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MARINE BIOLOGICAL SURVEYS AND RESOURCE INVENTORY OF SELECTED COASTAL SITES AT AMERICAN SAMOA

RANDALL AND DEVANEY, AUG 1974

FINAL REPORT

MARINE BIOLOGICAL SURVEYS AND RESOURCE INVENTORY

OF

SELECTED COASTAL SITES

AT

AMERICAN SAMOA

Corps of Army Engineers
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TABLE OF CONTENTS

FIGURES

Fig. 18 - Aunuu Island; Rich coral growth (Acropora samoensis and plate-like Pachseris speciosa) shoreward from patch reef at depth of 6 - 7 m.

Fig. 19 - Aunuu Island; explosive excavation for channel N of Transect N, 16 March 1963 USS "Reclaimer" project (courtesy American Samoa Museum).

Fig. 20 - Aunuu Island; explosive excavation N of Transect N, 16 March 1963, USS "Reclaimer" Project (courtesy of American Samoa Museum).

Fig. 21 - Fagaalu; map showing recent fill area and Transects S and N.

Fig. 22 - Fagaalu; low relief coral and rubble, depth o. 3 m, 25 - 30 m offshore on Transect S.

Fig. 23 - Fagaalu; coral and coralline algae-covered bottom, depth 0. 2 m, 50 m offshore on Transect S.

Fig. 24 - Fagaalu; coral rubble-dominated substratum with isolated heads of Acropora formosa, depth 0. 3 m, 75 m offshore on Transect S.

Fig. 25 - Fagaalu; view looking NW from fill area at Park towards head of embayment at high tide.

Fig. 26 - Fagaalu; view looking NNW along Transect N from shore at mid-tide.

Fig. 27 - Faganeanea; aerial photo showing Transects N and S.

Fig. 28 - Faganeanea; rubble substratum with outcropping of Porites lutea on Transect N, 10 m offshore.

Fig. 29 - Faganeanea; massive head of Coscinaraia columna along last 25 m of Transect N, depth 3 m.

Fig. 30 - Faganeanea; rubble substratum and colonies of soft coral, Sclerophylum at margin of channel, outer part of Transect N.

Fig. 31 - Faganeanea; rocky outcrop and cave at head of channel, outer part of Transect N.

Fig. 32 - Faganeanea; reef off Utulaina Pt. facing S towards Fatuuli Rock in area of Transect S.

Fig. 33 - Faganeanea; reef off Utulaina Pt. facing S towards Fatuuli Rock, Devaney standing along Transect S.

Fig. 34 - Faganeanea; Samoan boys fishing off Utulaina Pt.

Fig. 35 - Faganeanea; Samoan women fishing on reef between Faganeanea and Vasaaiga at low tide; woman on left with octopus in left hand.

Fig. 36 - Faganeanea; man fishing at NE side of drainage channel (at end of Transect N).

Fig. 37 - Asili Bay; aerial photo showing Transects S and N.

Fig. 38 - Asili Bay; beach and shallow exposed rock and coral along Transect N, facing NW.

Fig. 39 - Asili Bay; looking south from highway, area of Transect S in left background.

Fig. 40 - Nua-Seetaga Bay; aerial photo showing Transects S and W.

Fig. 41 - Nua-Seetaga Bay; low profile substratum dominated by truf algae and papillose sponge, 25 m offshore on Transect N, depth 0.4 m.

Fig. 42 - Nua-Seetaga Bay; Transect S, 75 to 100 m offshore showing damselfishes and surgeonfishes in front of mound of coral rock, depth 0.4 m.

Fig. 43 - Amanave Bay; aerial photo showing Transects N & S.

Fig. 44 - Amanave Bay; Utusiva Rock looking W.

Fig. 45 - Amanave Bay; bottom along Transect S, 25 m offshore with sand-algal matrix and sand patches, depth 1.5 m.

Fig. 46 - Amanave Bay; the view along seaward edge of landfill and seawall between Transects S and N looking SE.

Fig. 47 - Amanave Bay; bottom along Transect N, 115 m offshore, depth 0.3 m.

Fig. 48 - Amanave Bay; man fishing for octupus NW of Utusiva Rock at low tide.

COLOR PHOTO APPENDIX

Prints

Fig. 1 - Vatia Bay; Transect S, substratum composed of basalt boulders and sand-algal matrix, 9 m offshore.

Fig. 2 - Vatia Bay; live and dead coral (mainly Acropora) ca. 60 m offshore on Transect S.

Fig. 3 - Vatia Bay; Acropora samoensis and encrusting nullipores over tabular Acropora (foreground), ca. 60 m offshore along Transect S.

Fig. 4 - Afono Bay; shore between Transects E and W showing spring of freshwater (light brown discoloration) at high tide, 30 April 1974.

Fig. 5 - Aoa Bay; view towards the east at low tide on 4 May 1974.

Fig. 6 - Aoa Bay; view towards the west at low tide on 4 May 1974.

Fig. 7 - Aoa Bay; view towards the east at low tide on 4 May 1974, taken near Transect W ca. 50-60 m offshore.

Fig. 8 - Fagaalu; view from hillside off fill area (Fagaalu Park) and dredged sectors fringing reef.

Fig. 9 - Fagaalu; view from hillside of southern end of fill area (Fagaalu Park).

Fig. 10 - Amanave Bay; turbid water evident from brown discoloration NW of Utuseva Rock; some turbidity due to erosion of village land fill.

INTRODUCTION

Marine biological surveys were conducted at American Samoa on the Island of Tutuila between 21 April - 5 May, 1974. The surveys were in response to the U. S. Army Corps of Engineer's request for examination of the marine environment in areas where potential shoreline storm damage mitigation projects are proposed (Fig. 1). Three sites on the northeastern coast at Vatia, Afono and Aoa Bays were surveyed at locations where existing seawalls have been considered inadequate to protect public schools near the shore. Five more sites along the highway from Pago Pago Harbor to Amanave Bay on the west were selected as examples of areas where the highway comes close to shore and thus might be damaged by storm waves or long-term erosion. In addition, at the small island of Aunuu off the SE side of Tutuila, we investigated an area under consideration for a small boat harbor.

Maps were provided of each of our survey sites by the Corps of Engineers to indicate the limits. We chose to run transects along these lines and then to examine the area between these limits in a less formal manner. We utilized a line of 25 meters in length, marked off in meters, to run our transects. This proved to be a convenient distance for the reef flat work that comprised the bulk of our surveys. Notes were taken on plastic slates using waterproof paper.

Since the surveys were restricted to one or two days at most at each site, we decided to concentrate but not limit our observations on the dominant faunal and floral elements. For the most part these meant corals and fishes and to a lesser extent echinoderms and algae.

In the time available it was possible to make no detailed ecological studies, as in delineation of zones, quantitative assessments, or more than cursory physio-biological determinations. Thus our statements are primarily descriptive. Meaningful comparisons among the sites other than the obvious, such as grouping by bay localities and exposed shores, were not feasible. Rather each site presentation attempts to describe particular aspects of the areas from which a baseline of environmental information can be gleaned.

The areas surveyed are restricted portions of the coastline and do not necessarily represent the environment between sites or reflect conditions as they might occur at other times of the year.

With the exception of the Aunuu site, we observed no unique biological or geological features which might be destroyed by such activities as seawall construction renovation or road improvements at the survey sites visited. At Aunuu however the fringing reef and attendant marine life are among the best developed we observed in Samoan waters. We feel that the proposed breakwater and dredging operation for this area would be disruptive to the reef community.

In the environments which we surveyed, there are virtually no

endangered species of subsurface marine life. Apart from introduction of exotic species, none of man's usual depredations of the environment within the areas surveyed could be expected to cause extinction of the marine forms, due primarily to the lack of local endemism. However, care must be exercised in any shoreline activity impinging upon the marine environment so that serious depletion of indigenous marine animals and plants does not take place nor adversely alter marine habitats. This is particularly true of supralittoral and littoral (intertidal) forms which are restricted to the near shore where impact is expected to be greatest.

Our observations were made only during daylight hours, thus nocturnal forms which are concealed by day were often overlooked even though they may have been abundant. This is especially true of such groups as the moray eels (Muraenidae) and squirrelfishes (Holocentridae), ophiuroids, and crabs.

We were asked to determine, if possible, the local use of the marine resources of each survey area. Knowing that time was limited for such observations and in-depth interviews, we discussed this with Dr. Stanley N. Swerdloff, Director of the Department of Marine Resources, hoping that he might already have information on file of the fishing activity, etc. of the various villages on Tutuila. He informed us that he had begun a project of obtaining catch statistics for the fishing centers of the island, but found this impossible to attain. Only two villages submitted such data and for one, the amount of fish said to have been caught was grossly exaggerated and for the other it was significantly

understated. We therefore made an attempt to interview residents of the sites about fishing activity, etc., as well as note any such activity that occurred during our visits.

Both members of the survey team attended a public hearing conducted by the Corps of Engineers on Wednesday evening, 24 April 1974 at Pago Pago which included discussions of the proposed seawall construction at the three northeastern bays.

Two points germaine to environmental impact considerations were raised by one of the village chiefs. First, to what depth and extent would it be necessary to excavate into and out onto the reef? Second, would the new seawalls be built in the same place as the existing ones? To the first question, Col. Leonard Edelstein, District Engineer, stated that it would be necessary to reach solid reef bottom for attachment and that further seaward extension might be needed. As no firm construction design or plan criteria were available there had been no determination reached in answer to the second question, but that the seawall construction would basically cover the same shoreline position as present.

The majority of testimony by participants at the public hearing was in favor of the projects but residents of the bays wished that additional protection for the villages as well as schools could be provided.

ACKNOWLEDGEMENTS

Our trip and survey work was made successful through the cooperation of the Government of American Samoa. Dr. Swerdloff made every effort to have the facilities and personnel of the Department of Marine Resources available. An office and laboratory were provided in the Museum of American Samoa by Dr. Richard C. Wass of Marine Resources. Dr. Wass assisted in logistic support and joined us on trips to Aunuu Island, Aoa, Vatia, and Afono Bays. Mr. Gordon Yamasaki, VISTA volunteer affiliated with Marine Resources, also assisted us. Mr. John Alving, Assistant Director of the Department of Public Works, was very helpful in locating our survey sites and especially in granting us access to a series of aerial photographs of American Samoa which we were able to duplicate and use for this report. We also wish to thank the many residents of Tutuila and Aunuu who were most cooperative in providing pertinent information.

Assistance in the identification of corals was provided by Dr. James E. Maragos of the Hawaii Institute of Marine Biology and for algae by Dr. Maxwell S. Doty of the Botany Department, University of Hawaii.

Figure 1

● Survey Sites

ISLAND OF TUTUILA
AMERICAN SAMOA

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VATIA BAY

The first transect in the bay (N of Fig. 2) was conducted perpendicular from shore at the NE end of the concrete sandbag seawall in front of Vatia School (Fig. 3) on May 1. The seawall at this end is 1.5 m high; it then curves about a meter inshore and ends in a World War II pillbox, the aperture of which has been cemented. Sloping coral shingle and rubble material at the base of the pillbox has reduced the height of the wall to 0.9 m. The transect commenced at 1030 hours; a -0.2 low tide occurred at 0917 hours. A few Littorina and Nerita may be seen near the upper end of the seawall (Fig. 4). and the Nerita extended to the lower part of the wall. For the first 18 meters from the seawall the bottom was about 70% boulders (mainly basalt) and 30% sand. The first 11 m were exposed (Fig. 5). There was considerable freshwater seepage 3.5 m from the wall at a site almost on the transect line. There had been no appreciable rain the previous 24 hours; however, the day before there was considerable precipitation (see discussion of Afona Bay). In the shallowest part of the boulder zone some ankle deep pools were present. These contained juvenile damselfishes (Glyphidodontops glaucus, G. leucopomus and Abudefduf sordidus) and a few unidentified small blennies and gobies (it would have been necessary to collect them to be certain of their identification). Under rocks the dark brown sea cucumber Holothuria (Stauropora) ludwigi (?) was common; there were also small crabs (mainly xanthids), hermit crabs, and an occasional juvenile Turbo. Out of water on the tops of the boulders and on the seawall a few small coenobitid hermit crabs were seen.

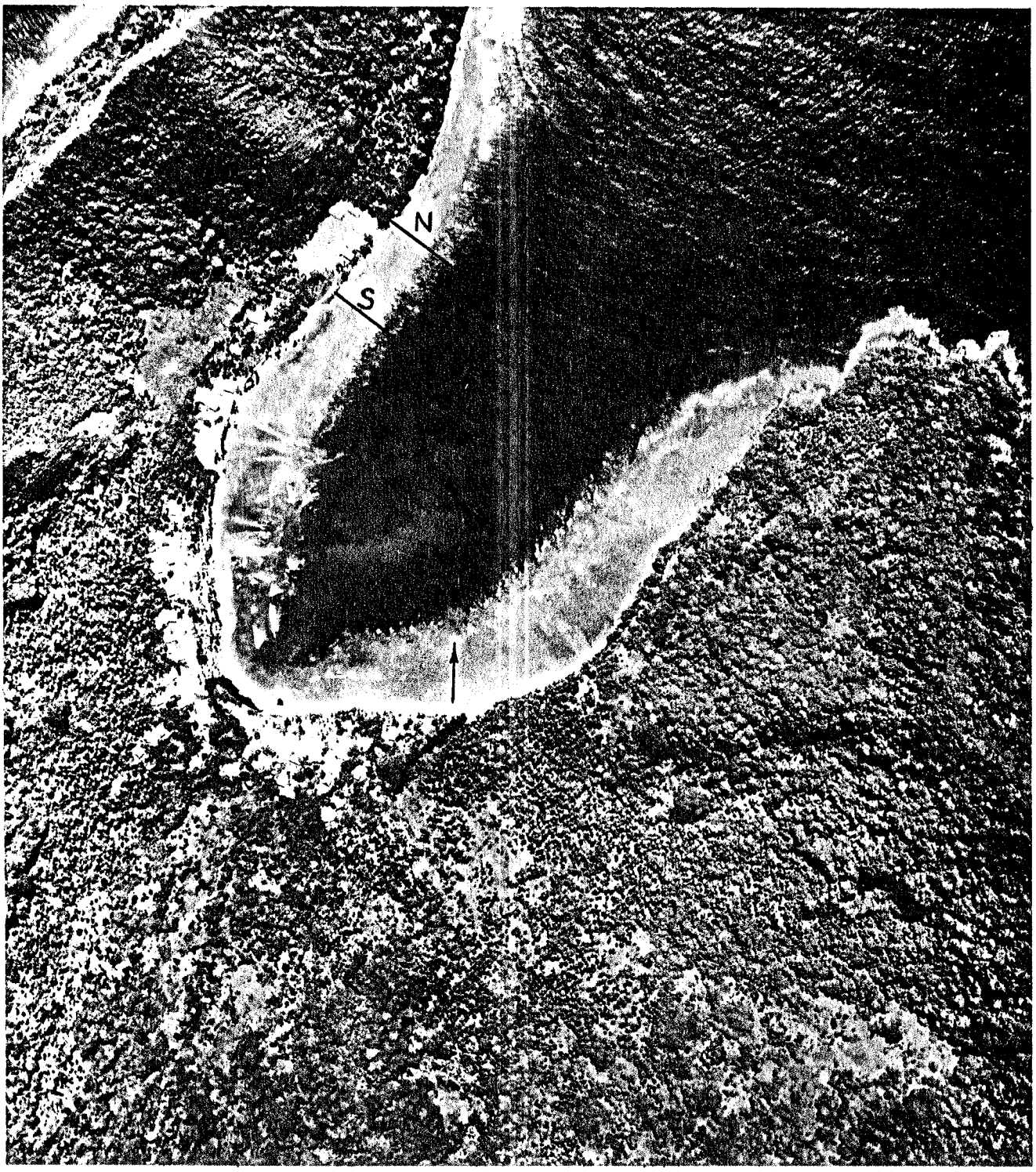


Fig. 2 - Vatia Bay; aerial photo showing Transects S and N.

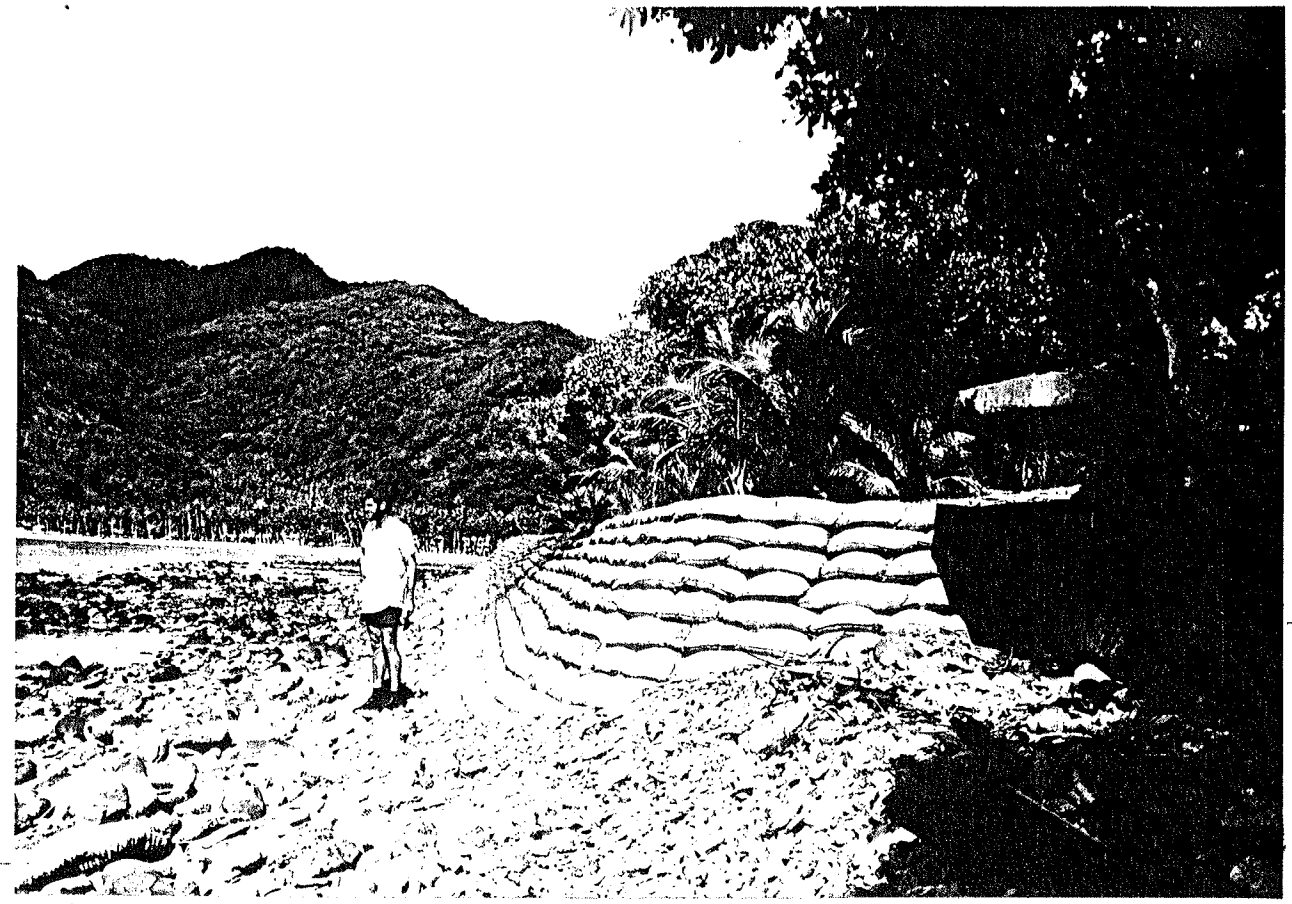


Fig. 3 - Vatia Bay; seawall in front of school at low tide looking in SE direction from NE end.

Fig. 5 - Vatia Bay; Transect N line from shore at low tide showing boulder substratum.

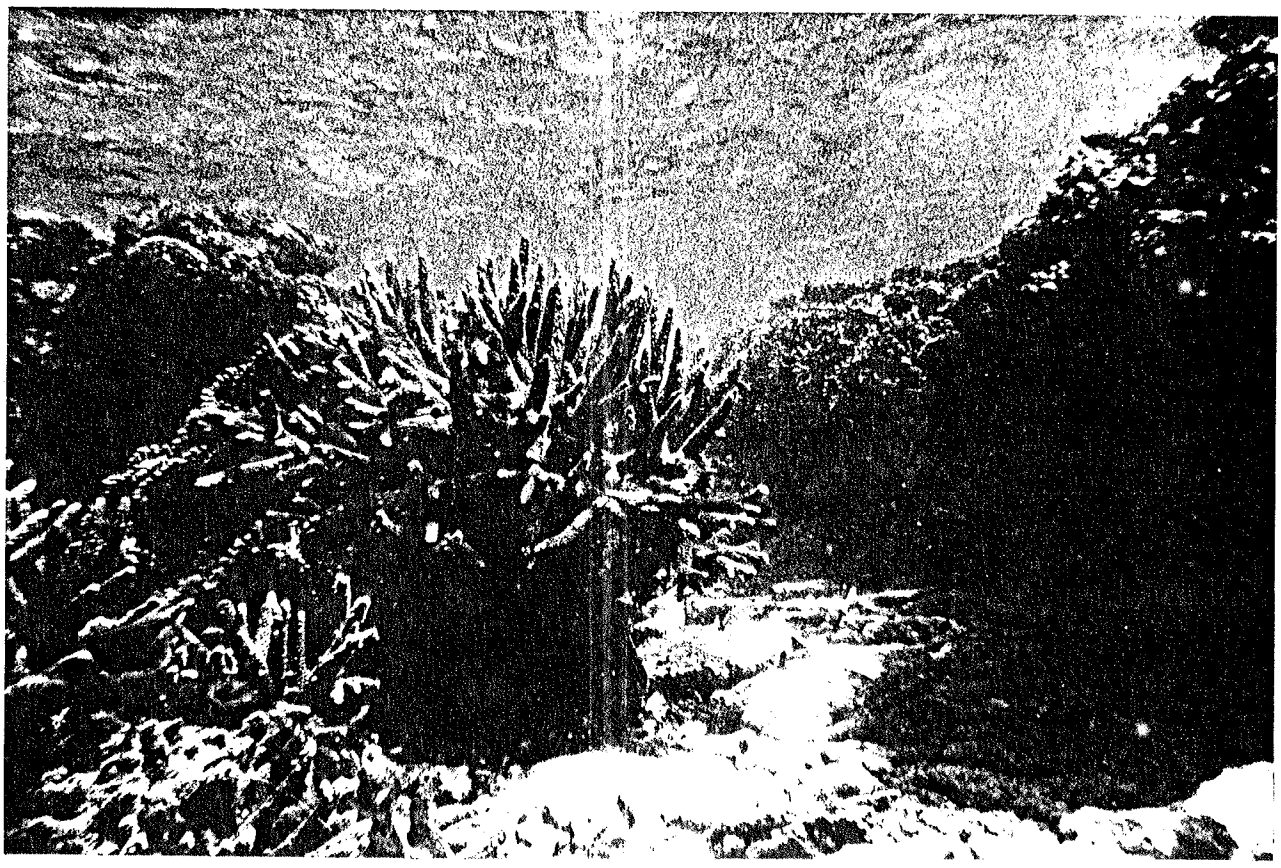


Fig. 6 - Vatia Bay; inner surge channel, Transect N, 75-100 m

The boulders 5 or 6 m from the base of the seawall begin to show pinkish patches of coralline red algae and a brown stain-like encrustation that may be a blue-green alga. The amount of nullipore covering increased seaward. At 18 m the number of large exposed boulders is greatly reduced and a lower profile of sand-algae-foram covered rocks (the same star-shaped forams as seen in Afono and more rarely in Aoa Bays) begins to develop.

The second 25 m began at 0.3 m depth; visibility was 15 m. The bottom is nearly all rocky with sand-turf algae covering (1 to 6 mm thick), with only small spaces of coarse sand between the edges of some rocks. A few small thalli of the green alga Dictyosphaeria were observed; this increases in abundance seaward. Coral first makes its appearance here in the form of very small colonies of Acropora humilus (?) and Pavona (less than 1% of substratum). Adults of Glyphidodontops glaucus are the most common fish. Others observed in moderate abundance were juvenile Acanthurus triostegus, Halichoeres margaritaceus, and Eupomacentrus albofasciatus.

About half way out in the second 25-m sector the amount of coral increases to about 2 or 3% of the bottom (Porites andrewsi and the previously mentioned corals). Here the first Millepora was seen as well as the first fishes of the species Glyphidodontops leucopomus, Acanthurus nigrofuscus, and Rhinecanthus rectangulus.

Toward the end of the second sector the bottom begins to be divided into irregular sand channels and dead coral rock, the

channels about 0.5 m in depth. The rock has progressively less sand-algae covering and more coralline red algae. The first live Acropora samoensis and Pocillopora verrucosa were observed here, as was an unidentified faviid coral, and the amount of Millepora increased. Glyphidodontops leucopomus became the dominant fish; juvenile Acanthurus lineatus were also common. One sea urchin (Echinometra mathaei) was observed.

Eight m beyond the third 25 m sector represented the deepest penetration into the reef flat of the main surge channels from the reef front. The dead coral rock is more elevated (water depth only 0.3 m), sand is almost entirely gone from the rock surface, and the low covering of turf algae is dark in contrast to the pale sand-algae matrix on the rock surfaces more inshore. The inshore ends of the surge channels drop to a sand and coral bottom of about 0.7 m. The edges of the channels are lined with delicately branching Millepora, Acropora samoensis, though in some places they appeared scoured and nullipore-covered. A combined head of this acroporan and stinging coral in a surge channel 60 m from shore is shown in Fig. 6. Acropora leptocyathus in small colonies occurs here too. The third 25 m sector ends nearly at the reef front. Here the bottom is either about 0.3 m or nearly 2 m deep, depending on whether one is on the top of a spur or in the bottom of a groove. Many different fishes occupy the surge channels - most fleeing toward the open sea with the appearance of a swimmer. The dominant species at the inshore end of the surge channels and over the top of the reef front is the blue, yellow, and black striped surgeonfish Acan-

thurus lineatus, mainly as adults in this zone. Other common and conspicuous species are A. achilles, the damselfishes Glyphidodontops uniocellatus (G. leucopomus may still be seen, but not glaucus), Plectroglyphidodon dickii, P. lacrymatus (the former associated with live coral, the latter more with the flat dead coral rock, lesser heads of coral and sand of surge channel bottoms), juvenile goatfishes (especially Parupeneus bifasciatus), the parrotfishes Scarus sordidus, S. oviceps, S. capistratoides, S. jonesi (others such as sexvittatus and formosus are present but not common), the wrasses Halichoeres marginatus, H. centriquadrus, Thalassoma hardwichei, T. quinquevittata (which was observed spawning in the outer surge channel zone), Gomphosus varius, and Macropharyngodon meleagris (usually in the "pardalis" form), the butterflyfish Chaetodon citrinellus, and unidentified blennies of the genus Cirripectes. In the outer part of the surge channels and just over the reef front the above species also occurred, but other fishes were common as well. These included the damselfishes Eupomacentrus fasciolatus (jenkinsi of most authors), Pomacentrus vaiuli, and Chromis caerulea (also observed spawning), the surgeonfishes Acanthurus glaucopareius, Zebrasoma scopas, and Ctenochaetus striatus, and the wrasse Stethojulis trilineata (S. bandanensis less than common), and the filefishes Amanses scopas and Oxymonacanthus longirostris,

The next 25 meters, beginning 75 m from the seawall (just short of the reef front) includes the outer surf zone and the region immediately seaward of it. The reef front is extremely

irregular; it is not a simple groove and spur system. There are many large isolated mounds of dead coral, covered to a varying degree with live coral rising as high or nearly as high as the reef flat, but cut off by narrow channels of about 2 m depth from the reef flat. Thus this zone is characterized by a maze of ever-deepening channels ending at the 100 m mark with a depth of about 6 m. In the outer part of the surge channels and off the reef front the dominant corals are Acropora hyacinthus and A. samoensis. Also there are some very large heads of Porites lutea. The live coral cover approximates 30%. Two branching coralline red algae (Amphiroa foliacea and Cheilosporum sp. as well as a considerable amount of Hypnea and Halimeda sp. are common in cracks and crevices on dead coral rock in the surge channels. The striking green alga Chlorodesmis was also evident.

