

8. SURVEY OF THE MACROFAUNA INHABITING LAGOON DEPOSITS ON AITUTAKI

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INTRODUCTION

Whilst various aspects of the marine faunas of many of the remote islands in the Central Pacific have been investigated, few studies have been directed towards the benthic, soft-bottom communities inhabiting atoll lagoons. In recent years ecological surveys of the lagoon benthos, especially of the molluscs and echinoderms, have been carried out at a number of the Tuamotu atolls, notably Mururoa and Réao (see Chevalier *et al.*, 1968; Renaud-Mornant *et al.*, 1971; Salvat, 1967, 1971, 1972; Salvat and Renaud-Mornant, 1969) and these studies have demonstrated the great variability of the lagoon communities according to the atoll structure and related sedimentological processes. This chapter describes the composition and distribution of the macrofauna within the lagoon on Aitutaki in the southern Cook Islands, a survey of which was carried out in August-September, 1969, as part of the Cook Bicentenary Expedition, organised by the Royal Society of New Zealand.

Descriptions of Aitutaki (latitude $18^{\circ} 51'45''S$, longitude $159^{\circ} 48'10''W$) will be found in Gibbs *et al.* (1971), Stoddart (this Bulletin) and Summerhayes (1971). Briefly, Aitutaki is an almost-atoll with an area of about 100 km^2 , approximately half of which is lagoon (Fig.36). Most of the lagoon is shallow, three quarters of its area being less than 4.5 m deep, and with a maximum depth of only 10.5 m. The tidal range at Aitutaki is small, about 0.5 m at springs.

Investigations were limited to the macrofauna, using this term in the sense of McIntyre (1971) i.e. comprising mainly the infauna of uncompacted sediments retained on a sieve of about 0.5 mm mesh. The positions of the stations sampled in the survey are shown in Fig.36. The littoral fauna was investigated at ten stations, eight around the mainland and two on the eastern reef at Ootu and Tekopua. At these stations the fauna was collected by digging and also sieving samples of sediment through 0.5 mm or 1.0 mm mesh. The bottom fauna of the lagoon was sampled at 20 stations, chiefly located in the eastern half of the lagoon, using a hand-operated naturalist dredge recovering 15-20 l of sediment. The infauna of these samples was separated by sieving through meshes of 0.5, 1.0 or 2.0 mm, the mesh size used depending on the sediment grade.

The lagoon sediments are almost entirely calcareous; even on the shores of the mainland the non-calcareous fraction is small (Stoddart, 1975). Three main deposit zones may be distinguished within the lagoon: (i) the poorly-sorted silty sands forming the extensive intertidal flat and shallow shelf around the mainland (Stations 1-8); (ii) the well-sorted medium to coarse sands, found around the reef islands and on the reef rim (Stations 10, L1-L9); and (iii) the poorly-sorted, fine sands, often with considerable admistures of silt, which cover the lagoon floor (Stations L10-L20).

FAUNA OF THE LITTORAL DEPOSITS

Mainland shore

Along the eastern shore of the mainland the broad sandflat that is exposed at low water springs for a distance of up to 400 m, was chiefly studied at Station 5 but similar observations were made at Stations 4 and 6. A notable feature of this flat is the absence of seagrasses. The number of species found on this flat is relatively low (Table 16) and, for the most part, the fauna is sparse.

The surface-burrowing forms are chiefly gastropods, the commonest of which are Cerithium variegatum Quoy and Gaimard, Pyramidella acus (Gmelin) and Rhinoclavis asper (L.) - the latter being a characteristic lagoon species of Pacific Islands (Morrison, 1954). Less frequent are Natica gaultieriana Recluz, Atys cylindrica (Helbling) and the bivalve (Gafrarium pectinatum (L.)). The infauna is dominated by sedentary polychaetes, particularly the chaetopterid species Mesochaetopterus sagittarius (Claparède), Phyllochaetopterus elioti Crossland, and Spiochaetopterus costarum (Claparède), together with fewer individuals of Phyllochaetopterus brevitentaculata Hartmann-Schröder, Glycera lancadivae Schmarda, Armandia melanura Gravier, Dasybranchus caducus (Grube) and Malacoceros indicus (Fauvel). An errant polychaete, Marphysa macintoshi Crossland, and two deep-burrowing bivalves, Asaphis violascens (Forskål) and Quidnipagus palatum Iredale, mainly occur along the landward edge of the flat where they penetrate cracks in the underlying clay-like rock. Species found under boulders lying on the sand surface include Siphonosoma cumanense (Keferstein), Callianassa (Callichirus) sp. (near C. placida de Man), Alpheus spp., Calcinus latens (Randall), Clibanarius humilis (Dana) and Cypraea moneta (L.).

