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THE APPA ISLAND AND ITS FRINGING REEF IN THE GULF OF MANNAR

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INTRODUCTION

FOOTE (1883, 1889) and Thurston (1890, 1895) pointed out the presence of a raised coral reef off the south coast of India. Foote (1889) stated that there is a raised coral and limestone quay wall along the coast of Southern India between Muttupettai and the spit opposite Pamban, also to the east of Kilakarai. Thurston (1890) provided a photograph of the raised fossil reef of Pamban and described its stratification in some detail. Sewell (1938) stated that he visited the area in 1926 and found little of the raised reef at Pamban, but examined this formation in some detail in the neighbourhood of Mandapam and Krusadai island. Narayanaswamy (1953) mentioned that there are 15 to 20 islands stretching along the fringing reef over a length of 145 kms. parallel to the coast from Tuticorin to Pamban. Dey and Gopal (1953) subsequently conducted geological surveys on 20 islands in the gulf of Mannar from Pamban to Tuticorin. Pillai (1967) mentioned that in the South-east coast of Indian Peninsula there is a chain of well-developed fringing reefs starting from Rameswaram island and extending beyond Tuticorin. Studies so far made on these islands are sketchy and many of these have not been even included in the large scale maps of India. The only reference on Appa island by Dey and Gopal was very brief, limiting themselves to the measurements of the islands and reef flat.

The Appa island (09° 14′ : 78° 50′) can be seen as a patch of land mass from the shores of Kilakarai in the Ramnad district of Madras State. It is separated from the mainland by a shallow channel of about 8 km. in width and about 10 metres in maximum depth. The island is 4 km. long and 1.5 km. wide, and its linear axis lies in N-S position. The island appears to be a continuous land mass in low tide, but as the tide rises, a stream appears at about the middle of the island to divide it into a northern half and a southern half. The northern island is all sandy and no trace of rock of any kind is visible on the beaches. The land here is only a metre above the high water mark and clothed with xerophytic growth, largely of *Acacias*.

THE FEATURES OF SOUTHERN APPA ISLAND

The southern part of the island (fig. 1B) is curved to the south-east and is fringed with washed coral rock all round it. It has a higher elevation ; the south-eastern part of it reaches maximum height. An area approximately covering one-third of the southern half is made of sandstone while the remaining part is covered by sand and xerophytic growth as in the case of northern Appa island. This rocky area at its centre is about 6 metres higher above the high tide sea level. The formation strikes at south 60° east and dips at an angle of 10° south facing the sea. This rocky area is cut, as a result of erosion, at two places deeply to form two miniature bays. The fringe of the rock is only a little over 1 metre above sea level. The dipping

