Guam

COASTAL MANAGEMENT PROGRAM

TECHNICAL REPORTS

Volume

II

BUREAU OF PLANNING
GOVERNMENT OF GUAM
AGANA, GUAM

SEE EDGE INDEX
ON BACK COVER

GUAM COASTAL MANAGEMENT PROGRAM

TECHNICAL REPORTS

VOLUME II

BUREAU OF PLANNING
GOVERNMENT OF GUAM
AGANA, GUAM

NOVEMBER, 1977

This volume was funded in part by a grant from the Office of Coastal Zone Management U.S. Department of Commerce.

David A. Bonvouloir, Program Coordinator
Patrick D. McMakin, Editor, Planner IV

SURVEY AND SPECIES INVENTORY OF REPRESENTATIVE PRISTINE MARINE COMMUNITIES ON GUAM

By

Jeanine O. Stojkovich

Submitted to

Coastal Management Section

Bureau of Planning

Agana, Guam

University of Guam Marine Laboratory

Technical Report No. 40

October 1977

ABSTRACT

Development of coastal areas around Guam, whether it be commercial or private, is steadily on the increase. Early recognition of naturally diverse and stable areas is crucial for their subsequent protection as well as coordinated environmental usage.

Under the objectives of the Bureau of Planning, 305 Program, work request #500811-7-09, and the authority of the Coastal Zone Management Act of 1972, this survey was commissioned to assist in the designation of representative pristine marine areas to be protected from impacts of construction and development, but not to inhibit existing sport fishing and other recreational uses within controlled limits. These limits are to be set by the Bureau of Planning.

Pristine marine communities are defined as those areas that have retained or successfully reestablished their natural character, where natural character includes the biotic, and to a lesser extent abiotic, components of scientific, educational and aesthetic value.

Twelve pristine marine areas were chosen around the island representing such physiographic features as estuaries, fringing reefs, barrier reefs, patch reefs, barrier reef channels, fringing reef channels, mangrove swamps, seagrass beds, cut benches and submarine cliffs.

Selection criteria included the current GEPA water classification and number of point discharges for the area; those communities which due to their ecological character are of critical importance for scientific investigation and preservation of intact community structures; and finally those areas which may contain rare, unique or endangered species.

A brief description of the areas, their character, and the presence of endangered or threatened species is summarized. Species lists for fish, macroinvertebrates, corals and benthic algae, plus maps and field sketches are also included.

TABLE OF CONTENTS

INTRODUCTION

Guam, like any other growing area, and perhaps more so because of its island nature, must carefully regulate the use and development of its coastal areas. The effects of development by the U. S. military, private industry and more recently tourism and recreational home building have led to accelerated use and landscape alteration stresses. Even some of the more remote areas are beginning to feel such effects.

The value of protected marine areas cannot be overemphasized. They not only provide recreational, photographic and scientific exploration, but the presence of intact dynamic communities containing a diverse array of organisms, some of which may be uncommon or unique to Guam, are important indications of environmental stability. In addition to providing a buffering capacity against external disruptive forces (Odum, 1971), the diversity-stability relationship also increases the probability of some of the organisms possessing characteristics such as high specific sensitivity to certain discrete environmental changes. These organisms are known as "indicator species" and their reactions are often more sensitive than any scientific parameter. By comparative monitoring of protected marine reserves and already modified systems, then, it may be possible to detect the difference between minor, relatively insignificant changes and the major divergent trends indicative of serious environmental stress and degradation. See The Nature Conservancy (1975).

The purpose of this report is to provide preliminary data towards the recognition and establishment of pristine marine communities (natural area marine sanctuaries or areas of particular concern) on Guam under the objectives of the Coastal Management Section of the Bureau of Planning, 305 Program, work request #500811-7-09, by the authority of the Coastal Zone Management Act of 1972. This report is to assist in the designation of certain areas (of which the communities discussed are selected examples) to be protected from impacts of construction and development, but not to inhibit existing sport fishing and other recreational uses where applicable.

Scope of Work

Twelve representative pristine marine communities were selected around the island. Areas were covered seaward from the mean high tide water mark to approximately thirty meters depth. Selection criteria included:

a. representatives of the specific areas known as:
    1. estuaries
    2. fringing reefs

3. barrier reefs
4. patch reefs
5. barrier reef channels
6. fringing reef channels
7. mangrove swamps
8. seagrass beds
9. cut benches
10. submarine cliffs

b. current area usage with respect to the Guam Environmental Protection Agency (GEPA) water classification ratings and known point source discharges.

c. those areas which due to their ecological character are of utmost importance for scientific investigation and preservation of intact communities as well as of unique and rare species and their critical habitats.

d. those areas which (in accordance with "c" above) should be protected from such developments as heavy pollutant discharges, dredging, land fill, coral harvesting, etc.

Specific work items for the survey included the following for each area selected:

a. species lists for marine plants (benthic algae and seagrasses), fishes, corals and macroinvertebrates.

b. maps of each area showing the major physiographic features and locations of interesting and/or unique biotic habitats.

c. a description of each area explaining the ecological significance and any special observations or findings.

d. recognition of threatened or endangered species and their critical habitats. (See section on endangered and threatened species).

e. recommendations of performance standards for the development and/or use of land and water adjacent to the described pristine areas.

The above items are presented in a systematic way, augmented by maps, tables and photographs for each selected area. The geographic size of each area is arbitrary at this time. Specific boundary areas are to be established by the Bureau of Planning at a later date.

The twelve selected areas are representative community types. Alternative or additional area candidates are suggested at the end of each individual section.

Figure 1 shows the selected pristine areas which are discussed separately in the subsequent sections.

Pristine Marine Community

In the strictest scientific sense there are probably no pristine marine communities on Guam, for the concept itself is one of ecologic perfection demanding the total absence of human activities and influences. Certainly, there are few places anywhere that can meet such stringent requirements. Casting aside the obvious points of definitional debate, however, there can be little argument as to the presence of many natural areas on Guam that have incurred minimal human impact and whose natural web of dynamic control systems have allowed them to remain stable and essentially unspoiled.

For purposes of this report, pristine marine community shall be defined as an area that has retained or successfully reestablished its natural character. Natural character includes the biotic, and to a lesser extent abiotic components of scientific, educational and aesthetic value. Of specific interest is the preservation of natural ecologic stability through diversity and to provide critical habitats for uncommon and possibly threatened or endangered species. Such selected representative areas need not be completely undisturbed but are those in need of protection against adjacent land or water use developments involving construction, pollutant discharge, dredging, filling, coral harvesting, commercial fishing, etc. Planned recreational use and sport fishing within tolerable environmental limits is to be retained where applicable.

Threatened and Endangered Species

The recognition and classification of threatened and endangered (formerly rare) marine species on Guam is an area of acute concern. The ambiguity of the 1973 Federal Endangered Species Act (Public Law 93-205) and its lack of specifically delineated selection criteria for such biota, has led to considerable confusion over which organisms should and should not be included. For this reason several preliminary efforts to identify candidate species by interested citizens and professionals alike, have met with marginal success at best.

At the present time there are no officially threatened or endangered species of algae, macroinvertebrates, fish or corals in the coastal marine waters of Guam.*

*Personal communications from H. T. Kami (Chief Biologist-Division of Aquatic and Wildlife Resources), R. H. Randall (Coral specialist-Marine Laboratory), Dr. L. G. Eldredge (Invertebrates-Marine Laboratory), Dr. R. T. Tsuda (Marine Plants-Marine Laboratory), and Dr. S. S. Amesbury (Fish-Marine Laboratory).

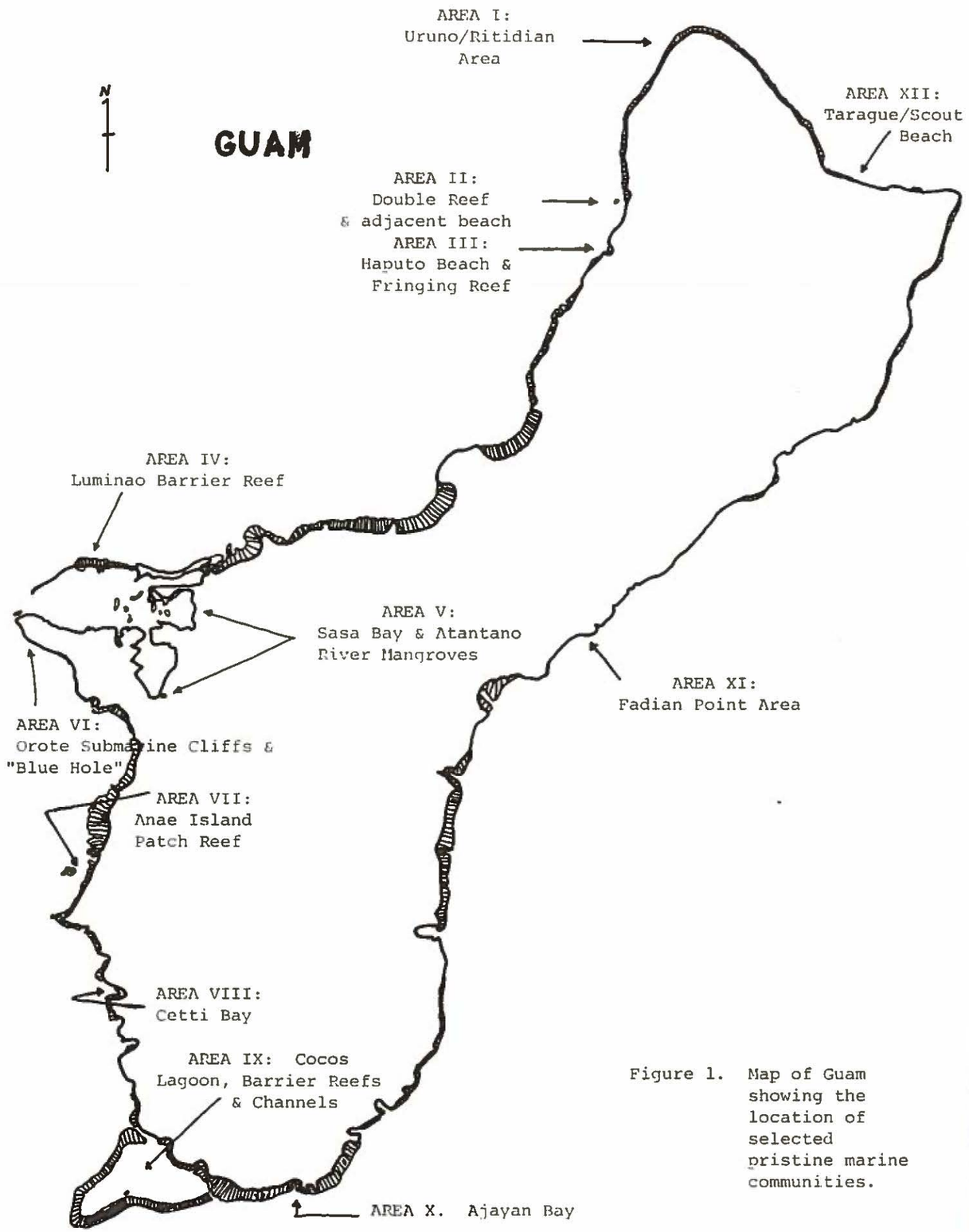


Figure 1. Map of Guam showing the location of selected pristine marine communities.

Larger pelagic (open ocean) organisms such as whales and turtles are already included in the Federal Register (U.S. Bureau of Sport Fisheries, 1973) and will not be discussed here. The fact that none are officially listed however, does not mean that such organisms do not exist, for undoubtedly they do. What it does mean is that systematic scientific investigation has not been conducted to realistically ascertain whether or not a species is genuinely threatened or endangered. The fact that a species has been seen in one locale does not justify its being classified as threatened or endangered since in most cases no one has searched for it elsewhere. Second, an uncommon organism on Guam may be found abundantly on other Micronesian islands. The range of organisms throughout Micronesia is not known.

In this report, threatened or endangered is used in a tentative sense only. Some of these organisms definitely need further investigation so that they may be nominated for official listing in the Federal Register. Table 1 lists those organisms thought to be threatened or endangered on Guam with pertinent information on location and status.

For additional information the reader is refered to O'Connor (1974) and Threatened Wildlife of the U. S., Resource Publication 114 (1973).

GEPA Water Quality Standards

The Guam Environmental Protection Agency (1975) recognizes two water quality classifications for the coastal marine waters of Guam (Fig. 2). These are:

Category "AA" = conservation

> The uses to be protected in this category of waters are marine research, propagation of aquatic life (particularly coral reef organisms), conservation of wilderness areas, aesthetic enjoyment, and such recreational activities as do not impair the other established uses. This category of waters shall remain free from pollution attributable to domestic, commercial, and industrial discharges or agricultural, construction and other land-use practices that impair their protected use. . .

Category "A" = recreational

> The uses to be protected in this category of waters are recreation (including swimming, surfing, skin and SCUBA diving, skiing, and other primary contact sports), aesthetic enjoyment, propagation of aquatic and associated wildlife, commercial, industrial and navigational uses.

Table 1. Coastal marine organisms thought to be rare (R) or uncommon (U) to Guam. Some of the listed organisms may be endangered or threatened species candidates for the Federal Register. These species are indicated with an asterick (*).

SPECIES	STATUS	REPORTED LOCATION
CORALS		
Euphyllia sp	R*	--
Pachyclavularia violacea	U	Orote submarine terrace
Pavona frondifera	U	Apra Harbor
Pectinia lactuca	U	Apra Harbor
Plerogyra sinuosa	R*	--
Tubastraea aurea	R*	Double Reef, Apra Harbor, Manell Channel
FISHES		
None		
ALGAE		
None		
MACROINVERTEBRATES		
ARTHROPODA		
Birgus latro	U	--
MOLLUSCA		
Cassis cornuta	U	--
Charonia tritonus	U	--
Cypraea aurantium	U	--
Tridacna maxima	U	--
CHORDATA		
Chelonia mydas (Green Turtle)	On Federal Register	variable
Eretmochelys imbricata (Hawksbill Turtle)	On Federal Register	variable
MANGROVE PLANTS		
Barringtonia racemosa	*	These organisms are locally abundant but their critical habitat is severely threatened. These plants could literally be lost overnight.
Bruguiera gymnorrhiza	*	
Lumnitzera littorea	*	
Rhizophora apiculata	*	
Rhizophora mucronata	*	
Xylocarpus moluccensis	*	

The main distinction between the two classifications is the allowance of commercial, industrial and navigational uses in the latter. In both cases pollutant discharges are to be controlled to meet the specific requirements of each, the requirements being more rigorous in the "AA" category.

In the majority of the cases the selected pristine communities lie within the "AA" classification. Exceptions are noted. Figure 2 maps the categories for the island.

Background

No broad study has been made of representative pristine marine community types as outlined above for the express purpose of the eventual establishment of marine sanctuaries, although several detailed studies have been done on specific locales, usually in conjunction with other developmental projects.

The Guam National Seashore proposal of 1967 wished to set aside most of the southern end of the island including the coastal areas extending from Facpi Point to Ajayan Bay. The large area involved and the implications of controlling such an area were among the factors leading to its demise. Currently, a new proposal is under review which will set aside sanctuaries under a similar plan.

The single best overview of geology, hydrology and physiography of Guam's coastal regions can be found in Coastal Survey of Guam (Randall and Holloman, 1974). The report contains numerous maps, tables, photographs and an extensive review of the related literature, especially that of Emery (1962).

Basic coastal outlines and fringing reef contour maps including brief physiographic descriptions and the presence of seagrass beds can be found in the Atlas of Reefs and Beaches of Guam (Randall and Eldredge, 1976). This atlas served as a mapping base in this report.

The Preservation of Natural Diversity: A Survey and Recommendations (Nature Conservancy, 1975) presents an excellent overview and in-depth discussion of possible conservation approaches and their legal implications. Specific national and international examples of functioning sanctuaries systems are given. A full discussion of these factors is beyond the scope of this paper but interested persons are strongly encouraged to consult this report.

Biotic information and species lists were obtained from several sources plus additional field visits. Those technical reports, marine environmental surveys, miscellaneous reports and personal communiques are reviewed and referenced for each individual area and included at the end of each section.

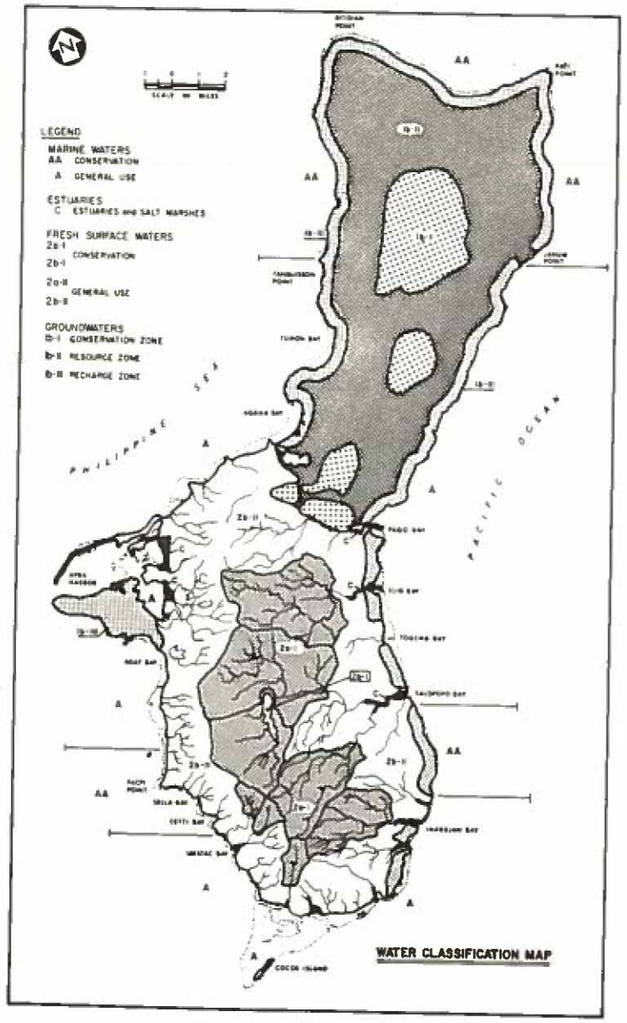


Figure 2. Guam Environmental Protection Agency water classification system. AA = conservation, A = recreational. (Courtesy GEPA)

METHODS

General study site information including both physiographic and biotic data was gleaned from the existing literature whenever possible. In most cases this proved insufficient and field visits were necessary. These consisted of single day reconnaissance trips to each area.

Field notes, sketches and photographs of reef detail were compiled and are shown on the maps for each area. All maps are 1:4800 scale unless otherwise specified using the Atlas of Reefs and Beaches of Guam (Randall and Eldredge, 1976) as a base. Reef and offshore details are included but are not to scale.

Information on species composition at each site was obtained by having all investigators snorkel or SCUBA through the area. Each person concentrated on a particular component, i.e., marine plants, fish, corals or macroinvertebrates, qualitatively noting the predominant species and/or any striking peculiarities of community size, diversity or distribution. Although six standard physiographic zones (intertidal, inner/outer reef flat, margin, margin face, submarine terrace and slope) are typically recognized, in many cases they have been "lumped together" biologically. This proved necessary based on available information and differing physical characteristics of each area.

It must be emphasized that no transects or other quantitative sampling methods were employed. No statistical inferences regarding abundance or density should be drawn from the species lists.

It is also noted that one day visits to an area necessarily preclude generation of a complete species list. This is particularly important with respect to transient individuals such as fish. Species lists for the Cocos area, Sasa Bay and the Uruno-Ritidian areas are fairly complete based on previous more extensive investigations. Obviously, no information is available for diurnal or seasonal biotic changes in species composition. The included lists are preliminary and cursory at best. Absence of common genera does not necessarily mean that they are not there but that they were not observed at the time of the study. Additions are expected and welcome.

AREA I:
URUNO-RITIDIAN AREA

The extreme northwestern coast of Guam extending from Falcona Beach north to Ritidian Point is the longest stretch of pristine beach on the island. The entire area lies within Andersen Air Force Base military reservation and, with the exception of a few private roads, the area is largely inaccessible to the public. Heavy swells and strong currents, especially near Ritidian, often make boat access hazardous as well.

A small section of reef flat between Ritidian Channel and Achae Point was selected (Fig. 3). The area was chosen because of its cuestal algal ridge and reef flat platform development, typical of northwest Guam. The reef flat extending from Achae to Uruno is similar although a deeper moat has resulted in a more highly developed coral community in several places. For purposes of this report, the general community types are lumped together.

Two previous studies have been conducted in the area. Dickinson and Tsuda (1975) investigated the biological and environmental impact of resort development at Uruno. Their species lists have been used to augment these listings, (Tables 2-5). Randall and Holloman (1974) studied the geology, hydrology and physiography of this coastal sector. Portions of their physiographic description are incorporated here.

The Guam Environmental Protection Agency's water quality classification for this area is "AA", conservation. No point source discharges are known in this area (Shidel, 1977).

The study site was divided into three broad zones (Fig. 4); (1) the reef flat and associated moat, (2) reef margin and face with its cuestal algal ridge, and (3) the submarine terrace and slope.

The sandy inner reef flat zone was only sparsely inhabited with the marked exception of Caulerpa antoensis, a small rhizoidal green alga able to tolerate constantly shifting sands. A shallow and well developed moat, ranging from 1-1.5 meters deep, extended out to the reef margin and algal ridge. Coral development in particular became progressively more luxurious, seaward towards the back side of the algal ridge. Small, low relief colonies gave way to larger thickets and colonies of Acropora and Porites. Goniastrea retiformis, Pocillopora damicornis, Psammocora contigua and Millepora species were also abundant. Towards Uruno, higher relief colonies were more common.

The moat and outer reef platform contained a rich composition of both turf and fleshy algae. Chlorodesmis, Halimeda, Caulerpa,

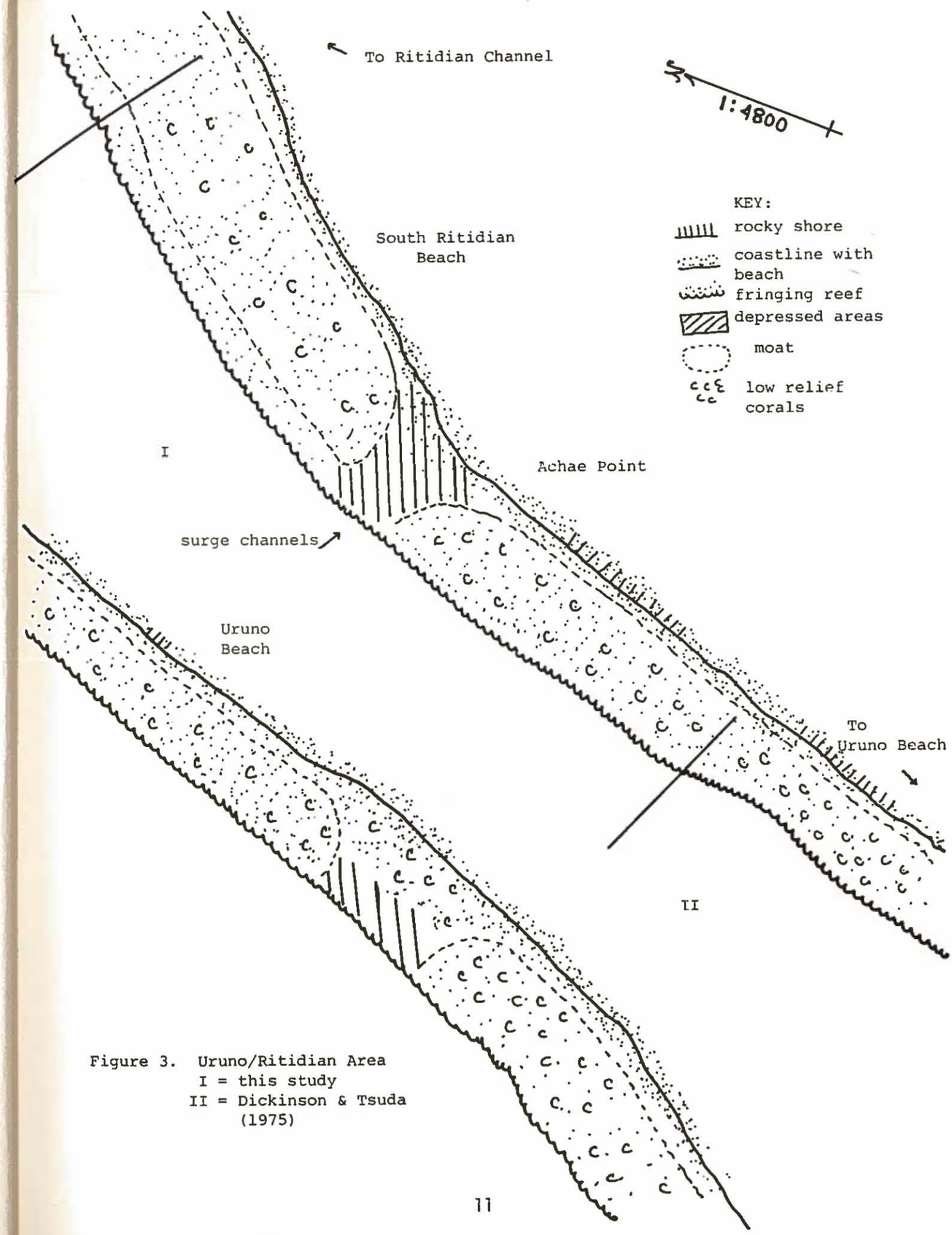


Figure 3. Uruno/Ritidian Area
I = this study
II = Dickinson & Tsuda (1975)

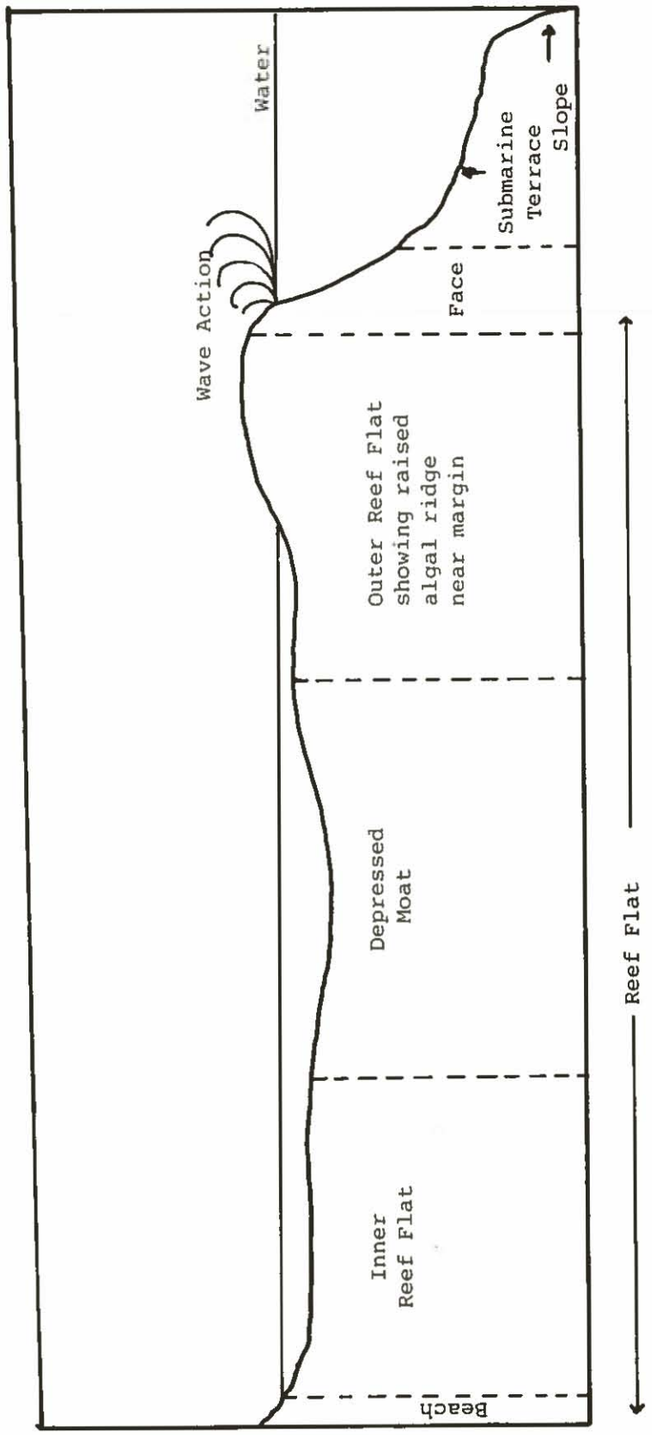


Figure 4. Generalized profile of major reef divisions along the northwest coast of Guam.