Over the outer (lagoonward) half of the flat the burrows of the large mantis shrimp Lysiosquilla maculata (Fabricius) are very conspicuous although from the surface indications, few burrows appeared to be occupied, a feature that could not be verified owing to the great depth to which this species burrows. No specimens were captured by the author, the species being identified from a specimen (c.250 mm in length) purchased from

a local fisherman. The deposit-feeder Holothuria atra Jaeger (see Bonham and Held, 1963) is fairly numerous in this area: many of these holothurians were examined for the commensal polynoid Gastrolepidia clavigera Schmarda but none of the latter were discovered despite the fact that this association is to be found on the outer reefs (see Gibbs, 1972). Crabs are frequently encountered ranging over the flat in shallow water; they include Calappa hepatica (L.), Thalamita admete (Herbst), Thalamita crenata (H. Milne Edwards), Metopograpsus thukuhar (Owen) and Percnon planissimum (Herbst), as well as several species of hermits, and probably all of these species are widespread in the lagoon. The largest of the lagoon crabs, Scylla serrata (Forskål), is generally trapped by local fishermen in nets laid in the muddier, northern part of the lagoon; the larger of two purchased specimens measures 20 cm across the carapace.

Along the landward edge of the flat, between the levels of about low water neaps and high water springs, the beach profile is steeper. In this narrow strip the ocypodid crabs Macrophthalmus (Macrophthalmus) convexus Stimpson and Uca tetragonon (Herbst) are common, the former extending from the upper levels of the flat to about mid-tide level and the latter from about mid-tide level up towards high water mark. Both species are found along the length of the eastern shore of the mainland but are commonest in the muddier deposits to the north, particularly in the backwater of Te 0 (Stations 7 and 8). On the other hand, the ghost crab Ocypode laevis Dana appears to be confined to the more southerly shoreline (e.g. Station 4) where it is found burrowing in moist sand at high water level. The land crab Cardisoma carnifex (Herbst) is found on the mainland but its distribution was not studied.

Along the lagoon shore of the mainland, in a narrow zone about mid-tide level, two spionid polychaetes dominate the infauna: these are Malacoceros indicus and Scoelepis (Scoelepis) squamata saipanensis Hartman, both of which form dense, often mixed, populations. Below this level, in the less silty deposits along the southern shoreline (Stations 2 and 3), the small opheliid Armandia melanura is frequently the only infaunal species but in patches Mesochaetopterus sagittarius occurs, its densely aggregated tubes often forming prominent, raised hummocks.

Special mention should be made of the polychaete Ceratone-reis vaipekae Gibbs, a species described from the material of the present survey. This small nereid is very abundant amongst the Uca burrows at Te 0 (Station 8) and it is also found amongst the roots of shoreline grasses (at Station 6) often with the intertidal oligochaete Pontodrilus matsushimensis Iizuka. It seems likely that C. vaipekae is able to tolerate periods of lowered salinity since in these habitats brackish conditions must occur with surface run-off after heavy rainfall.

Reef shores

The fauna of the lagoon shores of the eastern reef was investigated at two localities, namely at Ootu (Station 9) where the intertidal flat is composed of silty, fine sand, and at the southern end of Tekopua Island where the littoral deposits are medium to coarse sands. The main difference between the fauna at these two localities and that of the mainland shore is the presence of the enteropneust Ptychodera flava Eschscholtz, the abundance of which is clearly indicated by the numerous faecal casts on the sand surface. However, apart from this species, the fauna at Ootu is similar to that found on the flat of the mainland, with the three chaetopterids M. sagittarius, P. elioti and S. costarum being the dominant elements of the infauna, except that here the surface burrowing gastropods are remarkably scarce, only one specimen of Pyramidella acus being found.

At Tekopua (Station 10) the infauna is again dominated by chaetopterids but the species are different, namely Phyllochaetopterus verrilli Treadwell and P. brevitentaculata. Apart from P. flava, the remaining infauna is few in both species and individuals, perhaps the most striking being the two snake-eels Callechelys melanotaenia Bleeker and Leiuranus semicinctus (Lay & Bennett). However, the surface burrowers Strombus gibberulus gibbosus (Röding) and Rhinoclavis asper are common, together with hermits, including Calcinus elegans (H. Milne Edwards) and Aniculus aniculus (Fabricius).

