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W. K. S. S.

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P. B. No. 1912, COCHIN-682 018, INDIA

particular reference to the brown mussel. He (1950) had also suggested certain lines of inquiry on the mussel resources for better exploitation. A more detailed account of the resources and the magnitude of the fishery was given by Jones and Alagaraswami (1973). These authors estimated the mussel production by the sustenance fishery around 1000 tonnes. Subsequent to the development of techniques of mussel culture in India (CMFRI, 1978) there has been a growing interest in the country on the exploitation of mussel resources more by culture techniques than by the traditional fishery.

DISTRIBUTION AND EXTENT OF MUSSEL BEDS

The green mussel Perna viridis and the brown mussel Perna indica are the two species occurring along the Indian coasts. P. viridis enjoys a wider distribution along both the east and west coasts of India, including the Andaman islands, whereas P. indica is restricted to the extreme south-west coast, from Varkala near Quilon to Muttom near Kanyakumari. The east coast is relatively poor for the mussel resource and exploitation is nearly absent except in a few centres such as Ennore and Kakinada. On the other hand, there is a rich resource on the west coast where the fishery is of considerable magnitude on the sustenance scale. The mussel distribution follows the presence of coastal or submerged rocks which form its habitat. Based on abundance and level of exploitation, both of which show close correlation, three zones could be delineated along the west coast - a) Ratnagiri to Gangoli, b) Cannanore to Calicut, and c) Kovalam to Muttom. Along the east coast the mussel-bearing rocks are far between and, therefore, no such zonation could be made.

Ratnagiri to Gangoli

This zone lying in the maritime States of Maharashtra, Goa and Karnataka has a dispersed distribution of the green mussel P. viridis which is exploited by the fishermen of the localities on a low sustenance scale. The granite mussel beds are fewer and are submerged. Around Ratnagiri, the green mussel is found in Bhatia Creek, Purnagad, Goa Khadi, Goclankeri, Bathkarwada, Jayatapur and Sakunata. Near Malwan, mussels are collected at Deogad, Mohar and Kochra.

As reported by Rao et al. (1975), P. viridis occurs in Goa scattered all along the coastal region at the river-mouths of Tirakol, Chapora, Mandovi and Zuari. It is in fair abundance in Chapora, Anjuna, Calangute, Aguada, Miramar, Dona Paula (including Cabo-Raj Nivas) and Velsao. In these areas mussels are found over the laterite rocks and granite boulders, sometimes thickly set and sometimes sparse (Rao et al., 1975).

Around Karwar, the mussel is found in Hanavar-Mullukarve, Shedeguli, Gudiangadi, Holangadde, Gangavali, Belambare, Chendia, Binage, Kamath's Beach, Nichanhippal-Majali and around Kuramgad Islands in Karwar Bay. Philipose et al. (1980) have reported that the most important mussel beds of this area are located in Shankarbag, Devagad and Kuramgad areas. In Dakshina Kannada section of the Karnataka coast mussel-bearing rocks are scattered from Gangoli to Kap.

Cannanore to Calicut

The coast of Kerala from Cannanore to Calicut is the virtual mussel zone of India where the abundance of P. viridis and its exploitation are at maximum. Intertidal and submerged laterite or granite rocks form the habitat of the mussel. Table 1 gives details of the mussel fishing centres of this zone along with information on the approximate extent of beds, potential stock and estimated production.

The data have been collected based on detailed enquiries with the knowledgeable local fishermen engaged in mussel fishing at different centres and also from random samples of mussels collected from various beds.

Mussels occur on the coastal rocks in the intertidal zone, man-made granite protection walls and submerged rocks which are either scattered or form continuous stretches of a few kilometres distance and extend in depth upto 12 metres. Collection of mussels is normally restricted to the upper 5 metres in view of abundance of mussels up to this depth and limitations of physical endurance of the divers. The total extent of mussel beds in this zone is approximately 2218 ha, of which 143 ha are in the intertidal region and the rest on the submerged rocky stretches.

