VII ECOLOGY OF PEARL OYSTER AND CHANK BEDS

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The Gulf of Mannar and the Palk Bay zones of the southeast coast of India, the Halar coast of the Gulf of Kutch especially the reefs of Sachana, Salaya, Piroton, Ajad etc. and a narrow strip in the extreme southwest coast of India from Colachel to Trivandrum are all places where either the chanks or the pearl oysters or both occur in fairly large numbers. In addition to the above, chanks occur along the Coromandal coast upto Madras although this stretch is of minor importance. In some places in Andamans also chanks occur in limited quantities. Of all the places the most productive areas, as far as the pearl oysters are concerned, are located in the Gulf of Mannar and very rich chank beds exist both in the Gulf of Mannar and in the Palk Bay. Naturally much attention has been focussed on these two regions to study the fisheries and ecology of these two commercially important molluscs as evidenced by the works of Hornell (1914, 1916, 1922a), and Mahadevan and Nagappan Nayar (1966, 1967, 1968). Very little is known about the other areas except for Hornell's report (1909) on the marine biology of the Okhamandal coast of Kathiawar.

Herdman's reports (1903–1906) deal with the pearl fisheries and the fauna of the pearl oyster beds, exclusively of the Gulf of Mannar along the Ceylon coast and Thurston (1896) and Hornell (1922a) have given the first evaluation of the faunistic condions of the paars in the Gulf of Mannar of the Indian coast. It appears that the faunistic and topographical features are identical for both the coasts. While writing about the Ceylon oyster beds it was opined by Hornell (*vide* Herdman, 1905) that considerable changes take place periodically in regard to the sea-bottom there. If so the same might apply to the paars along the Indian coast also. It was not known whether any such notable changes had taken place in the long interval that had elapsed since Hornell (1922a) published his hypothetical diagrams of shapes of the pearl oyster beds and chank beds along the Indian coast of the Gulf of Mannar and if so to what extent. Therefore it was deemed necessary to undertake a survey of the sea-bottom of the most productive zones on scientific lines to chart the locations and extent of the paars and chank grounds and also to study the general ecological features. For this purpose direct underwater observations by Aqualung diving were undertaken by the authors between 1962–64 and again from 1968 onwards. In addition to the

above regular programme of work it was also possible to study the conditions of the pearl oyster beds and chank beds in the Palk Bay zone also, although restricted to cursory surveys, especially off Rameswaram and Tondi since periodical rumours were set afloat by the local fishermen that pearl oysters existed in great abundance in these areas.

The following account is the summary of the observations thus made and gives a picture of the ecological conditions as they exist now. Underwater photographs taken during the studies are given in Pl. I A-D and Pl. II A-D.

ECOLOGY OF PEARL OYSTER BEDS

A. Gulf of Mannar zone

The submarine plateau of the Gulf of Mannar bordered for the most part by the 15 to 25 m line widens greatly in the northern part of the Gulf as it approaches Pamban. This surface of the plateau is mostly sandy with outcrops of the rock or paar generally in the form of flat or slightly inclined ledges, occasionally forming low terraces, sometimes level with the surface and sometimes a few cm below it, the rock being then covered with either a thin or a thick layer of sand as the case may be. Right from Cape Comorin up to Pamban, at the head of the Gulf, there are about 65 paars (Hornell, 1922a). Many are extremely small and known to be only about a few hundred sq. metres in area. They owe their separate entities to the detailed local knowledge of the fishermen engaged in ordinary fishing. Hornell (*op. cit.*) divided these paars into 3 divisions viz., Northern or Kilakarai, extending from Adam's Bridge to Vaipar, the Central or Tuticorin from Vaipar to the latitude of Manapad and the Southern or Comorin from thence southwards to Cape Comorin. Of these, the central division is by far the most important in view of the fact that out of the 40 pearl fisheries that had taken place between 1663 and 1961 all but one fishery had been in the paars located in this division. Further this division contains paars of larger extent and hence have produced most of the recorded fisheries. Hornell's (*op. cit.*) diagrams of the paars of this division (Fig. 13 A and B) show the approximate disposition and extent of the various paars in this area. The paars in other divisions are considered as unimportant since most of them are unproductive and are always covered by turbid waters even during the most favourable season with long swells at the bottom throwing up the bottom silt in suspension with the consequence that the area constitutes a negative force for the healthy survival of pearl oysters. Therefore in order to get an idea of the typical conditions of the oyster beds the central division (Fig. 14) was first chosen for the study.

As already explained the widening of the plateau in the north allows the paar in the central division to form two series from Manapad northwards upto

