the Kerala, Karnataka and Maharashtra coasts the acceptance of the oyster meat as food is wider than in the east coast. In Europe, America and Japan oysters are highly esteemed seafoods. In recent times there is awareness about the nutritive value of oyster meat in the country. In Kerala it is sold at Rs 30/kg. Product development and extension work to create awareness about the nutritive value of oyster meat are required to develop market. In 1989 the export of dried oyster shell powder amounted to 160 t valued at Rs 0.112 million (source MPEDA). Apart from oyster shell, there is potential to export the oyster meat. To develop the oyster resources it is necessary to ensure that the areas of oyster beds are free from pollution since oysters accumulate heavy metals and pathogens.

Mussels

Along the Indian coast two species of mussels, viz. the green mussel *Perna viridis* (Linnaeus) and the brown mussel, *P. indica* Kuriakose and Nair, are commercially important. The former is found in small beds at several places along the east coast and extensively along the Kerala coast from Quilon to Kasargod. It is also found in Karnataka, Goa, Maharashtra and the Gulf of Kutch along the west coast. It occurs in the Andamans. *P. viridis* occurs from the intertidal zone to a depth of 15 m. *P. indica* has restricted distribution and is found along the south-west coast from Varkala near Quilon to Kanyakum... and from there to Tiruchkendur along the south-east coast.

Kerala State is rightly called the "Mussel fishery zone of India" since extensive beds of both mussel species occurred in this State. They account for the bulk of mussel production in the country. Mussels are exploited during September-April in Kerala by hand-picking. A chisel or knife is used to dislodge the mussels attached to hard substrate. Men either swim or use a canoe and masks to dive and collect the mussels in waters up to 5 m depth. Kuriakose *et al.* (1988) described the green mussel fishery. In the major green mussel landing centres in Cannanore-Calicut area about 325 full-time and 336 part-time divers, and 340 canoes are deployed. The green mussel production form this area has been estimated at 3 043, 3 074 and 2 597 t during 1981-82, 1982-83 and 1983-84 respectively. The catch per unit effort varied from 44.3 to 60.4 kg/canoe. The standing stock of the mussels has been estimated at 15 887 t in 555 ha of mussel beds. The density varies from 2.25 to 4.5 kg/m^2. In the Majali-Bhatkal area of Karnataka during 1982-83 a total of 36.5 t of green mussels were landed. The standing stock from a 5-ha mussel bed in this area has been estimated at 206 t. At several places in Goa, Maharashtra and a few east coast centres the green mussels are collected for local consumption.

Appukuttan *et al.* (1988) described the brown mussel fishery based on a study conducted during 1982-84. The important fishing centres for *P. indica* are located between Kovalam and Muttom in the southern part of south-west coast of India. About 300 catamarans, 520 active fisherman, 270 part-time are engaged in the brown mussel fishery. The annual production is estimated at 500 t and the standing stock at 1 586 t. The population density of the mussels is 5-8 kg/m^2.

For both the species of mussels the combined annual production works out to 3 400 t against the standing stock of 17 473 t indicating the scope to step up production. A wider section of the population in Kerala consumes mussels. Mussel meat is also used as prawn feed. At Calicut 100 kg of mussel meat is sold at Rs 500 and still it is a low-cost sea food. In 1991, a total of 13.1 t of frozen mussel meat valued at Rs 0.328 million was exported. There is need to explore the export potential of mussel meat.

State	Annual production (t)	%	Dominant species
Gujarat	No data	-	-
Maharashtra	1 103	2.4	*M. meretrix, K. opima*
Goa	887	2.0	*V. cyprinoides, M. casta*
Karnataka	6 592	14.5	*M. casta, P. malabarica*
Kerala	32 927	72.5	*V. cyprinoides, M. casta* P. malabarica
Tamil Nadu	1 087	2.4	*M. casta*
Andhra Pradesh	2 816	6.2	*A. granosa, M. reretrix*
Orissa	No data	-	-
West Bengal	No data	-	-
Total	45,412	-	-

Clams

Among the exploited bivalve molluscan resources of India clams are by far the most widely distributed and abundant. They form subsistence fisheries all along the Indian coast and are fished by men, women and children from the intertidal region to about 4 m depth. They are hand-picked. A hand-operated dredge is also used. Plank-built non-powered boats are deployed for transport.

The commercially exploited clams are *Villorita cyprinoides, Meretrix meretrix, M. casta, Paphia malabarica, Katelysia opima* and *Anadara granosa*. In the Andamans and Nicobar giant clams, *Tridacna maxima, T. squamosa, T. crocea* and *Hippopus hippopus* occur. The former two species have been reported from Lakshadweep also. The annual production data collected by several authors over a period of time have been summarized by Narasimham (1991). These form the basis for the state-wise production given in the Table in the next column.