FAUNA OF THE SUBLITTORAL DEPOSITS

Nine dredge hauls of the well-sorted medium to coarse sands found over the reef-rim (Stations L1-L9) were taken in depths of 1-2 m and 11 of the poorly-sorted finer deposits covering the lagoon floor (Stations L10-L20) in depths of 1-6 m (see Fig. 36). The species taken in these samples are listed in Table 16. It should be noted that the distributions of the chaetopterid species are wider than the records suggest since empty or fragmentary tubes were present in most samples but cannot be identified with certainty.

Many of the species recorded from the intertidal zone are also widely distributed throughout the lagoon. The commonest of these include Glycera lancadivae, Nematonereis unicornis (Grube), Aonides oxycephala (Sars), Malacoceros indicus, chaetopterid spp., Dasybranchus caducus, Rhinoclavis asper, Strombus gibberulus gibbosus, Natica gaultieriana, Pupa sulcata (Gmelin), Atys cylindrica and Ptychodera flava. Of the total of about 70 species dredged in the lagoon, at least 46 species (chiefly molluscs (31) and polychaetes (10)) are recorded only from the sublittoral zone but the majority of these are known only from one or two stations.

Excluding those taken intertidally, the commoner sublittoral species (i.e. those taken at 4 or more stations) are relatively few in number. Characteristic species of the coarser, reef-rim deposits are Strombus mutabilis Swainson and the cephalochordate Asymmetron lucayanum Andrews, whilst Lioconcha ornata (Dillwyn) and Glossobalanus sp. appear to be characteristic of the finer deposits. On the other hand, the bivalves Tellinella staurella (Lam.) and Arcopagia (Pinguicella) robusta (Hanley) do not appear to be so restricted in their distribution, both species being widespread throughout the sublittoral of the lagoon.

DISCUSSION

As mentioned above, surveys of the soft-bottom lagoon communities of only a few of the remote atolls in the Central Pacific have been made. A major interest in such surveys in this region obviously lies in obtaining records for defining the eastern limits of the distribution pattern of many shallow-water Indo-West-Pacific species. Although this aspect is fairly well documented for some groups, for example, brachyuran decapods (see Forest & Guinot, 1962) and molluscs (see Ranson, 1967), many other groups remain poorly known. Whilst the present survey has contributed many records towards a preliminary check-list of the Cook Islands marine fauna (see Gibbs et al, 1975), the primary aim in carrying out a survey of the Aitutaki lagoon was to obtain an estimate of the species diversity of the soft-bottom community.

The species composition of the soft-bottom community on Aitutaki is given in Table 16; its composition by group is as follows:

Polychaeta	27	Gastropoda	31
Oligochaeta	1	Pelecypoda	13
Sipuncula	1	Echinodermata	4
Phoronida	1	Cephalochordata	1
Stomatopoda	2	Enteropneusta	2
Decapoda	20+	Teleostei	3

Thus, from these preliminary data, the soft-bottom macrofauna of the lagoon is estimated at a total of about 100 species. The number of species represented in each of the three main deposit zones, i.e. the intertidal sand flat of the mainland, the reef rim, and the lagoon floor, are given in Table 17. These data show that the intertidal flat has fewer species than either of the other two zones chiefly because of the paucity of mollusc species. However, the fact that only 10 mollusc species were discovered on the intertidal flat could be a result of many of the sand-dwelling molluscs being highly regarded as food by the islanders, as noted by Banner (1952) for Onotoa Atoll, Gilbert Islands. Further, it should be mentioned that a number of species, notably terebrids

and mitrids, represented in the Morgan Collection of mollusc shells (see Chapter 10 of this Bulletin) and collected at Aitutaki, were not found in the present survey.