Although the limitations of the projections given are admitted and the figures are subject to revision in future, they are indicative of the magnitude of the fishery potential in the absence of more reliable data. In terms of area, the beds at Thikkodi and Moodadi, Chombala, Mahe, Koduvally and Tellicherry are of considerable importance.

Kovalam to Muttom

This zone which is partly in Kerala and partly in Tamil Nadu is well known for the fishery of the brown mussel Perna indica (Jones, 1950). The habitat occupied by the brown mussel is similar to that of green mussel, namely intertidal and submerged rocks. But the coast is exposed to exceptionally heavy seas during the monsoon and in spite of this the mussel thrives in great abundance on rocks from low tide to a depth of up to 15 m. During the recent years, the green mussel P. viridis is also found in this zone to the extent of 5% of the total population. The mussel fishing centres in this zone are Kovalam, Avaduthura, Pulloorkonam, Vizhinjam, Kottappuram, Karimpally, Mulloor,

Pulinkudi, Chowhara, Enayam, Colachel, Kadiapatnam and Muttom. No estimates have been made on the extent of mussel beds in this zone.

Apart from the centres mentioned above, mussel fishery at a low sustenance level is conducted at some centres, such as Chilakkoor, Papanasam and Vettoor near Varkala (south of Quilon), Valiathura near Trivandrum and Kodimunai, Vanikudi, Kurumpanai, Enayam, Enayam-Puthenthurai, Ramanthurai and Kovalam (near Kanyakumari). This fishery is dependent on the brown mussel and the beds are limited in extent. In some centres the mussels are found on the concrete pillars of harbour structure as at Valiathura and Fort Cochin, breakwaters (tetrapod structures) as at Vizhinjam and wave breakers at Varkala.

A recent development relating to the mussel resources is the settlement of green mussel on the stone embankments and groynes laid as an anti-erosion measure along the central coast of Kerala. This resource was identified by Jones and Alagarwami (1973) and surveyed by Nair et al. (1975). At several centres mussels are collected from these rocks either for domestic consumption or for sale.

Along the east coast, mussel resource (P. viridis) as known at present is restricted to a few centres. On the coast of Tamil Nadu, mussels are found at Porto Novo, Mahabalipuram, Cuddalore, Pondicherry and Ennore of which only the estuarine bed at Ennore is of some importance. At other centres, these are found on concrete pillars of jetty and side walls. In Andhra Pradesh, the only known mussel bed is at Kakinada Upputeru to an extent of 1.5 km along the creek. In Orissa, the green mussel is found in the Sonapur backwater on the river Bahudha, conjointly with the edible oyster. From the Andamans, P. viridis has been recorded from Chippighat near Port Blair.

MAGNITUDE OF MUSSEL FISHERY AND PRODUCTION

The mussel fishery of India is of a sustenance nature and is slightly more evolved in the form of a trade in the Cannanore-Calicut Zone with a concentrated market in Calicut. Jones (1950, 1968) has given detailed account of the mussel fishery. The divers reach the mussel beds either by swimming or in canoes depending on the distance of beds and collect the mussels either by handpicking or with sharp tools like chisel. Invariably each diver has a bag tied around his waist in which he keeps the mussel till he surfaces after a dive. Women and children collect mussels from the intertidal rocks. No improvements on the methods of fishing have taken place except that some use locally made masks while diving.

Manpower employed

Jones and Alagaraswami (1973) gave some estimate of manpower employed in mussel fishery. According to them, about 24 to 36 persons are in mussel fishing in Ratnagiri, Malwan and Karwar; 250 full-time and 75 off-time workers in the zone Cannanore to Calicut; and about 690 persons in the Kovalam - Muttom Zone.