Kerala State stands far ahead of all maritime states in clam production with a catch of 32 927 t which accounts for 72.5% of the estimated 45 412 t of clam landings. The Vembanad and Ashtamudi lakes are important production centres. Karnataka ranks second with 6 592 t forming 14.5% of clam production.

The black clam (*V. cyprinoides*) accounts for 64%, venerid clams 30.9%, and blood clam (*Anadara granosa*) 4.4% of clam production.

A few studies were conducted on the stock assessment of clams. In Karnataka, based on the surveys conducted during 1979-80, Rao and Rao (1985) estimated the standing stock of clams in 11 estuaries at 5 345 t. During 1984 the standing stock was estimated at 8 027 t in 8 estuaries by Rao *et al.* (1989). These studies showed wide variations in the abundance of clams in some estuaries. In the Karnataka estuaries Joseph and Joseph (1988) estimated the Y max of *M. casta* in Nethravathi-Gurapur at 661 t, in Mulky at 2 581 t, in Udyavara at 1 592 t, and in Coondapur at 8 110 t. The same authors gave Y max of *K. opima* in Mulky at 1 035 t.

In the Kakinada bay during March-May 1983, the standing stock of the blood clam *A. granosa* has been estimated at 6 895 t and that of *M. meretrix* at 1 082 t; these figures are considerably higher than the annual catch of 2 000 t and 400 t respectively. In a detailed study on the population dynamics of *A. granosa* in the Kakinada bay, Narasimham (1988) estimated the instantaneous rates of total (Z), natural (M) and fishing mortality (F) at 3.9, 1.3 and 2.6 respectively. The age at recruitment (t_r) = 0.29 year and age at first capture (t_c) = 1.0 year. This study showed that at the current level of F, reduction of the age at first capture from 1 year (L_c = 41mm) to 0.6 year (L_c = 32.6 mm) gives the maximum yield per recruit. Since the length at first maturity in *A. granosa* is 20 - 24 mm there is no danger of recruitment overfishing at a higher level of effort. These studies indicated that there is a scope to step up clam production in the Kakinada Bay.

Sea ranching of hatchery-produced seed helps to enhance the natural stocks of marine animals. With the development of hatchery technology in clam seed production by CMFRI, a beginning has been made in 1993 to ranch the hatchery-raised seed of *P. malabarica* in the coastal waters of Kerala. A retrieval up to 17% of the ranched stock has been observed after $4^1/_2$ months.

The consumption of clams is generally limited to coastal communities. Export of frozen clam meat began in 1981 and in 1991, 1 231.8 t valued at Rs 37.4 million was exported to 18 countries (source MPEDA). Also 3 t of dehydrated clam meat valued at Rs 8.72 million was exported in 1991. There is considerable potential in the export market for Indian clams.

Exploitation of shell deposits

The subsoil shell deposits, also called lime shell (mostly clams) are exploited for industrial purposes. As is the case with live clams, the data on production of shells pertain to different years and the data as summarized by Alagarswami and Meiyappan (1989 b) and Narasimham (1991) are given here.

The annual production from the Karnataka estuaries (mainly from the Kalinadi, Coondapur and Swarna estuaries) is 62 000 t, Vembanad lake in Kerala 1 48 000 t, Pulicat lake in Tamil Nadu 57 000 t, Vaigai estuary in T N 5 500 t and from other sources 5 500 t, (a total annual produciton of 278 000 t). The estimated reserve of lime shell in Karnataka estuaries is 2 135 700 t, suggesting vast scope to step up production.

Suggestions for the development of bivalve resources

1. Regular monitoring of the fisheries characteristics of the bivalves at important production centres is to be taken up. Stock assessment studies are to be intensified. Publication of atlases and timely dissemination of information on the status of the resources helps the industry to realize the potential.
2. The problem faced in locating the ranched pearl oyster seed is to be sorted and the programme on clam seed ranching in the mainland needs to be intensified. The giant clams are endangered species and have considerable potential for development. Detailed studies on biology and also programmes on the development of hatchery technology, leading to sea ranching of giant clam seed should receive priority.
3. There are reports that dredging of subsoil deposits for collecting lime shell damages the habitat. It is desirable to

demarcate the area for exploitation of lime shell and live clams if they are fished in the same area. In heavily exploited areas, to replenish the bivalve stocks, creation of 'sanctuaries' containing a reserve of the spawning stock is suggested.