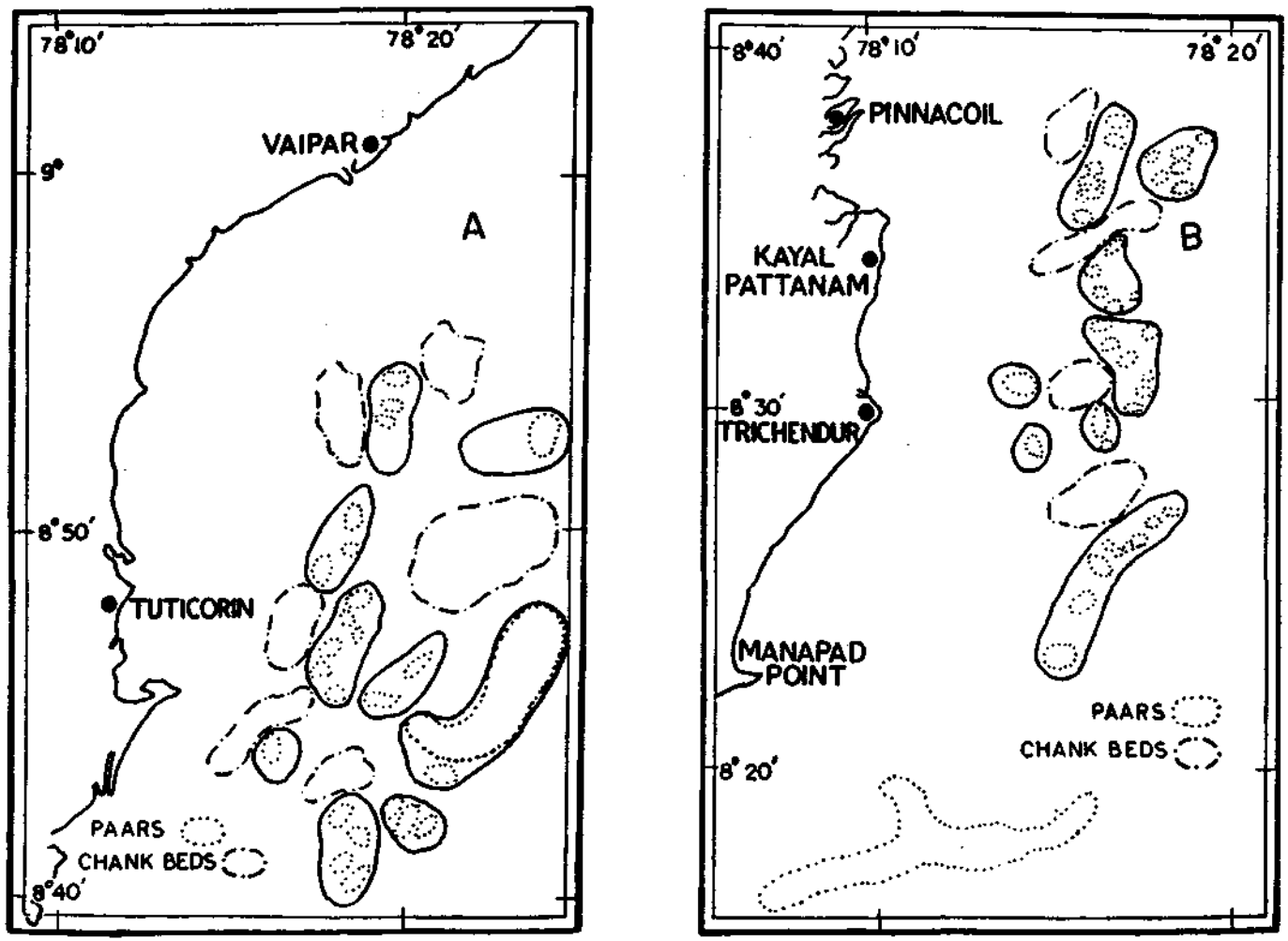

Fig. 13. Showing the paars and chank beds as given by Hornell (1922a) for the region 8°00′ N lat. and 9°00′ N lat. A. Chart of the northern half of the Central division. B. Chart of the southern half of the Central division.

Vaipar, one in shallow water from 10–14 m and the other at 19–23 m roughly parallel with the coast, the inner being at about 9 km distance from the coast and the outer 18 km from land.

The general physical and faunistic features of the paars lying on the inner series within 14 m range appear to be same throughout. However, here and there interesting differences do occur. The sea floor is essentially of sand grains of coarse nature, but broken up by multitude of rocky outcrops of loose blocks of calcrete of various sizes; elsewhere there are fragments of corals black or brownish in colour.

Dead shells with rounded-off edges mixed with bits of *Porolithon* sp. and *Halimeda* spp. are also found. In some areas the rock may be of grit stone cemented by carbonate of lime as in the area off Manapad. In the northern areas, however, very often the eastern fringe of the paar is seen very distinctly, especially in the areas off the small islands north of Tuticorin well-demarcated because of the elevated rocky edge dropping vertically down to the adjacent sandy ground, the deep undercuts of the shelfs of the rock sand interface housing lobsters and varieties of large-sized perches. It is also not uncommon to see laminated rocky flats devoid of crevices or fissures over which coarse sand is spread all over. Large drifted shells such as *Bulla* sp., *Pinctada fucata* (Gould), *Pecten* spp., *Arca* spp., *Anomia* spp. and *Turritella* sp., all in worn out state, make up the coarse material. In addition to these, foraminifers of *Textularia* sp., *Pulvulina* sp. and *Heterostegina* sp. are commonly found intermingled.

The area is subjected to heavy oscillations at the bottom always because of the nearness to the shore-line. The water over the beds is very often turbid even during fair weather. The proportion of mud in the sand is greater than in the outer series. This might be due to the vicinity of the embouchure of the Vaipar, Vembar and Tambaraparni rivers. This feature combined with the oscillation experienced in this area is likely to adversely affect the settlement and survival of the pearl oysters.

Characteristic of the area is the dense growth of sponges, especially in the northern Vaipar area. *Aulospongus tubulatus* (Bowerbank), *Phakellia donnani*, *Siphonochalina communis* (Carter), *Iotrochota* spp., *Clathria procera* (Ridley), *C. indica* Dendy, *Mycale grandis* Gray, *Zygomycale parishii* (Bowerbank), *Phyllospongia* spp., *Spongionella* spp., and *Suberites* spp., are abundant. Dense forest-like growth of the gorgonid *Juncella juncea* Pallas and *J. gemmacea* (Valenciennes) is noticed in the northern area.

The growth of the coral *Heteropsammia* sp. is characterstic of the inner series. *Montipora* sp. and *Echinopora* sp. are the other common corals in addition to *Porites* sp.

