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ON

LIVING RESOURCES *of* THE SEAS AROUND INDIA

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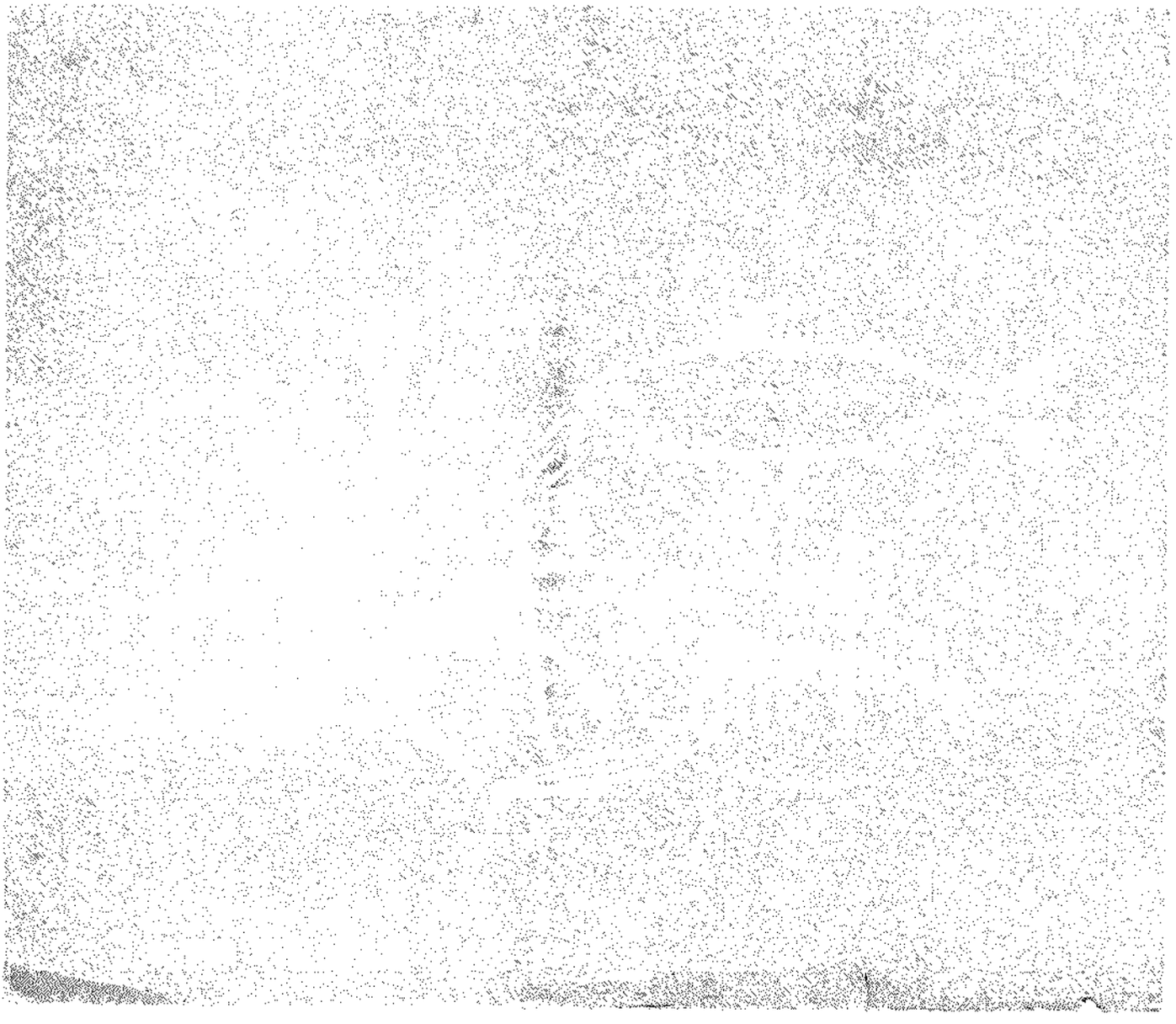

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MUSSEL FISHERY RESOURCES OF INDIA

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ABSTRACT

In the recent years there has been a growing world interest to develop mussel fisheries in various countries which sustain fairly adequate mussel resources. Holland and Spain, the two leading countries in mussel production, have developed simple but effective techniques of mussel farming and together account for about 80% of mussels caught in the world. In India, in common with the other molluscan shellfishes, mussel fishery is still in an underdeveloped state, mussels being collected by hand-picking from the exposed rocks or diving in shallow waters.

