NOTES ON A BRIEF VISIT TO SERINGATAPAM ATOLL NORTH WEST SHELF, AUSTRALIA

by B.R. Wilson

INTRODUCTION

In October 1978, the author joined the Soviet Research Vessel 'Professor Bogorov' during a cruise in Northern Australian waters. Three working days were spent at Seringapatam Atoll on the North West Shelf. This reef is of great interest to students of Australian coral reefs and marine biogeography because of its geographic position and because it is one of the very few atolls in Australian waters. There are no published records of its biology and little on its geology. Therefore, although there was too little time for detailed studies, it seems appropriate to place on record observations made on the structure of the reef and its fauna.

The expedition was one of a series conducted by the Pacific Institute of Bio-organic Chemistry, Far-East Science Centre, Vladivostok. The basic objective of the expedition was to conduct comparative chemical and biochemical studies of marine invertebrates and algae inhabiting coral reefs with particular reference to some low molecular compounds and biopolymers which possess anti-tumoral and anti-fungal activities.

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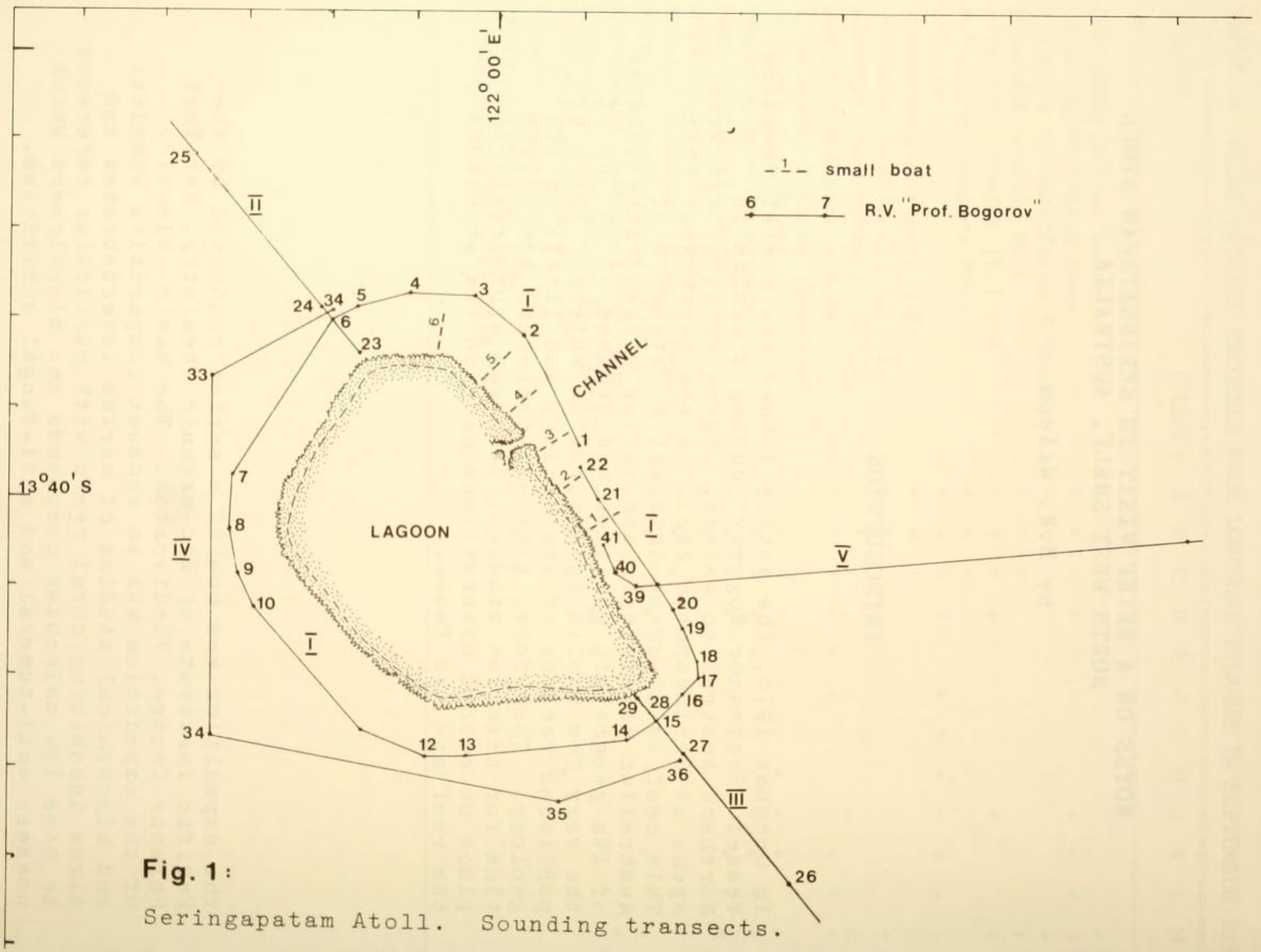

Fig. 1:

Seringapatam Atoll. Sounding transects.