From 100 to 125 m along the transect we encountered a drop from 6 to 16.5 m at the base of which is coral sand. This area of the transect is irregular in bottom profile being dissected by stands of live and dead coral and meandering channels whose bottoms are composed mainly of dead coral (including overturned heads of Acropora hyacinthus) partially cemented by pink encrusting coralline algae. Live coral along this sector of the transect comprises 30-40% of the substratum. The corals in the upper one-half of the sector are mainly Acropora samoensis, A. hyacinthus, Psammocora contigua and some mounds of Porites sp. A colony of the staghorn A. teres, 2 m in diameter was also noted. Other minor heads include branching Acropora spp., Leptoria and

other faviids as well as an occasional head of Pocillopora eydouxi and encrusting Montipora sp. The last half of this transect sector consisted of dead and live coral, the latter mainly mounds of Porites (Synaraea) convexa in the form of brown vertical and horizontal outgrowths, and an occasional head of branching Acropora (including the delicately branching Seriatopora angulata) near the sand-reef interface. Along vertical slopes of some of the coral mounds, an extensive foleacious yellow colony of alcyonarian soft coral 2 m across was observed. A smaller mauve-colored fleshy species also occurred nearby.

The number of species of fishes increased considerably in this sector, particularly in the Labridae, Pomacentridae, Mullidae, and Chaetodontidae, but few could be said to be as common as those encountered on the reef flat, surge channels, and just off the reef front. Notable among those few are the half black, half white damselfish Chromis iomelas, the sabertooth blenny Meiacanthus atrodorsalis, and, the butterflyfish, Chaetodon reticulatus (Fig. 7).

The last 25 meters of the transect extended from the base of the fringing reef seaward across a predominately coral sand zone which is punctuated by mounds of live coral which decrease in size from 2-3 m in diameter to less than 1 meter, a distance of about 5 meters from the end of the transect line. The mounds are generally covered by live Porites lutea and/or Porites (Synaraea) convexa (Fig. 7). One strand of the green unbranched black coral, Cirripathes sp., with three small symbiotic fishes

Fig. 7 - Vatia Bay; reef at base of slope on Transect N, ca. 125 m from shore, depth 15 m; Chaetodon reticulatus in center.

on it, was seen growing from one of the mounds at a depth of 20 meters. The slope along this sector of the transect is gradual, terminating at a depth of 24 m. The fine coral sand reveals pyramidal mounds from an unknown burrowing animal (possibly a polychaete worm). An unidentified goby was seen in the depression between the mounds. The green angiosperm plant, Halophila, was just beginning to grow at the end of our transect (150 meters from shore).

Transect S was carried out from the base of the seawall in line with a large half-dead tree 95 m from Transect N (Fig. 2). The seawall here is slightly more than 2 m in vertical height. The transect commenced at 1230 hours, at which time the sea had reached the base of the seawall. The bottom for the first 9 m is three-fourths smooth rock boulders (mainly basalt) and one-fourth sand (Fig. 1 in color photo appendix). Then there is an area of white sand about 2 m broad (knee deep at this point). Actually, this is just the southern edge of a large patch of sand that extends nearly to the seawall about 10 m to the NW.

The next 25 m are comparable to Transect N though a little more sandy. Inshore on this sector the coral cover is about 1% (small colonies of Porites andrewsi, Pocillopora verrucosa, and Acropora samoensis). In the outer part it increases to about 5%, now including Porites andrewsi and Psammacora. Coralline red algae grow on the more elevated parts of the rocks.

At 58 m one encounters the inshore end of a surge channel. The outer reef flat and surge channel area are similar to Transect N. There is now more dead coral, but at one time

coral is not restricted to certain species or to any particular depth (Fig. 2 in color photo appendix). It is very suggestive of the damage we have seen from the crown-of-thorns starfish (Acanthaster). Judging from the amount of solidification and overgrowth by nullipores and other organisms, (Fig. 3 in color photo appendix) the partial coral kill took place something on the order of two or three years ago. We saw no live A. planci and no fresh feeding scars on the coral of the area.

The fishes on the reef flat of Transect S were nearly the same in species composition and abundance as Transect N, as would be expected. We saw a few individuals of the wrasse Halichoeres trimaculatus inshore on S not seen on N and a small school of atherinid fishes at the surface near the reef edge on S.

At the outer edge of the reef of Transect S in 12 m there is a huge head of Porites lutea and Porites (Synaria) convexa 7.3 m in diameter at the base and 4.6 m in height, under which there is a large cave. Large amounts of the green alga Halimeda were growing on this head, and the northern surface was overgrown by an immense colony of alcyonarian soft coral. Adult squirrelfishes (Myripristis adustus and M. borbonicus) and snappers (Lutjunus fulvus) were common in the cave. The small damselfishes Chromis iomelas and C. acares (the latter recently described as new by Randall and Swerdloff) were the dominant plankton-feeding fishes above this coral mound.

The bottom of Transect S from 126 to 150 m is fine white sand ending at a depth of 17 m. For a few meters out from the reef

it is without any obvious plant cover, but beyond this there is sparse growth of Halophila. The dominant organism on the sand is a slender yellowish brown "sipunculid" which is buried except for the dark branchial plume (about 3 mm in diameter). The worms themselves are about 20 mm long. They were very numerous (about 10 per square inch on the average). These seem to be the same as those observed in the shallows of Aoa Bay. Several individuals of an unidentified razorfish (Hemipteronotus) were observed hovering over the sand. These fish dive into the sand with the approach of danger.

The principal of Vatia School, Mr. Isameli Anae, informed us that the storm waves damaged the sloping sandbag seawall and eroded the fill behind the wall but did not flood any of the buildings. The village repaired the damage to the front of the wall, and more fill material was carried in to replace that which had been eroded behind the wall. Mr. Anae felt that large boulders (many of which are now in the sea in front of the wall) could be moved at the base of the wall and the wall elevated by three or four more layers of cement sandbags.

We asked Mr. Anae about local use of the marine resources of the reef area off the school. He said that most fishing is done on the outer part of the reef, and much of this is by spearing. Some spearfishing is done at night with waterproof flashlights. There is also fishing for lobster by this method. Most of the canoe fishing is conducted outside the bay.

Mr. Anae told us that sea conditions during our survey were average. We regarded the surf as light and the current negligible.

AFONO BAY

Upon our arrival in the morning of April 30, 1974 the weather was overcast and rainy. Later we inquired of the Weather Bureau and learned that 2.19 inches had been recorded for the 24-hour period ending 1600 hours April 30. The water off the seawall of the school was very turbid. Considerable freshwater was entering the bay from a stream 10 meters NW of the NW end of the seawall. Salinity was taken inshore off the seawall; it was 16 o/oo. Another salinity sample was taken at the reef front off the school; it was 30 o/oo.

Transect W (Fig. 8) commenced at 1135 hours from the NW end of the seawall in front of the school, perpendicular to the shore line. A 2.7 high tide occured at 1448 hours. The seawall is about 3 m high. When the transect began the sea just reached the base of the wall which is undercut in places with some of the construction rocks breaking free of the concrete (Fig. 9). Off the seawall the botton sloped within a few meters to a depth of 0.5m. Over the first 25 m the depth increased to 0.8m. Visibility in the brown-colored water was only 25 cm. The bottom consisted of basalt and coral rock embedded in muddy sand. The surfaces of the rocks were thinly covered with turf algae mixed with sand and a great amount of the star-shaped foram, Baculogypsina sphaerulatus. Padina and Valoniopsis seemed the most common of the algae which could be observed with the naked eye (but still the thalli were small). There were occasional clumps of Halimeda thickly enmeshed basally with the star-shaped Foraminifera.

The next 25 m were similar to the first but the bottom

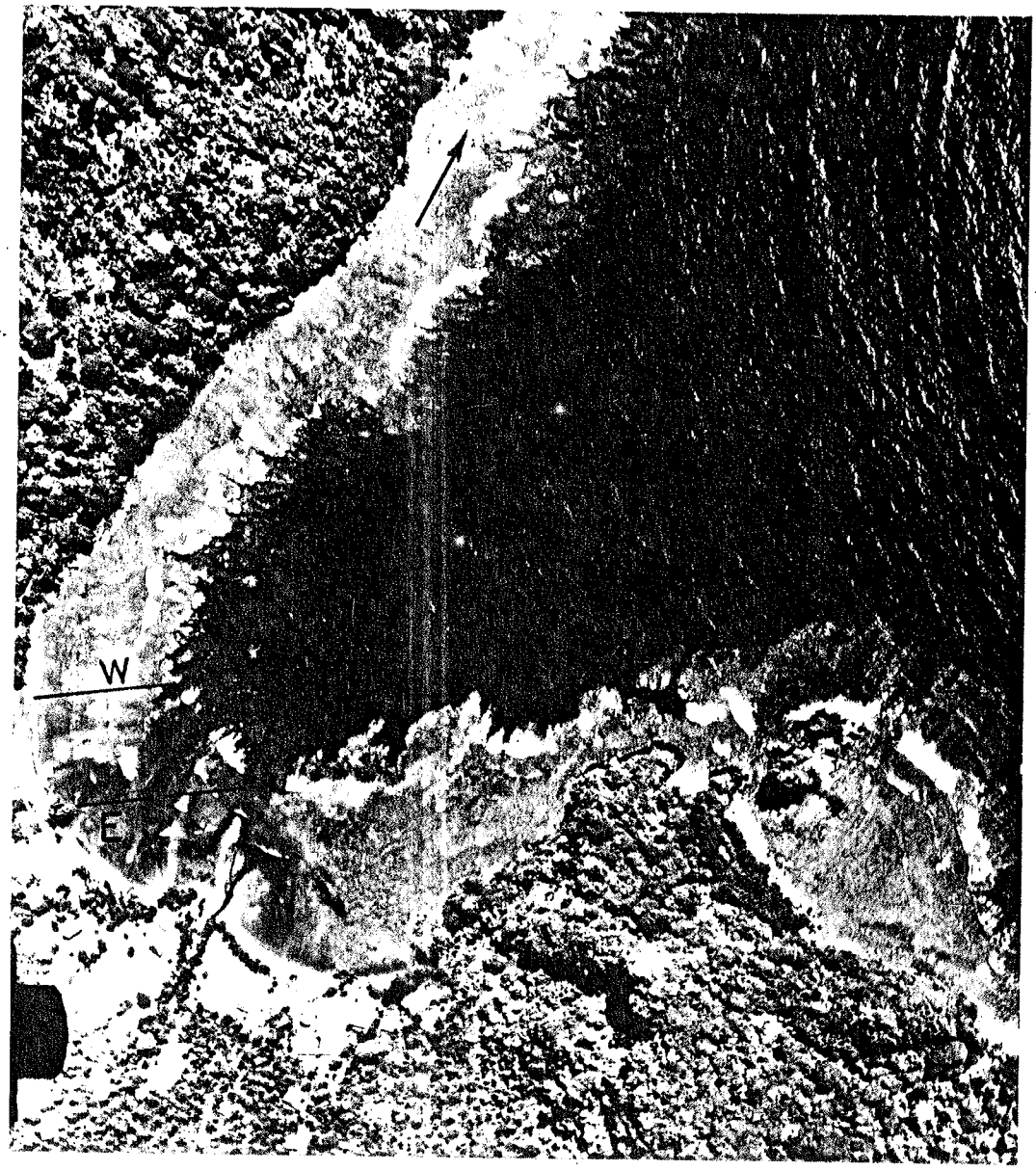


Fig. 8 - Afono Bay; aerial photo showing transect lines W and E.

Fig. 9 - Afono Bay; boulder and cement seawall in front of school, incoming tide, looking from NW to SE.

had some larger algal-covered rocks (up to 0.3 m); there were traces of live Porites on some boulders. Only three fishes were briefly seen; of these only one was identified as a juvenile triggerfish. The mollusks Cypraea moneta and C. annulus were not uncommon. The crab Plagusia was encountered under some rocks. The visibility increased to 40 cm by the end of this sector, but the depth remained essentially the same.

From 51 to 75 m the depth was still the same, but the amount of algae-sand-foram matrix diminished considerably and coralline red algae and Dictyosphaeria became more prominent. Also small patches of pale bluish green sponge were seen. There was a little more coral (Porites, Pavona, and Psammacora), though only covering 3% or less of the substratum. Visibility increased to more than a meter providing one was below the dirty freshwater layer on the surface. Fishes were now commonly seen, the dominant species being the damselfish Glyphidodontops leucopomus. Next in abundance were the wrasse Halichoeres margaritaceus and juveniles of the surgeonfish Acanthurus lineatus.

The edge of the reef flat was another 10 m beyond the 75-m mark. Visibility here was 2 m. The bottom was mostly dead coral rock with depressions, holes, and small crevices, but these irregularities were of low profile; thus in overall effect the substratum is relatively smooth. Coralline red algae was obviously dominant in this zone as indicated by the prevailing pinkish color of the bottom. There is a increase in coral, with low colonies of Acropora leptocyanthus, some tabulate A. hyacinthus, and staghorn A. samoensis appearing. The

coral cover is only slightly greater than 5%, however. The acroporan corals increase greatly in amount over the edge of the reef front which drops off an average of 2 meters. The floor of the surge channels cutting into the reef front are paved with smoothly rounded somewhat flattened rocks averaging about 10 cm in size (some black, hence basaltic, and some white from limestone origin). The variety of fishes increased dramatically over the edge of the reef, many as adults. The dominant species was Acanthurus lineatus. Other common fishes were the wrasses Thalassoma hardwickei, T. quinquevittata, Halichoeres marginatus, H. margaritaceus, H. centriquadrus, and Gomphosus varius, the surgeonfishes Acanthurus glaucopareius, A. nigrofuscus, A. triostegus, and Ctenochaetus striatus (the latter toward the base of the reef front), the damselfishes Glyphidodontops leucopomus, G. uniocellatus (toward the base of the reef front), Eupomacentrus albofasciatus, E. fasciolatus (jenkinsi of most authors), and Plectroglyphidodon dickii, the file fish Oxymonacanthus longirostris, and the butterflyfishes Chaetodon citrinellus and C. reticulatus. The latter four fishes were closely associated with live coral; they are mainly coral polyp feeders.

Beginning at 1300 hours transect E was run from the base of the large tree at the shoreline about 3 m from a culvert just east of the school across the reef flat in the direction of magnetic Fig. 8. Gatia Point (hence bearing/NNE 35°)/ For the first 25 m the bottom consists of smooth rounded flattish rocks set close together (hence resembling a stream bottom) and having only small amounts of algae and minute serpulids (Hydroides) on them. At the base of the tree the visibility was about 0.2m. 25

meters out it was nearly a meter; the depth here was 1.3m. The second 25 meters of the transect was much like the first two of Transect W. No fishes were seen, however, and the water was a little deeper (1.5 m 50 m from shore).

The third 25-m sector had principally the same low algal covered rock bottom, but there were some rather large rocks with nullipore covering and a few moderate heads (up to o.5 m) of Porites lutea with many holes from vermitids (Fig. 10). The fishes Glyphidodontops leucozona, Stethojulis bandanensis, juvenile Epinephelus merra, Eupomacentrus albofasciatus, Halichoeres margaritaceus, Chaetodon citrinellus and Acanthurus tristegus made their appearance.

The last 26 meters carried to the reef front. This was comparable in bottom form, corals, and fishes to the Transect W. Over the edge were some large stands of Millepora in addition to luxuriant colonies of Acropora spp. Also one striking head of a faviid coral about 2 m long and a meter wide was noted.

Snorkeling between the two transects on the inner half of the reef flat we encountered two bands of white sand which began about 15 m from shore, the first 3 m in width and the second slightly more than 10 m wide gradually lessening as rock, covered with algal turf and foams, is found to the NW. These can be seen on Fig. 8..

More remarkable was the discovery 10 m from the base of the seawall directly in front of the eastern school building of a discharge of freshwater, readily apparent from the swirling sand at the surface and the much cooler water (Fig. 4 of color photo appendix). No pipe outfall could be seen at this point,

so this is probably a spring.

Between the transects, on the outer part of the reef, a long narrow crevice dissects into the reef. It was lined with fleshy red alga.

We interviewed the school principal, Jack Logoai, who had lived at Afono for one year. He told us that the eastern waterfront building of the school was flooded by water in early April as a result of a combination of heavy waves, high tide, and a strong onshore wind.

We also asked him about fishing activity on the reef off the school. He said there is fishing every day, though mostly off the reef front. Women sometimes hunt for octopus on the reef flat, and lobsters are taken with the use of a light at night near the outer part of the reef flat. When the water is turbid, as during our visit (by no means a rare event, according to Logoai), there is no fishing on the reef flat.

AOA BAY

On April 23-24 and May 4, 1974, we examined Aoa Bay, especially the area off the sea wall of the school at the west end of Aoa Village. At the east end of the school, Tapua stream enters the sea (Fig.10). On April 23rd the stream was 4 m wide at the mouth and only ankle deep at low tide (a -0.2 tide at 1343 hours). The dirt road ends at the stream. Access to the school is via a suspension foot bridge. Under the bridge at low tide the maximum depth was 35 cm. Actually near the sea the stream forms a small estuary which is lined by mangroves a short distance south of the bridge. During high tide sea water invades the estuary, at low tide there is an outflow of low-salinity water. Salinity at 1130 hours in the stream under the bridge was 12 o/oo and the temperature 82°F, and at the mouth of the stream, 17 o/oo and 84°F. At 1430 hours the salinity under the bridge had dropped to 3 o/oo and 83°F, and at the mouth 7 o/oo and 90°F. About 135 m off the stream mouth at low tide where the largest exposed rocks may be seen (Fig.11), the salinity was 33 o/oo (hence nearly oceanic in salt content), and the surface temperature was 87°F.

Although there was no obvious current inshore on the reef flat, it was suggested from salinity measurements near the stream mouth that there was a slight set to the west: at 1430 hours, 15 m to the west of the stream mouth the salinity was 16 o/oo while 15 m to the east it was 25 o/oo. We learned that the stream mouth shifts its position along the sandy shore. Only two days before our first visit, it entered the bay about 30 m to the east of the

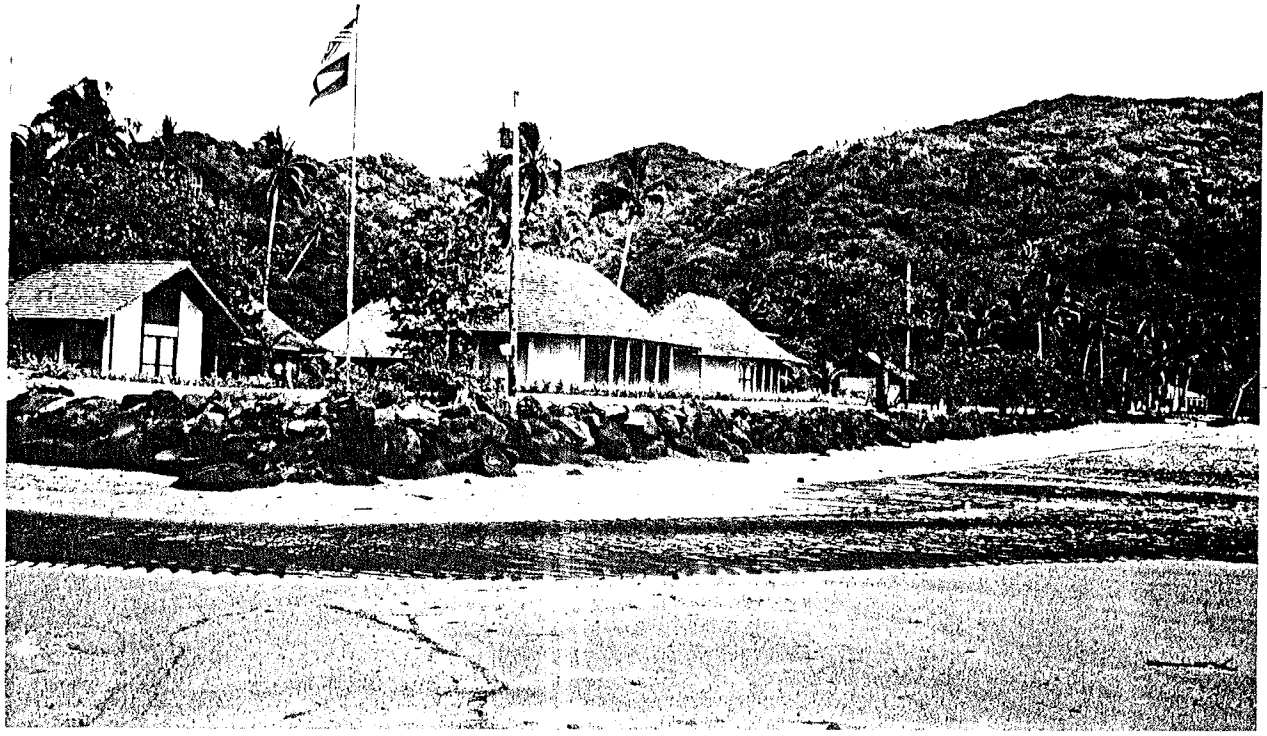
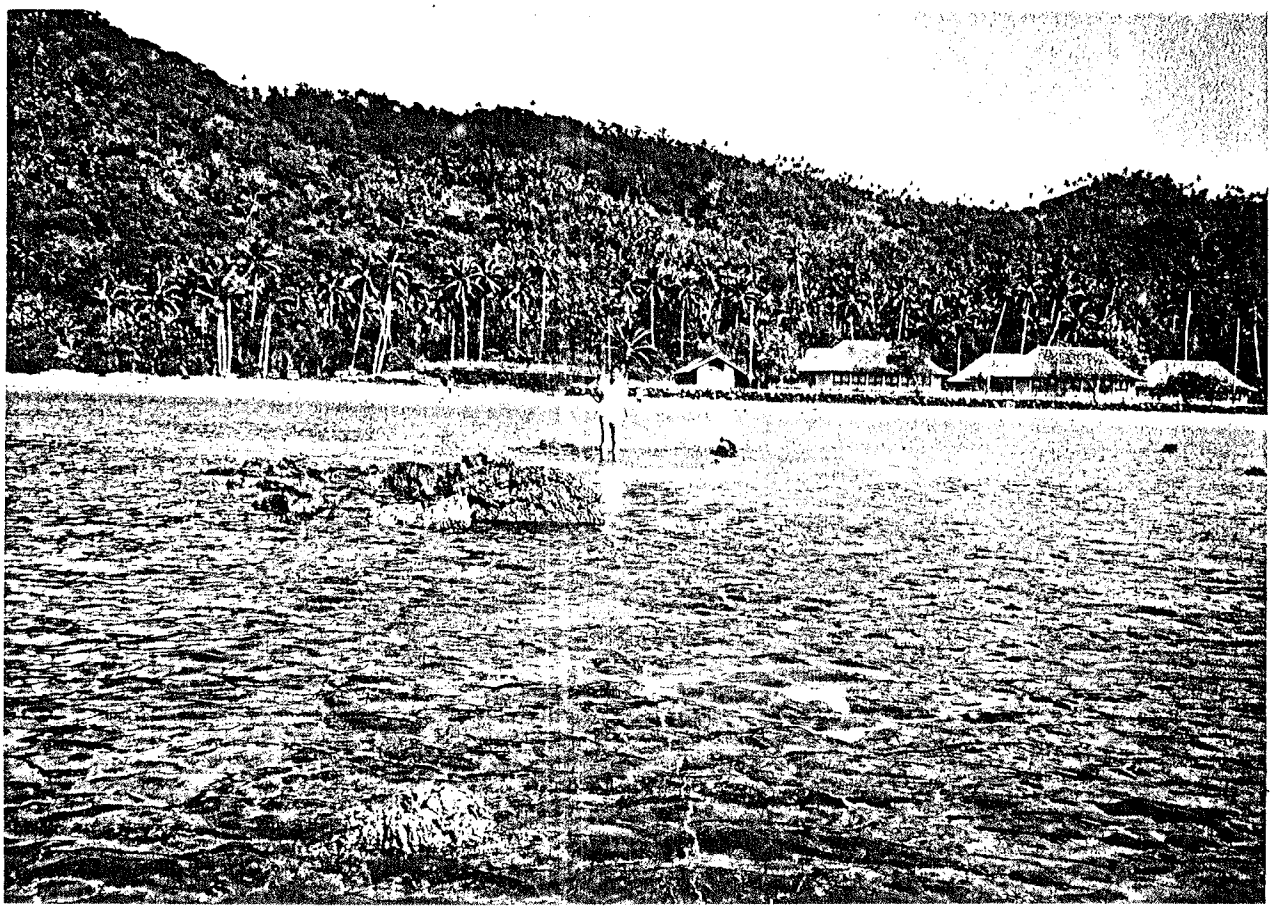


Fig. 10 - Aoa Bay; seawall in front of school from NE looking SW during incoming tide.



bridge (information supplied by Mr. and Mrs. Joseph Gibbs, resident schoolteachers). During our stay the mouth was slightly west of the bridge.

On April 23rd we conducted a transect beginning at the seawall on the east side (Transect E of Fig.12) beginning at 1435 hours. The first 25 m of this transect is clean sand without rock; it was entirely exposed at low tide and completely covered at high tide (high tide mark at seawall observed morning of April 24th). In the outer part of this 25 m sector there are shallow ripple marks nearly parallel to shore. Numerous small holes (about 5 mm or less), usually rimmed by sand occur between 9 and 51 meters from shore. At 25 m from the seawall, the density of the holes ranged between 17 and 49 per m^2 ($n = 5$; $x = 35$). Several fragments of annelid worms, perhaps the animal responsible for the burrows, were obtained by digging deeply into the sand (on April 24 and May 4).

From 26 to 50 m the sand is mixed with some rock (mainly coralline) from gravel size to about 15 cm. These are mostly in ripple depressions which are now more marked; the depth in this zone at 1435 hours was 25 cm.

In the next 25 m sector from the seawall the ripple marks disappear and rocks are more common; they are fixed in the sand and have a sparce covering of algae of which Padina is the most common of the larger forms. Some of the larger coral rocks had as many as six goldring cowries (Cypraea annulus) hidden in crevices. Toward the end of this sector, the first thallus of the large-bladed Halimeda discoidea was noted. It was spotty in occurrence.