Boodlea, Turbinaria and Gelidium species were visually dominant though many species were observed.

A wide and colorful variety of fish were observed in the moat area. Chaetodontids, pomacentrids, acanthurids and balistids were abundant. These are among the most beautiful reef fishes.

Dominant macroinvertebrates in this zone included the sea cucumbers Holothuria atra and Stichopus chloronotus, and the blue starfish Linckia laviegata.

The second zone was characterized by a cuestal algal ridge. The Uruno-Ritidian area is a good representative of this type of margin development. The ridge is typically above the high water line and continuously wave washed. A thick orange mat of the red alga Gelidiella acerosa covers the entire ridge. The coralline alga Porolithon onkodes was also dominate though less conspicuous. Small Pocillopora colonies were found in a few sheltered crevices.

The third zone consisted of a terrace 5-10 meters in width which abruptly dropped to approximately 15 meters. Scoured surge channels up to 8 meters wide cut through the reef platform in several places allowing free access between the reef platform and terrace.

Coral cover was moderate to sparce in this zone due to heavy Acanthaster planci predation in the late sixties (Chesher, 1969). Recolonization is evident but a low relief is still maintained. The encrusting coral Montipora is quite common in several different colors. Favia, Platygyra, Porites and Pocillopora species were also common.

Algal cover was rich with the larger forms prevalent. Halymenia, Galaxaura and Halimeda species dominated.

The radical topography, holes, overhangs and crevices present in the terrace and slope zones have created numerous habitats for fish and invertebrates. Acanthurids, blennies, pomacentrids and labrids were abundant. Larger game fish and grey sharks are known to inhabit the area though none were seen.

The Federally endangered hawksbill turtle (Eretmochelys imbricata) has been seen in this area in the deeper slope waters. This is probably a transient condition. No other threatened or endangered species are known for this area.

CONCLUSIONS AND RECOMMENDATIONS

The coastline extending from Uruno Point to Ritidian, a distance of approximately 1.9 kilometers is one of the most pristine stretches of beach and reefs on Guam. The size of this area necessarily pre-

cluded its entire consideration in this report. However, it is strongly recommended that the entire coastal sector be made a reserve if possible. Any section of this strip could serve as an alternative site.

The presence of many beautiful corals and fish on both the reef flat platform and terrace areas, combined with an abundance of game fish, striking topography and clear water, make this area a strong preservation candidate.

The following recommendations are suggested:

1) that this area be established as a natural marine sanctuary in which no coral harvesting, net fishing or other such activity be permitted.

2) because of heavy swells and strong currents, recreational development is probably not a viable alternative without major developmental modification (Dickinson and Tsuda, 1975).

Table 2. Checklist of benthic algae observed at the Uruno/Ritidian study site. * = observed by Dickinson and Tsuda (1975).

SPECIES	ZONES 1	2	3
CYANOPHYTA (blue-green algae)			
Microcoleus lyngbyaceus	x	x	x
Schizothrix calcicola	x	x	x
S. mexicana	x	x	x
CHLOROPHYTA (green algae)			
Boergesenia forbesii	x		
Boodlea composita	x		
Caulerpa antoensis	xx		
C. racemosa	x	x	
*C. serrulata	x	x	
Chlorodesmis fastigiata	x	x	
*Cladophoropsis membranacea	x		
*Dictyosphaeria cavernosa	x		
D. versluysii	x		
*Enteromorpha clathrata			x
*Halimeda copiosa		x	x
*H. discoidea		x	x
H. incrassata		x	x
H. opuntia	x	x	x
H. velasquezii	x		x
*Microdictyon okamurai	x	x	
Neomeris annulata	x	x	x
*Neomeris vanbosseae	x	x	x
*Valonia aegagropila	x		
Valonia ventricosa	x	x	
*Valoniopsis pachynema	x		
PHAEOPHYTA (brown algae)			
Dictyota bartayresii	x		
D. friabilis		x	x
*Feldmannia indica	x		x
Lobophora variegata	x	x	x
Padina jonesii		x	x
P. minor	x		
*Ralfsia pangoensis	x		
Sargassum cristaefolium		x	
*Sphacelaria tribuloides		x	x
Turbinaria ornata	x	x	

Table 2. (continued)

SPECIES	ZONES 1	2	3
RHODPHYTA (red algae)			
Actinotrichia fragilis		x	
Amphiroa fragilissima	x	x	
*Champia parvula	x		
*Chondria sp.	x		
*Dasyphila plumarioides		x	
Desmia hornemanni		x	
*Galaxaura filamentosa	x		
G. marginata	x	x	
G. oblongata	x	x	
Gelidiella acerosa	x	xx	
Gelidiopsis intricata	x	x	
Gelidium pusillum	x	x	
Gelidium sp.		x	x
*Hypnea cervicornis		x	
Jania capillacea	x	x	x
*Leveillea jungermannioides		x	
Liagora sp.		x	
Polysiphonia sp.	x	x	x

Table 3. Checklist of corals observed at the Uruno/Ritidian study site. * = observed by Dickinson and Tsuda (1975).

SPECIES	ZONES 1	2
ANTHOZOA		
THAMNASTERIIDAE		
Psammocora contigua	x	x
POCILLOPORIDAE		
Styolphora mordax	x	
Pocillopora damicornis	x	
P. elegans	x	
P. setchelli	x	
*P. verrucosa		x
ACROPORIDAE		
*Acropora abrotanoides		x
A. aspera	x	
A. hebes	x	
*A. irregularis	x	x
A. nasuta		x
A. squarrosa	x	
*A. tubicinaria	x	
*Astreopora listeri		x
*A. myriophthalma		x
*Montipora conicuia		x
M. ehrenbergii		x
*M. floweri		x
*M. tuberculosa		x
*M. verrucosa		x
AGARICIIDAE		
*Pavona clavus		x
*P. varians	x	
FUNGIIDAE		
Fungia fungities		x
PORITIDAE		
*Porites lichen		x
P. lutea	x	x

Table 3. (continued)

SPECIES	ZONES 1	2
FAVIIDAE		
Favia pallida		x
*F. stelligera		x
Favites virens		
*Oulophyllia crispa	x	
Plesiastrea sp.		x
*Goniastrea pectinata		x
G. retiformis		x
Platygyra rustica		x
P. sinensis		x
*Leptoria phrygia		x
L. sp.		x
Leptastrea purpurea		x
Cyphastrea chalcidicum		x
*C. serailia		x
MUSSIDAE		
Acanthastrea echinata		x
HELIOPORIDAE		
Heliopora coerulea		x
ALCYONIIDAE		
Lobophytum crebriplicatum	x	x
Sinularia densa	x	x
NEPHTHEIDAE		
Stereonephthya sp.		x
HYDROZOA		
MILLEPORIDAE		
Millepora dichotoma	x	
M. exaesa		x
M. platyphylla		x

Table 4. Checklist of common macroinvertebrates observed at the Uruno/Ritidian study site. * = observed by Dickinson and Tsuda (1975).

SPECIES	ZONES 1	2	3
PORIFERA			
Cinachyra australiensis	x		
MOLLUSCA			
GASTROPODA			
Astrea rhodostoma	x		
*Conus chaldaeus	x		
*C. ebraeus	x		
*C. miles	x		
*C. miliaris	x		
*C. sponsalis	x		
*Cymatium poleare	x		
*Cypraea meneta	x		
*C. tigris	x		
Drupa clathrata	x		
D. morum	x		
D. ricinus	x		
*Lambis sp.	x		
*Latirus sp.	x		
Thais armigera	x		
*T. tuberosa	x		
*Nerita plicata	x		
Trochus niloticus	x		
*Turbo argyrostoma	x		
*Vasum ceramicum	x		
V. turbinellus	x		
BIVALVIA			
Tridacna maxima	x		
ECHINODERMATA			
ASTEROIDEA			
*Choriaster granulatus	x		
*Culcita novaeguineae	x		
Linckia laevigata	x		
L. multiflora	x		
L. pacifica	x		

Table 4. (continued)

SPECIES	ZONES 1	2	3
ECHINOIDEA			
*Echinometra mathaei	x		
Echinostrephus aciculatus	x		
Echinothrix diadema	x		
HOLOTHUROIDEA			
Actinopyga echinites	x		
Bohadschia argus	x		
B. bivittata	x		
Holothuria atra	x		
*H. cinerascens	x		
*H. difficilis	x		
*H. hilla	x		
H. nobilis	x		
Stichopus chloronotus	x		
ARTHROPODA			
CRUSTACEA			
Calcinus gaimardi	x		
Dardanus guttatus	x		

Table 5. Checklist of fishes observed at the Uruno/Ritidian study site. * = observed by Dickinson and Tsuda (1975).

SPECIES	ZONES 1	2	3
ACANTHURIDAE			
Acanthurus glaucopareius	x		
A. guttatus	x	x	
A. lineatus	x	x	
A. nigrofuscus	x		
*A. olivaceous	x		
A. triostegus	x		
Ctenochaetus striatus	x		
Naso lituratus	x		
APOGONIDAE			
*Cheilodipterus quinquelineata	x		
BALISTIDAE			
Balistapus undulatus	x		
Balistes chrysopterus	x		
Melichthys vidua	x		
*Rhinecanthus rectangulus	x	x	
BLENNIIDAE			
Cirripectes variolosus		x	x
C. sp.		x	x
Plagiotremus tapeinosoma	x		
BLOTHIDAE			
*"Bothid sp."			
CANTHIGASTERIDAE			
Canthigaster solandri	x		
CARCHARHINIDAE			
Carcharhinus melanopterus			x
C. menisorrah			x
CHAETODONTIDAE			
*Centropyge flavissimus	x		

Table 5. (continued)

SPECIES	ZONES 1	2	3
*Chaetodon auriga	x		
C. citrinellus	x		
C. ephippium	x		
C. ornatissimus	x		
C. quadrimaculatus	x		
*Megaprotodon strigangulus (=C. trifascialis)	x		
Pomacanthus imperator	x		
CIRRHITIDAE			
Cirrhitus pinnulatus	x	x	
Paracirrhites forsteri	x		
P. hemistictus		x	x
FISTULARIIDAE			
Fistularia sp.	x		
GOBIIDAE			
*Eleotrides strigatus	x	x	
Ptereleotris tricolor	x		
HOLOCENTRIDAE			
*Adioryx sp.	x		
LABRIDAE			
Anampses caeruleopunctatus	x		
*Cirrhilabrus sp.	x		
Cheilinus rhodochrous	x		
C. trilobatus	x		
Gomphosus varius	x		
Halichoeres hortulanus (=H. centiquadrus)	x	x	
*H. marginatus	x	x	
*H. trimaculatus	x	x	x
*Hemigymnus fasciatus		x	
*H. melapterus		x	
Labroides dimidiatus	x	x	
Macropharyngodon pardalis	x		
*Stethojulis axillaris	x	x	
S. bandanensis	x		
Thalassoma fuscum		x	x
*T. hardwickei		x	

Table 5. (continued

SPECIES	ZONES 1	2	3
T. purpureum		x	x
T. quinquevittata		x	
LUTJANIDAE			
Caesio sp.	x		
Lutjanus monostigmus		x	x
Lutjanus sp.			x
*Scolopsis cancellatus		x	
MONACANTHIDAE			
Amanses sp.	x		
MUGILOIDIDAE			
*Parapercis cephalopunctatus		x	
MULLIDAE			
*Mulloidichthys auriflamma		x	
*M. samoensis		x	
Parupeneus bifasciatus	x		
P. cyclostomus		x	
P. multifasciatus	x	x	
P. pleurostigma		x	
POMACENTRIDAE			
*Abudefduf amabilis (=Glyphidodontops leucopomus)	x		
*A. dicki (=Plectroglyphidodon dickii)	x		
*A. glaucus (=Glyphidodontops glaucus)	x		
*A. leucopomus (=Glyphidodontops leucopomus)	x		
*A. leucozona (=Glyphidodontops leucozona)	x		
*A. septemfasciatus	x		
*A. sordidus	x		
*Chromis caeruleas	x		
*Dascyllus aruanus	x		
Glyphidodontops leucopomus		x	x
Plectroglyphidodon dickii	x		
P. imparipennis	x		
P. leucozona		x	x
P. phoenixensis			x
*Pomacentrus amboinensis	x		

Table 5. (continued)

SPECIES	ZONES 1	2	3
*P. nigricans (=Eupomacentrus nigricans)	x		
*P. vaiuli	x	x	
SCARIDAE			
Scarus sordidus	x		
S. sp.	x		
Xanothon margaritus		x	
SERRANIDAE			
Epinephelus sp.	x		
TETRAODONTIDAE			
*Arothron hispidus		x	
TRIAKIDAE			
Triaenodon obesus		x	
ZANCLIDAE			
Zanclus cornutus	x		

AREA II:
DOUBLE REEF

Located on the northwest coast of Guam, between Falcona Beach and Pugua Point, Double Reef consists of a narrow fringing reef and an adjacent patch reef, approximately 350 meters off shore (Fig. 5). The surrounding land is part of the U. S. Naval Communications Finegayan Military Reservation and the Federal Aviation Administration. Calm seas and good anchorage make water access possible throughout most of the year. No land access is possible. Clear water and changing topography, combined with two highly diversified reef communities, make Double Reef an excellent representative pristine marine area.

No previous survey has been done for the Double Reef area with respect to the marine biotic community. A partial physiographic description of the area is given by Randall and Holloman (1974). The following summary is taken in part from their report.

Double Reef is a small oval patch reef measuring approximately 300 meters in diameter. The upper surface of the reef is typically wave-washed and occasionally exposed during low spring tides. An adjacent developmental reef front and submarine terrace zone extend both northwest and shoreward to the fringing reef platform. A sandy channel floor lies south of the patch reef. Many holes, and coral ridges with equivalent reliefs of 20-50 feet (6 - 15 meters) are located shoreward on the submarine terrace. The range of topography and its beauty make Double Reef a favorite recreational spot for SCUBA diving, fishing and photography.

The Guam Environmental Protection Agency water rating for the Double Reef area is "AA" - conservation. No point source discharges are known in the area (Shidel, 1977).

Two visits were made to the Double Reef area. For purposes of this discussion the study area was divided into four zones: (1) the inner reef flat, (2) outer reef flat and margin face, (3) submarine terrace with its massive coral ridges and sand channels and (4) the patch reef. Tables 6 through 9 list the various species observed in the four zones.

Zone 1, the inner reef flat platform, consisted of a narrow, poorly developed, sand covered limestone pavement. Freshwater springs were abundant. The green alga, Enteromorpha clathrata and the invertebrate Holothuria atra were the only organisms observed. Most of the platform is exposed at low tide.

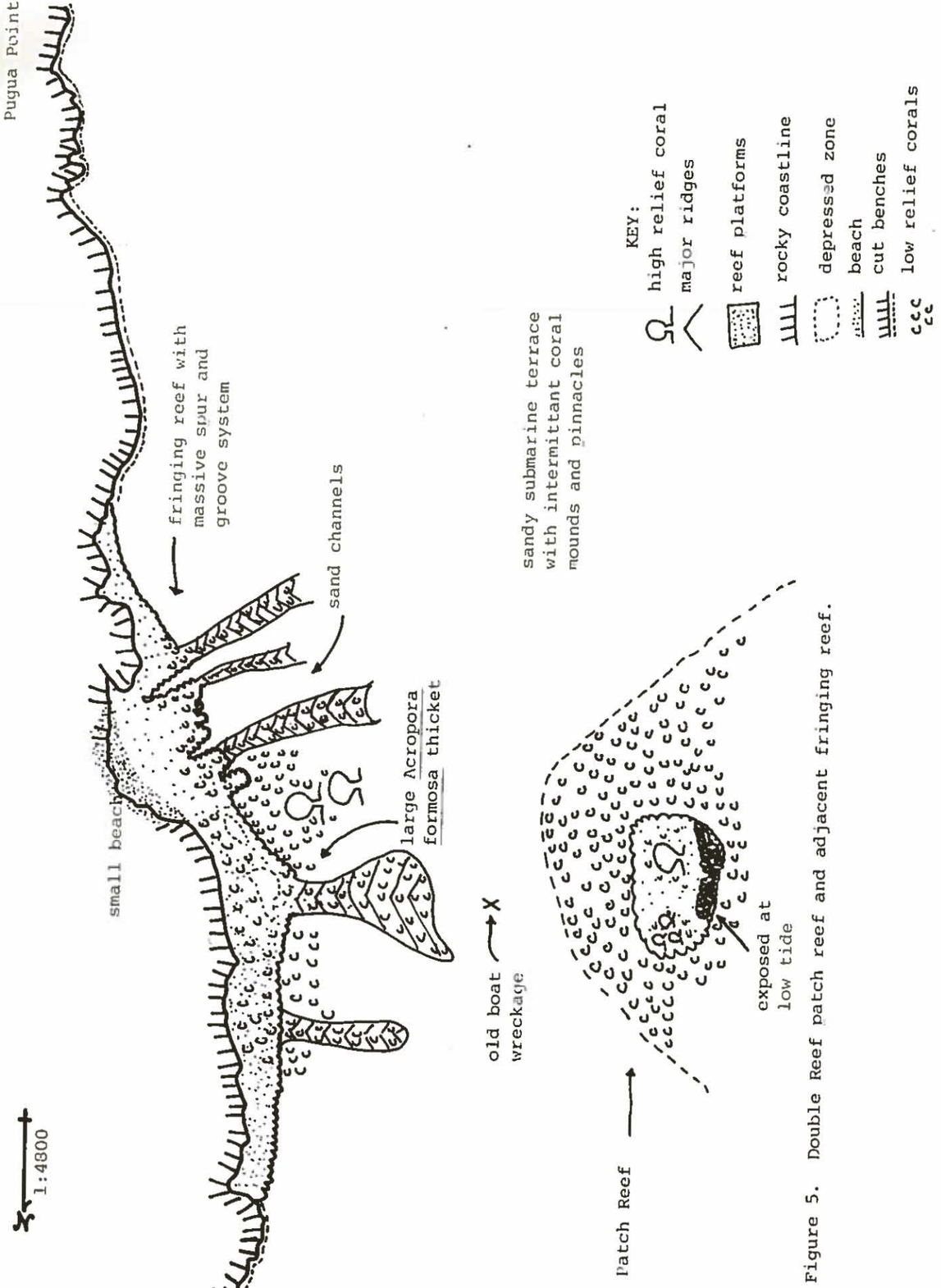


Figure 5. Double Reef patch reef and adjacent fringing reef.

The outer reef flat and margin face (Zone 2) were characterized by a porous substratum riddled with small channels, indentations and holes, some measuring 8-10 meters in depth. In several places grooves were overgrown at the top by calcareous algae and coral, forming semi-enclosed overhangs which formed a triangle in cross-section. Holes in the ceiling structure admit light, creating spectacular and well protected habitats for a wide variety of organisms, especially fish. This honeycombed reef structure was similar to that found at Haputo Reef approximately one mile south.

Coral coverage was high and remarkably diverse for northwestern Guam. In general, colonies tended to be of low relief and of the encrusting type. Many attractively branched and colorful Pocillopora and Acropora species were noted.

The honeycombed reef structure has resulted in a highly diversified and exceedingly rich ichthyofauna. Twenty-four families representing 108 species were identified for the three combined areas. With more observations this could be increased by 25-30 percent. Chaetodontids and pomacentrids were visually dominant.

Algal cover was rich and diverse. Both turf and fleshy algae were well represented. Gelidium, Ceramium and Polysiphonia species along with Halimeda, Chlorodesmis, Dictyota, Galaxaura, Mastophora and Amphiroa species dominated. Of special importance were the crustose and coralline red algae. Mesophyllum, Lithophyllum, Lithoporella and Corallina species were abundant though less impressive than those specimens observed at Haputo.

Macroinvertebrates seemed to be fairly evenly dispersed. The blue starfish Linckia laviegata and the holothurion Stichopus chloronotus were common. The "crown-of-thorns" starfish, Acanthaster planci was only observed twice. See Table 8.

The submarine terrace (Zone 3) was characterized by massive coral ridges. This physiographic feature was not well developed at Haputo. The ridges rise at angles of 45 degrees or more from wide sand channel floors to within 3 meters of the surface. Many were 10 meters or more in height and 100-120 meters long, gradually tapering off with the terrace floor.

Because of the widely variable relief in this zone, considerable differences in community structure were apparent. The massive coral ridges were virtually covered by small Pocillopora and Acropora colonies with a variety of other genera interspersed. In several places massive Porites and Acropora mounds and pillars added to the relief. Directly opposite the patch reef, two extensive thickets of the staghorn coral, Acropora formosa, extended from the reef margin to the terrace.

Much of this zone, notably south of the patch reef, consisted of sand floors with little vegetation. In one area the wreakage of an old boat has created an artificial reef for many colorful corals and fishes.

The diversity of marine plants was somewhat less than that observed in Zone 2. Chlorodesmis, Halimeda, Galaxaura, Desmia and Turbinaria species were visually dominant in addition to many turf algal species. Particularly striking was the fleshy red alga, Halymenia durvillaei. Some of the bushy thalli were one meter tall.

The patch reef (Zone 4) consisted of reef-rock pavement with local patches of sand, rubble and scattered coral/algal communities. The extreme western side of the patch reef is almost continuously wave washed. The turf alga, Gelidiella acerosa, and the fleshy algae, Halimeda, Dictyota and Galaxaura species were conspicuous, although many other genera were also present in abundance.

CONCLUSIONS AND RECOMMENDATIONS

The Double Reef area represents a rich and diverse pristine marine community. The "rare to Guam" coral, Tubastraea aurea, has been reported by Randall in this area. No threatened or endangered species have been identified specifically for this area, although it is important to realize that the fragile nature of any pristine community is such that anything short of preservation and controlled recreational use could result in a large number of species being locally threatened in a short time.

The following recommendations are suggested for the Double Reef area:

1) that this area be established as a natural sanctuary in which no coral harvesting, fishing or other such activity be allowed.

2) that swimming, snorkeling and SCUBA diving activities should be retained.

3) that a "Thermos Law" be enforced to halt beverage can litter.

Table 6. Checklist of benthic algae observed at Double Reef.

SPECIES	ZONES 1	2	3	4
CYANOPHYTA (blue-green algae)				
Microcoleus lyngbyaceus	x	x	x	x
Schizothrix calcicola		x		x
Schizothrix mexicana		x	x	x
CHLOROPHYTA (green algae)				
Boergesenia forbesii		x		
Bryopsis pennata		x		x
Boodlea composita		x		
Caulerpa racemosa		x	x	x
C. serrulata		x	x	x
Chlorodesmis fastigiata		x	x	x
Codium edule		x		
Dictyosphaeria versluysii		x		x
Enteromorpha clathrata	x			
Halimeda macroloba			x	x
H. opuntia		x	x	x
H. velasquezii		x		x
Neomeris annulata		x	x	x
Rhipilia orientalis		x		
Tydemannia expeditionis		x	x	
Udotea argentea			x	x
U. geppi			x	
Valonia ventricosa		x		
PHAEOPHYTA (brown algae)				
Dictyota bartayresii		x	x	x
D. divaricata			x	x
C. friabilis		x	x	
Lobophora variegata		x	x	x
Padina jonesii			x	
P. tenuis		x		x
Turbinaria ornata			x	x
RHODOPHYTA (red algae)				
Actinotrichia fragilis		x		
Amphiroa foliacea		x		
A. fragilissima		x		

Table 6. (continued)

SPECIES	ZONES 1	2	3	4
Centroceras minutum		x		
Ceramium gracillimum		x		
C. sp.		x		
Corallina sp.		x		x
Desmia hornemanni		x		x
Galaxaura marginata		x	x	x
Gelidiella acerosa				x
Gelidium crinale		x		
G. divaricatum		x		
Halymenia durvillaei		x	x	x
Hypnea pannosa		x		x
Jania capillacea		x		x
J. tenella		x	x	x
Leveillea jungermannioides		x		
Lithophyllum sp.		x		
Lithoporella sp.		x		
Mastophora sp.		x	x	x
Mesophyllum mesomorphum		x		
Peyssonelia rubra		x		
Porolithon onkodes		x		x

Table 7. Checklist of corals observed at Double Reef.