There are two species of mussels, the commoner green mussel and the brown mussel, both belonging to the genus *Mytilus*. While the former is widely distributed on the east as well as west coast the latter has a restricted distribution in the Kanyakumari-Tinnevely coast of the Madras State and the South Kerala Coast. Almost all the rocky stretches, including the breakwaters, piles, etc. laid by man, along the coast from the shoreline to a depth of 6–8 m. harbour mussels and the west coast contains more mussel beds than the east coast. Adequate statistics are not available on the mussel landings and their size composition. In this article an attempt is made to assess the extent of presently known mussel resources objectively. The need for obtaining necessary biological data is stressed. Systematic farming of the mussels by collecting the seed and growing them in sheltered areas will increase the production at least fivefold. Enhanced production will also open up scope for mussel canning. The possibilities of developing mussel fishery as an organized industry by a more scientific utilization of this potential resource are pointed out.

INTRODUCTION

WORLD production of sea-mussels stood at 2,82,900 m tons in 1966, next only to oysters and clams among the molluscan shellfish. The major mussel producing countries are Holland (90,000 to 1,00,000 m tons), Spain (1,00,000 m tons), France (30,000 m tons), Denmark (19,000 m tons) and Germany (11,000 m tons). The species that contribute to the fishery in various countries are *Mytilus edulis* and *M. galloprovincialis* (the latter being considered by some authors as only a variety of the former) which are widely distributed in the North-West, West Central and North-East Atlantic and Mediterranean, *M. perna* in the West Central Atlantic, *M. californianus* in the North-east Pacific, *M. smaragdinus* and *M. crassitesta* in the North-West and West Central Pacific, *Choromya choro* in the South-east Pacific, *Aulocomya* sp. in the Chilean Coast, *M. planulatus* in the Australian waters, *M. canaliculatus* in the New Zealand waters, *M. viridis* and *Mytilus* sp. (brown mussel) in the Indian waters, the former also occurring in the Malayan region.

In the European countries mentioned above mussel culture which is practised in various ways accounts for a considerable portion of the total production. The simplest of all methods involves transferring mussels from the slow-growing deeper waters into areas near low water mark from where they are collected either by hand-picking or raking. A slight improvement over this method is collecting mussel spat from the natural grounds and transplanting them into sheltered bays where there is an abundance of planktonic food. The mussels are harvested from these areas by dredging

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as done in Holland and U.K. A method known as "bouchot" culture is in vogue in the middle section of the Atlantic coast of France. In this method rows of poles are driven into the sea bottom. The spat settles on the poles. The young ones later are transferred to other "bouchots" for growing and fattening. A major development in mussel farming that has happened in the recent years is the raft culture developed in Spain. This method introduced for the mussels of the Galician bays has proved a tremendous success and there are more than 2,600 culture parks in the bays now (Andreu, 1968). In this method ropes are hung from anchored rafts in the natural grounds and the spat settles on these ropes. In seasons when spat settlement does not take place on the ropes they are collected from natural rocky beds and littoral cliffs and are placed on the rope and secured by a very fine net. When the spat grow and overcrowd the ropes they are thinned out by transferring some to new ropes. The commercial size of about 75 mm is attained after a year's time (Andreu, *op. cit.*).

It is unfortunate that India has not caught up with the growing world interest to increase the mussel production by adopting suitable methods of culture. This situation has been mostly due to our pre-occupation with development programmes on the piscine fisheries. What little information we have on the mussel resources of India are from the works of Hornell (1917, 1922) and Jones (1950, 1968 *a, b*). The observations made in the present paper can be said to be only of a preliminary nature and a more detailed study on a regional basis is needed to understand the problems relating to the development of the mussel fishery.