4. Bivalves accumulate heavy metals, marine toxins and sewage and pesticide pollutants. It is necessary to ensure that the areas of production are free from pollution. Apart from establishing pollution monitoring in the shellfish growing areas, depuration of the harvested shellfish is advised.
5. Extraction of pearls from the windowpane oyster at Kakinada and Goa is recommended as it is a bonus to the usual earnings from the fishery.
6. The domestic market for clams, mussels and oysters is limited as they are not conventionally eaten. Product development and extension work are required to expand the domestic market. Also foreign markets are to be explored.

GASTROPODS

Chank

The shell of the sacred chank *Xancus pyrum* (Linnaeus) is extensively used in the bangle industry in West Bengal and is exploited from time immemorial. Over 90% of the catch is taken by skin diving in depths up to 20 m. The major resources occur in the Gulf of Mannar along the Ramanathapuram-Tuticorin coast. They are incidentally caught in bottom trawling along Thanjavur-Chingalpet coast, and in hook and lines along Vizhinjam coast. The average annual production in numbers as summarized by Alagarswami and Meiyappan (1989 b) show the catch from the Tuticorin coast as 8 77 000, Ramanathapuram 3 00 000, Thanjavur-Chingalpet coast 40 000, Quilon-Vizhinjam 22 000, Gulf of Kutch 12 000 and Andaman & Nicobar islands 5 000. The overall production comes to 1 256 000 numbers. The minimum size for capture is 64 mm in maximum shell diameter in Tamil Nadu. Devaraj and Ravichandran (1988) estimated the average annual stock in the Gulf of Mannar at 2 million chanks and in the intertidal region of the Gulf of Kutch at 25 000 chanks. The initial stock size varies from year to year. Chank is slow growing with theoretical life-span of 51 years.

Top shell and turban shell

The top shell (*Trochus niloticus*) and the turban shell also called turbo shell (*Turbo marmoratus*) occur in the Andaman and Nicobar group of Islands. These are ornamental molluscs and the shells fetch lucrative price. The union territory is divided into 9 zones and the fishing right in each zone is auctioned. The minimum legal size fixed for *T. niloticus* is 9 cm and for *T. marmoratus* 6.35 cm. The annual production ranges from 400 to 600 t for top shell and 100 to 150 t for turban shell (Appukuttan 1977). Very little information is available on the fishery biology of these two species.

Ornamental molluscs

Apart from the windowpane oyster, a number of clam species and the 3 gastropods mentioned above, several ornamental gastropods occur in the Gulf of Mannar, Palk Bay, Gulf of Kutch, Andaman & Nicobar, and Lakshadweep. The important shells are *Babylonia, Cypraea, Conus, Cassis, Cymatium, Cymbium, Drupa, Fistularia, Hemifusus, Lambis, Murex, Natica, Nerita, Oliva, Pyrene, Strombus, Tonna, Tibia, Umbonium* etc. They are regularly collected, cleaned and marketed, and form the basis for the shell craft articles. Alagarswami and Meiyappan (1989 b) estimated the annual production at 600 t. In 1989, a total of 7.2 t of ornamental shells valued at Rs 0.464 million were exported.

Suggestions for the development of gastropod resources

1. Information on the biology of chank, top shell and turban shell, relevent for resource management is scanty and detailed studies on growth, spawning, recruitment and mortality are needed.
2. The above 3 species are well suited for sea ranching. To augment production, the hatchery technologies are to be developed and sea ranching programmes taken up.
3. In the Gulf of Mannar chank fishery, it is suggested that introduction of SCUBA diving in the place of skin diving would help to exploit the resources beyond 20 m depth.

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REFERENCES

Achuthankutty C T, Sreekumaran Nair S R, Madhupratap M. 1979. Pearls of the windowpane oyster, *Placuna placenta. Mahasagar. Bulletin of National Institute of Oceanography* **12**(3) : 187-189.

Alagarswami K. 1991. *Production of Cultured Pearls*. 1-111 pp. Published by Publication and Information Division, ICAR, Krishi Anusandhan Bhavan, New Delhi.

Alagarswami K and Meiyappan M M. 1989 a. Prospects for increasing cephalopod production of India. *Bulletin of the Central Marine Fisheries Research Institute* **44** (1) : 146-55.

Alagarswami K and Meiyappan M M. 1989 b. Prospects and problems of management and development of the marine molluscan resources (other than cephalopods) in India. *Bulletin of the Central Marine Fisheries Research Institute* **44**(1):250-61.

Anonymous. 1991. Report of the Working Group on Revalidation of the Potential Marine Fisheries Resources of Exclusive Economic Zone of India. Ministry of Agriculture and Co-operation, New Delhi. (mimeo). 57 pp.