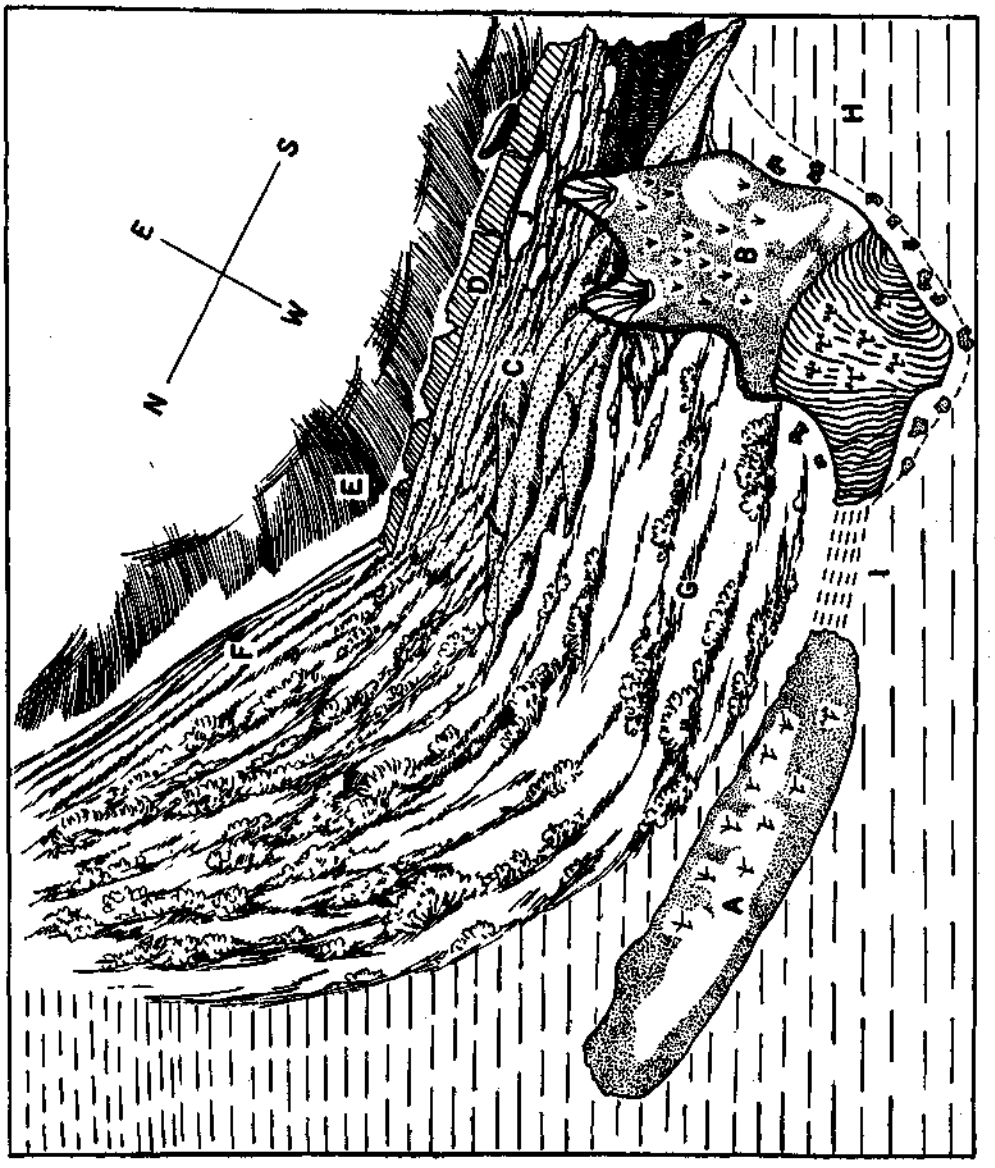

FIG. 1. The Appa island and its fringing reef (diagramatic view): A, The Northern half of the island; B, The Southern half of the island; C, Beach rock; D, Buttress zone; E, Seaward of the reef; F, Boulder zone; G, Shoreward reef flat; H, Leeward of the island; I, Temporary channel; J, Rock pool on the old reef flat.

from height of 6 metres at the centre to a metre at the fringe is gradual and conforms very much to a dipping that normally occurs on a sandy beach in this area, indicating that whenever the sandstone was formed, the area was once a beach at that height. This rock is therefore, referred to as the base rock of the island and it is constantly subjected to erosion, more so by the closeness of the breaker zone. The base rock of the island dips down seaward until its fringes are a metre above the high water sea level. The area covered by tide marks below is also made of rock which is commonly referred to as beach sandstone or a secondary rock conglomerate (fig. 1C). The rock is generally flat up to a distance of about 20 metres seaward. This beach rock is uneven containing holes and cavities but the area immediately following the base rock is more firmly lithified than the one abutting the breaker zone. There are occasional rock pools of different sizes, not greater than 2 metres deep, containing live corals of *Acropora, Porites, Favia* and *Montipora* (fig. 1J).

Beyond this flat rock towards the south-east and directly facing the rollers of the low tide sea within only 15 metres beyond, is a smooth flat rock about 200 metres long and raised over a metre above the level of the beach sandstone (fig. 1D). The strike of this rock appears somewhat perpendicular to the strike of the base rock and dips at an angle less than 5° north. The rock, referable as the algal ridge is brittle, easily breakable by a hammer and has the nature of a pure limestone. This limestone rock is formed largely by the calcarious algae to buttress against the sea and to protect the island from rapid erosion by meeting the force of the breakers (fig. 1E). This rock presents the view of the platform with ridges so as to give the appearance as separate blocks and are overgrown by algae, barnacles and other organisms. This ridge, however, stands in some contrast to the buttresses of atolls in the dip direction, composition of rock and in the formation of surge channels, and in the zonation of the coral fauna. The beach sandstone imperceptibly merges into the reef flat eastwards.