REEF STRUCTURE AND FORM

Position. On the Australian hydrographic chart (1047) Seringapatam Atoll is shown with its centre at 13° 40'S, 122° 5'E. However, the Master of the 'Professor Bogorov', by use of 'Sputnik' fixes, advised that the approx. centre of the lagoon has the co-ordinates 121° 59' 35"E, 13° 40' 35"S.

Shape and Dimensions. Seringapatam Reef is an atoll possessing the habitats typical of Indo-West Pacific inundated atolls. The atoll is roughly trapezoidal with the longest (NE) side being almost straight and bearing about 140°. Its length is approximately 4.5 nautical miles (NW-SE) and its maximum width approximately 3 nautical miles (Fig. 1). The peripheral reef, which varies from 300-500m wide, encloses a broad and deep lagoon.

Relief and Geology. At high tide no emergent structures are visible but at mid and low tide the central part of the annular limestone reef emerges. The highest zone or reef crest is located about 100m behind the outer reef edge and behind that the back-reef varies from about 200 to 300m wide.

Reef flat. Around the entire perimeter of the atoll on the reef crest there is a well developed 'boulder zone' which provides conspicuous irregular relief to the reef when seen from a distance at mid or low tide. Most of the boulders are free-lying blocks of reef limestones; relatively few are coral slabs. In addition to the 'loose' boulders there are many 'attached' erosional relics, or stacks, which are part of the limestone substrate, the highest being about 2m tall (Plate 1). Many of them are mushroom-shaped, have a dense calcrete capping and are deeply undercut by biological and physical erosive forces (Plate 2). Burrowing barnacles (*Lithotrya valentiana*) are the principal biological erosive agent. Those which have been completely undercut have toppled to become reef crest boulders.

The reef limestone itself is fossilferous, containing abundant fossil corals and some molluscs. It is assumed to be of Pleistocene age.

Large sand cays exposed at low tide were observed in the back-reef zone at the NW and NE corners. There may be others at the southern end although none were visible when the ship passed around that end of the atoll at low to mid tide.

Channels. A shallow, bent channel was located on the NE side at about 122° 0' 15"E, 13° 40"S (Fig. 1). It can be entered only by small vessels drawing less than about 2.5m and only at high to mid tide. At low tide there is a torrent of water pouring out of the lagoon making extremely turbulent and hazardous conditions. The channel is about 80m wide at its seaward entrance and narrows and divides as it enters the lagoon where there is a dangerous central patch reef which is very difficult to see in the late afternoon due to the angle of the sun. The deepest and safest arm of the inner channel turns NW.

There may be other similar channels into the lagoon, perhaps at the southern side, but none could be located.

Reef Front (= fore-reef). This was examined at a number of locations along the NE side. There the intertidal part of the reef-flat (i.e. seaward of the reef crest to the reef-edge) has a width of about 100m. There is no raised rim at the reef-edge and no prominent spures and grooves or drainage gutters; the reef-flat slopes gently, or with a series of little terraces up to 10cm high, to the reef-edge (Plate 3). Periodic broad, shallow, depressed zones carry the out-flowing water off the ree-flat at low tide. The reef-edge itself is very irregular and indistinct. There is little living coral or crustose coralline algae on the reef-front which has a close-cropped cover of leafy brown algae.

From the intertidal reef-edge there is a broad reef-front slope progressing seaward for a distance of 100-150m apparently around the entire perimeter of the atoll. On the side of the atoll which was examined (NE), the upper part of this zone is gently sloped with an average angle of about 5°. It is characterized by high sub-tidal spurs or ridges roughly normal to the reef-edge and bearing moderate growths of living scleractinian corals, alternating with deep