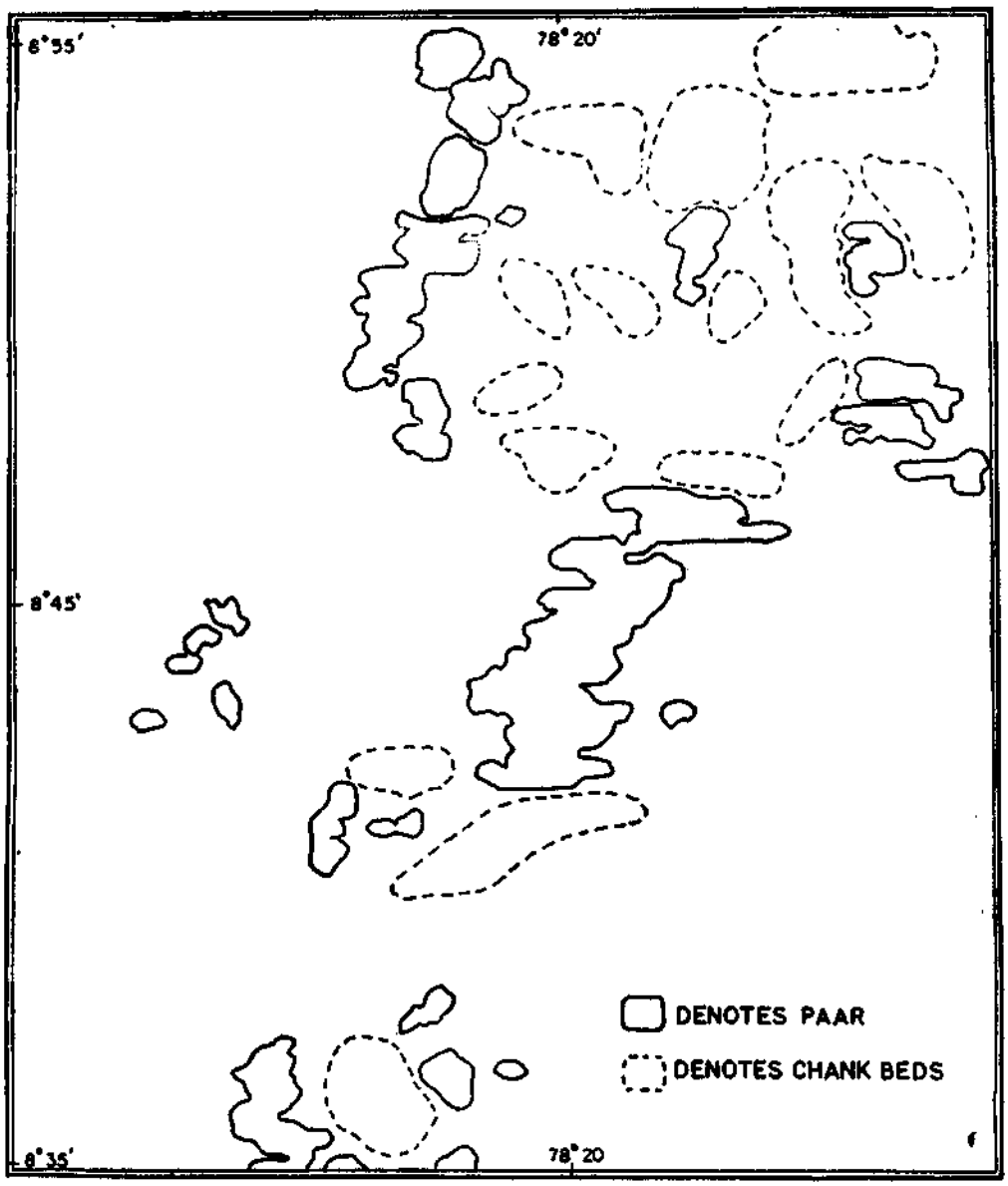

Fig. 14. Showing the paars and chank beds in the region between 8° 35′ N lat. and 8° 55′ lat. as they exist to-day.

The molluscan fauna is mostly represented by myriads of *Modiolus* spp. spreading like mattress on the bottom. Large *Pinna* spp. are found in good numbers rooted in thin layer of sand covering the rock in many places. *Cypraea tigrinus* are seen in rocky pits. *Oliva* spp., *Conus* spp., *Nassa* sp. and *Bulla ampulla* are the other common shells.

Among the echinoderms *Lamprometra palmata palmata* (J. Muller) and *Comanthus* (*Comanthus*) *timorensis* (J. Muller) were the most common living under rocky crevices and over the gorgonids and sponges. *Holothuria edulis* Lesson, *Protoreaster lincki* (Blainville) and tests of *Clypeaster humilis* (Leske) are the most common.

The fish fauna is fairly rich and consists of *Scolopsis bimaculatus* Rüppell, *S. vosmeri* (Bloch), *Abalistes stellaris* (Bloch), *Upeneoides* spp., *Chaetodon* spp., *Pomacanthodes annularis* (Bloch) and *Lutjanus lineolatus* (Rüppell). Large fishes like *Gaterin* spp., *Enneacentrus miniatus* (Forsk), *Epinephelus* spp., *Lethrinus* spp. and *Siganus* spp. are abundantly seen.

The flora is poor in the southern area but in the Vaipar area *Gracilaria* spp., *Hypnea* spp. and *Sargassum* spp. are common.

Compared to the inner series the outer series is richer in fauna and flora qualitatively and quantitatively. The formation of the outer series runs in a southeast to northwest direction, generally between 15m–25 m depth range. The formations are fairly extensive stretches of rock whose outcrops differ greatly from tubular fragments, rock of a metre or two across to great areas of a km in extent. Fine grained sand covers the rock filling up the hollows and crevices occasionally cutting off the continuity of paars to give the impression of sandy bottom whereas actually the hard core of the bottom can be easily detected by removing the engulfing sand of 5–10 cm thickness. Live corals are seen as a low fringe running along the 18–19 m depth on the eastern side of the paar. Broken and worn out fragments of pearl oyster shells, cockles, *Pecten* spp., *Cardium* spp., *Conus* spp. etc. are scattered about in great profusion. Balls of *Porolithon* sp. from the size of a nut to that of a lime are seen on the edges of the rocky expanse. All through the length and breadth of the paar are a number of pits ranging from 0.5 – 1 m diameter and of equal depth. Such pits are inhabited by a number of small and large fishes, eels and lobsters. The general set-up of the area appears ideal for the settlement of oysters as the horizontal clarity at the bottom exceeds 15 m on most days and because of the variety of fauna and flora inhabiting the area.