SPECIES	ZONES 2-3	4
ANTHOZOA		
THAMNASTERIIDAE		
Psammocora (S.) sp.		x
POCILLOPORIDAE		
Stylophora mordax	x	x
Pocillopora damicornis	x	x
P. elegans	x	x
P. meandrina		x
P. sp. 1	x	x
P. sp. 2		x
ACROPORIDAE		
Acropora cuneata	x	x
A. nana	x	x
A. humilis	x	
A. irregularis	x	
A. nasuta	x	x
A. squarrosa	x	x
A. formosa	x	
A. sp. 1	x	x
A. sp. 2	x	x
Montipora ehrenbergii	x	x
M. foveolata		x
M. tuberculosa		x
M. sp.	x	
PORITIDAE		
Goniopora columna		x
Porites lutea	x	x
P. matthaii	x	
P. sp. 1	x	x
P. sp. 2		x
P. sp. 3		x
FAVIIDAE		
Favia sp. 1	x	x
F. sp. 2	x	
Favites abdita	x	

Table 7. (continued)

SPECIES	ZONES 2-3	4
Plesiastrea sp.	x	
Goniastrea sp.	x	
Platygyra sinensis	x	
P. sp.	x	
Leptoria sp.	x	x
Leptastrea sp.		x
OCULINIDAE		
Galaxea sp.	x	x
MUSSIDAE		
Lobophyllia sp. 1	x	x
L. sp. 2		x
HELIOPORIDAE		
Heliopora coerulea		x
ALCYONIIDAE		
Lobophytum sp.	x	
Sarcophyton trocheliophorum	x	x
Sinularia densa	x	x
S. sp.	x	
ZOANTHIDAE		
Palythoa sp.	x	
HYDROZOA		
MILLEPORIDAE		
Millepora dichotoma	x	x
M. platyphylla	x	x
M. tenera	x	
STYLASTERIDAE		
Distichopora violacea	x	

Table 8. Checklist of common macroinvertebrates observed at Double Reef.

SPECIES	ZONES 1	2	4
PORIFERA			
Cinachyra australiensis		x	x
MOLLUSCA			
AMPHINEURA			
Unknown sp.		x	
GASTROPODA			
Astraea rhodostoma		x	
Conus ebraeus		x	
C. flavidus		x	
C. lividus		x	x
C. miles		x	x
C. rattus		x	x
C. sponsalis		x	
Cypraea caputserpentis		x	x
C. moneta		x	x
Drupa morum		x	x
D. ricinus		x	x
Mancinella tuberosa		x	
Morula granulata		x	
M. uva		x	x
Patella sp. 1		x	
P. sp. 2		x	
Trochus niloticus		x	x
Tectus pyramis		x	x
Vasum ceramicum		x	
V. turbinellus		x	
BIVALVIA			
Tridacna maxima		x	x
CEPHALOPODA			
Unknown octopus sp.		x	
ECHINODERMATA			
ASTEROIDEA			
Acanthaster planci		x	x

Table 8. (continued)

SPECIES	ZONES 1	2	4
Culcita novaguineae		x	
Linckia laevigata		x	x
ECHINOIDEA			
Echinometra mathaei		x	x
Echinostrephus aciculatus		x	
Echinothrix sp.		x	x
Heterocentrotus mamillatus		x	
HOLOTHUROIDEA			
Actinopyga echinites		x	x
Bohadschia argus		x	
Holothuria atra	x	x	
H. nobilis		x	x
Stichopus chloronotus		x	
OPHIUROIDEA			
Ophiocoma erinaceus		x	
O. sp.		x	
ARTHROPODA			
CRUSTACEA			
Grapsus grapsus		x	
Hapalocarcinus marsupialis		x	
Panulirus versicolor		x	
Trizopagurus strigatus		x	

Table 9. Checklist of fishes observed at Double Reef.

SPECIES	ZONES 2-3	4
ACANTHURIDAE		
Acanthurus glaucopareius	x	x
A. lineatus	x	x
A. nigrofuscus	x	x
A. sp.	x	
Ctenochaetus striatus	x	x
Naso hexacanthus		x
N. lituratus	x	x
N. unicornus	x	x
Zebrasoma flavescens	x	
Z. veliferum	x	x
AULOSTOMIDAE		
Aulostomus chinesis	x	
BALISTIDAE		
Balistes chrysopterus (=Sufflamen chrysoptera)	x	x
B. undulatus (=Balistapus undulatus)	x	x
Melichthys niger		x
Pseudobalistes flavomarginatus		x
Rhinecanthus aculeatus		x
BLENNIDAE		
Cirripectes sebae		x
C. variolosus	x	
Meiacanthus atrodorsalis		x
CANTHIGASTERIDAE		
Canthigaster margaritatus	x	
C. solandri	x	
CHAETODONTIDAE		
Centropyge bispinosus	x	
Chaetodon auriga		x
C. bennetti	x	
C. citrinellus	x	x
C. ephippium	x	x
C. lunula	x	x
C. ornatissimus		x

Table 9. (continued)

SPECIES	ZONES 2-3	4
C. punctato-fasciatus		x
C. reticulatus	x	x
C. trifasciatus	x	x
C. ulientensis	x	x
Forcipiger flavissimus	x	x
CIRRHITIDAE		
Cirrhitus pinnulatus	x	x
Paracirrhites forsteri		x
GOBIIDAE		
Ptereleotris tricolor	x	
HEMIRAMPHIDAE		
Hyporhamphus sp.	x	
HOLOCENTRIDAE		
Adioryx spinifer	x	x
Myripristis amaenus		x
M. sp.	x	
KYPHOSIDAE		
Kyphosus sp.		x
LABRIDAE		
Anampses caeruleopanctatus	x	x
A. twisti	x	
Cheilinus rhodochrous		x
C. trilobatus	x	x
Coris aygula	x	
C. gaimard	x	
Epibulus insidiator	x	x
Gomphosus varius	x	x
Halichoeres hortulanus (=H. centiquidrus)	x	x
H. margaritaceus	x	x
H. marginatus	x	x
Hemigymnus fasciatus	x	
H. melapterus	x	x

Table 9. (continued)

SPECIES	ZONES 2-3	4
Hemipteronotus taeniourus	x	x
Labroides bicolor		x
L. dimidiatus	x	x
Macropharyngodon meleagris	x	x
Stethojulis bandanensis	x	x
Thalassoma hardwickei	x	x
T. lutescens	x	
T. quinquevittata	x	x
LETHRINIDAE		
Monotaxis grandoculis	x	
LUTJANIDAE		
Aphareus furcatus		x
Lutjanus fulvus	x	
L. gibbus	x	x
L. sp. 1	x	
L. sp. 2		x
MONACANTHIDAE		
Cantherhines pardalis	x	x
Oxymonacanthus longirostris	x	x
MULLIDAE		
Parupeneus cyclostomus	x	x
P. trifasciatus	x	x
P. sp.		x
OSTRACIONTIDAE		
Ostracion meleagris	x	x
PEMPHERIDAE		
Pempheris oualensis	x	
POMACENTRIDAE		
Abudefduf coelestinus		x
A. saxatilis	x	x

Table 9. (continued)

SPECIES	ZONES 2-3	ZONES 4
A. vaigiensis	x	
Amphiprion melanopus	x	x
Chromis acares	x	
C. atripectoralis	x	x
C. caerulea		x
Dascyllus aruanus	x	
D. reticulatus	x	x
D. trimaculatus		x
Glyphidodontops leucopomus	x	x
Pomacentrus pavo	x	
P. vaiuli	x	
Stegastes fasciolatus	x	x
S. sp.	x	
Plectroglyphidodon lacrymatus	x	x
P. dickii		x
P. sp. 1		x
P. sp. 2		x
SCARIDAE		
Scarus ghobban		x
S. oviceps	x	
S. sordidus	x	
S. venosus	x	x
S. sp. 1	x	
S. sp. 2	x	
S. sp. 3		x
SERRANIDAE		
Epinephelus merra	x	
SIGANIDAE		
Siganus argenteus		x
S. spinus	x	
TETRAODONTIDAE		
Arothron nigropunctatus	x	
Canthigaster solandri		x
C. sp.		x
ZANCLIDAE		
Zanclus cornutus	x	x

AREA III:
HAPUTO BEACH FRINGING REEF

Haputo Beach and fringing reef (also know as B.A.B. and F.A.A. Beaches) is a small embayment on the northwest coast of Guam (Fig. 6). The surrounding land is part of the U. S. Naval Communications Station. A small access road leads to the rim at which point a foot trail and steps lead down to the beach on the north side. Calm seas and good anchorage make water access possible throughout most of the year. The white sand beach and steep surrounding cliff walls combined with a beautiful and highly diversified reef community make Haputo an excellent representative pristine marine community.

No previous survey has been done for the Haputo area with respect to the marine biotic community. A partial physiographic description of the area is given by Randall and Holloman (1974). The following summary is taken in part from their report.

Haputo Beach measures approximately 300 meters long by 80 meters wide. The embayment is bordered by cut benches and steep rocky slopes on both the north and south sides. The south side is characterized by a series of large blocks which have broken off the cliff wall and have since eroded forming nips. One block in particular is used as a popular reference point by boaters due to its large "mushroom" shape. The beach sand is composed of coral and algal-shell debris. Randall and Holloman (1974) divide the seaward zonations into the inner and outer reef flat, reef margin and face, margin channels (here a spur and groove system), terrace and finally the submarine slope. Additional physiographic and geologic data are outlined in their report.

The Guam Environmental Protection Agency water rating for the Haputo area is "AA", conservation. No point source discharges are known in the area (Shidel, 1977).

Two visits were made to Haputo's reef. For purposes of this report three broad biotic zones were recognized. A discussion of each and its biotic components follows.

The inner reef flat zone consisted of a smooth reef-rock pavement with a 4-5 cm sand covering. Lack of a hard substrate and intermittant exposure at low tide has prevented much community development. The blue-green algae *Schizothrix calcicola* and *Hormothamnion enteromorphoides* were found in small patches throughout this zone. The calcareous green alga, *Halimeda macroloba*, was occasionally observed, mostly in the central reef area where sand was beginning to be replaced by coral and rock rubble.

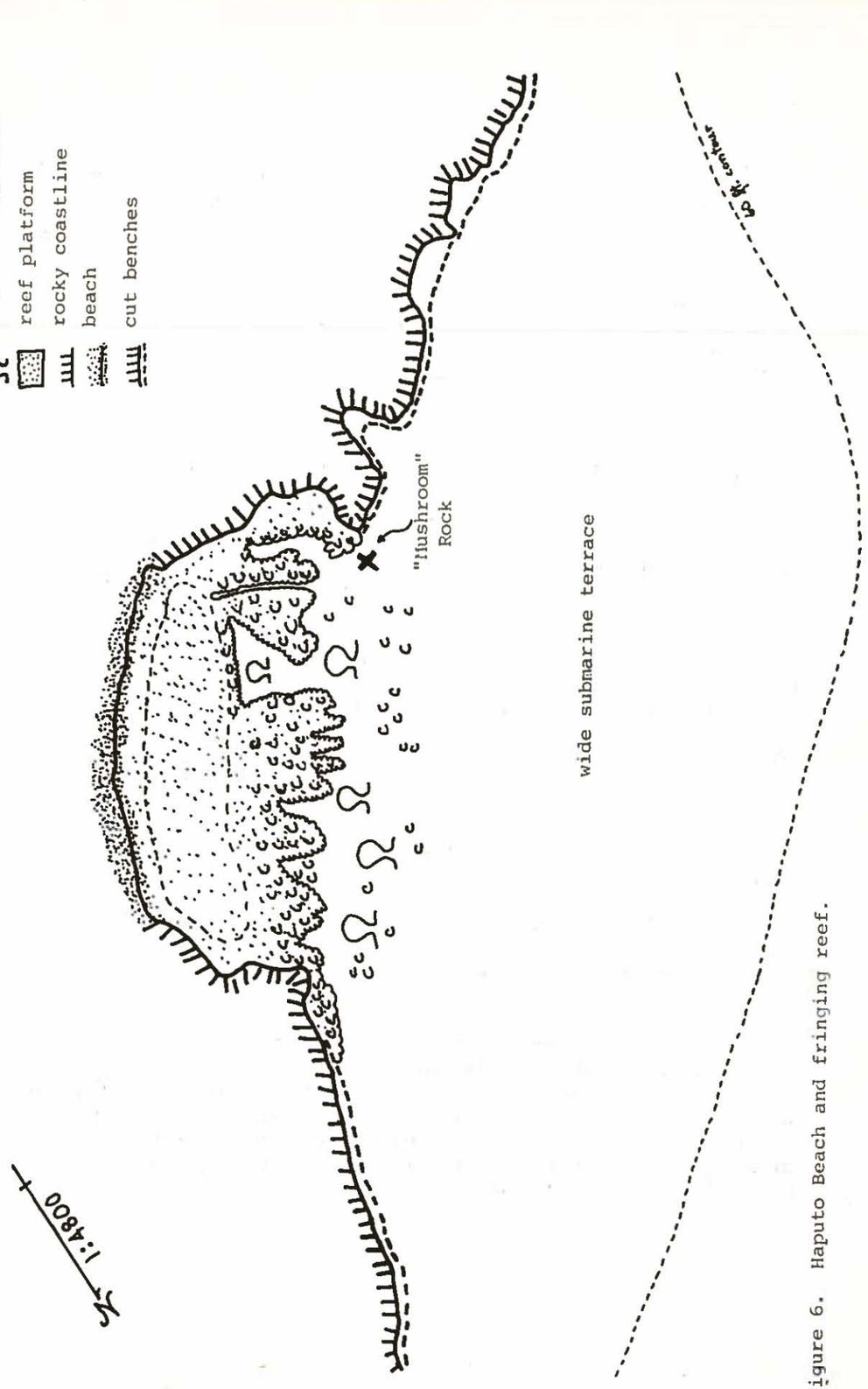


Figure 6. Haputo Beach and fringing reef.

The only corals observed in this zone were an occasional small Porites, Pocillopora or Stylophora mordax colony attached to a rock.

The macroinvertebrate Holothuria atra was also observed throughout this zone.

A few small unidentified mullet were also seen in the inner reef zone.

The second zone has been lumped to include the outer reef-flat margin and its associated channels. The nature of the biotic community and the integrated nature of these zones facilitates this. The outer reef-flat and margin areas were characterized by a porous substrate riddled with small channels, indentations and holes. The spur and groove system is well developed with some of the grooves measuring 3-4 meters deep. In several places grooves were overgrown at the top by calcareous algae and corals, forming semi-enclosed overhangs which formed a triangle in cross-section. Holes in the "mesh-like" structure admit light creating spectacular and well protected habitats for a wide variety of organisms, especially reef fishes.

Coral coverage was outstanding and diversity remarkably high for northwestern Guam. In general, colony size was less impressive than in other pristine areas examined. No single genus seemed to visually dominate though a dense cover of attractively branched Pocillopora and Acropora species were evident. Brilliant blue, purple and yellow colonies were particularly striking.

The honeycombed reef structure has resulted in a highly diversified and exceedingly rich ichthyofauna. Although only twenty-one of the ninty-five families of fish known to occur on Guam are listed, many more undoubtedly exist there but were not observed on the day of our visit. Chaetodontids and pomacentrids were visually dominant, the former being of particular interest to photographers.

Algal cover was rich and diverse with turf algae dominating the outer reef-flat and margin. Gelidium, Ceramium and Polysiphonia species dominated the turf group. The fleshy algae were widely distributed and fairly uniform in abundance. Visually dominant species included three Halimeda species, Chlorodesmis, Dictyota, Turbinaria, Amphiroa, Galaxaura, Desmia and Halymenia species. Of special importance were the crustose and coralline red algae. Outstanding examples of Mesophyllum mesomorphum, Lithophyllum, Lithoporella and Corallina species were abundant. These genera prefer shaded habitats and virtually lined the overhang and grotto areas. The protection afforded them against strong water surge has allowed extensive morphological development.

The macroinvertebrate population was rich but not particularly diverse. No particular genus was visually dominant over another.

The last zone consisted of the submarine terrace which began at a depth of approximately 6 meters, gradually sloping to a plateau depth of 15-20 meters. The effects of Acanthaster planci were less apparent than in other leeward areas. The sixty foot contour line extends approximately 1000 meters off shore at which point the submarine slope begins. The slope zone was not investigated. The terrace areas were fairly unremarkable. A few low ridges and mounds interrupted an otherwise flat topography. Occasionally large Porites colonies were seen along with small colonies of many other genera. Randall and Holloman (1974) refer to this type of coral community as non-accretional. Typical deeper water algae were also seen, notably Padina, Schizothrix and Galaxaura species.

Larger fishes patrol these areas but the general lack of protective habitats make their presence transient. A large manta-ray was observed by one team member. Tables 10-13 list the common organisms associated with the reef and adjacent areas.

CONCLUSIONS AND RECOMMENDATIONS

The Haputo fringing reef represents a rich and diverse pristine marine community. While there are no known threatened or endangered species specifically identified for this area, it is important to realize that the fragile nature of any pristine community is such that anything short of preservation and controlled recreational use could result in a large number of species being locally endangered all at once.

The following recommendations are suggested for the Haputo area:

1) that this area be established as a natural sanctuary in which no coral harvesting, fishing or other such activity be allowed.

2) that swimming, snorkeling and SCUBA diving activities should be retained. The rich corals and symbiont ichthyofauna are popular with photographers.

3) that mooring buoys be installed for boaters to avoid unnecessary coral breakage due to setting anchors.

4) that a "Thermos Law" be enforced to halt beverage can litter.

5) that the relatively small size and well defined boundaries of this area make it an ideal monitoring site for tropical reef habitats. Identification of indicator species is highly desirable.

6) that the calcareous red algal community is one of the finest around the island and should be protected for aesthetic as well as scientific purposes.

Table 10. Checklist of benthic algae observed at Haputo Beach fringing reef.

SPECIES	ZONES 1	2	3
CYANOPHYTA (blue-green algae)			
Hormothamnion enteromorphoides	x	x	
Microcoleus lyngbyaceus		x	x
Schizothrix calcicola	x	x	
S. mexicana	x	x	x
CHLOROPHYTA (green algae)			
Bryopsis pennata		x	x
Boodlea composita		x	
Caulerpa filicoides		x	
C. racemosa		x	
Chlorodesmis fastigiata		x	x
Codium edule		x	
Enteromorpha clathrata		x	
Halimeda gigas		x	x
H. macroloba	x	x	x
H. opuntia		x	x
H. velasquezii		x	x
Neomeris annulata		x	x
Tydemannia expeditionis		x	x
Udotea argentea		x	x
PHAEOPHYTA (brown algae)			
Dictyota bartayresii		x	
D. friabilis		x	
Lobophora variegata	x	x	x
Padina minor		x	x
Padina tenuis		x	
Turbinaria ornata		x	
RHODOPHYTA (red algae)			
Actinotrichia fragilis		x	
Amphiroa fragilissima		x	
A. foliacea		x	
A. sp.		x	
Asparagopsis taxiformis		x	
Ceramium gracillimum		x	
Corallina sp.		x	

Table 10. (continued)

SPECIES	ZONES 1	2	3
Desmia hornemanni		x	x
Galaxaura marginata		x	x
Gelidium sp.		x	
Halymenia durvillaei		x	
Hypnea pannosa		x	
Jania capillacea		x	
Lithophyllum sp.		xx	
Lithoporella sp.		xx	
Mastophora sp.		x	
Mesophyllum mesomorphum		xx	
Mesophyllum sp.		x	
Polysiphonia sp.		x	
Porolithon onkodes		xx	
Pterocladia parva		x	
Tolypiocladia glomerulata		x	
SPERMATOPHYTA (seagrasses)			
none seen			

Table 11. Checklist of corals observed at Haputo Beach fringing reef.

SPECIES	ZONES 1	2	3
ANTHOZOA			
POCILLOPORIDAE			
Stylophora mordax	x	x	
Pocillopora elegans	x	x	
P. eydouxi	x	x	
P. meandrina	x	x	
P. setchelli	x	x	
P. verrucosa	x	x	
ACROPORIDAE			
Acropora humilis		x	
A. palifera		x	
A. sp. 1		x	
A. sp. 2		x	
Astreopora sp.		x	
Montipora ehrenbergii		x	
M. foveolate		x	
M. sp.		x	
AGARICIIDAE			
Pavona sp. 1		x	
P. sp. 2		x	
P. sp. 3		x	
P. sp. 4		x	
P. sp. 5		x	
PORITIDAE			
Goniopora sp.		x	
Porites sp. 1	x	x	x
Porites sp. 2		x	x
FAVIIDAE			
Favia pallida		x	
Plesiastrea sp.		x	
Goniastrea retiformis		x	
Platygyra rustica		x	
Leptoria phrygia		x	
Hydnophora microconos		x	

Table 11. (continued)

SPECIES	ZONES 1	2	3
Leptastrea purpurea		x	
L. sp.		x	
Cyphastrea sp. 1		x	
C. sp. 2		x	
Echinopora sp.		x	
MUSSIDAE			
Lobophyllia sp.		x	
HELIOPORIDAE			
Heliopora coerulea		x	
ALCYONIIDAE (soft corals)			
Sinularia densa		x	
Sarcophyton sp.		x	
HYDROZOA			
MILLEPORIDAE			
Millepora exaesa		x	x
M. platyphylla		x	x

Table 12. Checklist of common macroinvertebrates observed at Haputo Beach fringing reef.

SPECIES	ZONES 1	2	3
PORIFERA			
Cinachyra australiensis		x	x
MOLLUSCA			
GASTROPODA			
Cerithium nodulosum		x	
Conus ebraeus		x	
C. miles		x	
C. sponsalis		x	
Cypraea caputserpentis		x	
C. isabella		x	
C. moneta		x	
Drupa morum		x	
D. ricinus		x	
Latirus sp.		x	
Morula granulata		x	
M. uva		x	
Nerita plicata		x	
Patella sp.		x	
Terebra sp.		x	
Trochus niloticus		x	
Turbo sp.		x	
Vasum turbinellus		x	
BIVALVIA			
Tridacna maxima		x	x
ECHINODERMATA			
ASTEROIDEA			
Culcita novaeguineae		x	
Linckia laevigata		x	
L. multiflora		x	x
ECHINOIDEA			
Echinometra mathaei		x	
Echinothrix calamaris		x	
Echinostrephus aciculatus		x	

Table 12. (continued)

SPECIES	ZONES 1	2	3
HOLOTHUROIDEA			
Actinopyga echinites		x	
A. mauritiana		x	
Holothuria atra	x	x	
ARTHROPODA			
CRUSTACEA			
Grapsus grapsus		x	

Table 13. Checklist of fishes observed at Haputo Beach fringing reef. All observations made in Zone 2.

SPECIES	ZONES 1	2	3
ACANTHURIDAE			
Acanthurus glaucopareius		x	
A. lineatus		x	
A. nigricans (=A. gahhm)		x	
A. nigrofuscus		x	
A. olivaceous		x	
A. pyroferus		x	
A. xanthopterus		x	
Ctenochaetus striatus		x	
Naso brevirostris		x	
N. lituratus		x	
APOGONIDAE			
Apogon novae-guineae		x	
A. novemfasciatus		x	
BALISTIDAE			
Balistes bursa (=Sufflamen bursa)		x	
B. chrysopterus (=Sufflamen chrysoptera)		x	
Melichthys vidua		x	
Rhinecanthus rectangulus		x	
BLENNIIDAE			
Cirripectes variolosus		x	
C. guagga		x	
Meiacanthus atrodorsalis		x	
Plagiotremus tapeinosoma		x	
CANTHIGASTERIDAE			
Canthigaster bennetti		x	
C. solandri		x	
CHAETODONTIDAE			
Centropyge flavissimus		x	
Chaetodon auriga		x	
C. citrinellus		x	
C. ephippium		x	

Table 13. (continued)

SPECIES	ZONES 1	2	3
C. lunula		x	
C. mertensii		x	
C. ornatissimus		x	
C. punctato-fasciatus		x	
C. quadrimaculatus		x	
C. reticulatus		x	
C. trifasciatus		x	
C. ulietensis		x	
Forcipiger longirostris		x	
Heniochus monoceros		x	
Holacanthus trimaculatus		x	
CIRRHITIDAE			
Cirrhitus pinnulatus		x	
Neocirrhites armatus		x	
Paracirrhites forsteri		x	
GOBIIDAE			
Nemateleotris magnificus		x	
Ptereleotris microlepsis		x	
P. tricolor		x	
Valenciennea strigata		x	
HOLOCENTRIDAE			
Adioryx spinifer		x	
Flammeo sammara		x	
Myripristis kuntee		x	
KYPHOSIDAE			
Kyphosus vaigiensis		x	
LABRIDAE			
Bodianus axillaris		x	
Cheilinus rhodochrous		x	
C. trilobatus		x	
Coris aygula		x	
C. gaimard		x	
Epibulus insidiator		x	
Gomphosus varius		x	
Halichoeres hortulanus (=H. centigusdrus)		x	
H. margaritaceus		x	

Table 13. (continued)

SPECIES	ZONES 1	2	3
H. trimaculatus		x	
H. sp.		x	
Labroides bicolor		x	
L. dimidiatus		x	
Macropharyngodon pardalis		x	
Thalassoma lutescens		x	
T. quinquevittata		x	
LUTJANIDAE			
Aprion virescens		x	
Gnathodentex aureolineatus		x	
Lethrinus sp.		x	
Lutjanus fulvus		x	
Monotaxis grandoculis		x	
Plectorhincus chaetodonoides		x	
MOBULIDAE			
Manta sp.		x	
MONACANTHIDAE			
Oxymonacanthus longirostris		x	
MUGILOIDIDAE			
Parapercis sp.		x	
MULLIDAE			
Parupeneus barberinus		x	
P. bifasciatus		x	
P. cyclostomus		x	
P. multifasciatus		x	
P. sp.	x	x	
OSTRACIONTIDAE			
Ostracion melagris		x	
POMACENTRIDAE			
Chromis margaritifer		x	
C. xanthura		x	

Table 13. (continued)

SPECIES	ZONES 1	2	3
C. sp.		x	
Dascyllus reticulatus		x	
D. trimaculatus		x	
Dischistodus perspicillatus		x	
Glyphidodontops leucopomus		x	
G. tracyi		x	
Neopomacentrus hemurus		x	
Plectroglyphidodon imparipennis		x	
P. johnstonianus		x	
P. lacrymatus		x	
Pomacentrus vaiuli		x	
SCARIDAE			
Scarus ghobban		x	
S. lepidus		x	
S. sordidus		x	
S. venosus		x	
S. sp. 1		x	
S. sp. 2		x	
S. sp. 3		x	
SERRANIDAE			
Cephalopholis urodelus		x	
Grammistes sexlineatus		x	
ZANCLIDAE			
Zanclus cornutus		x	

AREA IV:
LUMINAO BARRIER REEF

Luminao Reef is one of two barrier reefs on Guam. Extending west from Cabras Island and continuous with the submerged Callalan Bank, Luminao Barrier Reef serves as the foundation for Glass Breakwater. The entire area lies within the boundaries of Apra Harbor Naval Reservation.