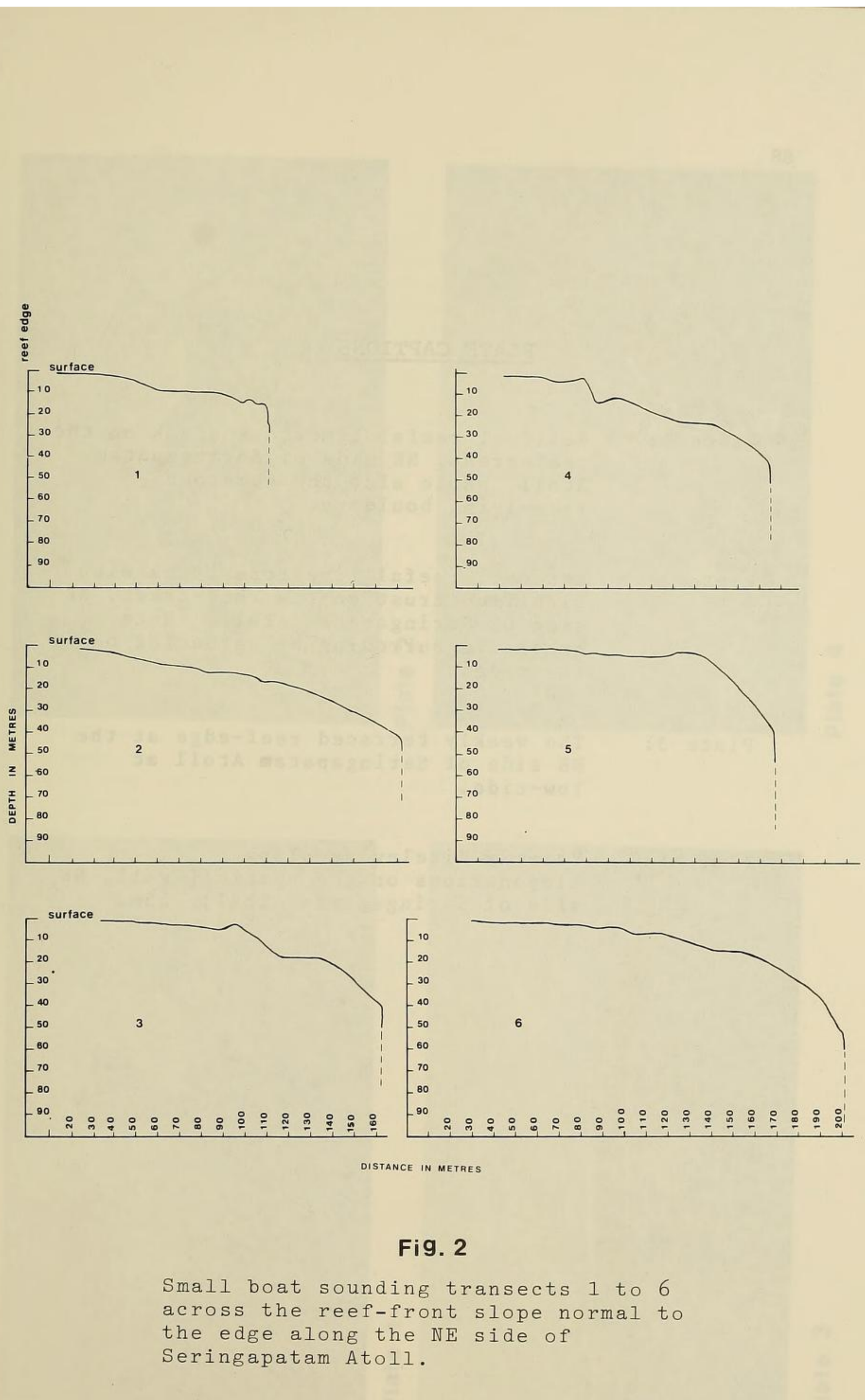

Fig. 2

Small boat sounding transects 1 to 6 across the reef-front slope normal to the edge along the NE side of Seringapatam Atoll.

PLATE CAPTIONS

Plate 1: Residual reefal limestone stack on the reef-crest, NE side of Seringapatam Atoll. Note also the numerous free-lying boulders.

Plate 2: Residual reefal limestone stack with lithified crust on the reef-crest, NE side of Seringapatam Atoll. Note extensive burrowing by barnacles on the sides.

Plate 3: The weakly terraced reef-edge at the NE side of Seringapatam Atoll at low-tide.

Plate 4: Valeriy Kiselev sampling alcyonarious on the vertical wall, NE side of Seringapatam Atoll; 55m.