Sea-Mussel Resources in Indian Waters

Two species of sea-mussels occur in Indian waters: the green mussel, *Mytilus viridis* Linnaeus and the brown mussel, *Mytilus* sp. The green mussel has a wider distribution occurring all along the Indian coasts wherever submarine or intertidal rocky stretches are present. But on the south-west coast of Kerala from Varkalai, South of Quilon and on the Kanyakumari and southern Tinnevely coasts the brown mussel replaces the green mussel in abundance though the latter occurs in stray numbers. The sandy nature of most part of our coasts preclude the settling of mussels but wherever rocks are present in natural formation or laid by man in construction of harbours, for instance, Madras and Cochin harbours, or to ward off sea erosion as along the Kerala Coast, planktonic larvae settle as spat and grow. It would either indicate the presence of mussel beds in slightly deeper waters not known at present or that the larvae drift long distances from the adjacent regions along with the coastal currents and settle on suitable substrata when made available.

Considering the distribution of mussels State-wise, it is seen that along the Gujarat Coast there are no mussel beds. In Maharashtra State, Ratnagiri and Malwan are the important centres for the green mussel and in Bombay though it does not occur in abundance a few could be collected. Around Ratnagiri, mussels are found in Bhatia creek (near Rajewada), Purnagad, Goa Khadi, Goolamkeri, Bathkarwada, Jayatapur and Sakunata. The mussel-bearing rocks are submerged and are not extensive. The mussel is known in this area by various local names like "Kakai", "Vakunda", and "Shintana" of which the first is the most popular. Around Malwan mussels are collected along with other shellfish at Deobag, Mohar and Kochra. The local name in these centres is "Kulachi".

In Mysore State, around Karwar, mussels are found in Hanavar-Mallukarve, Shedeguli, Gudiangadi, Holangadde, Gangavali, Belambare, Chendia, Binage, Kamath's Beach, Nichanhippal-Majali and around Kurmgad Islands in Karwar Bay. In the South Kanara section of Mysore coast from Gangoli to Kap the rocky stretches harbour mussels. The local name for the green mussel in these centres is "Neel-Kallu".

It is along the Kerala coast the mussel fishery has attained a high significance because of the presence of extensive beds and the culinary preference of the people for the mussel. From

Kasargod in the north to Varkalai Cliffs near Quilon in the south the green mussel is profusely distributed in all the rocky areas, the most important mussel centres being in the northern section from Cannanore to Calicut. The mussel fishing centres in this sector are Cannanore (Moppilla Bay), Dharmadom, Tellicherry, Thalai, Mahe, Chombala, Badagara, Tikkodi, Valavilkadapuram (Kadaloor), Kollam, Elathur, Puthiyappa-Puthiyangadi, Calicut, Kappakadavu, Chaliam and Beypore. In each of these centres the mussel bed extends from 100 to 400 m. In the central section of Kerala, *i.e.*, from Beypore to Alleppey the mussels are rare as the coast is mostly of a sandy nature. But at Fort Cochin thick growth of green mussel is seen on the breakwaters. A remarkable feature observed in the recent years is the carpet-like spatting of mussels on the rocks laid along the shore for protection against erosion. This phenomenon implies great possibilities of augmenting the mussel production by giving suitable settling surface in potential areas where mussels are not known to occur at present. At Alleppey Port green mussels are present on the piles of the pier extending into the sea. At Varkalai both the green and brown mussels are present but south of Trivandrum the predominant species is the brown mussel. Centres where mussels are collected are Kovalam, Avaduthura, Cheriamannu, Vizhingam, Mathilpuram, Chevvara, Mullorkodi and Kalladi. These centres are adjacent to one another and can be considered as a continuous rocky stretch with intermittant sandy patches. Apart from the coastal rocks, submarine rocks at a distance of about 300 m from the shore and at a depth up to 15 m bear dense growth of mussels. Along the coast of Kerala the green mussel is known as "Kallumakai" the young ones by the name "Kadukka" and the brown mussel as "Chippi" when small and as "Muthuva" or "Muthuva Chippi" when large.