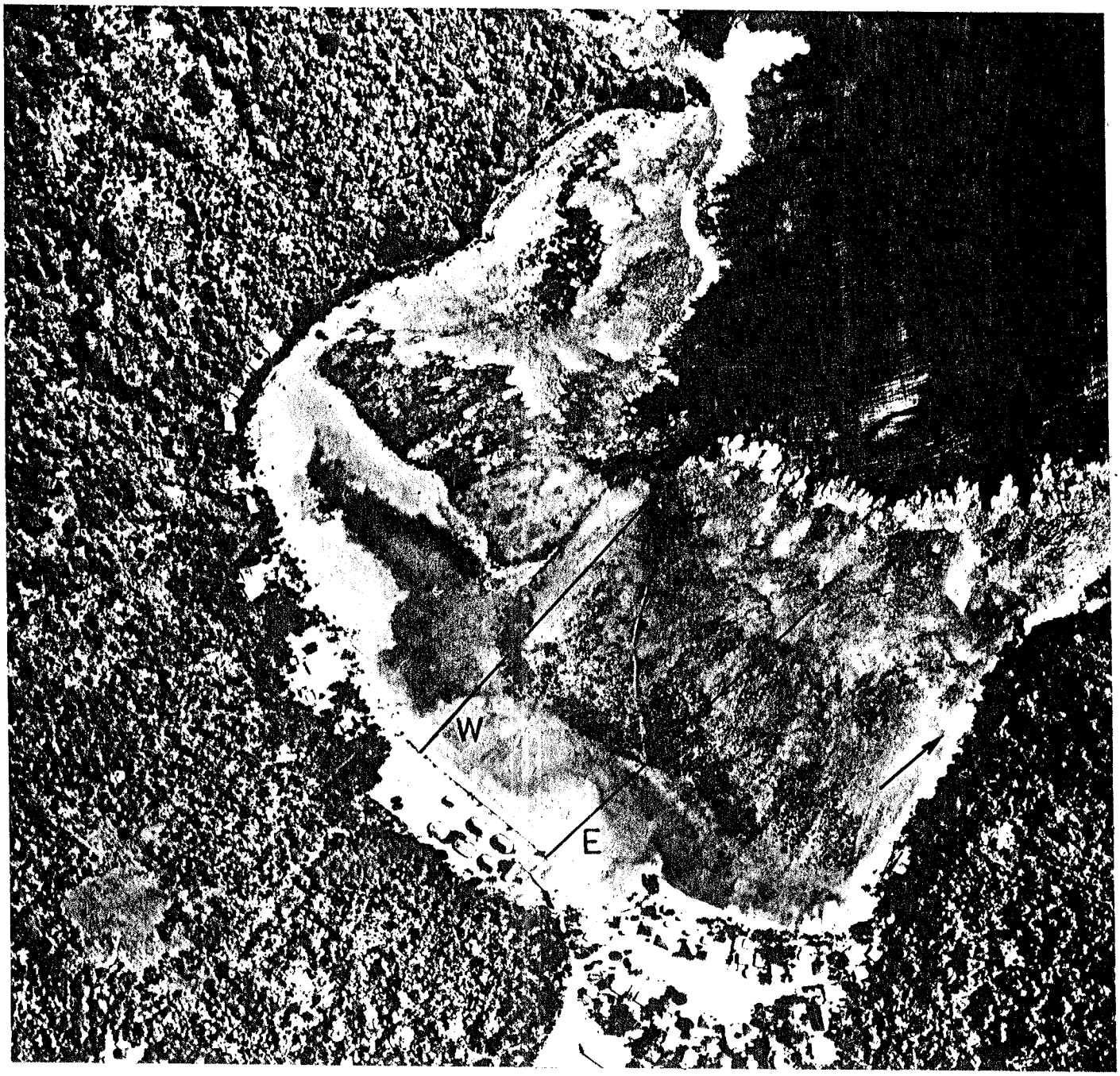


Fig. 12 - Aoa Bay; aerial photo showing Transects E and W.

In the sector 76 to 100 m from the sea wall the spermatophytic plant Halophila is the dominant benthic organism visible on the surface of the sandy bottom beginning at 83 m. The blades of this plant, about 1 cm in height, were frequently heavily covered with epiphytic algae. The Halimeda disappeared at about the 95 m mark. The bottom sediment is now muddy sand, much of the sand consisting of foraminifera; there were also small fragments of mollusk shells, coralline algae, and dead coral. Maximum depth to this point was 0.4 m at low tide.

The only fishes observed out to this point were small schools of juvenile mullet (Chelon vaigiensis) goatfish (Mulloidichthys flavolineatus), and an occasional small jack (Caranx melampygus).

Live coral was first observed between 101 and 125 m from the seawall. Scattered heads of Porites lutea, the largest more than a meter in diameter (Fig. 13) are present. These large heads, however, have the live coral growing only at the outer edges; the broad central part is truncate to slightly concave. The largest head of P. lutea in which all the coral was alive measured 33 cm in diameter. Visibility under water was about 2 m. It was in this sector of the transect that the water depth was greatest, 0.7 m, and here that the first reef fishes were seen. The most common was the damsel Plectroglyphidodon leucozona (brown with a pale bar in middle of body). Others frequently seen were the surgeonfish, Acanthurus triostegus, the damselfish Eupomacentrus albofasciatus, juveniles of the grouper Epinephelus merra, the wrasse Halichoeres trimaculatus, and the butterflyfishes Chaetodon citrinellus and Heniochus

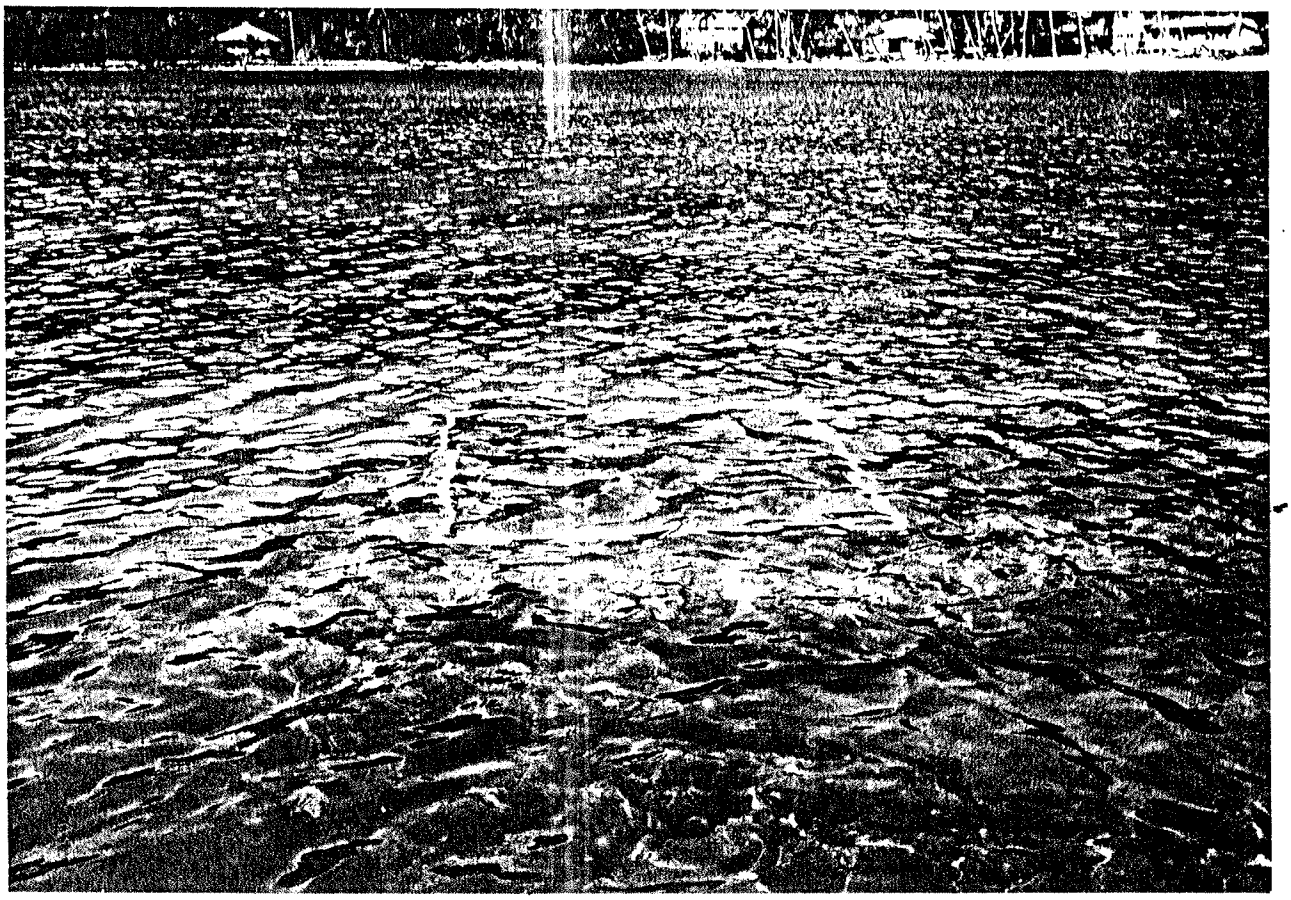
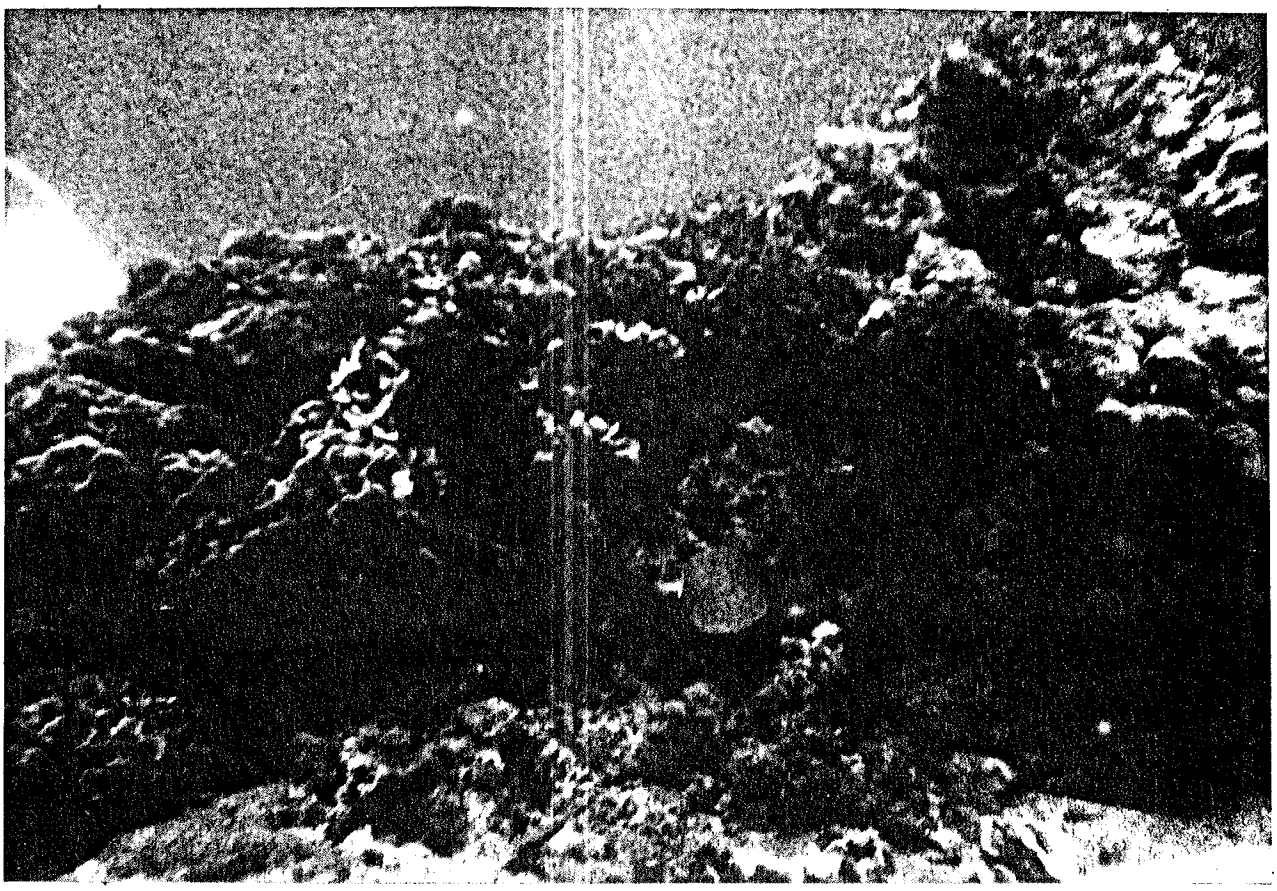


Fig. 13 - Aoa Bay; meter square on Transect E, partially covering Porites lutea, 100-125 m off shore.



chrysostomus. By 125 m from the seawall approximately 75% of the bottom consisted of heads of coral (mostly P. lutea, but Pavona decussata and Leptastrea purpurea also evident).

A few of the large Porites heads were close together, forming small caves in which cardinalfishes and juvenile squirrelfishes (mainly Myripristis) were hiding. On the sand and rubble around the heads occasional gobies (Cryptocentrops maculosus and Cryptocentrus koumansi were observed sharing burrows with their symbiotic partner, the snapping shrimp, Alpheus djiboutensis.

From 126 to 150 m, Pavona decussata and P. frondifera are the dominant corals; most of these heads are dead, however, and large colonies of P. lutea are still present. Psammocora contigua was also noted but rarely. In this part of the reef flat a number of coral rocks are exposed at low tide; at 3:15 p.m. the largest was 0.5 m above the surface (Fig. 11). This rock was used as the principal seaward bearing for Transect E. Algal covering on the dead coral rock surfaces was sparse, but there were occasional clumps of Jania and Halimeda.

Moving seaward there is progressively less sand and more dead coral rock and rubble. By 200 meters from shore the sand is almost absent. Also the depth had decreased at this point to about 15 cm. The upper surface of the corals (in this sector principally Pavona frondifera and Porites lutea were even more truncated than inshore. At 200 to 275 meters from shore the depth varied from 15 to 25 cm, and there is a reduction in coral

and increase in the amount of coral rubble which is partially consolidated by encrusting calcareous red algae (Porolithon).

A transect (W on Fig. 12) off the west side of the school, 10 m east of the basketball court, was conducted on April 24th, beginning at 1110 hours during a falling tide. The bottom for the first 20 m from the seawall is predominately clean white sand without evident biota except a few burrows of ocypod crabs near the seawall. At the outer half of the first 25 m sector we observed an organism not seen along the eastern transect. Small tentacular crowns 1-2 mm diameter appear close together on the surface of the sand. They withdraw rapidly upon stimulation, leaving small holes. These animals were dug out of the fine sand; they proved to be a sipunculid. They occurred nearly to the 100 m mark. Also from about 20 m offshore to 75 m there were scattered groups of parchment-like tubes of about 2 mm diameter sticking 2.5 cm above the surface of the sand and covered with epiphytic algae; the tubes are formed by terebellid worms.

From 26 to 50 m the bottom continues to be sandy; the depth was 0.5 m at 1200 hours (low tide of -0.1 at 1434 hours) and show ripple marks. Unlike transect E there were no small rocks mixed with the sand until farther out (at 84 m).

In the next 25 m sector we encountered the spermatophytic plant Halophila at 66 m from the sea wall. The small burrowing sipunculid worms are still numerous, and there are a few scattered crater-like holes, possibly formed by the mantis shrimp Lysos-

quillus maculatus. The bottom is fine muddy sand without rubble or coral.

At 84 m from the seawall we noted some dead coral with the mollusk Cypraea annulus in depressions. By 93 m most of the Halophila is gone and Halimeda discoidea is evident. As with transect E the bottom sediment is predominantly muddy sand, with foraminifera, fragments of mollusk shell, coralline algae, and bits of coral on the surface. At 96 m the algae Padina was noted on dead coral. A silt-covered sponge (yellow internally) about 7 cm in diameter was seen on a limestone outcropping. Rocks have a covering of the algae Jania, Dictyota and a small-leaf Halimeda.

Towards the end of this sector, nearly 100 m from the seawall, the live corals Pavona frondifera and Porites lutea are evident on a slightly raised bank (depth of 7 to 10 cms). The whole sector is now about 85% sand bottom; there is still considerable Halimeda.

From 101 to 125 m offshore there is a progressive decrease in sand with more coral-covered boulders. Pavona frondifera is quite evident from 113 m growing on dead coral which covers about 50% of the bottom (the rest mainly sand). The sea cucumbers Stichopus chloronotus and Polyplectana kefersteini were observed, but only rarely. The bottom is more irregular; live coral cover is about 15% of the substratum (Fig. 14). The coral heads afforded more shelter for small fishes. The dominant species were the damsel-fishes Plectroglyphidodon leucozona, Eupomacentrus albofasciatus,

Dascyllus aruanus, Chromis caerulea, Abudefduf coelestinus, the wrasses Halichoeres trimaculatus and Thalassoma hardwickei, the surgeonfish Acanthurus nigrofuscus, the butterflyfishes Chaetodon citrinellus, C. vagabundus, and Heniochus chrysostomus, the grouper Epinephelus merra, the snapper Lutjanus fulvus, the rabbitfish Siganus rostratus, the sharpnose puffer Canthigaster solandri, the cardinalfish Cheilodipterus quinquelineatus and the moorish idol Zanclus cornutus. The water here was 0.7 m at 1230 hours.

At 126 to 150 meters from the seawall the water became shallower and the coral diminished, with Porites lutea replacing Pavona frondifera as the dominant coral. Again in contrast to Transect E there is more sand farther offshore; at 200 to 225 meters from the seawall the sand covers 50% of the bottom; there is much coral rubble and little live coral.

At 225 to 250 meters the depth again begins to increase and the live coral cover as well (about 20%), mostly Pavona decussata and Pavona frondifera.

Shortly thereafter a channel area is reached with much larger heads of coral (Pavona up to 1/2 meter in diameter) and dead coral boulders rising to within a foot of the surface from a depth of about 1 meter. Here we saw the first Acropora, A. leptocyathus. The channel is one which drains the reef, running from the Porites lutea area at the deepest part of Transect E diagonally across the reef flat. The resulting drainage causes a set of

currents to the NW out the channel mouth.

We spoke with several individuals at Aoa about fishing off the school site. It is evident that relatively little fishing takes place on the reef flat. The paucity of fishes and their small size clearly demonstrate that there is no important fishery resource there. There is only a small amount of hook and line fishing, mainly by children, and occasionally people hunt for octopus or use a light at the outer edge of the reef at night searching for spiny lobster. Some throw netting is carried out, but no one utilizes a seine (although this would be possible over the sandy upper part of the reef flat at high tide). At low tide during the second day of our visit, we saw a man, a woman and three children poison the water of the reef flat just north of the northern transect about 1/3 of the way out on the reef flat. They were reluctant to discuss this with us (understandably, as it is illegal). Probably the poison was from one of two local plants.

On Saturday, May 4th, one of us (D.M.D.) visited Aoa in the morning and early afternoon during the period of a -0.3 tide (at 1203 hours). At the period of ebb tide an extensive sand zone at the head of the bay in front of the school is exposed for a distance of 77 m from the seawall (Figs. 5-6-7 of color photo appendix).

During a three hour period on May 4th, only a single man with a bamboo pole was observed in the water out on the reef.

AUNUU ISLAND

This 1.2 by 1.7 km island (170°33'30"W, 14°17'28"S) lies 13 km off the SE end of Tutuila. On April 25, 1974, Randall and Devaney conducted a survey of the marine environment off the village at the west end where a small boat harbor has been proposed.

A northern transect was initiated from an anchored boat 185 m from the seawall in the middle of the north side of a large circular reef (pale area immediately south of west end of Transect N on Fig. 15) at the reef sand interface at a depth of 16.5 m. The transect terminated on shore 20 m north of the church. The patch reef slopes downward west of our transect about 50° to sand at a depth of 17 m. This sloping reef front consists of pieces of dead coral on which a wealth of live coral is growing, especially in the deeper part. The average live coral cover is about 50%, of which half is encrusting and half is branching. The principal corals are Porites sp., two species of Montipora, Psammacora, Pocillopora verrucosa, and Acropora hyacinthus which was particularly conspicuous (tips of branches violet). Beneath the coral rocks sponges, tunicates, and crinoids were commonly seen. Fishes were abundant on the slope, and a great number of different species are represented. The dominant ones are the surgeonfishes Ctenochaetus striatus, C. strigosus, and Zebrasoma scopas, the parrotfish Scarus sordidus, and the damselfishes Pomacentrus vaiuli, P. melanopterus, Plectroglyphidodon lacrymatus, Chromis iomelas and C. opercularis. The latter, feeding on zooplankton, is black with a white tail.

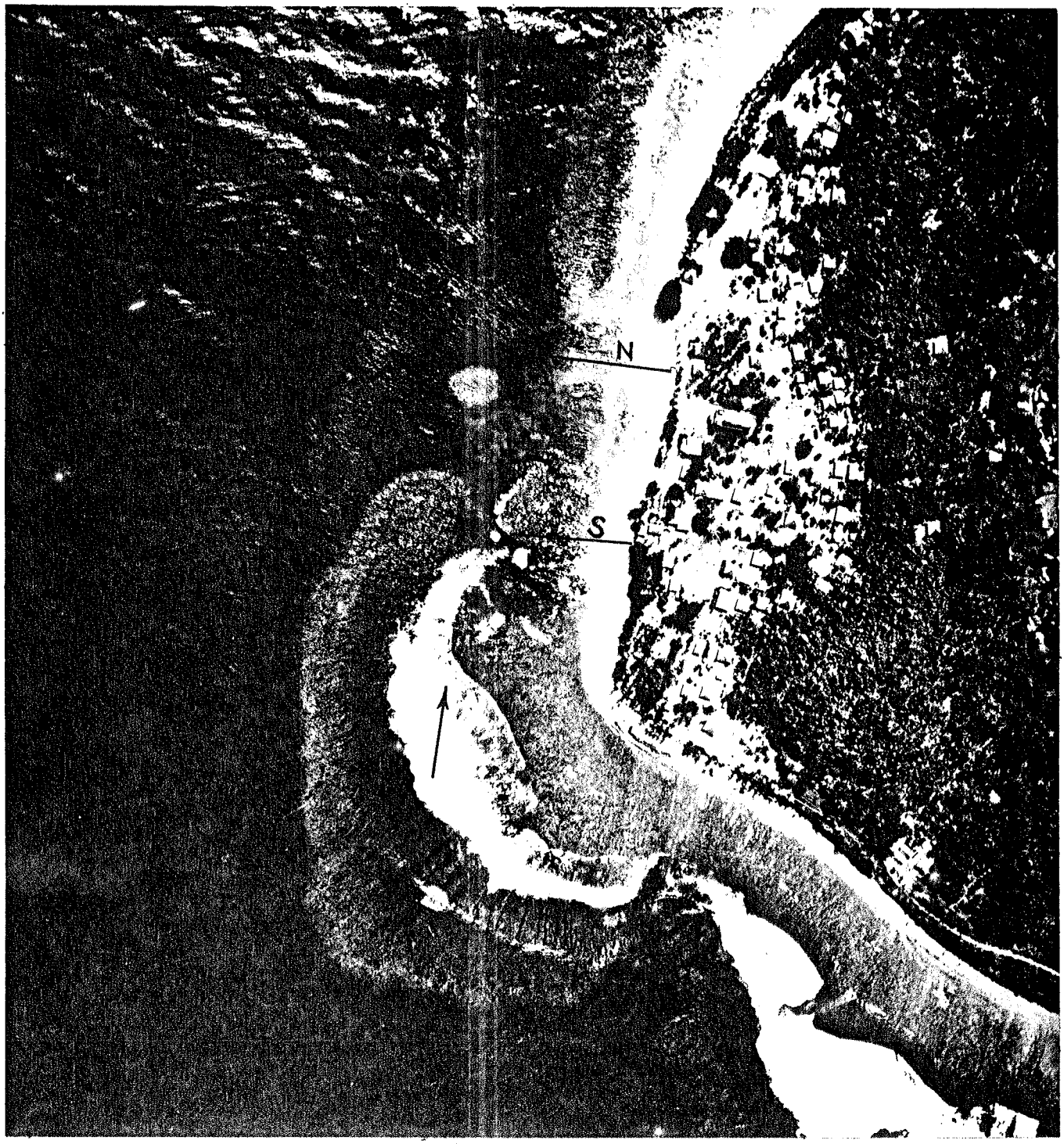


Fig. 15 - Aunuu Island; aerial photo showing Transects N and S.

It feeds higher in the water column (with the exception of another plankton feeder, Acanthurus thompsoni, also black with white tail) than any of the other plankton feeders. Many different labrid fishes are present but none in notably greater abundance than any others. The two damselfishes Dascyllus trimaculatus and D. reticulatus are associated with the larger branching corals and may be locally common.

Our transect followed the edge of the patch reef for 44 m; then the contour of the reef curves toward the south. The reef is separated from the fringing reef on shore by a sandy channel with large mounds of dead coral on which scattered heads of live coral are growing. The number of fishes and their abundance drops greatly at this point; the dominant ones were the bright blue Pomacentrus coelestis, P. vaiuli, and the goatfish Parupeneus trifasciatus.

Our transect line did not enter this channnel, however. Instead it crossed 22 meters of clean white sand to the north of the channel from a depth of 14.5 m to 13 m. The only fishes seen over this sand stretch were several razorfish (Hemipteronotus). The sand bottom slopes off into deeper water to the north. At the end of the sand on our transect we reached the reef front of the fringing reef. This consists of mainly of coral rock over which there is a good deal of sand, and a few isolated small coral colonies except for several mounds of coral rock with a rich covering of live coral. Passing over the steeper part of the slope (it rose to a depth of 6 m over a distance

of 18 m) we encountered a stretch of bottom with live coral cover of approximately 60% (mainly Acropora samoensis and A. hyacinthus). The substratum is far from even; it is characterized by mounds which rise 1 to 2 m above the depressions between them. This bottom continues for 11 m, shoaling to 3.5 m. Then it changes rather suddenly to one dominated by large dead coral boulders and slabs covered mainly by pale pinkish Porolithon (Fig. 16). Coral cover drops to about 10%. The principal species is Pocillopora verrucosa; the acroporans are still present, but the colonies much smaller (Fig. 17). Immediately to the south of the transect the fringing reef at this distance from shore (about 70 m) still has a heavy cover of live coral; immediately to the south it is dominated by the pale Porolithon. The pale area is visible on the aerial photo of Fig. 15. The nature of the bottom suggests that there may have been some blasting here many years ago but not with the thoroughness evident in the channel discussed below. Though coral is reduced the bottom is still very irregular and would be a very poor place to try to launch or land a boat. From this point on surge was strong and turbidity very high. Moving shoreward the amount of coral diminished and the rocks were more scoured. The total width of the fringing reef is 100 m. At water's edge at low tide there is a zone of coarse sand and small shingle about a meter wide ending in a conspicuous berm of coarse sand and coral rubble which merges into the exposed sand beach which extends 19 m to the high-tide line. On the inner part of the fringing reef the dominant fishes

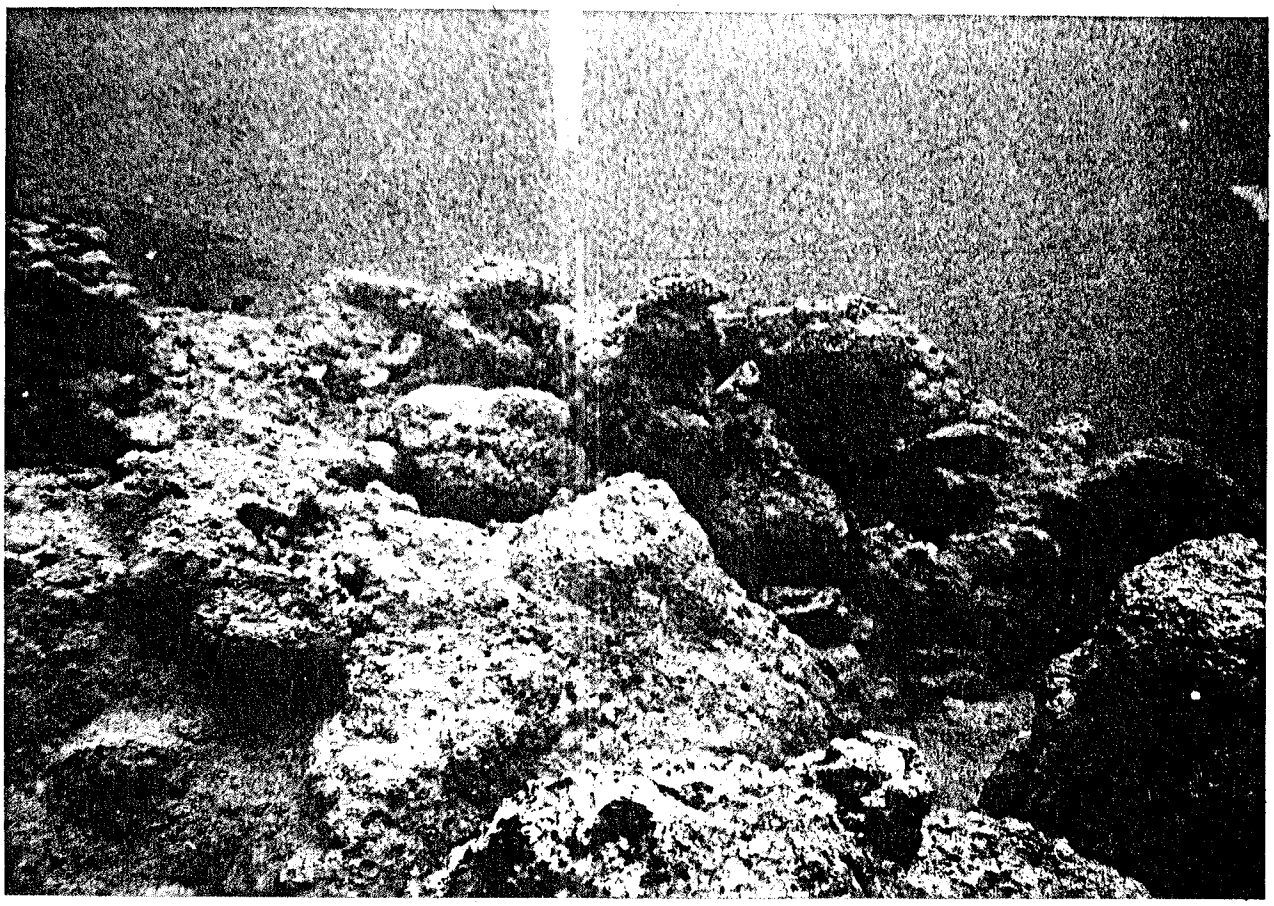


Fig. 16 - Aunuu Island; dead coral cemented in place by calcareous algae (Porolithon) on Transect N inshore.