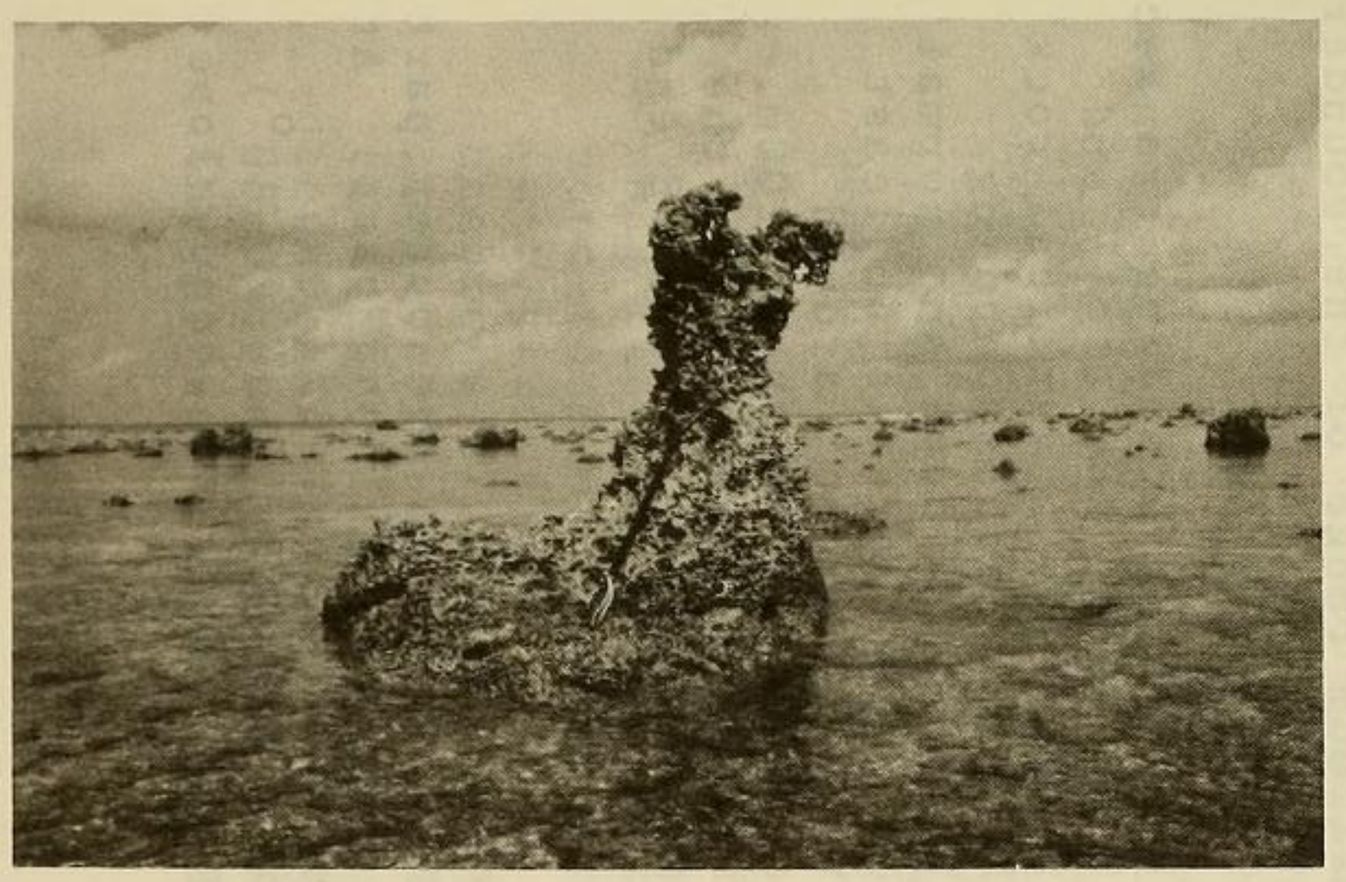

Plate 1

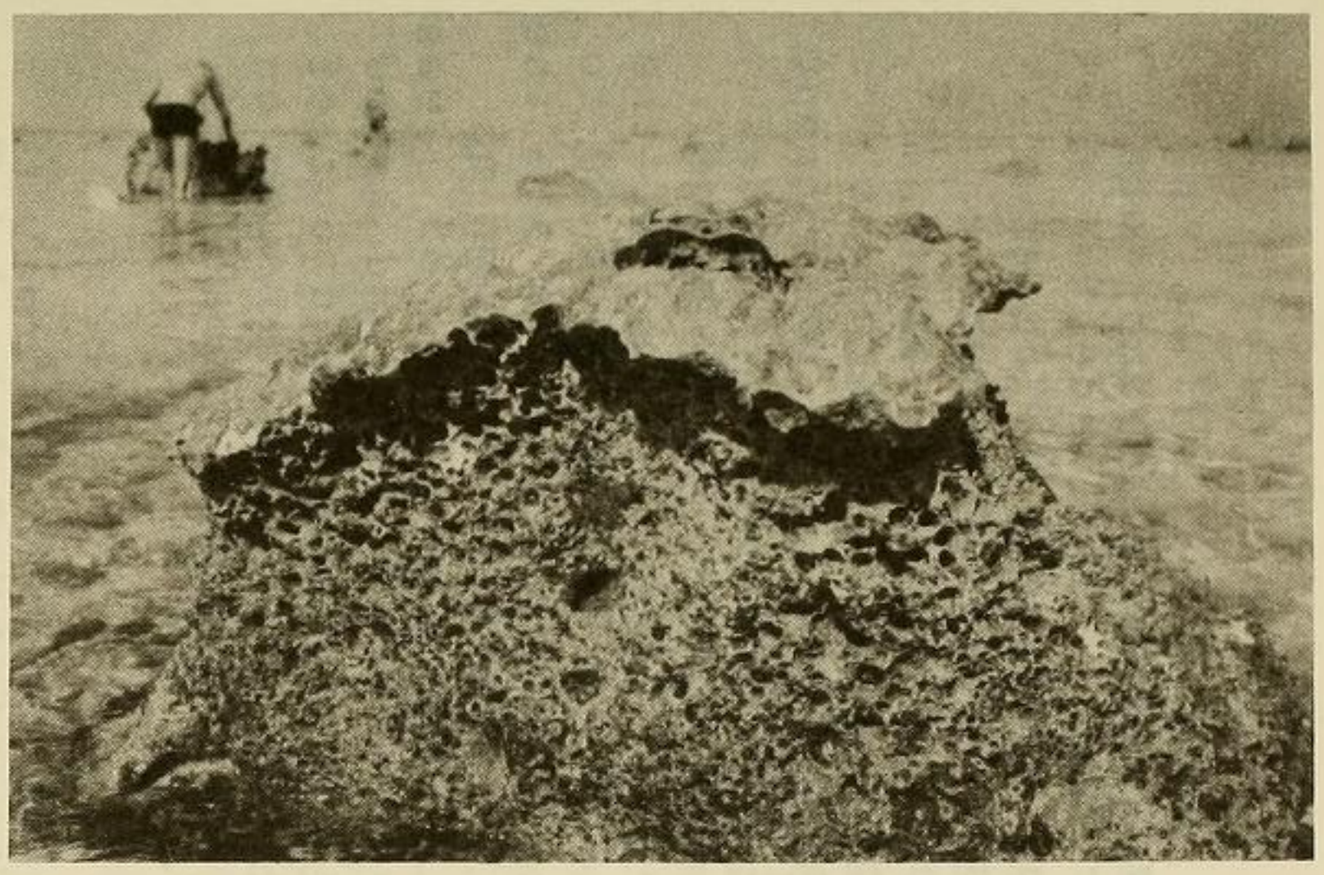

Plate 2

Plate 3

Plate 4

grooves or gutters which have coarse sand and coral boulders and rubble on their beds. The sides of the spurs are deeply undercut and cavernous. The spur and groove system terminates at a depth of about 12-15m. Below this the slope increases to about 15°. Here coral rubble and soft corals predominate but there are some living scleractinians. The reef-front slope terminates abruptly at the edge of a vertical 'drop-off' at 30-40m. Deep dives down the drop-off wall were made at 4 localities in the vicinity of the channel (between stations 5 and 3) to depths of 60 to 80m. Narrow ledges no more than 1m or so wide are the only horizontal features of the wall as far down as 75m. At that depth a steep rubble slope (ca. 25°) was observed, but this too was only 10-12m wide and below that was another vertical wall which continued out of sight. There is little scleractinian coral growth on the vertical rock face, but numerous soft corals and tree-like gorgonians (Plate 4).

A series of small-boat sounding transects normal to the reef-edge along the NE side confirmed the existence of the vertical drop along the whole length of that side (Fig. 2). The traces ended abruptly at the drop-off edge because the depth at the foot of the vertical wall exceeded the maximum range of the sounder used (110m).

No equivalent deep dives or small-boat sounding transects were made on the NW, SW and S sides of the atoll and it was not determined whether there is a vertical rock wall there also. However, 'Bogorov' echo-sounding traverses as close as possible, both around and normal to the reef (Figs. 1 & 3) show that there is at least an extremely steep if not vertical 'slope' around the entire perimeter of the atoll down to about 200m. Below that there is a steep slope of about 35° to the sea floor which is reached at about 500m at the SE end and 750m at the NW end (Fig. 3).

Back-Reef. Behind the reef crest there is a wide back-reef zone, rich in living corals in the outer part and sloping very gently back to a sandy inner part. At its sandy inner edge, at a depth of about 5m, the back-reef slope begins, angling abruptly (ca. 20-30°) down to the bottom of the lagoon. On this steep slope

and on the sandy inner back-reef there are extensive dense patches of staghorn *Acropora* corals.