The concentration of sponges is very high especially in the upper (northern) regions of the paar. The predominant species are *Petrosia testudinaria* (Lamarck), *P. similis* Ridley, *Aulospongus tubulatus* (Bowerbank), *Axinella donnani* (Bowerbank), *A. symmetrica* Dendy, *Spirastrella inconstans* (Dendy),

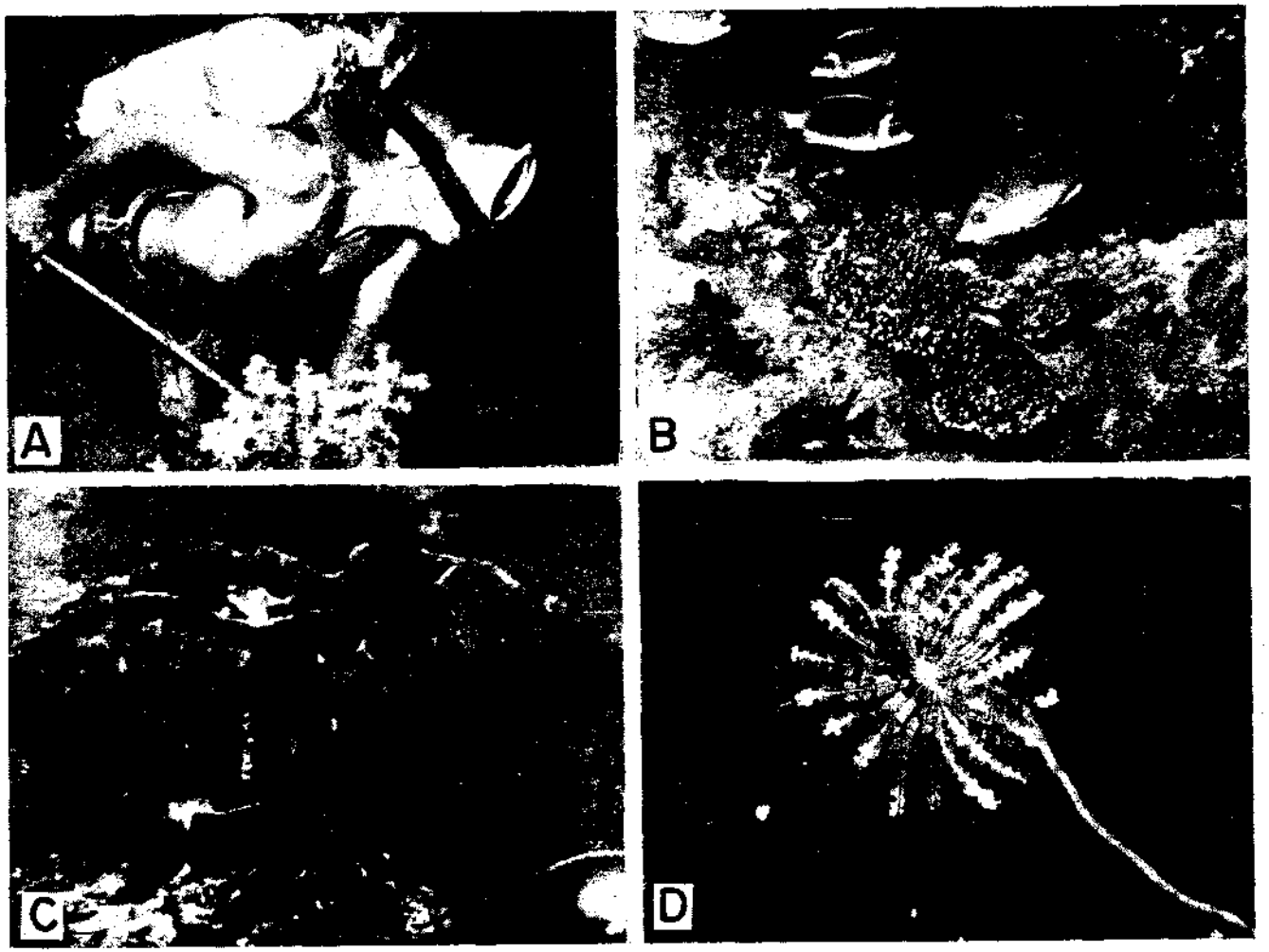

Plate I. A. Senior the author (S.M.) exploring the sea-bottom. B. Coral reef with *Scolopsis vosmeri* and other fishes hovering around. C. *Petrosia testudinaria* on a rugged paar with *Chaetodon* sp. around it. D. The Sea-lily *Lamprometra* sp. on the stem of a gorgonid.

Suberites spp., *Cliona vastifica* Hancock, *Clathria indica* Dendy, *C. procera* (Ridley), *Mycale grandis* Dendy, *Raspailia hornelli* Dendy, *Myxilla arenaria* Dendy, *Iotrochota purpurea* (Bowerbank), *Pachychalina subcylindrica* Dendy and *Phakellia donnani* (Bowerbank). There are other species of *Auletta, Spongionella, Hippospongia, Phyllospongia* and *Hircinia* met with in the 25 metre depth-line also.

The area is rich in coelenterates with a conspicuous growth of anemones, alcyonarians and gorgonids. Some of the fleshy alcyonarians that are common are *Sarcophytum* spp., *Lobophytum* spp. and *Sclerophytum* spp. *Spongodes rosea* Kukenthal. *Nepthya* sp., *Solenocaulon tortuosum* Gray, *Suberogorgia* sp., *Acanthogorgia* sp., *Lopohogorgia* sp. and the gorgonids. *Juncella juncea* Pallas and *J. gemmacea* (Valenciennes) harbouring many commensals are noticed commonly.

