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TALOFOFO BAY COASTAL SURVEY

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TALOFOFO BAY

COASTAL SURVEY

By

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SPECIFIC AREA REPORT

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INTRODUCTION

BACKGROUND

This is a report on Talofofo Bay and its associated "coastal regions" in the Territory of Guam. "Coastal region" is here defined as the sea and land area bordering the shoreline. It is more or less limited in a seaward direction to the inshore water mass and in a landward direction which would include the beach zone to the top of the first major change encountered in topographical structure.

This report is part of a broader work that includes a study of all the coastal regions on Guam. It is being submitted as a separate and special report, as requested by Mr. Clarence Fujii of the C.O.E. The completion date was the middle of December, 1972, and contains all the findings of the Talofofo Bay study area to that date.

SCOPE OF THE STUDY

The study objectives include a general assessment of the items outlined in the "Preliminary Scope of Work" of the proposal as follows:

a) The major structural elements comprising the environment of Talofofo Bay and its associated coastal region.

b) The dominant biological elements comprising the ecosystems of Talofofo Bay and its associated coastal region.

c) The environmental factors of Talofofo Bay and its associated coastal region.

The study began on June 29, 1972, upon receiving the "Notice to Proceed" from the Army Corps of Engineers and for this report, terminated on December 20, 1972.

SECTION II

THE PHYSICAL ENVIRONMENT

GENERAL DESCRIPTION OF THE STUDY AREA

Talofofo Bay is located on the southeast coast of Guam (Figs. 1 and 2) about midway between the southern end of the island and Pago Bay. The main axis of the Bay lies in an east-west direction. The Talofofo River empties into the west end or head of the Bay, while the mouth of the Bay faces the Pacific Ocean. Paicpouc Cove forms a small secondary indentation along the southern shoreline of Talofofo Bay (Fig. 2). The Asalonso River empties into the head of this small secondary bay. Talofofo Bay is 3,200 feet in length and is fairly uniform in width, ranging from 800 feet at the mouth of the Bay to 1,000 feet near the head of the Bay. A narrow limestone reef platform borders the entrance to both Talofofo Bay and Paicpouc Cove and continues along their sides but does not "fringe" across the heads of the two bays. Steep limestone slopes and cliffs border the north and south sides of the Bay. A low alluvial flood plain borders the heads of both Talofofo Bay and Paicpouc Cove.

GEOLOGY

The rock units used in this section are those described and mapped by Tracey et al. (1964) during a geological survey of the island. Figure 4, shows this distribution of rock units around Talofofo Bay and follows those mapped during the geologic survey, except at Malala Point and its associated fringing platforms (Fig. 3). At these locations the limestones are contaminated with numerous inclusions of nonbioclastic material and in this report are mapped with this Agana argillaceous member (QTma) of the Mariana formation.

Mariana Limestone Formation

This formation forms a broad belt of limestone along the eastern side of southern Guam. At Talofofo Bay it uncomformably overlies older limestones or volcanic rocks of the Alutom formation (Tracey et al., 1964). Even though the Talofofo River valley cuts through the Mariana limestone, the basal part of the formation is not exposed in the vicinity of Talofofo Bay. The limestone is Pleistocene and Pliocene (Tertiary h) in age, according to Tracey et al. (1964). Although all the limestone around Talofofo Bay is mapped as that of the Mariana formation, the lower terraces may be capped with younger limestones that were deposited contemporaneously with the formation of the steplike terraces found on both sides of the Bay.

The Mariana limestones of Guam consist of two members: the Mariana member which is relatively free of clay and volcanic contaminate and the Agana argillaceous member, both of which are present around the Talofofo Bay region (Fig. 3). The Mariana member was subdivided by Tracey et al. (1964) into four facies. The only facies present at Talofofo Bay region is the reef facies (QTmr). The Agana argillaceous member (QTma) was subdivided into facies in the field by Tracey et al. (1964), but were not mapped.

Mariana Limestone Member (Reef Facies QTmr) - Figure 3 shows the distribution of this facies around Talofofo Bay. The lithology is similar, except for recrystallization, to that found in the limestones of the reef margins on the present fringing reef platforms along both sides of the mouth of Talofofo Bay. The limestone is composed principally of framework corals, similar in generic composition to those found living on the present reef. The corals are in position of growth and well cemented into a rather compact mass by crustose coralline algae and other carbonate secreting organisms. The upper margin and face of the cliff, bordering the southeast side of Paicpouc Cove, are exceptionally dense and recrystallized. The face of the cliff is generally cut by large joints and fissures. The upper surface of the limestone is greatly solution-pitted and irregular in relief.

Agana Argillaceous Member (QTma) - Distribution of this member (QTma) is shown on Fig. 3 and is much more extensive than the reef facies (QTmr) of the Mariana member. It forms the bluffs along the north side of Talofofo Bay and those along the south side from the Asalonso River to the Talofofo River. The limestone is yellowish tan to light brown in color. The bluff along the north side of the Bay is composed of fossiliferous detrital limestone, yellowish to brown in color. A good example of this detrital form is found on the north side of the Bay, where a roadcut (Route 4, Fig. 3) has exposed a vertical section. Another good exposure is found along the cliffs which border the north side of the Talofofo River mouth near the bridge. The north shore of Talofofo Bay is composed of steep slopes and cliffs that are cut by large cracks, joints, and fissures. The vertical faces of the above structures are compact and recrystallized. Sea caves are common features in the cliff faces which border the Talofofo Bay shoreline. Features of the south shore are similar to those described for the north shore except for the lower elevation of the cliffline which has been displaced vertically by the Santa Rita- Talofofo River valley fault zone.

Tentatively included in the Agana argillaceous member (QTma) is the fringing bay platform located along the southeast side of Paicpouc Cove, the fringing reef platform flanking the south side of the mouth of Talofofo Bay, and the six and twelve foot raised limestone/terraces located at Paicpouc Point. A conspicuous feature of both the present sea level platforms and elevated terraces is the presence of, what appears to be, secondarily deposited brown-colored aggregations (Fig. 4). The deposits are in the form of irregular shaped nodules and tabular sheets which fill the joints and cracks in the limestone. The brown deposits are mostly noncalcareous with boundaries sharply defined within the general limestone matrix which is lithologically similar to that described for the Mariana reef facies (QTmr). The deposits are more resistant to erosion and stand out in relief, a few inches to a foot or more, from the general surface of the fringing platforms or elevated terraces (Fig. 4). The presence of these nodules standing out in relief indicates that the reef flat platforms are being eroded and truncated by various factors associated with the present sea stand.

There is some evidence of local growth along the margin of the fringing bay platform near the mouth of Talofofo Bay as some corals and calcareous algae are found there. Overhanging submarine walls found at the margin of the fringing bay platforms along the outer seaward regions could be interpreted as either growth, or the undercut walls could have been associated with, and cut during, a lower sea stand. This is especially true for the -60 foot sea stand which is where the overhanging walls are most prominent.

Alluvium (Qal)

The Talofofo and Asalonso River valleys contain deposits of alluvial clay. Exposures of this clay can be seen along the cut banks of the Talofofo River. Where the floodplain consists of marsh and swamp land the clay contains considerable organic matter and forms a dark colored muck. Borings made by the Pacific Islands Engineers in the Talofofo valley floor show an alluvial thickness at Talofofo Bay of 219 feet and two miles upstream from the Bay, a thickness of 118 feet (Tracey *et al.*, 1964). Near the mouth, the Talofofo River floodplain is about five feet in altitude and that of the Asalonso River is generally less than three feet at the mouth.

Beach Deposits (Qrb)

Beach deposits form a narrow band along the heads of both Talofofo Bay and Paicpouc Cove. These deposits are predominantly of volcanic origin but in most places contain a small fraction of bioclastic material. Emery (1962) analyzed the beach deposits of Talofofo Bay and reported the following characteristics: 1) insoluble volcanic residue - 91.0%, 2) median grain diameter for the high tide sample was .21mm and for the low tide sample .82mm, and 3) Trask sorting coefficient was 1.29 for the high tide sample and 1.86 for the low tide sample.

A conspicuous feature of the beach sands from Paicpouc Cove and to a lesser degree those from Talofofo Bay is the presence of the black mineral, magnetite (Fig. 5).

HYDROLOGY OF THE TALOFOFO RIVER[1/]

The Talofofo River system is the largest in Guam and drains an area of about 21 square miles. The area drained by the system is underlain largely by deeply weathered volcanic rocks and noncalcareous alluvial sediments, Alluvium occupies long stretches of the valley floors of the main part of the river and larger tributaries.

Dense forest vegetation covers the alluvial valley floor and bordering limestone regions. Savanna vegetation consisting of grasses, shrubs, and scattered trees covers the areas underlain by volcanic rocks and noncalcareous sediments.

The Ugum River joins the Talofofo River about 0.5 miles from the Bay. This river drains an area of about seven square miles. The drainage basin of the upper Ugum River is underlain mostly by deeply weathered volcanic rocks. Alluvium underlies the lower stretches of the river. Savanna vegetation covers the volcanic rocks of the upper basin, whereas coconut trees and dense vegetation covers the alluvial lower stretches of the river.

Discharge rates for the two rivers are given in Tables 1 and 2. No gaging station is located below the point where the Ugum and Talofofo Rivers join. Discharge data for the Ugum River was obtained from a gaging station located 0.3 miles upstream from where the two rivers join. Discharge data from the Talofofo River was obtained from a gaging station located just below the confluence of the Maagas and Mahlac Rivers. The total discharge

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[1/]The following discussion of the hydrology of the Talofofo River is taken in part, from the "Military Geology of Guam, Mariana Islands, Water Resources Supplement" (Ward and Brookhart, 1962).

rate for the Talofofo River system is not known because flow rates from the Sarasa and Sagge Rivers are not gauged. These two rivers discharge downstream of the gaging stations, although by combining the discharge rates of the Ugum and Talofofo Rivers an estimate of the total discharge can be obtained for the Talofofo River system where it empties into the Bay. No discharge data is available for the Asalonso River at the head of Paicpouc Cove.

WATER QUALITY

The Guam Water Pollution Control Commission has four water quality sampling stations located at the head of Talofofo Bay. Water sample stations are shown on Fig. 6. Fecal coliform levels are listed for the year of 1972 on Table 3. Two of these stations are located in the Talofofo River and two at the head of Talofofo Bay where high density surfing and swimming activities frequently take place. Most high coliform counts on the river stations occur during periods when the Talofofo River is flooding and turbid. Except during extremely high floodwater stages the polluted river water becomes diluted and mixed with the seawater of Talofofo Bay, which reduces the coliform count to a nonpolluted level below the 200 coliform/100 ml as established by the Guam Water Pollution Control Commission.

The Talofofo estuary was investigated upstream to a point located at the confluence of the Ugum and Talofofo Rivers (Fig. 6). A series of stations were established from the bridge at the river mouth (Sta. 1) to the point of confluence (Sta. 12). Depth of the river at the midstream stations is shown on Table 4 and ranges from 3 meters at the bridge (Sta. 1) to 4 meters at Station 7. Other parameters investigated at each station were: 1) temperature, 2) dissolved oxygen, 3) salinity, 4) total coliform, 5) fecal coliform, 6) sediments, and 7) shore communities. Table 4 summarizes all of the above parameters except 6, 7. River studies and sampling was conducted first on September 7, 1972, after a period of heavy rainfall and turbid floodwater conditions, and a second time on October 3, 1972, during a period of normal river flow and little water turbidity.

Water temperature was taken at the surface and one foot above the stream floor. The surface water temperature was cooler than the bottom water at all stations on October 3, 1972, during normal flow and low turbid conditions. The average difference in temperature between the surface and bottom water layer was .9°C. Salinity results show (Table 4) that the river water was well stratified flowing over a layer of quite saline seawater. The temperature difference between the upper and lower water layers is due to the presence of the two distinct water regimes. During floodwater conditions the water temperature was nearly the same for the surface and bottom water samples. This would be expected, as salinity data on Table 4 shows that a well stratified layer of riverwater floating on the surface of saline water was absent, except at Station 1B, at the river mouth, and Station 4B and 7B where deep water pockets of residual seawater were trapped on the river floor. Table 4 indicates that with normal (nonfloodwater) flow conditions a saline interface extends beyond Station 12.

Oxygen studies show that the fresh water lens is higher in dissolved oxygen than the seawater lens. Very low values were obtained for the deep water pockets of saline water at Stations 4B and 7B.

Total coliform bacteria counts (Table 4) were too numerous to count on September 7, 1972, during floodwater conditions at all stations. Normal river flow conditions on October 3, 1972, gave high counts for the surface water and relatively low counts for the bottom saline lens. Fecal coliform counts were high in both the surface and bottom samples during floodwater conditions on September 7, 1972. On October 3, 1972, all stations except 3S had counts within the nonpollution limits of 200 counts/100 ml, as established by the Guam Water Pollution Control Commission. Fecal coliform counts were especially low for the saline water layer during this period. Using the pollution cut-off limit of 200 counts of fecal coliform/100 ml, as an index, the data indicate that during flood conditions the river waters are generally polluted and during normal flow periods are generally nonpolluted.

SEISMIC SEA WAVES (TSUNAMIS)

The following information regarding tsunamis was condensed from Tracey et al. (1959, pp. 106-107).

The only recorded tsunami causing damage to Guam was associated with the earthquake of January, 1849. According to Repetti (1939) this earthquake generated a wave which entered Talofofo Bay and carried out to sea a woman walking along the coastal road. The approximate seiche (natural period of resonance) for Talofofo Bay is 7 3/4 minutes. Tsunamis are reported to have periods of ten minutes to one hour which is close to the natural period of resonance for Talofofo Bay. It is possible that large tsunamis with a period close to the natural resonance of Talofofo Bay could generate destructive waves.

SECTION III

BIOTOPE DESCRIPTIONS

INTRODUCTION

In this report, the dominant benthic and other inshore, shallow water organisms are discussed within the modified framework of an ecological unit, the biotope (Hesse et al., 1951). The biotope concept normally "embraces the entire complex of habitat conditions in the area defined, including substrate accretional and erosional processes, hydrologic factors, and life associations" (Cloud, 1959, p. 374). The biotope descriptions included in this report are by no means complete, for it is impossible to acquire all or even a major part of the complex parameters which make up this ecological unit within the time frame of this report. The major objective of the descriptions is to provide a basic framework on which future data can be added. Wherever distinct differences in physical and biological parameters were observed within the larger biotope unit, the biotope was subdivided into smaller ecological divisions called "facies" (Cloud, 1959). Tables were prepared which lists the organisms occurring in each biotope and its facies.

BIOTOPE 1 (Fringing Reef Platforms)

This biotope consists of the fringing reef platforms which flank both sides of the mouth of Talofofo Bay (Fig. 7). It is separated from the fringing bay platforms (Biotope 2) because its developmental, physical, and biological features are related more to the oceanic setting than to those of the Talofofo Bay and River. The biotope is subdivided into four facies as follows: Facies A - the seaward facing margin of the platform, a region commonly referred to as the reef margin zone; Facies B - the reef platform proper, extending from the reef margin shoreward to the intertidal zone, a region commonly referred as the reef flat; Facies C - the intertidal zone, including the cut "nips" and patches of supratidal limestone found scattered over the inner third of the platform; Facies D - a series of elevated rimmed terraces located at the seaward edge of the platform flanking the south side of the Talofofo Bay channel.