Lagoon. A small boat sounding traverse was made down the centre of the northern part of the lagoon. The maximum depth measured was 27m. The bottom is very irregular with numerous coral patch reefs, mounds and pinnacles but these rarely rise closer than 2m to the surface. (Thus, once entered the lagoon is freely navigable by small boats.)

At a diving station near the centre of the lagoon the bottom sediment was found to consist of thick, white, calcareous silt. Bottom visibility when undisturbed was only 3-4m. Corals were diverse in patches; staghorn *Acropora* species were the most abundant but many foliose corals such as *Pachyseries*, *Echinophyllia*, *Merulina* and massives like *Lobophyllia* were also common.

DISCUSSION

Teichart & Fairbridge (1948), Jones (1973), Hinz et al (1978) and others have discussed the geological history of the North West Shelf and Sahul Shelf region. The outer part of the shelf is believed to have been subjected to substantial subsidence since the Mesozoic. Seringapatam, its neighbour Scott Reef and the Rowley Shoals further south, rise from the sea floor of the depressed continental slope at depths of 500 to 800m. Seringapatam and Scott lay on the crests of anticlinal trends. Below Scott Reef there is a thickness of more than 2000m of Tertiary and Quaternary reefal limestone (Jones, 1973). Faulting is common along the shelf margin in this region; the fault direction is usually NW, ie normal to the margin (Jones, 1973).

Thus, and taking account of its extremely steep and rather straight-sided, trapezoidal form, it seems reasonable to interpret Seringapatam as a coral reef structure of considerable antiquity, built originally (early Tertiary?) upon an upthrust block in the faulted basement. The strikingly straight NE side, for example, lies in the regional fault direction and implies that the shape and character of this atoll are structurally controlled. Continuing regional subsidence and rapid reef growth since the early Tertiary has resulted in the present flat-topped, tower-like structure. The

vertical sides in the upper 200m or so are probably a result of coral growth and terrestrial erosion in successive Pleistocene eustatic stages.

The undercut stacks of the reef-flat boulder zone are interpreted as erosional relics of an earlier reef-flat which stood about 2m higher than the present one. The rate of erosion is very rapid and the age of the higher reef-flat was probably Holocene.