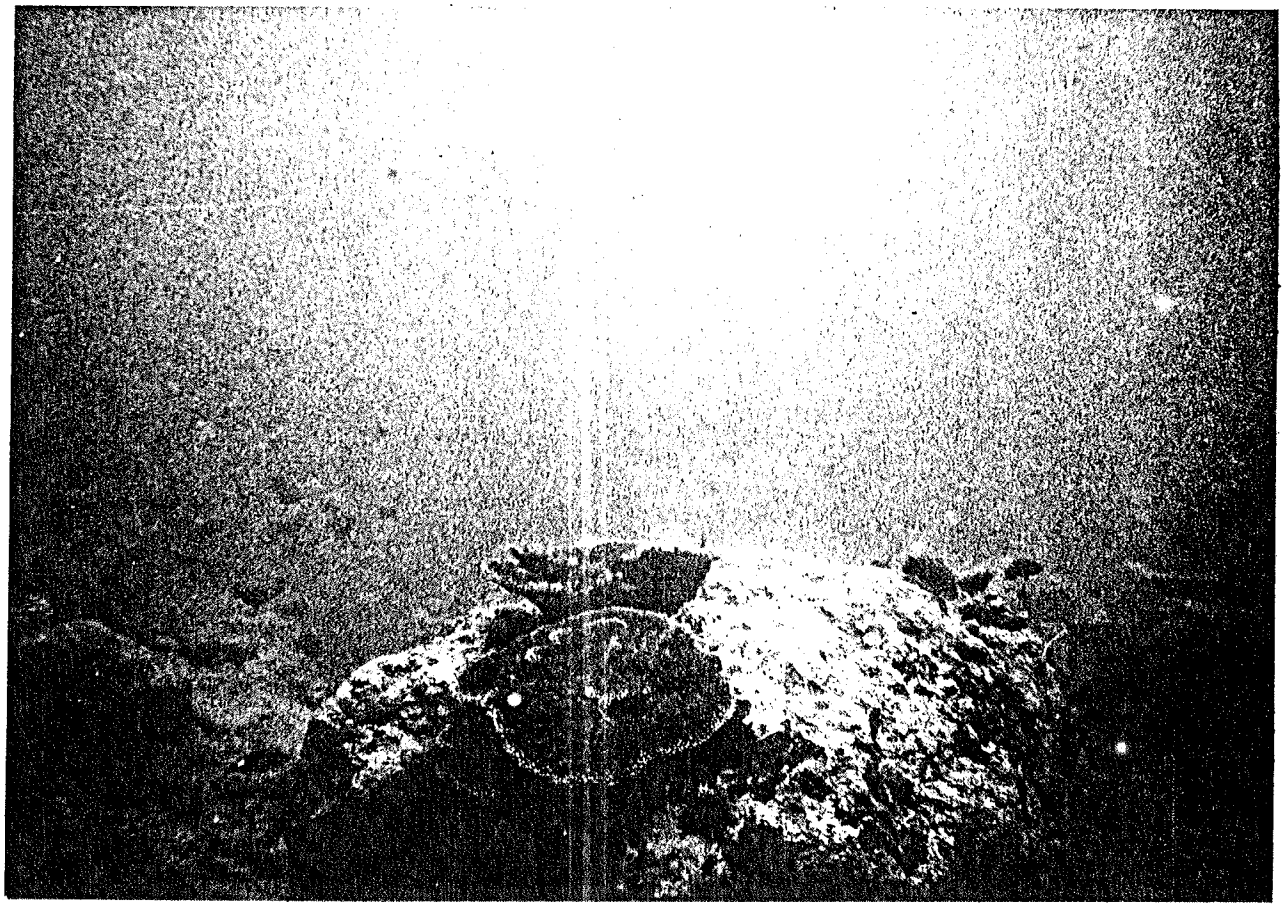


Fig. 17 - Aunuu Island; colonies of Acropora brueggemanni growing

were Glyphidodontops leucopomus and to a lesser degree Halichoeres margaritaceus. On the outer part Acanthurus lineatus is clearly the dominant species; other abundant fishes were Thalassoma quinquevittata, Acanthurus nigrofuscus, Pomacentrus vaiuli, and Glyphidodontops uniocellatus. Over the deeper part of the reef front there was a greater variety of fishes. Parrotfishes, particularly Scarus sordidus, and surgeonfishes, especially Ctenochaetus striatus, were common. A school of about 30 adult rabbitfish (Siganus rostratus) crossed our transect line at a depth of 3 m.

The same width of beach and an even better developed berm occurred at the site of the second transect (S of Fig. 15), 150 m S of Transect N. At the shore this was off two green houses with tin roofs where there is a break in the low sea wall at the upper end of the beach. The transect carried seaward to a prominent exposed rock (the only exposed rock in this vicinity even at low tide approximately 85 m from the berm.

The first meter offshore is sand and shingle; beyond this for about 4 m the bottom is low profile scoured limestone on which there is minimal algal growth or a very thin algal covering admixed with sand. In some of the holes in the larger rocks small thalli of Halimeda and Caulerpa could be seen. Very few fishes were observed in this inshore zone: a small school of the clupeid Spratelloides sp., Acanthurus triostegus, Glyphidodontops leucopomus, Halichoeres margaritaceus, and

Thalassoma purpureum.

At 5 m a zone of dead branching coral began which merged at 7 meters from shore with the first live corals Pocillopora verrucosa, Acropora leptocyathis and the stinging "coral" Millepora playphilia. Also conspicuous with the appearance of the live corals was the encrusting green alga Dictyosphaeria. At 10 m from shore the live coral cover is about 10%, with A. samoensis as the dominant species. From this point on the amount of coral cover increases rapidly to 50% or more, as do the number of species. Toward the outer part of the reef flat the tubular Acropora hyacinthus was particularly abundant. The depth of the water at low tide (-0.1 at 1604 hours) over this part of the reef flat averaged about .3 m. Seventy-five m from the berm the reef flat dropped off precipitously into a channel seven to eight meters in depth, partially sand and partly live and dead coral at the bottom. Conspicuous corals included Acropora hyacinthus, and A. tutuiliensis. Over the reef flat from the first coral growth to the edge the dominant fishes were the surgeonfishes Acanthurus lineatus and A. nigrofuscus, the damselfishes Eupomacentrus albofasciatus, Glyphidodontops leucopomus, Plectroglyphidodon dicki, P. lacrymatus, and the wrasses Thalassoma quinquevittata, T. hardwickei, and Halichoeres margaritaceus, and H. marginatus. A second level of abundance included the most common of several butterflyfishes, Chaetodon citrinellus, the wrasses Thalassoma purpureum, Halichoeres centriquadrus, Pseudocheilinus hexataenia and Gomphosus varius, the damselfish Plectroglyphidodon johnstonianus, a

juvenile parrotfish (Scarus sp.), and the blennies Cirripectes sp. and Istiblennius sp. The only grouper that was seen was Epinephelus merra.

An even greater variety of fishes was encountered at the edges and bottom of the channel, with Eupomacentrus nigricans and Ctenochaetus striatus dominating at the upper edge and Acanthurus glaucopareius, C. striatus, and Glyphidodontops uniocellatus at the bottom, along with several scarids.

Across the channel on the transect line seaward there is a large mound of coral rock, much of which is covered with live coral, ending in the exposed dead coral rock. Moderately heavy surf broke over the exposed rock during our stay at Aunuu.

Our transect nearly paralleled the channel course, and had we chosen a position a few meters to south, the reef flat would have soon have gradually deepened into the channel. Along the shore during our transect period of about 2 hours, there was a set of currents to the north. In the channel, however, there is a current to the open sea, except when heavy sets of waves occurred and the surge carried into the channel toward shore.

Because of its prominence and proximity to survey limits and clear demarkation on the aerial photograph (Fig. 15), a large circular patch reef at the seaward terminus of our N Transect was examined. The coral slope extends to within 3 m of the surface. Not only are the slopes of this patch reef prolifically covered with live corals (up to 50%) as already mentioned, but the upper (about 43 x 36 m) portions, which dips centrally to about 5 m depth, has a rich live coral cover (ca. 40%). There

are areas, however, where nullipores encrust the calcareous surfaces (giving the patch reef a light surface color in the aerial photo). Southwest of our N Transect the edge of this coral platform slopes down to a depth of more than 30 m to the sand seaward (in some places this slope is nearly vertical, but averages about 60°). Several large isolated coral mounds occur in the sand at depths to 38 m. A rich, varied, and diversified live coral, gorgonian, and soft coral realm is encountered along the deeper slope of the patch reef and on isolated knolls.

Moving north (seaward) from the terminus of our N. Transect at the patch reef interface there is a sloping white sand bottom with a sparse growth of the spermatophyte Halophila and green algae Halimeda cunita. The government buoy mooring was visible down a steep slope to the west. We swam down this slope to the mooring at 44 m. Very few fishes were observed over the white sand or Halophlia area. The dominant fish species was a razor fish (Hemipteronotus sp.), garden eels(Heterocongrinae) at 30 m; there were a few Malacanthus hoedtii, Valenciennca sp., and Halichoeres hartzfeldtii. Only small isolated clumps of coral rock support a reduced live coral or gorgonian fauna in this part of the sandy realm.

Moving shoreward around the base of the patch reef in a SE direction we swam into a sandy channel where coral growth is quite rich, especially Acropora samoensis and Pachyseris sp. in distinct patches (Fig. 18). Mixed with the corals, however, are areas of coral rubble and sand. The highest mounds of live coral come

Fig. 18 - Aunuu Island; rich coral growth (Acropora samoensis and plate-like Pachyseris speciosa) shoreward from patch reef at depth of 6-7 m.

to within about 6 m of the surface. One conspicuous man-derived feature in this area is a 6 m metal piling about 30 cm in diameter which is canted to the SW and on which some small heads of Pocillopora and Acropora are growing.

On May 2, 1974, a second visit was made to Aunuu. We talked with Reverend Fred Kisona of the village who has lived on the island 12 years. He informed us that a channel was blasted through the fringing reef about 10 years ago which serves for the launching and landing of long boats and fishing canoes. Two photographs of this event were found at the Museum of American Samoa in Pago Pago. These are dated March 16, 1963, and labelled USS "Reclaimer" and are reproduced herein as Figs. 19 and 20.

Mr. Kisona showed us the channel. It is about 10 m wide and is located 70 m north of the church. We investigated the channel at noon (a -0.3 low tide occurred at 1010 hours). Ten meters from shore the depth was 0.7 m; the bottom is limestone boulders and sand. Twenty-five meters seaward the depth was 1.5 m deep and the bottom coral rock with a thin covering of sand. At this point it was no longer possible to stand on the bottom because of a strong set of current offshore. Approximately 25 m remained of the channel to the edge of the fringing reef at a depth of 6 m. This part of the channel consists mainly of large scattered pieces of coral rock which appear to have been displaced by blasting. There was almost no live coral in the bottom of the channel. The front of the reef sloped at an angle of about 60°, ending in sand at a depth of 16.8 m.

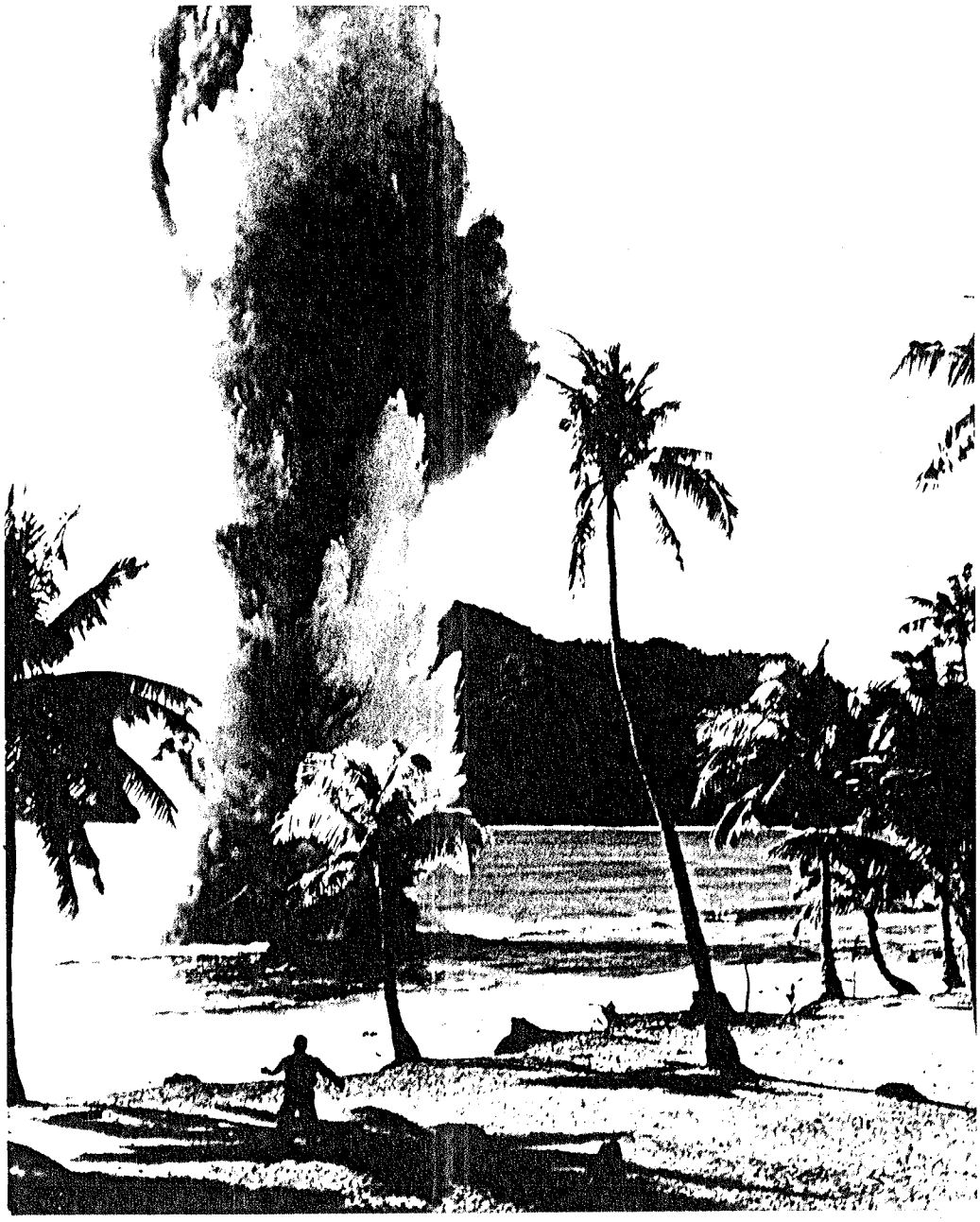


Fig. 19 - Aunuu Island; explosive excavation for channel N of Transect N, 16 March 1963 USS "Reclaimer" project (courtesy American Samoa Museum)

Fig. 20 - Aunuu Island; Explosive excavation N of Transect N, 16 March 1963, USS "Reclaimer" Project (courtesy of American Samoa Museum).

Mr. Kisona informed us that the principal hazard in travel by boat to Tutuila is the landing at Auasi. He said that four people had lost their lives in boat mishaps at Auasi during his 12 years on Aunuu, but no one had been killed in the launching or landing of boats in the man-made channel of Aunuu. He feels that it would be more important to make Auasi a safer place to launch and land boats than to create a small boat harbor at Aunuu.

We asked Mr. Kisona about fishing in the area of the proposed boat harbor. Most fishing takes place from canoes in the deeper water. Occasionally people (especially small boys) will fish from shore with hook and line, but most fishing on the inner reef areas is with spears. He specifically mentioned that fishing was good on the large circular patch reef discussed above. There is some night spearfishing with flashlights. On the reef flats at night fishes and spiny lobsters are taken with the aid of hand-held lights.

On May 4, one of us (Randall) returned to Aunuu Island to confirm a few points, arriving at the time of low tide. It was then noted that six people were engaged in fishing on the reef flat and inshore areas. Two were spearfishing in the vicinity of our Transect S. The other four were standing at the edge of the reef south of the transect, and all seemed to be fishing with hook and line.

During our first visit to Aunuu, we observed boys gathering coral rubble from the beach in sacks. When questioned about this activity, they told us that the material is used as a covering for access areas to their homes.

PAGO PAGO HARBOR OFF FAGAALU VILLAGE

The marine area off the SE side of Fagaalu Village was surveyed within the limits indicated in Fig. 21 . A southern transect (S of the Figure 21) was conducted, beginning at 1645 hours on April 24. It ran from the base of a rocky seawall (about 2 m high) at the edge of the main highway across the reef flat in a NE direction. The high-water mark extends to the base of the seawall.

The bottom along the first 25 m is composed primarily of basaltic and coral rocks (most are about 15 cm in size but a few are as large as 0.6 m). A small amount of sand was noted in pockets. The average depth in this sector was about 0.4 m (a -0.1 low tide occurred at 1434 hours). There are small coral colonies of Porites lutea, Psammacora contigua, and Pocillopora damicornis on these rocks, but the total coral cover approximates only 1%. Coralline algae is apparent throughout this zone by its pinkish color. One polyplectanid synaptid sea cucumber was noted. Fishes were not common; those seen included juvenile Acanthurus triostegus, Plectroglyphidodon leucozona, Halichoeres trimaculatus, and juvenile Mulloidichthys flavolineatus.

Just beyond 25 meters from the seawall the water shoaled to about 0.3 m and a coral rubble area (mostly of cylindrical pieces about 7 to 13 cm long) with occasional coral and basaltic boulders begins. It extends about 4 m seaward. Beyond this there is a proliferation of live coral in low relief (most colonies about 7.5 to 10 cm in diameter (Fig. 22). The domi-

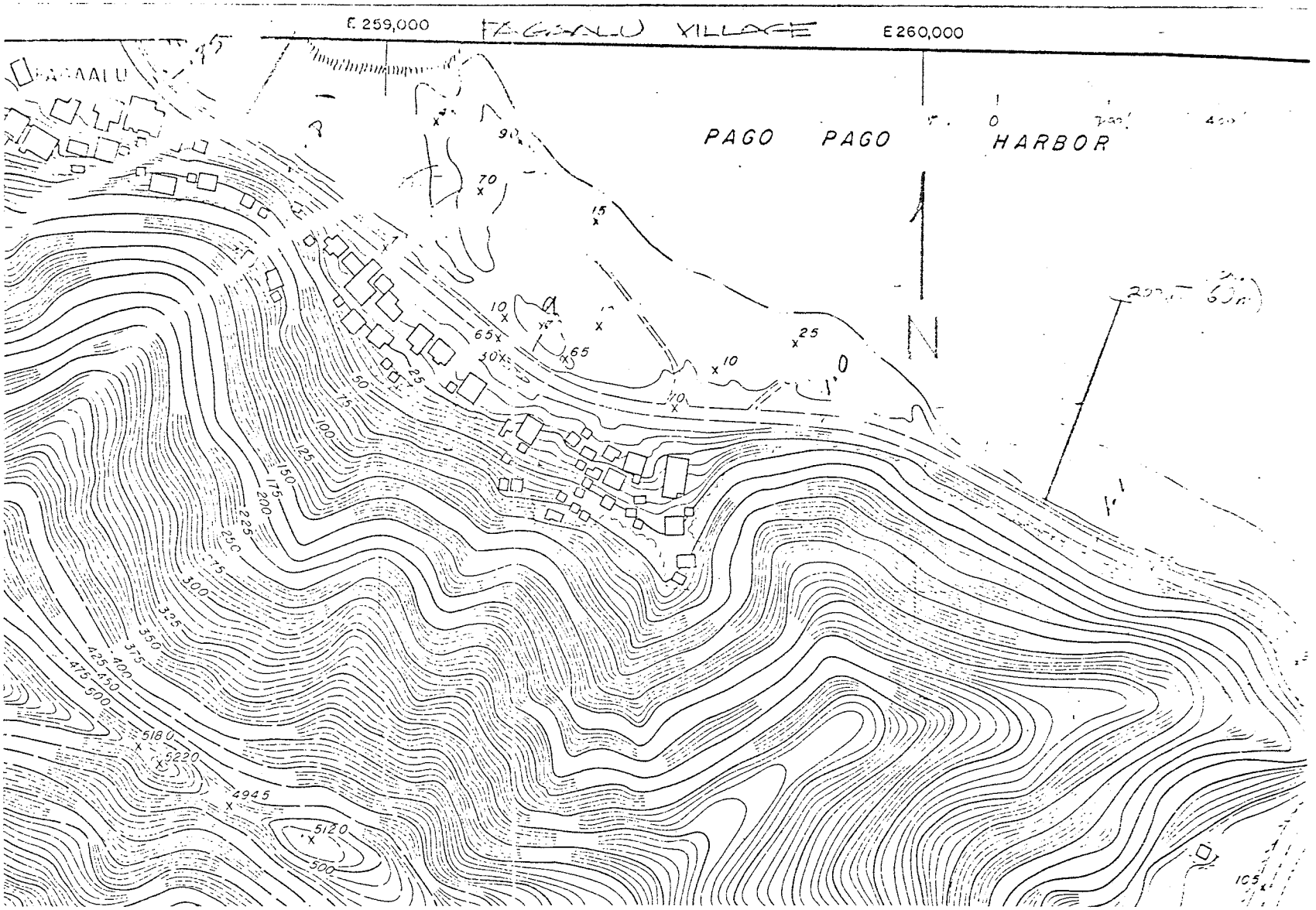
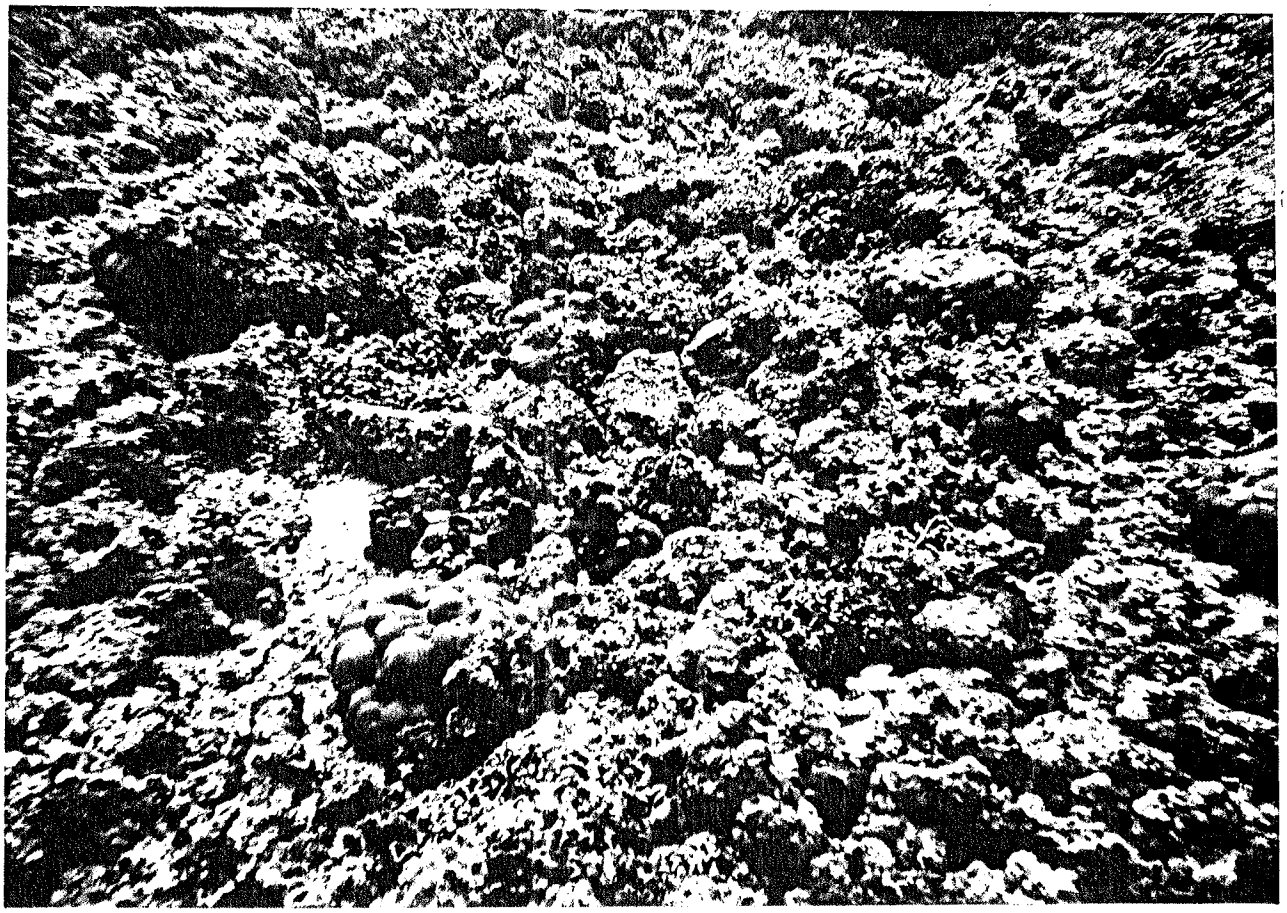


Fig. 21 - Fafaalu; map showing fill area and Transects S and N.

Fig. 22 - Fagaalu; low relief coral and rubble, depth 0.3 m, 25-30 m off shore on Transect S.



nant species are Psammacora contigua, Pocillopora sp., encrusting Porites, branching P. andrewsi, and Pavona spp. By the end of the 50-m sector the amount of coral cover increases to about 30%. A considerable amount of dead coral is also evident. The rocks are covered mainly with coralline red algae and an encrusting deep red-colored noncoralline red alga (Fig. 23). Scattered individuals of the bright blue sea star Linckia laevigata and the synaptid Polyplectana were observed, as were some individuals of the urchin Echinometra mathaei hiding in crevices. Seaward of 75 m the staghorn coral Acropora formosa is evident (Fig. 24), as are clumps of soft coral (Sclerophytum).