Although data relating to species diversity and faunal composition of the soft-bottom benthos of other atoll lagoons are not available for comparison, several features of interest emerge in relating the present observations with those of the surveys of Tuamotu atolls. The most abundant molluscs on Aitutaki are Rhinoclavis asper, Strombus spp., Natica gaultieriana, Pupa sulcata, Tellinella staurella and Arcopagia (Pinguitellina) robusta; interestingly only the last-named species is included in the list of the 12 most abundant molluscs found by Salvat (1972) on Réao. On Réao, and other atolls (see Ranson, 1954; Salvat, 1967), Fragum fragum (L.) is the dominant mollusc, but on Aitutaki this species appears to be uncommon, only two live specimens being taken in the 20 dredge hauls. Also the Aitutaki fauna appears to lack any species of spatan-goid: no specimens or traces of such forms as Rhinobrissus hemiasteroides A. Agassiz and Brissopsis luzonica (Gray) were discovered, although both of these species are common in the lagoon of Mururoa (Salvat & Renaud-Mornant, 1969). The widespread abundance of enteropneusts, particularly Ptychodera flava, except on the mainland shore, is a striking feature of the Aitutaki lagoon fauna: on other atolls that have been investigated this group appears to be less dominant. Whilst such differences in the relative abundance of species may be related to sedimentological processes and atoll structure (see Salvat, 1967), before comparative and regional analyses can be attempted, much faunistic data remains to be compiled both for individual atolls and atoll groups.

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Table 16. Aitutaki lagoon: list of species occurring in samples taken at littoral Stations 1-10 between high and low water levels and in samples dredged at Stations L1-L20 in depths of 1-6m (see Fig. 36)

SPECIES	STATION
Polychaeta	
<i>Paleanotus debilis</i> (Grube)	10
<i>Eurythoe complanata</i> (Pallas)	15
<i>Gyptis capensis</i> (Day)	12, 13, 14, 15, 16
<i>Typosyllis regulata</i> Imajima	15
<i>Ceratonereis vaipekae</i> Gibbs	8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Glycera lancadivae</i> Schmarda	12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Marphysa macintoshi</i> Crossland	12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Nematonereis unicornis</i> (Grube)	12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Aonides oxycephala</i> (Sars)	17
<i>Malacoceros indicus</i> (Fauvel)	8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Prionospio malmgreni</i> Claparède	18
<i>Scolecopsis aitutakii</i> Gibbs	10
<i>Scolecopsis squamata saipanensis</i> (Hartman)	3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Spio filicornis</i> (Müller)	4
<i>Poecilochaetus tropicus</i> Okuda	16, 17, 18, 19, 20
<i>Mesochaetopterus sagittarius</i> (Claparède)	15, 16, 17, 18, 19, 20
<i>Phyllochaetopterus brevitentaculata</i> Hart-Sch.	13, 14, 15, 16, 17, 18, 19, 20
<i>Phyllochaetopterus elioti</i> Crossland	13, 14, 15, 16, 17, 18, 19, 20
<i>Phyllochaetopterus verrilli</i> Treadwell	12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Spiochaetopterus costarum</i> (Claparède)	9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Armandia melanura</i> Gravier	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Polyophthalmus pictus</i> (Dujardin)	11
<i>Dasybranchus caducus</i> (Grube)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
<i>Myriochele haplosoma</i> Gibbs	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

Table 16 continued

SPECIES	STATION
Myriochele sp.	
Branchiomma cingulata (Grube)	L1 +
Branchiomma picta (McIntosh)	L11 +
Oligochaeta	
Pontodrilus matsushimensis Iizuka	L5 + L6 + L7 +
Sipuncula	
Siphonoma cumanense (Keferstein)	L5 +
Phoronida	
Phoronopsis harmeri Pixell	L3 + L8 + L9 +
Crustacea ¹	
Amphipod sp(p).	L1 + L8 +
Lysiosquilla maculata Fabricius	L10 + L11 + L12 + L13 + L14 + L15 + L16 + L17 + L18 + L19 + L20 +
Heterosquilla sp.	L4 (+) L5 (+) L6 (+) L7 (+) L8 (+) L9 (+)
Alpheus crassimanus Heller	L5 +
Alpheid sp.	L15 +
Callianassa sp.	
Aniculus aniculus (Fabricius)	L10 +
Calcinus elegans (H. Milne Edwards)	L10 +
Calcinus latens (Randall)	
Clibanarius humilis (Dana)	L5 + L6 + L7 + L8 + L9 +
Pagurid sp(p).	L3 + L4 + L5 + L6 + L7 + L8 + L9 +
Calappa hepatica (L.)	L3 + L4 + L5 + L6 + L7 + L8 + L9 +
Macrophthalmus convexus Stimpson	L3 + L4 + L5 + L6 + L7 + L8 + L9 +

Table 16 continued

SPECIES	STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Echinodermata																															
<i>Amphipholis squamata</i> (Delle Chiaje)																															
<i>Amphiodia</i> sp. aff. <i>A. individua</i> Mort.																															
<i>Chiridota hawaiiensis</i> Fisher																															
<i>Holothuria atra</i> Jaeger																															
Hemichordata																															
<i>Ptychodera flava</i> Eschscholtz																															
<i>Glossobalanus</i> sp.																															
Cephalochordata																															
<i>Asymmetron lucayanum</i> Andrews																															
Teleostei																															
<i>Leiuranus semicinctus</i> (Lay & Benn.)																															
<i>Callichelys melanotaenia</i> Bleeker																															
<i>Echelid</i> sp.																															