A highly diversified reef community (Fig. 7) combined with calm waters and easy access from the breakwater, has made the Luminao area a popular place for snorkelers and photographers. The apparent stability and active reef growth of this area permit its consideration as a pristine marine community under the criteria of reestablishment.

No previous survey has been conducted for this area with respect to the marine biotic community. Randall and Holloman (1974) provide information on physiography, geology and hydrology. The following is summarized from their report.

Luminao Barrier Reef forms a wide, shallow platform cut by an intermittant spur and groove system. Considerable reef-building is taking place in several locales. A narrow submarine terrace, 3-5 meters in depth, abruptly drops at the (18 meter) 60 feet contour. The lagoon side of Luminao Reef has for the most part been altered by dredging, filling and construction. This area was not considered in this report.

The Guam Environmental Protection Agency water quality classification for this area is "A", recreational. No point source discharges are known (Shidel, 1977).

The western end of the seaward side of the barrier reef was chosen for this study. Only the reef flat platform was examined. A narrow sandy inner reef strip approximately 3-4 meters wide runs parallel to the breakwater. The wide middle reef platform consists of a uniform moat varying from 1-3 meters deep. Many coral colonies are exposed during low tides. A narrow outer reef flat is exposed at low tide and was generally depauperate with occasional patches of the brown alga, Sargassum polycystum. For purposes of this report, no distinctly different biotic zones were recognized. See Tables 14-17 for species lists.

The coral community was highly diverse and luxuriant. Large mounds of Acropora, Porites and Millepora were abundant. Some colonies were 1.5 meters or more in width. The upper portions of many Porites heads were exposed at low tide and thus dead. Many turf and fleshy algae crown the tops of these colonies. Porites andrewsi and Porites cocosensis were most common in the inner reef flat, while Millepora dichotoma and Millepora platyphylla (fire corals) were more abundant

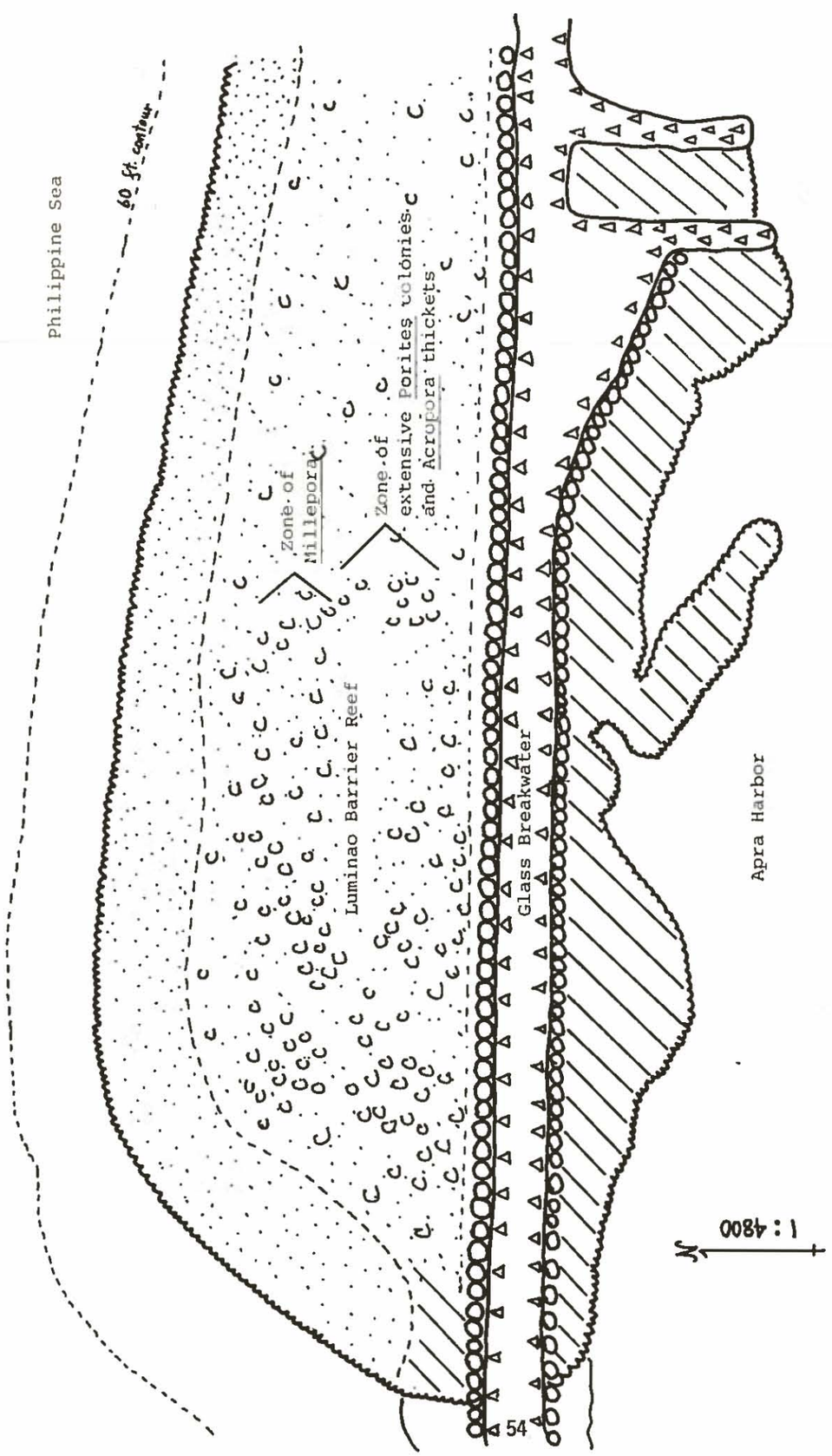


Figure 7. Extreme western section of Luminao Barrier Reef. Only the north side was investigated.

towards the middle and outer moat areas. Of particular interest were the presence of corals typically associated with the margin and terrace areas.** These large Pocillopora colonies were common in the moat.

The soft corals, Sinularia, Lobophytum and Sarcophyton species were common and well developed. Some colonies were more than a meter in diameter.

Luminao Barrier Reef exhibits a moderately diverse algal cover and diversity. The green alga Boergesenia forbesii was common along the narrow sandy inner strip, while Sargassum polycystum dominated the outer reef flat and margin. Halimeda and Caulerpa species were abundant in the side moat along with many smaller forms. The dead and exposed portions of Porites colonies were covered with Amphiroa, Caulerpa, Halimeda and Schizothrix species. Other less conspicuous genera were also abundant.

A colorful and diverse array of reef fishes were observed. Acanthurids, chaetodontids, pomacentrids and labrids were common.

The sea cucumbers Actinopyga echinites and Holothuria atra were common in the shallow sandy areas near the breakwater, while Stichopus chloronotus and Bohadschia argus were common in the middle reef sections. The blue starfish Linckia laevigata was also common.

CONCLUSIONS AND RECOMMENDATIONS

Luminao Barrier Reef is one of the few readily accessible pristine areas covered in this survey. The barrier reefs of the Cocos Lagoon complex are the only alternative sites. Calm, shallow water combined with a diverse and beautiful reef community make this area a good candidate for preservation.

The following recommendations are suggested:

1) that this area be established as a natural sanctuary in which no coral harvesting, net fishing or other such activity be permitted.

2) that a series of underwater trails be developed with appropriate supportive literature and signs.

**R. H. Randall, personal communication.

Table 14. Checklist of benthic marine algae observed on the reef flat at Luminao Barrier Reef. * = present on tops of exposed Porites colonies.

SPECIES

CYANOPHYTA (blue-green algae)

Anacystis sp.
Calothrix sp.
*Microcoleus lyngbyaceus
*Schizothrix calcicola
Schizothrix mexicana

CHLOROPHYTA (green algae)

Boergesenia forbesii
Caulerpa cupressoides
*C. racemosa
C. serrulata
Chlorodesmis fastigiata
*Dictyosphaeria versluysii
Enteromorpha clathrata
*Halimeda opuntia
*Neomeris annulata
Tydemannia expeditionis

PHAEOPHYTA (brown algae)

Dictyota bartayresii
Ectocarpus breviarticulatus
*Lobophora variegata
Padina tenuis
Sargassum polycystum
Turbinaria ornata

RHODOPHYTA (red algae)

Actinotrichia fragilis
Amphiroa foliacea
*A. fragilissima
Ceramium sp.
Galaxaura marginata
Gelidiella acerosa
Gelidium pusillum
Gelidium divaricatum
Hypnea pannosa
Hydrolithon sp. (nodules)
Polysiphonia sp.

Table 15. Checklist of corals observed on the reef flat at Luminao Barrier Reef.

SPECIES

ANTHOZOA

THAMNASTERIIDAE

Psammocora contigua
P. togianensis
P. sp.

POCILLOPORIDAE

Pocillopora damicornis
P. danae
P. elegans
P. eydouxi
P. ligulata
P. setchelli
P. meandrina
P. sp.

ACROPORIDAE

Acropora aspera
A. formosa
A. humilis
A. hystrix
A. irregularis
A. kenti
A. nana
A. nasuta
A. palifera
Astreopora sp.
Montipora hoffmeisteri
M. lobulata
M. monasteriata
M. patula
M. tuberculosa
M. verrucosa
M. sp. 1
M. sp. 2

AGARICIDAE

Pavona decussata
P. (Polyastra) obtusata
P. sp.

FUNGIIDAE

Fungia fungites
F. sp.

PORITIDAE

Goniopora arbuscula
G. tenvidens
Porites andrewsi
P. annae
P. cocosensis
P. (Synaraea) convexa
P. (Synaraea) iwayamaensis
P. iobata
P. lutea
P. matthaii
P. sp.

FAVIIDAE

Favia favus
F. pallida
F. stelligera
Favites abdita
Platygyra rustica
P. sinensis
Leptoria phrygia
Leptastrea bottae
L. purpurea
L. sp.
Cyphastrea sp.

MUSSIDAE

Lobophyllia costata
L. corymbosa

HELIOPORIDAE

Heliopora coerulea

Table 15. (continued)

SPECIES
ALCYONIIDAE
Lobophytum sp.
Sarcophyton sp.
Sinularia sp.
HYDROZOA
Millepora dichotoma
M. platyphylla

Table 16. Checklist of common macroinvertebrates observed on the reef flat at Luminao Barrier Reef.

SPECIES
MOLLUSCA
GASTROPODA
Cantharus undosus
Cerithium nodulosum
C. sp.
Conus ebraeus
C. flavidus
C. miliaris
C. pulicarius
Coralliophila violacea
Cypraea erosa
C. moneta
Drupa morum
D. ricinus
Imbricaria punctata
Lambis lambis
Littorina coccinea
Mitra mitra
Morula granulata
M. uva
Nerita plicata
Patella sp.
Rhinoclavis asperi
Strombus luhuanus
S. mutabilis
Tectus pyramis
Trochus niloticus
Vasum turbinellus
Vexillum sp.
BIVALVIA
Scutarcopagia scobinata
Tridacna maxima
ECHINODERMATA
ASTEROIDEA
Culcita novaeguineae
Echinaster luzonicus
Linckia laevigata
L. multiflora
ECHINODEA
Diadema savignyi
Echinometra mathaei
Echinothrix calamaris
E. diadema
Eucidaris metularia
HOLOTHUROIDEA
Actinopyga echinites
Bohadschia argus
Holothuria atra
H. hilla
H. nobilis
Stichopus chloronotus
Synapta maculata
ARTHROPODA
CRUSTACEA
Grapsus grapsus
Xanthid sp.

Table 17. Checklist of fishes observed on the reef flat at Luminao Barrier Reef.

SPECIES
ACANTHURIDAE
Acanthurus lineatus
A. nigrofuscus
A. triostegus
Ctenochaetus striatus
Naso lituratus
N. sp.
Zebrasoma flavescens
Z. veliferum
APOGONIDAE
Apogon novemfasciatus
BALISTIDAE
Rhinecanthus aculeatus
R. rectangulus
BLENNIDAE
Meiacanthus atrodorsalis
Plagiotremus tapeinosoma
"Blenny" sp.
CANTHIGASTERIDAE
Canthigaster bennetti
C. solandri
CHAETODONTIDAE
Chaetodon auriga
C. citrinellus
C. ephippium
C. lunula
C. ornatissimus
C. reticulatus
C. trifascialis
C. trifasciatus
C. ulietensis
C. unimaculatus
Heniochus chrysostomus
CIRRHITIDAE
Paracirrhites forsteri
GOBIIDAE
Valenciennea strigata
HOLOCENTRIDAE
Adioryx spinifer
A. sp.
LABRIDAE
Anampses caeruleopunctatus
Cheilinus chlorourus
C. trilobatus
C. undulatus
Coris gaimard
Epibulus insidiator
Gomphosus varius
Halichoeres hortulanus (*H. centiquadrus*)
H. margaritaceus
H. marginatus
H. trimaculatus
H. sp.
Hemigymnus melapterus
Labroides dimidiatus
Macropharyngodon meleagris
Stethojulis bandanensis
S. linearis
Thalassoma hardwickei
T. lutescens
T. umbrostygma
LUTJANIDAE
Lutjanus fulvus
L. sp.
MONACANTHIDAE
Amanses carolae
Oxymonacanthus longirostris

Table 17. (continued)

SPECIES
MULLIDAE
Mulloidichthys samoensis
Parupeneus barberinus
P. bifasciatus
P. cyclostomus
P. trifasciatus
NEMIPTERIDAE
Scolopsis cancellatus
POMACENTRIDAE
Abudefduf coelestinus
A. sordidus
Amblyglyphidodon curacao
Amphiprion melanopus
Chromis caerulea
Dascyllus aruanus
D. trimaculatus
Glyphidodontops cyaneus
G. glaucus
G. leucopomus
Plectroglyphidodon dickii
P. leucozoma
Pomacentrus pavo
P. vaiuli
Stegastes albifasciatus
S. fasciolatus
S. lividus
S. nigricans
SCARIDAE
Scarus lepidus
S. sexvittatus
S. sordidus
S. sp. 1
S. sp. 2
S. sp. 3
S. sp. 4
SCORPAENIDAE
Synanceia verrucosa
SIGANIDAE
Siganus spinus
SYNGNATHIDAE
Corythoichthys intestinalis
SYNODONTIDAE
Synodus sp.
TETRAODONTIDAE
Arothron nigropunctatus
ZANCLIDAE
Zanclus cornutus

AREA V:
EAST APRA HARBOR WETLANDS - SASA BAY
AND ATANTANO RIVER MANGROVES

Like coral reefs, mangrove communities are unique to tropical and subtropical latitudes, but unlike coral reefs, mangroves are not typically striking areas of color and form. The associated mudflats, extensively intertwining prop root systems and pungent odor during low tides has made them prime candidates for destruction or modification by man. Land reclamation is relatively easy and many of the best representative communities have been destroyed.

The dynamics of this community type include both land building and erosional protection. The prop root system reduces tidal currents and traps much floating debris, resulting in extensive deposition of sediments. The resulting mudflats provide burrows for mud crabs and the prop roots, attachment sites for a variety of molluscs. In addition, mangroves exhibit high primary productivity and possibly represent the best example of the detrital food chain (Odum, 1971).

Three excellent reports have been prepared in recent years identifying and assessing the biologic components of wetlands and, more specifically, mangrove communities on Guam.

Moore et al. (1977) studied seventeen wetland areas. Their report includes descriptions, maps, keys, photographs and inventories of associated flora. This study will provide a solid working base for any wetland associated project.

A report by the University of Guam Marine Laboratory (1977) provides information on Sasa Bay in general. They divided the area into four regions, one of which included the mudflat and mangrove communities along the east side. Species lists were gleaned from this report.

Wilder (1976) mapped the estuaries and mangroves around Guam. These maps have been used as a base in this report.

Physiographic data was taken from Randall and Holloman (1974) and additional map information from Randall and Eldredge (1976). All of these reports contain additional bibliographical references.

The GEPA water quality classification for this area is "A", recreational use. No point source discharges are known for this area though it is likely that intermittant discharges do occur in relation to the many commercial and industrial activities in the harbor.

The east Sasa Bay and Atantano River mangroves were selected. Both lie in the Apra Harbor wetland area (Figs. 8 and 9). Although extensive

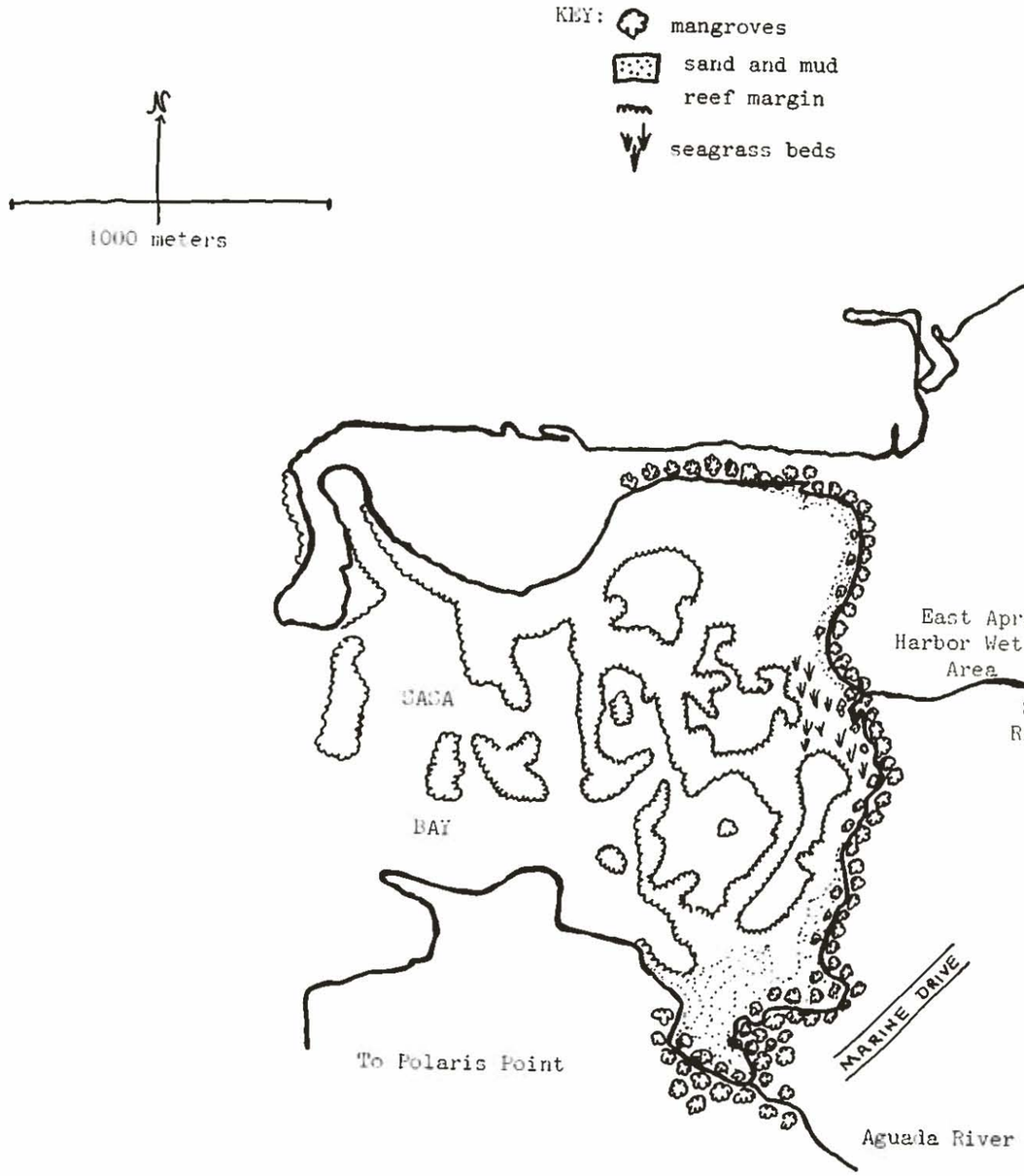


Figure 8. East Sasa Bay Mangroves

Figure 9. Atantano River mangrove community.

modification of these areas has occurred in the past with the construction of Route 1 (Marine Drive), dredging, construction and landfill (extending from the Dry Dock Peninsula, east and south, to Polaris Point), these areas still represent the most extensive and mature mangrove communities on Guam. In keeping with the definition of pristine, these areas have met the criterion of reestablishment.

Wetland zonation is typically divided into seven sections. See Figure 10 (Coastal Zone Management, 1977). Standard marine species lists of corals and fishes are replaced by benthic algae, terrestrial plants and mangrove associated macroinvertebrates (Tables 18-20). Terrestrial vertebrates such as rodents and birds were not included.

The Sasa mangroves are estimated to be 90 percent Rhizophora mucronata and R. apiculata (University of Guam Marine Laboratory, 1977). Other dominant mangrove species include Bruguiera gymnorrhiza, Avicennia alba and Lumitzera littorea. Moore et al. (1977) found that the mangrove sediments were ankle-deep in most places. Large patches of mature mangroves were observed with interspersed patches of less mature plants. On the seaward, peripheral edge of the mangrove, large stands of the seagrass Enhalus acoroides were abundant.

Moore et al. (1977) considers the mangrove swamp at the Atantano River mouth to be the best developed, most mature stand on Guam. Avicennia alba dominates. A particularly dense stand can be found on the north side of the river mouth. Rhizophora apiculata accounts for less than five percent (Wilder, 1976) along with Bruguiera gymnorrhiza and Rhizophora mucronata, which were also abundant. The mangrove associated plants Dalbergia candenatensis, Barringtonia asiatica and Pluchea indica were also present. The interior of the marsh is dominted by Phragmites karka and Hibiscus tiliaceus.

Three algal genera were observed. The cyanophytes Schizothrix and Microcoleus were attached to the prop roots of some plants and the green alga Avrainvillea obscura was occasionally seen interspersed with the seagrass.

The substratum along the east bay area was composed of thick mud and silt. A typical mangrove invertebrate community is described by the University of Guam Marine Laboratory (1977). The high intertidal gastropod, Littorina scabra was by far the most dominant, typically attached to prop roots and low-hanging mangrove leaves. The oyster Saxostrea mordax was also found attached to prop roots. Other common species included fiddler crabs (Uca sp.), grapsid and portunid crabs, cerithiid gastropods (near Sasa River mouth only) and occasionally the mudskipper, Periophthalmus koelreuteri.

The presence of numerous crab burrows and freshly broken bivalve shells slightly north of the Sasa River was suggestive of the presence of the mangrove crab, Scylla serrata, though none were seen.

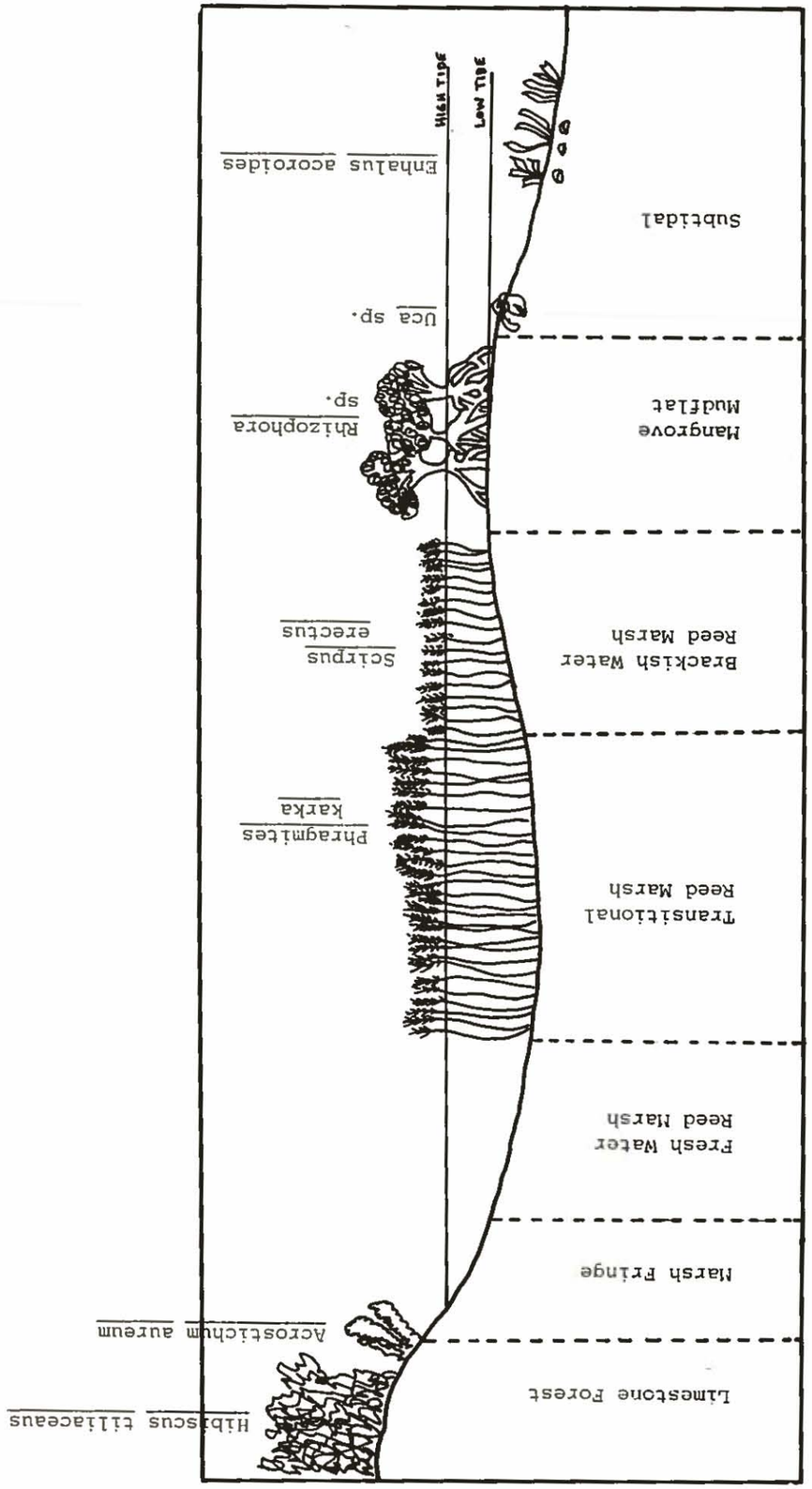


Figure 10. Generalized cross-section of mangrove river mouth showing typical zonation pattern. (Adapted from CZM Newsletter 1977).