At 100 to 125 meters the depth varied from .5 to .8 m. Several large coral rocks were nearly exposed in this sector. Appearing in this sector were several diadematid sea urchins, the holothurians Sticopus chloronotus and Holothuria argus, and the brittle star Ophiarthrum elegans (under rocks).

From 125 to 150 meters the reef flat shows a reduction in coral cover from about 10% to less than 5% (very little other than Porites); here the bottom is mainly coral rubble with coarse sand and gravel in low places. At 170 m staghorn (Acropora formosa and A. samoensis) becomes conspicuous; this is approximately the same distance at the end of an exposed basaltic outcrop east of the transect line. Other corals included A. leptocyathus, Psammacora, Pavona, and Pocillopora. The total coral cover from here to 200 m is about 30% of the bottom.

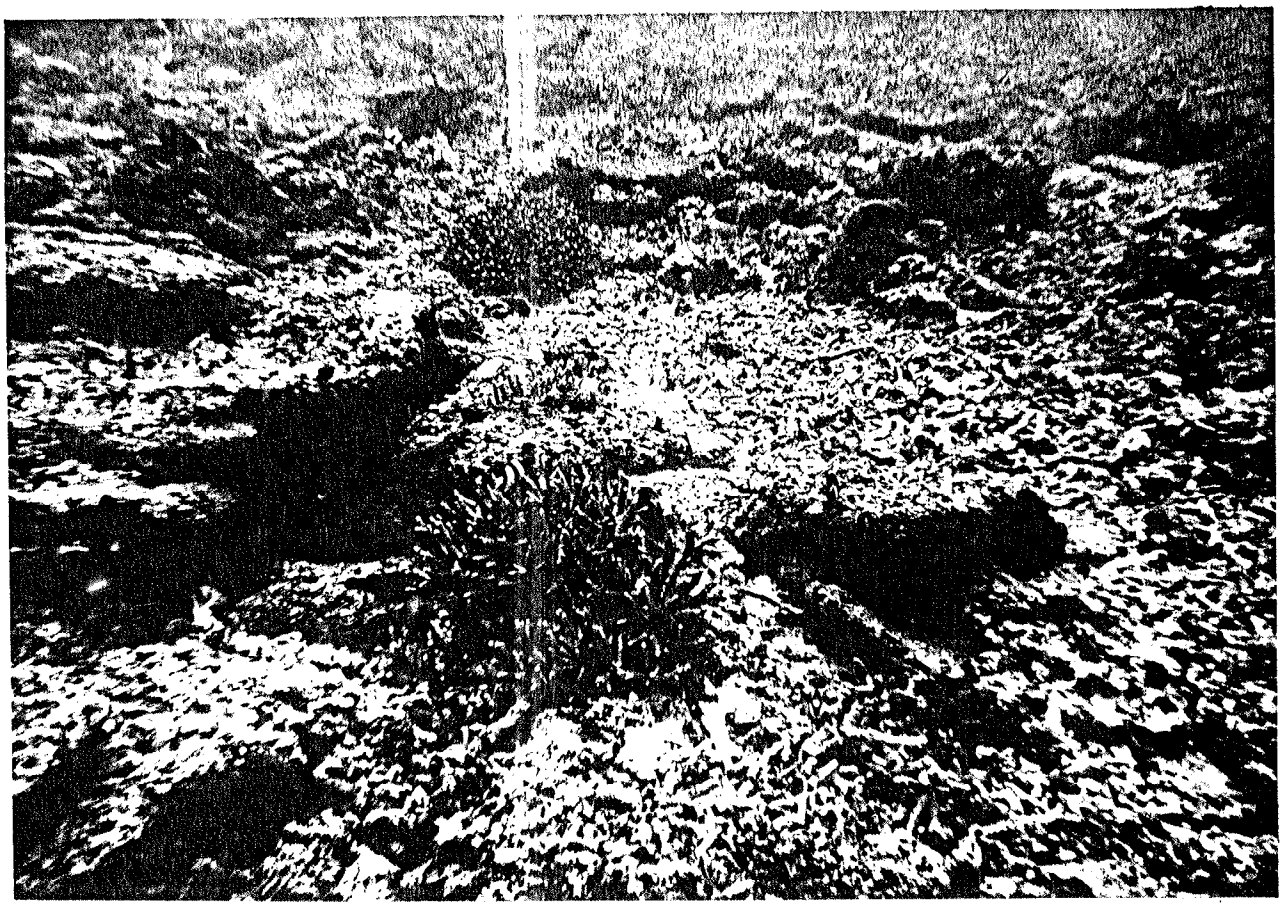


Fig. 24 - Fagaalu; coral rubble-dominated substratum with isolated heads of Acropora formosa, depth 0.3 m, 75 m off shore on Transect S.

The fishes became progressively numerous and the number of species increased generally as we moved seaward on the reef flat. The following could be regarded as common: the damselfishes Plectroglyphidodon leucozona, Pomacentrus vaiuli, Eupomacentrus albofasciatus, Glyphidodontops uniocellatus, and G. leucopomus, the surgeonfishes Acanthurus triostegus and A. nigrofuscus, the wrasses Halichoeres trimaculatus, H. marginatus, H. margaritaceus, Thalassoma hardwickei, and Stethojulis bandanensis, the goatfishes Mulloidichthys flavolineatus and Parupeneus trifasciatus, the butterflyfishes Chaetodon citrinellus, C. lunula, C. vagabundus and Heniochus chrysostomus, the moorish idol Zanclus cornutus, the sharpnose puffer Canthigaster solandri, juveniles of the grouper Epinephelus merra, juvenile rabbitfish Siganus spinus, unidentified parrotfishes (mainly as juveniles), and a blenny (probably Salarias). Associated with certain corals were the damselfishes Dascyllus aruanus and Chromis caerulea. Near the reef front Acanthurus lineatus and the triggerfish Rhinecanthus rectangulus made their appearance.

The water over the reef flat was especially clear, with visibility about 30 meters. A current was setting parallel to shore toward Fagaalu Village.

Moving NW along the reef flat between 0-25 m from the high water mark toward the head of the Fagaalu embayment there is a gradual increase in the amount of sand with large (up to 1.5 m diameter) basaltic boulders becoming prominent toward the fill

area (line A on map). At 120 meters along the shore from the transect, there is an extensive area of fill which is being developed as a park area (Figs. 8 and 9 of color photo appendix); the reef flat off this fill has been extensively altered by dredging and deep sandy pits are evident.

On April 29 between 1030-1200 hours (rising tide; high tide of 2.7 ft. at 1345 hours) a visual survey was made beginning approximately 170 m from shore on the S transect (at end of exposed basaltic rocks exposed east of the transect) and moving toward the shore in a diagonal toward the SE edge of the fill area.. The offshore area contains considerable live coral (30% cover) mainly of staghorn, Acropora formosa and A. samoensis among the most conspicuous. About half way along the line there is a large stand of Porites andrewsi with closely grouped colonies. Quite evident deep sandy dredged areas were observed off the east side of the fill area. A strong current to the NW, lateral to shore, was evident during this period.

Transect N (Fig. 21) was carried out at the head of the embayment just NW of the fill area at 1500 hours April 26. A -0.0 low tide occurred at 1641 hours. The highway at this point comes very close to the high tide mark about 1.5 m above the beach (Fig. 25). Transect N was carried out from this point in a SW direction (toward a 2-inch pipe driven into the bottom near the drop off to deeper water of the harbor) (Fig. 26). The beach is 7 m broad and is composed of dirty sand. It then alters abruptly to mud, which at 1500 hours was covered inshore

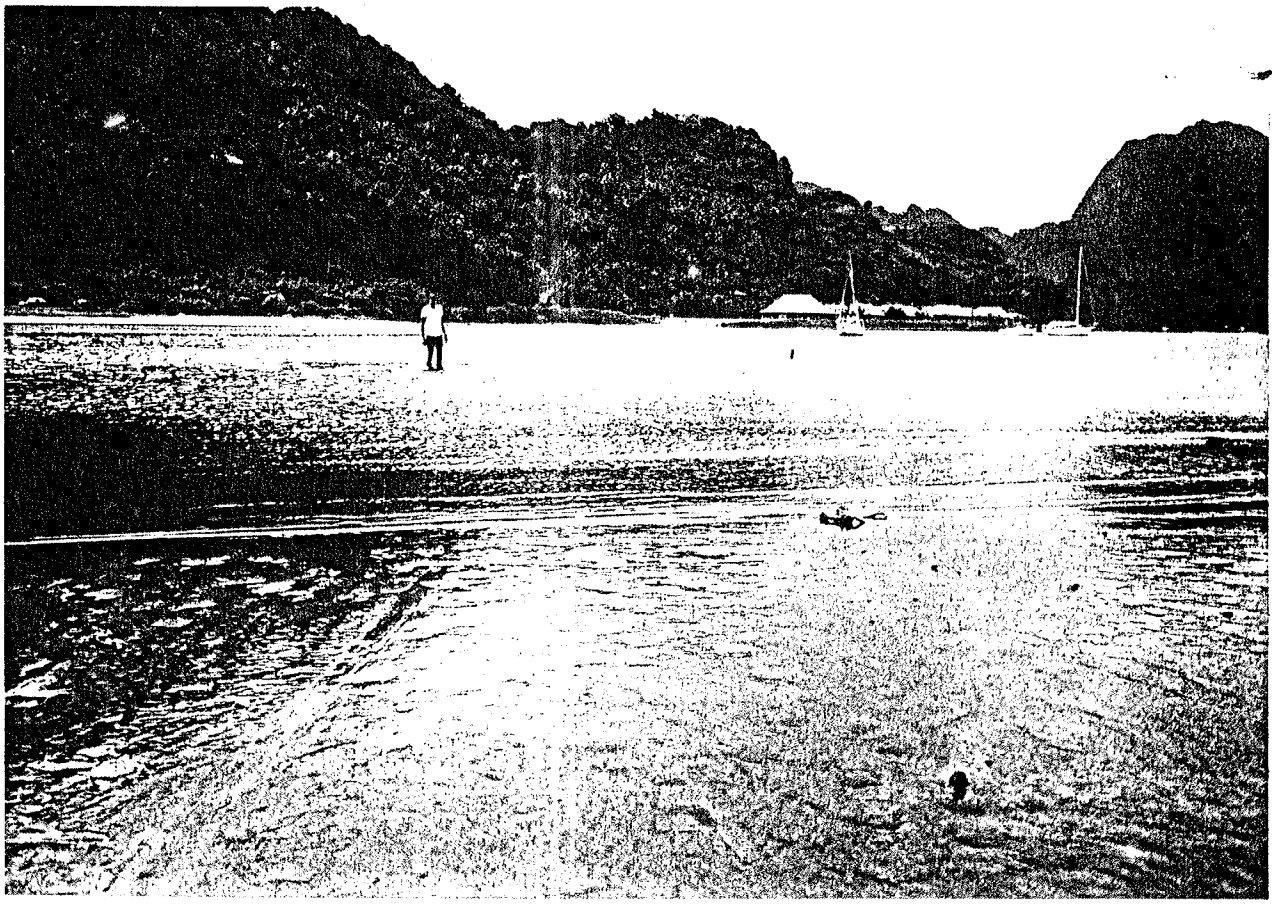


Fig. 26 - Fagaalu; view looking NNW along Transect N from shore at mid tide.

by only about 2 to 3 cm of water. The mud flat extends 50 meters from the high-tide mark; the water was knee-deep at the 2-inch pipe and dropped off to 2 meters and more about 8 m beyond the pipe. Visibility over the edge of the mud flat was about 6 m.

Burrow holes were evident over the entire expanse of the mud flat. At 1800 hours with much of the mud flat exposed, it was apparent that most of these burrows were formed by fiddler crabs (the male has a large yellow claw). The species was identified as Uca marionis. Several specimens were obtained by digging on the flat about 10 m from the high tide mark. A tube-dwelling polychaete was also uncovered by digging. Digging farther out from shore we obtained specimens of ghost crabs (Callianassa). Only two species of fishes were seen on the mud flat. A single individual of the puffer Arothron immaculatus and a school of about six individuals of the tigerfish (Therapon jarbua) was observed in the shallows, each about 15 cm long. At the edge of the drop-off, a short distance to either side of our transect, there are outcrops of rock at a depth of about 1 meter. With the exception of a small head of Pocillopora damicornis on one rock, they are free of coral growth as well as other benthic invertebrates (at least on the upper surfaces - beneath the rock outcrops there are small caves). The surface has a thin layer of silt and sparse growth of algae. The dominant fishes at the rocks were the blue damselfish Pomacentrus pavo and the snapper Lutjanus fulvus (vaigiensis of most authors). Other fishes included the lionfish Pterois volitans, the cleaning wrasse

Labroides dimidiatus, and the goby Amblygobius phalaena. One moray eel was seen crossing the steep front of the mud bank, and a school of half-grown pompano (Trachinotus) circled one of the rocks briefly.

We observed only two small rivulets of freshwater entering the sea over the mud flat to the north of Transect N. Evidently this was not enough to affect the salt content of the sea at the outer edge of the mud bank, for we determined the salinity at this point as 32 o/oo. Shortly thereafter we took a salinity at the base of Transect S, and it was the same. Later during a rainy period a much heavier flow of freshwater and silt was observed at this site. According to Cary (1931, p. 56), "At its inner end (of the deep cove at Fagaalu) there enters a small stream that brings enough freshwater and sediment to prevent the growth of corals and thus provides an entrance through the reef."

We discussed the utilization of marine resources at this site with an articulate resident of Fagaalu Village. He informed us that most fishing was off the reef front. While we were present, however, three boys were fishing from the shore immediately north of Transect N by casting feather lures out into the harbor. They caught a juvenile and a subadult of the jack Caranx sexfasciatus.

Three sailing vessels were moored in the harbor off Fagaalu during our stay.

REEF FROM FAGANEANEA VILLAGE TO UTULAINA POINT

At 1500 hours on April 29, 1974 a transect (N. of Fig. 27) was carried out in an easterly direction (magnetic bearing 85°) from the high water mark to the SW end of Faganeanea Village to the principal drainage channel for this sector of reef. A high tide of 2.7 feet occurred at 1345 hours, and a low tide of -0.1 feet was predicted for 1955 hours. The surf was moderate, and several surfers were observed off Vasaaiga Village. They used the swift current of the drainage channel to move offshore. A 1-knot current was setting along shore in a NW direction, toward the drainage channel in the vicinity of our transect. The highway where the transect began is 5 meters from the high-tide line. A seawall of rock faced with cement drops steeply about 3.5 m to the beach. The base of the seawall is slightly undercut by the wave action at the shore. The beach is nearly 10 m broad and rather steep. It is mainly rock in the upper part (rocks mainly basalt, some boulders being as large as a meter, but some are cement, presumably from the seawall) and mainly sand in the lower.

As indicated in Fig. 27 , the transect ran diagonally from the shore, thus the zonation was expanded. The first 25 meters consisted of coarse sand and smooth scoured rocks (the larger ones with a trace of algae) from boulder size down to small pebbles. The depth at 25 meters was 1 m. No fishes were seen in this inshore sector and only two small heads of Porites lutea which, though still alive, showed evidence of transport shoreward

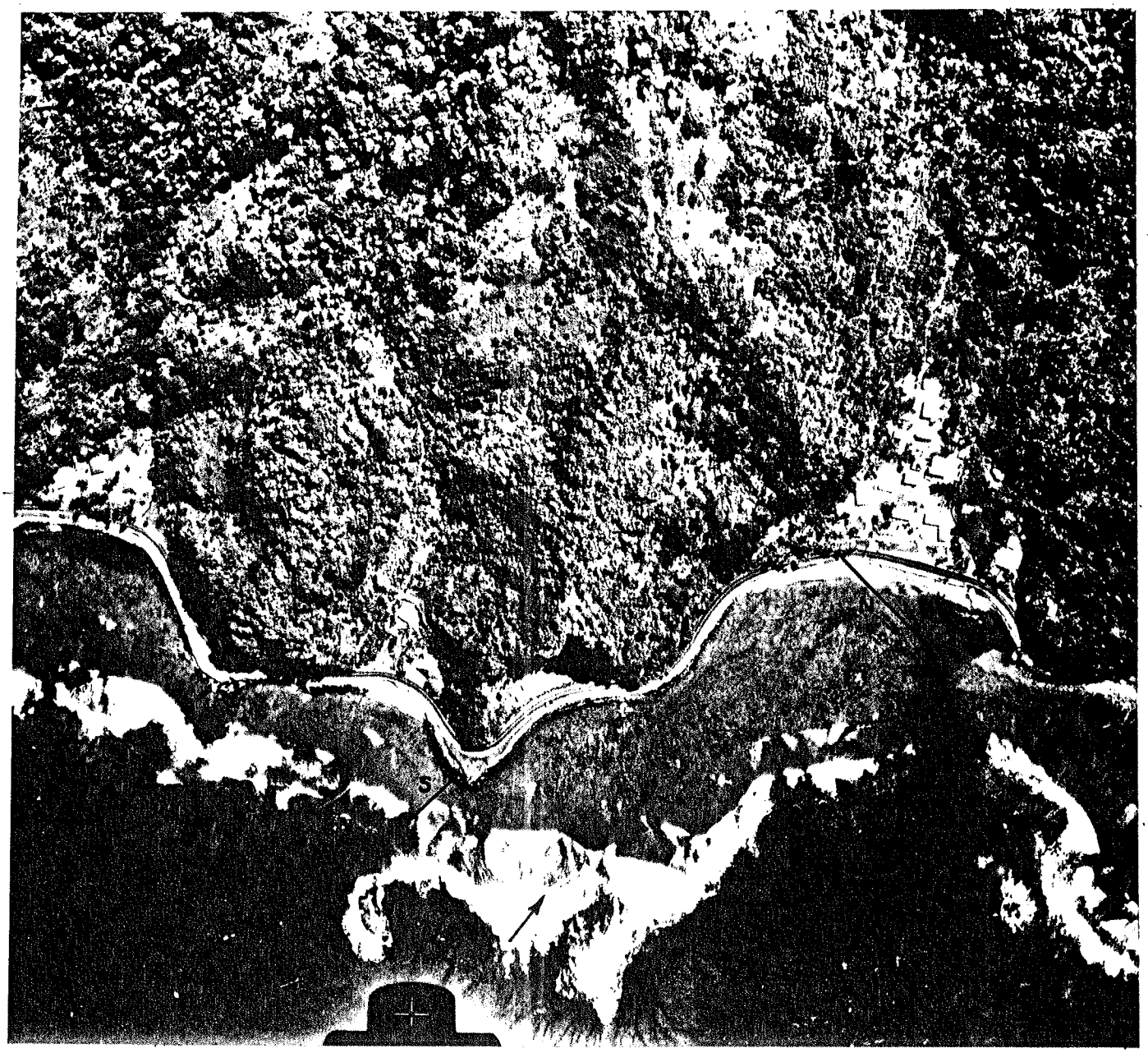


Fig. 27 - Faganeanea; aerial photo showing Transects N and S.

by wave action. The water was somewhat milky, and the visibility at best 1 m.

At 25 meters there was the beginning of a transition zone of a few meters in which sand largely disappeared and much coral rubble appeared. Visibility increased to about 9 m. Here the rocks had more algal covering and the first pieces of fixed live coral (nearly all small heads of P. lutea, Fig. 28.) were apparent (less than 5% of substratum). The first fishes appeared with the transition zone: Halichoeres trimaculatus, Parupeneus trifasciatus, and Stethojulis bandanensis. In the second 25 meters, there were, in addition, Halichoeres margaritaceus, juvenile Acanthurus triostegus, Glyphidodontops leucopomus, G. unimaculatus (especially near the larger rocks), Eupomacentrus albofasciatus, a few G. glaucus and two Rhinecanthus aculeatus.

The third 25 meter zone was not very unlike the second. Coral cover increased slightly; a small amount of encrusting Montipora was seen as well a s P. lutea. A few holothurians (Stichopus chloronotus) and echinoids (Echinometra mathaei) were observed. The money cowrie, Cypraea moneta, was moderately common. The water deepened at the 75-m point to nearly 2 m.

The last 25 meters carried to the edge of the drainage channel. Here the current and the deeper water (2.5 m at the edge) made the survey difficult. In this last sector there are more corals and some individual heads of P. lutea were very large (mostly live only at the periphery). One head of Coscinaraea columna

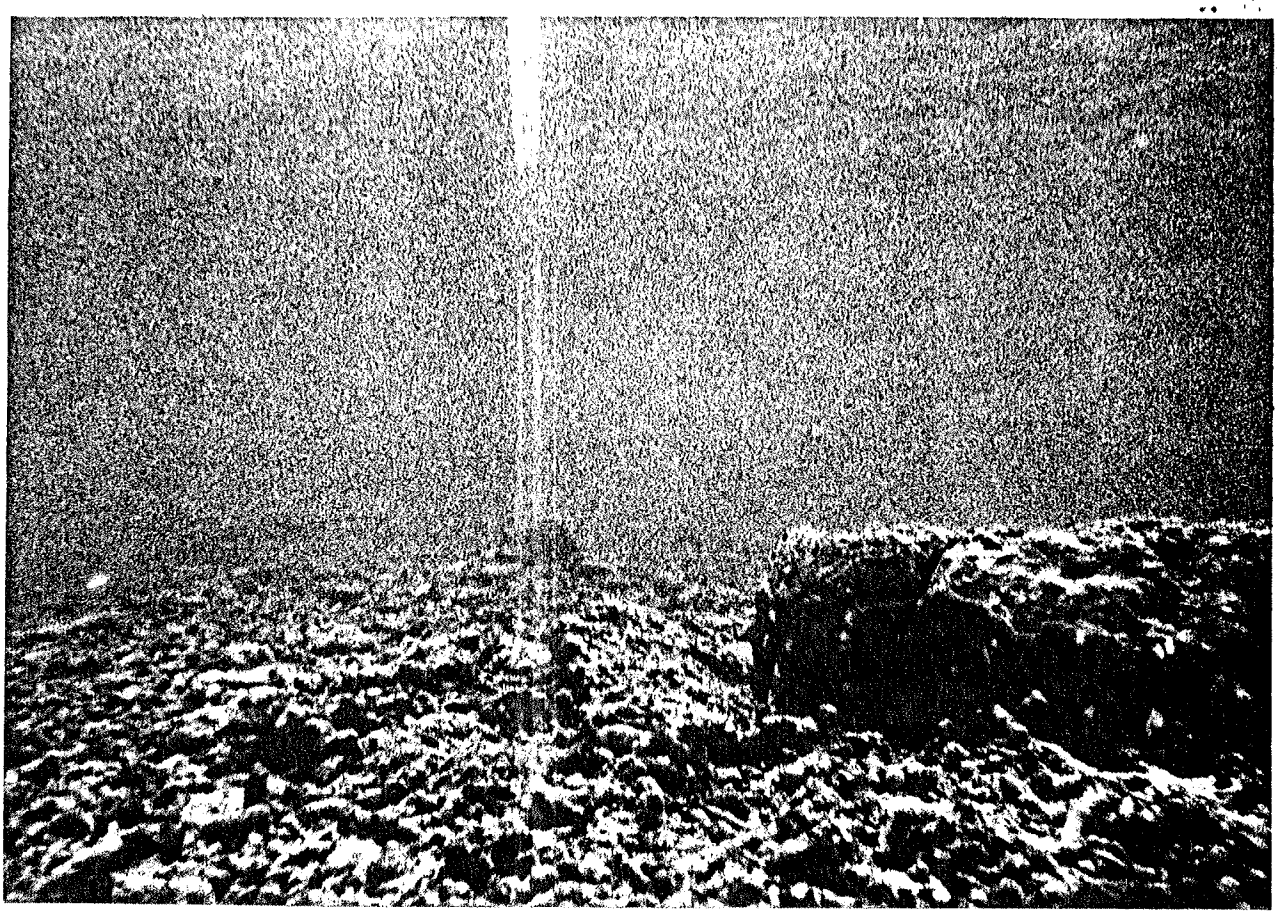
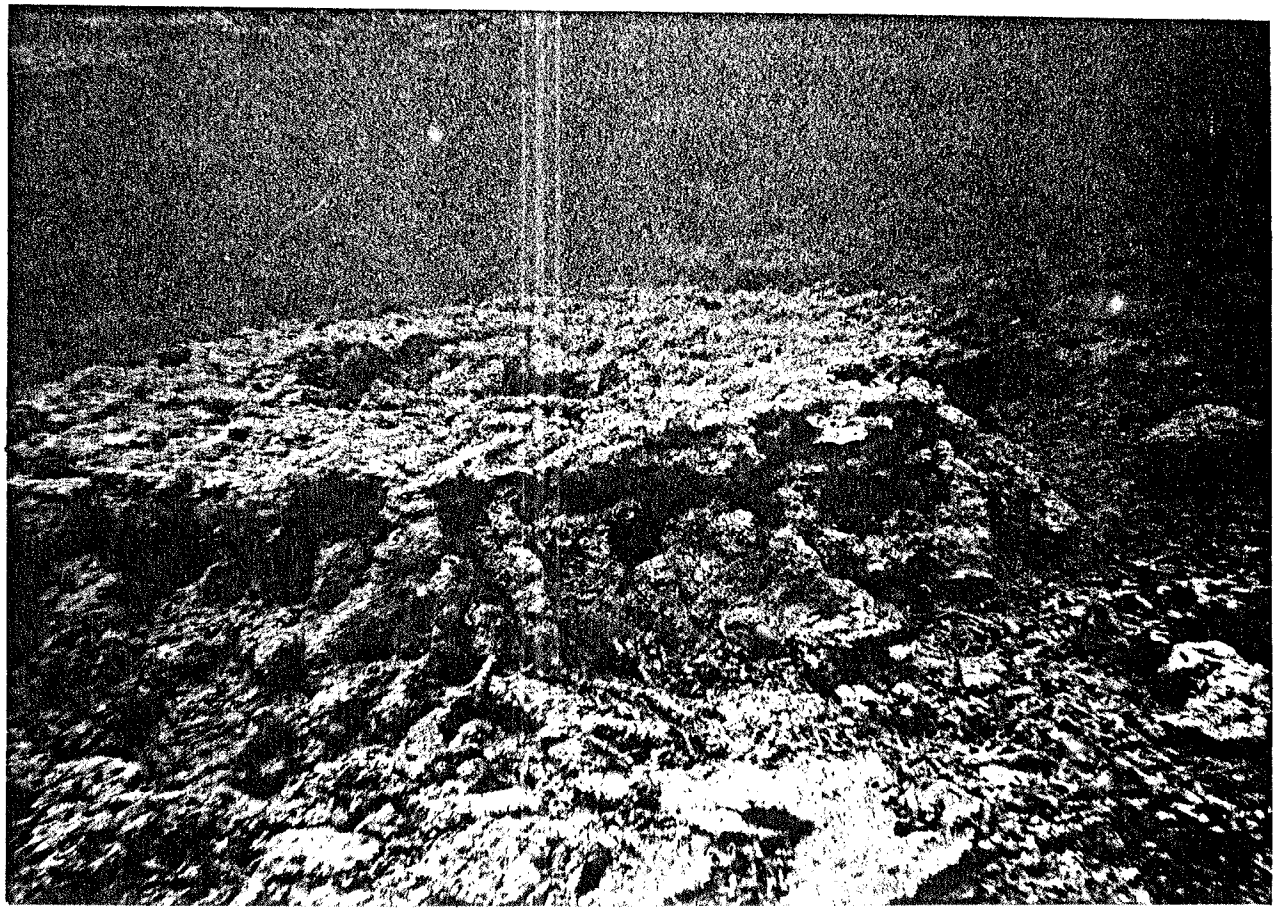


Fig. 28 - Faganeanea; rubble substratum with outcropping of Porites lutea on Transect N, 10 m off shore.