As previously discussed, in the geology section, the region appears, for the most part, to be a truncated platform. It is cut, at the present sea level, into limestone that was deposited at an earlier time and is not contiguous with the limestone deposition, if any, that may now be taking place at the reef margin (Facies A). Other evidence for it being a truncated platform is the presence of numerous brown-colored nodules of a noncalcareous material which stand out in erosional relief against the limestone matrix containing them (Fig. 4). The narrow band of limestone deposited by the present reef margin complex lacks these nodules. In most places the reef platforms contain these inbedded nodules right out to the reef margin (Fig. 4).

The biotope is physically divided by Talofofo Bay into a north and south platform. Width of the two platforms ranges from 150 to 200 feet for the south and 75 to 150 feet for the north. Structurally the south platform is more complicated than that of the north. The south platform is divided into two sections (A and B) by a small local fault (Fig. 8). The section nearest the channel, (A) is lower in respect to that located to the south, (B). The fault line is marked by several rimmed terraces (Fig. 8) that cut across the fringing platform at right angles.

Biologically this biotope has the greatest species diversity (Table 5).

Facies A (Reef Margin Zone)

This facies is least affected by freshwater and silt from the Talofofo River system than any other part of the study area. There is little difference between the reef margin communities found on these platforms, adjacent to the Bay mouth, and some of those located along other parts of the windward exposed coast of Guam, away from the influence of river mouths. The reef margin is constantly awash, even during times of lowest tides and calm seas. Communities, in this zone, are well adjusted to conditions of turbulent surf and strong wave action, although during typhoons a considerable amount of reef margin coral and calcareous algae is broken loose and worked shoreward over the reef platforms.

Platform A - The margin of Platform A is cut by long shallow-floored surge channels (Fig. 9). The channels on this part of the platform appear to be erosional features related to structural joints, cracks and slump zones found in the limestone platform of Facies B.

The walls and floors of the surge channels are covered with widely scattered corals, calcareous algae of both crustose and articulated forms, and a wide variety of fleshy benthic algae. Both species density and diversity decrease as the Talofofo Bay margin is approached. *Porolithon gardineri*, a crustose branching coralline alga, forms conspicuous rounded clumps in this zone which together with *Porolithon onkodes*, a crustose encrusting coralline alga, form the dominant community covering the floors and walls of the surge channels. These two coralline algae also give the reef margin its characteristic pink color when it is exposed during wave swells. Beneath the rounded clumps of calcareous algae are cavernous regions, containing clusters of elongated bivalves; red, pink, and white patches of encrusting foraminifers; and numerous small crabs, shrimp, and amphipods. In small cavities and holes snake head cowries, Cypraea caputserpentis, and Conus distans were observed. Several slate-pencil sea urchins, Heterocentrotus trigonarius, were found in cracks and cavities. A brown-colored holothurian, Actinopyga, is very common in this zone. This holothurian is adapted to rough water habitats by the presence of numerous tube feet used for attachment. Considerable force is required to remove them from the reef surface. Large greenish brown gastropods, Turbo setosus were also fairly common in the wave washed margin. On the upper surface of the elongate ridges, which are periodically exposed to the air, limpets and barnacles were fairly common. In regions where fleshy benthic algae is common, numerous rock snails of the genus Drupa were attached tightly to the reef surface. A common fish, observed in the turbulent surf, is Acanthurus guttatus.

Common corals observed in this zone are pink and brown colonies of stoutly branched Pocillopora, various ramose forms of Acropora, encrusting patches of Montipora and Porites, yellowish plates of Millepora, and rounded massive colonies of Favia, Favites, and Goniastrea. A dark grey zoanthid, Palythoa sp., with bright green peristomes encrusts several square meters of reef surface at several locations along the inner shoreward part of the facies.

Platform B - The margin of Platform B (Fig. 10) lacks surge channels and forms the steep wave washed seaward face of Facies D, which is described later.

Platform C - The margin of Platform C (Figs. 11 and 12), located on the north side of Talofofo Bay (Fig. 7), is very similar in most aspects to the margin of Platform A except as follows: 1) the surge channels are better developed in that they show more signs of growth rather than erosional features, and 2) a more diverse and dense coverage of both corals and calcareous algae is found there.

Facies B (Fringing Reef Flat Zone)

This facies consists of the broad reef flat platforms located between the wave washed reef margin (Facies A) and the intertidal zone (Facies C). During low tides and calm seas the region is exposed and hence the communities are quite different from those of the reef margin.

Platform A - The surface of Platform A is a flat pavement which is patterned at low tide by rimmed terrace pools (Fig. 13). The rimmed pools are shallow and superficial along the Bay margin and reef margin zone, ranging from two or three inches to less than a foot in depth. The rimmed pools increase in depth in a shoreward direction. Depth in those pools range from six inches to nearly two feet in some of the larger ones. The rimmed pools trap water during low tides, which is heated if the tide is correlated with a bright sunny day. Water trapped in these pools may also be diluted with freshwater during periods when heavy rains coincide with the low tides. On several occasions the shallower pools near the Talofofo Bay margin were observed with dead or dying fish as well as other benthic organisms because of temperature increase and dissolved oxygen depletion in the trapped water (Fig. 14). The floor of these pools are irregular and many contain rounded boulders, coarse sand, and gravel. In nearly all the pools with unconsolidated sediments a reducing environment was encountered, generally less than an inch below the surface.

A zone of coral microatolls is located along the inner third of the platform in some of the deeper rimmed terrace pools (Fig. 8). Only two species are found, Porites lutea and Porites compressa. The microatolls of these two species grow upward to the low tide level of the pooled terrace water and then spread horizontally. Several pools are nearly filled with these microatoll colonies which increase in diameter by horizontal growth and subsequent coalescence. This coral growth on the reef platform was probably initiated by down faulting, which creates a new environment favorable for coral growth. Within a relatively short period of time, though, these coral colonies will probably fill in most of the available rimmed pool space and build a new platform level adjusted to the present sea level. Other organisms inhabiting the rimmed pools are holothurians such as: Holothuria atra, Actinopyga mauritiana, Stichopus cloronotus, Holothuria argus; echinoids are fairly common, especially Echinothrix diadema; gastropods are represented by various Conus species, numerous small high spired Cerithium sp., and money cowries, Cypraea moneta; the coral microatolls have numerous vermetid molluscs embedded within the coral skeleton; and most pools have clumps of dark green Halimeda opuntia and Sargassum polycystum growing in them. Growth of algae is much more pronounced on the terraced pool rims (Fig. 15) than on the pool floors. Common algae growing on these rims is Dictyosphaeria, Boodlea, Sargassum, Gelidiella, Padina, and Jania along the outer seaward half of the platform.

A considerable amount of organic debris, in the form of bamboo canes, palm fronds and nuts, Phragmites canes, and roots, accumulates on the platform (Fig. 16) and in the rimmed pools. Most of this debris originates from the floodwaters of the Talofofo and Asalonso Rivers after periods of heavy rainfall.

Platform B - Platform B is bounded by a series of terraces where it borders Platform A (Fig. 8) on the north. On the south side another small local fault has lowered the general level of the platform beyond the study area. This boundary, like that on the north side, is marked by a series of rimmed terraces which cut across the fringing reef platform at right angles (Fig. 17). Along the seaward margin, the platform is elevated into an elongate series of step-like terraced pools (Fig. 18, Facies D). This series is as much as one meter above the general level of the main body of the platform behind it. At low tide the entire platform forms a single large pool (Figs. 8 and 18). The large pool in turn is subdivided by a network of numerous terrace rims. The upper surface of these terrace rims are slightly submerged, which is rather unique because a prerequisite for rim formation, at least here on Guam, seems to be the presence of an elevated platform which is exposed, during low tide, and periodically inundated by wave wash. Local downfaulting on both sides of Platform B has probably caused the development of the elongate terraced rims along the faultlines where water spills over to the lower levels. The series of terraces along the seaward margin of the platform (Facies D) along with the above terrace development along the sides has formed the boundary of the large pool on Platform B (Figs. 8 and 18) and has subsequently, slightly submerged the more slowly developing rims over the main body of the platform.

The banded horn shell, Cerithium bacticum forms the most conspicuous community found on the platform. These colorful molluscs are scattered over the entire platform surface and at the seaward margin are concentrated into a long sinuous band (Figs. 19 and 20) by the sweeping motion of waves that break over the elevated terraces located there (Facies D). Density of the gastropod population was measured at five random points across the platform. In a shore to seaward sequence the Cerithium density was found to be 24, 28, 17, 6, and 17 per 100 cm^2.

Other common gastropods observed were cones such as: Conus flavidus, C. miliaris, C. ebraeus, C. catus, C. rattus, C. chaldaeus, and C. ceylanensis on the rimmed pool floors, a few scattered drupes on the upper margins of the pool rims; on the undersides of loose boulders in the pools were a few money cowries, Cypraea moneta, and tritons of the genus Cymatium; and in the pool floor sediments several miters were found. A few corals are located in some of the deeper pools near the shoreline but they are not as abundant as those found on Platform A.

Benthic algae is more abundant on Platform B than on Platform A. A nodular yellow to pink colored encrusting coralline is the dominant alga in pool floors and rims near the outer seaward margin. Cladophora occurs in long strands and is the most conspicuous alga along the inner half of the platform. Short strands of the seasonal alga, Sargassum polycystum, are beginning to grow on the pool rims now, and will later form long leafy thalli replacing the Cladophora as the most conspicuous alga.

Table 6 lists the most common algae from Transects 1 and 2 for Biotope 1 and gives the relative abundance of each. Figure 21 shows the locations for these two transects.

Platform C - The fringing platform on the north side of Talofofo Bay (Platform C) is fairly similar biologically and structurally to those on the south side (Platforms A and B). A small fault, similar to the one described for the south platform, has lowered a narrow section along the bay margin about one foot in respect to the remainder of the platform (Fig. 22). The platform surface is relatively flat but contains several large pools (Fig. 23), remnant knobs of raised limestone along the shoreward border, numerous small knobs of brown-colored nodules imbedded in the limestone, and near the Bay margin some very superficial terrace rims are visible (Fig. 24). Along this side of Talofofo Bay the platform receives less wave attack than the corresponding south side because the predominating direction of swells and sea is from the northeast.

Several surge channels terminate on the platform into pools about one meter in depth. These pools possess coral colonies of Favia, Pocillopora, Goniastrea, Porites, Favites, and Acropora. A dense stand Caulerpa racemosa forms large mats among the coral colonies. The development and surface coverage of Porolithon gardineri and Porolithon onkodes is greater here than that found on the southern platforms (A and B).

This platform, like those on the south side of the Bay, appears to be cut into limestone that is not contiguous in development with that which is presently taking place at the reef margin.

Facies C (Intertidal zone)

This facies is located in the intertidal region which borders the shoreward part of platforms A, B, and C. It consists of scattered knobs and pinnacles of remnant limestone found along the inner third of the reef flat platform, concave shaped "nips" cut into the raised limestone (Fig. 25) and limestone blocks and rubble which have accumulated at the base of shoreline cliffs (Fig. 26). At places a limpet-nerite-chiton community forms the most conspicuous organisms in the above intertidal regions. This gastropod community is discussed in more detail in the section covering the "nips" of Biotope 2. Along Platform B the banded horn snail, Cerithium bacticum, is quite abundant (24 per 100 cm^2) at the base of the "nip" (Fig. 20). Grapsid crabs were observed scuttling over the rocky shorelines of all three platforms. Antithamnion sp. 1, forms a yellowish-brown band of alga located just above the mean high tide line on the rocky surfaces of this zone. Another common filamentous alga of this region is, Champia parvula, which forms a dark reddish-brown band, located just above the mean low tide line. Ralfsia forms a dark brown encrustation on the basal regions of the "nips".

Drift debris consisting of bamboo and Phragmites canes; fruits of Cocos, Nypa, and Pandanus; and tree roots and other plant material lodge in this zone on both sides of Talofofo Bay (Fig. 26). Amphipod populations are abundant in the damp regions of the drift debris.

The development of cut "nips" at the base of the six-and ten-foot raised limestone terraces is not as well developed on the seaward facing platforms as those bordering Talofofo Bay (Biotope 2, Facies B). Limpet density is lower in the "nips" bordering Platform B than at any other region. Since Platform B is at a higher elevation than the others, it may receive less wave splash and spray, thus, reducing the limpet population there.

Facies D (Reef Margin Terraced Pools)

This facies consists of a series of elongated rimmed terrace pools located on the outer reef margin of Platform B (Figs. 18 and 27). The upper series of terraces is about one meter in elevation above the general level of the reef flat platforms. The seaward margin of the terraces (Fig. 10) is steep-faced and lacks surge channels. Brown nodules stand out in relief on the upper surface (Fig. 4) and at several places large sections of the terrace have slumped away (Fig. 28). Waves break over the upper surfaces of the terraces, even during periods of relatively calm seas. Figure 9 shows the step-like arrangement of the terraced pools at the north end of the facies. Water depth in the pools range from a few inches to about a foot.

Since the terraces are constantly inundated by wave sets it is a region rich in algal development, especially on the upper and outer margins of the terraced pool rims (Table 5 and Fig. 9). Gilidiella acerosa is the dominant alga on the upper seaward face of the terraces (Fig. 10). Other algae associated with it are Mastophora, Dictyosphaeria, Polyopes, and Jania. The lower seaward face is dominated by encrusting and articulated "corallines" such as: Porolithon onkodes, Porolithon gardineri, Amphiroa fragilissima, Corallina sp., and Cheilosporum multifidium. The upper surface of the terraced pools and rims and shoreward facing part of the facies is dominated by Cladophora, Cladophoropsis, Laurencia, Dictyosphaeria, Porolithon (in pool floors), Sphacelaria, Ectocarpus, Gracilaria, and Jania. Table 6 (Transect 1) lists the dominant algae encountered on a transect which runs across the top of this facies (Fig. 21), parallel to its seaward margin.

The shoreward facing terraced rims are usually concave where they drop downward from one level to another (Fig. 29)--Limpets and chitons are common on these concave faces. Transect 3 (Fig. 21 and Table 7) gives the limpet distribution on the shoreward facing concave face of a large terraced rim (Fig. 29). Grapsid crabs are abundant on the seaward face of the terraces and numerous gastropods are found in the terraced pool floors and rims (Table 5). One coral colony, Porites lutea, was found on the floor of a pool located near the seaward margin where wave wash is more vigorous. A few holothurians, Actinopyga mauritiana were found tightly attached to the margin and floor of pools located at the shoreward side of the facies.

BIOTOPE 2 (Fringing Channel Platforms)

This biotope consists of the intertidal (littoral) platforms which border most of the shoreline at Talofofo Bay. The unconsolidated sand, at the head of the Talofofo Bay and Paicpouc Cove, (Biotope 5) are the only places where this habitat is not represented along the shoreline of the study area. Figure 7 shows the distribution of this biotope at Talofofo Bay. This biotope is divided into two facies, A and B. Facies A (Fig. 30) is the upper surface of the platform proper extending from the Bay margin to the shoreline. Facies B (Fig. 31) is the intertidal "nip" or concave-shaped notch that is cut into the shore where emergent limestone borders the platform.