Moore et al. (1977) considers the mangrove plants, Lumnitzera littorea, Bruguiera gymnorrhiza, Xylocarpus moluccensis, Rhizophora mucronata, R. apiculata and Barringtonia racemosa to be endangered. Although these species are locally abundant, their critical habitats are severely threatened by wetland modifications of any kind.

CONCLUSIONS AND RECOMMENDATIONS

Since mangroves are an integral component of wetlands, it follows that modification or destruction of the associated wetlands will bring about the eventual demise of the mangrove. In addition, the less extensive development of mangrove communities on Guam in comparison to other Micronesian islands, for example, tends to magnify their importance as nursery areas for many organisms. For these reasons, mangrove preservation on Guam is of the utmost importance.

It is recommended that:

1) preservation of these areas include the adjacent support-wetland community.

2) the landfill, dredging and pollutant discharges be severely regulated.

3) a walkway-system and nature trail should be constructed to provide both public education and enjoyment as well as access for scientific investigation.

Table 18. Checklist of wetland associated plants observed in eastern Apra Harbor. A = abundant, C = common, and R = rare. (adapted from Moore et al., 1977).

SPECIES	Sasa	Atantano
FILICINAE		
ASPIDIACEAE		
Thelypteris interrupta		R
PTERIDACEAE		
Acrostichum aureum	C	C
Pteris vittata	C/R	
ANGIOSPERMAE		
ARACEAE		
Alocasia macrorrhiza	R	
CYPERACEAE		
Cyperus compressus	C	
C. javanicus	C/R	
C. odoratus	C	C
Fimbristylis cymosa	C	C
F. dichotoma	C	C
F. globulosa	C	
Scirpus littoralis v. thermalis	A	
Scleria lithosperma	C	
S. polycarpa	C	
Rhynchospora corymbosa	C	
FLAGELLARIACEAE		
Flagellaria indica	C	C
GRAMINEAE		
Bambusa vulgaris	C	
Brachiara mutica	C	
Centothecca lappacea		C
Eleusine indica	C	
Imperata confecta	C	
Oplismenus sp.	C	C
Panicum maximum	C	C
Pennisetum polystachion	C	A/C
Phragmites karka	C	A
Saccharum spontaneum	C	

Table 18. (continued)

SPECIES	Sasa	Atantano
HYDROCHARITACEAE		
Enhalus acoroides	C	
ORCHIDCEAE		
Spathoglottis plicata	C	C
PALME		
Cocos nucifera		C
Nypa fruticans	C	C
PANDANACEAE		
Pandanus dubius	C	
P. tectorius	C	C
AMARANTHACEAE		
Alternanthera sessilis	C	
BORANGINACEAE		
Messerschmidia argentea	C/R	
CASUARINACEAE		
Casuarina equisetifolia	C	C
COMBRETACEAE		
Lumnitzera littorea	A	
Terminalia catappa	C/R	
COMPOSITAE		
Elephantopus mollis	C	
Mikania scandens	C	A
Pluchea indica	C	C
CONVOLVULACEAE		
Ipomoea aquatica	C	
I. pes-caprae	C	

Table 18. (continued)

SPECIES	Sasa	Atantano
CUCURBITACEAE		
Momordica charantia	C	
EUPHORBIACEAE		
Glochidion marianum	C	C
GOODENIACEAE		
Scaevola taccada	C	C
HERNANDIACEAE		
Hernandia sonora	R	
LABIATAE		
Hyptis capitata		C
LAURACEAE		
Cassytha filiformis	C	C
LECYTHIADACEAE		
Barringtonia asiatica	C	C
LEUGUMINOSAE		
Cassia occidentalis	R	
Dalbergia candenatensis	C/R	A
Delonix regia		R
Desmanthus virgatus	C	C
Entada pursaetha	C	
Leucaena leucocephala	A/C	C
Mimosa pudica	C	
Pithecellobium dulce	C	C
Sesbania cannabina	C	
LYTHRACEAE		
Pemphis acidula	R	

Table 18. (continued)

SPECIES	Sasa	Atantano
MALVACEAE		
Hibiscus tiliaceus	C	A
Sida acuta	C	
Thespesia populnea	C	C
Urena lobata	R	
MELIACEAE		
Xylocarpus moluccensis	C/R	R
OLEACEAE		
Jasminum marianum	C	C
PASSIFLORACEAE		
Passiflora foetida v. *hispida*	C	C
P. suberosa	C	C
POLYGALACEAE		
Polygala paniculata	C	C
RHAMNACEAE		
Colubrina asiatica	C	C
RHIZOPHORACEAE		
Brugiera gymnorrhiza	C	R
Rhizophora apiculata	C	A
R. mucronata	A	C
RUBIACEAE		
Morinda citrifolia	R	C
RUTACEAE		
Triphasia trifolia	C	C/R
STERCULIACEAE		
Heritiera littoralis	R	
Melochia villosissima		R
VERBENACEAE		
Avicennia alba	A	AA
Clerodendrum inerme	C	C

Table 19. Checklist of algae observed in east Sasa Bay and Atantano mangroves.

SPECIES	Comments
CYANOPHYTA	
Microcoleus lyngbyaceus	on prop roots
Schizothrix sp.	on prop roots
CHLOROPHYTA	
Avrainvillea obscura	mud/sand substratum

Table 20. Checklist of common mangrove associated macroinvertebrates observed in east Sasa Bay area. * = abundant. (adapted from Univ. Guam Mar. Lab., 1977).

SPECIES
MOLLUSCA
GASTROPODA
Cerithium sp.
Chicoreus penchinati
**Littorina scabra*
BIVALVIA
Gafrarium tumidum
**Saxostrea mordax*
**Septifer bilocularis*
ANNELIDA
POLYCHAETA
Sebellastarte indica
ARTHROPODA
CRUSTACEA
**Cardisoma* sp.
Clibinarius striolatus
Pachygrapsus planifrons
P. plicatus
Thalamita crenata
**Uca chlorophthalmus crassipes*
Uca vocans

AREA VI:
OROTE SUBMARINE CLIFFS

The cliffline extending from the tip of Orote Peninsula to approximately Neye Island exhibits a unique physiographic feature of Guam. The familiar fringing reefs and cut benches are replaced by submarine cliffs and terraces (Fig. 11). Despite inaccessibility other than by boat, this pristine area is popular with SCUBA divers and fisherman. Throughout the summer months the northwest swell is small. Strong currents, depth and scouring make this area less rich and diverse than other communities studied.

The selected area measures approximately 500 meters along the coast from the "Blue Hole" and cliff line tripod, at the northwest, to a white fracture zone in the cliffs, to the southeast. The entire coastal land is part of the U. S. Naval, Apra Harbor Reservation. The study area chosen is well beyond the 1000 meter radius required for the proposed U. S. Naval Ammunition Wharf east of Orote Island and should not be affected by it.

No previous survey has been done for the Orote submarine cliff area with respect to the marine biotic community. A complete physiographic description of the area is given by Randall and Holloman (1974). The following summary is taken in part from their report.

The cliffs drop vertically to the first submarine terrace at a depth of15-20 meters. The narrow terrace varies in width from 20-45 meters at which point another submarine cliff drops to the second terrace at a depth of approximately 80 meters (Fig. 12). Sea level nips are prominant along most of the cliff line and in several places large blocks have broken off from the cliff and are found on the terrace below. Some of these are 10 meters or more in relief.

A large hole approximately 7 meters in diameter known as the "Blue Hole" opens on the first terrace at approximately 18 meters. The shaft extends vertically to approximately 80 meters with a window opening at 35 meters.

The Guam Environmental Protection Agency water quality classification for this area is "A", recreational use. No point source discharges are known for the immediate area (Shidel, 1977).

For purposes of this report three physiographic zones were recognized: (1) the slope beginning at the sea level nip and extending to the first terrace, (2) terrace and (3) the blue hole. The true submarine cliff was only partially examined as the depth quickly exceeded the safe limit for SCUBA diving. Tables 21-24 list the organisms observed during the study.

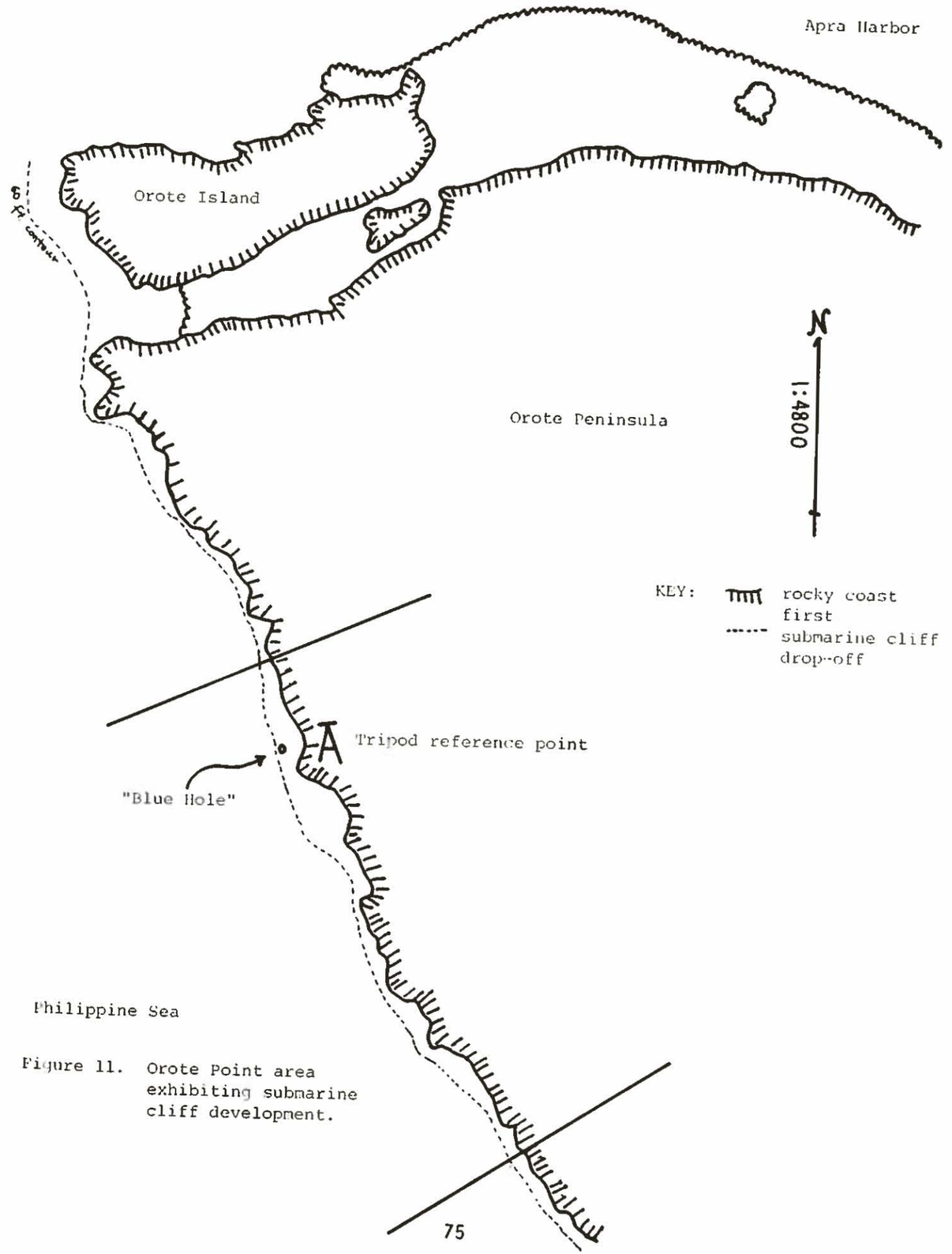


Figure 11. Orote Point area exhibiting submarine cliff development.

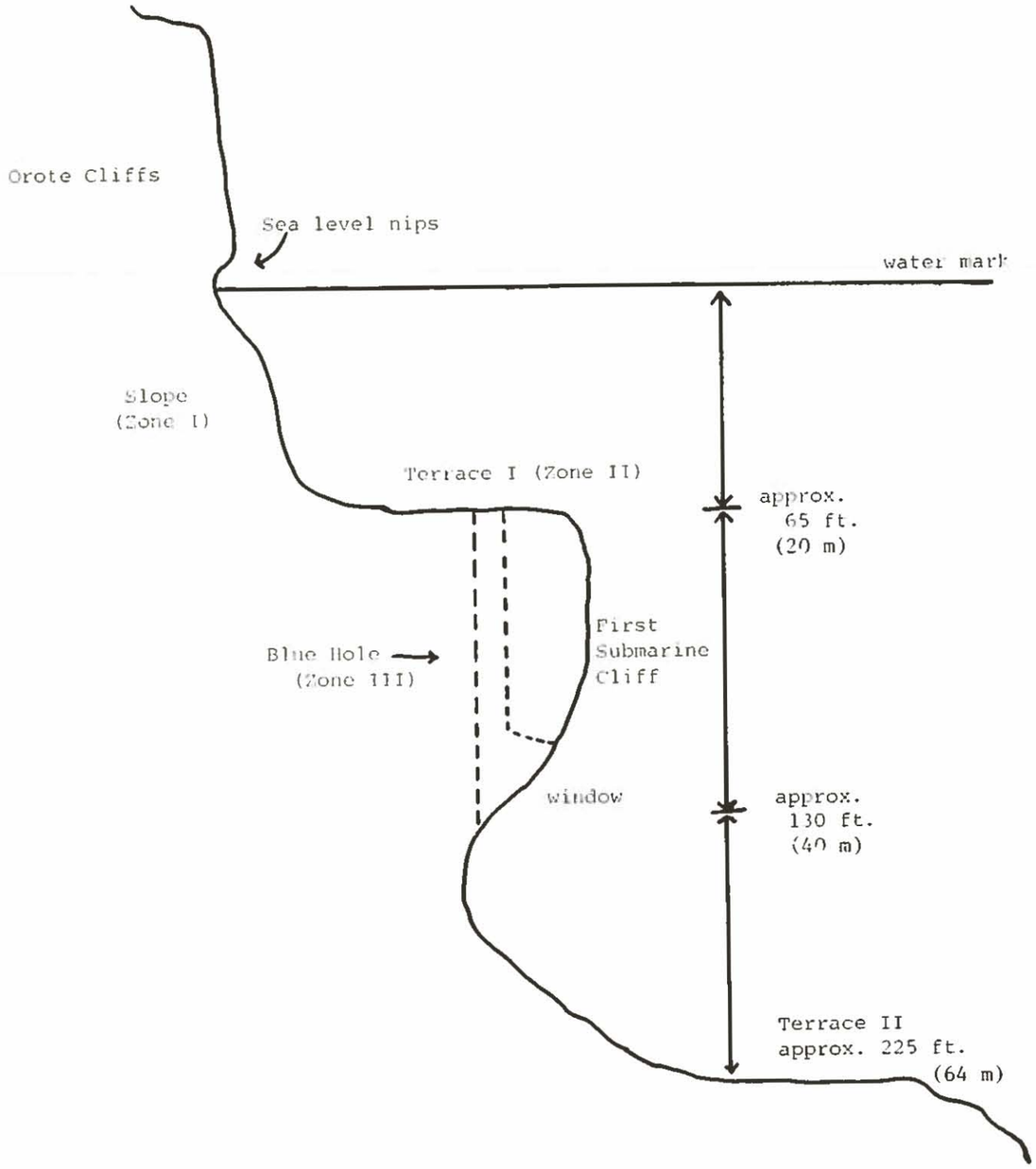


Figure 12. Profile of Orote Cliff area showing major physiographic transitions. (Not to scale)

Coral cover was minimal. No extensive community development including ridges, knobs or pinnacles was observed. The upper slope and most of the terrace floor consisted of scattered small Pocillopora colonies. In more protected habitats around fallen blocks and larger rubble, a much richer coral community was evident. Acropora and Porites colonies were common along with patches of soft corals and crinoids. Diversity was moderate with no single genus dominating. The "Blue Hole" provides a cavelike habitat with subdued light and little water movement. Deep water and cryptic corals were moderately abundant.

Turf algae dominated the slope and terrace areas. In the wave agitated nip zone Gelidium, Ectocarpus and Cheilosporum species were dominant. Further down the slope, Schizothrix, Turbinaria, Dictyota and Padina species were visually dominant. In protected areas, many more genera were observed.

In contrast to the slope and terrace zones, the "Blue Hole" was virtually lined with both turf and macroalgae. Schizothrix mexicana in a variety of forms along with small clumps of Padina minor and Dictyota divaricata provided the backdrop for the striking presence of Tydemannia expeditionis in both life forms and Rhipilia orientalis, displaying large velvety thalli. These two common algae were tremendously abundant and beautiful. The tiny Caulerpa filicoides was also abundant.

Despite the rather barren topography and lack of typical coral reef habitats, many plankton feeding fish such as pomacentrids were observed. On the terrace margins transient pelagic predators including sharks are frequently seen. Skipjack, large snappers and groupers are relatively common though they were not observed.

Various urchinsand gastropods were evenly distributed throughout the area. The small crab, Grapsus grapsus was common along the nip area. The spiny lobster Panulirus sp. and the crab Carpilius maculatas have been observed by the author on night dives.

The flat and brilliantly purple coral, Pachyclavularia violacea was observed in semi-protected areas along the submarine terrace. This species has not been seen elsewhere on Guam to date.

CONCLUSIONS AND RECOMMENDATIONS

The submarine cliffs along the Orote Peninsula are a unique physiographic feature on Guam. The area selected is typical of the entire section and while a more southern representative site could be substituted, there are no alternative sites around the island. No threatened or endangered species have been reported in this area. Barring a major oil spill or other castastrophe, the nature of this area with its strong currentsreduces the probability of serious environmental alteration.

The following recommendations are suggested for the Orote submarine cliff area:

1) that this area or a section of it be established as a natural sanctuary in which no coral harvesting, net fishing or other such activity be allowed.

2) that SCUBA diving and spear fishing activities be retained.

3) that no landfill waste or garbage be dumped along the cliffs.

Table 21. Checklist of benthic algae observed at the Orote Submarine Cliffs and Blue Hole area.

SPECIES	ZONES 1	2	4
CYANOPHYTA (blue-green algae)			
Calothrix sp.	x		
Microcoleus lyngbyaceus	x	x	x
Schizothrix calcicola	x	x	x
S. mexicana		x	x
CHLOROPHYTA (green algae)			
Caulerpa filicoides			x
C. racemosa		x	
Chlorodesmis fastigiata	x	x	
Dictyosphaeria versluysii	x	x	
Halimeda opuntia	x	x	x
Neomeris annulata	x	x	x
Rhipilia orientalis			xx
Tydemannia expeditionis			xx
Valonia ventricosa	x	x	
Udotea geppi		x	x
PHAEOPHYTA (brown algae)			
Dictyota bartayresii		x	
D. divaricata	x	x	x
Ectocarpus breviarticulatus	x		
Hydroclathrus clathratus	x		
Padina minor	x		
P. jonesii		x	x
Turbinaria ornata	x		
RHODOPHYTA (red algae)			
Actinotrichia fragilis	x		
Cheilosporum sp.	x		
Desmia hornemanni		x	
Galaxaura oblongata		x	x
Gelidium pusillum	x		
Halymenia durvillaei		x	
Polysiphonia sp.	x		
Pterocladia parva	x	x	
Tolypiocladia glomerulata	x	x	

Table 22. Checklist of corals observed at the Orote Submarine Cliffs and Blue Hole area.

SPECIES	ZONES 2-3	ZONES 4
ANTHOZOA		
POCILLOPORIDAE		
Pocillopora verrucosa	x	
P. sp. 1	x	
P. sp. 2	x	
ACROPORIDAE		
Acropora sp. 1	x	
A. sp. 2	x	
A. sp. 3	x	
Astreopora sp. 1	x	
A. sp. 2	x	
Montipora ehrenbergii	x	
M. foveolate	x	x
M. sp. 1	x	x
M. sp. 2		x
AGARICIIDAE		
Pachyseris sp.	x	x
Pavona sp.		x
PORTIDAE		
Porites sp. 1	x	x
P. sp. 2	x	
FAVIIDAE		
Favia sp.		x
Goniastrea retiformis	x	
Leptastrea purpurea	x	
L. sp.		x
Cyphastrea sp.	x	
Diploastrea heliopora	x	
MUSSIDAE		
Lobophyllia sp.	x	
CLAVULARIIDAE		
Pachyclavularia violacea	x	

Table 23. Checklist of common macroinvertebrates observed at the Orote Submarine Cliffs and Blue Hole area.

SPECIES	ZONES 1-3
MOLLUSCA	
GASTROPODA	
Conus miles	
C. rattus	
C. sponsalis	
Cypraea arabica	
C. caputserpentis	
C. isabella	
C. poraria	
Drupa grossularia	
D. morum	
D. ricinus	
Patella sp.	
Vasum ceramicum	
V. turbinellus	
ECHINODERMATA	
ECHINOIDEA	
Echinometra mathaei	
Echinostrephus aciculatus	
Echinothrix calamaris	
Heterocentrotus mamillatus	
ARTHROPODA	
CRUSTACEA	
Carpilius maculatns	
Grapsus grapsus	
Panulirus sp.	

Table 24. Checklist of fishes observed at the Orote Submarine Cliffs and Blue Hole area.

SPECIES	ZONES 1	2	3
ACANTHURIDAE			
Acanthurus glaucopareius	x	x	
A. lineatus	x		
A. nigrofuscus		x	
A. olivaceus		x	
A. triostegus	x	x	
Ctenochaetus striatus	x	x	
Naso lituratus		x	
APOGONIDAE			
Apogon fraenatus			x
BALISTIDAE			
Balistes bursa (=Sufflamen bursa)		x	
B. chrysopterus (=Sufflamen chrysoptera)		x	
Melichthys niger		x	
M. vidua		x	
Rhinecanthus rectangulus		x	
BLENNIIDAE			
Aspidontus taeniatus		x	
Meiacanthus atrodorsalis	x	x	
"Blenny" sp. 1			x
"Blenny" sp. 2			x
CHAETODONTIDAE			
Chaetodon ephippium		x	
C. mertensii			x
Forcipiger longirostris		x	
Heniochus chrysostomus			x
Holacanthus trimaculatus			x
Pygoplites diacanthus			x
CIRRHITIDAE			
Neocirrhites armatus		x	
Paracirrhites forsteri		x	
GOBIIDAE			
Nemateleotris magnificus		x	

Table 24. (continued)

SPECIES	ZONES 1	2	3
HOLOCENTRIDAE			
Adioryx sp.			x
Myripristis sp.			x
KYPHOSIDAE			
Kyphosus sp.	x		
LABRIDAE			
Cheilinus rhodochrous		x	
Epibulus insidiator		x	
Labroides dimidiatus		x	
Thalassoma lutescens		x	
T. purpureum	x		
T. quinquevittata		x	
LUTJANIDAE			
Aphareus furcatus	x	x	
Plectorhincus sp.			x
MULLIDAE			
Parupeneus multifasciatus		x	
POMACENTRIDAE			
Chromis acares			x
C. elerae			x
Dascyllus trimaculatus		x	
Glyphidodontops leucopomus	x		
G. traceyi			x
Plectroglyphidodon imparipennis	x		
Pomacentrus melanopterus	x		
P. vaiuli		x	
Pomachromis guamensis			x
SCARIDAE			
Scarus ghobban		x	
S. sordidus		x	
S. venosus		x	

Table 24. (continued)

SPECIES	ZONES 1	2	3
SERRANIDAE			
Anyperodon leucogrammicus			x
Cephalopholis argus			x
C. urodelus		x	
SYNGNATHIDAE			
"Syngnathid" sp.			x

AREA VII:
ANAE ISLAND PATCH REEF AND TERRACE

Anae Island, with its associated patch reef and terrace, is located just south of Nimitz Beach Park, approximately one kilometer offshore (Fig. 13). The island and patch reef form a mini-barrier reef system which protects the inside (shoreward) submarine terrace from large swells and strong currents. The submarine terrace between the patch reef and adjacent fringing reef supports one of the richest and most diverse coral communities found in Guam's coastal waters. This pristine area is readily accessible by small boat from the shore and is a popular area for SCUBA diving and underwater photography.

No previous survey has been done for the Anae area with respect to the marine biotic community. A partial physiographic description of the area is given by Randall and Holloman (1974). The following is taken in part from their report.

Anae Island is one of eight islets located along the southwest coast of Guam, but is the only one not associated with the fringing reef. The western and northern exposures of the island and patch reef slope steeply to a 30 meter terrace while the eastern and southern exposures consist of a gently sloping terrace approximately 3-8 meters in depth. In these protected waters spectacular coral mounds, pinnacles and ridges, with their associated icthyofauna are separated by sandy floored channels and holes. The relief of these coral mounds is often 6-8 meters or more.

The Guam Environmental Protection Agency water rating for the Anae area is "AA" - conservation. No point source discharges have been identified for the immediate area (Shidel, 1977).

Much of the surface of the patch reef is exposed during low tides and was largely devoid of live corals. The surface consisted of coral-algal-shell debris with a fine veneer of turf algae. The area of primary interest was the shoreward edge and terrace zones previously described. Two reconnaissance visits were made. Organisms observed at the study site are listed in Tables 25-26.

The coral community along the inside patch reef edge consisted of smaller Acropora, Leptastrea and Porites colonies. Goniastrea retiformis was found in scattered patches. Sloping down towards the terrace, at a depth of 4-9 meters, the diversity and colony size increased tremendously. Huge Acropora palifera and hemispherical Porites colonies dominated creating a room and pillar effect in many places. Other notable species included Millepora platyphylla, Goniastrea pectinata, Leptoria phrygia and Pavona frondifera.