(Fig. 29) measures 3.4 m across and is 0.6 m high; it is truncate with a depression of about .6 m in diameter in the middle, about 15 cm deep. The live coral is growing only on the upper part of the sides and along the edges of the depression. Some small heads of Pocillopora verrucosa and Acropora spp. are present. Still the total coral cover does not exceed 10%. The rest of the bottom is about half coral rubble and half dead coral rock, largely covered with nullipores. In addition to the above-mentioned fishes (except G. glaucus and R. aculeatus), the following were common: Acanthurus nigrofuscus, Chaetodon citrinellus, Halichoeres centriquadrus, Thalassoma hardwickei, T. quinquevittatus, Pomacentrus vaiuli, and a few Siganus spinus, Acanthurus maculiceps (not yet recorded from the Samoa Islands), and Rhinecanthus rectangulus. One school of subadult Acanthurus olivaceus crossed the survey area.

At the edge of the channel there was an abundance of fishes of which several species of parrotfishes as adults (Scarus oviceps, S. ghobban, etc.) and surgeonfishes (adults of Acanthurus triostegus and A. nigroris in schools) were dominant. Adults of Ctenochaetus striatus and juveniles of Acanthurus lineatus were also common. Two large colonies of the soft coral Sclerophylum were noted at the margin of the channel Fig. 30), and a huge outcrop of rock with a cave beneath is situated at the head of the channel (Fig. 31). The channel sides of coral rubble and sand drop off at a slope of about 45 degrees to a depth of approximately 8 m.

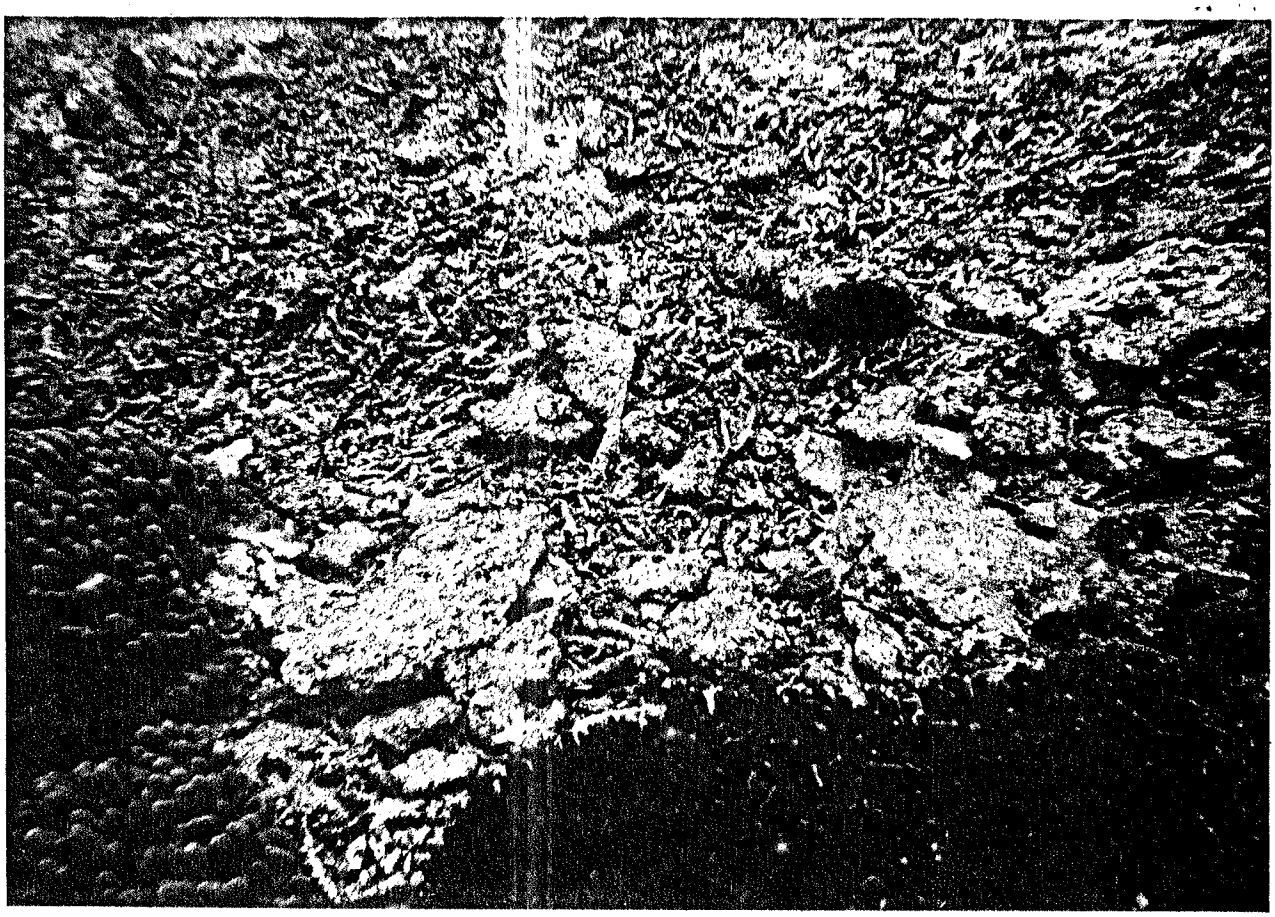


Fig. 30 - Faganeanea; rubble substratum and colonies of soft coral, Sclerophylum at margin of channel, outer part of Transect N.

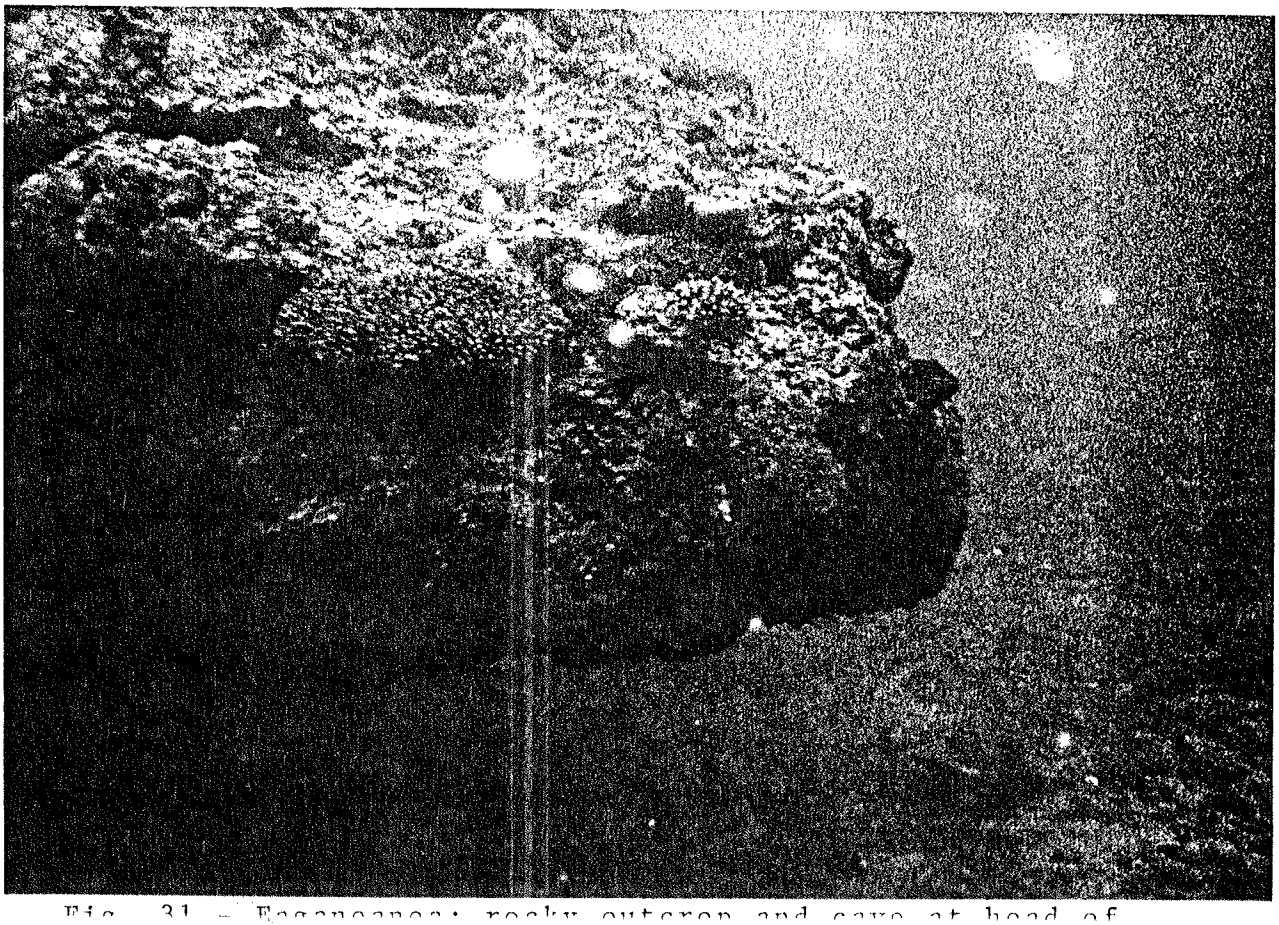


Fig. 31 - Faganeanea; rocky outcrop and cave at head of

Heavy surf was breaking on the reef off Utulaina Point and Fatuuli Rock on April 29 (Fig. 32) and it was not possible to run a transect there at this time. Although surf continued to be heavy on the point the next few days, we were able to execute a transect nearly to the reef edge during a -0.3 low tide at 1056 hours on May 3. The direction of this transect (S of Fig.27) is due south from the west side of Utulaina Point.

The road is 3.5 m from a sloping seawall consisting of basalt boulders filled with cement. High tide reaches the base of the seawall. There is no beach at the point (though there is a small one of sand with some rock a short distance to the west); the intertidal consists of large boulders of basalt.

Seven meters from the seawall the sea was 0.3 m deep. About 80% of the bottom is rock, mainly small boulders, covered with a sand-algae mixture; the remaining 20% is sand between the boulders. Surprisingly there is about 5% live coral cover this close to shore, consisting of small colonies of Porites lutea, Leptastrea purpurea, and Acropora samoensis. About 12 m from the seawall several colonies of the soft coral, Sclerophytum sp., were grouped near the transect line. About 15 m out, Psammacora, Pavona, and Pocillopora damicornis make their appearance, as does the small diadematid urchin Echinostephus in holes in limestone rock. Stichopus chloronotus was unusually abundant in this zone (about one per square meter). In the outer part of the first 25-m sector small heads of Acropora are the dominant corals but the coral cover has not increased beyond

Fig. 32 - Faganeanea; reef off Utulaina Pt. facing S towards Fatuuli Rock in area of Transect S.

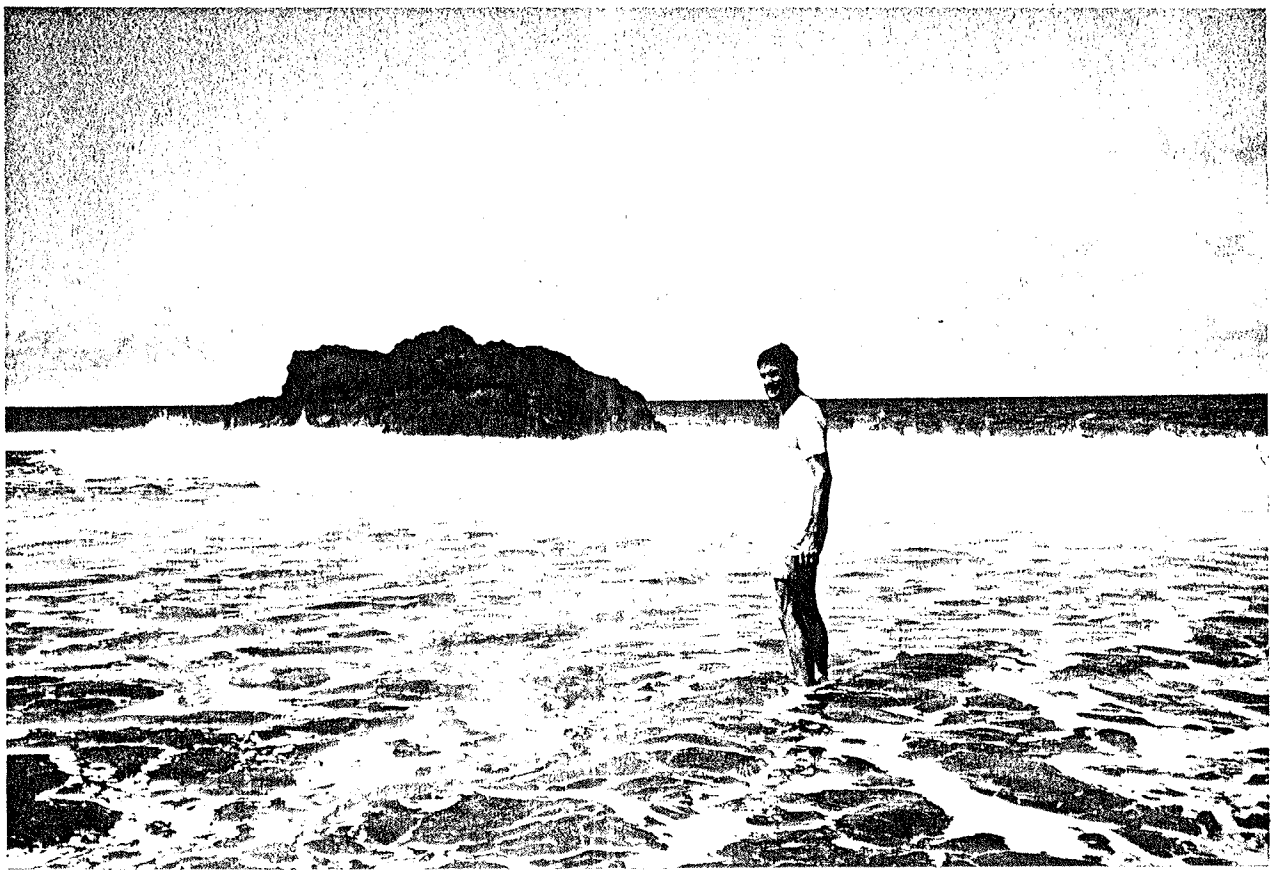


Fig. 33 - Faganeanea; reef off Utulaina Pt. facing S towards

about 5%. Also the depth has remained about the same. The dominant fishes are Glyphidodontops leucopomus, Acanthurus triostegus and Halichoeres margaritaceus.

The second 25-m of the transect show a gradual diminution in depth; at the end of this sector the depth is 0.1 m. Half way out in this segment the corals Acropora humilus and Pocillopora verrucosus appear. Over the last 7 m of this sector Porolithon is progressively more abundant. With the shoaling of the bottom, the coral growth is low and/or encrusting (even an encrusting acroporan), but the coral cover is increased to about 15%. The first Favites was seen at this time. Almost no fishes were observed on this 25 m, however.

In the next 4 m the shallowest part of the reef flat was reached; it then averaged 70 to 80 cm (discounting the rise as waves swept over the reef flat). The reef flat then slopes gradually seaward, and a small-scale groove and spur effect can be noticed. In Fig. 33 , Devaney is standing on the shallowest part of the reef flat. Wave action precluded our carrying the transect any farther.

On April 29th an attempt was made to examine the bottom by drifting with the current from a point about 50 m north of Utulaina Pt. down to Transect N, approximately 25 m off the seawall. Cursory observations in the relatively turbid water failed to reveal any significant differences compared with the bottom and faunal features 25 m off Transect N.

On May 3rd, however, at low tide with the diminished swell, we were able to walk across the reef area between Transects S to N. North of Utulaina Pt. off the broadest part of the reef, there is a zone which begins a few meters from shore and extends 25 to 50 m seaward characterized by irregular channels of sand and rubble about 0.7 m wide separated by ridges upon which corals are growing. The holothurian Stichopus chloronotus was common. Farther out on the reef flat approximately 75 to 125 m from shore is an area of branching Acropora corymbosa, the surface of some of these corals just exposed at low tide. One individual of the sea cucumber Actinopyga mauritiana and one of the sand-covered Holothuria atra were noted. Along the rocky basalt-strewn shore many dark colored blennies (Istiblennius) were observed at the low water line, jumping from rock to rock when disturbed.

Three Samoan boys were fishing with bamboo poles off Utulaina Point on April 29 (Fig. 34). Their catch consisted of several small jacks (Caranx melampygus), goatfish (Parupeneus trifasciatus) and one snapper (Lutjanus monostigmus).

On May 3 two Samoan women were observed fishing for octopus on the reef between Faganeanea and Vasaaiga at low tide (Fig. 35), and a man was fishing with rod and reel at the NE side of the drainage channel (where Transect N terminated) (Fig. 36).

Fig. 34 - Faganeanea; Samoan boys fishing off Utulaina Pt.

Samoan women fishing on reef between
woman on

Fig. 36 - Faganeanea; man fishing at NE side of drainage channel (at end of Transect N).

ASILI BAY

The first transect (N of Fig.37) originated at the shore in the NE corner of the bay. It was laid out in a WSW direction (bearing 250° magnetic). The road is about 3 m above the beach at this site. The distance from across the beach from the high tide mark to the water's edge at 1645 hours (low water at 1749 hours) was 11 m. The beach is flat, composed of pebbles, gravel, and dirty sandy, and strewn with basalt boulders of variable size (Fig. 38). A few small limpets were found on the larger exposed boulders of the intertidal.

The water inshore was silty with a brownish cast, the depth averaging 0.3 m 25 meters from the high-tide line. A layer of freshwater was apparent from the cooler temperature and the roily effect when one tried to use a face mask at the surface. Evidently this was from seepage all along the shore as no obvious runoff was observed. The first 25 meters was mainly dirty sand with low isolated clumps of dead coral (only a small amount of live Pavona frondifera was present). The depth averaged 0.4 m. Between 30 and 40 meters from shore the amount of hard bottom increased, and the sand substratum existed mainly as shallow channels between the coralliferous rock (principally dead Pavona, but some Porites lutea). Living coral of these two species occurs mainly at the periphery of of the dead colonies. There are also some rounded, silt-covered sponges as well as small colonies of papillose encrusting sponges (same as from Nua-Seetaga Bay). From 50 to 75 m the amount of hard substratum increased and the water shoaled to an average of 0.3 m. Approximately 15% of the

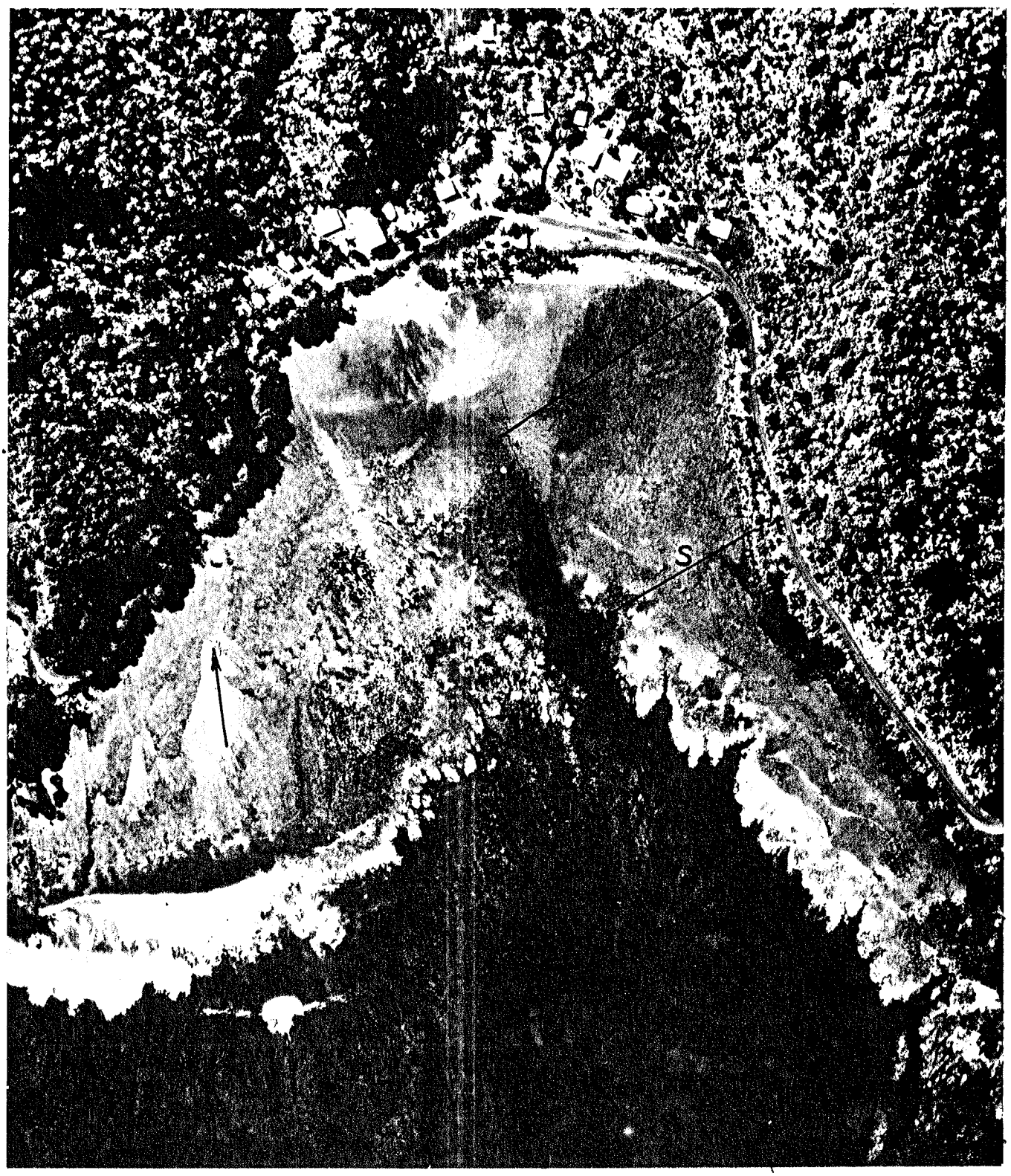


Fig. 37 - Asili Bay; aerial photo showing Transects S and N.

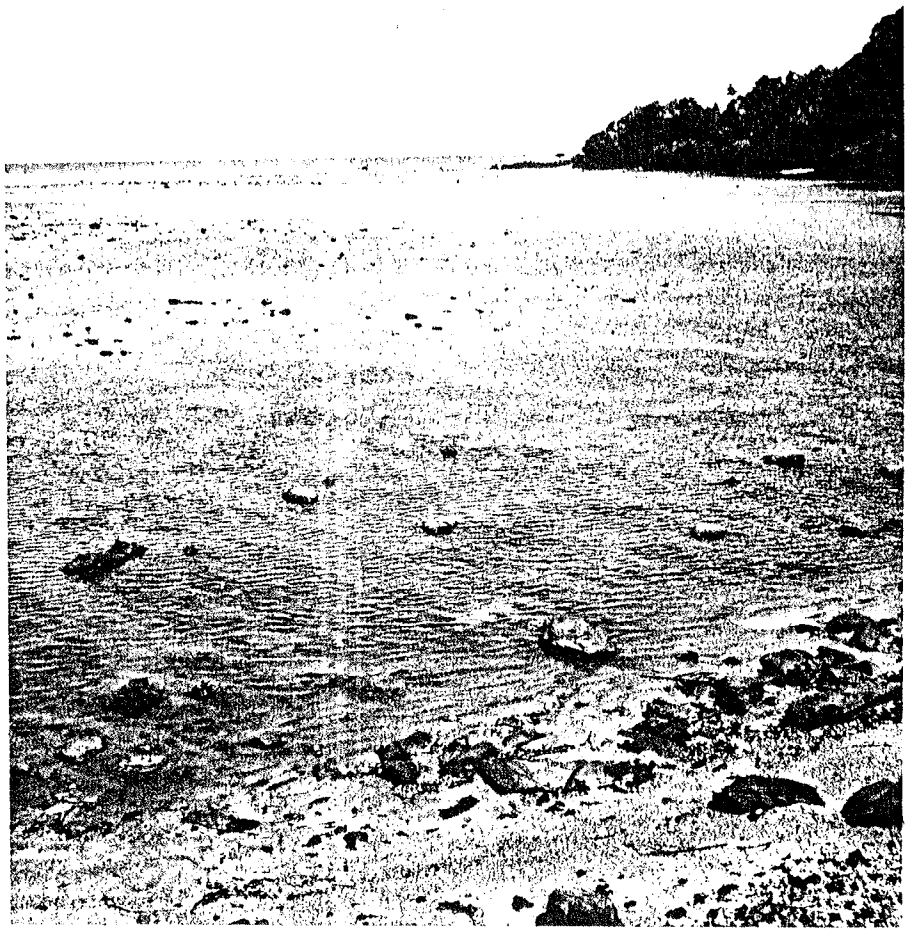


Fig. 38 - Asili Bay; beach and shallow exposed rock and coral along Transect N, facing NW.

Fig. 39 - Asili Bay; looking south from highway, area of Transect S in left background.

bottom is live coral (mainly Pavona frondifera). The bottom to 100 m is similar, with a few truncated low heads of Porites lutea and small patches of Leptastrea purpurea appearing, the the amount of sand increasing. In this inshore area there were surprisingly few fishes in view of the ample cover for small species. Only a few damselfish (Plectroglyphidodon leucozona), moorish idols (Zanclus cornutus), and butterflyfishes (Chaetodon auriga, C. lunula and Heniochus chrysostomus) were seen. From 126 to 150 m the bottom changed to one of silty sand with more massive heads of P. lutea (depth 0.3 m).

At this point the transect line was perpendicular to the head of the central channel of the reef which is the main drainage for the entire bay. The water deepened gradually from the transect to this channel which is mainly sand and rubble bottom with some live coral along the sloping margins, including some very large heads of P. lutea. It reached 2 meters in depth 30 m from the transect.

The second transect (S of Fig.37) was carried out 175 m along the shore to the south at 1815 hours. The beach here is a steep slope, more rock and boulders than sand, about 5 m in width (Fig.39). The first 25 m from the shore are only 2 to 15 cm deep in the pools. The next 25 m are ankle deep with patches of sand in low areas. Coral in this zone consists mainly of small low colonies of Acropora formosa, A. samoensis, and Pavona. The coral covers slightly less than 10% of the substratum. The next 25 m carried to within 4 or 5 m of the

eastern edge of the central drainage channel. The average depth at this time was 20 to 25 cm and the coral cover increased to 35%, with A. formosa the dominant species. The dark-green holothurian Sticopus chloronotus was moderately common. Fishes were also common, the dominant species being Glyphidodontops leucopomus, Acanthurus triostegus, A. lineatus, Halichoeres margaritaceus, Thalassoma hardwickei, T. purpureum and Eupomacentrus albofasciatus, (mainly juveniles except for G. leucopomus). The last 4 or 5 meters to the edge of the channel were only ankle deep - hard bottom covered mainly by Porolithon. Unlike the inshore end of the channel, here it drops off almost vertically. Just over the edge, in the rough swirling water, Acanthurus lineatus is the dominant fish.

Walking laterally between transects about half-way to shore at ankle-depth we saw numerous dead coral rocks exposed (some 0.5 meters out of water). There is an irregular hard rock bottom and almost no sand. Low areas tend to be filled with masses of coral rubble which are cemented in place with nullipores. There are also some masses of rubble and low dead coral colonies on the reef flat away from depressions. No fishes were observed in this shallow water.