The area is rich in molluscan fauna. Noteworthy among the bivalves are *Pinna* spp., *Malleus* sp., *Cypraea* spp., *Murex* spp., *Sistrum* spp., *Nassa* spp., *Conus* spp., *Dentalium formosum* Adams and Reeve, *Pecten* spp., *Avicula zebra* Reeve on sea fans and *Pinctada fucata* (Gould) lying loose in crevices and fissures. *Modiolus* spp. are found settled down over the entire area covering the floor like a carpet. It is feared that this settlement of *Modiolus* spp. albeit a short period, might have deleterious effect on the existence of the general fauna itself, not to mention oysters. The observations of Herdman (1906), Hornell (1922) and Mahadevan and Nagappan Nayar (1968) are of interest in this regard. Shells of *Pteria penguin* (Roding) are seen in 25 m line. *Xancus pyrum* (Linn.) are also seen here and there.

A variety of ophisthobranchiate molluscs are seen in different habitats on seaweeds, on dead shell valves, on crinoids and on sand or underneath coral blocks. Species of *Eolis, Hervia, Discodoris, Halgerda, Phyllidea, Pleurophyllidea, Platydoris, Chromodoris* and *Philene* are seen commonly.

Octopus (*Polypus* spp.) are common in pits and holes. Great numbers of dead, empty broken shells are found in crevices and faults in the rocks haunted by the octopus. Pearl oysters are particularly preyed upon by them thus posing the question as to whether they are the chief enemies of the pearl oysters. On many occasions the octopus has been noticed to open the shell valves of the oysters and eat the flesh.

The echinoderm fauna is found to be lacking in abundance as a whole. By far the crinoids are the most abundant, found attached to the gorgonids, under coral blocks or on sponges. *Lamprometra palmata palmata* (Muller) and *Comanthus annularis* (Bell) are the most common. Among holothurians, *Holothuria edulis* Lesson is the most common. The synaptid *Chondrocloea striata* (Sluiter) is common in deeper waters. Of the sea stars, *Protoreaster lincki* (Blainville) is the

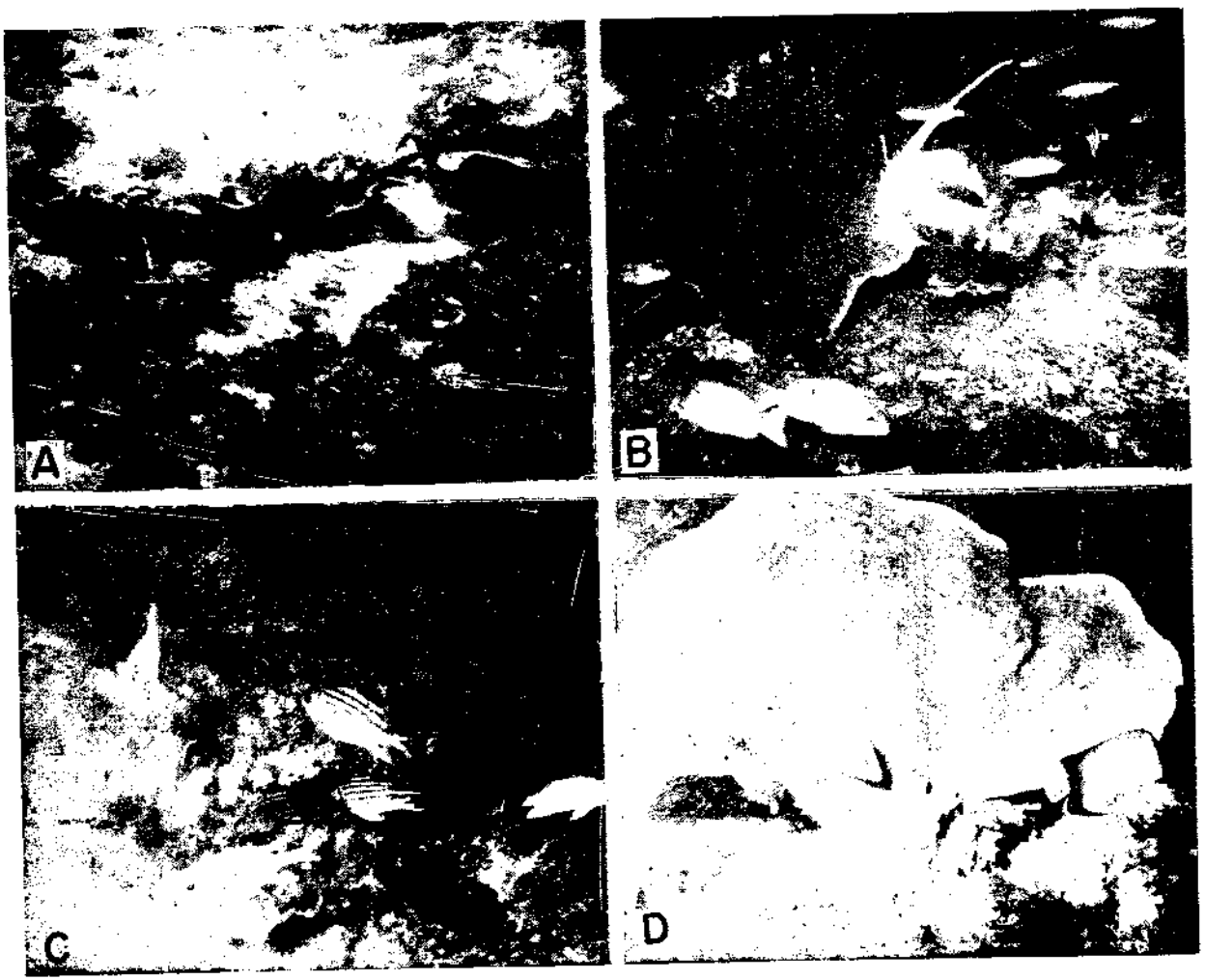

Plate II. A. Sand spread over paar. This type of bottom is common in the outer series of paars off Tuticorin
B. An inverted coral with *Heniochus acuminatus* and *Lutjanus kasmira* living around the area.
C. The Red soldier fish, *Holocentrus* sp. over a rocky crevice.
D. *Chaetodon* sp., *Scolopsis* and *Lutjanus* around a coral block.

most abundant although *P. affinis* (Muller and Troschel) and *P. australis* (Lutken) are also seen rarely. The southern areas are more thickly populated whereas in the north and shoreward areas there are only 2 per 100 sq. metres. The other sea stars are *Pentaceraster multispiralis* V. Martens, *Linckia laevigaeta* (Linnaeus) and occasional specimens of *Culcita schmideliana* (Retz), *Protoreaster nodosus* (Linn.), *Astropecten indicus*. Doderlein and *A. monocanthus* Sladen are also seen.