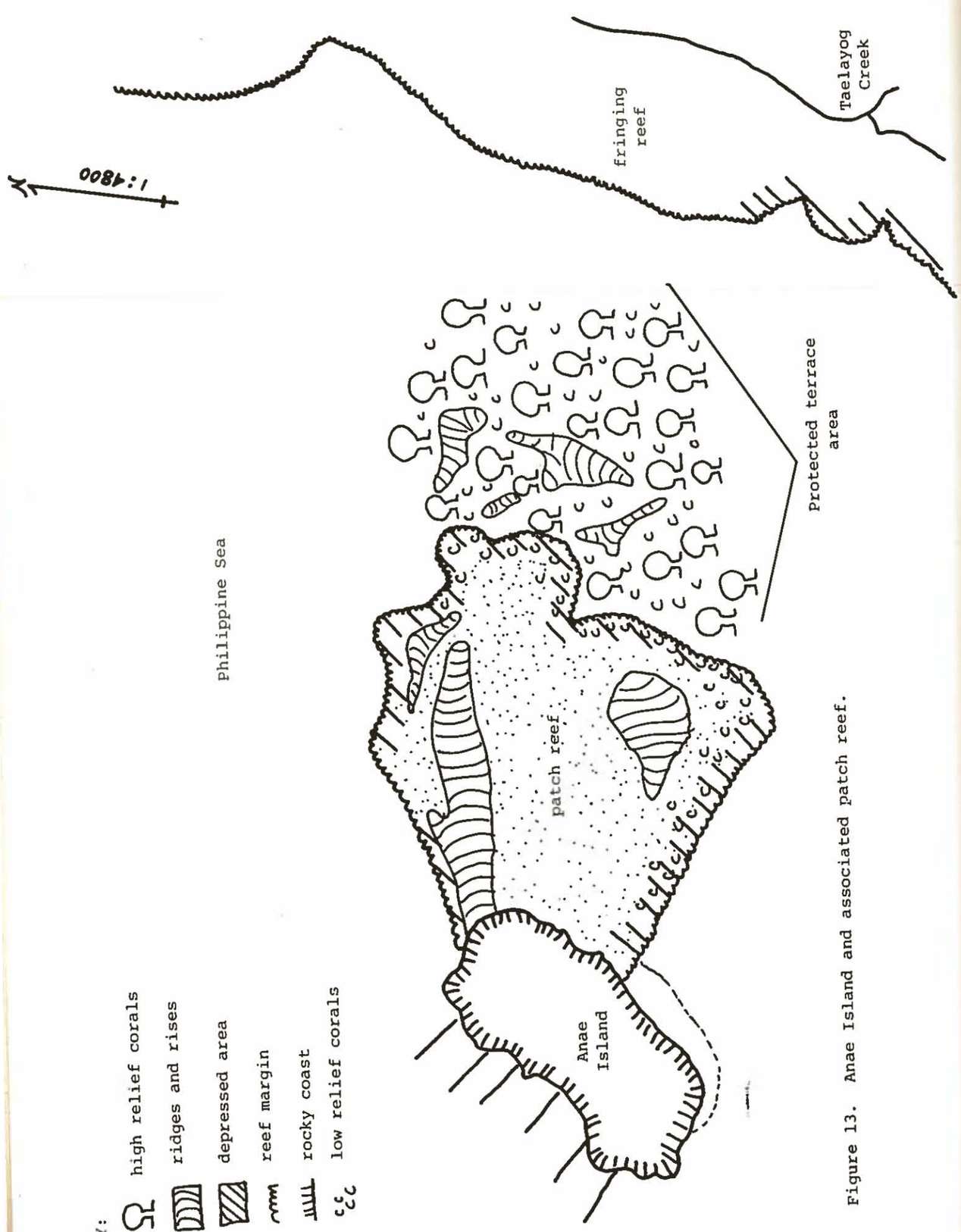


Figure 13. Anae Island and associated patch reef.

The algal community was moderately diverse with no single genus particularly dominant. Chlorodesmis fastigiata, Tydemannia expeditionis, Desmia hornemanni and Asparagopsis taxiformis species were common.

The fish community was very diverse which follows from the many habitats provided by the rich coral community. Typical reef associated pomacentrids and chaetodontids were abundant in addition to acanthurids, blennies and labrids.

No threatened or endangered species have been identified for this area.

CONCLUSIONS AND RECOMMENDATIONS

The beauty of the Anae area, with its pristine coral community and clear, protected waters, makes it an important preservation site for both scientific study and controlled recreational use. The area is readily accessible and a favorite spot for SCUBA diving and underwater photography.

The following recommendations are suggested for the Anae area:

1) that this area be established as a natural sanctuary in which no coral harvesting, fishing or other such activity be allowed.

2) that swimming, snorkeling and SCUBA diving activities be retained.

3) that mooring buoys be installed for boaters to avoid unnecessary coral breakage due to setting anchors.

4) that an underwater park with trails be developed.

Table 25. Checklist of benthic algae observed at Anae Island patch reef.

SPECIES
CYANOPHYTA (blue-green algae)
Anacystis sp.
Microcoleus lyngbyaceus
Schizothrix calcicola
S. mexicana
CHLOROPHYTA (green algae)
Boodlea composita
Caulerpa racemosa
Chlorodesmis fastigiata
Codium edule
Dictyosphaeria versluysii
Halimeda opuntia
Neomeris annulata
Tydemannia expeditionis
Udotea geppi
PHAEOPHYTA (brown algae)
Lobophora variegata
Sphacelaria tribuloides
RHODOPHYTA (red algae)
Actinotrichia fragilis
Amphiroa foliacea
A. fragilissima
Asparagopsis taxiformis
Ceramium sp.
Corallina sp.
Desmia hornemanni
Galaxaura marginata
G. oblongata
Gelidium divaricatum
Jania sp.
Liagora sp.
Polysiphonia sp.
Porolithon onkodes
Tolypiocladia glomerulata

Table 26. Checklist of common macroinvertebrates observed at Anae Island patch reef.

SPECIES
MOLLUSCA
GASTROPODA
Cerithium nodulosum
C. sp.
Conus miles
C. rattus
C. striatus
Coralliophila violacea
Cypraea sp.
Sabia conica
Tectus pyramis
Thais armigera
Trochus niloticus
T. maculatus
Turbo argyrostoncus
Vasum turbinellus
BIVALVIA
Tridacna maxima
ECHINODERMATA
ASTEROIDEA
Culcita novaeguineae
Linckia laevigata
L. multiflora
ECHINOIDEA
Diadema savignyi
Echinometra mathaei
Echinostrephis aciculatus
Echinothrix diadema
Toxopneustes gratilla
HOLOTHUROIDEA
Actinopyga echinites
Bohadschia argus
Holothuria atra
H. hilla
H. nobilis
Stichopus chloronotus

AREA VIII:
CETTI BAY

Cetti Bay (Fig. 14) is located on the southwest coast of Guam between Sella and Fouha Bays. The bay is extremely isolated and can be reached only by boat or a long hike. Route 4 overlooks the bay. The steep surrounding slopes and sandy beaches, combined with a diverse reef community, make Cetti Bay one of the most picturesque pristine marine communities on Guam.

No previous study has been conducted for Cetti Bay with respect to the marine biotic community. Randall and Holloman (1974) give a partial physiographic description of the area. A summary of their findings are incorporated below.

The Guam Environmental Protection Agency water quality rating for Cetti Bay is "AA" -conservation. No point source discharges are known for the area (Shidel, 1977).

The study area was divided into two broad zones: (1) reef flats and (2) margin, face and terrace. Tables 27-30 list those organisms observed in the area.

The reef flat is continuous around the bay with the exception of two breaks occurring at the river mouths. The platforms are narrow (15-20 meters) with no moat or algal ridge development. At low tides they are typically exposed and therefore largely devoid of corals, though a rich algal community persists. A diverse macroinvertebrate community was also evident. The holothurians Holothuria atra and Actinopyga echinites were abundant. In addition, many large sea anemones, measuring a meter or more in diameter, were common along the shallower waters of the upper margin and terrace zones.

The reef margin, face and terrace were fairly uniform around the bay with the exception of a volcanic area on the north side. There, the margin is cut by irregular cracks and fissures. Some of the fissures were up to 6 meters deep and 2-3 meters wide.

The margin face typically extended down for 3-4 meters and then sloped to a tilted terrace zone averaging 4-10 meters deep. Beyond that point the sand floor of the bay began. The floor of the bay was not investigated.

The algal and coral communities in Zone 2 were very rich and diverse. In addition to low relief colonies along the upper margin face, massive columns and mounds of Porites characterized the adjacent terrace. Large colonies of Montipora and Acropora were common in addition to Galaxia, Cyphastrea, Pavona and Goniastrea species.

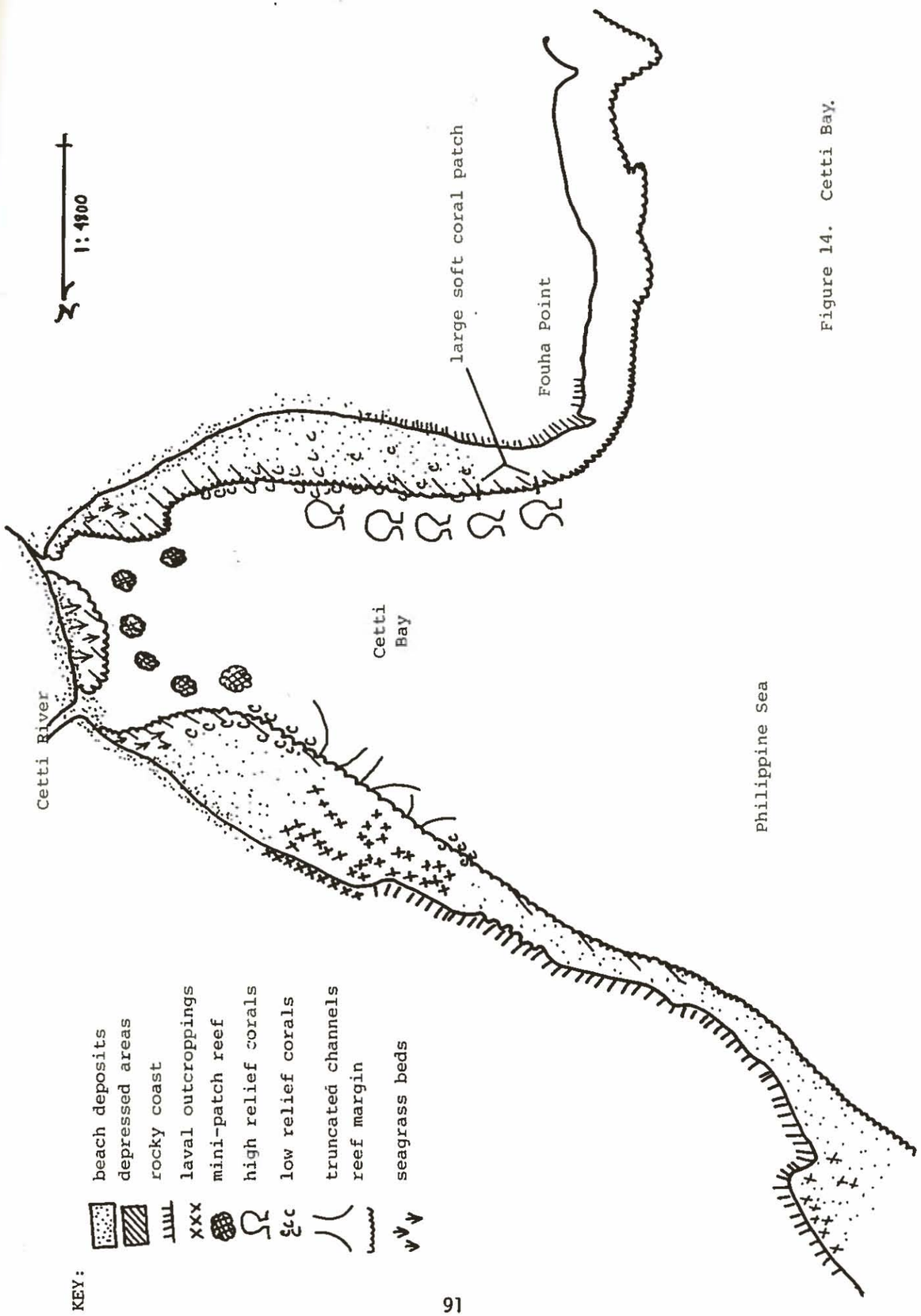


Figure 14. Cetti Bay.

Of particular interest was a huge bed (6 meters in diameter) of the soft corals Sinularia and Lobophyton species. This patch is located midway out on the south side.

The algal genera, Caulerpa and Halimeda, were particularly abundant along the lower margin. Asparagopsis taxiformis was observed only on the north side of the bay. The seagrass Enhalus acoroides was found in small patches along the east side of the inner bay reef flat. In all, forty-three genera of benthic algae were observed.

The fish community was sparse in the inner bay where silt content was high and visibility low. In general, however, visibility was excellent throughout most of the bay. Many pomacentrids and chaetodontids were present in addition to acanthurids, blennies and other reef associated fishes.

No threatened or endangered species have been identified for Cetti Bay.

CONCLUSIONS AND RECOMMENDATIONS

Cetti Bay is one of the most picturesque pristine areas on the island, both above and below the water. Though isolated, its protected waters make it a favorite spot for divers, boaters and fisherman.

The following recommendations are suggested for Cetti Bay:

1) that this area be established as a natural sanctuary in which no coral harvesting, fishing or other such activity be allowed.

2) that swimming, snorkeling and SCUBA diving activities be retained.

3) that mooring buoys be installed for boaters to avoid unnecessary coral breakage due to setting anchors.

4) that a "Thermos law" be enforced to halt beverage can litter.

Table 27. Checklist of benthic algae observed at Cetti Bay.

SPCIES	Reef flat	Margin & Face
CYANOPHYTA (blue-green algae)		
Microcoleus lyngbyaceus	x	x
Schizothrix calcicola	x	
S. mexicana	x	
CHLOROPHYTA (green algae)		
Boodlea composita	x	
Bryopsis pennata		x
Caulerpa cupressoides	x	x
C. filicoides		x
C. racemosa		x
C. serrulata	x	x
Codium edule		x
Dictyosphaeria versluysii	x	x
Enteromorpha clathrata	x	
Halimeda gigas		x
H. macroloba	x	x
H. opuntia	x	x
Neomeris annulata		x
Tydemannia expeditionis		x
Udotea argentea	x	x
PHAEOPHYTA (brown algae)		
Dictyota bartayresii		x
D. divaricata		x
D. friabilis		x
Hydroclathrus clathratus	x	x
Lobophora variegata	x	x
Padina minor	x	x
Sphacelaria tribuloides	x	x
Turbinaria ornata	x	
RHODOPHYTA (red algae)		
Actinotrichia fragilis		x
Amphiroa foliacea	x	x
A. fragilissima	x	x
Asparagopsis taxiformis	*x	x
Ceramium gracillimum	x	x
C. mazatlanense		x
C. sp.		x

*Alga found on north reef flat only.

Table 27. (continued)

SPECIES	Reef flat	Margin & Face
Cheilosporum sp.		x
Corallina sp.		x
Desmia hornemanni		x
Galaxaura filamentosa		x
G. marginata		x
G. oblongata	x	x
Gelidium crinale	x	x
G. pusillum	x	
Gracilaria arcuata	x	
Gracilaria sp.	x	x
Hypnea sp.	x	
Jania capillacea		x
J. tenella		x
Liagora sp.		x
Peyssonelia rubra		x
Pterocladia parva		x
Tolypiocladia glomerulata		
SPERMATOPHYTA (seagrasses)		
Enhalus acoroides	x	

Table 28. Checklist of corals observed at Cetti Bay.

SPECIES	North Bay	South Bay
ANTHOZOA		
ASTROCOENIIDAE		
Stylocoeniella armata	x	x
THAMINASTERIIDAE		
Psammocora sp.	x	x
POCILLOPORIDAE		
Stylophora mordax	x	x
Pocillopora damicornis		x
P. elegans	x	x
P. setchelli	x	x
P. verrucosa	x	
P. sp. 1	x	x
P. sp. 2	x	
ACROPORIDAE		
Acropora formosa	x	
A. irregularis		x
A. nana	x	x
A. nasuta	x	
A. histrix	x	
A. palifera	x	
A. sp. 1	x	
A. sp. 2		x
A. sp. 3		x
A. sp. 4		x
Astreopora sp.		x
Montipora sp. 1	x	
M. sp. 1	x	
M. sp. 2		x
M. sp. 3		x
M. sp. 4		x
M. sp. 5	x	x
M. sp. 6	x	
M. sp. 7	x	
AGARICIIDAE		
Goniopora sp. 1	x	x
G. sp. 1	x	

Table 28. (continued)

SPECIES	North Bay	South Bay
Porites andrewsi	x	
Porites reticulosa	x	
P. lutea		x
P. sp. 1		x
P. sp. 2		x
P. sp. 3		x
P. sp. 4	x	
P. sp. 5	x	
FAVIIDAE		
Favia speciosa		x
F. sp. 1		x
F. sp. 2	x	x
Goniastrea retiformis	x	x
G. sp. 1		x
Platygyra rustica	x	x
P. sinensis	x	x
Leptoria sp.	x	x
Leptastrea purpurea	x	x
L. sp.		x
Cyphastrea sp.	x	x
Echinopora sp.		x
Diploastrea heliopora	x	
OCULINIDAE		
Galaxea sp.	x	x
MUSSIDAE		
Lobophyllia hemprichii	x	x
L. sp.	x	x
Acanthastrea echinata		x
HELIOPORIDAE		
Heliopora coerulea		x
TUBIPORIDAE		
Tubipora musica	x	x
ALCYONIIDAE		
Alcyonium utinomii	x	
Sarcophyton glaucum		x

Table 28. (continued)

SPECIES	North Bay	South Bay
Sinularia densa	x	
S. maxima	x	
S. polydactyla		x
S. sp. 1	x	x
S. sp. 2		x
ZOANTHIDAE		
Zoanthus sp.	x	x
HYDROZOA		
MILLEPORIDAE		
Millepora exaesa	x	x
M. platyphylla	x	x

Table 29. Checklist of common macroinvertebrates observed at Cetti Bay.

SPECIES

PORIFERA

Cinachyra australiensis

MOLLUSCA

AMPHINEURA

Unknown sp.

GASTROPODA

Astraea rhodostoma
Bursa bufonia
Cerithium nodulosum
C. sp. 1
C. sp. 2
Chicoreus penchinati
Conus chaldeus
C. lividus
C. miles
C. rattus
C. sponsalis
Coralliophilla violacea
Cypraea arabica
C. caputserpentis
C. carneola
C. isabella
C. moneta
C. proaria
Drupella cornus
Drupa ricinus
Morula granata
M. uva
Nerita plicata
N. sp.
Patella sp. 1
P. sp. 2
Sabia conica
Strombus sp.
Thais armigera
Trochus niloticus
Vasum turbinellus

BIVALVIA

Grafrarium sp.
Septifer bilocularis
Tridacna maxima

CEPHALOPODA

Octopus sp.

ECHINODERMATA

ASTEROIDEA

Linckia lavegata

ECHINOIDEA

Diadema savignyi
Echinometra mathaei
Echinostrephus aciculatus
Echinothrix calamaris
E. diadema

HOLOTHUROIDEA

Actinopyga echinites
Holothuria atra
Stichopus chloronotus

OPHIUROIDEA

Ophiothrix sp.

ARTHROPODA

ANOMURA

Calcinus latens
Clibinarius humulis

BRACHYURA

Calappa calappa
Carpilius maculatus
Etisus dentatus
Grapsus grapsus
Percnon sp.
Thalamita sp.

Table 30. Checklist of fishes observed at Cetti Bay.

SPECIES	North Bay	South Bay
ACANTHURIDAE		
Acanthurus glaucoparieus	x	x
A. lineatus	x	x
A. nigrofuscus	x	x
A. triostegus		x
Ctenochaetus striatus	x	x
Naso lituratus	x	x
N. sp.	x	x
Zebrasoma flavescens		x
Z. scopas		x
APHAREIDAE		
Aphareus furcatus	x	x
APOGONIDAE		
Apogon sp.	x	
Paramia quinquelineata	x	
AULOSTOMIDAE		
Aulostomus chinensis		x
BALISTIDAE		
Balistapus undulatus	x	
Balistes bursa (=Sufflamen bursa)	x	
B. chrysopterus (=S. chrysoptera)		x
Rhinecanthus rectangulus	x	
BLENNIIDAE		
Cirripectes variolosus		x
Meiacanthus atrodorsalis	x	x
Plagiotremus rhinorhynchos		x
P. tapeinosoma		x
CANTHIGASTERIDAE		
Canthigaster bennetti		x
C. solandri	x	x
CHAETODONTIDAE		
Centropyge flavissimus		x

Table 30. (continued)

SPECIES	North Bay	South Bay
Chaetodon auriga		x
C. bennetti		x
C. citrinellus	x	x
C. ephipium	x	x
C. lineolatus	x	x
C. lunula	x	x
C. mertensii		x
C. ornatissimus	x	x
C. punctato-fasciatus	x	x
C. quadrimaculatus	x	x
C. reticulatus	x	x
C. trifascialis (*Megaprotodon strigangulus*)	x	x
C. ulietensis	x	x
C. unimaculatus		x
Forcipiger sp.	x	x
Heniochus varius		x
Pygoplites diacanthus		
CIRRHITIDAE		
Paracirrhites arcatus		x
GOBIIDAE		
Eviota sp.		x
Cryptocentrus sp.	x	
Ptereleotris tricolor	x	
Valenciennea strigata	x	
Goby sp. 1		x
Goby sp. 2		x
HOLOCENTRIDAE		
Adioryx spinifer		x
A. sp.		x
Myripristis sp. 1		x
M. sp. 2		x
M. sp. 3	x	
LABRIDAE		
Anampses caeoruleapunctatus	x	x
Bodianus axillaris	x	
Cheilinus rhodochrous	x	x
C. trilobatus	x	x
C. sp.		x
Cymolutes lecluse	x	
Epibulus insidiator		x

Table 30. (continued)

SPECIES	North Bay	South Bay
Gomphosus varius	x	x
Halichoeres hortulanus (=*H. centiquadrus*)	x	x
H. margaritaceus		x
H. marginatus	x	x
H. nebulosus		x
H. trimaculatus	x	x
H. sp.	x	
Hemigymnus fasciatus		x
H. melapterus		x
Labroides bicolor		x
L. dimidiatus	x	x
Macropharyngodon meleagris	x	x
Stethojulis bandanensis	x	x
Thalassoma hardwickei	x	x
T. lunare		x
T. purpureum	x	x
T. quinquevittata	x	x
T. sp.	x	
LUTJANIDAE		
Caesio sp.	x	
Lutjanus fulvus		x
L. kasmira		x
L. vaigiensis	x	x
L. sp.		x
MONACANTHIDAE		
Amanses carolae	x	x
Oxymonacanthus longirostris	x	x
MULLIDAE		
Mullet sp.		x
MUGILOIDIDAE		
Parapereis sp.		x
MULLIDAE		
Mulloidichthys samoensis	x	x
Parupeneus barberinus		x
P. bifasciatus		x
P. cyclostomus	x	x
P. trifasciatus	x	x
P. sp.	x	

Table 30. (continued)

SPECIES	North Bay	South Bay
NEMIPTERIDAE		
Scolopsis cancellatus	x	
OSTRACIONTIDAE		
Ostracion meleagris	x	x
O. sp.	x	
PEMPHERIDAE		
Pempheris oualensis	x	x
POMACENTRIDAE		
Abudefduf coelestinus	x	x
A. saxatilis		x
A. sordidus		x
Amblyglyphidodon curacao		x
Amphiprion chrysopterus		x
A. melanopus	x	x
A. perideraion	x	
Chromis caerulea	x	x
C. margaritifer	x	
C. sp. 2		x
C. sp. 3	x	
Dascylus aruanus	x	x
D. reticulatus	x	
D. trimaculatus	x	x
Glyphidodontops leucopomus	x	x
G. sp.		x
Plectroglyphidodon dickii	x	x
P. johnstonianus	x	
P. lacrymatus	x	x
Pomacentrus vaiuli	x	x
P. sp.		x
Stegastes lividus	x	
S. nigricans	x	
S. sp.	x	
Pomacentrid sp.	x	
SCARIDAE		
Leptoscarus vaigiensis		x
Scarus sordidus	x	x

Table 30. (continued)

SPECIES	North Bay	South Bay
SCORPAENIDAE		
Synanceia verrucosa	x	
SERRANIDAE		
Epinephelus merra		x
SIGANIDAE		
Siganus argenteus	x	
S. spinus		x
S. vermiculatus		x
SYNODONTIDAE		
Synodus sp.		x
TETRAODONTIDAE		
Arothron nigropunctatus		x
ZANCLIDAE		
Zanclus cornutus	x	x

AREA IX:
COCOS BARRIER REEFS AND LAGOON AREA

The Cocos area, a triangular barrier reef, lagoon and associated islands, is located just off the extreme southwest coast of Guam, opposite the village of Merizo. This complex area is unique to Guam, covering approximately 6.6 square kilometers and representing seven of the ten physiographic features outlined for this survey. These include barrier reefs, fringing reefs, patch reefs, barrier reef channels, mangroves, seagrass beds and estuaries. The increasing popularity of the Merizo coast and nearby Cocos Island, as a full time fishing and tourist operation makes preservation ever more urgent for this pristine area.

An extensive biological survey was prepared by Randall et al. (1975). Their report covers the above community types with particular emphasis given to the barrier reef, lagoon and channel communities. Quantitative physiographic as well as biotic data are included. The bibliography contains 41 references. The reader is strongly urged to consult the Randall et al. (1975) survey for an in-depth discussion.

Randall et al. (1975) divided the entire Cocos complex into three biotopes with multiple facies. Biotopes are defined as "primary ecological units including the entire complex of habitat, substrate, accretional and erosional processes, hydrologic factors and life associations." Facies are the smaller divisions made within biotopes. The following biotopes and associated facies were established for Cocos Lagoon:

Biotope I - This biotope includes the lagoon, barrier reef-flat platforms, and fringing reef-flat platforms.

Facies A - Barrier reef-flat platform.

Facies B - Shallow lagoon terrace or floor which forms a shelf extending from the lagoonward edge of the barrier reef and fringing reef-flat platforms to the 3 meter depth contour.

Facies C - Lagoon floor deeper than 3 meters.

Facies D - Patch reefs, mounds, and knolls which form distinct physiographic features on the lagoon floor.

Facies E - Nearshore shelf of fringing reef-flat platform which borders the landward side of Cocos Lagoon.

Biotope II - This biotope consists of the deep Mamaon and Manell Channels.

Facies A - Shallow channel margin shelves located at the upper margin of the channel slopes or walls.

Facies B - Channel slope located between the upper channel margin or shelf and the channel floor.

Facies C - Channel slopes which form steep rocky walls or submarine cliffs, located between the upper channel margin or shelf and channel floor.

Facies D - Cavernous parts of channel slopes and walls and the overhanging ceilings of submarine cliffs.