The reef flat : The breaker zone which is so closely situated at this point of the island runs on an East-West axis, thus leaving a wide gap between the Appa island and the breaker zone. This gap is very shallow containing the boulder zone of the fringing reef which may be termed the reef flat (Fig. 1G). The sea bottom in this area is normally exposed only up to a little distance from the shore of the island but when the height of tide is about 0.03, the entire area from the island to the breaker zone will be completely exposed. It is evident from the nature of exposure that the boulder zone is formed very close to the island consisting of living and dead coral boulders greater than 4 metres in diameter deeply embedded in the sandy mud. It is dangerous to venture walking more than a furlong or two for the coral bed is traversed by an intricate system of deep channels into which one can easily slip especially when the floor becomes invisible by the onrushing high tide. Until a few years ago, the fishermen of Kilakarai used to visit the reef flat for collection of certain types of commercial sea weed and their experience suggests that the boulder zone extends up to about less than 1 km. shoreward beyond which is the sandy mud reef flat for over 3 km. The huge living boulders commonly seen in the reef are those of *Porites, Goniopora* and *Montipora* mixed with the growth of *Acropora*. Since the reef flat is invariably covered with water and only very rarely exposed in its entiriety and since the waters are better protected from the force of waves or currents, the reef flat provides ideal conditions for the growth of all kinds of marine organisms. Further, the comparatively calm reef flat is fed by rich plankton brought by the onrushing but the slow movement of the tidal waves which help the organisms to establish firmly and grow. The sand, silt and land mud brought by the waves settle on the reef flat and are piled into heaps or hills with a number of interconnected or

closed rock pools. It is inside the rock pools that the coral and other organisms grow profusely until the seaward boundary of the reef flat where huge boulders of coral are seen, is reached (Fig. 1F).

The Fauna

The island is of special interest to a marine biologist for he finds in it not only an amazing variety of hermatypic coral but also a number of other invertebrate groups.

Burton (1937) recorded more than 90 species of sponges in the Gulf of Mannar and a good number of these may be found on the reef flat. The sponges are largely confined to the shoreward region of the eastern Appa island. The massive sponge species, *Spirastrella inconstans* and *Callyspongia fibrosa* predominate the area. These are often attached to the coral rocks or other hard area below and the sandy mud above. The large sea anemone, *Stoichactis giganteum* is present on the sandy shore throughout the island. At least 9 genera and 20 species of corals inhabit the reef of which the massive species of flat topped *Porites*, *Montipora* and *Acropora* occupy the shoreward part of the reef. Species of *Favia*, *Symphylia*, *Psammocora*, *Platygyra*, *Poecilopora*, *Merulina* and *Leptastria* generally occur in the interior though some of these are found in the rock pools of the island close to the shore. Species of *Acropora*, however, appear to occupy the shoreward region. Along the reef margin, where the breakers of the low tide pound, are massive corals of *Porites* and the calcarious algae. In the more sheltered spots delicate forms like *Acropora* predominate.

The annelid fauna is perhaps the most abundant with a good number of polychaet families represented. Though the identifications of our collections have not yet been made, it is quite possible that most of 119 species recorded by Fauvel (1930) in the Gulf of Mannar may be represented. *Neries*, *Polynoe*, *Eunis* among Annelids, and *Dendrostomum*, *Aspidosiphon* and *Phascolosoma* among the sipunculids (Gurumani, 1969) are most common. The area is also rich in mollusc fauna. The most common of these are the nudibranch species, *Aplysia*, *Dolabella* and *Dendrodoris* which are seen moving often along the shores immediately after the fall of the tides. The fact that these show a marked contrast to their absence at Tuticorin at depths of 15 metres (See Mahadevan and Nair, 1968) suggest more probably that these are essentially species of the intertidal zone. The smaller species of nudibranchs such as *Eolis*, *Pleurophylledea* etc., are found in large numbers among the crevices of coral rocks. Live shells of *Cyprea*, *Conus*, *Turbo*, *Trochus*, *Pteria*, *Murex* are more common among gastropods. The commercial species of gastropod, *Xancus purum* (Chank shell) is often found under the coral rocks of the reef flat though the pearl oyster is rare. Most of 450 species recorded by Satyamurthy (1952) may be found on this island. Of the echinoderms, the most common forms are *Holothuria atra*, *H. scabra* and *H. edulis* which are found on the sandy mud shore of the island. *Protereaster lincki* is a common star fish in the area.