NUA-SEETAGA BAY

A transect (W of Fig. 40) was carried out in the northern part of the bay in a near north-south direction (bearing 185° magnetic) 110 m west of the nearest culvert under the highway (drainage of four different streams of the area). There is no seawall at this point; the road lies 14 m from the high tide line. At 1400 hours (a falling tide at this time; low tide 0.0 feet at 1749 hours) the distance from high water to the sea's edge was 9 m. The beach is moderately sloping and consists of clean medium-grained sand primarily of calcareous origin. Seaward of the water's edge sand and scattered boulders extend another 3 meters. Beyond this to about 25 m the bottom is of consolidated rock (mainly basalt) with sand in pockets. Most rocks are covered by turf algae in which considerable sand is bound. Visibility was only 2 m. The bottom then becomes more even (depth approximately 0.4 m), the surface of the rock covered by patches of two species of sponge (a dark gray encrusting form and a light bluish papillose species, the latter forming elevations several cm high) (Fig. 41). These two sponges cover about 50% of the bottom and turf algae most of the remaining 50%. There are a few irregularities in the hard-pan bottom - either shallow depressions or isolated low mounds of dead coral. On the dead coral some small colonies of Pavona decussata, Leptastrea purpurea, Favites, and Porites lutea were seen. For the inshore 50 m only a few damselfishes of the species Glyphidodontops glaucus and G. leucopomus were

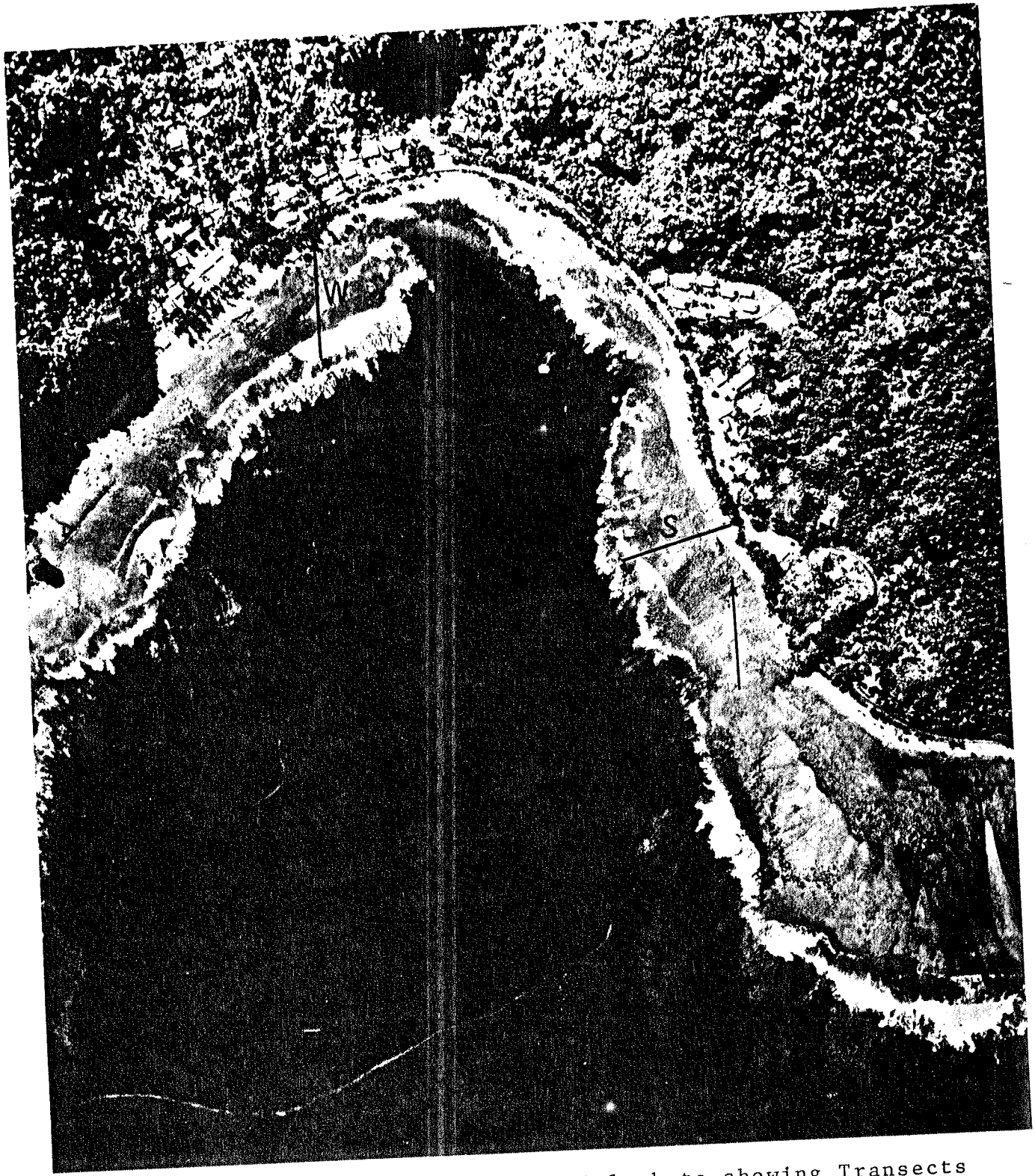


Fig. 40 - Nua-Seetaga Bay; aerial photo showing Transects S and W.

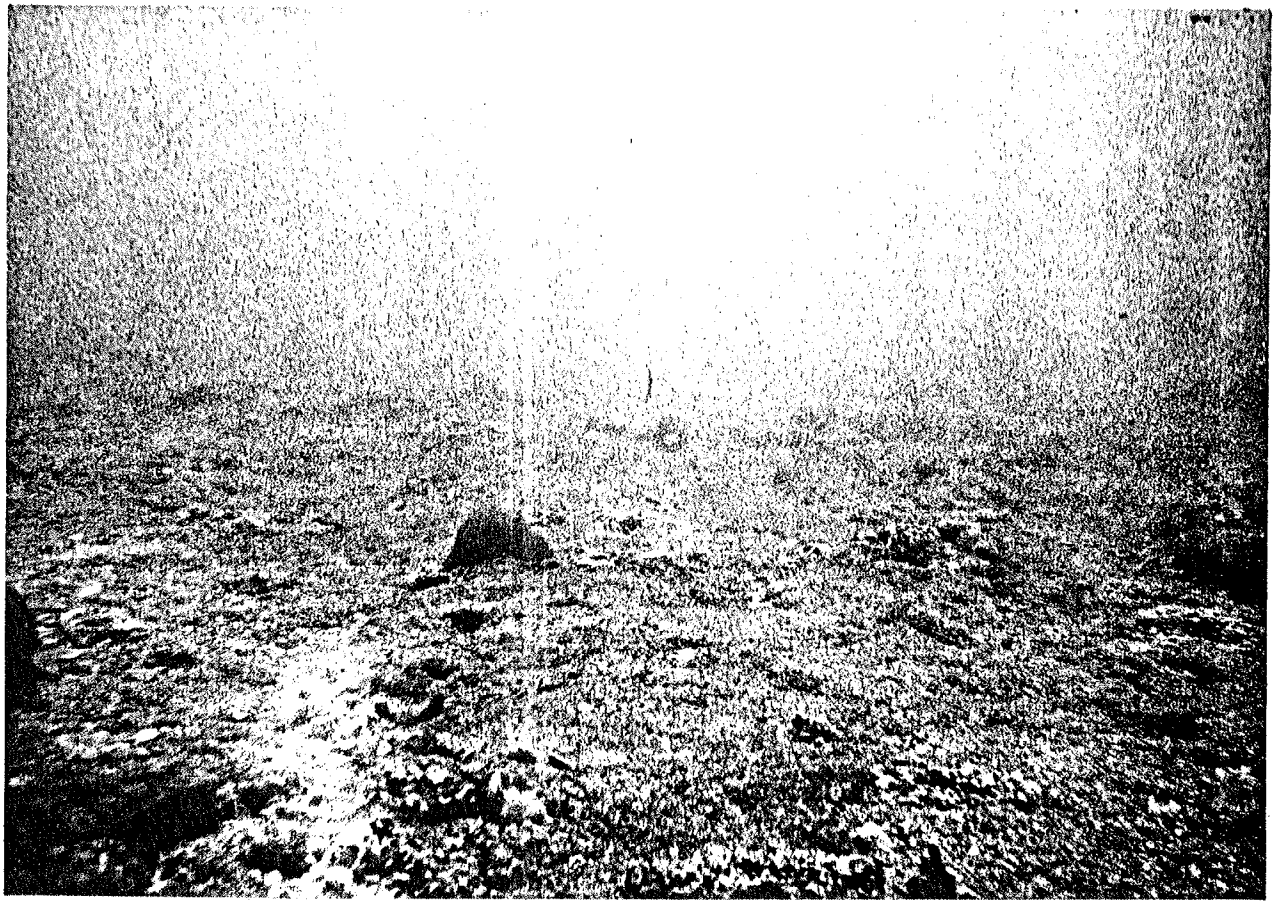


Fig. 41 - Nua-Seetaga Bay; low profile substratum dominated by turf algae and papillose sponge, 25 m off shore on Transect N, depth 0.4 m.

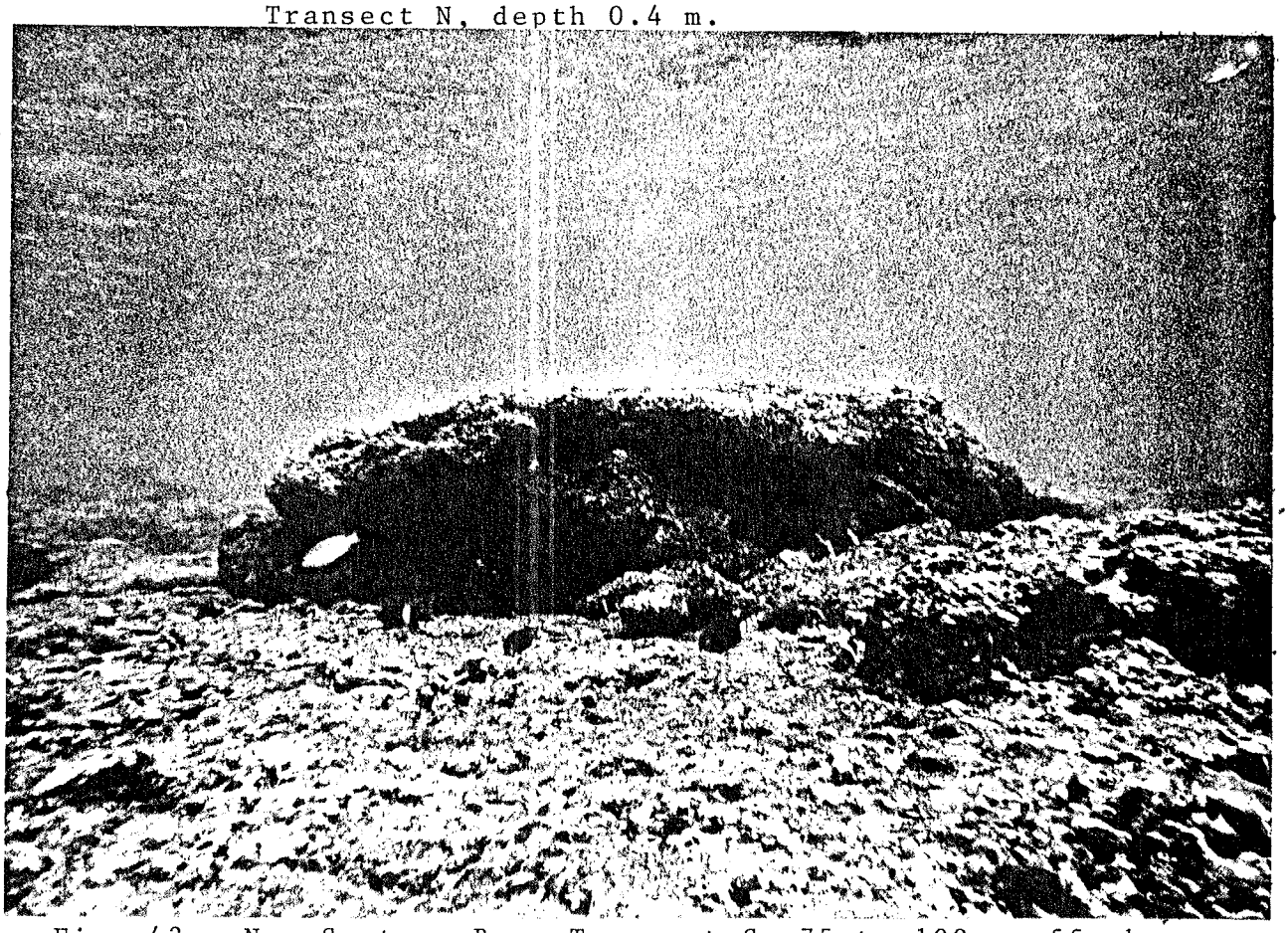


Fig. 42 - Nua-Seetaga Bay; Transect S, 75 to 100 m off shore,

observed. From 50 to 100 m the depth was about 0.8 m. The bottom is more irregular and porous. Corals increased in the number of species (in addition to the above we note Acropora formosa and A. humilis) and in abundance, but still live coral is only about 5% of the substratum. In the outer part of this sector, covering the edges of depressions, are colonies of the zoanthid Palythoa. The only fishes seen in addition to the damsels listed above were Halichoeres margaritaceus and an unidentified blenny. Strong surf near the edge of the reef flat prevented carrying the transect much beyond 100 m.

Swimming east of the transect line, the bottom is much more strongly sculptured and strewn with boulders of various sizes, many partially exposed at this tide. As would be expected from the greater shelter, there were many more fishes than in the transect area. Coral cover remained very low, however. Approaching the culvert the sea became so roily with freshwater that observation was difficult.

A second transect (S of Fig. 40) was conducted in the southern part of Nua-Seetaga Bay along a bearing of 260° magnetic from shore. A culvert without noticeable runoff was located 20 m N of the transect. A 10-m distance separates the highway, without seawall, from the high-tide mark. The beach, which is similar to that of Transect W in slope and composition, measures 15 m in width. In contrast to W where little current was noted, there was a 2-knot current running north parallel

to shore. To maintain position on the transect line it was necessary to grasp coral or irregularities in the bottom (Randall's finger was lacerated by a small moray while clinging to holes in the reef). The first 4 m of the bottom are soft shifting sand with some boulders. In this inshore zone a small school of Therapon jarbua and several juvenile Mulloidichthys flavolineata (samoensis of most authors) were observed. Beyond this there is a hard, nearly flat, consolidated rock bottom on which occasional flat rocks may be seen (in such a current, only flat rocks could resist the current). Some of these rocks were partially cemented to the substratum by coralline algae; others were free. Pinkish coralline reds and blue-greens were the most apparent of the algae on the substratum. In the latter part of the first 25 m of the transect the same dark gray sponge became evident; at 25 m it formed about 10% of the substratum. The depth (at 1500 hours) at this point was 0.4 m. Three species of fishes were moderately common: Glyphidodontops glaucus, Acanthurus triostegus, and Halichoeres margaritaceus. Beyond 25 m the bottom became more irregular and the faunal and floral components more varied; these included small encrustations of the green alga Dictyosphareria, much coralline red algae, sponges, matted turf algae, and low coral colonies (Pavona, Favites, and Porites - forming about 5% of the substratum). A few Stichopus chloronotus were seen. Some coral rocks were exposed at this time. In the next 25 meters scattered low

AMANAVE BAY

A transect (S of Fig.43) was conducted SW of Utusiva Rock, a prominent tombolo (Fig.44) separated from shore by a narrow channel, beginning at 1205 hours (high tide of 2.7 feet at 1129 hours) with moderate surf conditions. The transect was run perpendicular to shore (hence in a SW direction, approximately 230° magnetic). There is a clean white sand beach 7 meters in width from maximum high tide line to a cobble and sand bottom at water's edge. Immediately seaward of the narrow zone of coral cobble (which moved to and fro with the wave action on the beach) there is a predominantly rocky bottom in waist-deep water over which sand was being swept with the surge. The rocks were thinly covered with a sand-algal matrix; on the larger rock surfaces occasional thalli of the green alga Dictyosphaeria could be seen. This bottom remained essentially the same 90 meters from the high tide mark (where incoming surf terminated the transect). At 25 m from shore (Fig.45) there are a few scoured basalt boulders up to 0.6 m in size in the water which measured 1.5 m in depth. Almost no coral was seen; there was only an occasional small colony of faviid coral (Leptastrea purpurea) on the upper part of larger rocks. There was also a dearth of fishes. Only one fish (Halichoeres trimaculatus) was noted in the first 25 m and beyond this only a few Glyphidodontops glaucus and G. leucopomus.

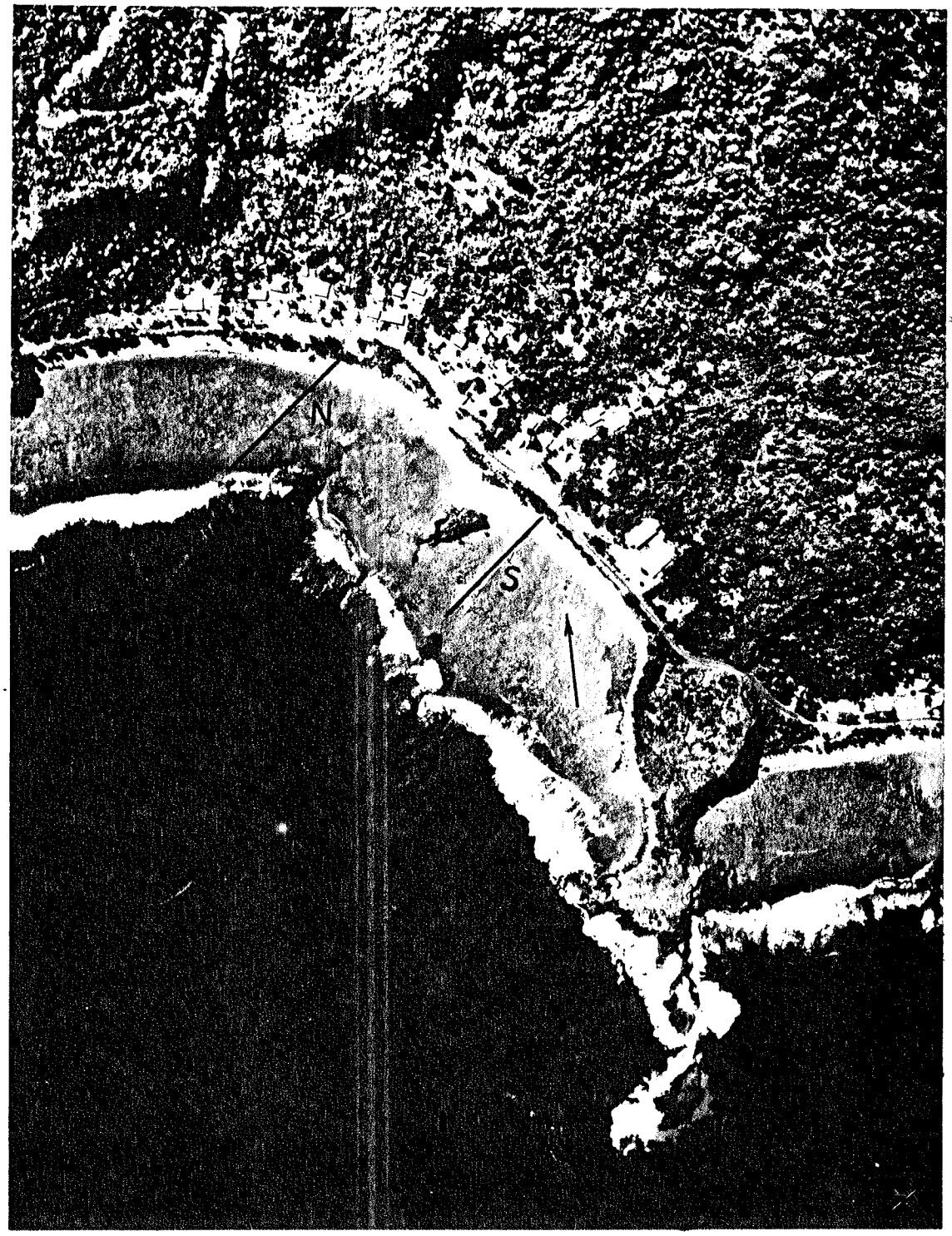


Fig. 43 - Amanave Bay; aerial photo showing Transects N and S.

Fig. 44 - Amanave Bay; Utusiva Rock looking W.

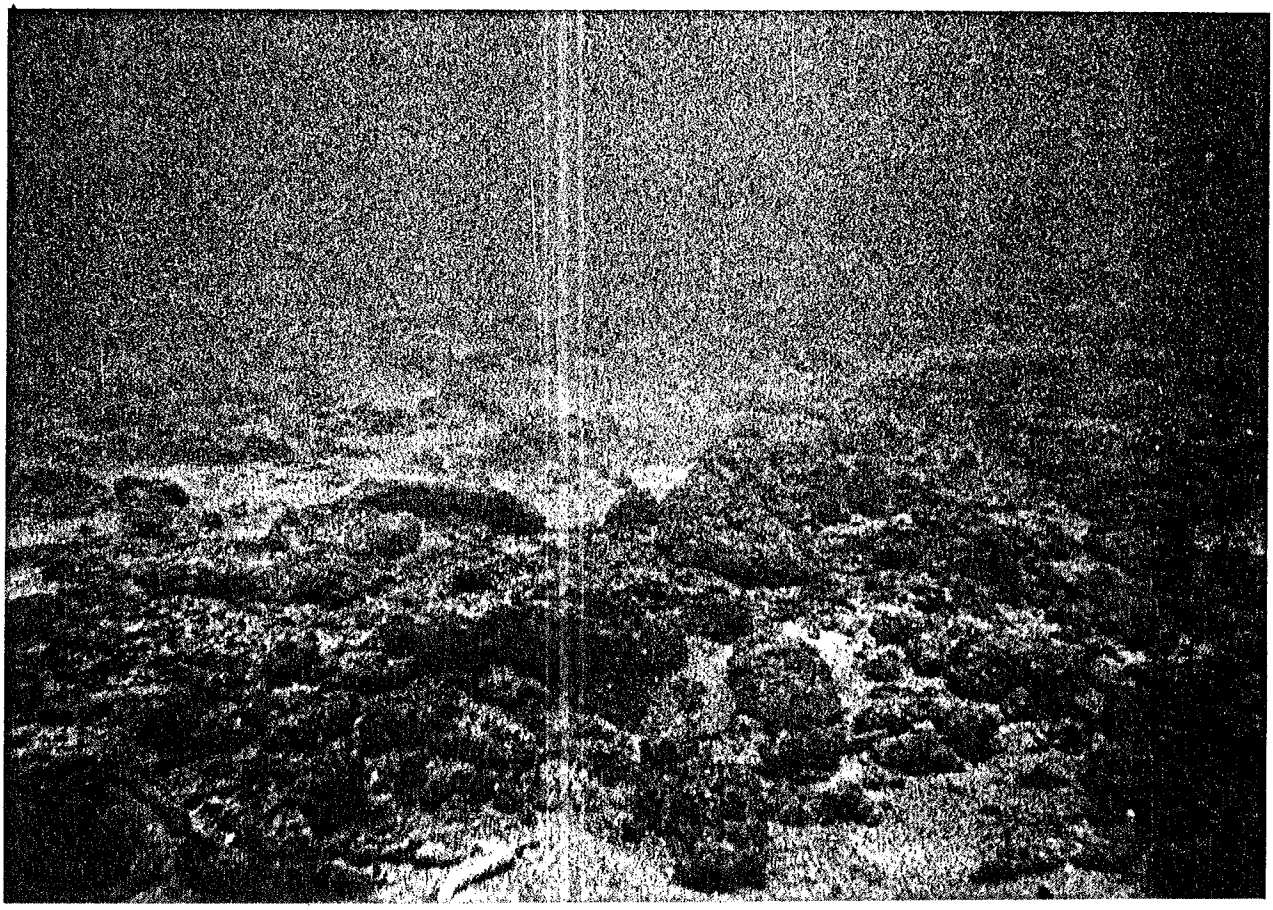


Fig. 45 - Amanave Bay; bottom along Transect S - 25 m off shore

Both survey members examined the bottom from the transect line to Utusiva Rock. A few small colonies of branching Porites andrewsi and encrusting P. lutea were observed. Nearing the tombolo there was an increase in the amount of basaltic material, some as rather large rocks. Also more fishes were seen, including Stethojulis bandanensis, Halichoeres marginatus, Canthigaster solandri and Abudefduf sordidus, but none was common.

A strong current was setting in a NW direction over the reef, attaining river-like velocity in the channel of 0.3 m depth between the tombolo and shore when sets of large waves swept across the reef.

Freshwater was observed entering the bay NW of Utusiva Rock from Leafu Stream. Apparently heavy rains of the night before had resulted in considerable runoff because the water was very turbid; a broad band of brown water containing flotsam spread NW and W from the stream mouth; plumes of this discolored water could be seen extending offshore toward the principal channel draining the reef (Fig. 10 of color photo appendix). Some of the brown water also occurred on the NW shore of Utusiva Rock.

The discolored water rimmed the land fill between Leafu and Maululu streams (Fig. 46). According to sources in the Dept. of Public Works, this was a village project by the people of Amanave, without any guidance from Public Works. This fill is being eroded at this time. During our site visit we

Fig. 46 - Amanave Bay; view along seaward edge of landfill and seawall between Transects S and N looking SE.

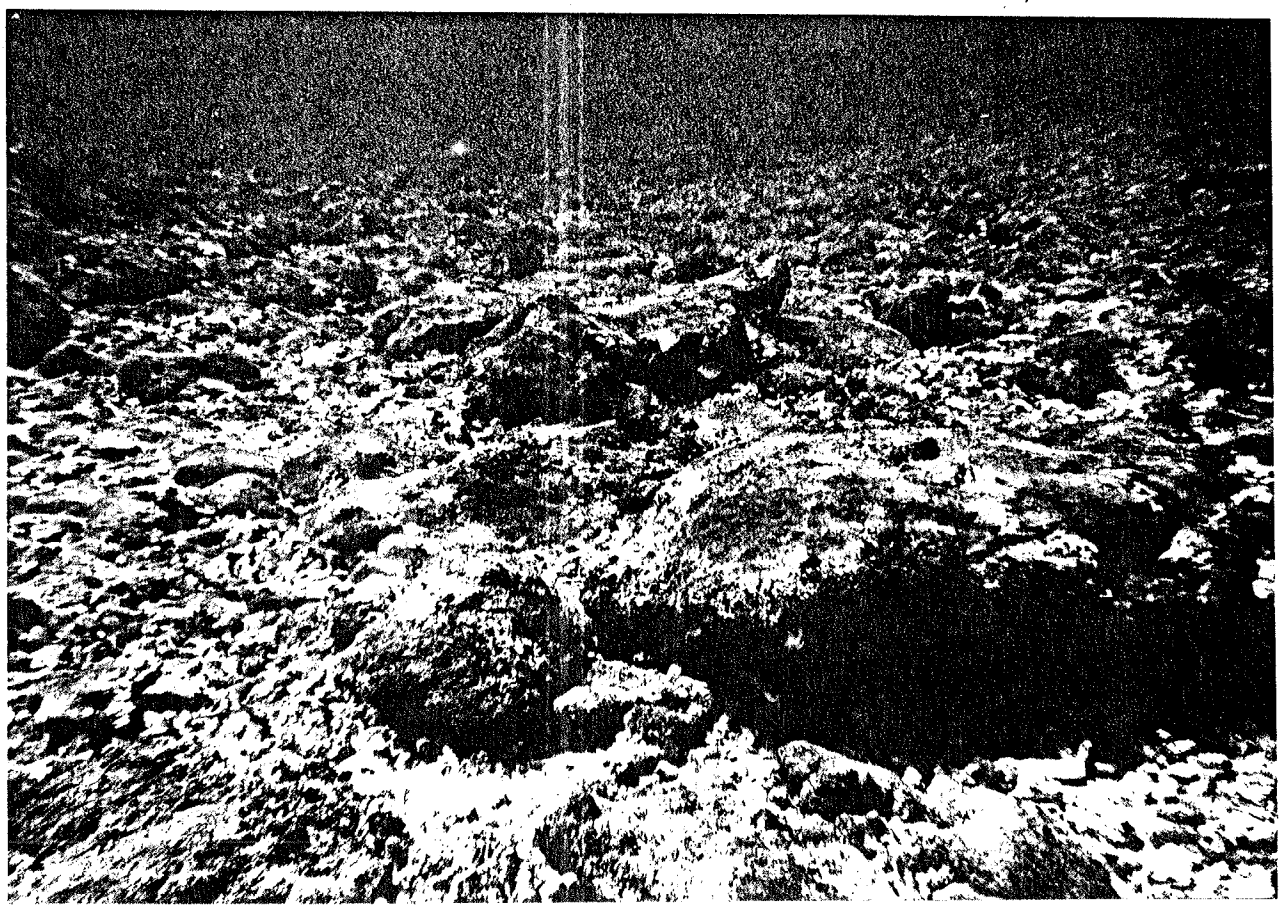


Fig. 47 - Amanave Bay; bottom along Transect N, 115 m off shore.

observed waves strike the front of the fill, resulting in some sand and dirt being swept into the sea.