¹The portunid and grapsid crabs, which probably range widely within the lagoon have been omitted: these are *Thalamita admete* (Herbst), *Thalamita crenata* (H. Milne Edwards), *Scylla serrata* (Forskål), *Metopograpsus thukuhar* (Owen) and *Percnon planissimum* (Herbst).

²Burrows seen but specimens not collected.

³Mollusc species recorded only from empty shells.

Table 17. Comparison of the number of species represented in the three main deposit zones of the lagoon on Aitutaki

Zone Group	Intertidal flat HWM-LWM	Reef rim LWM-2m depth	Lagoon floor 1-6m depth
	Stations 3-8	Stations 10, L1-L9	Stations L10-L20
Polychaeta	12	15	17
Crustacea ¹	9	6	1
Mollusca ²	10	27	23
Other	3	7	7
Total	34	55	48

¹Excluding portunids and grapsids - see Table 1

²Including trace (shell only) species

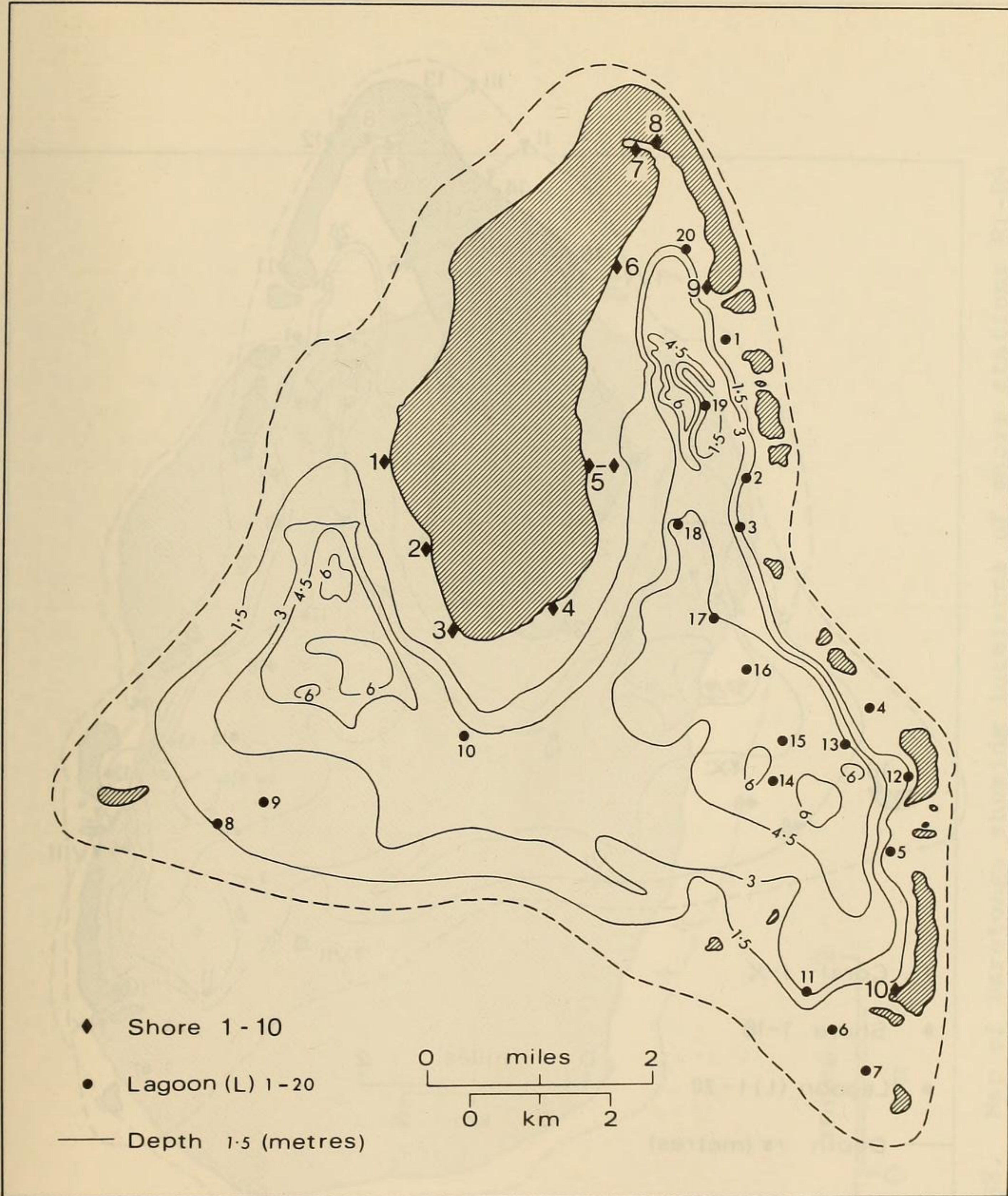


Figure 36. Map of Aitutaki showing lagoon bathymetry and location of sampling stations