Facies E - Channel floor, usually composed of unconsolidated sediments.

Biotope III - This biotope consists of the terrestrial regions at Cocos Island and the small sand islet at its eastern end, Babe Island, and the landward border along Cocos Lagoon.

A discussion of each facies is beyond the scope of this report though the species lists reflect the biota of each one. A synopsis of the major biological findings in Biotopes I and II follows. Biotope III is terrestrial and therefore not included. Tables 31-35 list those organisms observed in the study area.

HARD AND SOFT CORALS

Biotope I includes the lagoon and its peripheral reef flat platforms divided into five concentric facies, beginning with the outermost area (Fig. 15). Coral cover on facies A was variably dense and diverse based on differing degrees of reef-flat exposure. In general, an increase in coral cover and diversity from the seaward side to the lagoon side was noted. Thirty-nine species representing 18 genera were observed.

Facies B consisted of the shallow lagoon terrace extending lagoonward to the 3 meter submarine contour. Width of this facies varied widely from 200-1000 meters. The boundary along the near shore shelf was demarcated by the seagrass Enhalus acoroides Extensive regions of the terrace floor were covered by the staghorn coral, Acropora formosa. Thickets ranging in diameter from a few meters to many meters created a varied range of habitats. In general, coral growth was more dominant on the southern terrace. Toward the eastern end of the lagoon, the Acropora thickets became increasingly large with zones of mixed corals between patches. Coral diversity was highest here.

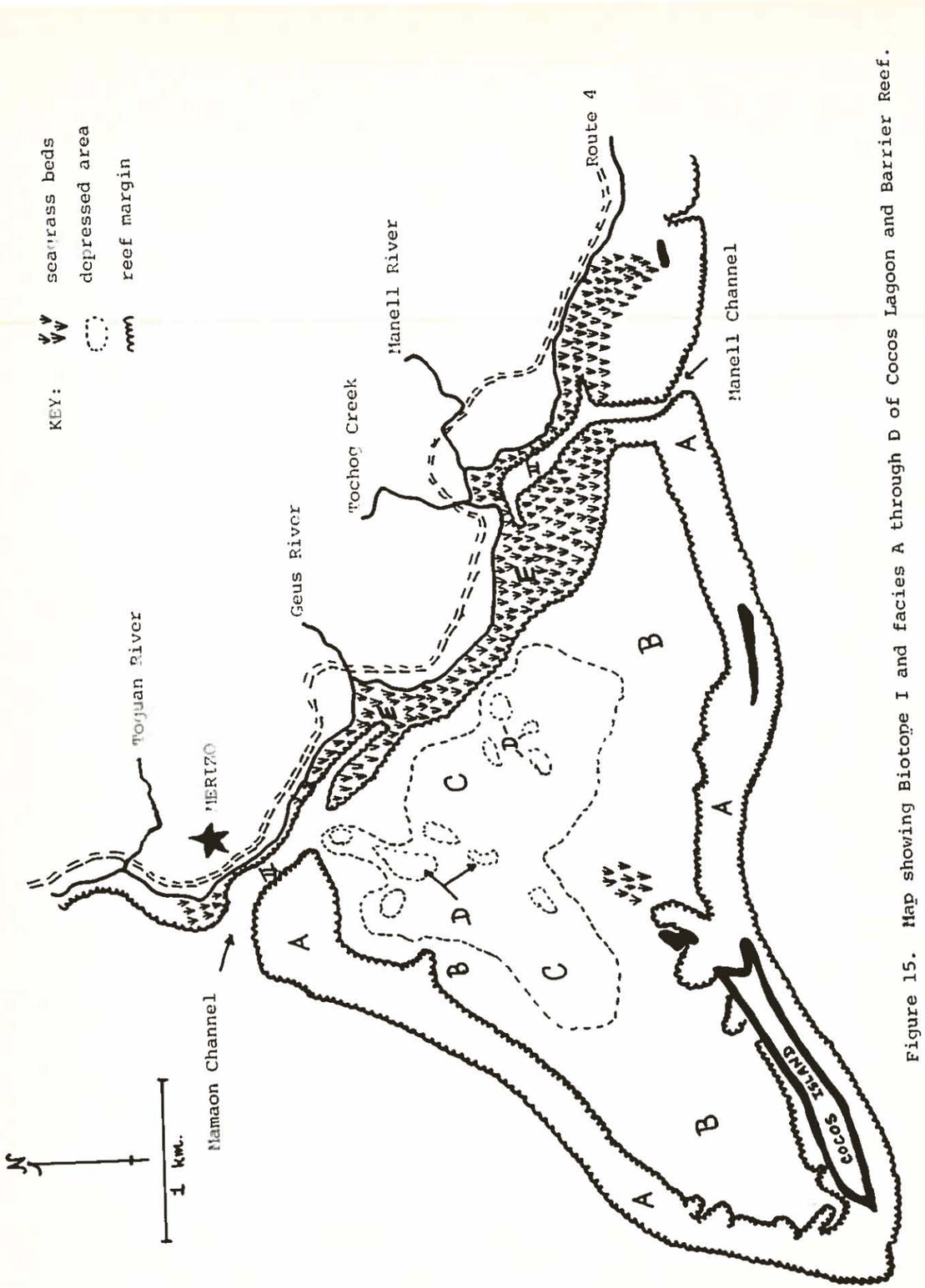


Figure 15. Map showing Biotope I and facies A through D of Cocos Lagoon and Barrier Reef.

The western portion of this area was devoid of corals for the most part. Seventy-nine species representing 27 genera were noted.

Facies C and D represent the central portion of the lagoon deeper than 3 meters and the patch reefs. The sand floor is interrupted by mounds, knolls and knobs. These relief features are zones rich in coral, algae, associated invertebrates and fish. These facies contained the richest and most diverse communities in biotope I. The under surface of overhanging mushroom shaped knolls are the habitats of various Leptoseris, Pavona, Plerogyra and Porites coral species, which are typically found in much deeper habitats. A total of 102 species representing 35 genera were observed.

Facies E consists of the narrow fringing reef bordering the landward side of the lagoon. The intertidal zone is dotted by mangrove patches (Mamaon Channel side) providing habitats for small gastropods and crabs. In general, this zone was rather barren. The most dominant community along the fringing reef-flat platform were the seagrasses.

Many beautiful soft corals (alcyonaceans and zoanthids) were noted in biotope I. Although they were seen in virtually all facies, they were particularly rich in facies C and D. Sinularia polydactyla was the most common. It was estimated that there was one soft coral for every 1.37 square meters. Facies E was also rich in soft corals.

Biotope II consists of the deep Mamaon and Manell barrier reef channels and their associated facies (Fig. 16). The shallow channel margins (Facies A) were highly variable with respect to coral density, diversity and physiographic character. In general, lagoonward sides of the channels were more highly developed with diversity highest at the channel mouths (particularly Mamaon). Several species of Porites dominated. Coral diversity for this facies was the highest in the lagoon with 104 species representing 34 genera.

The steep channel slopes (Facies B) and submarine cliffs (Facies C) ranged in depth from 3-30 meters. Characteristically turbid water and high sedimentation rates inhibited a rich coral growth though isolated patches were noted. The submarine cliff areas (near channel mouths) exhibited less sediment accumulation and therefore a more diverse community. Pavona and Acropora species were abundant in addition to Porites.

Facies D consisted of the cavernous parts of the channel including overhangs and ceilings. This area was considered rather special in that the low light intensities have allowed for the development of many deep water corals. Leptoseris sp., Stylocoeniella armata, Pavona minuta, Pachyseris speciosa, Porites (S.) hawaiiensis, Echinophyllia aspera, Mycedium, Plerogyra sinuosa and Euphyllia glabrescens were abundant. Bryozoans and larger foraminiferans were also common.

The channel floors (Facies E) are largely devoid of corals. A few small Porites colonies were noted. Near the channel mouths a

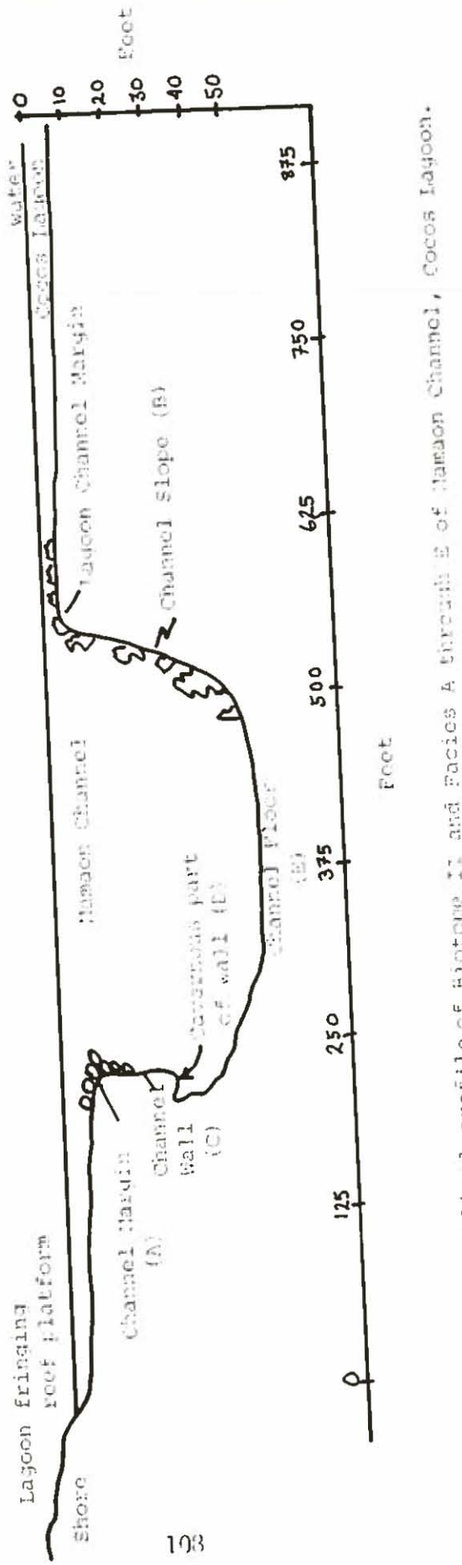


Figure 16. Generalized profile of Biotope II and facies A through E of Lagoon Channel, Cocos Lagoon.

few gorgonians and small hydroids were seen.

The upper facies of Biotope II contained a diverse soft coral community. Twenty different species were observed compared to four in all other facies of both biotopes combined. Density, however, was considerably less than that found on the nearshore shelf described in Biotope I.

MARINE PLANTS

Marine flora for both biotopes was very diverse. Ninty-one species were observed. The highest diversity was found in biotopes IA (barrier reefs) and ID (patch reefs). The most depauperate areas were biotopes IC and IIE, lagoon and channel floors respectively.

Polysiphonia sp. and Dictyota bartayresii (windward side), and Caulerpa racemosa and Padina tenuis (leeward side), dominated Biotope IA. Polysiphonia sp. and Dictyota bartayresii also dominated Biotope IB. Biotope IC was dominated by Halimeda macroloba, Avrainvillea obscura, Halophila minor and Caulerpa sertularioides, all of which have specialized holdfast systems for sandy substrates. Biotope ID was dominated by Feldmannia indica, an important dietary item for juvenile siganids. Biotopes IE and IIA were vastly dominated by the seagrass Enhalus acoroides. Biotopes IIB-D were dominated by Halimeda incrassata and Tolypiocladia glomerulata. The crustose and coralline algae Porolithon onkodes and Peyssonelia sp. were virtually the only genera found in Biotope IIE.

MACROINVERTEBRATES

An inventory of the major macroinvertebrates is included in the species lists. Emphasis was placed on molluscs and echinoderms. No discussion of their relative abundance and distribution is given in the Randall report.

FISHES

The ichthyofauna found in Biotopes I and II was divided into a slightly different facies scheme (Fig. 17). These include the outside reef (I), channel walls (II), lagoon patch reefs (III), barrier reef flat (IV), seagrass beds (V), sand bottom (VI), estuarine and freshwater (VII) and a miscellaneous category (M) for those fish observed by previous workers without regard to location. The following observations and conclusions were made regarding the fish population in the Cocos area (Jones and Chase, 1975).

> Although the channel-wall (II) of Cocos Lagoon proved to be more diverse than the biotope outside the barrier (I), in terms of transect species, diversity, and biomass, it seems that the lagoon as a whole is not supporting an exceptionally rich ichthyofauna. . . Qualitative observations as well

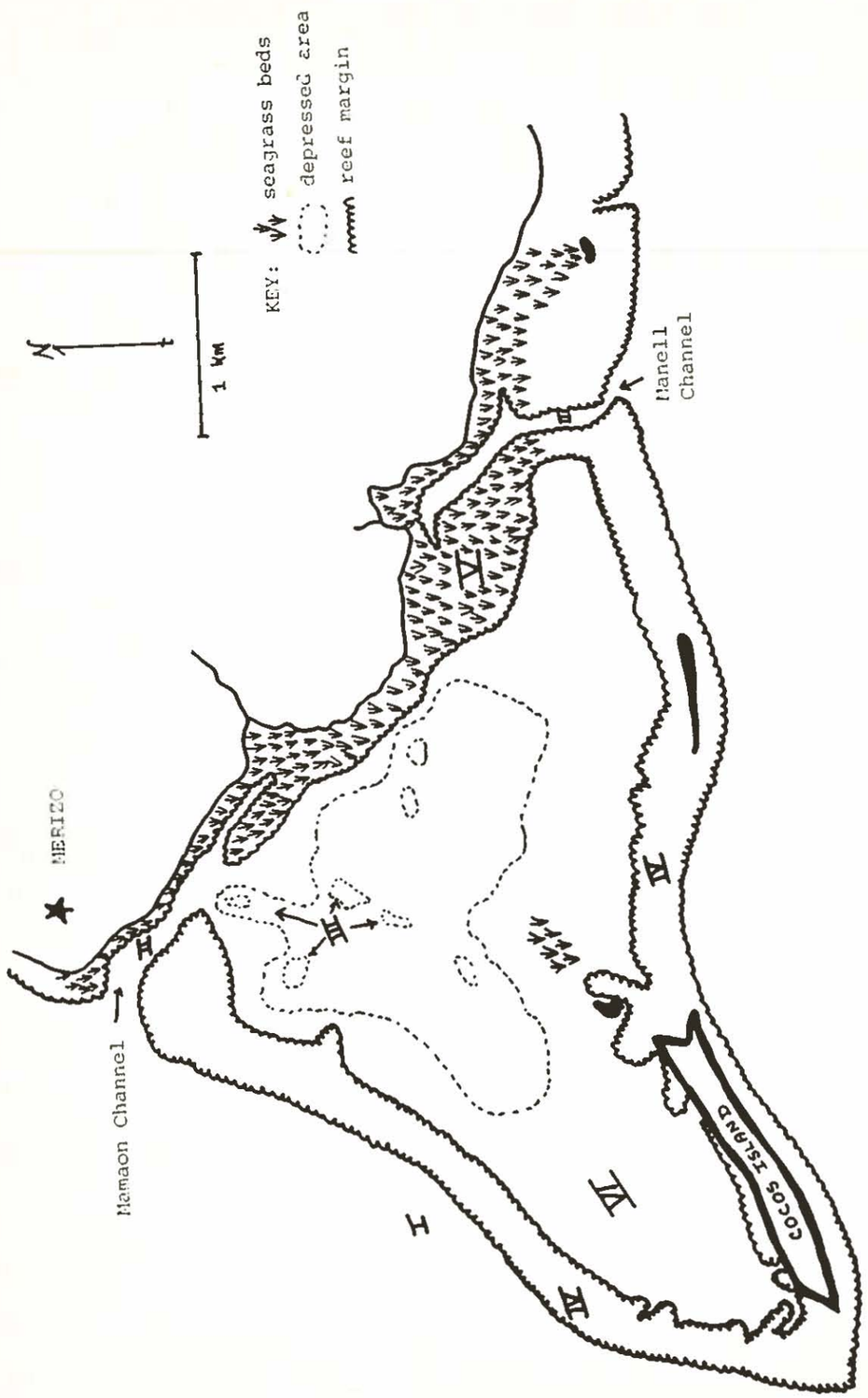


Figure 17. Icthyofaunal Biotopes I through VI at Cocos Lagoon. (Adapted from Jones and Chase, 1975)

as many of our transect counts indicated that large numbers of juvenile reef fish species occurred in the lagoon. This was true both in areas with reef cover and in the seagrass beds. These observations lead us to believe that the lagoon's enclosed nature, coupled with the natural cover available, makes Cocos Lagoon an invaluable nursery for many of the species.

THREATENED AND ENDANGERED SPECIES

The federally registered endangered species Eretmochelys imbricata (hawksbill turtle) is often present in Cocos Lagoon. The sea cow Dugong dugong has been reported in the lagoon by Gawel, Hotaling and Tobias in 1974. Whether this organism is still present is doubtful. The coconut crab, Birgus latro, has been extensively harvested on Cocos Island and may be threatened. The coral Tubastrea aurea is rare on Guam but abundant throughout Micronesia.

WATER CLASSIFICATION

GEPA water classification ratings for this area are "A", recreational. Over twenty-five point source discharges are known along the Merizo coastline. Fortunately, most are small and the Manell and Mamaon channels are able to transport the discharges laterally into the Philippine Sea and Pacific Ocean, respectively, thus largely protecting the adjacent lagoon. While carrying capacity appears to be stable at the present time, the maximum supportable discharge load is not known and further development involving waste discharge must be carefully monitored.

CONCLUSIONS AND RECOMMENDATIONS

The beauty of the Cocos area, with its pristine lagoon and associated features as well as clear and protected waters make it an important preservation site for both scientific study and limited recreational use. No alternative site exists on Guam. The Cocos area is unique. Recreational development and tourism have increased tremendously, necessitating an immediate appraisal of potential environmental stresses. Randall et al. (1975) concluded that the delicate nature of the area is such that any physical disruption of the seagrass beds, coral reefs, etc., within the lagoon or immediately adjacent areas could have serious effects on the fish population in particular. For these reasons the following recommendations are suggested:

1) that the entire Cocos area be made into a marine sanctuary in which fishing, coral harvesting and shell collecting be outlawed except by special permit.

2) that the GEPA water quality classification be changed to "AA", conservation.

3) that an upper limit on the number and type of point source discharges into Mamaon and Manell Channels be established.

4) that strictly controlled recreational activities including SCUBA diving, snorkeling, and swimming be retained along with authorized glass bottom boat tours and the transport of picnickers and bathers to Cocos Island proper.

5) that an upper limit on the number of transport boats and persons utilizing the area at any given time be established.

6) that the entire Cocos area be made into a marine underwater park with trails and basic information on the geology, physiography and biota. This should be made available through pamplets and signs in the area written in layman's language. The system could be modeled after Hanauma Bay (Oahu, Hawaii).

7) that the placement of artificial reefs and fish traps for scientific and maricultural purposes be allowed with the issuance of a special permit.

8) that strict litter laws be implemented, notably a "Thermos Law", curtailing the problem of waste beverage cans. This is already in effect on Cocos Island and should be added to the adjacent coastal areas included in the sanctuary.

Table 31. Checklist of marine plants observed at Cocos Lagoon. (Adapted from Randall et al., 1975).

SPECIES	Biotope I A	B	C	D	E	Biotope II A	B	C	D	E
CYANOPHYTA (blue-green algae)										
Calothrix crustacea	x	x		x	x	x	x	x	x	
Hormothamnion enteromorphoides	x	x	x	x	x	x				
Microcoleus lyngbyaceus	x	x	x	x	x	x	x	x	x	x
Schizothrix calcicola	x	x		x	x	x	x	x	x	
Schizothrix mexicana	x	x		x	x	x				
Rivularia atra					x					
CHLOROPHYTA (green algae)										
Acetabularia moebii	x			x						
Avrainvillea obscura	x	x	x		x					
Boergesenia forbesii	x	x		x		x				
Boodlea composita	x	x		x	x	x	x	x	x	
Caulerpa cupressoides	x	x	x	x	x	x	x	x	x	
Caulerpa filicoides										x
Caulerpa lentillifera		x		x	x					x
Caulerpa racemosa	x	x	x	x	x	x	x	x	x	
Caulerpa serrulata	x	x		x	x	x				
Caulerpa sertularioides	x	x	x	x	x					x
Caulerpa taxifolia	x	x		x	x	x				
Caulerpa verticillata		x		x		x				
Chlorodesmis fastigiata	x			x	x	x	x	x	x	
Cladophoropsis membranaceae	x				x					
Codium edule				x						
Dictyosphaeria cavernosa	x	x		x	x	x				
Dictyosphaeria versluysii	x	x		x	x	x	x	x	x	
Enteromorpha compressa					x					
Halimeda copiosa				x		x				
Halimeda discoidea	x	x		x	x	x	x	x	x	
Halimeda gigas						x	x	x	x	
Halimeda incrassata					x	x	x	x	x	
Halimeda macroloba	x	x	x	x	x					
Halimeda opuntia	x	x	x	x	x	x	x	x	x	x
Neomeris annulata	x			x	x	x				
Neomeris vanbosseae							x	x	x	
Rhipilia orientalis						x				
Tydemannia expeditionis	x			x	x	x				
Udotea argentea						x				x
Valonia fastigiata	x	x		x	x	x	x	x	x	
Valonia ventricosa	x	x		x	x	x				

Table 31. (continued)

SPECIES	Biotope I A	B	C	D	E	Biotope II A	B	C	D	E
PHAEOPHYTA (brown algae)										
Chnoospora implexa	x	x	x	x						
Dictyota bartayresii	x	x	x	x	x	x				x
Dictyota cervicornis	x	x	x	x	x					
Dictyota divaricata	x	x	x	x		x	x	x	x	
Dictyota friabilis	x	x		x			x	x	x	
Dictyota patens				x	x	x				
Ectocarpus breviarticulatus	x				x					
Feldmannia indica	x	x		x	x		x	x	x	
Hydroclathrus clathratus	x	x	x	x	x					
Lobophora variegata	x	x		x	x		x	x	x	
Padina jonesii			x			x	x	x	x	
Padina tenuis	x	x		x	x					
Sargassum cristaefolium	x									
Sargassum polycystum	x				x					
Sphacelaria tribuloides	x			x	x		x	x	x	
Turbinaria ornata	x	x		x	x	x	x	x	x	
RHODOPHYTA (red algae)										
Acanthophora spicifera	x	x	x	x		x	x	x	x	
Actinotrichia fragilis	x	x			x	x	x	x	x	
Amphiroa foliacea	x				x	x	x	x	x	
Amphiroa fragilissima	x	x		x	x	x	x	x	x	x
Antithamnion sp.										
Asparagopsis taxiformis						x				
Botryocladia skottsbergii				x						
Centroceras clavulatum				x						
Ceramium sp.				x						
Champia parvula				x						
Desmia hornemanni						x	x	x	x	
Galaxaura fasciculata	x	x		x	x	x				
Galaxaura marginata				x						x
Galaxaura oblongata		x		x		x	x	x	x	x
Gelidiella acerosa	x	x		x						
Gelidiopsis intricata	x	x		x	x					
Gelidium divaricatum	x	x		x	x	x	x	x	x	
Gelidium pusillum	x									
Gracilaria arcuata	x			x						
Gracilaria crassa	x			x	x					
Griffithsia sp.				x						
Halymenia durvillaei				x						
Hypnea cervicornis							x	x	x	
Hypnea pannosa	x	x		x	x	x	x	x	x	
Hypnea valentiae	x			x						

Table 31. (continued)

SPECIES	Biotope I A	B	C	D	E	Biotope II A	B	C	D	E
Jania capillacea	x			x		x	x	x	x	
Laurencia sp.					x					
Lithophyllum sp.	x	x		x	x	x	x	x	x	x
Mastophora sp.	x					x				
Neogoniolithon sp.							x	x	x	
Peyssonelia sp.				x		x	x	x	x	x
Polysiphonia sp.	x	x		x	x		x	x	x	
Porolithon onkodes	x									
Porolithon sp.	x	x			x	x				
Rhodymenia sp.	x	x		x	x	x				x
Spyridia filamentosa	x	x	x	x						
Tolypiocladia glomerulata	x			x		x	x	x	x	
Trichogloea sp.							x	x	x	
SPERMATOPHYTA (seagrass)										
Enhalus acoroides					x					
Halodule uninervis			x							
Halophila minor			x							

Table 32. Checklist of corals observed at Cocos Lagoon. (Adapted from Randall et al, 1975).