Some beautifully coloured fish inhabit the reef corals. These belong to the genera *Holocentrus*, *Lutianus*, *Pomacanthoides*, *Chaetodontopsis*, *Chaetodon*, *Linophora*, *Abudefduf*, *Thallasoma* and *Zanclus*. Two species of eels, *Gymnothorax undulatus* and *G. punctatus* abound the reef flat and are found in almost every stone lifted.

When the beach sandstone layer is exposed after the fall of the tide, a large number of birds mainly the large crested tern, *Sterna bergii* and the eastern

golden plover, *Pluvialis dominica fulva* flock over the exposed flat rock to peck the food organisms.

The commercial species of seaweed of the genera *Gracillaria*, *Gelidium* and *Sargassum* which contain 50 to 75% of Agar is regularly collected by divers of Kilakarai from the reef flat and sold in the local markets. The corals of the reef flat facilitate favourable growth of sea weed. The calcarious sea weed is represented by *Lithothamnion* (*Porolithon*), *Gonolithon*, *Lithophyllum* and *Halimeda* sp. Though these are the most common species, a more detailed study may uncover most of the 60 species recorded by Verma (1960) from the pearl beds off Tuticorin.

On the western side of the Appa island, the water is shallow, about half to one metre deep but no live coral is encountered. There were, however, dead coral which appear to have been washed from the neighbouring reef flat, and some have grown in small patches and died. Though the area is shallow, the force of waves especially during the south-west monsoon is tremendous and therefore not congenial for the growth of coral in this side of the island.

Discussion

The occurrence of an old coral reef on Rameswaram island led Bruce Foote (1889) to conclude that the island underwent elevation which also affected the adjoining mainland exposing wall like cliffs of sandstones. This sandstone quay wall is prominent at Mandapam (Thurston, 1890 and Sewell, 1938) and also at Kilakarai (Thurston, 1890). Thurston writes that a perfect wall of sandstone extends for some distance along the shore at Kilakarai. This wall is present to this day, confined largely to the harbour area. Sewell (1938) reported the occurrence of beach sandstone on the sand bar at Tuticorin. A similar sandstone presently reported on the Appa island is probably the 5th instance of its occurrence in the Gulf of Mannar. The only other island which is said to contain this rock is Katcha Tivu. Foote (1889) discovered an isolated mass of coral exposed in the sandstone cliff 1½ km. east of Kilakarai and concluded that its appearance and condition is identical with that of the old reef east of Pamban. If, as Foote considered, the sandstone cliffs of Kilakarai are of similar formation as that of Pamban some 40 km. away, it would not be surprising that the cliffs of the Appa island at only 8 km. away would have arisen at about the same time. Similarities in age or origin, if anything significant, are only relative terms referable only to that limited area for Sewell (1938, p. 503) points out that sandstone is a very common rock found along coral reefs and atolls in Indian waters or other oceans of the world with almost identical succession of strata. He concludes (p. 505) that this sandstone like that on the islands of atolls and elsewhere, has been formed by percolation of water through a sandy deposit to some depth beneath the surface and has subsequently been exposed by erosion along the beach and by removal of the sand, probably by the action of the wind, from the upper surface.

Whatever is its manner of formation, there is no doubt that the sandstone forming the base rock of this island as in the case of the coral islands elsewhere, has an amazing similarity in the general strike direction, in the direction and dip of stratification to that at Kilakarai, Mandapam, Pamban and Rameswaram. From Setukarai to Kilakarai there are exposures of sandstone between and beyond the tide marks, while at the ebb, tiers of well-formed sandstone of 2 metres in height dipping seawards are visible in the bay at Kilakarai.