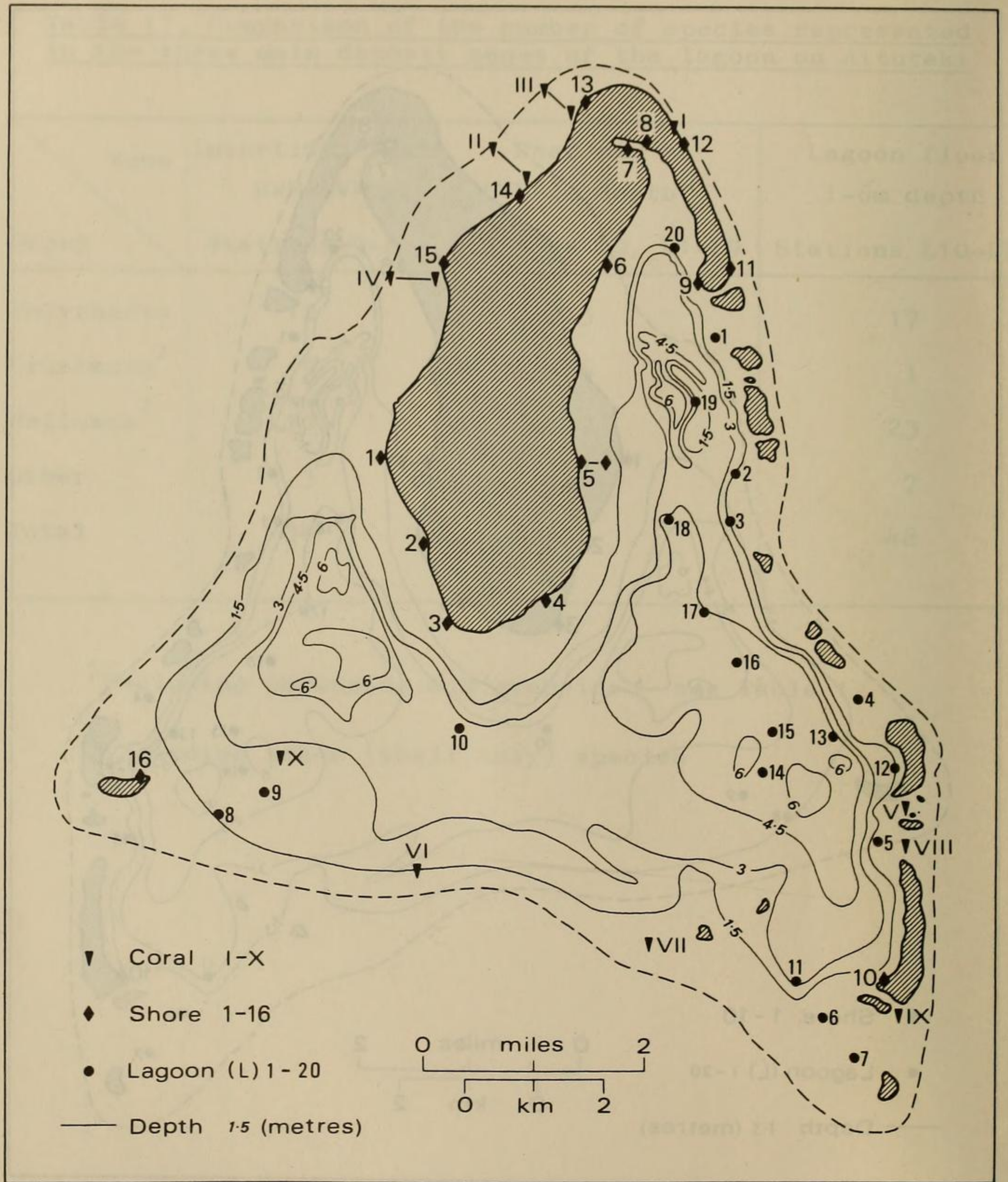


Figure 37. Map of Aitutaki showing positions of shore stations 1-16, dredge stations L1-L20, and coral collection areas I-X.