Of the cake urchins *Clypeaster humilis* (Leske), *Echinodiscus auritus* (Leske) and *Laganum depressum* Lesson are common. Of the heart urchins *Echinolampus ovata* (Leske) and *E. alexandri* de Lorial appeared here and there. Among sea urchins *Salmacis bicolor* Agass. and *Salmaciella dussumieri* (L. Agassiz) occur wherever dead coral blocks are covered by coarse sand. In the crevices of the coral stones and under the boulders live many numbers of ophiuroids of which *Astrob clavata* (Lyman), *Ophiocnida echinata* (Lungman), *Ophiocnemis marmorata* (Lamarck), *O. cataphracta* (Brock) and *Ophionereis dubia* (Muller & Troschel) are more common.

Fishes: All over the rocky bottom, fishes are found abundantly. Numerically *Abalistes stellaris* (Bloch), *Sufflamen capistratus* (Shaw), *Odonus niger* (Rüppell), *Scolopsis bimaculatus* Rüppell and *S. vosmeri* (Bloch) are the most abundant. But wherever the area is rugged with boulders and pits fishes like *Gaterin* spp., *Lethrinus* spp., *Enneacentrus* sp., *Epinephelus* spp., *Pomacanthodes annularis*, *Lutjanus sebae* (Cuvier), *Pterois miles* (Bennet), *Chaetodon* spp., *Zanclus cornutus* (Linn.) and *Heniochus acuminatus* (Linn.) live in large numbers.

Throughout the rocky expanse studied the density of algal vegetation seems to be moderate especially on the eastern edge between 17–25 m line. The flora on the southern areas seem to be luxuriant with *Sargassum* spp., dominating in most of the areas. Among the red algae *Gracilaria edulis* (Gmel.) Silva and *Hypnea valentiae* (Turn) are common. The other common species in the pearl banks of the outer series are *Caulerpa* (3 species), *Codium* sp., *Halimeda* spp., (2 spp.), *Dictyota* (3 spp), *Padina* spp., *Porolithon* sp., and *Spathoglossum* sp., It has been remarked by Prasanna Varma (1960) that the algal flora of the pearl beds is mostly of the types found in coral beds or rocky regions of Indian coast, irrespective of depths. In other words there appears to be no selectivity for algae with regard to depth.

Palk Bay zone

I) *Tondi area:* In addition to the pearl oyster beds in the Gulf of Mannar it has been stated (Hornell, 1916) that two distinct beds of oysters were present off Tondi in the Palk Bay also, a larger one for a distance of 8 km with a width of 0.8 km between Pasipattinam and Thondi in 10 m and a smaller one at 9 m off Karangadu. It was stated that no rocks occur there and all the oysters

were found attached to molluscan shells lying loose at the bottom. Never before has *Pinctada fucata* (Gould) been seen living in such an environment. In the Gulf of Mannar they are always found on continuously rocky ground or else in patches of intermingled stretches of rock and sand. A small fishery off Tondi was conducted by Hornell for 20 days in 1914. After this lone instance, so far no *P. fucata* have been collected from this area. Choodamani and Mahadevan (1962) investigated this area of the Palk Bay in 1958 and concluded that it would be a waste of time to inspect this area and that the grounds here cannot be considered as oyster beds in view of the extremely sandy nature of the bottom.

The area was studied for the faunistic features in 1968 by the authors in addition to the survey of the nature of the bottom. The bottom is of sand upto 7 metres, coarse sand and sand-built polychaete tubes in profusion upto 8.5 m and wavy furrowed sand track upto 11 m off Tondi. Shells of *Strombus* sp., *Melogina* sp. and *Murex tribulus* are the most abundant. *Xancus* pyrum (Linn.) are commonly seen in the coarse sandy areas where the polychaete tubes are abundant. *Clypeaster humilis* (Leske) and *Protoreaster australis* (Lutken) are the other inhabitants of the area in general. The beds off Pasipattinam are located at 7–10 metres depth aporoximately 4.5 sq. km in area, the bottom being muddy and sandy. Only one stray specimen of *P. chemnitzi* was obtained in this area. The bottom fauna is identical to that of Tondi area with the exception that the chank population is not evident. But the prolific numbers of *Salmacis bicolor* var. *typica* Martens and *Holothuria scabra* Jaeger and luxurious growth of colonies of *Lytocarpus* sp. and *Thirea* sp. on dead shells is very characteristic of this area. The area off Vattanam was reported to be rocky by the local fishermen. Survey of this region showed that there is an area of approximately 3 sq. km between 4 and 5.5 metres depth where the bottom is made up of sand and accumulation of dead coral pieces smoothened and rounded off due to wave action, lying loose intermingled with dead and worn-out shells of different species. But there is no evidence of any pearl oyster settlement in this area.

The physical features of the Tondi area are such that there is always turbidity over the bottom reducing the visibility to less than a metre. This factor is not quite conducive for the healthy survival of the pearl oysters even if they were to settle here by any chance. The beds cannot, therefore, be considered as pearl oyster beds.