MARINE FAUNA

Several hours were spent during the afternoons of October 14 and 15 on the reef-flat at low tide at a location on the NE side of the atoll about 0.5km north of the channel. Some hand collecting was done there. Collections were also made by snorkel and scuba diving in the lagoon and along the reef-front slope on the NE side.

Voucher specimens of the samples from which the ship's biochemists took extracts for analysis were lodged at the W.A. Museum for future reference. Other specimens of echinoderms, molluscs and some scleractinian corals, representative of the common elements of the fauna, were also collected and lodged at the W.A. Museum.

Although these collections were far from exhaustive they seem sufficient to characterize the invertebrate fauna. Figure 4 shows diagrammatically the reef-flat habitats sampled.

Habitat Zones:

1. The platform surface, crevices and shallow pools of the outer reef-flat.

2. Under coral and reef-rock slabs of the reef crest.

3. On high rocks and stacks of the high intertidal zone on the reef crest.

4. Sand and rubble substrates of the back-reef shallows.

5. Under coral and reef-rock slabs of the back-reef shallows.

Tables 1 and 2 list the common macro-molluscs and echinoderms taken.

CORALS

Although no extensive collection of corals was made during this expedition the variety observed was great in the lagoon where many ramose, foliose, massive and encrusting forms occurred. On the other hand, growth of hard corals on the reef-front slope seemed less luxuriant than on many near-shore reefs further south on the Western Australian coast.

Soft corals were a conspicuous feature of the benthic fauna, especially on the lower parts of the reef-front slope on the NE side of the atoll where they out-numbered scleractinians. In that situation the alcionacean genera *Nepthya*, *Alcionia*, and *Alcionaria* were especially abundant, as were the gorgonaceans *Plexaura* and *Gorgonia*. These animals were sampled extensively by the biochemists.

ECHINODERMS

A representative series of the common echinoids and asteroids was retained (Table 2). The material identified indicates that the echinoderm fauna is typical of the Central Indo-West Pacific region. Many holothurians were collected for biochemical analysis but not all the specimens were kept for subsequent identification. No crinoids and only a few ophiuroids were collected.

MOLLUSCS

The macro-molluscs of the reef-flat form a community typical of oceanic atolls and reefs of the Central Indo-West Pacific region with browsing and predatory prosobranchs being most conspicuous. The fauna is

different in several respects to the analogous reefs on the coastal islands of the Western Australian coast.

The common *Modiolus* is M. *auriculatus*, a very widespread intertidal mussel found on clear-water, oceanic reefs. On the turbid-water coastal reefs north of North West Cape, this species is absent and instead one finds there M. *nipponicus* Oyama, 1950.

On the mainland and coastal reefs, coral rocks and boulders of the reef-flat are heavily bored by *Lithophaga teres*, *L. obesa*, *L. nasuta* and *L. malaccana*. At Seringapatam species of *Lithophaga* were not seen and instead the coral boulders of the reef-crest (Zone 3) were heavily bored by the cirripede *Lithotrya valentiana*. There were no oysters on the high intertidal rocks and stacks; the only molluscs collected there were *Patella flexuosa*, *Nerita* sp., and *Thais armigera*.

Cerithium nodulosum, *Cypraea histrio*, *C. depressa* and *Lambis chiagra* are all conspicuous gastropods on the Seringapatam reef-flat (Zones 1 and 2) but these are absent or rare on the northern coastal reefs where the water is more turbid. (*Lambis chiagra* and *Modiolus auriculatus* are found on the fringing reef south of North West Cape where the water is clear.)

Faunal differences of this kind are interpreted as ecological, the fauna of Seringapatam showing the characteristics of an isolated oceanic atoll not subjected to turbid coastal water.

Another noteworthy feature of the fauna is the presence of the Pacific thaid *Nassa serta*. On the mainland and coastal reefs, including those south of North West Cape, the Indian Ocean species *Nassa francolina* Bruguière occurs but not *N. serta*. Also, on the coastal reefs, the Indian Ocean species *Drupina lobata* Blainville occurs together with the Pacific *D. grossularia*, while at Seringapatam only the latter is found. These observations suggest that the intertidal fauna of Seringapatam lacks the peculiarly Indian Ocean elements in favour of their Pacific analogues.

DISCUSSION & SUMMARY

The intertidal invertebrate fauna of Seringapatam is typical of Indo-West Pacific oceanic atolls and seems to have a Pacific rather than Indian Ocean flavour. This is not inconsistent with the location and the north-easterly ocean currents.

There is a very diverse scleractinean coral fauna although soft-corals dominate the reef-front slope, at least along the NE side.

The reef-flat molluscan fauna is dominated by browsing and predatory prosobranchs. Suspensory-feeders are uncommon.