Current estimations have been made on this aspect for the last two zones. In the Cannanore-Calicut zone 335 persons are engaged actively in the mussel fishery out of a total 530 mussel collectors. These persons are distributed among the 16 centres referred to in Table 1. Fifty active mussel pickers are from Chombala, 35 from Badagara, 30 each from Koduvally, Mahe and Challium, 25 from Muttungal, 22 from Poyilkavu, 20 each from Tellicherry and Thallai and the rest from other centres. In the Kovalam-Muttom Zone about 790 persons are engaged in mussel picking, of whom 340 are from Vizhinjam area including the centres of Kovalam, Avaduthura, Pulloorkonam, Vizhinjam

and Kottappuram, 225 are from Karimpally, Mulloor and Chowhara, and 225 are from Enayam, Colachel, Kadiapatnam and Muttom. Of the total 790 fishermen, 520 are engaged actively in mussel fishing. Between Varkala and Trivandrum about 45 persons collect mussels.

These figures add up to a total manpower of about 1400 persons engaged in mussel fishing along the west coast. Along the east coast, the manpower may not exceed about 100 persons, including about 50 in Kakinada. Thus mussel fishery offers employment to about 1500 persons in the country. It has to be stressed that the mussel fishing activity is confined only to part of the year, generally November to May along the west coast, with peak season during December-February at most of the centres, and during the rest of the year, they are engaged in other types of small fishing operations or diving for chanks. Even during the season, on many days they go for fin-fishes. All the major religious communities in the coastal region are represented in the manpower and Harijans also from part of it at some centres. Including the dependents, the mussel fishery can be considered to sustain the livelihood of a coastal population of not less than 5000 persons. Compared to the estimations given by Jones and Alagarswami (1973), there has been a considerable increase in the manpower engaged in mussel fishery presently, by approximately 20% which would indicate one aspect of the growth of this fishery.

Production means

Canoes and Catamarans form the main base of the means of production along the west coast. Simple logs are used at Thikkodi and carvel-built boats in Kakinada. The estimates of Jones and Alagarswami (1973) were 170 canoes and 50 logs for the Cannanore-Calicut Zone and 295 catamarans for the Kovalam-Muttom Zone. The present estimates are 307 canoes and 10 logs in the Cannanore-Calicut Zone which shows a considerable increase over the previous figures. Revised estimates have not been made for the other zones.

Production

Jones and Alagaraswami (1973) have given an estimated production of 823.4 tonnes of mussels, of which 321.0 tonnes were contributed by the green mussel and 502.4 tonnes by the brown mussel. According to them, given the limitations of the study, an estimate of about 1000 tonnes would not be wide of the actual figures. Some efforts were made in the present study to update the landing figures through detailed enquiries.

The estimates of production for the Cannanore - Calicut Zone have been given in Table 1. The annual landings of the green mussel in the zone are 2615 tonnes. Chombala, Thikkodi - Moodadi and Mahe are the most important centres, followed by Koduvally and Tellicherry. In terms of extent of mussel beds, manpower employed and canoes used these centres have a lead over others. As against the estimated potential harvest of 7910 tonnes, the present exploitation is only 33.06%, that is one-third of the potential. The average production in the total 2218 ha of mussel beds works out to only 1.18 tonnes which is pitifully low.

The size of mussels harvested and marketed range 40-120 mm, majority of the mussels averaging 75-100 mm.

In the southern zone Kovalam - Muttom, the annual landings of brown mussel have been estimated at 427 tonnes, of which 183 tonnes come from the Vizhinjam area (Kovalam to Kottapuram), 76 tonnes from Mulloor - Chowhara area and 168 tonnes from Enayam-Muttom area. The potential harvestable stock in the first two areas have been estimated to be about 900 tonnes. The landings in these areas account for only 28.8% of the potential stock. The yield in terms of area works out to about 14.9 tonnes per ha.

TABLE 1. Extent of mussel beds (ha) and estimated annual production (tonnes) at different centres in the Cannanore-Calicut Zone.

Centre	Extent of mussel beds (ha)		Estimates of production(t)	
	intertidal	deeper water	Exploited	Potential
Azhikkal	-	9	15	30
Cannanore (Moppila Bay)	3	20	12	40
Mythanapally	-	20	36	60
Koduvally (Dharmodom)	5	200	260	900
Tellicherry	30	125	220	600
Thallai	20	80	180	400
Mahe	30	300	360	1100
Chombala	-	400	600	1200
Muttungal	-	80	125	380
Badagara	-	5	13	30
Thikkodi & Moodadi	40	700	420	2400
Kollam	4	16	20	100
Poyilkavu	3	10	26	60
Elathur	3	30	88	160
Calicut (South Beach)	-	20	90	100
Challium & Beypore	5	60	150	350
Total	143	2075	2615	7910

The size of mussels harvested remains small at 40-65 mm. Due to the great demand for mussels, there has been indiscriminate fishing resulting in the removal of stocks before they reach the normal harvestable size. The large sized mussels, called 'Muthuva', in the range 70-90 mm contribute only to a small portion of the landings.