Facies A (Fringing Platforms)

At most places the platforms are periodically exposed during low tides, although during conditions of high surf they may be awash at times of lower tides. During high tides the platforms are covered by 1.0 to 1.5 feet of water. Some variation occurs in the elevation of the platforms due to orientation to the prevailing ocean swell that enters the Bay mouth, local faulting, and slumping. Paicpouc Point in particular receives the predominant NE swell from the Bay mouth and is elevated in a series of rimmed terraces, to about 1.5 meters (Fig. 32) above the fringing platforms on each side.

The width of the fringing platforms is not uniform and ranges from 10 feet at the seaward exposed sections on both sides of the Bay mouth (Fig. 30) to 50 feet in width near the middle part of the Bay. The outer margin of the platforms is very irregular in outline (Fig. 30) and terminates abruptly forming vertical to overhanging submarine cliffs (Biotope 3). At some locations the platform margin is honeycombed with subterranean holes and cavities which connect with deeper parts of the platform face (Fig. 33). At other locations the margin is rather dense and solid (Figs. 30 and 34). Slumping (Fig. 30) is evident along many parts of the platform margin which contributes much to its irregularity. At most places the surface of the platforms are relatively flat with most irregularities being in the form of cracks, pools, small potholes, terraced pool rims, and remnant pinnacles of emergent limestone near the shore. Most cracks and joints on the platform surface are contiguous with, related to, and aligned with those present in the raised limestone bordering the shore. The larger platform pools and holes contain rounded boulders and coarse sand and gravel. The platforms bordering the southern part of Talofofo Bay are narrower and less well developed than those found along the northern border and in Paicpouc Cove (Fig. 7).

Biologically the platforms are rather barren because of periodic exposure during low tides and freshwater dilution and silt accumulation from the

Talofofo and Asalonso Rivers. A fine layer of silt commonly covers the surface of the platform, especially the regions located near the river mouths. The main channel of the Talofofo River sweeps by the inner part of the north shore platform and the silt load there is considerably greater than at other parts of the Bay. Table 5 lists the organisms from each facies unit.

There is an increase in species diversity and abundance of benthic organisms in a seaward direction along the fringing platforms (toward the Bay's mouth). These increases can be correlated with the diminishing effects due to exposure at low tide and freshwater dilution and siltation from the rivers as one progresses in a seaward direction along the platforms.

The platform surface of Facies A is conspicuously barren at many places except for scattered patches of filamentous algae which forms a mat of hair-like turf about one-quarter inch in height. The algal turf traps and holds much of the yellowish-brown silt, originating from the rivers, and gives the platform its characteristic color. Several transects were run (Fig. 21) on the platforms to determine the abundance of some of the dominant species of algae. Table 6 tabulates these data. A particular rich stand of algae was present on the elevated rimmed terraces at Paicpouc Point. Where the platforms receive a considerable amount of wave wash a dense stand of <u>Enteromorpha</u> forms a bright green mat. Platform pools have abundant growths of <u>Cladophora</u> in them, which forms long filamentous strands, sometimes reaching a meter or more in length.

Small fishes are fairly common in the holes, cracks, and pools on the platforms especially on the north side of the Bay. Transient fishes were observed moving onto the platforms and feeding during high tides.

Corals are absent in this region even though some of the larger pools are connected to the submarine portions of the platform face via cavernous cracks and holes. At Paicpouc Cove on the southeast shore several pools possess dead coralla that appear to have died very recently.

One of the most consistent communities on the Facies A platform was the presence of a small sea anemone. A specimen of this anemone was sent to Dr. Schmitt, of Heidelberg University, Germany, for identification. At times when the platforms are exposed during low tide the anemones tightly constrict the oral disc and tentacular ring into a small rounded dome. Presumably this traps water in the coelenteron and allows the animal to survive for the period of time that the platform is exposed to air. This anemone community was most common on the platforms along both sides of Paicpouc Cove. Size ranged upward to two cm in diameter when the oral disc was in the expanded condition.

Facies B (Intertidal Raised Limestone)

Wherever the fringing Bay platform is bordered on the shoreward side by a zone of raised limestone, a concave-shaped "nip" (Facies B) is generally cut into the rock at its basal part (Figs. 31, 34, and 35). The basal part of the nip is usually located at the same level as the fringing platform but the deepest cut part is generally located somewhat above the reef flat platforms depending upon the nip location in respect to ocean swell and wave action. The sea level nip is particularly well developed along both sides of Paicpouc Cove and the seaward two-thirds of the platform located between the head of Talofofo Bay to Paicpouc Point. The northern platforms have sea level nip development but are much reduced in respect to those found on the southern platforms. The most distinctive organism found in the nip is a limpet population (Fig. 36). Seven transects were established (Fig. 21) to determine the density (Table 7) of these limpet populations at various locations on the fringing platforms. The transects start at the seaward margin of the platform, where the first occurrence of limpets is found and continue in a shoreward direction to the upper ceiling of the nip. Each transect consists of a continuous strip of quadrat grids, each 25 cm on a side. Table 7 lists the data from the seven transects. In most cases the greatest density of limpets was found to be located between the basal part and the deepest cut section of the nip (Table 7). At three transect stations (5, 6, and 7) the average size of the limpets were determined. Size of limpets seem to be related to the amount of wave wash that is present. Limpets are larger at Transects 7 and 3, which receive more wave and surf action, than those at the other transect locations receiving less water movement. Nerites are associated with the limpet communities (Fig. 36) but are usually much less abundant except at the head of small embayments located along the channel where they form concentrated aggregations.

A few chitons were observed in the deepest cut part of the "nips". Grapsid crabs were found along most of the intertidal areas, especially, where boulder rubble and wave washed rimmed terraces are present.

BIOTOPE 3 (Submarine Cliffs)

Biotope 3 consists of the vertical and overhanging submarine cliffs located along the outer margin of the fringing platforms of Biotope 2 (Fig. 7). This region was investigated only briefly during the study period because of turbid water conditions, but it was observed on several occasions during the dry seasons of 1970 and 1971.

Several parts of the cliffs are overhanging forming semicavernous conditions. These overhanging walls probably represent nips and sea caves that developed subaerially during a former sea stand when the sea level was much lower. Another possible explanation for the overhanging cliffs is that they are developmental and were formed by the outward growth of corals and calcareous algae along the upper well-lighted margin of the fringing platforms. There is little evidence for developmental formation, at the present time, as coral and calcareous algae growth is very limited along the upper margin of the cliffs. Exceptions to this may be found near the mouth of the Bay where the submarine channel cuts through a living coral reef. Large angular blocks of limestone are found along the base of the cliffs. These blocks are the result of slumping along the submarine cliff face and contribute much to the irregularity of the fringing Bay platform margin (Fig. 30).

Species diversity increases toward the mouth of the Bay where the effects of siltation and freshwater dilution of seawater are less. There is considerable water movement along the submerged wall faces, in the form of surge, as swells and large waves enter the mouth of Talofofo Bay and move toward the head of the Bay. This water movement reduces somewhat the accumulation of silt in the region. Corals are absent along the inner two-thirds of the submarine walls. Widely scattered colonies of Montipora, Favia, Favites, Goniopora, Millepora, Porites, Leptastrea, Psammocora, Stylocoeniella, and Pavona were observed along the upper margin of the outer third of the region. Occasional colonies of Euphyllia, Plerogyra, and Goniopora are found at deeper depths.

Red algae (Rhodophyta) is predominant on the cliff faces, especially at deeper depths. Long swaying growths of Antithamnion were conspicuous at places where the wall is overhanging. Cavernous regions have thick accumulations of a calcareous alga (Peyssonelia). The foliaceous growth form of this alga is different from any other in that it forms layers of very thin and fragile, petal-like scales. The multiple layers of this alga in several places, form vesicular masses up to a foot in thickness. Porolithon gardineri forms ramose clumps on the upper margin of the cliff near the mouth of the channel. A few flat-bladed fronds of the green (Chlorophyta) calcareous algae, Udotea, was found attached to the cliff walls in the coral zone.

Some calcareous sponges, Astrosclera willeyana, were observed on the ceilings of caves. Several large Gymnothorax eels were observed in holes and cracks along the outer third of the channel. Table 8 lists the organisms found in this biotope.

BIOTOPE 4 (Channel)

Biotope 4 consists of the deeper open water column environments of Talofofo Bay (Facies A) and the Bay floor (Facies B). Figure 37 shows the water depth in Talofofo Bay. A maximum depth of 90 feet was measured at the Bay mouth. Even though the Bay is deep at the seaward end, it shoals rapidly to 15 feet at a point midway between the mouth and head.

Talofofo Bay floor was visually examined at 17 stations (Fig. 37) and at all locations was found to be composed of unconsolidated sediments derived mainly from the Talofofo River drainage basin. A major fraction of the sediments is composed of silt, clay, sand, and gravel of volcanic origin and a minor fraction consists of bioclastic material of reef origin.

During periods of light rainfall the fresh muddy floodwater from the Talofofo River tend to float out to sea on top of the more dense seawater below it, similar to that described for the Pago River channel by Emery (1962). Observations made during SCUBA dives after periods of heavy rainfall revealed that visibility was less than three feet throughout the entire water column (5 to 90 feet). These observations differ from those found by Emery (1962) at Pago Bay channel where after a heavy rainstorm only the upper water layer was found to be turbid. Salinity samples were not taken during the sediment collecting dives to determine whether or not the turbidity observed was due to mixing of the muddy freshwater or whether it was caused by settlement of silt and clay particles. Salinity samples collected from the Talofofo River estuary (Table 4) on September 7, 1972 after a period of moderate rainfall showed stratification at stations 1 and 2, but not to the extent found by Emery (1962) for the Pago Bay channel after rainstorm. Possibly the greater volume discharge and subsequent silt load of the Talofofo River plus greater wave and surf activity within the Bay itself, compared to that of the Pago River channel, contributes to the turbid water found throughout the water column at Talofofo. Another factor which tends to increase turbidity in Talofofo Bay is that floodwater is limited to the confines of the Bay itself, whereas at the Pago Bay channel fresh muddy water can spread out over wide bordering reef flats (Fig. 1). Diving observations in both regions, though, show a much richer coral fauna along the channel margins and submarine cliffs at Pago Bay than at Talofofo Bay.

Biologically Talofofo Bay floor is rather barren. During the SCUBA dives no benthic organisms were found, but observations were rather restricted because of the limited visibility. A considerable amount of organic debris was found covering the bottom such as palm fronds, fruits from *Cocos* and *Nypa* palms, *Pandanus* fruits, bamboo canes, and other fibrous plant remains.

Periodically a considerable number of hydrozoan jellyfish (*Physalia*) float into the Bay, particularly when strong winds with an easterly component are blowing. Swimmers and surfers occasionally are stung by these jellyfish when they float into the surfing and swimming zone from the open sea at the head of the Bay.

BIOTOPE 5 (Beach Deposits)

This biotope consists of the unconsolidated beach deposits (littoral and supralittoral zones) located at the head of Talofofo Bay and Paicpouc Cove (Fig. 3). A description of the beach deposits was previously discussed in the "Geology Section", p. 5.

Talofofo Bay (Beach Deposits)

The littoral part of the beach is unstable and shifts about the inner part of Talofofo Bay. During the dry season (January - May), a sand bar develops on the north side of the river mouth (Fig. 38). The development of this sand bar is accompanied by a corresponding shift of the shallow river channel to the south. During the wet season (July - November), increased river discharge removes the sand bar and the shallow river channel shifts back to a course close to the fringing channel platform along the north shore. Although the shifting of the river channel and sand bars tend to be seasonal; periods of heavy rainfall, tropical storms, and typhoons may change the position of these features at any time of the year.

The section of beach located directly in front of the highway (Route 4) is subject to erosion by storm waves which enter the Bay through the channel mouth. The land area occupied by the present highway has been artificially "filled" in and appears to have become stabilized. A Nypa palm community occupies the region immediately behind the highway and probably marks the location of the former beachline at the head of the Bay. The artificial "fill" in front of this Nypa community is not stable because the present hydrologic factors of the Bay and river tend to restore the original shoreline configuration.

Biologically the region is rather barren. The unstable sediments of littoral (foreshore) zone are unsuited for the establishment of most benthic organisms. A few grapsid crabs and shorebirds were the only organisms observed in the zone.

The supratidal (backshore) part of the beach is more stable than the littoral zone and consequently, at places, has a community of strand plants developed on its surface (Fig. 39 and Table 9). The strand community is dominated by beach morning glory, Ipomea pes-caprae, and another creeping beach plant, Dolichos lablab.

The lower part of the supralittoral zone is a region where beach debris accumulates (Fig. 39). This debris consists predominately of bamboo canes, palm leaves, and the fruits of Cocos, Nypa, and Pandanus. Many of the Cocos have sprouted small fronds and root systems which tend to stabilize the beach deposits somewhat, allowing Ipomea runners to establish themselves. Numerous amphipods were found wherever beach drift was accumulated in quantities large enough to retain a considerable amount of moisture.

Paicpouc Cove (Beach Deposits)

At the head of this small cove the beach deposits form a veneer about three feet in thickness over a limestone platform. This platform is contiguous with and at the same elevation as the fringing platforms which border both sides of the Cove (Biotope 2). The river cuts through a layer of sandy alluvium along the north side of a narrow floodplain (Fig. 40). The beach deposits contain a considerable fraction of magnetite. At the mouth of the river a small bar of this black mineral forms a layer two to four inches in thickness (Fig. 5). Except for the greater abundance of magnetite and bioclastic material the sediments are similar to those from the beach at Talofofo Bay. Beach drift is abundant at the lower edge of the foreshore zone (Fig. 41).

Beach strand vegetation and amphipod communities are similar to those described for the beach at Talofofo Bay. A large population of land crabs occupies a section of the floodplain about one-hundred feet inland from the head of the cove. Shorebirds were commonly observed wading in the shallow river mouth and beach areas. Chinese bitterns and seasonal golden plovers were nearly always present near the river mouth.

BIOTOPE 6 (Talofofo River Estuary)

The Talofofo River course meanders through the alluvial floodplain sediments of the river valley. Slumping is evident at many places along the river bank where the river is undercutting the bank (Fig. 42). At other places sediments are accumulating, forming bars of silt and sand. The river banks show a higher degree of stability where the banks are occupied by a *Nypa fruticans* community (Fig. 43). These *Nypa* communities occupy about 50 percent of the river bank from Station 1 to 7 (Fig. 6). The remainder of the river bank is occupied by mixed vegetation, the more common species, consisting of: *Hibiscus tiliaceous*, *Cocos nucifera*, *Intsia bijuga*, *Pithecellobium dulce*, *Bambusa* sp., *Leucaena leucocephala*, *Hernandia ovigera*, and *Astrum diurnum*.

A tall cane, *Phragmitces karka* forms dense stands at some locations (Fig. 44). Swamp fern, *Acrostichum aureum* forms large clumps along the river bank between Stations 8 and 9 (Fig. 6). *Barringtonia racemosa* is found along the river banks near the confluence of the Ugum and Talofofo Rivers. Floating plants of *Pistia stratiotes* form dense patches (Figs. 44 and 45) which some times reach completely across the river. The edible subaquatic vine, *Ipomea aquatica*, was found at a few places along the river banks from Stations 8 through 12 (Fig. 6).