We were unable to carry out a proper northern transect at the recommended site due to wave action, current, and especially turbidity. We entered the water about 100 m west of the mouth of Maululu Stream. Nothing could be seen in the brown water for the first 20 to 25 m from shore. Beyond this, at a depth of about 2 m, with visibility at best 0.5 m, we noted a few corals.

On May 3, 1974 we were able to conduct a more complete transect from shore across the reef flat (Transect N of Fig. 43). Our position was 61 m west of a culvert at the edge of the land fill and 20 m E of a World War II pillbox. Our bearing seaward was 220° magnetic, hence not perpendicular to the reef front. The distance from the highway to the high tide line is 18 m and from high tide to water's edge 14 m (we began at 1215 hours; a low tide of -0.3 at 1056 hours). The upper half of the exposed beach is coral sand and the lower half is small rock and coral rubble. At the end of 25 m from the high tide mark the depth was 0.3-0.5 m with a bottom composed of coral rock and approximately 30% sand. The green alga Valoniopsis was fairly evident as well as some Dichyospheria. No live coral was seen and there are only a few big boulders. Very near the shore two juvenile pompano (Trachinotus) and a school of six adult Therapon jarbua were observed. Near a big rock two subadult Abudefduf sordidus had established a territory.

Other fishes included juvenile Acanthurus triostegus, Halichoeres margaritaceus, H. trimaculatus, Glyphidondontops leucopomus and G. glaucus. About half way out on the first 25 m of the transect, the latter fish is the dominant species.

The second 25-m sector of the transect revealed the first live coral in the form of small patches of Leptastrea purpurea. The bottom is essentially like the more shoreward area. The depth was a maximum of 0.5 m. At the beginning of the third 25-m sector, small low patches of Pocillopora verrucosa, Leptoseris, encrusting Montipora, and a little Acropora formosa and Pocillopora damicornis were observed. The live coral cover appears to be about 2% of the substratum which now has more coral rubble initially. Although there are no sand patches, some sand is evident between the rubble and bound with low algae and forams on the rocks. The depth at the end of this sector was 0.6 m, and the most prevalent corals observed are encrusting Montipora and Pocillopora verrucosa with a little branching Acropora and Favites. Farther out along our fourth 25 m sand was virtually absent, visibility in the shallow water reached 14 m, and low breaking waves were coming over the reef front. The bottom was composed of low profile consolidated limestone, and about half way out the semi-encrusting coral Acropora leptocyathus was common together with low stands of species seen shoreward. Coral cover at the end had increased to about 5% (Fig. 47). The depth had decreased slightly to about 0.3-0.4 m. There was an increase in the pink crustose coralline alga (Porolithon) as well as

Dictyosphaerea and a red (Jania). The first echinoderms were noted at the end of this sector: the sea urchin Echinostrephus, burrowing in the limestone. Approximately half way from the shore to the reef edge the damselfish Glyphidodontops leucopomus replaced G. glaucus as the dominant species of fish on the reef flat. Other fishes common on the outer half of the reef flat were Halichoeres margaritaceus, Eupomacentrus albofasciatus, Acanthurus nigrofuscus, and juvenile A. lineatus. An adult male of the parrotfish Scarus sordidus was seen in only a few centimeters of water. Two blennies were occasional, both living in holes in the reef: Istiblennius paulus and Entromacrodus decussatus.

The fifth 25 m showed an abundance of low corals in depths only slightly awash closer to the reef edge (the first surge channel was estimated to be within 4 m of the beginning of this transect sector. Coral cover increased to approximately 40% among which A. leptocyathus, Pocillopora damicornis, P. verrucosa, low branching acroporans, and an encrusting form are the most conspicuous. The bottom is composed of limestone with small grooves and a pink cast due to continued Porolithon cover, as well as scattered thalli of the green Dictyosphaeria and Halimeda sp. and the branching coralline red Actmotricha rigida.

Approximately 25 m seaward of the fill area (which lies between the two transects) we observed the amount of sand increasing, depth increasing (0.6 m), and visibility decreasing

(2 m). The green alga, Valaniopsis was prevalent over a low profile rocky bottom having a sand-algal turf matrix.

On May 3 we observed one man fishing on the reef flat for octopus shortly after low tide (Fig.48).

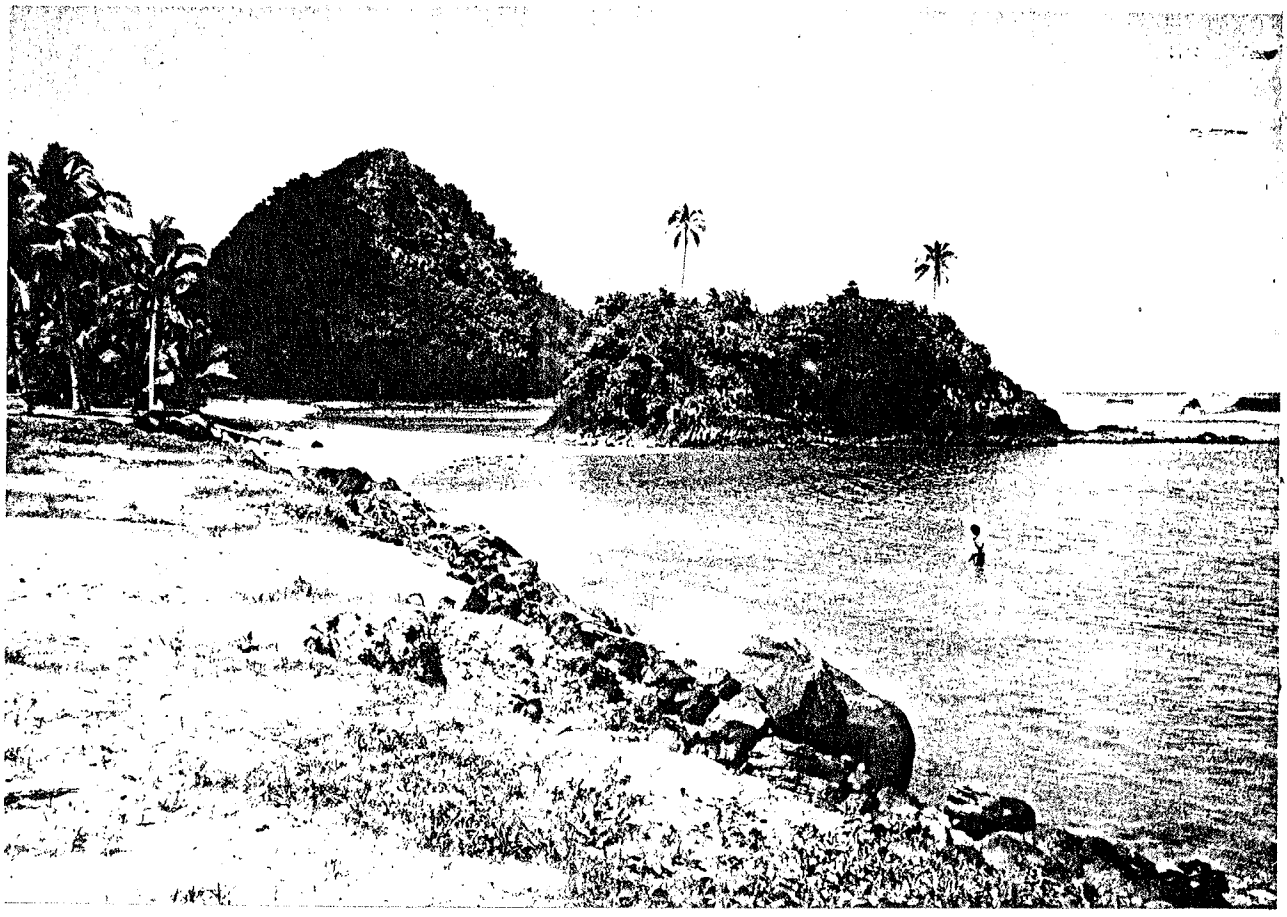


Fig. 48 - Amanave Bay; man fishing for octopus NW of Utusiva Rock at low tide.

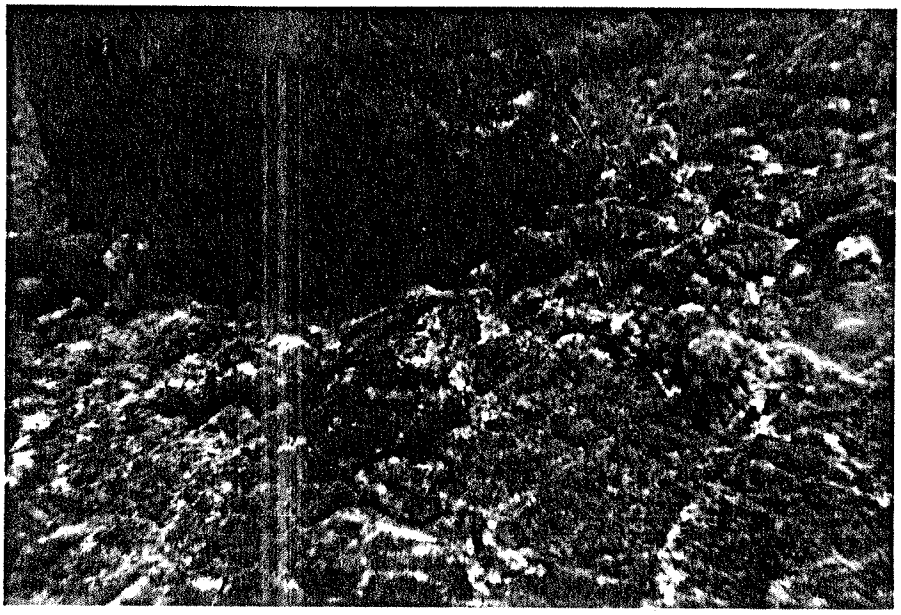


Fig. 1 - Vatia Bay; Transect S, substratum composed of basalt boulders and sand-algal matrix, 9 m off shore.

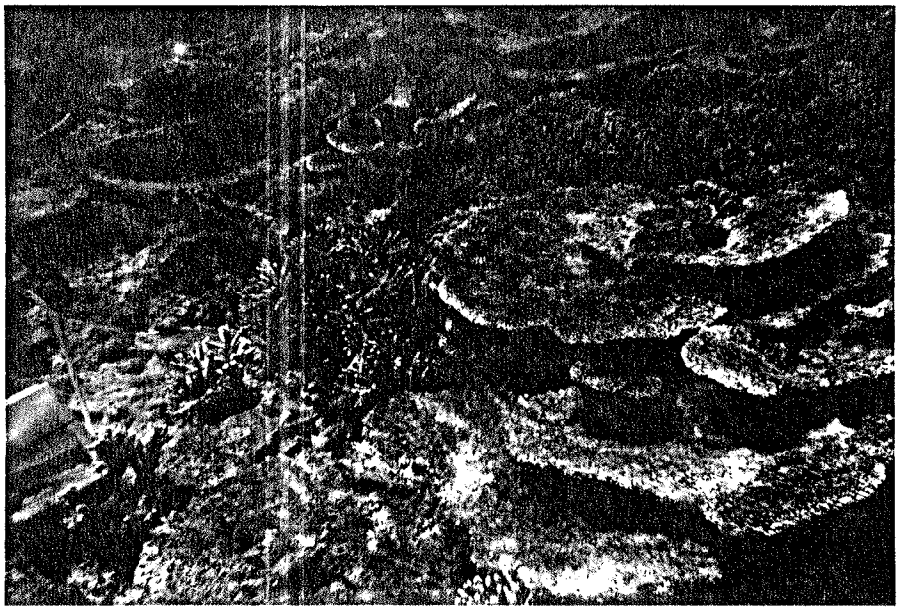


Fig. 2 - Vatia Bay; live and dead coral (mainly Acropora) ca. 60 m off shore on Transect S.

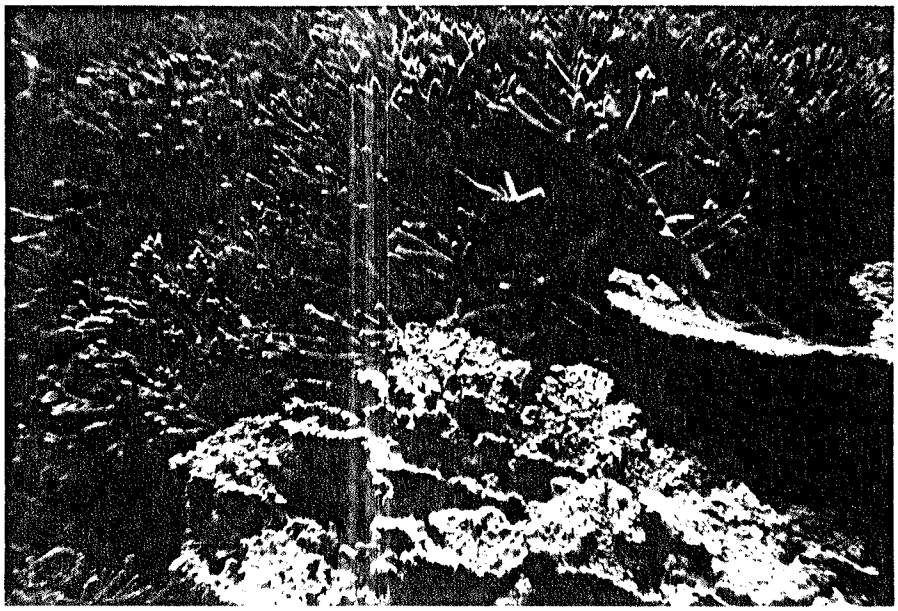


Fig. 3 - Vatia Bay; Acropora samoensis and encrusting nullipores over tabular Acropora (foreground), ca. 60 m off shore along Transect S.

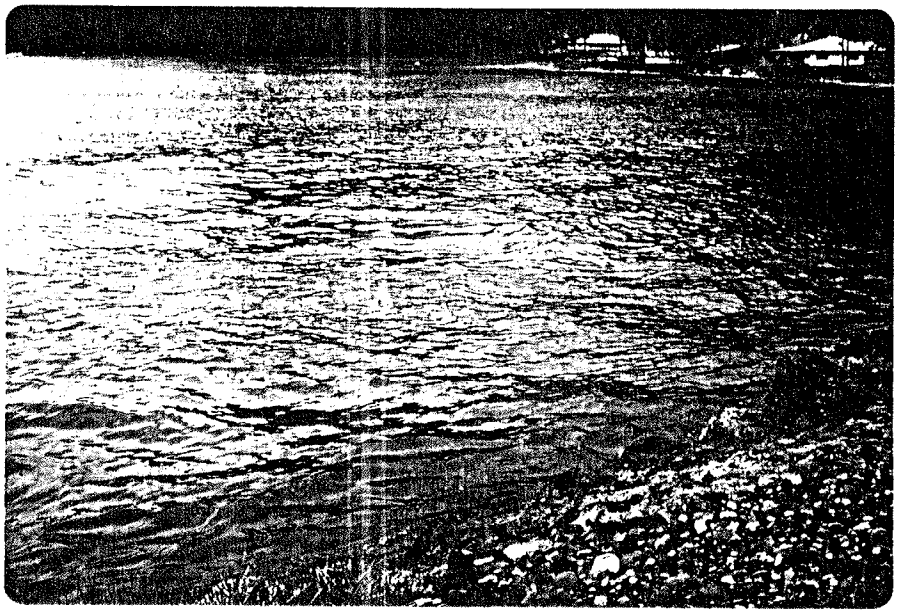


Fig. 4 - Afono Bay; shore between Transects E and W showing spring of freshwater (light brown discoloration) at high tide, 30 April 1974.

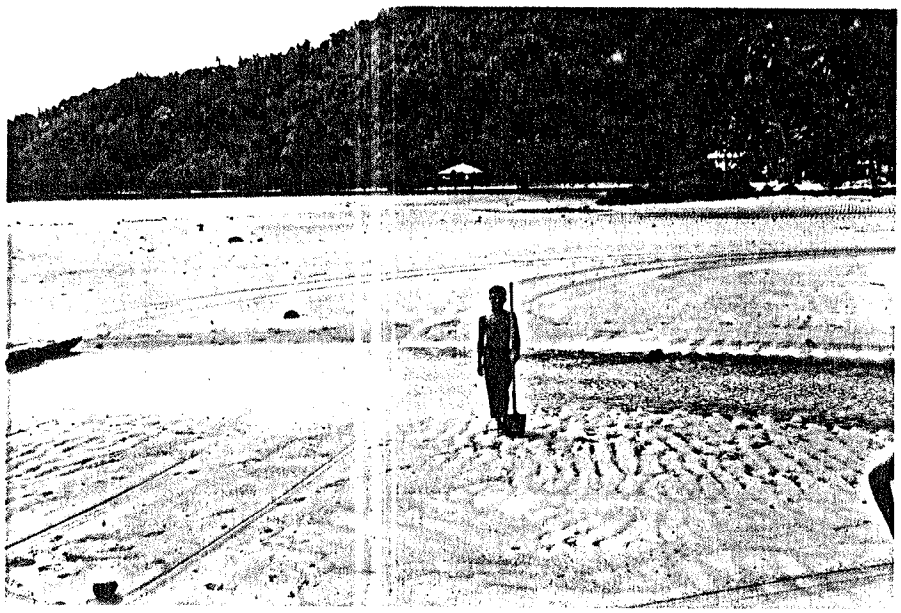


Fig. 5 - Aoa Bay; view towards the east at low tide on 4 May 1974.

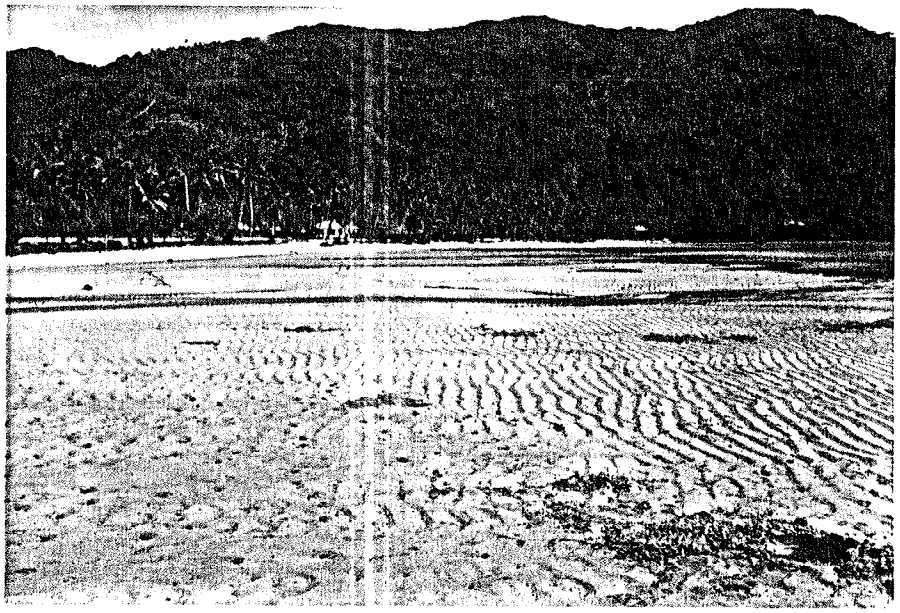


Fig. 6 - Aoa Bay; view towards the west at low tide on 4 May 1974.

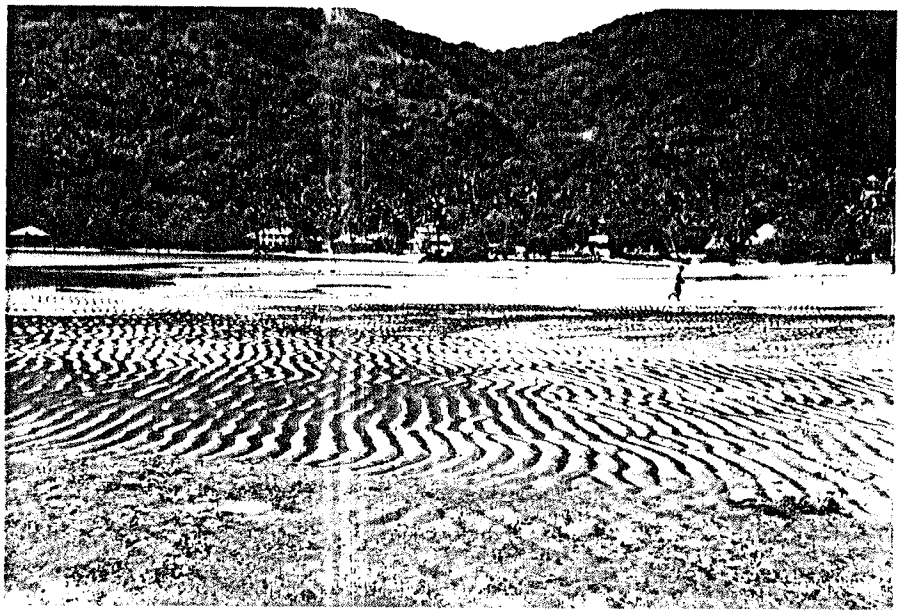


Fig. 7 - Aoa Bay; view towards the east at low tide on 4 May 1974, taken near Transect W ca. 50-60 m off shore.

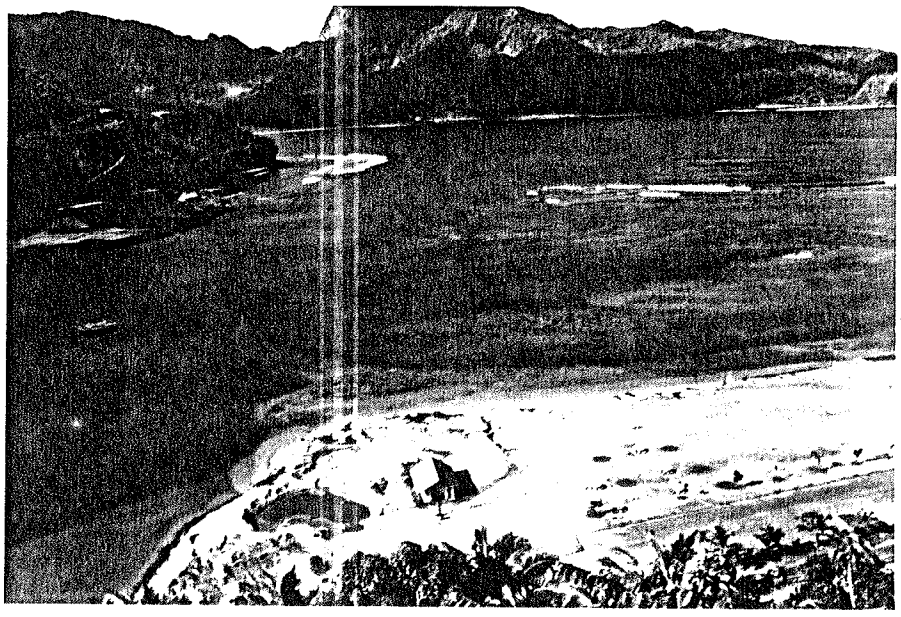


Fig. 8 - Fagaalu; view from hillside off fill area (Fagaalu Park) and dredged sectors of fringing reef.

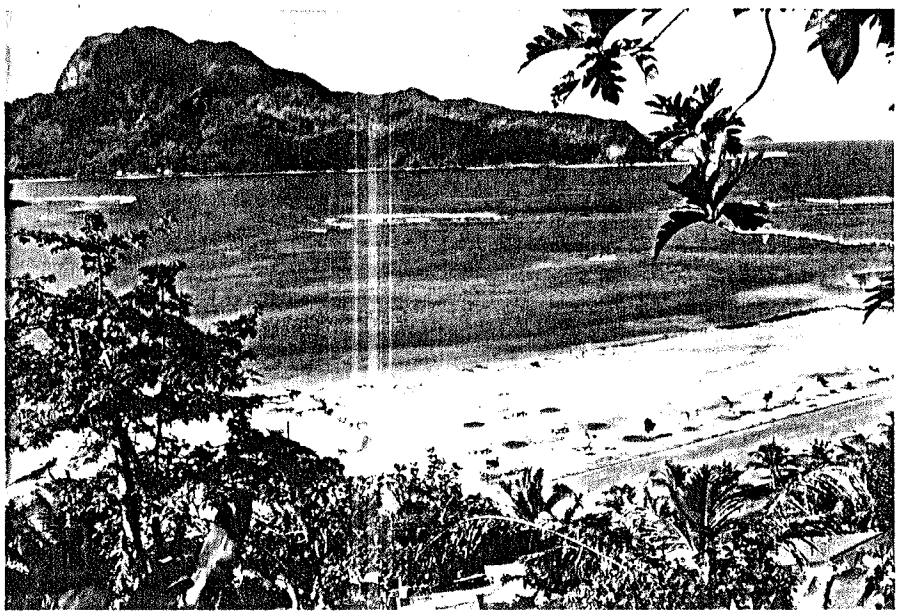


Fig. 9 - Fagaalu; view from hillside of southern end of fill area (Fagaalu Park).

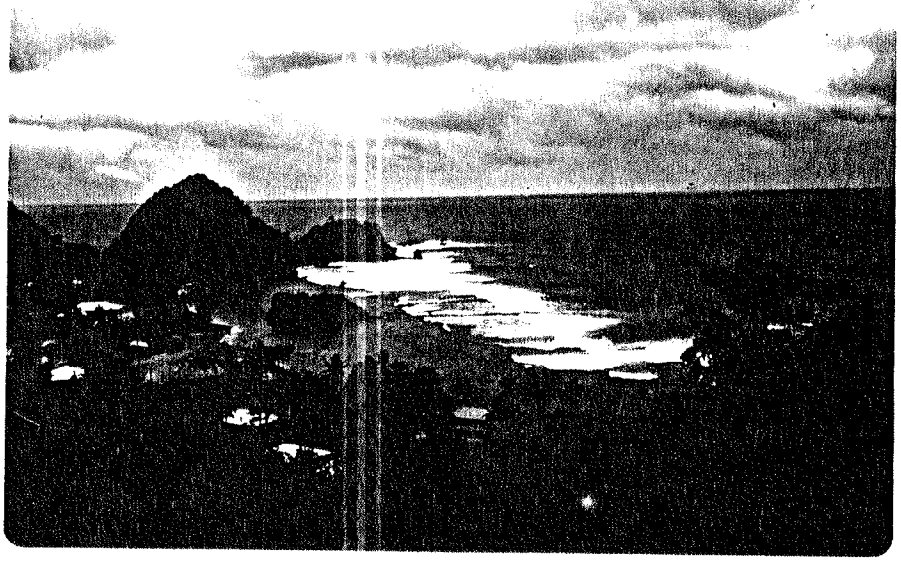


Fig. 10 - Amanave Bay; turbid water evident from brown discoloration NW of Utuseva Rock; some turbidity due to erosion of village land fill.