II) *Rameswaram area:* East of Rameswaram, lying at 9 metres depth is a paar over which sand and mud have been deposited to 10 cm thickness. The area is about a sq. km and is populated by *Holothuria scabra*, *Salmacis bicolor* and few wormed chanks. Polychaete tubes are seen frequently. But there is no evidence of any pearl oysters living on the bed. Another paar north of this area at 9½ metres depth is of flat rock bottom with considerble sprinkling of coarse

sand over the rocky substratum. The bottom fauna is typically that the of rocky area. *Suberogorgonia* spp., sponges specially *Suberites* sp., *Phakellia* sp., *Spongionella* sp., *Heteronema* sp., *Sigmadocia* sp., *Aulospongus tubulatus, Clathria* sp., *Axinella donnani* and *Spirastrella* sp. are seen commonly. But the area of the paar is very limited. Flanking the shoreward and seaward sides of this area are two stretches of paars of considerable width and length running north to northeast and south to southeast respectively at 9 metres depth. The bottom is hard with stetches of sand and grit fouled with mud covering the rocky bottom in most of the places. The fauna is similar to that of the previous area. But the starfish population is considerable, *Protoreaster australis* (Lutken) being very common. Simple and compound ascidians, and gorgonid sespecially *Juncella* sp. are also seen here and there. Another rocky stretch lying at depths of 5 to 7 metres northeast of Rameswaram shows rocky bottom with live corals of *Acropora* sp., *Pocillopora* sp., *Echinopora* sp., *Montipora* sp., *Favia* sp., and *Porites* sp., growing in abundance with the crannies and crevices inhabited by small coral fishes. Gorgonids and ascidian colonies are commonly seen. This area is rugged and is fairly extensive being longer than broad. Another rocky stretch situated at 10–12 metres depth also shows similar features with fewer numbers of live coral blocks and more numbers of starfish and holothurians particularly *Holothuria scabra.* In this area a few numbers of *Pinctada chemnitzii* occur lying loose at the bottom.

Although the rocky nature of the bottom of the Rameswaram area is very much like that of the shoreward areas of the Gulf of Mannar, it also suffers from the drawback of permanent turbidity with lot of silt–laden water always overlying the bottom. Rameswaram area has the advantage of a hard rocky core underneath unlike the Tondi area. But the present set up does not seem to be quite suitable for pearl oyster settlement. The mud deposit on the paar is unavoidable since the adjacent areas beyond 12 metres in Palk Bay is predominantly sandy and muddy which causes a perennial turbidity over the rocky zone due to swells affecting the bottom throwing up silt in suspension and consequently enveloping the low rocky relief. This feature is not the case with the oyster beds in the Gulf of Mannar and therefore the chances of the oyster spat settling down over the paar area in the Gulf zone appear to be more than in the Bay zone.

ECOLOGY OF CHANK BEDS

A. Gulf of Mannar zone

The habitat of the chank, *Xancus pyrum* was considered to be comparatively shallow water region and the minimum depth at which it was taken was stated to be 11 fathoms (Moses, 1923). But the observations of the authors (1968) using SCUBA have shown that chanks of large size are available at 25 metres depth also in sufficiently large numbers as to warrant commercial exploitation with the help of aqua-lung diving. Beyond this limit also chanks might

exist but it remains to be explored in due course. The shoreward limit of chank population cannot be exactly delineated as instances of chanks being taken from even less than 6 metres have come to our notice. This depth can be considered as the minimum depth for chanks to exist in fair quantities. It would be therefore reasonable to assume the ideal depth range for the chanks to flourish is between 10-27 metres.

Hornell (1922a) has shown ten chank beds between the region from Manapad to Vaipar in the Gulf of Mannar without mentioning how he demarcated these beds. Till 1968 there was no other record to show exactly the disposition of the chank beds and their extent. But a survey of the sandy bottom between Pinnakayal and Vaipar undertaken by the authors using SCUBA in 1962 to find out the nature of the sea floor, faunistic richness and the density of population of chanks in different depths enabled the plotting of chank grounds accurately. The chart prepared thus (Mahadevan and Nayar, 1968) brought to light extensive beds between long. 78°20′ E–78°35′ E (Fig. 15). The region between Pinnakayal and Manapad (8°25′ N Lat–8°35′N Lat.) remains to be investigated after which it is proposed to explore the regions north of 8°55′ N latitude. It is proposed to give a comprehensive picture of the chanks beds in Gulf of Mannar and Palk Bay at the end of the investigations.

From the studies on the nature of bottom in the regions investigated so far it is evident that the sandy sea bottom in which chanks are found can be divided into the following five categories:

a) Coarse sand region with plenty of worn out, drifted, brown coloured, broken shells of the species of *Arca, Anomia, Cardium, Crucibulum, Bulla, Meretrix, Nassa* and *Dentalium* along with small molluscs, echinoid spines, quartz grains and a few foraminiferan shells. This area extends from 8 metres upto 13 metres limit.

b) A region with sand grains of brownish colour in between coarse and fine grade, inhabited here and there by *Clypeaster humilis, Salmacis bicolor, Holothuria atra* and *Murex tribulus*. The percentage of broken shells was less while that of foraminiferan shells was higher than in the previous region. The area extends from 13 to 17 metres.

c) A region of fine sand of silky texture, superficially muddy coloured with loosely lying small corals, dense growth of *Solenocaulon* sp., *Pteroides* sp., *Virgularia* sp., tests of *Echinolampus* sp., *Clypeaster humilis*, occasional *Astropecten* sp., *Rhabdocynthia* sp. and sea anemones like *Stoichactis giganteum*. Broken shells were rare while foraminiferan shells were fairly common. The area extends between 18 and 23 metres. The sandy bottom appeared furrowed.

d) A region of very fine, loose sand in furrowed formation with *Rhabdocynthia* sp., alcyonarians, pennatulids, a few *Holothuria atra*, filamentous green algae etc. This region extends from 23 to 27 metres. The floral population here often consisted of *Avrainvillea* sp., *Halophila ovalis* and *Cymodocea* sp.

e) A region of sand, spread along the periphery of the rocky areas. This showed a mixture of all conditions seen in (b), (c) and (d). Here the sand was spread 10–25 cm over the hard bottom. *Porolithon* sp., dead coral pieces, scattered calcareous sea-weed *Halimeda* sp., algae belonging mostly to Rhodophyceae group grew here and there and dead shells were seen in addition.