Whether such an exposure is caused by the elevation of the beach or by the lowering of sea level, there has been difference of opinion. Sewell (1938) discussed various views on the subject and argued that it is in the coral growing regions that evidence of this relative rise of land is most easily obtainable owing to the fact that coral, as we know, must have been originally formed below the low water sea level, so that if we now find masses of it, still *in situ*, as it grew, but now raised high above the level of low water, it is a clear indication that a change of level of sea and land had taken place. In other words what is considered as elevation of land may be treated as due to apparent fall in sea level. It has been acknowledged by at least five authorities (Daly, 1920 ; David, 1926 ; Gardiner, 1936 ; Sewell, 1938 ; Kuenen, 1950) that in the comparatively recent times, there has been a world-wide alteration in the relative levels of land and sea through the tropical regions to the extent of 5 to 7 metres and such a change has been attributed to a fall in the level of sea than to an elevation of land. There are so far 20 records of such fall in levels of considerable uniformity on the Indian coast which are invariably evidenced by raised rocks or raised sandy beaches generally varying to the extent of 3 to 5 metres with the exceptions of Chilka lake (7 to 10 m.) Minicoy (8 m.) and Kathiawar (16 to 36 m.) to consider it as more of a fall in sea level than of a crustal movement. The sandstone of the base rock of the Appa island is at least 5 metres above the high tide mark which is greater than the 2 metres exposure at Kilakarai, 2.5 metres exposure at Mandapam (Sewell, 1938) and 3.5 metres exposure at Rameswaram (Thurston, 1890) suggesting that the base rock at Appa island is the first exposed of all the neighbourhood islands in the Gulf of Mannar.

SUMMARY

The topographic features of Appa island, one of the chain of twenty islands in the Gulf of Mannar, hitherto very little known, are described. The northern part of the island is sandy while a good portion of its southern half is rocky, with a well-formed fringing reef. Studies on the formation of rocks reveal that the island's elevation is the highest among the neighbourhood islands in the gulf. The most common fauna of the reef flat with vigorous growth of reef building corals and their associated organisms have been outlined.

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REFERENCES

BURTON, M. 1937. Porifera of Krusadai island. *Bull. Madras Govt.* Mus., 1(2) : 1-58.

DALY, R. A. 1920. A recent world-wide sinking of ocean level. Geological magazine Vol. 57.

DAVID, E. 1926. Lecture to the Geological Society, London.

DEY, A. K. AND GOPAL, V. 1953. Report on the detailed survey of the coral islands in the Gulf of Mannar between Tuticorin and Pamban (unpublished).

FAUVEL, P. 1930. Annelida polychaeta of the Madras Government Museum. *Bull. Madras Govt. Mus.*, 1(2) : 1-79.