Along the Madras Coast the brown mussel occurs from Colachel to Cape Comorin at Kodimunai, Vanikudi, Kurumpanai, Enayam, Enayam-Puthenthurai, Ramanthurai, Kadiapatnam, Colachel, Muttom and Kovalam (near Kanyakumari). Some of the submarine rocks are quite extensive up to about 800 metres in extent, as wide as 70 m occurring at a depth of about 7 meters. The Colachal—Muttom area has the most productive mussel beds in this region. The green mussel is found in stray numbers. The brown mussel is locally known as "Thodu", "Kallika chippi" or "Muthuva Chippi". Along the east coast of Madras from the north Tinnevely Coast mussel beds are not known to occur except for small beds of green mussel in the Madras Harbour and Pulicat Lake. The bed near the Harbour at Kasimedu is about 100 m in length, and 15 m in breadth and lies at a depth of about 3 to 4 metres. In Ennur backwaters the green mussel occurs conjointly with the oyster. The vernacular name for the mussel around Madras is "Aali".

In Andhra Pradesh, Kakinada appears to be the only Centre where mussel beds exist. In the Kakinada Upputeru for about 1·5 km along the creek mussels are collected. The green mussel is locally known as "Aalichippalu". In Orissa and West Bengal States no mussel fishery has been reported as the coast is sandy for most part.

Fishery, Production, Utilisation and Marketing

Fishery

The fishing methods are comparatively simple and can be grouped under three categories: (1) collecting mussels from rocks on the shore, (2) swimming to reach the rocks, and 3) by going in boats or canoes and diving. The first method is employed mostly by women and children during receding tides and only men engage in the second and third methods. The mussels are either hand-picked or removed with the help of simple iron implements like chisel with or without a wooden handle or a knife. In the case of the diving method the collected mussels are placed in a coir bag tied around the waist of the diver and on coming up emptied into a basket. Though mussel fishing is carriedout generally as an off-time occupation by fishermen, in the seasons when they cannot go out into the sea for other fishery and during the peak abundance of mussels most of them are engaged full time solely diving for mussels. The fishing duration varies depending on the demand and availability, but it is generally from about 8 or 9 A.M. to 2 or 3 P.M. Low tide, calm water and clear sunny days are preferred.

In Ratnagiri area boats are used to reach the mussel-bearing rocks and about 15 to 25 persons are engaged in the fishery. The fishing season is from November to April with maximum activities in November-December. In Malwan hardly one or two canoes are used and only 4–5 persons engage themselves for mussel fishing during September-May. In Karwar 5-6 persons go for collecting mussels and the season is from December to May.

It is in the Cannanore–Tellichery–Mahe–Calicut section that the mussel fishery is carried out on an extensive scale. During the fishing season which extends from November to May about 170 canoes and 50 logs are in operation and about 250 men are engaged in full-time occupation and about 75 on an off-time basis.

In Fort Cochin area the collection is done from the coastal rocks and canoes are not engaged. The season is from December to May. In the Vizhingam area about 25 catamarans are in operation. About 100–150 persons collect mussels in the season from November to May with a peak in January-February.

In Colachel-Muttan area about 250 catamarans are in operation. Each craft carries generally a crew of 2, each diving in turn on reaching the mussel beds. The beds are reached also by swimming. The fishing season extends from November to April. While big mussels are removed at the beginning of the season, towards the end only smaller ones are available.

At Cape Comorin and Kovalam nearby, about 20 catamarans are employed to reach the rocks. Diving is not generally resorted to, the mussels being hand-picked from the exposed rocks.

On the east coast at Madras the fishermen swim to the rocks, dive and collect the mussels. The bed being limited in extent only about 10 persons are engaged off time during the season from January to September.

At Kakinada about 6 carvel boats are used for mussel fishing each boat carrying 6 or 7 divers. The total number of persons engaged in mussel fishing is about 50. The peak of the fishing season is May. At Sonapur the mussels were once exploited more for the small pearls than for food, but this fishery does not exist at present.

Production

It is well nigh impossible to attempt to estimate the mussel landings of India as the required basic data on the mussel fishery is not available. However, a questionnaire circulated among the survey staff of this Institute has brought in some information on the landings at some of the centres and from this an attempt has been made to compute an all-India figure. It should be stressed here that the figures furnished here are provisional based on rough estimates.