It is mostly in the last three types of environment that the chanks were found in large numbers. A few were found at random in region (b) while in (a) they were very rare. The calcium content of the bottom zone especially in areas (c), (d) and (e) ranged from 10,490–12,930 mgm/1, a value considered high, when compared to other regions in the Gulf of Mannar (Malu Pillai, 1962). The temperature over these areas ranged from 26°C to 30·5°C (May), and pH 8·1 (May) to 8·6 (August). The salinity ranged from 32·07‰ (Nov.) to 35·91‰ (September) and the dissolved oxygen varied from 6·84 cc/1 to 3·4 cc/1.

'Drift method' diving observations made over these areas have consistently confirmed that it is mostly in the last three types of habitat that the chank population was dense. During the trimester, January to March chank egg capsules were found planted in large numbers only in these types of environment whereas in areas (a) and (b) the picture was rather thin and bleak.

Judging from the various factors above it appeared reasonable to conclude that environments (c), (d) and (e) constitute the chank grounds where a great proportion of available food material as well as the calcium content in the surrounding water would help in providing the ideal habitat for the chanks.

B. Palk Bay zone

In the Palk Bay area, however, a different variety of chanks with shorter spire thrive well in less deep water at depth range 12–14 m. The nature of bottom is essentially of sand of fine texture superficially muddy, inhabited by *Pteroides* spp., *Virgularia* spp., *Salmacis* spp., *Clypeaster humilis, Holothuria scabra, H. atra, Astropecten indicus, Pentaceraster australis, P. affinis* and *Solenocaulon* spp. The polychaete fauna appears to be richer than in the area of corresponding depth in the Gulf of Mannar as evidenced by innumerable numbers of tube-dwelling polychaetes, especially terebellids found over the bottom. Many hundreds of square metres are populated by such a combination of *Xancus*-terebellid-echinoderm communities. Thus the habitat in Palk Bay zone also appears an ideal one for the chank to thrive well.

In the Gulf of Kutch area and west coast grounds along Kerala not much information is available about the ecological conditions of the chank beds.

The chank is an excellent instance of the acquisition by an animal of characters which appear for all practical purposes absolutely perfect to enable to hold its own with ease in the struggle for existence. Against every one of its known enemies it appears to have suitable means of defence. Several large pits are commonly seen in the grounds created by the smaller and larger rays and skates resting on the bottom. Naturally the chanks are exposed to the attacks of these predators. But the thick and massive shell of the chank and the animal's semi-burrowing habits given it protection against rays and other fishes which have the habit of either snapping the protruded feet of this gastropod or wrench-the shell. The thick periostracum protects it to a great extent from the insiduous attack of the boring sponge, *Cliona* sp. and its shell-boring congenors. The strong capsule it constructs for its young gives them adequate protection till they reach a self-supporting stage endowed even at this early period with a resistant shell. The camouflaging colouration of the periostracum with that of the bottom on which the chank lives affords further protection against its presence being discovered by enemies.

The outline of the various important rocky outcrops in the area between Vaipar and Pinnakayal studied and chartered by us (Mahadevan and Nagappan Nayar, 1968) shows a changed pattern when compared with the figures given by Hornell (1922a). This difference might be due to the gradual silting up of the rocky areas since Hornell first outlined them or it may be that his marking of the contours of the paars was approximate, not entirely based on scientific method of surveying them, the latter being more probable since nowhere had he stated how he drew the outlines of the paars. It is possible that they were based on the detailed information he obtained from the local fishermen and from the bearings taken from the log books of the motor launches engaged in pearl bank inspection work. The same is true of the position and extent of the chank beds which he had shown in the same maps. The survey conducted by the authors had helped to demarcate the exact position and extent of not only the paar area but also those of the chank grounds as well, although it should be admitted that much work remains to be carried out in the area south of Pinnakayal upto Manapad and in the sector north of Vaipar also.

Regarding the physical characteristics of the paars in Palk Bay and Gulf of Mannar it is noted that the sea bottom in Palk Bay is unsuitable for the settlement and growth of the pearl oyster *P. fucata*. The Rameswaram area, however, shows rocky bottom but for reasons which are beyond our control no pearl oysters ever settle down here. During the period 1950–1960 when myriads of oysters had settled down and supported successive fisheries off Tuticorin area in the Gulf of Mannar, the Rameswaram beds remained thoroughly barren through-

out. Perhaps the current system in the area does not carry the veligers to the eastern side of the Rameswaram Island and even if it does the larvae drift too far away and perish.

Added to this is the permanent turbidity of the watermass over the bottom due to muddy sediment suspension in Palk Bay. As such the usefulness of Rameswaram beds for pearl oyster settlement is rather questionable. This is supported by the fact that from the records of inspection done in that area for over 70 years not a single instance is there to show that pearl oysters had settled down in that area. However, it is noticed that *P. chemnitzii* which is not considered good as a pearl bearing oyster exists in considerable numbers in Palk Bay lying loose over the sandy and muddy bottom, a feature constrasting with the Gulf of Mannar.

The chank beds in Gulf of Mannar and Palk Bay are equally important and are very productive. In recent years there has been a spurt in the landings from Palk Bay side due mainly to greater number of divers operating there. In the Gulf of Mannar the fishery is not brisk. This is more due to administrative difficulties rather than due to paucity of chanks in the beds. Survey of the beds off Tiruchendur would help to bring to light possibilities of further expansion of chank fishing Industry and it is hoped to study these beds in the near future.