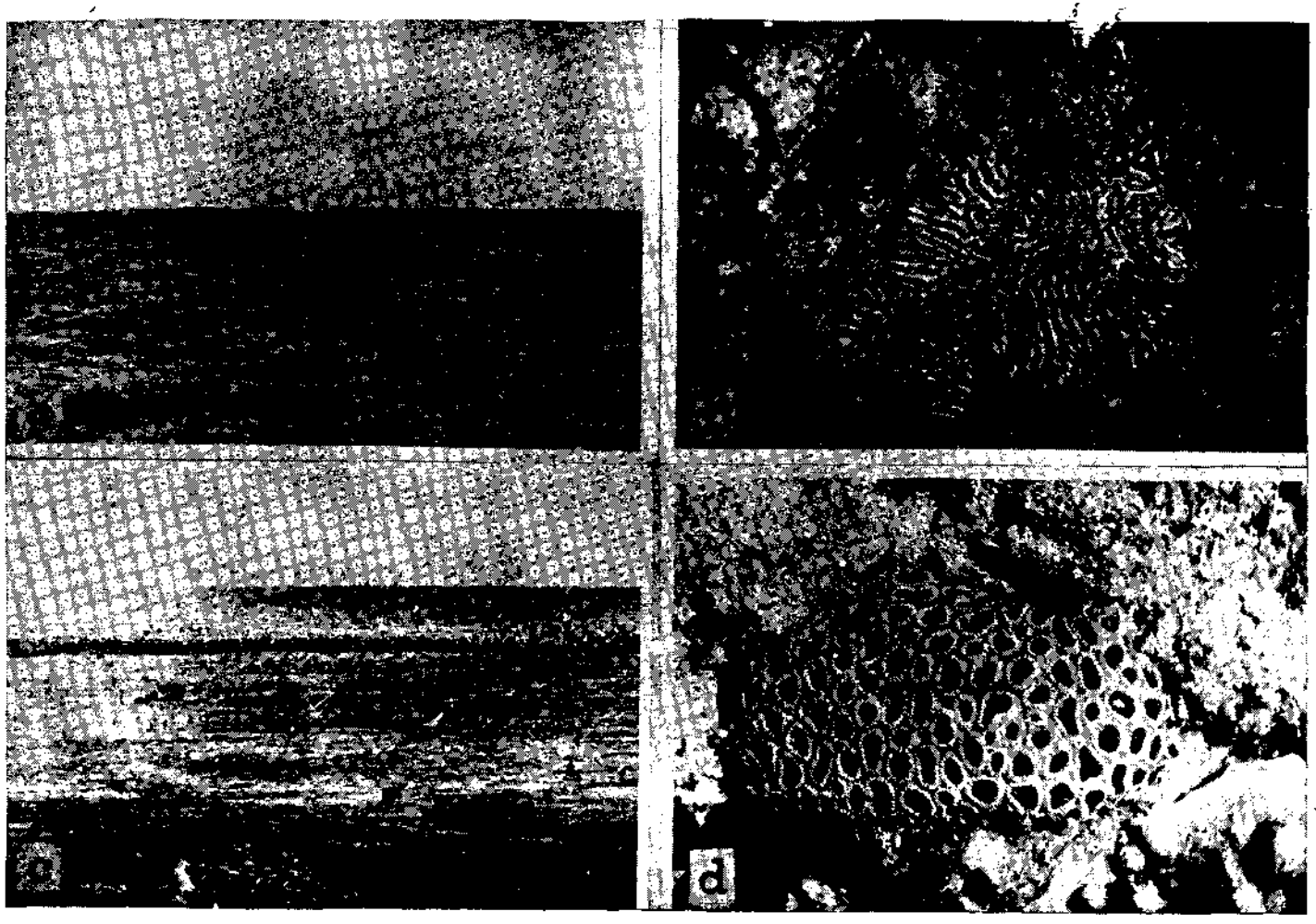

PLATE I. The Appa island and its fringing reef. *a*, Distant view of Appa island showing Northern part (left) separated from the Southern part (right) by a narrow channel; *b*, *Platygyra* sp. in rock pools; *c*, Sea Gulls, large crested terns and the Eastern golden plovers flocking over the old reef platform for pecking food; *d*, Species of *Favia* in rock pools.