Numerous fish were observed at all stations. Mangrove crabs were observed in the Nypa communities. Local fishermen use traps to catch this edible crab. Several species of crabs and snails of a Littorina sp. were common in the lower fronds of the Nypa palms. Freshwater shrimp, Macrobrachium lar, and freshwater eels, Anguilla mammorata were also seen in the estuary.

BIOTOPE 7 (Raised Limestone Terraces and Cliffs)

Except for the head of Talofofo Bay and Paicpouc Cove the entire shoreline is bordered by raised limestone terraces or steep rocky slopes and cliffs (Figs. 7 and 46). Near the mouth of Talofofo Bay and Paicpouc Point the fringing reef platforms and fringing Bay platforms are bordered by a raised six foot limestone terrace (Facies A). At most places where the six foot terrace is present, a twelve to fifteen foot raised terrace (Facies B) is usually associated with it (Fig. 47). Cliffs of varying heights dominate most of the remaining Talofofo Bay shoreline (Facies C, Fig. 46). At most places a sea level "nip" is cut into the base of the six foot terrace (Biotope 1 - Facies 3, and Biotope 2 - Facies 2).

The upper surface of the six foot terrace (Facies A) is greatly solution pitted and cut into irregular pinnacles and knobs (Fig. 47). This facies is more prominent, bordering the seaward facing platforms, than along the Bay platforms. Generally the six foot sea-stand is represented along the channel walls as a cut "nip" (Figs. 31, 34 and 35). Where wave splash and spray occur, numerous flat-floored solution pools are common along the outer seaward fringe of the terrace (Fig. 12). These pools range in size from less than a foot to over ten feet in diameter. Most of the larger pools, that receive constant wave splash, contain communities of fish, algae, and crabs. Particularly noticeable and abundant was a black-colored benthic ostracod. Examination of water samples from these pools with a microscope revealed rich protozoan and algal communities. In the algal community, diatoms were especially abundant. Solution pools located farther away from the wave splash zone are frequently dry and contain a thick rind of sediment and algae. During periods of high surf and/or rainfall these communities are rejuvenated, turning the water green from rich algal blooms.

The 10-foot terrace (Facies B) is distributed along both the seaward facing raised limestone regions and the Bay platforms (Figs. 31 and 47). The remainder of the shoreline is occupied by steep boulder slopes and cliffs (Facies C), particularly along the north shoreline (Figs. 9 and 46) and along the south shoreline near the head of the Bay. Sea caves are found at the base of the cliffs bordering both sides of the channel.

Table 10 lists the most common plants and animals for Facies A, B, and C. Along the seaward exposed regions of Facies A, where the salt water spray zone occurs, *Pemphis acidula* forms nearly a pure stand of low prostrate shrubs (Fig. 47). Along the upper part of the present sea-level "nip" a distinct band of algae, *Antithamnion* sp. 1, forms a yellowish-brown band. At places the above alga is associated closely with *Champia parvula*, a reddish-brown alga that forms a distinct band at the base of the sea-level nips.

SECTION IV

UNIQUE ENVIRONMENT ELEMENTS AND LAND USE

REGIONS OF HISTORICAL INTEREST

An interesting region was found at the head of Paicpouc Cove which may have been an early habitation site of the Chamorros. Numerous pottery fragments were found mixed with the beach and alluvium deposits. The fragments were especially abundant at the backshore zone of the beach. Giant taro (Fig. 48), Alocasia macrorhiza, and spider lilies (Fig. 49), Hymenocallis littoralis, form conspicuous patches along the river and alluvial floodplain. These plants are possibly indicators of previous habitation sites.

During SCUBA investigations of the Talofofo Bay floor a sunken vessel was found. The vessel is located about midway between the mouth of Talofofo Bay and the mouth of Paicpouc Cove in about 40 feet of water (Fig. 7). It lies at the base of a submarine cliff which forms the margin of the reef flat platform along this part of the bay. The exact attitude at which the ship is resting on the bottom was not determined as the visibility at the time of investigation was less than two feet. Prior to typhoon "Allyn" in 1949 a portion of the superstructure was exposed. This storm must have moved the ship into deeper water or changed its attitude on the bottom as no part of it is now within 40 feet of the surface.

An old cemetery site was previously located on the alluvial flood plain at the head of Talofofo Bay near the shore of Gayloup Cove (Fig. 7). According to residents of Inarajan the cemetery was moved because of shoreline erosion which exposed some of the grave sites. The grave sites were excavated and the remains moved to another site because of the probability of further erosion of the shoreline.

During the Japanese occupation of Guam the Talofofo Bay area was defensively fortified as a potential landing site for vessels. Several "pillbox" fortifications still remain along the sides and head of the bay. Figure 50 shows a typical fortification of this type that is built into the seaward facing escarpment of the 10-15 foot raised limestone terrace on the north side of the bay.

PARKS

A public surfing beach about 6.6 acres in extent (Parks and Recreation Division, 1971) is located at the head of Talofofo Bay between the shoreline and Route 4 highway (Fig. 7). The physical characteristics and location of the bay on the windward side of the island gives the region a high number days in which the swell height is sufficient for surfing. The setting and its characteristics make the park a favorite location for surfing activities. Any manmade changes in the physical properties of the bay should be carefully examined to determine whether or not they will alter the characteristics of the natural swells which enter the bay.

The remainder of the shoreline along Talofofo Bay is privately owned at the present time.

UNIQUE FLORAL AND FAUNAL ELEMENTS

At the present time no endangered plants and animals are known from the Talofofo Bay, area but there are a few unique elements present.

Nypa swamp communities which border parts of the Talofofo River estuary, are not extensively developed on Guam (Fig. 13). The Talofofo estuary, at the present time, supports one of the largest of these swamp communities. Historically the large fronds from this swamps palm was used for "roof thatching" because of its superior quality and longer life than fronds from coconut trees, (*Cocos nucifera*).

A relatively rare tree, *Barringtonia racemosa*, is found along the banks of the Talofofo River estuary and local patches of swamp land located on the adjacent floodplain. At some locations, upstream from Station 12 (Fig. 6), this small tree forms nearly pure stands in low wet areas.

FISHERIES

Most of the fishing conducted in the Talofofo Bay and River is mainly of a noncommercial nature. There are no boat launching facilities located at the Talofofo Bay or River for large boats but small boats which can be launched by hand are occasionally seen in the bay or river. Most fish are caught by hand-lines, poles, or nets. Fresh water shrimping and crabbing are also conducted in the river. Table 11 is a list of fishes of recreational value found in Talofofo Bay and River that were compiled by Mr. H. T. Kami, of the Division of Fish and Wildlife, Government of Guam.

SECTION V

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SECTION VI

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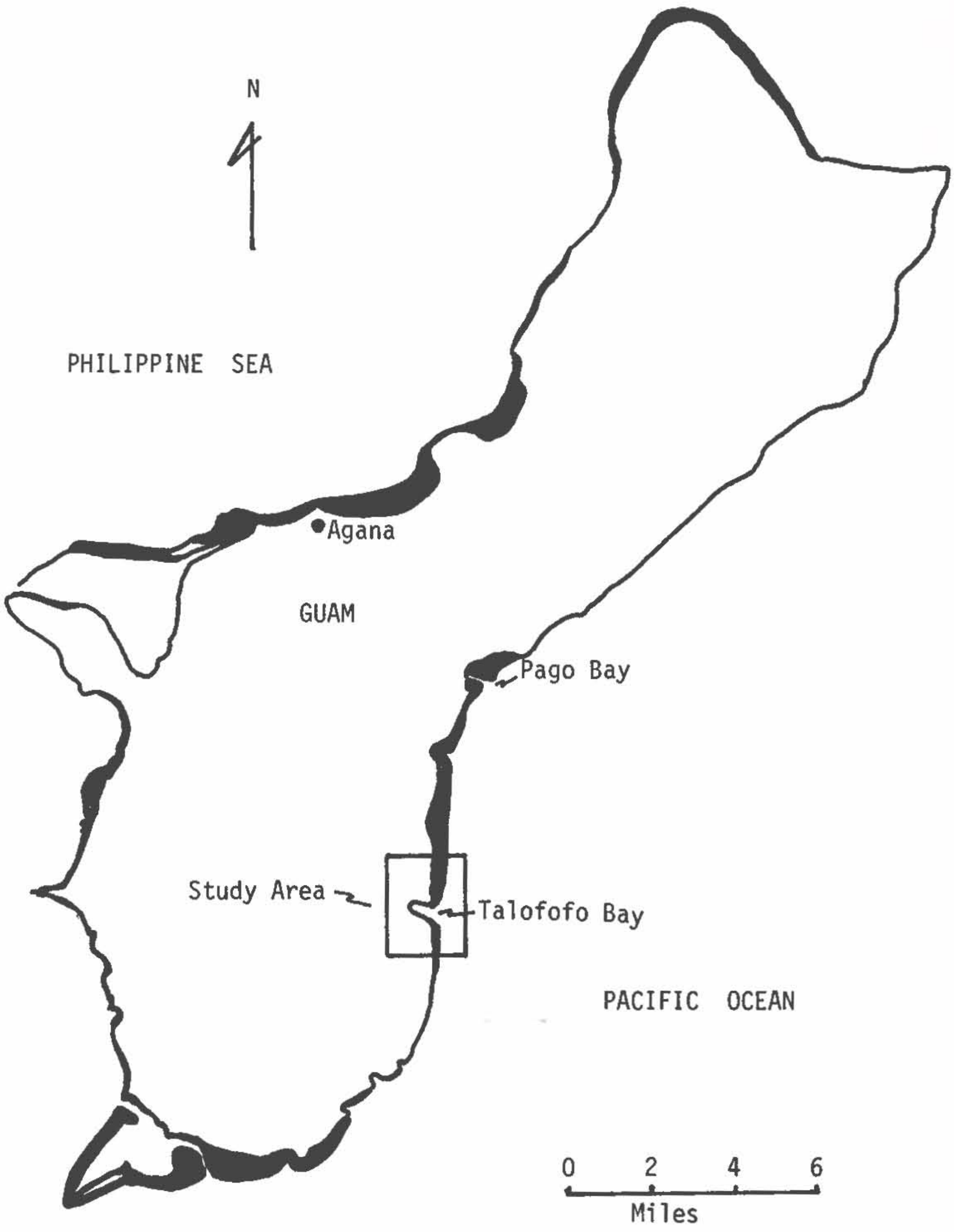

Figure 1. Map of Guam. Fringing and barrier reefs are shaded. Map modified from Emery (1962).

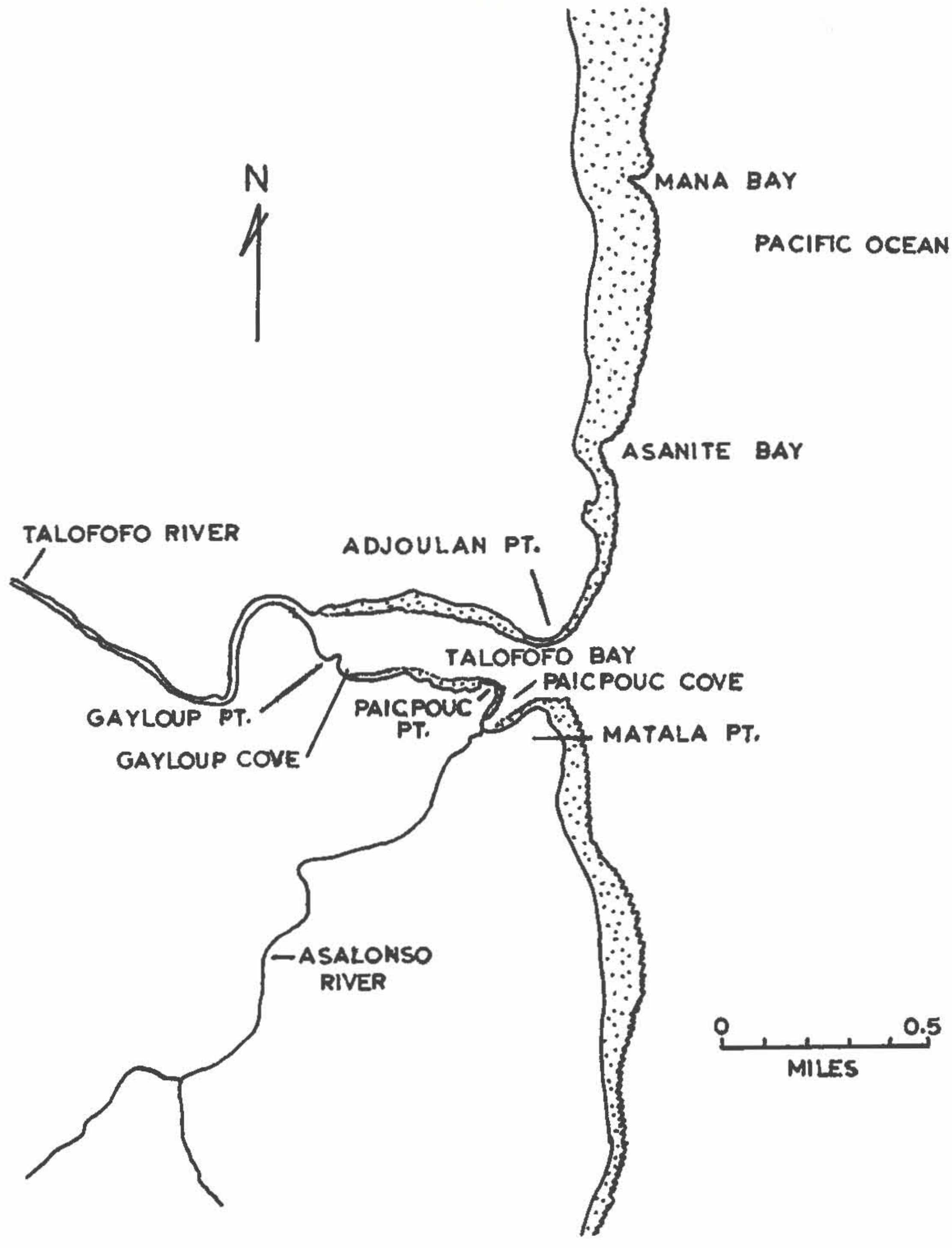

Figure 2. Map of Talofofo Bay study area and nearby coastal regions. Fringing reef platforms are stippled.