Revised estimates of production have not been made for other centres, except that the annual production of the Ennore bed may be around 5-7 tonnes and from other centres of Tamil Nadu about 5 tonnes.

In the light of the data presented here it is worthwhile to update the Indian mussel production figures against those provided by Jones and Alagarwami (1973) which were based on data collected in 1968. In the case of centres for which current figures have not been estimated, a nominal increase of 10% over the figures given by Jones and Alagarwami (1973) has been made. The data are presented in Table 2. The total estimated annual production of mussels is about 3079 tonnes. This is over three times the estimate of Jones and Alagarwami (1973). It has been mentioned earlier that the production accounts for only about one-third of the potential stock in the two important mussel zones of the south west coast. The scope for increasing production to thrice that of the present level becomes evident.

TABLE 2. Estimates of mussel production (annual landings in tonnes)
in India.

Zone/Centre	Species	Production (t) of mussels (Shell-on)
Ratnagiri to Gangoli	<u>P. viridis</u>	17
Cannanore to Calicut	<u>P. viridis</u>	2615
Kovalam to Muttom	<u>P. indica</u>	427
East Coast Centres (Cuddalore, Pondicherry, Ennore and Kakinada)	<u>P. viridis</u>	20
Total		3079

CONSTRAINTS AND PROSPECTS FOR DEVELOPMENT OF
MUSSEL FISHERY

With the availability of technology for mussel culture, the development efforts in future would be towards encouraging production of mussel through farming, particularly in view of the fact that the yield in culture is very high. However, till an organised industry with capital and all infrastructure facilities develops, the natural fishery will continue to play its role. It has been the experience in India that the artisanal fisheries cannot be totally replaced by modern fishing techniques and this might also be relevant to the mussel fishery.

The present mussel fishery is at sustenance level and is carried out by certain families traditionally engaged in mussel picking. The fishery is carried out only during fair weather outside monsoon and mostly it is a part-time occupation. Except in Cannanore-Calicut and Kovalam-Muttom zones, the fishery is of a casual nature. The mussel divers in the Colachel-Muttom area prefer to go for Chank diving which gives higher returns than for mussel collection. The governmental assistance to mussel fishery is nil. There is an urgent need to have a fresh look at the problems of the mussel fishery and assist its development in view of the fact that it supports the livelihood of a few thousand people in the coastal sector.

The production problem will relate to providing assistance towards conoes/catamarans which form the only inventory requiring capital. Marketing of mussels is another aspect which deserves attention. In view of the demand in centres such as Vizhinjam and Calicut the daily collection of mussels are sold out readily but it is not so at other centres. Trucks are engaged to move the mussels from as far as Mahe to Calicut and therefore a good portion of the returns goes to the hands of middlemen who are engaged in the trade. There is

no organised set-up among the mussel pickers for taking care of their interests.

Some efforts have already been made towards development of processed products of mussels. This needs further attention to put them into commercial practice. At present the mussels are marketed fresh without subjecting them to any purification process. Simple and effective depuration techniques will have to be evolved and practised to maintain higher hygienic conditions. Serious efforts must be made for exploring export market for the mussel products so that more remunerative price could be realised for the raw mussel. There is also need for enlarging the consumer sector through appropriate demonstrations and follow-up action.

Further development of the mussel fishery towards realising the indicated potential would largely depend on providing the services mentioned above on a collective or cooperative basis. This could be attempted at least at the most important centres of mussel fishery in the Cannanore-Calicut and Kovalam-Muttom zones to begin with and extended to other centres on a planned programme.

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