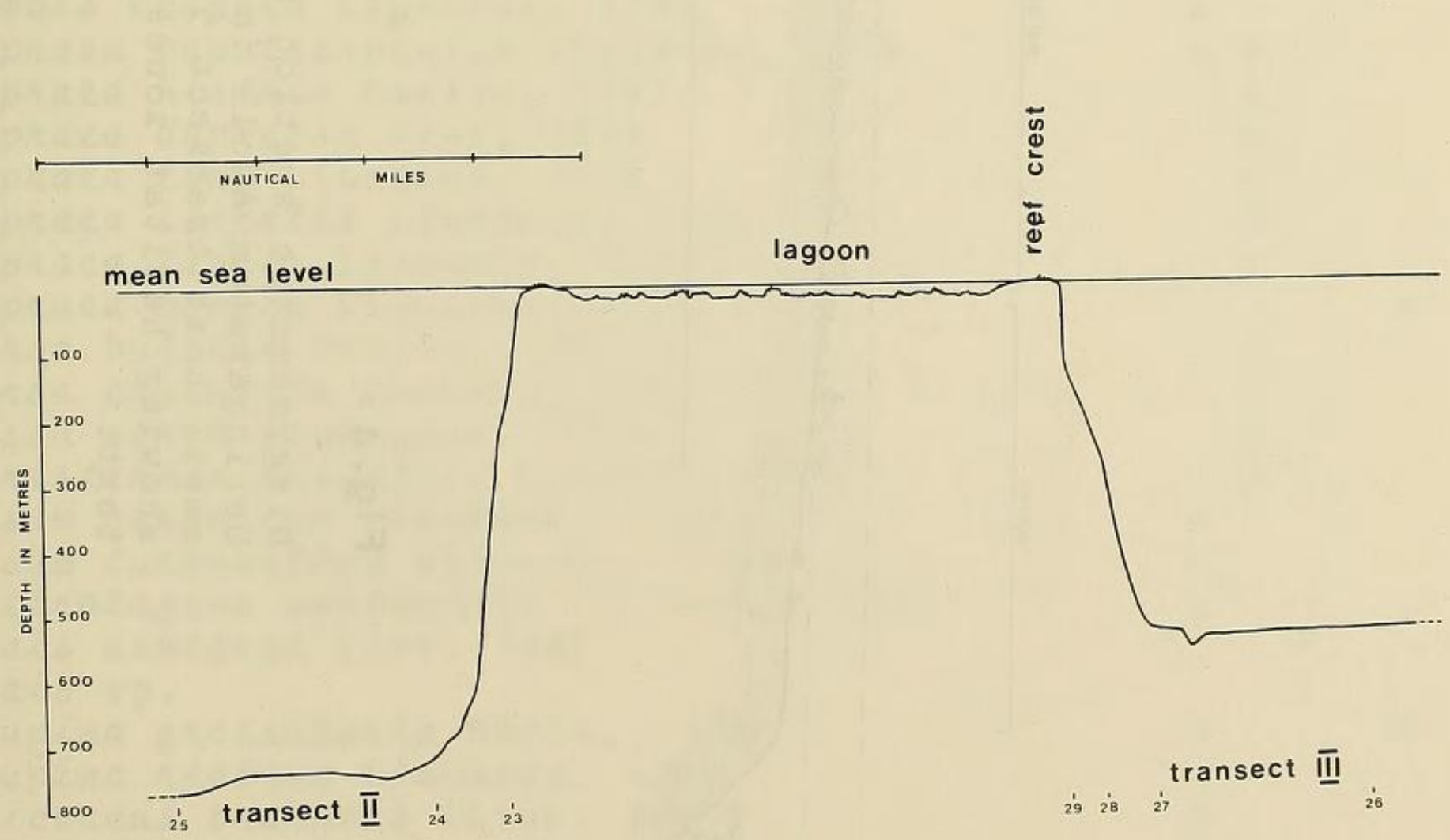

Fig. 3 : Diagrammatic section through Seringapatam Atoll along the NW-SE axis, derived from sounding transects II and III by the R.V. 'Professor Bogorov' and observations on the reef.