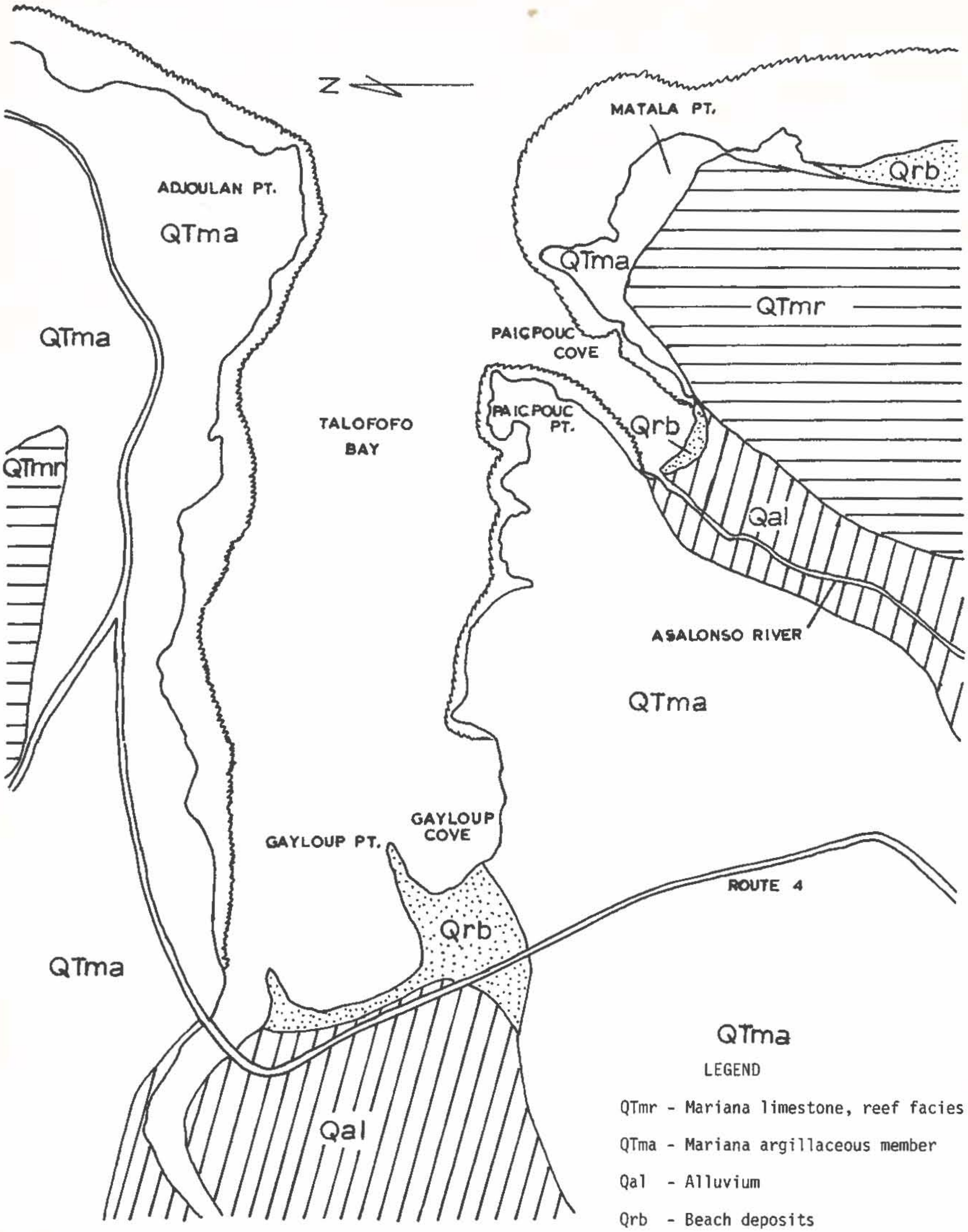

Figure 3. Map of Talofofo Bay study area showing the distribution of Mariana limestones, alluvium, and beach deposits.

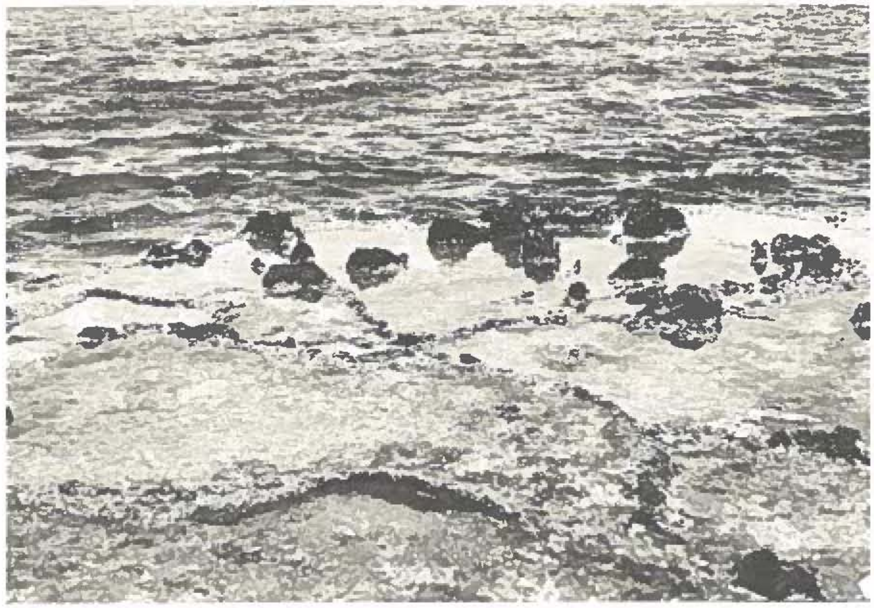

Figure 4. Noncalcareous nodules embedded in the limestone at the reef margin of Platform B, Facies D. Relief of the nodules is one foot or less.

Figure. 5. Black magnetite sand at the head of Paicpouc Cove.

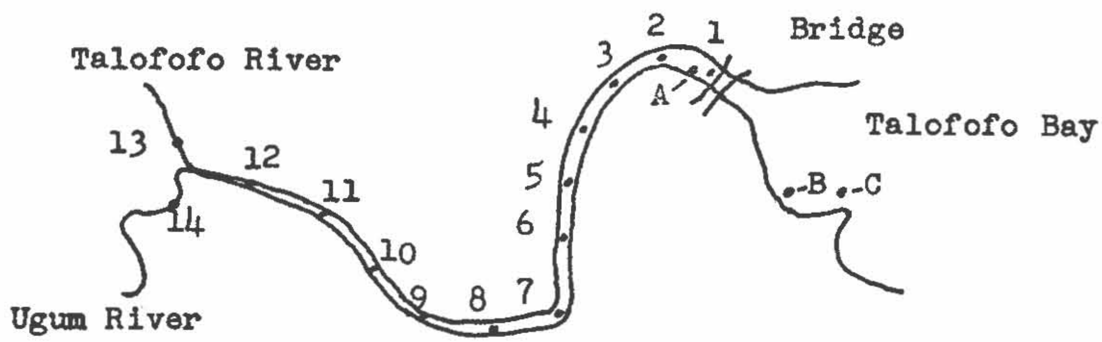

Figure 6. Talofofo River and Guam Water Pollution Control Commission sample stations. Station A - Talofofo Bridge, Station B - Talofofo Bay, Station C - Talofofo surf area, and an upstream station located at river station 10.

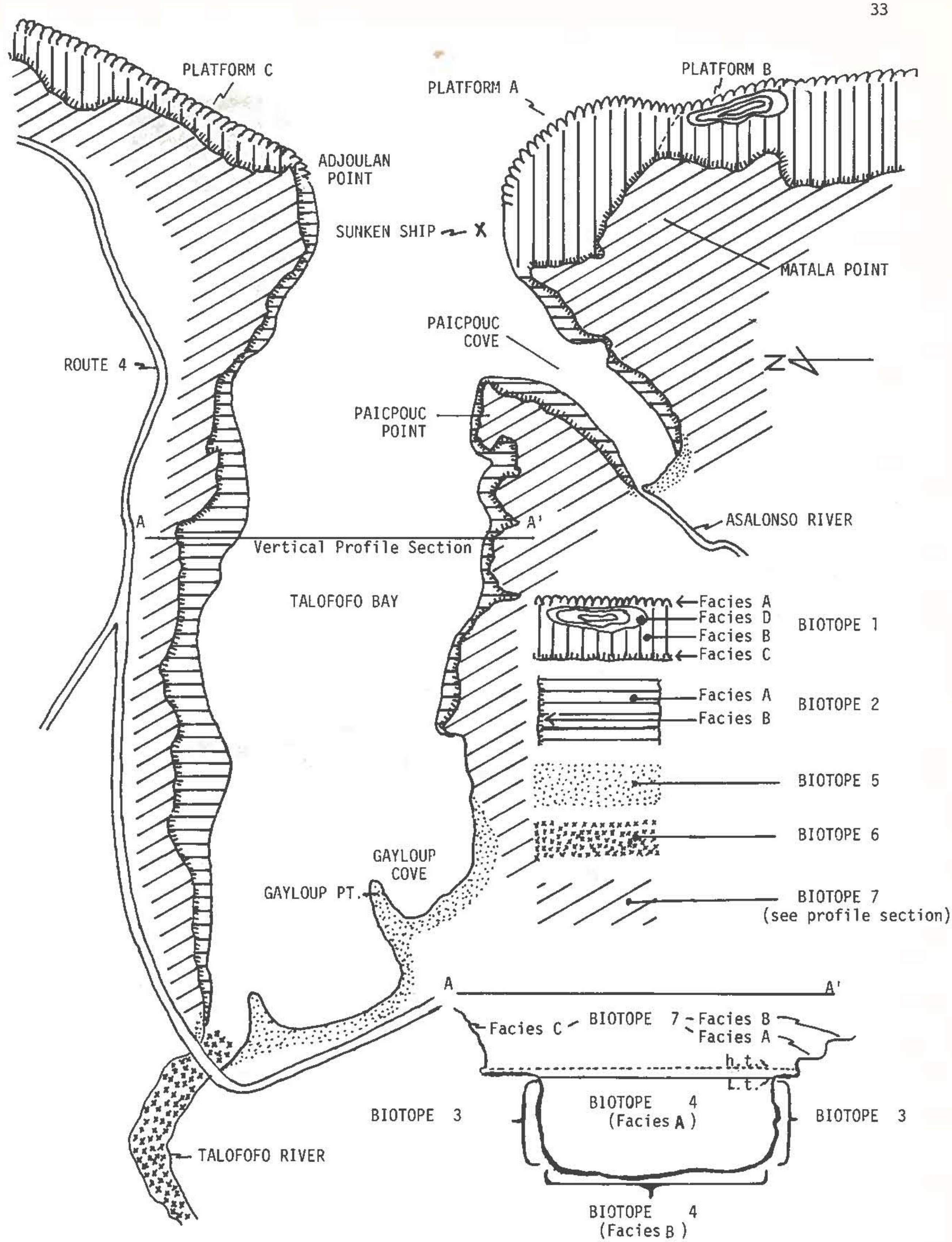

Figure 7. Distribution of biotopes.

Figure 8. Rimmed terraces marks the location of a faultline cutting across the fringing reef flat separating Platform A (foreground) from Platform B (background). Microatolls of Porites can be seen in the pool of Platform A.

Figure 9. Surf breaking on the reef margin surge channels of Platform A. Foreground is part of a series of rimmed terraces located at the junction of Platform A and B. In the background the north side of Talofofo Bay is bordered by steep limestone slopes and cliffs. Arrow points to cap of Mariana limestone, reef facies (QTmr).

Figure 10. Reef margin of Platform B, Facies D. This margin differs from that in Figure 9 by the absence of surge channels. Gilidiella acerosa forms an algal mat on the upper seaward face of the platform margin. Coralline red algae encrusts the lower platform face.

Figure 11. Fringing reef flat and reef margin of Platform C. Raised 6 foot limestone terrace is present at the left.

Figure 12. A view of the reef margin of Platform C showing the surge channel development. In the foreground is a large solution pool located on the upper surface of the 6 foot raised terrace.

Figure 13. Shallow rimmed terrace pools on the seaward half of the fringing reef flat of Platform A.

Figure 14. Pearlfish, Encheliophis gracilis, (arrow) protruding from the cloaca of a holothurian, Stichopus chloronotus, which is trapped in a shallow pool at low tide. The holothurian and fish are dying because of water temperature increase and oxygen depletion.

Figure 15. Dense stand of benthic algae growing on the upper rim of a terrace pool on Platform A.

Figure 16. Drift debris on the reef flat of Platform A. Origin of the drift material is from the Talofofo and Asalonso River.

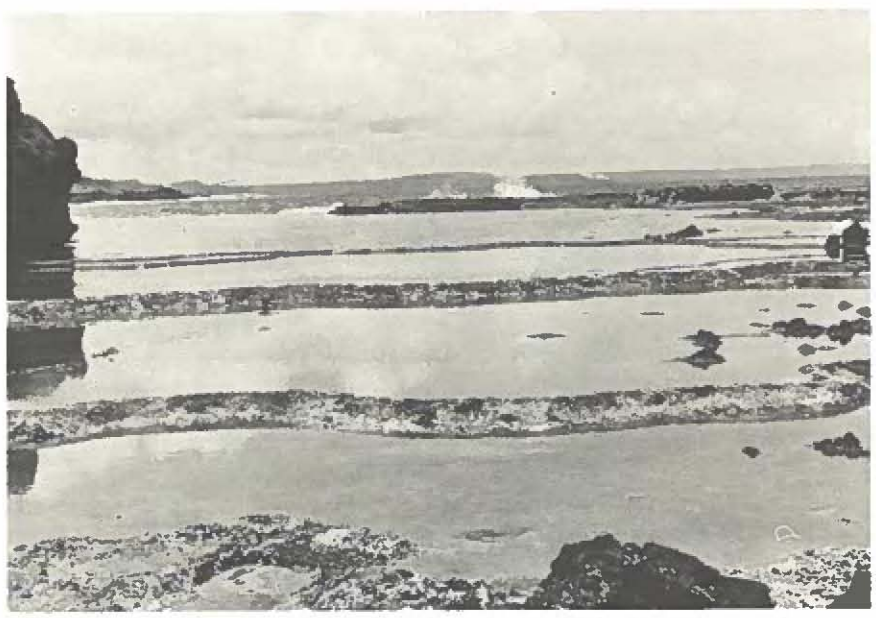

Figure 17. A series of terraces marking the location of a faultline on the south side of the reef flat, Platform B.

Figure 18. Large pool located on Platform B. In the background the elevated terraces of Biotope 1, Facies D, form the seaward boundary of the pool.

Figure 19. Band of gastropods, Cerithium bacticum, located on reef flat, Platform B.

Figure 20. Cerithium bacticum at the base of a sea-level "nip" located on reef flat, Platform B.

Figure 21. Map of Talofofo Bay showing the locations of the "algal" and "limpet" transects. Circled transect numbers denote "algal" transects and uncircled numbers "limpet" transects.

Figure 22. Small fault on Platform C. Vertical displacement of about one foot is visible at the arrows.

Figure 23. Large reef flat pool located on Platform C. Depth of water in the pool is about four feet.

Figure 24. Low terraced rims located near the channel margin of Platform C.

Figure 25. Concave shaped "nips" cut into the 10 foot raised terrace bordering reef flat Platform B. The upper "nip" represents a former sea-level stand.

Figure 26. Block rubble at the base of the 12 foot raised terrace at Platform A. Drift debris is lodged among the boulders. Porites lutea colonies are visible in the foreground.

Figure 27. Rimmed terrace pools at the seaward margin of Platform B, Facies D.

Figure 28. Large limestone block which has slumped off from the outer face of the fringing reef margin. Noncalcareous nodules can be seen standing out in relief on the upper surface.

Figure 29. Shoreward side of the terraces located at Platform B, Facies D. The back side of the step-like terraced rims are usually concave where they drop to the next lower level. Limpet Transect No. 3 is located on the concave part of the terraced rim at the right.

Figure 30. Fringing platform, Biotope 2, Facies A. The margin here is very irregular due to erosion by slumping.