Based on the number of fishermen engaged in mussel fishing at each centre, the average number of mussels collected on each fishing day and the approximate number of active fishing days the figures for the areas as given in the table on next page have been computed.

This estimate is likely to be erring on the low side as the factors used in the computation are based on information obtained from the fishermen at various centres and for other centres even such basic data were not available for computation. It is, however, believed that an estimate of 1,000 m tons as the total marine mussel landings of India will not be wide of the actual figures. It is proposed to improve this situation by devising a suitable sampling scheme.

Utilization

Mussel meat is consumed as food by fishermen and among others by those who cannot afford to buy other fishes. But there are a few centres like Tellicherry, Calicut, Vizhingam and Colachel

(all figures in m tons: weight with shell)

Ratnagiri	.. ..	1·4
Malwan	.. ..	1·0
Karwar	.. ..	1·2
South Kanara	.. ..	12·0
Calicut-Cannanore	.. ..	290·0
Cochin	.. ..	6·0
Vizhingam	.. ..	180·0
Colachel-Muttam	.. ..	300·0
Cape Comorin	.. ..	22·4
Madras	.. ..	2·4
Kakinada	.. ..	7·0
	TOTAL ..	823·4

where even the well-to-do have taken a liking for it. In Ratnagiri mussel is considered the next best to oysters among the shellfishes. Mussels are boiled to get the shells opened and the meat is fried in oil with condiments or made into curry. In some cases the meat is sun-dried for later use. Raw mussel is occasionally eaten by those accustomed to it. Mussel meat forms bait in hook and line fishing in Ratnagiri area and crushed mussels are used as bait in lobster traps in Colachel-Cape Comorin area. The shells are burnt in kilns and converted into lime, along with those of other species.

Marketing

The mussel catches are disposed of at the landing centres to the consumers and merchants. The latter, mostly women, either hawk door to door and sell or take the commodity to the market. The mussels are sold with shell, in counts. The market price varies from place to place and depending on the size and on the availability of other food fishes. Generally the range is 50 P. to Rs. 2 per hundred. In Kakinada the mussel fetches a higher price of up to Rs. 4 per hundred. The earnings of a fisherman per day ranges from Rs. 2 to Rs. 12 depending on the quantity caught and the prevailing demand.

MUSSEL POLLUTION

Not much is known on the problem of mussel pollution in India except a single instance near Calicut where the Korapuzha river discharges into the sea (Venkataraman and Sreenivasan, 1955). In the above case faecal pollution has been observed mainly during the south-west monsoon (June-August) when the rain water carries the town refuse into the sea.

In the light of the above it is interesting to consider a common belief of the Calicut mussel consumers that the mussels during the south-west monsoon season are poisonous or unwholesome. Some of them attribute this to the turbidity of the waters and the presence of sand and mud inside the mantle cavity while others hold the lowering of salinity of sea-water during this season as the contributory factor. There is yet another belief that the commensal crab, *Pinnotheres* sp. present in the mussels in increasing numbers during the monsoon season makes the mussel poisonous. Korringa (1952) refers to a similar belief that prevails in Holland that *P. pisum* is responsible for bringing about nettlerash in those who consume *Mytilus edulis*. He concludes that no special flavour

has been noticed in mussels containing *Pinnotheres* and there is no justification for assuming that *Pinnotheres* has anything to do with the allergic reaction seen in some people after eating mussels. The necessity for a thorough clinical investigation of this problem is indicated as a belief like this, if goes unchecked by scientific means, may bring about a fall in demand of the mussels.