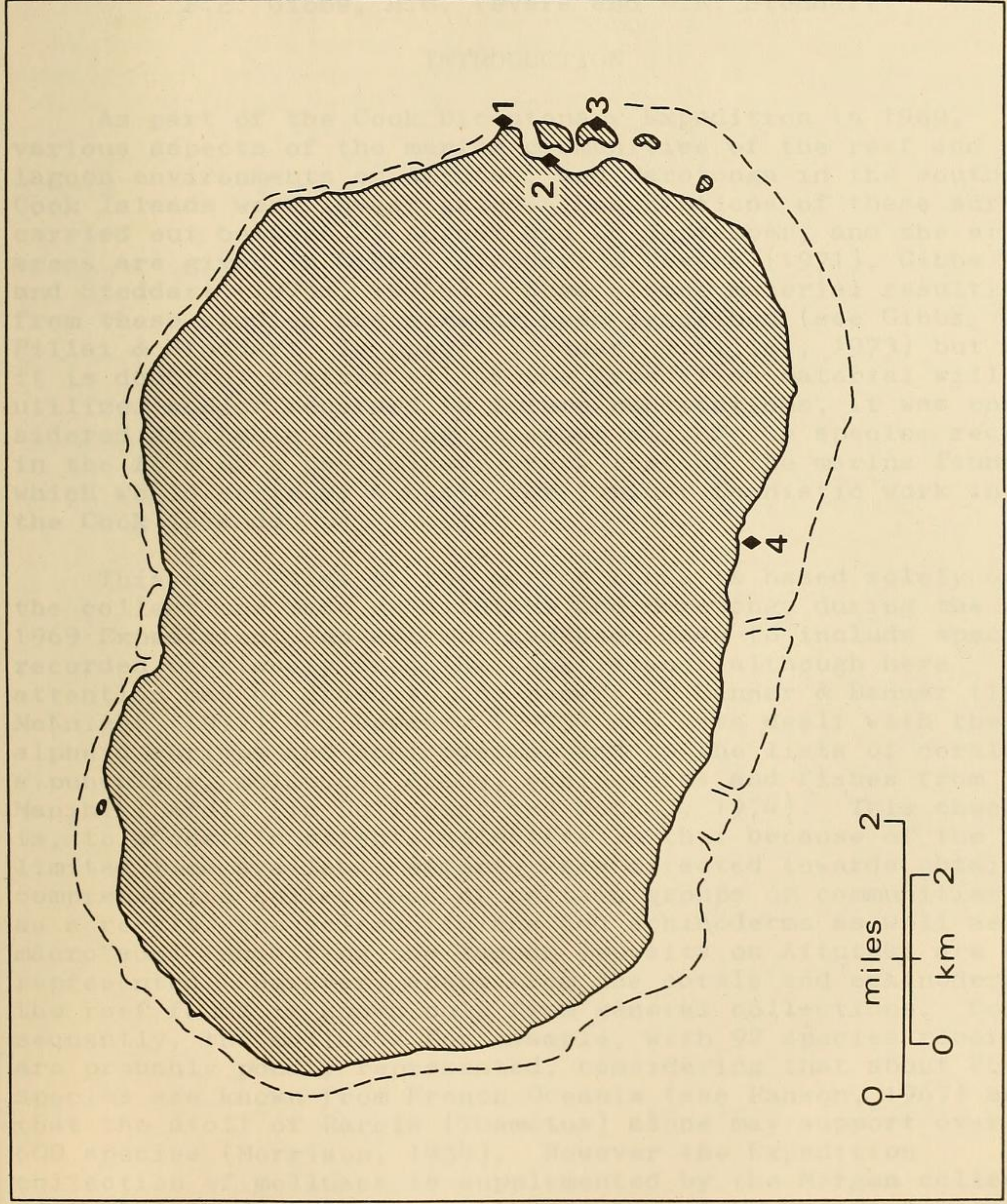
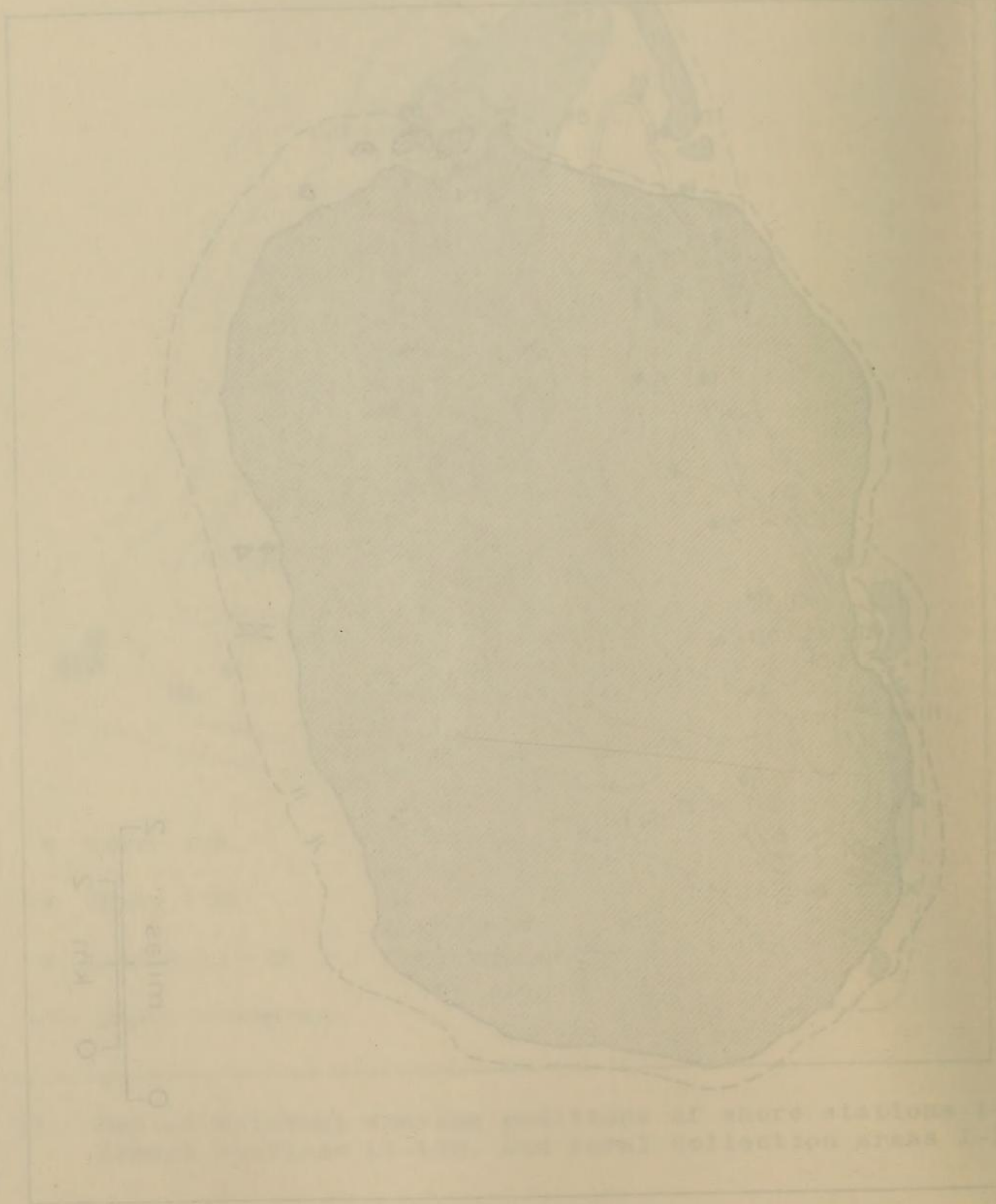


Figure 38. Map of Rarotonga showing locations of shore stations R1-R4

Map of the study area showing the location of the study area in the Pacific Ocean.



Map of the study area showing the location of the study area in the Pacific Ocean. The map includes a scale bar (0 to 5 km) and a north arrow.