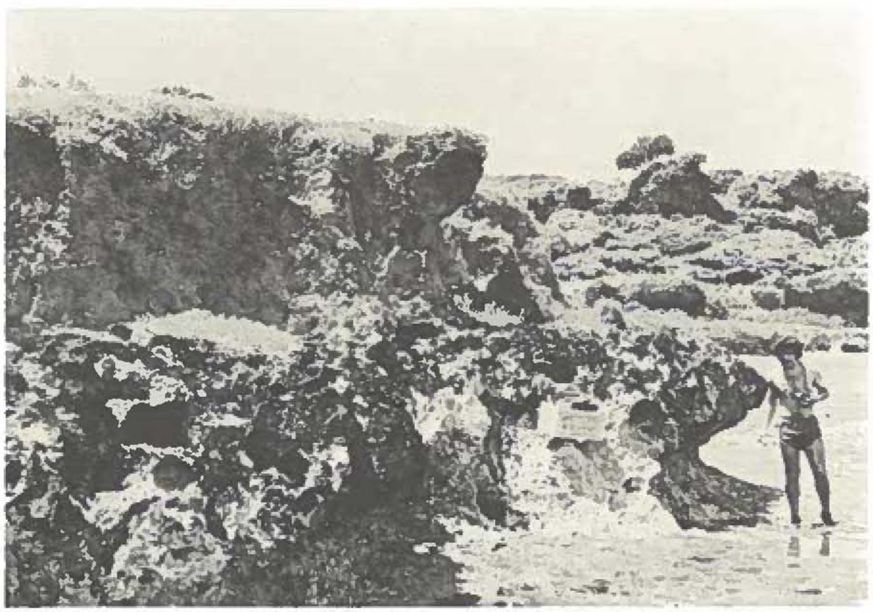

Figure 31. Concave shaped "nip" cut into the raised 6 foot limestone terrace along the fringing platform, Biotope 2, Facies A. The raised 10 foot terrace is located at the upper left.

Figure 32. Elevated rimmed terraces (arrows) located at Paicpouc Point.

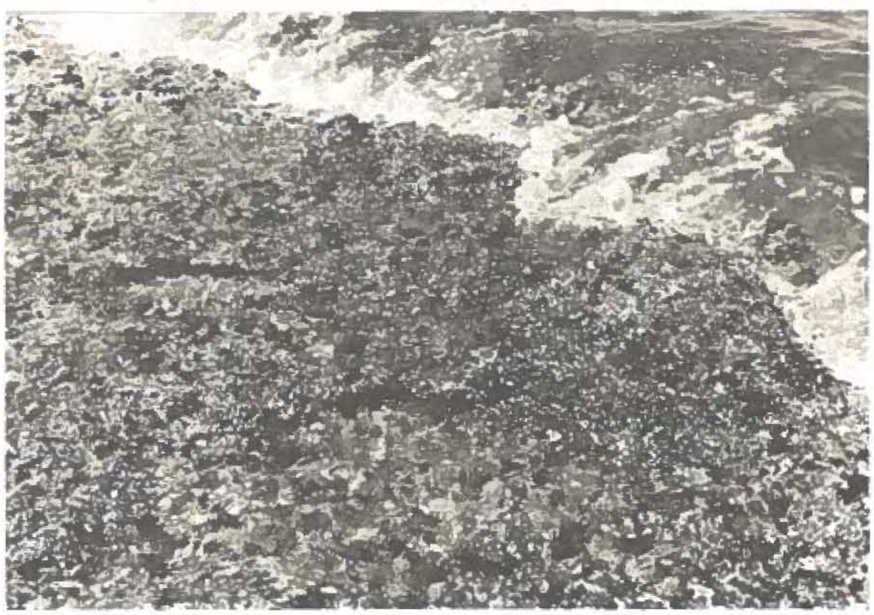

Figure 33. Honeycombed margin of the fringing platform at Paicpouc Cove.

Figure 34. Solid margin of the fringing platform located along the south side of Talofofo Bay.

Figure 35. "Nips" along the fringing channel platform of Biotope 2. The lower sea-level "nip" is less developed than the upper 6 foot "nip".

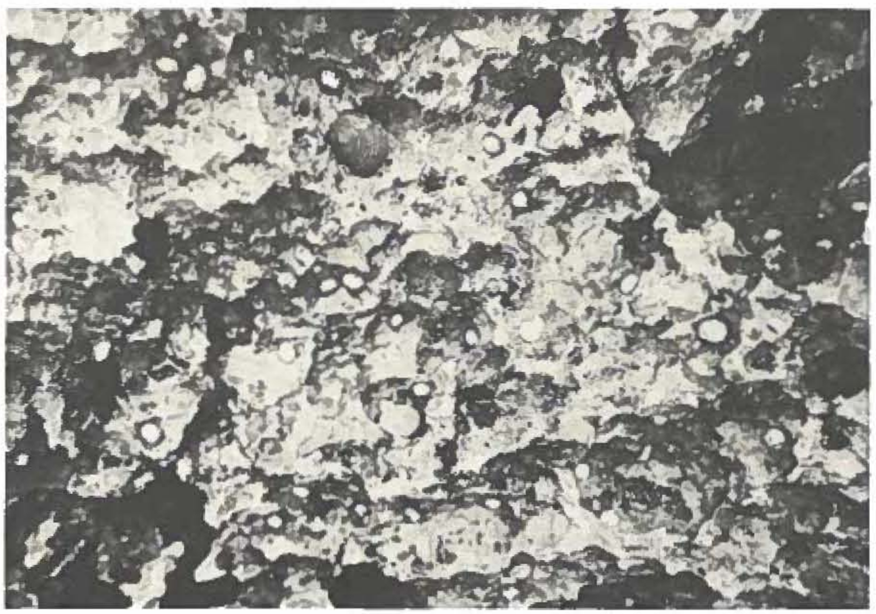

Figure 36. Mixed limpet and Nerite community located in the basal region of the sea-level "nip" illustrated in Figure 35.

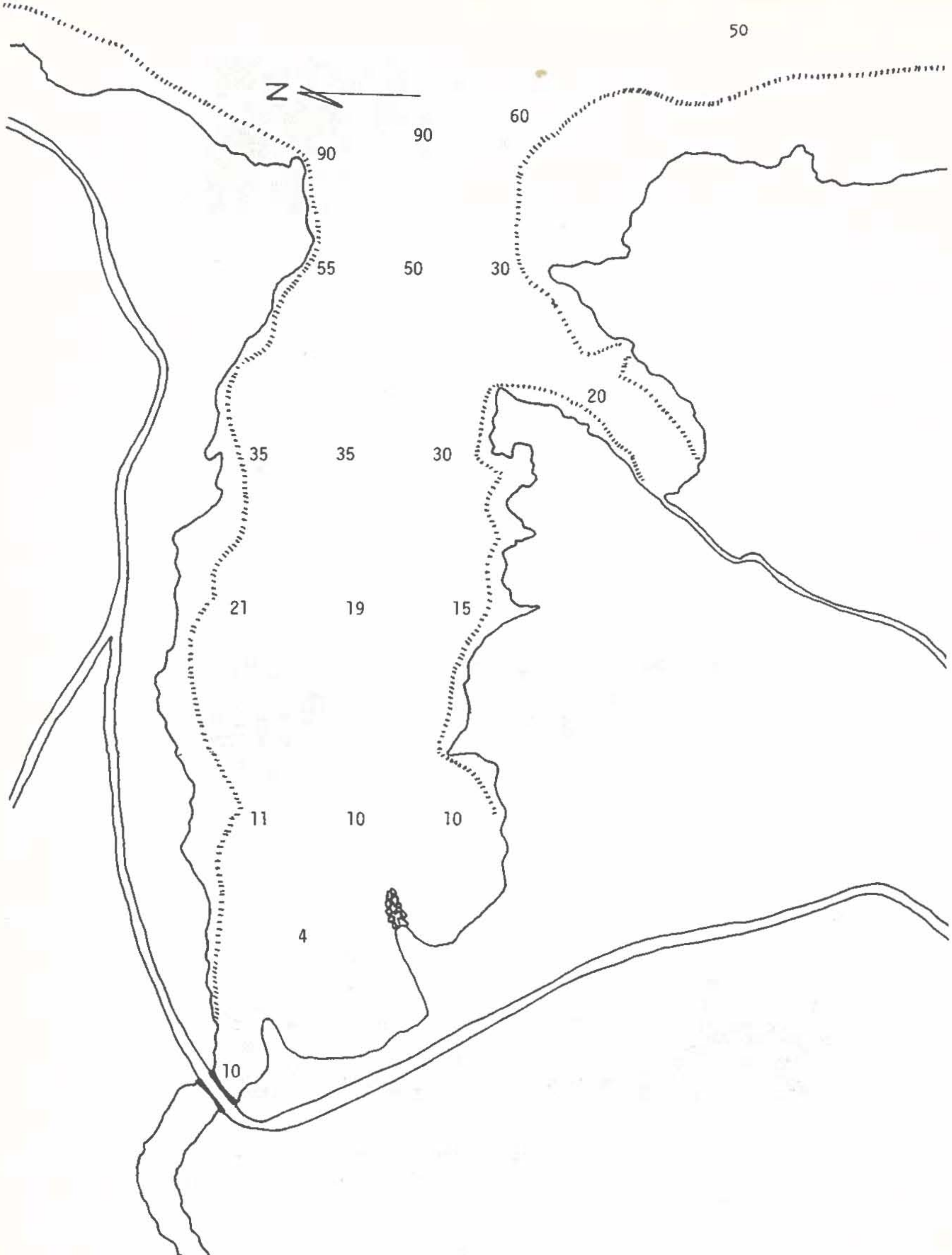

Figure 37. Locality map for soundings taken in Talofofo Bay. Depths are given in feet.

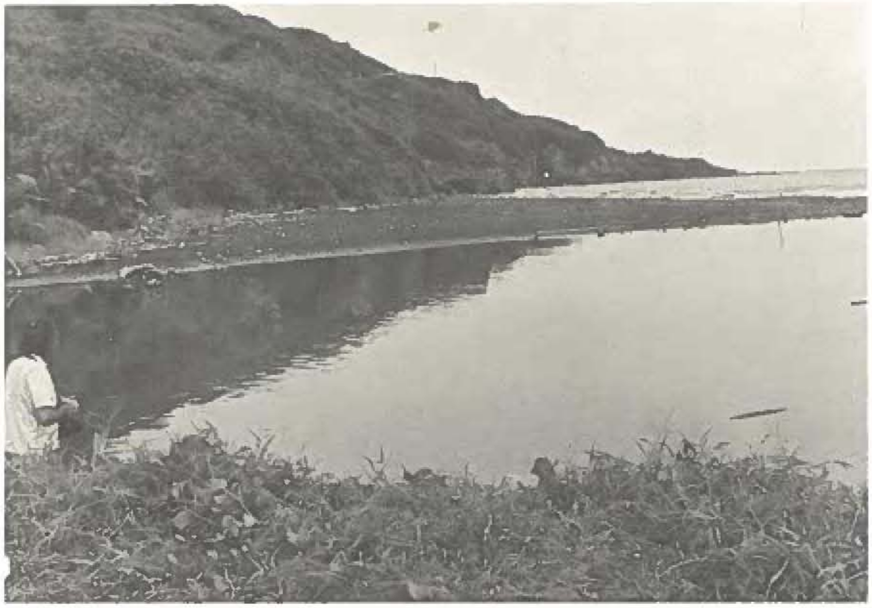

Figure 38. Sand bar development at head of Talofofo Bay.

Figure 39. Beach strand community at the head of Talofofo Bay. Ipomea pes-caprae and Dolichos lab-lab form a dense stand on the back shore part of the beach.

Figure 40. Asalonso River at the head of Paicpouc Cove.

Figure 41. Beach drift accumulation at the head of Paicpouc Cove.

Figure 42. Undercutting and slumping of the alluvial bank along the Talofofo River.

Figure 43. Talofofo River with a dense Nypa fruticans community on the left shore and a mixed forest community on the right.

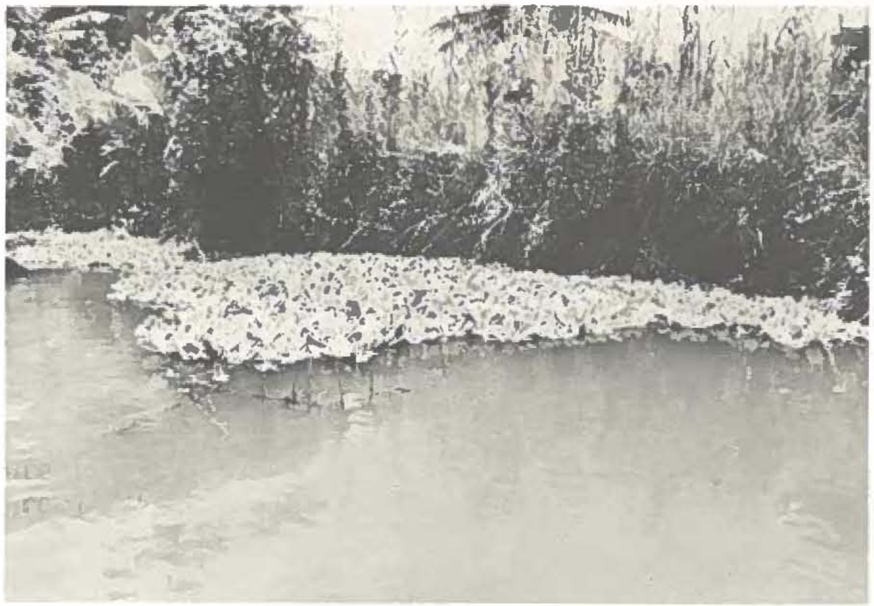

Figure 44. A floating aquatic plant, _Pistia stratiotes_, and _Phragmites karka_ growing along the Talofofo River (Biotope 6).

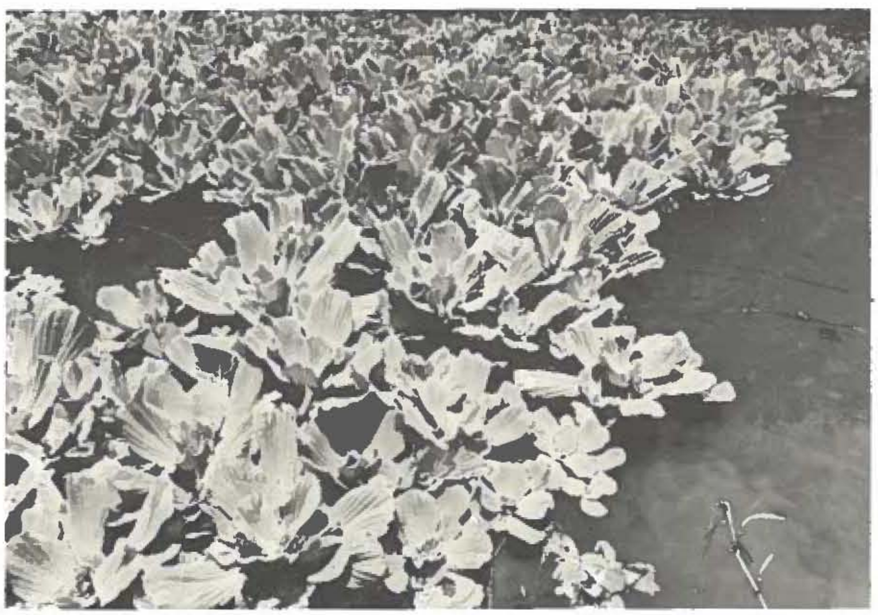

Figure 45. A detail of the floating plants, _Pistia stratiotes_, from Figure 44, above.