Future Prospects of Mussel Fishery in India

The mussel fishery in India has not been influenced in the least by the growing scientific knowledge in the West on the rational exploitation methods of this resource. Fortunately the mussel beds do not seem to have undergone depletion despite the fact the mussels have been harvested fairly intensively in at least centres around Calicut, Vizhingam and Colachel. The settlement of young mussels on the freshly laid rocks against sea erosion along the central Kerala coast also suggests the presence of beds which may lie beyond the exploited sectors. Mussels are prolific breeders attaining maturity within 1½ months at a length of 15·5 mm. (Paul, 1942) and spawn with an extended duration with a peak from June to August and a secondary spurt in October and November (Jones, 1950). That the planktonic larvae settle on any clean surface, may it be rocks, tiles, hulls of ships or ropes is a well-known fact. The growth rate of mussel in Indian waters is very high attaining 34·5 mm. in 84 days, 52·0 mm. in 164 days and 113·0 mm. in 243 days (Paul *op. cit.*) the last two groups generally forming the commercial sizes. This reflects the immensely high potential of the Indian mussel compared against the European mussel, *Mytilus edulis* which takes about 2½ years to reach the marketable size of 60–65 mm. in Wales and about a year to reach 75 mm in Spain. The food chain of mussel is a short one from primary production through plankton to mussel.

The above information goes to show that the mussel potential of India is considerable and the present rate of exploitation does not cause any fear of depletion. Taking the protein requirement of our people it is necessary that the utilisation of mussel protein should be considerably increased. The answer to this problem lies in developing the mussel resources in scientific ways. Increase in yield could be obtained by (1) intensifying the present rate of exploitation with the existing methods (2) introducing mechanisation, (3) locating new beds by surveying and (4) resorting to culture practices. Before attempting the first two methods a sound knowledge on the production and optimum yield is necessary as otherwise the beds are likely to be depeleted. A survey of the submarine rocky areas within the 20 m depth limit may bring to light unexploited beds. A survey of the known and hitherto unknown mussel beds is very much needed before launching any expansion programme.

On the other hand adopting the culture method necessitates the collection of spat or the seed mussel which is available in plenty in the vicinity of the natural beds and rearing them in suitable areas up to commercial size. The major mussel producing countries like Spain, Holland and France have developed specialised culture methods as already referred to. Raft culture as done in Spain, though has the advantage of relative freedom from predators and faster growth, involves greater capital investments. Also the monsoon conditions along the west coast from June to August preclude leaving rafts in the coastal waters. Sheltered and calm bays both along the east and west coasts are too few to embark on large-scale raft culture. However on an experimental basis the raft culture could be tried in one of the bays like the Karwar Bay.

Ground culture method as practised in U.K. and Holland appears to be more practicable under the Indian conditions. The natural spat could be collected and relaid in productive areas. Also suitable cultches like rocks, tiles etc. could be laid in areas adjacent to natural beds to facilitate settlement of spat.

The primary production of the coastal waters around India has been estimted to be high with a production rate of 2·0–4·5 g C/m³/day off Cape Comorin, more than 5 g C/m³/day off Tuticorin and a much higher rate around Minicoy (Prasad, 1967). Compared to this, the rate of primary

production in the Galician bays is low between 0·07 and 7·6 g C/m²/day with an annual average of 0·9 g C/m²/day (Andreu, *op. cit.*) which sustains an annual production of about 100,000 tons of mussels. The present exploitation of mussels in India is pitifully low. Even with ground culture a very conservative estimate will be the possibility of increasing the present rate of commercial production at least five times in the immediately ensuing years.

From the industrial point of view the mussel could offer material for canneries. In Spain about 20% of mussel production is used for canning (Andreu, *op. cit.*). A preliminary trial of canning mussels in oil and brine has shown that the oil-preserved sample was in good condition and gave better taste (Jones, 1968 *b*). With the increased production of mussels the canners could play a useful role by starting mussel canning. With these developments a thorough quality control programme will have to be introduced for screening mussels for the market. Much on the biological aspects of the mussel remains yet to be done.

Though the present account deals with the resources of the true mussel of the genus *Mytilus* it will not be out of place to refer to the potential resource of the weaving mussels of the genus *Modiolus* which form extensive carpet-like beds especially in the Palk Bay and Gulf of Mannar (Hornell, 1922). Though it seldom grows more than 2·5 cm. in length the enormous quantity suggests the possibilities of commercial utilization of this resource for food or chick-feed or manure.

Among all the molluscan shellfishes of India, mussels offer tremendous scope for development. The Central Marine Fisheries Research Institute is presently interested in this problem and in the coming few years a clear picture of the mussel fishery resources is expected to be obtained.

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