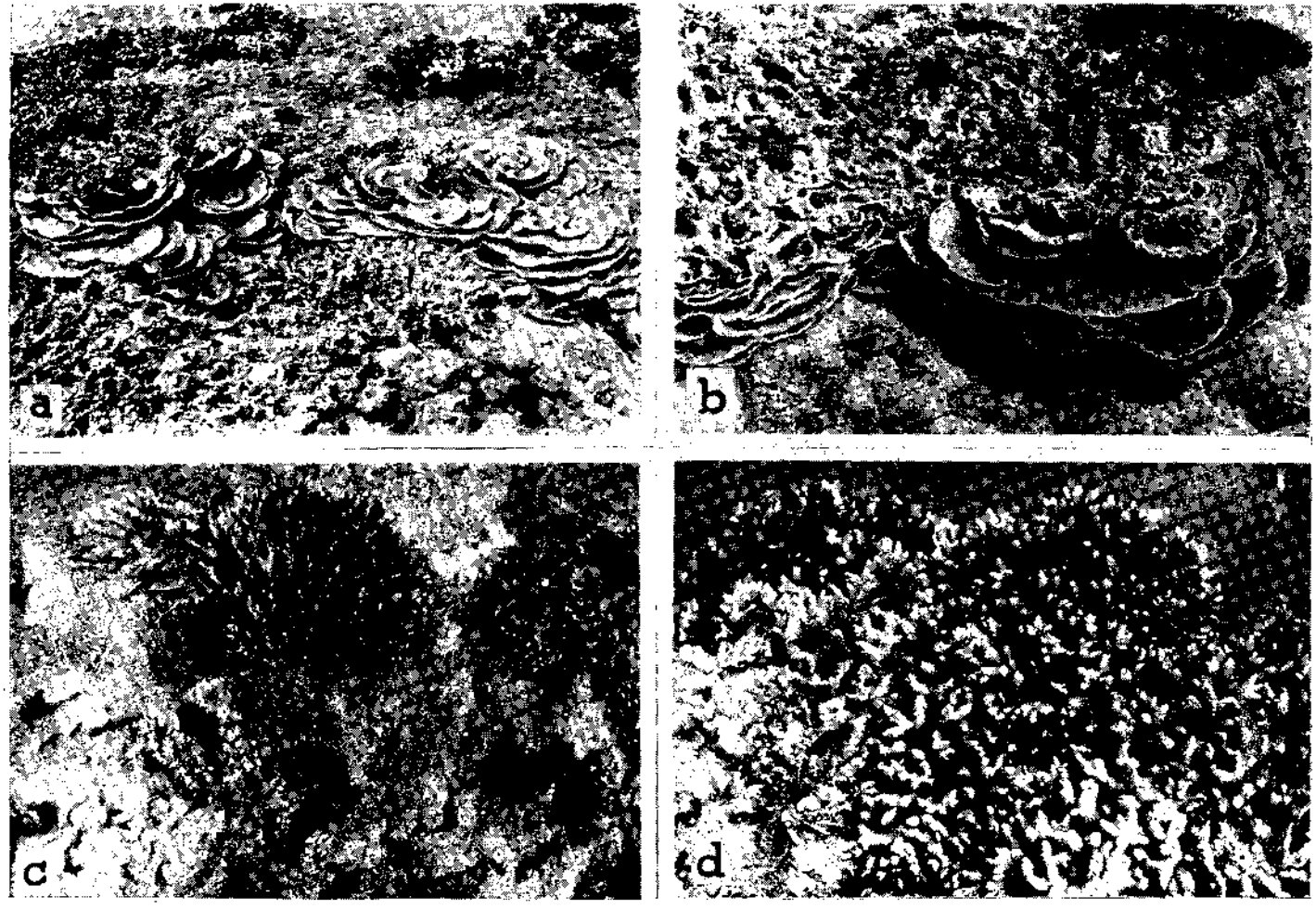

PLATE II. Some commonest corals of the reef flat: *a*, *Montifora foliosa* in fully grown condition; *b*, *Montifora foliosa* showing arrest of vertical growth and resumption of lateral growth; *c*. *Acropora formosa* (on top) *Poecillopora danicornis* (below) showing active growth in the rock pools; *d*, *Acropora formosa* as a large aborescent colony.