Figure 46. In the foreground, near the mouth of Talofofo Bay, the 6 foot (Biotope 7, Facies A) and 12-15 foot raised limestone terraces can be seen (Biotope 7, Facies B). In the background the steep rocky slopes bordering the north channel can be seen (Biotope 7, Facies C).

Figure 47. This shows the 6 foot (Biotope 7, Facies A) and 12-15 foot raised terraces (Biotope 7, Facies B) at the mouth of Talofofo Bay. The upper surface of the 6 foot terrace is greatly solution pitted and eroded into sharp-crested pinnacles, knobs, and solution pools. A low prostrate shrub, Pemphis acidula veneers the terrace.

Figure 48. Patches of "giant taro", <u>Alocasia macrorhiza</u>, border the base of the forested cliff along the Asalonso River.

Figure 49. "Spider lilies" growing along the Asalonso River.

Figure 50. A "pillbox" fortification, built by the Japanese during World War II, is located on a seaward facing terrace on the north side of Talofofo Bay.

Table 1. Hydrological data for the Ugam River. 1/

Ugam River near Talofofo

Location. --Lat 13°20'00" N., long 144°44'55" E., on left bank 0.3 mile upstream from mouth, 1.3 miles south of Talofofo, and 4.2 miles north of Inarajan.

Drainage area. --7.20 sq mi.

Records available. --June 1952 to June 1958.

Gage. --Water-stage recorder and concrete control. Altitude of gage is 30 ft (by barometer).

Average discharge. --6 years, 28.0 cfs.

Extremes. --Maximum and minimum discharges for the fiscal years 1953-58 are contained in the following table:

Fiscal year	Maximum			Minimum		
	Date	Discharge (cfs)†	Gage height (feet)	Date	Discharge (cfs) †	Gage height (feet)
1953	Feb. 22, 1953	1,400	10.04	Jul. 26,27, 1952	3.4	0.44
1954	Oct. 15, 1953	1,620	11.72	Jun. 21, 1954	3.85	.46
1955	Sept. 4, 1954	1,450	10.41	Jun. 25-29, 1955	3.85	.46
1956	Sept.10, 1955	1,580	11.42	Jul. 5, 1955	3.85	.46
1957	Dec. 14, 1956	1,570	11.30	Jun. 16,17, 1957	4.1	.47
1958	Oct. 6, 1957	1,610	11.63	Aug. 6, 1957	3.6	.45

† From rating curve extended above 200 cfs on basis of slope-area measurement at gage height 11.3 ft.

1952-58: Maximum discharge, 1,620 cfs Oct. 15, 1953 (gage height, 11.72 ft), from rating curve extended above 200 cfs on basis of slope-area measurement at gage height 11.3 ft; minimum, 3.4 cfs July 26, 1952.

Remarks. --Records good except those for periods of fragmentary, doubtful or no gage-height record, and those above 200 cfs, which are poor.

Rating table, June 18, 1952, to June 30, 1958 (gage height, in feet, and discharge, in cubic feet per second)

0.4	2.6	2.0	200
.5	4.8	2.5	290
.6	8.0	3.0	375
.8	17.5	4.0	530
1.0	32	6.0	830
1.3	66	8.0	1,120
1.6	115	10.0	1,400

Table 1. (Continued)

Discharge, in cubic feet per second, 1952

June 18	†3.7	June 25	4.5
19	4.5	26	4.8
20	3.85	27	4.3
21	4.1	28	4.3
22	4.8	29	4.1
23	5.3	30	4.1
24	4.5		

*Discharge measurement made on this day.
†Result of discharge measurement.

1/ Table taken from "Military Geology of Guam, Mariana Islands Water Resources Supplement"(Ward and Brookhart, 1962).

Table 2. Hydrological data for the Talofofo River. 1/

Talofofo River near Talofofo

Location. --Lat 13°21'05" N., long 144°43'50" E., on left bank 1.5 miles southwest of Talofofo and 5.3 miles north of Inarajan.

Drainage area. --16.2 sq mi.

Records available. --November 1951 to June 1958.

Gage. --Water-stage recorder and steel weir. Altitude of gage is 40 ft (by barometer).

Average discharge. --6 years (1952-58), 50.2 cfs.

Extremes. --Maximum and minimum discharges for the fiscal years 1952-58 are contained in the following table:

Fiscal year	Date	Discharge (cfs)†	Gage height (feet)	Date	Discharge (cfs)†	Gage height (feet)
1952†	Dec. 6, 1951	2,300	††8.60	Feb. 25,25, 1952	0.82	0.59
1953	Deb. 22, 1953	2,550	8.83	Jun. 18, 1953	1.06	.65
1954	Oct. 15, 1953	8,560	12.69	Jun. 21, 1954	1.17	.54
1955	Sept.15, 1954	2,300	8.62	Jul. 1, 1954	1.51	.63
1956	Sept.29, 1955	2,550	8.78	May 24,24, 1956	1.14	.53
1957	Dec. 14, 1956	2,550	8.77	Jun. 18, 1957	1.32	.58
1958	Nov. 16, 1957	3,700	9.56	May 27,28, 1958	1.39	.60

† Period November to June.
† From rating curve extended above 80 cfs by test on model of station site.
†† From floodmark.

1951-58: Maximum discharge, 8,560 cfs Oct. 15, 1953 (gage height, 12.69 ft), from rating curve extended above 80 cfs by test on model of station site; minimum, 0.82 cfs Feb. 25, 26, 1952.

Remarks. --Records good except those for Dec. 6, 1951, and Oct. 17-20, 1954, which are fair, and for periods of faulty or no gage-height record in 1952-53, which are poor. Water for domestic use is diverted from Fena Valley Reservoir.

1/ Table taken from the "Military Geology of Guam, Mariana Islands, Water Resources Supplement" (Ward and Brookhart, 1962).

Table 3. Fecal coliform values for 1972 at Talofofo River and Talofofo Bay.

Date (1972)	Talofofo River Upstream Station 10	Talofofo River Bridge Station A	Talofofo Bay Station B	Talofofo Surf Area Station C
1/10	130	220	13	13
1/24	490	220	4	2
2/1	330	170	4	13
2/22	542	79	8	2
3/6	240	542	918	130
3/20	918	1609	1609	542
4/3	348	230	0	8
4/17	70	348	23	33
5/1	172	348	49	
5/15	40	225	10	10
5/30	735	55	40	46
6/12		24	24	12
6/26	33	210	54	56
7/10	550	670	630	
7/24	450	500		900
8/7	30	80		30
8/23	60	10		0
9/19		400		100
10/2			16	2
10/16	72	88		19
10/30	78	88		15
11/13	226	160		40
11/29		34		30
12/13	72	46		22

Data was compiled from records of the Guam Water Pollution Control Commission, Water Control Laboratory. Membrane filter technique used.

Table 4. Talofofo River station data. For station locations see Figure 6.

Station (S = Surface B = Bottom)	Depth (meters)	Temp. 10/3/72	Dissolved Oxygen* 9/7/72	Dissolved Oxygen* 10/3/72	Salinity* 9/7/72	Salinity* 10/3/72	Coliform* TOTAL 9/7/72	Coliform* TOTAL 10/3/72	Coliform* FECAL 9/7/72	Coliform* FECAL 10/3/72
1S	-	27.6	6.4	6.8	2.846	4.437	TNTC	3100	786	0
1B	3.0	29.0	3.2	4.9	25.786	30.579		100		3
2S	-	28.0	6.8	6.3	2.846	2.861				
2B	2.0	28.8	5.5	5.9	6.966	28.689				
3S	-	28.0	6.8	6.0	2.846	3.053	TNTC	2000	940	TNTC
3B	2.0	28.9	6.1	5.7	2.846	29.331		100		3
4S	-	28.3	6.4	6.1	2.846	*				
4B	3.5	28.2	3.8	5.0	24.328	27.924				
5S	-	28.0	6.4	6.1	2.846	*	TNTC		460	
5B	2.5	29.2	6.0	5.0	2.846	30.291	TNTC		260	
6S	-	28.2	6.3	6.1	2.846	*		1500		50
6B	2.5	29.2	6.3	4.9	2.846	30.029		0		1
7S	-	28.1	6.2	6.1	2.846	*	TNTC		700	
7B	4.0	29.4	2.7	4.9	30.502	30.541				
8S	-	28.4	6.3	6.1	2.846	*		2400		10
8B	2.75	29.2	6.2	5.2	2.846	29.684		400		8
9S	-	28.5	6.3	6.1	2.846	*	TNTC		620	
9B	3.0	29.4	6.1	5.0	2.846	30.141				
10S	-	28.4	6.3	6.1	2.846	*		2500		30
10B	2.25	29.4	6.2	5.5	2.846	28.022		200		-
11S	-	28.5	6.3	6.3	2.846	*	TNTC		520	
11B	3.5	29.4	6.3	5.7	2.846	29.830	TNTC		740	
12S	-	28.6	6.5	6.4	2.846	*		2400		170
12B	2.0	29.5	-	5.6	-	29.419		100		3
13S	-	-	-	-	-	-	TNTC	-	400	
14S	-	-	-	-	-	-	TNTC	-	460	

Temperature in ° Celsius.
Dissolved oxygen* in mg/l.
Salinity* in °/oo. (Values with * have conductivity values less than .1000).
Coliform* in counts/100 ml, using a membrane filter technique for both (Total and Fecal) counts.

TNTC = To numerous to count.

Table 5. Tabulation of plants and animals from Biotope 1 and 2

	BIOTOPE 1				BIOTOPE 2	
	Facies				Facies	
	A	B	C	D	A	B
Algae						
Cyanophyta:						
Calothrix pilosa Harvey					x	
Calothrix crustacea B & F		x				
Entophysalis deusta (Menegh.) Dr. & Dailey			x	x		x
Microcoleus lyngbyaceus (Kutz) Cronan				x	x	
Oscillatoria sp. 1		x			x	
Schizothrix calcicola (Ag.) Gomont		x		x	x	
Schizothrix mexicana Gomont						x
Cholorophyta:						
Boodlea composita (Harv.) Brand	x				x	
Caulerpa racemosa (Forrskal) J. Ag.				x	x	
Chaetomorpha indica (Kutz)					x	
Chlorodesmis fastigiata (C. Ag.) Ducker		x				
Chlodophora sp. 1	x			x	x	
Chlodophora sp. 2		x		x	x	
Cladophoropsis gracillima Dawson	x	x		x	x	
Cladophoropsis membranacea (Ag.) Boerg					x	
Cladophoropsis sp. 1					x	
Dictyosphaeria cavernosa (Forrskal) Boerg		x		x	x	
Enteromorpha intestinales (L.) Link		x			x	
Enteromorpha tuberosa (Kutz) Kutz					x	
Enteromorpha sp. 1		x		x	x	
Halimeda opuntia (L.) Lamx.					x	
Halimeda descoidea Decaisne					x	
Valonia fastigiata Harvey		x				
Phaeophyta:						
Ectocarpus breviticularis J. Ag.				x		
Ectocarpus indicus (Sonder) Womersley & Bailey	x					
Lobophora variegata (Lamx.) Womersley					x	
Padina minor Yamada				x		
Padina tenuis Bory		x				
Ralfsia pangoensis Setchell	x		x		x	x
Sargassum crystaefolium J. Ag.	x	x				
Sargassum polycystum C. Ag.		x		x	x	
Sphacelaria tribuloides Meneghini				x	x	
Turbinaria ornata (Turner) J. Ag.	x	x		x		
Rhodophyta:						
Acanthophora spicifera (Vahl) Boerg					x	
Amansia glomerata C. Ag.					x	
Amphiroa fragilissima (L.) Lam.	x					x
Antithamnion sp. 1			x			x
Antithamnion sp. 2				x	x	

Table 5. Continued.

	BIOTOPE 1				BIOTOPE 2	
	Facies				Facies	
	A	B	C	D	A	B
Callithamnion sp. 1					x	
Centroceras calvulatum (C. Ag.) Montagne					x	
Cheilosporum multifidium (Kutz) Manza	x	x		x		
Chondria sp. 1				x		
Chondria sp. 2					x	
"Coralline" sp. 1	x	x		x	x	x
"Coralline" sp. 2	x	x			x	
Desmia hornemania Lyngbye				x	x	
Champia parvula (C. Ag.) Harvey			x			x
Gelidiella acerosa (Forrskal) Feldm. & Hame	x			x	x	
Gelidiopsis sp. 1					x	
Gelidiopsis sp. 2					x	
Gelidium pusillum (Stackh.) Le Jolis	x					
Gelidium sp. 1					x	
Gelidium sp. 2	x					
Gracilaria lichenoides (L.) J. Ag.				x	x	
Gracilaria salicornia (Mert.) Grev.		x		x	x	
Hypnea cervicornis J. Ag.				x	x	
Hypnea cf. nidulans Setchell					x	
Hypnea cf. pannosa J. Ag.		x				
Hypnea esperi Borg.				x		
Hypnea pannosa J. Ag.					x	
Hypnea sp. 1					x	
Hypnea sp. 2					x	
Hypnea sp. 3					x	
Jania capillacea Harvey	x					
Jania decussato-dichotoma (Yendo) Cronan					x	
Jania sp. 1				x		
Laurencia obtusa (Huds.) Lamx.				x	x	
Laurencia tropica Yamaga	x				x	
Laurencia sp. 1				x		
Laurencia sp. 2					x	
Mastophora sp. 1	x			x		
Peyssonelia sp. 1					x	
Polyopes clarionensis S. & G.				x	x	
Polysiphonia sp. 1	x			x		
Polysiphonia sp. 2					x	
Polysiphonia sp. 3					x	
Polysiphonia sp. 4					x	
Porolithon gardineri (Foslie) Foslie	x			x		
Porolithon onkodes (Heydrich) Foslie	x			x		
Spyridia velasquezii Trono					x	
Tolypiocladia glomerulata (Ag.) Schmitz & Hauptfleisch		x				
Wurdemania sp. 1					x	
Chrysophyta:						
Diatom mat.					x	

Table 5. Continued.