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

Appukuttan K K, Nair T P, Josheph M and Thomas K T. 1988. Brown mussel (*Perna indica*) resources on the southwest coast of India and the results of farming experiments at Vizhinjam. *Bulletin of the Central Marine Fisheries Research Institute* **42** (2) : 257-67.

Bapat S V, Deshmukh V M, Krishnamurty B, Muthiah C, Kagwade P V, Ramamritham C P, Mathew K J, Pillai S K and Mukundan C. 1982. Fishery resources of the Exclusive Economic Zone of the Northwest coast of India. *Bulletin of the Central Marine Fisheries Research Institute* **33** : 86

Chikuni S. 1983. Cephalopod resources in the Indo-Pacific region. In : Caddy J F. (ed.) Advances in assessment of world cephalopod resources. *FAO Fisheries Technical Paper* **231** : 264-305.

Devaraj M and Ravichandran V. 1988. Dynamics of Indian Chank fisheries. *Bulletin of Central Marine Fisheries Research Institute* **42** (1) : 100-105.

George P C, Antony Raja B T and George K C. 1977. Fishery resources of Indian Exclusive Economic Zone. *Silver Jubilee Souvenir. Integrated Fisheries Project* **79**-116.

Joseph K M. 1986. Some observations on potential fishery resources from the Indian Exclusive Economic Zone (EEZ). *Bulletin of Fishery Survey of India.* **14**: 1-20.

Joseph M M and Joseph P S. 1988. Biotic potential and environmental resistance of bivalves of Mangalore coast. *Bulletin of the Central Marine Fisheries Research Institute* **42** (1) : 205-209.

Kuriakose P S, Sivasdasan M P and Surendranathan V G. 1988. Fishery and resource of green mussel, *Perna viridis* along the west coast of India. *Bulletin of the Central Marine Fisheries Research Institute* **42** (1) : 24-29.

Nair K N V, Ninan T V, Joseph P J and Jagannadh N. 1992. An account of exploratory sequid jigging of West Coast of India. *Bulletin of Fishery Survey of India* **23** : 1-26.

Narasimham K A. 1987. Fishery and population dynamics of the windowpane oyster, *Placenta placenta* (Linnaeus), from Kakinada Bay. *Indian Journal of Fisheries* **34** (3) : 277-82.

Narasimha K A. 1988. Fishery and population dynamics of the blood clam, *Anadara granosa* (Linnaeus) in the Kakinada Bay. *Bulletin of Central Marine Fisheries Research Institute* **42** (1) : 130-34.

Narashimham K A. 1991. Present status of clam fisheries of India. *Journal of Marine Biological Association of India* **33** (1&2) : 76-88.

Philip K P and Somavanshi V S. 1991. Squids and cuttlefish resources of the Indian continental shelf and slope. *Proceedings of the National Workshop on Fishery Resources Data and Fishing Industry.* Published by Fishery Survey of India: pp 89-97.

Pota K A and Patel M I. 1988. Fishery and biology of windowpane oyster *Placenta placenta* L. in Poshitra, Gulf of Kutch. *Bulletin of the Central Marine Fisheries Research Institute* **42**(1):163-66.

Rao G S and Rao K S. 1985. Survey of clam and oyster resources of some Karnataka estuaries. *Indian Journal of Fisheries* **32** (1) : 74-89.

Rao G S, Kariakose P S, Ramachandran N, Meiyappan M M, Achary G P K, Nagaraja D and Shivanna HS. 1989. Atlas of clam resources of Karanataka. *Central Marine Fisheries Research Institute, Special Publication* **46** : 1-56.

Silas E G. (Ed.) 1985. Cephalopod bionomics, fisheries and resources of the Exclusive Economic Zone of India. *Bulletin of the Central Marine Fisheries Research Institute* **37** : 1-195 pp.

Sudarsan D, John M E and Somavanshi V S. 1990. Marine fishery resources potential in the Indian Exclusive Economic Zone - An update. *Bulletin of Fishery Survey of India* **20** : 27.

Sundaram K S. 1988. Rock oyster resources of Bombay coast. *Bulletin of the Central Marine Fisheries Research Institute* **42** (1) : 29-35.

Swaminath M and Vethabothagam P K. 1987. Transfer of Technology in diversified fishing - a successful Gujarat Story. *Bulletin of the Central Institute of Fisheries Nautical and Engineering Training* **4**:86.

Varghese M A. 1976. Windowpane oyster (*Placenta placenta* Linn.) of the Gulf of Kutch. *Seafood Export Journal* **8**(5): 25-28.