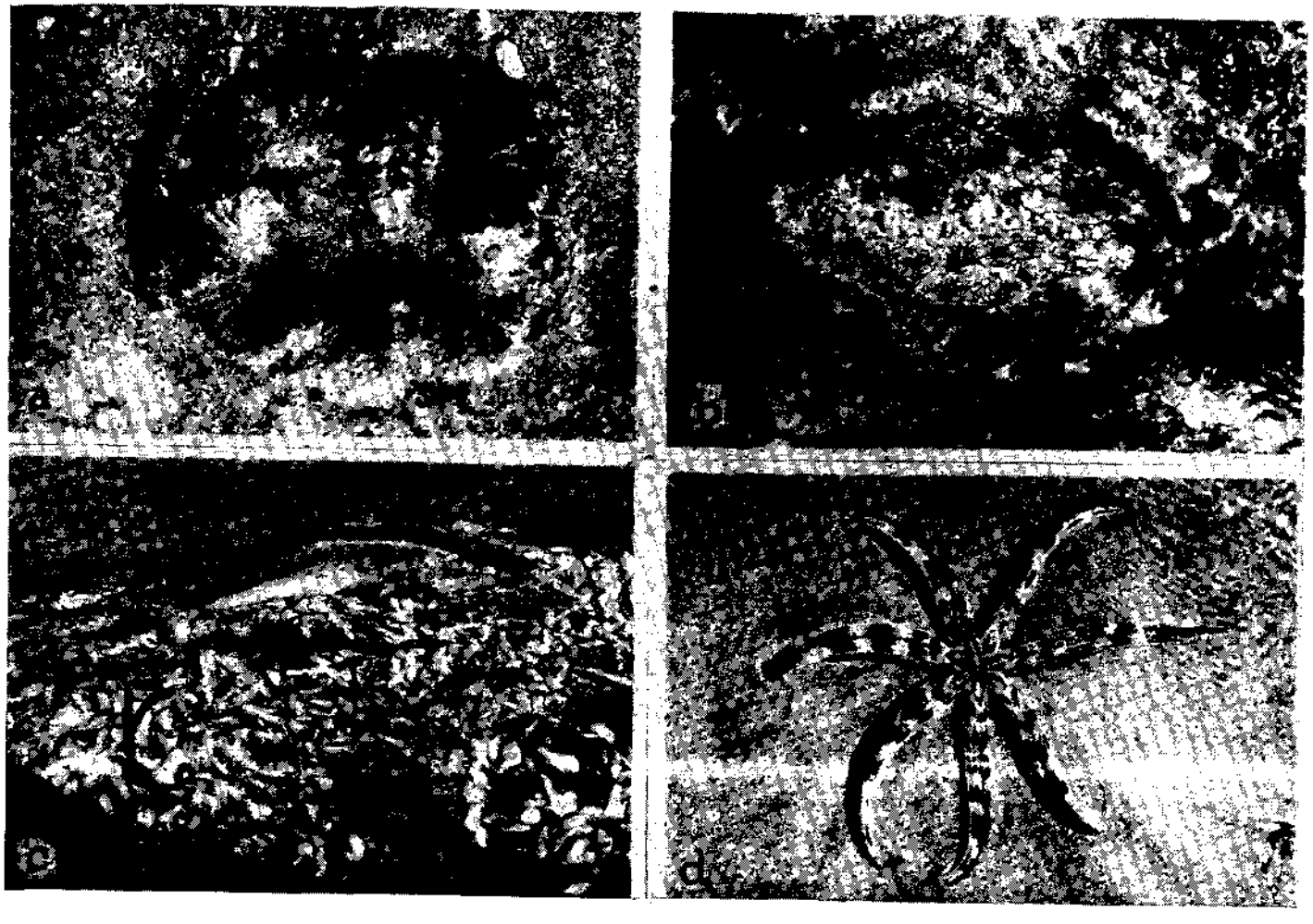

PLATE III. *a*, *Stoichactis giganteum*, the giant sea-anemone associating with a holothurian *Holothuria atra*; *b*, *Aplysia benedicti* the commonest nudibranch in the reef flat; *c*, A shoal of commercial and reef fishes from a shore seine operated on the island; *d*, Luidia sp. an uncommon starfish.

FOOTE, R. B. 1883. The Geology of Madura and Tinnevelly districts. *Mem. Geol. Soc. India*, 20(1) : 1-103.

———. 1889. The coral reefs of Rameswaram island. *Madras Christian College Magazine*, 7 : 43-56.

GARDINER, S. 1903. The Fauna and Geography of Laccadive and Maldive Archepelagoes, pp. 471. Cambridge University Press.

GURUMANI, O. N. 1969. Personal communication.

KUENEN, P. H. 1950. Marine Geology, pp. 568, John Wiley, New York.

MAHADEVAN, S. AND NAYAR, K. N. 1968. Underwater ecological observations in the Gulf of Mannar off Tuticorin. VII. General topography and ecology of the rocky bottom. *J. Mar. Biol. Assn.* India, 9(1) : 147-163.

NARAYANASWAMY, S. 1953. Limestone deposits of Tinnevelly district. *Rec. Geol. Surv. India*, 84(3) : 325-366.

PILLAI GOPINATH, C. S. 1967. Souvenir : Marine Fisheries Institute Club, Mandapam.

SEWELL, R. B. S. 1932. The coral coasts of India. *The Geographical Journal*, Vol. 79.

———. 1938. Studies on coral and coral formations in Indian waters. *Mem. Asiatic Soc. Bengal*, 9 : 461-539.

SATYAMURTHY, S. T. 1952. The Mollusca of Krusadai island. Amphineura and Gastropoda. *Bull. Madras Govt. Mus.*, 1(2) : 1-265.

THURSTON, E. 1890. Preliminary report on the marine fauna of Rameswaram. Madras Government Museum Bulletin, No. 1.

———. 1895. Rameswaram island and Fauna of the Gulf of Mannar. *Madras Government Museum Bulletin*, No. 3.

VARMA, R. P. 1960. Flora of the pearl beds off Tuticorin. *J. Mar. Biol. Assn. India*, 2(2) : 221-225.