	BIOTOPE 1				BIOTOPE 2	
	Facies				Facies	
	A	B	C	D	A	B
Protozoa - Foraminifera:						
Calcarina spengleri (Gmelin)		x			x	
Homotrema rubrum (Lamarck)	x	x				
Marginopora vertebralis Blainville		x			x	
Manicina miniacea (Pallas)	x					
Porifera:						
Cinachyra australiensis (Carter)	x				x	
Cnidaria						
Corals - Scleractinia:						
Acanthastrea echinata (Dana)	x					
Acropora humilis (Dana)	x					
Acropora hystrix (Dana)	x					
Acropora monticulosa (Bruggemann)	x					
Acropora murrayensis Vaughan	x					
Acropora nana (Studer)	x					
Acropora nasuta (Dana)	x	x				
Acropora ocellata (Klunzinger)	x					
Acropora palmerae Wells	x					
Acropora smithi (Brook)	x					
Acropora surculosa (Dana)	x	x				
Acropora syringodes (Brook)	x					
Acropora vallida (Dana)	x					
Astreopora myriophthalma (Lamarck)	x					
Cyphastrea serailia (Forskal)	x					
Favia pallida (Dana)	x	x				
Favia speciosa (Dana)	x					
Favia stelligera (Dana)	x					
Favites abdita (Ellis & Solander)	x	x				
Galaxea fascicularis (Linnaeus)	x					
Goniastrea parvistella (Dana)	x					
Goniastrea retiformis (Lamarck)	x	x				
Leptastrea transversa (Klunzinger)	x					
Leptoria gracilis (Dana)	x					
Montipora elschneri Vaughan	x					
Montipora foveolata (Dana)	x					
Montipora hoffmeisteri Wells	x					
Montipora verrilli Vaughan	x					
Pavona varians Verrill	x					
Platygyra sinensis (Milne Edwards & Haime)	x					
Plesiastrea versipora (Lamarck)	x					
Pocillopora brevicornis Lamarck	x	x				
Pocillopora danae Verrill	x					
Pocillopora meandrina Dana	x					
Pocillopora setchelli Hoffmeister	x	x				
Porites australiensis Vaughan	x					

Table 5. Continued.

	BIOTOPE 1 Facies A	B	C	D	BIOTOPE 2 Facies A	B
Porites compressa Vaughan	x					
Porites lichen Dana	x					
Porites lobata Dana	x					
Porites lutea Milne Edwards & Haime	x	x		x		
Porites sp. 1	x	x				
Psammocora nierstraszi van der Horst	x					
Psammocora (*P.*) *haimeana* Milne Edwards & Haime	x					
Stylocoeniella armata (Ehrenberg)	x					
Coenothecalia:						
Helipora coerulea (Pallas)	x					
Hydrozoa - Milleporina:						
Millepora dichotoma Forskal	x					
Millepora exaesa Forskal	x					
Millepora platyphylla Hemprich & Ehrenberg	x					
Annelida						
Eurythoe complanata (Pallas)		x			x	
Mollusca						
Amphineura:						
Acanthochiton? sp. 1			x	x		x
Pelecypoda:						
Botulina sp. 1		x				
Septifer sp. 1	x					
sp. 1		x				
sp. 2	x					
Gastropoda:						
"Limpets"						
Acmaea sp. 1	x		x	x		x
Patella stellaeformis Reeve			x	x		x
Patella sp. 1						x
Siphonaria sp. 1						
Turbinidae:						
Turbo setosus Gmelin	x					
Neritidae:						
Nerita plicata Linnaeus			x	x		x
Nerita sp. 1						x

Table 5. Continued.

	BIOTOPE 1				BIOTOPE 2	
	Facies				Facies	
	A	B	C	D	A	B
Littorinidae:						
Littorina sp. 1			x			x
Littorina sp. 2			x			
Vermetidae:						
Spiroglyphus sp. 1			x			x
Cerithiidae:						
Cerithium bacticum Pease		x	x	x	x	x
Cerithium morus Brugiere		x	x	x	x	x
Naticidae:						
Natica marochiensis Gmelin		x			x	
Cypraeidae:						
Cypraea caputserpentis Linnaeus	x					
Cypraea erosa Linnaeus		x				
Cypraea lynx Linnaeus		x				
Cypraea moneta Linnaeus		x			x	
Cypraea vitellus Linnaeus		x				
Cymatiidae:						
Cymatium pileare (Linnaeus)		x			x	
Cymatium sp. 1		x			x	
Bursa sp. 1		x			x	
Muricidae:						
Drupa arachnoides (Lamarck)	x	x		x		
Drupa grossularia Roding	x					
Drupa morum Roding	x	x		x	x	
Drupa nodus (St. Vincent)		x	x		x	x
Drupa ricina (Linnaeus)	x			x		
Morula granulata Duclos	x	x			x	
Nassa sp. 1		x				
Thais sp. 1		x				
Mitridae:						
Mitra litterata Lamarck		x			x	
Mitra papalis (Linnaeus)		x				
Vasidae:						
Vasum turbinellus (Linnaeus)	x	x				
Conidae:						
Conus catus Bruguiere		x				
Conus ceylanensis Sowerby		x			x	
Conus chaldaeus (Roding)		x			x	
Conus distans Bruguiere	x					

Table 5. Continued.

	BIOTOPE 1				BIOTOPE 2	
	Facies				Facies	
	A	B	C	D	A	B
Conus ebraeus Linnaeus		x			x	
Conus flavidus Lamarck		x			x	
Conus lividus Bruguiere		x				
Conus miles Linnaeus		x			x	
Conus pulicarius Bruguiere		x				
Conus rattus Bruguiere		x				
Terebridae:						
Terebra maculata (Linnaeus)		x				
Potamididae:						
Batillaria ? sp. 1		x				
Crustacea						
Cirripedia:						
"Barnacles" sp. 1	x					
Amphipoda:						
"Amphipod" sp. 1			x			x
Decapoda:						
Carpilleus sp. 1		x				
Grapsus sp. 1			x	x		x
Echinodermata						
Echinoidea						
Echinometra mathaei (de Blainville)	x					
Echinothrix diadema (Linnaeus)		x				
Ophiuroidea:						
"Brittle-star" sp. 1		x				
Holothuroidea:						
Actinopyga mauritians (Quoy & Gaimard)	x	x				
Holothuria argus (Jaeger)		x				
Holothuria atra (Jaeger)		x				
Holothuria sp. 1		x			x	
Stichopus chloronotus Brandt		x				

Table 6. Frequency of abundance for the dominant species of algae on the fringing reef platforms (Transects 1 and 2) and on the fringing Bay platforms (Transects 3-7). Figure 21 shows the locations of the transects. Frequency of abundance is expressed by the number of points of occurrence for each species of algae at each quadrat station. It is determined with a grid 30 cm on a side, with 36 points, each point 5 cm apart. Only those species with a frequency of abundance with a total of 5 or greater are listed.

Transect 1

	Quadrats*												
Species	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
Laurencia tropica Yamada	28	17				28	5	8	4	3			88
Cladophoropsis gracillima Dawson				2			5						7
Porolithon onkodes (Heydrich) Foslie	6	9	30	20	10		12			7			94
Cladophora sp. 1													

*Quadrats three meters apart.

Transect 2

	Quadrats*						
Species	1	2	3	4	5	6	TOTAL
Oscillatoria sp.	28	36	21				85
Calothrix crustacea B. & F.			15				15
Hypnea cf. *pannosa* J. Ag.				30	13		43
Valonia fastigiata Harvey					8	8	16
Sargassum polycystum C. Ag.					7	15	22

*Quadrats three meters apart.

Table 6. Continued.

Transect 3					Quadrats*			
Species	1	2	3	4	5	6	7	TOTAL
Gelidiella acerosa (Forsskal) Feldm. & Hamel	36	33	36	36	1	9		151
Cladophoropsis gracillima Dawson						6	1	7
Dictyophaeria cavernosa (Forsskal) Boerg.					6	9		15

*Quadrats one meter apart.

Transect 4					Quadrats*	
Species	1	2	3	4	5	TOTAL
Diatom mat	29	36	31			96
Enteromorpha sp. 1	7		5	36		48
Enteromorpha intestinalis (L.) Link					36	36

*Quadrats three meters apart.

Table 6. Continued.

Transect 5

Species	Quadrats* 1	2	3	4	5	6	TOTAL
Oscillatoria sp. 1 in Diatom mat	19	27		19	22		87
Enteromorpa sp. 1				17	12	20	49
Hypnea cf. *pannosa* J. Ag.						12	12
Enteromorpa intestinalis (L.) Link	15	6					21

*Quadrats two meters apart.

Transect 6

Species	Quadrats* 1	2	3	4	5	6	7	8	9	10	TOTAL
Oscillatoria sp.		36	36	36	36	36	36	25	26		267
Enteromorpha intestinalis (L.) Link	34										34
Enteromorpha tuberosa (Kutz.) Kutz.								11	10		21

*Quadrats two meters apart.

Transect 7

Species	Quadrats* 1	2	3	TOTAL
Enteromorpha intestinalis (L.) Link	5	7	26	38

*Quadrats four meters apart.

Table 7. Distribution and density of "limpets" in nips at Talofofo Bay. Quadrat size is (25 x 25) cm.

Transect No.

Quadrat Station	1	2	3	4	5	6	7	8
1	5	3	18 b	3 b	4	5	6 b	9
2	41 b	5	13 x	31	6	4	12 x	11
3	21	6	3 t	37 x	8	4	9	16
4	26 x	11 b		11 t	13	9	2 t	12 b
5	1 t	24 x			18 b	3		14 x
6					12 x	2		4 t
7					15 t	0		
8						3		
9						1		
10						0		
11						0 b		
12						2		
13						9 x		
14						6 t		
Total	94	71	34	82	76	48	29	66
Area (m^2)	.31	.44	.19	.25	.44	.88	.25	.38
Density (lim/m^2)	303	162	181	328	174	55	116	176
Ave. size l/w-inch					.41/.33	.40/.31	.78/.64	

b = basal part of nip.
x = deepest cut part of nip.
t = top of nip.

Table 8. Tabulation of plants and animals from Biotope 3.

Algae

Chlorophyta:

Udotea sp. 1

Rhodophyta:

Antihamnion sp. 3
Peyssonelia sp. 1
Porolithon gardineri (Foslie) Foslie

Porifera:

Astrosclera willeyana Lister

Cnidaria:

Corals - Scleractina:

Euphyllia glabrescens (Chamisso & Eysenhardt)
Favia speciosa (Dana)
Favites flexuosa (Dana)
Goniopora sp. 1
Leptastrea transversa (Klunzinger)
Leptoseris hawaiiensis Vaughan
Leptoseris incrustans (Quelch)
Montipora verrucosa (Lamarck)
Pavona varians Verrill
Plerogyra sinuosa (Dana)
Porites lobata Dana
Porites lutea Milne Edwards & Haime
Porites (S.) iwayamaensis Eguchi
Psammocora nierstraszi van der Horst
Stylocoeniella armata (Ehrenberg)

Hydrozoa - Milleporina:

Millepora exaesa Forskal

Table 9. Tabulation of plants and animals from Biotope 5.

	Talofofo Bay	Paicpouc Cove
Algae:		
Chaetomorpha sp. 1		x
Enteromorpha sp. 1		x
Callithamnion sp. 1		x
"Diatom mat"		x
Angiosperms:		
Alocasia macrorhiza (L.) Schott		x
Artocarpus mariannensis Trecul		x
Bidens pilosa L.	x	
Carica papaya L.		x
Chloris sp. 1		x
Clerodendum inerme (L.) Gaertner		x
Cocos nucifera L.	x	
Colubrina asiatica (L.) Brongniart		x
Crinum asiaticum L.		x
Derris trifoliata Loureiro	x	
Dolichos lablab L.	x	
Ficus sp. 1		x
Hernandia ovigera L.		x
Hibiscus tiliaceous L.	x	x
Ipomoea pes-caprae (L.) Roth	x	x
Melanolepis multiglandulosa (Reinwardt) Reichb.		x
Mimosa pudica L.	x	x
Morinda citrifolia L.		x
Nypa fruticans Wurmb.	x	
Panicum sp. 1		x
Phragmites karka (Retz.) Trin.	x	
Pipturus argenteus (Forster f.) Weddell		x
Pistia stratiotes L.	x	
Psidium guajava L.		x
Scaevola taccada (Gaertner) Roxburgh		x
Sophora tomentosa L.		x
Terminalia catappa L.	x	
Wedelia biflora (L.) DC.		x
Animals		
Amphipoda:		
"Amphipod" sp. 1	x	x
Decapoda:		
Grapsus sp. 1	x	x
Isopoda:		
"Isopod" sp. 1	x	x

Table 10. Tabulation of plants and animals from Biotope 7.

	Facies A	Facies B	Facies C
Algae:			
Entophysalis sp. 1	x	x	x
Rivularia sp. 1			x
Antithamnion sp. 1	x		
Champia parvula (C. Ag.) Harvey	x		
Angiosperms:			
Allophylus timorensis (DC.) Blume			x
Annona reticulata L.			x
Artocarpus mariannensis Trecul			x
Asclepias curassavica L.			x
Barringtonia asiatica (L.) Kurz			x
Bikkia tetrandra (Forst. f.) A. Rich.			x
Callicarpa candicans (Burmann fil.) Hochreutiner		x	x
Cassia occidentale L.			x
Cassia sp. 1			x
Cassytha filiformis L.	x	x	x
Casurina equisetifolia L.			x
Cestrum diurnum L.			x
Chloris sp. 1			x
Clerodendrum inerme (L.) Gaertner	x		x
Cocos nucifera L.			x
Colubrina asiatica (L.) Brongniart			x
Cordia subcordata Lamarck			x
Derris trifoliata Loureiro	x	x	x
Digitaria sp. 1			x
Emilia sonchifolia (L.) DC.			x
Eugenia sp. 1		x	x
Ficus sp. 1			x
Hedyotis foetida (Forster) J. E. Smith			x
Hedyotis sp. 1			x
Hernandia ovigera L.			x
Hibiscus tiliaceus L.	x		x
Intsia bijuga (Colebr.) O. Kuntze.			x
Jatropha curcas L.			x
Lantana camara L.			x
Leucaena leucocephala (Lam.) DeWit			x
Melanolepis multiglandulosa (Reinwardt) Reichb.			x
Melothria guamensis Merrill			x
Messerschmidia argentea (L. f.) Johnston			x
Mikania scandens (L.) Willd.			x
Morinda citrifolia L.			x
Pemphis acidula Forst.	x	x	x
Pipturus argenteus (Forster f.) Weddell			x
Phyllanthus sp. 1			x
Pithecellobium dulce (Roxb.) Bentham			x
Scaevola taccada (Gaertner) Roxburg	x	x	x
Sophora tomentosa L.			x

Table 10. Continued.

	Facies A	Facies B	Facies C
Terminalia catappa L.			x
Thespesia populnea (L.) Solander		x	x
Triphasia trifolia (Burm. f.) P. Wils.			x
Wedelia biflora (L.) DC.	x	x	x
Cyperus sp. 1	x	x	x
Animals:			
Mollusca:			
Nerita plicata Linnaeus	x		
Littorina sp. 1	x		
Tectarius sp. 1	x	x	
Decapoda:			
Grapsus sp. 1	x		
Coenobita sp. 1	x	x	x
Ostracoda:			
"Ostracod" sp. 1	x		

Table 11. List of fishes & crustaceans of recreational value in Talofofo Bay and Talofofo River.

Carangidae - Skipjacks (various species)

Sphyraena barracuda - Barracuda

Lutjanus vaigiensis and *L. argentimaculatus* - Snappers

Anguilla marmorata - Fresh water eel

Kuhliidae - *Kuhlia ruperstris*

Mugil cephalus and *Chelon vaigiensis* - Mullet

Tilapia mossembica

Meglops cyprinoides - Tarpon

Clarias batrachus - Cat fish

Siganus punctatus, *S. rostratus*, and *S. spinous* - Rabbit fish

Scylla serrata - Mangrove crab

Macrobrachium lar - Fresh water shrimp