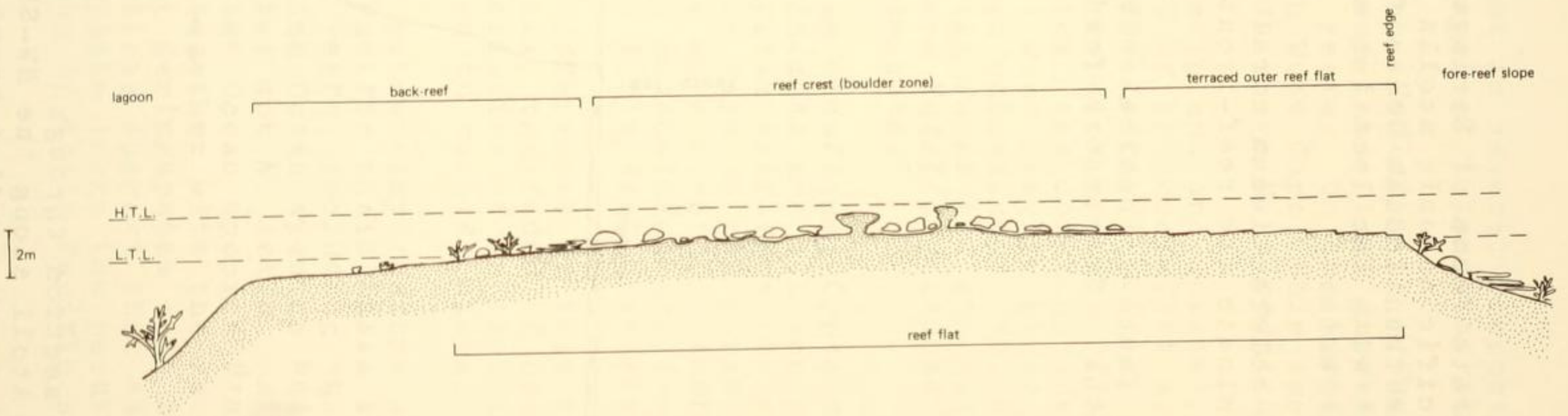

Fig. 4 :

Diagrammatic section across the reef of Seringapatam Atoll in the vicinity of small boat transect 5 (see Fig. 1), showing habitat zones described in the text.

TABLE 1 Common molluscs of the reef flat in the vicinity of small-boat transect 5. See Figure 4 and text for explanation of zones.

MOLLUSCS	ZONES 1	2	3	4	5
Modiolus auriculatus Krauss, 1848	x				
Tridacna maxima Röding, 1798	x				
Tridacna squamosa Lamarck, 1819				x	
Hippopus hippopus (Linnaeus, 1758)				x	
Fragum fragum (Linnaeus, 1758)				x	
Marmarostoma chrystomus (Linnaeus, 1758)		x			x
Trochus maculatus Linnaeus, 1758		x			
Trochus pyramis Born, 1778	x	x			x
Patella flexuosa Quoy & Gaimard, 1834			x		
Nerita sp.			x		
Cerithium nodulosum Bruguiere, 1792	x			x	
Cerithium echinatum Lamarck, 1822	x				
Rhinoclavis sp.	x				
Strombus lentiginosa Linnaeus, 1758				x	
Lambis chiagra Linnaeus, 1758	x				
Cypraea caputserpentis Linnaeus, 1758	x	x			
Cypraea histrio Gmelin, 1791		x			
Cypraea depressa Gray, 1824		x			
Cypraea lynx Linnaeus, 1758		x			
Cypraea isabella Linnaeus, 1758		x			
Cypraea tigris Linnaeus, 1758		x			
Cypraea moneta Linnaeus, 1758					x
Bursa bufonia Gmelin, 1791		x			
Bursa cruentata Sowerby, 1835		x			
Nassa serta Bruguiere, 1789		x			
Peristernia nassatula Lamarck, 1822		x			
Vasum ceramicum Linnaeus, 1758	x				
Vasum turbinellum Linnaeus, 1758	x				
Latirolagena smaragdula Linnaeus, 1758	x				
Thais armigera Link, 1807			x		
Thais sp.			x		
Drupina grossularia Röding, 1798	x				x
Drupina ricinus Linnaeus, 1758	x				
Chicoreus brunneus (Link, 1807)	x				
Conus lividus Hwass, 1792	x				
Conus flavidus Lamarck, 1810	x				
Conus miles Linnaeus, 1758	x				x
Conus rattus Hwass, 1792	x				
Conus imperialis Linnaeus, 1758	x				
Conus marmoreus Linnaeus, 1758	x				
Conus coronatus Gmelin, 1791	x				
Conus sponsalis Hwass, 1792	x				

TABLE 2 Common echinoderms of the reef flat in the vicinity of small-boat transect 5. See Figure 4 and text for explanation of zones.

ECHINODERMS	ZONES 1	2	3	4	5
Parasalenia gratiosa A. Agassiz, 1863; burrowing in the outer surface of *Tridacna maxima*			x		
Echinometra mathaei (de Blainville, 1825); burrowing in hard reef surface			x		
Echinothrix diadema (Linnaeus, 1758); pools			x		
Tripneustes gratilla (Linnaeus, 1758); pools			x		
Eucidaris metularia (Lamarck, 1816)				x	
Echinoneus cyclostomus Leske, 1778; buried in sand under stones				x	
Culcita novaeguinae Muller & Troschel, 1842; pools			x		
Linkia laevigata (Linnaeus, 1758); pools and reef surface		x			
Linkia multifora (Lamarck, 1816)				x	
Ophidaster granifera Lutken, 1872				x	
Asterina cepheus (Muller & Troschell, 1842)				x	
Asterepsis carinifera (Lamarck, 1816)					x
Nardoa tuberculata Gray, 1840					x
Lehinaster luzonica (Gray, 1840)					x
Stichopus chloronotus Brandt, 1835					x
Thelonota ananus (Jaegar, 1833)					x
Bohadschia argus Jaegar, 1833					x
Ophiarthrum pictum Muller & Troschell, 1842					x
Ophiocoma deoderleini de Lorid, 1899					x
Ophiarachna incrassata (Lamarck, 1816)				x	

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I am especially grateful to Mrs L.M. Marsh of the Western Australian Museum and Dr F. Rowe of the Australian Museum for identifying the echinodernus.

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