BIOTOPES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
Stylocoeniella armata		x	x	x	x	x	x	x	x	
Stylocoeniella guentheri			x				x	x		x
Psammocora contigua	x	x			x	x				
Psammocora nierstraszi		x		x	x	x	x	x		
Psammocora profundacella							x			
Psammocora stellata	x	x			x	x				
Psammocora verrilli							x			
Psammocora (S.) togianensis		x		x		x	x			
Psammocora (P.) haimeana		x		x	x	x	x	x	x	
Stylophora mordax						x	x			
Seriatopora hystrix			x	x	x	x	x	x		
Pocillopora brevicornis		x		x	x	x				
Pocillopora damicornis	xx	x	x	x	x	x	x	x	x	x
Pocillopora danae		x		x						
Pocillopora elegans						x				
Pocillopora eydouxi						x	x			
Pocillopora ligulata		x				x				
Pocillopora meandrina		x		x		x				
Pocillopora setchelli						x				
Pocillopora verrucosa		x	x	x	x	x	x			
Acropora abrotanoides						x				
Acropora acuminata	x	x	x	x	x	x				
Acropora arbuscula	x	x	x	x	x					
Acropora aspera	x	x	x	x	x					
Acropora brueggemanni						x	x			
Acropora convexa						x	x			
Acropora delicatula				x			x	x		
Acropora echinata				x						
Acropora formosa	x	xx	xx	xx	x	x	x			
Acropora hebes	x	x								
Acropora humulis		x	x	x	x	x	x	x		
Acropora hystrix							x	x		
Acropora kenti			x				x	x		x
Acropora murrayensis						x	x			
Acropora nana						x				
Acropora nasuta		x	x	x		x	x			
Acropora nobilis		x								
Acropora palifera		x	x	x	x	x	x			
Acropora palmerae						x				
Acropora rambleri							x	x		x
Acropora rayneri							x	x		x
Acropora smithi						x				
Acropora squarrosa							x	x		
Acropora surculosa		x		x	x	x	x	x		
Acropora syringodes					x					

Table 32. (continued)

BIOTOPES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
Acropora studeri						x	x			
Acropora teres	xx	xx	xx	xx	x	x	x			
Acropora rubicinaria		x		x						
Acropora virgata		x	x	x						
Acropora wardii				x						
Acropora sp. 1						x				
Astreopora gracilis				x		x				
Astreopora listeri				x		x				
Astreopora myriophthalma		x		x		x	x	x		
Montipora composita									x	x
Montipora conicula							x			
Montipora ehrenbergii				x		x	x			
Montipora elschneri				x	x	x				
Montipora floweri							x			
Montipora foveolata		x	x	x	x	x	x	x	x	x
Montipora granulosa			x				x			
Montipora hoffmeisteri		x		x		x	x			
Montipora lobulata	x	x	x	xx	x	x	x			
Montipora monasteriata						x				
Montipora patula						x				
Montipora subtilis		x	x	x			x			
Montipora tuberculosa		x		x		x				
Montipora verilli	x	x	x	x	x	xx	x	x		
Montipora verrucosa		x	x	x		x	x	x	x	x
Pavona clavus						x	x			
Pavona decussata	x	x			xx	x				
Pavona divaricata	x				x					
Pavona frondifera	x				x					
Pavona minuta									x	x
Pavona varians	x	x	x	x	x	x	x	x	x	
Pavona gardineri								x		x
Pavona (P.) pollicata								x		
Pavona (P.) planulata				x		x	x	x		
Pavona (P.) obtusata	x	x	x	x		x	x	x		
Pavona (P.) sp. 1				x	x	x	x			
Leptoseris hawaiiensis			x	x					x	x
Leptoseris incrustans			x	x					x	x
Leptoseris mycetoseroides									x	
Pachyseris speciosa								x	x	x
Anomastraea sp. 1		x	x	x		x	x	x	x	
Coscinaraea columna						x				
Cycloseris sp. 1										x
Fungia fungites		x		x			x			
Fungia scutaria		x	x	x			x			
Goniopora columna							x			
Goniopora arbuscula	x	x	x	x		x	x			
Stylaraea punctata	x	x	x	xx	x	x	x	x		x

Table 32. (continued)

BIOTOPES	Biotope I A	B	C	D	E	Biotope II A	B	C	D	E
Porites andrewsi	x	xx	x			x				
Porites annae	x	x		x	x	x				
Porites australiensis		x		x		x				
Porites cocosensis	x	xx	xx	xx	x	x	x	x		x
Porites compressa	x	x	x	x		x				
Porites duerdeni		x								
Porites lichen		x		x		x	x			
Porites lobata	x	x	x	x		x	x	x		x
Porites lutea	xx	xx	x	xx	x	xx	x	x		x
Porites murrayensis		x		x		x	x			
Porites matthaii	x	xx	x	xx	x	xx	x	x		x
Porites sp. 1						x				
Porites sp. 2				x		x	x			
Porites (S.) convexa		x	x	xx	x	x	xx	x		x
Porites (S.) hawaiiensis		x	x	x		x	x	x	xx	x
Porites (S.) horizontalata			x	x			x	x	x	x
Porites (S.) iwayamaensis	x	x	x	xx	x	x	xx	xx	x	x
Porites (S.) sp. 1				x		x				
Alveopora japonica		x								
Alveopora verrilliana						x	x			
Favia favus		x								
Favia pallida		x	x	x		x	x	x		x
Favia speciosa		x		x		x	x	x		
Favia stelligera		x		x			x			
Favia rotumana				x			x			
Favites abdita						x				
Favites complanata		x	x	x		x	x	x		
Favites favosa				x			x			
Favites flexuosa				x			x			
Favites virens				x		x				
Oulophyllia crispa				x			x			
Plesiastrea versipora				x		x	x			
Plesiastrea sp. 1				x		x	x			
Goniastrea parvistella	x	x	x	x	x	x	x	x		
Goniastrea pectinata		x		x		x	x	x		
Goniastrea retiformis	x	x		x		x	x			
Platygyra rustica	x	x		x		x	x			
Platygyra lamellina				x			x			
Platygyra sinensis		x		x		x	x	x		
Leptoria phrygia		x		x		x	x	x		
Hydnophora microconos				x		x	x	x		
Leptastrea bottae	x	x			x	x				
Leptastrea purpurea	x	xx	x	xx	x	xx	xx	x	x	x
Leptastrea transversa				x			x			
Cyphastrea chalcidicum				x						

Table 32. (continued)

BIOTOPES	Biotope I A	B	C	D	E	Biotope II A	B	C	D	E
Cyphastrea serailia	x	x		x		x	x	x		x
Cyphastrea sp. 1				x						
Echinopora lamellosa				x		x		x		
Diploastrea heliopora							x	x		
Galaxea fascicularis	x	x	x	x	x	x	x	x		
Galaxea hexagonalis							x			
Acrhelia horrescens		x	x	x	x	x	x	x		
Merulina ampliata							x	x	x	
Lobophyllia corymbosa	x	x	x	x		x	x			
Lobophyllia costata				x			x			
Lobophyllia hemprichii				x			x			
Acanthastrea echinata				x			xx	x		
Echinophyllia aspera			x	x		x	x	x	x	x
Mycedium sp. 1				x						x
Paracyathus sp. 1				x						x
Plerogyra sinuosa		x	x	x		x	x	x	x	x
Euphyllia glabrescens	x	x	x	x		x	x	x	x	x
Heliopora coerulea	x	x	x	x	x	x	x	x		
Millepora dichotoma	x	x		x		x	x			
Millepora exaesa		x	x	x	x	x	x	x	x	x
Millepora platyphylla	x	x		x		x	x	x	x	x
Distichopora violacea						x	x	x	x	x
Total Species 159										
Total Genera 44										

Table 33. Checklist of soft corals observed at Cocos Lagoon. (Adapted from Randall et al, 1975).

BIOTOPES	Biotope I						Biotope III			
	A_W	A_L	B	C	D	E	A	B	C	D
ASTEROSPICULARIIDAE										
Asterospicularia randalli	x		x		x					
ALCYONIIDAE										
Alcyonium sp. 1		x			x		x			
Cladiella sp. 1							x			
Cladiella sp. 2							x			
Lobophytum sp. 1							x			
Lobophytum sp. 2							x			
Lobophytum sp. 3				x	x	x				
Sarcophyton sp. 1		x					x	x		
Sarcophyton sp. 2		x	x	x	x	x	x			
Sinularia polydactyla										
Sinularia conferta var. gracilis	x		x			x	x			
Sinularia sp. 1					x					
Sinularia sp. 2							x			
Sinularia sp. 3							x			
Sinularia sp. 4								x		
Sinularia sp. 5								x		
Sinularia sp. 6								x		
Sinularia sp. 7								x		
Sinularia sp. 8										
Sinularia sp. 9		x					x			
Sympodium coeruleum										
NEPHTHYIDAE										
Species 1							x			
Species 2							x			
XENIIDAE										
Xenia sp.					x					
ZOANTHIDAE										
Palythoa sp.							x	x	x	x
Zoanthus sp.					x					

Table 34. Checklist of common macroinvertebrates, other than corals, observed in Cocos Lagoon. (Adapted from Randall et al., 1975).

SPECIES	Biotope I					Biotope II				
	A	B	C	D	E	A	B	C	D	E
PROTOZOA										
SARCODINA										
Marginopora vertebralis		x								
CNIDARIA										
SCYPHOZOA										
Cassiopea andromeda					x					
Stephanoscyphus racemosus							x			
HYDROZOA										
Porpita sp.				x						
ANNELIDA										
POLYCHAETA										
Spirorbis sp.				x						
MOLLUSCA										
GASTROPODA and BIVALVIA(*)										
Acmaea sp.	x									
Arca ventricosa	x									
Astralium petrosum					x					
Barbatia sp.	x	x								
Bursa sp.	x									
Cantharus fumosus	x									
Cantharus undosus	x									
Cantharus sp.	x									
Cerithium columna	x									
Cerithium nesioticum	x									
Cerithium nodulosum	x	x								
Cerithium ravidum		x								
Cerithium sp.					x					
Chicoreus brunneus		x								
Chione sp.		x								
Chlarys sp.				x						
*Codakia divergens					x					
Contumax nodulosus		x								
Conus arenatus	x									
Conus distans	x									
Conus flavidus		x								
Conus ebraeus	x									
Conus imperialis		x								
Conus litteratus		x								

Table 34. (continued)

SPECIES	Biotope I A	B	C	D	E	Biotope II A	B	C	D	E
Conus lividus	x				x					
Conus marmoreus		x								
Conus miliaris					x					
Conus pulicarius	x	x	x		x					
Conus rattus	x									
Conus sponsalis					x					
Conus sp.	x									
Coralliophilia violacea	x									
*Ctelina sp.		x								
*Ctelinidae sp.	x									
*Ctena divergens					x					
Cymatium muricinum					x					
Cymatium pileare	x				x					
Cymatium sp.					x					
Cypraea carneola	x									
Cypraea moneta	x	x								
Cypraea tigris		x		x						
Drupa morum	x									
Drupa risinus	x									
Drupa rubisidaeus	x									
Drupella cornus	x									
*Fragum fragum	x	x	x							
*Gafrarium pectinatum	x				x					
Imbricaria conularis			x							
Latirus barclayi					x					
Latirus polygonus					x					
Latirus sp.	x				x					
Maculotriton digitata					x					
Mitra mitra			x							
Mitridae sp. 1					x					
Mitridae sp. 2	x									
*Modiolus auriculatus					x					
Morula uva	x									
Muricidae sp.	x									
Nassarius graniferus	x									
Natica marochiensis		x			x					
Nebularia cucumerina (Mitra cucumerina)	x									
Oliva minacea			x							
Otopleura auriscatis					x					
Otopleura sp.	x									
*Periglypta puerpera					x					
*Pinctada sp.					x					
Pyramidella sp. 1	x				x					
Pyramidella sp. 2	x									

Table 34. (continued)

SPECIES	Biotope I A	B	C	D	E	Biotope II A	B	C	D	E
*Quidnipagus palatam					x					
Rapa rapa	x				x					
Rhinoclavis asper	x	x	x		x					
Sagaminopteron psychedelicum						x				
*Septifer bilocularis	x									
*Spondylus sp.			x							
Strombus gibberulus	x	x	x							
Strombus luhuanus	x	x								
Strombus sp.	x									
*Telina sp.	x									
Terebra affinis	x		x		x					
Terebra areolata			x							
Terebra babylonia			x							
Terebra dimidiata	x				x					
Terebra guttata			x							
Terebra maculata			x							
Terebra sp. 1			x							
Thais armigera		x								
Thais tuberosa					x					
Tonna perdix					x					
Trochus niloticus						x				
Trochus ochroleucus	x									
Truidrupa bijubata					x					
Turridae sp.					x					
Turbo sp.						x				
Vasum turbinellus										
ECHINODERMATA										
ASTEROIDEA										
Acanthaster planci				x	x					
Asterina sp.	x									
Astropecten polyacanthus		x								
Choriaster granulatus					x					
Culcita novaeguineae	x			x	x					
Echinaster luzonicus	x									
Fromia hemiopla	x									
Gomophia egyptica	x									
Linckia guildingi	x									
Linckia laevigata	x									
Linckia multiflora		x		x						
Mithrodia clavigera					x					
Ophidiaster granifera	x									
Ophidiaster robillardi	x									

Table 34. (continued)

SPECIES	Biotope I A	B	C	D	E	Biotope II A	B	C	D	E
OPHIUROIDEA										
Macrophiothrix longipeda	x									
Ophiocoma erinaceus	x									
ECHINOIDEA										
Diadema savignyi				x						
Diadema setosum						x				
Echinometra mathaei	x	x		x	x	x				
Echinometra aciculatus (Echinostephus aciculatus)				x	x	x	x	x		
Echinothrix calamaris							x			
Echinothrix diadema	x				x					
Heterocentrotus mammillatus						x				
Toxopneustes pileolus	x									
Tripneustes gratilla	x									
HOLOTHUROIDEA										
Actinopyga echinites	x									
Actinopyga mauritiana	x				x		x	x	x	
Bohadschia argus	x	x	x	x	x		x			
Bohadschia bivitata	x	x	x	x	x		x			
Holothuria (Cystipus) inhabilis		x								
Holothuria (Halodeima) atra	x	x		x			x	x	x	
Holothuria (Halodeima) edulis	x	x	x	x	x		x			
Holothuria (Mertensiothuria) leucospilota	x	x	x	x	x		x	x		
Holothuria (Thymiosycia) hilla	x	x		x	x					
Holothuria (Microthele) nobilis	x	x	x	x			x			
Holothuria sp. 1					x					
Holothuria sp. 2	x									
Stichopus chloronotus	x	x	x	x	x		x	x	x	
Stichopus horrens	x			x						
Stichopus variegatus	x			x						
Synapta maculata				x						x
Thelenota ananas										

Table 35. Checklist of fishes observed at Cocos Lagoon. Category M (miscellaneous) lists those fish reported by various workers for which the exact locations were not specified. (Adapted from Randall et al, 1975).

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
ACANTHURIDAE							
Acanthurus glaucopareius	x	x	x				
A. lineatus	x	x					
A. mata							x
A. nigrofuscus	x	x	x	x			
A. olivaceous							x
A. pyroferus	x	x					
A. thompsoni	x						
A. triostegus		x	x	x			
A. xanthopterus	x	x	x		x		
Ctenochaetus binotatus	x	x					
C. striatus	x	x	x	x			
Naso brevirostris	x						
N. hexacanthus	x						
N. lituratus	x	x	x	x			
N. unicornis	x	x	x	x			
Zebrasoma flavescens	x	x	x				
Z. scopas		x	x				
Z. veliferum	x	x	x				
APOGONIDAE							
Apogon exostigma		x					
A. leptacanthus							x
A. mydrus							x
A. novemfasciatus				x			
A. robustus							x
A. trimaculatus							x
A. sp.		x					
Cheilodipterus macrodon		x	x				
C. quinquelineata		x	x		x		
ATHERINIDAE							
Pranesus insularum							x
AULOSTOMIDAE							
Aulostomus chinensis	x	x	x		x		

Table 35. (continued)

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
BALISTIDAE							
Balistapus undulatus	x	x					
Balistoides niger	x						
Melichthys niger	x						
M. vidua	x						
Pseudobalistes flavomarginatus			x				
Rhinecanthus aculeatus				x			
R. rectangulus				x			
Sufflamen bursa	x						
S. chrysoptera	x	x					
BLENNIIDAE							
Aspidontus taeniatus	x	x	x	x			
Cirripectes sebae	x						
C. variolosus	x	x		x			
Ecsenius bicolor	x						
E. opsifrontalis	x						
Exallias brevis	x						
Istiblennius coronatus	x			x			
Meiacanthus atrodorsalis	x	x	x				
Petroscirtes mitratus					x	x	
Plagiotremus tapeinosoma	x	x		x			
P. sp.	x						
Salarias fasciatus	x			x			
BOTHIDAE							
Bothus mancus		x					
CANTHIGASTERIDAE							
Canthigaster amboinensis	x						
C. coronatus	x	x	x				
C. janthinopterus	x	x					
C. solandri	x	x	x	x			
CARACANTHIDAE							
Caracanthus maculatus	x						
CARANGIDAE							
Carangoides malabaricus	x						
Caranx melampygus	x		x			x	
Gnathanodon speciosus							x

Table 35. (continued)

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
CARAPIDAE							
Carapus homei							x
CHAETODONTIDAE							
Centropyge bispinosus	x						
C. flavissimus	x	x	x	x			
C. heraldi	x						
Chaeotodon auriga	x	x	x	x			
C. bennetti	x	x	x				
C. citrinellus	x	x	x	x			
C. ephippium	x	x	x	x			
C. falcula (=C. ulietensis)	x	x	x				
C. kleini		x					
C. lunula	x	x	x	x			
C. melannotus		x	x				
C. mertensii	x	x	x				
C. ornatissiums	x	x					
C. punctato-fasciatus	x	x	x				
C. quadrimaculatus	x						
C. reticulatus	x	x	x				
C. strigangulus (=C. trifasualis)	x		x				
C. trifasciatus	x	x	x	x			
C. unimaculatus	x	x					
Forcipiger flavissimus	x	x					
Heniochus permutatus	x	x	x				
H. varius							x
H. monoceros	x	x	x	x			
Holacanthus trimaculatus	x						
Pomacanthus imperator		x		x			
Pygoplites diacanthus		x					
CIRRHITIDAE							
Cirrhitus pinnulatus	x						
Neocirrhites armatus	x						
Paracirrhites arcatus	x		x				
P. forsteri	x	x					
P. hemistictus	x						
DASYATIDAE							
Dasyatis kuhli							x
DIODONTIDAE							
Diodon hystrix							x

Table 35. (continued)

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
ENGRAULIDAE							
Thrissina baelama							x
FISTULARIDAE							
Fistularia petimba				x			
GOBIIDAE							
Acentrogobius belissimus		x	x				x
A. triangularis		x	x	x	x	x	
Amblygobius albimaculatus							x
A. decussatus						x	
A. sp.				x	x	x	
Asterropteryx semipunctatus							x
Bathygobius fuscus	x			x			
Eleotriodes strigata							x
Eviota prasites		x		x	x		
Gnatholepis deltoides					x	x	
Gobius ornatus		x					
Nemateleotris magnificus						x	
Obtortiophagus kousmani						x	
Oxyurichthys guibei							x
Periopthalmus koelreuteri	x						
Pogonoculius zebra	x						
Ptereleotris tricolor							x
Rhinogobius decoratus							x
Trimma caesiura							
HEMIRAMPHIDAE							
Hyporhamphus laticeps							x
HOLOCENTRIDAE							
Adioryx caudimacula	x						
A. microstomus	x			x			
A. spinifer	x	x		x			
A. tiere	x						
A. lacteoguttatus							x
A. sp.							x
Flammeo sammara		x	x	x			
Myripristis amaenus		x	x				
M. kuntee		x					
M. microphthalmus							x
M. murdjan							

Table 35. (continued)

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
KUHLIIDAE							
Kuhlia taeniura							x
KYPHOSIDAE							
Kyphosus cinerascens							x
LABRIDAE							
Anampses caeruleopunctatus	x						
Cheilinus celebicus							x
C. chlorourus		x	x	x	x		
C. fasciatus	x	x	x	x	x		
C. rhodochrous	x	x	x				
C. trilobatus	x	x	x	x			
C. undulatus	x	x	x	x			
Cheilio inermis					x	x	
Cirrhilabrus temmincki	x						
Coris aygula							x
C. gaimard	x			x			
Epibulus insidiator	x	x	x	x			
Gomphosus varius	x	x	x	x			
Halichoeres biocellatus	x						
H. hortulanus (=H. centiquadrus)	x	x		x			
H. margaritaceus	x	x		x	x		
H. marginatus	x	x		x			
H. trimaculatus		x	x	x	x		
Hemigymnus fasciatus	x	x					
H. melapterus	x	x	x	x	x		
Hemipteronotus sp.	x				x	x	
Labrichthys unilineata		x	x				
Labroides bicolor	x	x					
L. dimidiatus	x	x	x	x			
Macropharyngodon meleagris		x					
M. pardalis	x	x		x			
Pseudocheilinus hexataenia	x	x	x				
Pteragogus guttatus		x					
Stethojulis (axillaris) bandanensis	x	x	x	x	x	x	
S. strigiventer		x	x		x		
Thalassoma amblycephalus	x	x					
T. hardwickei	x	x	x	x			
T. lutescens	x	x	x	x			
T. purpureum	x			x			
T. quinquevittata	x			x			
Xyrichthys taeniourus	x			x			

Table 35. (continued)

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
LUTJANIDAE							
Aphareus furcatus	x	x	x				
Aprion virescens	x						
Caesio caerulaureus							x
Gnathodentex aureolineatus		x					
Lethrinus reticulatus							x
L. rhodopterus	x	x	x	x	x		
L. sp.			x		x		
Lutjanus argentimaculatus	x	x					
L. (vaigiensis) fulvus	x	x	x	x			
L. kasmira							x
L. monostigmus	x						
Macolor niger							x
Scolopsis cancellatus			x	x			
MALACANTHIDAE							
Malacanthus scripta							x
MONACANTHIDAE							
Alutera scripta							x
Amanses carolae	x						
A. sandwichensis	x	x	x				
Oxymonacanthus longirostris	x	x	x	x			
Paraluteres prionurus		x					
Pervagor melanocephalus							x
MONODACTYLIDAE							
Monodactylus argenteus		x					
MUGILIDAE							
Chelon vaigiensis							x
Crenimugil crenilabis							x
Mugil cephalus							x
MUGILOIDIDAE							
Parapercis cephalopunctatus	x	x					
P. clathrata	x	x		x			

Table 35. (continued)

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
MULLIDAE							
Mulloidichthys auriflamma			x				
M. samoensis		x	x	x	x	x	
Parupeneus barberinus	x	x	x	x	x		
P. bifasciatus	x			x			
P. cyclostomus	x	x	x	x			
P. multifasciatus	x	x	x	x	x		
P. pleurostigma		x		x	x		
P. prophyreus		x	x		x		
Upeneus vittatus						x	
MURAENIDAE							
Echidna nebulosa		x		x			
E. zebra							x
Gymnothorax gracilicaudus							x
G. javanicus		x					
G. pictus							x
G. undulatus	x						
Uropterygius concolor							x
MYLIOBATIDAE							
Aetobatus narinari							x
OPHICHTHIDAE							
Leiuranus semicinctus							x
OSTRACIONTIDAE							
Lactoria cornutus							x
Ostracion cubicus		x	x				
O. meleagris camurum	x	x	x				
PEMPHERIDAE							
Pempheris oualensis		x					
POMACENTRIDAE							
Abudefduf amabilis (=Glyphidodontops leucopomus)	x	x				x	
A. curacao (=Amblyglyphidodon curacao)		x	x				
A. dickii (=Plectroglyphidodon dickii)	x	x					
A. glaucus (=G. glaucus)						x	
A. imparipennis (=P. imparipennis)	x						

Table 35. (continued)

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
A. johnstonianus (=Plectroglyhidodon johnstonianus)	x						
A. lacrymatus (=P. lachrymatus)	x	x	x	x			
A. leucopomus (=G. leucopomus)	x	x		x			
A. leucozona (=P. leucozona)				x			
A. saxatilis	x						
A. septemfasciatus				x			
A. sexfasciatus (=A. coelestinus)			x				x
Amphiprion bicinctus	x			x			
A. chrysopterus		x	x	x			
A. melanopus	x						
A. perideraion		x	x	x			
Chromis atripectoralis		x	x	x			
C. caerulea	x	x					
C. (dimidiatus) hanui (=C. margaritifer)	x						
C. leucurus (=C. margaritifer)	x						
C. vanderbilti	x						
C. xanthochir	x	x					
C. sp.		x	x	x			
Dascyllus aruanus	x	x					
D. reticulatus	x	x		x			
D. trimaculatus				x			
Pomacentrus albofasciatus (=Eupomacentrus albifasciatus)		x					
P. amboinensis	x	x		x			
P. jenkinsi (=E. fascidatus)		x	x	x			
P. lividus (=E. lividus)		x	x	x			
P. nigricans (=E. nigricans)		x	x				
P. pavo	x	x	x				
P. traceyi	x	x	x	x			
P. vaiuli	x						
P. sp.							
PSEUDOCHROMIDAE							
Plesiops corallicola							x
SCARIDAE							
Calatomus spinidens		x		x			
Chlorurus bicolor		x	x				
C. gibbus			x				
Leptoscarus vaigiensis							x
Scarus dubius	x	x	x				x
S. lepidus	x	x	x	x			
S. sordidus	x	x	x	x			x
S. venosus	x	x	x	x			

Table 35. (continued)

SPECIES	FISH BIOTOPES I	II	III	IV	V	VI	Misc.
SCORPAENIDAE							
Pterois antennata							x
P. volitans	x	x					
Scorpaenopsis gibbosa							x
SERRANIDAE							
Cephalopholis argus							x
C. urodelus	x						
Epinephelus emoryi	x						
E. merra		x	x	x			
Grammistes sexlineatus	x						
SIGANIDAE							
Siganus argenteus					x		
S. punctatus			x				
S. spinus				x	x		
SPARIDAE							
Monotaxis grandoculis	x	x	x	x			
SPHYRAENIDAE							
Sphyraena sp.					x		
SYNGNATHIDAE							
Corythoichthys intestinalis waitei		x	x		x		
C. sp.				x			
SYNODONTIDAE							
Saurida gracilis		x					x
Synodus variegatus		x	x	x			x
TETRAODONTIDAE							
Arothron alboreticulatus	x	x					
A. immaculatus					x		
ZANCLIDAE							
Zanclus cornutus	x	x	x	x			

AREA X:
AJAYAN BAY

Ajayan Bay is located on the southeast coast of Guam, along Route 4 just north of Manell Channel (Fig. 18). The area was chosen because of its well developed fringing reef channel and extensive seagrass beds.

No previous survey has been done for Ajayan Bay with respect to the marine biotic community. Moore et al. (1977) studied the Ajayan River basin wetland area. Most of their report deals with terrestrial communities and is not included here. Randall and Holloman (1974) provide an excellent physiographic description of the area. The following summary is taken in part from their report.

The fringing reef platform bordering most of the southeast shoreline is completely cut by the Ajayan River, forming a small estuary embayment with moderate alluvial silt deposition at the river mouth. Portions of the reef flat are markedly depressed as a result of local faulting. A small islet (Agrigan Island) is located on the southwest reef flat. The channel is characterized by progressively steeper fringing reef walls seaward to approximately 18 meters in depth. The floor of the channel grades from a silt-mud zone to sand approximately midway out. Water visibility improved seaward. The reef flats are wide and largely covered by seagrass beds on the inside, representing some of the most extensive communities of their type on Guam.

The Guam Environmental Protection Agency water rating for Ajayan Bay is "A" - recreational. No point source discharges are known in the immediate area (Shidel, 1977).

Two visits were made to Ajayan Bay. For purposes of this report the area was divided into five zones: (1) east bay, (2) west side channel wall and margin, (3) reef-flat, (4) seagrass beds and (5) mud-silt zone. Tables 36-39 list those organisms observed during the study.

The east and west side channel walls (Zones 1 and 2) were considerably different in both physiography and associated biota. The east bay sloped gradually to the channel floor while the west channel wall dropped almost vertically. The inner bay had a considerably higher silt content resulting in a less rich community development.

A wide variety of algae was found equally distributed along the length of both channel walls, with the marked exception of Asparagopsis taxiformis which was limited to the east side only. Abundance and diversity also tended to increase seaward as the water became clearer.

Coral development was considerably more diverse on the west side and again became richer seaward.

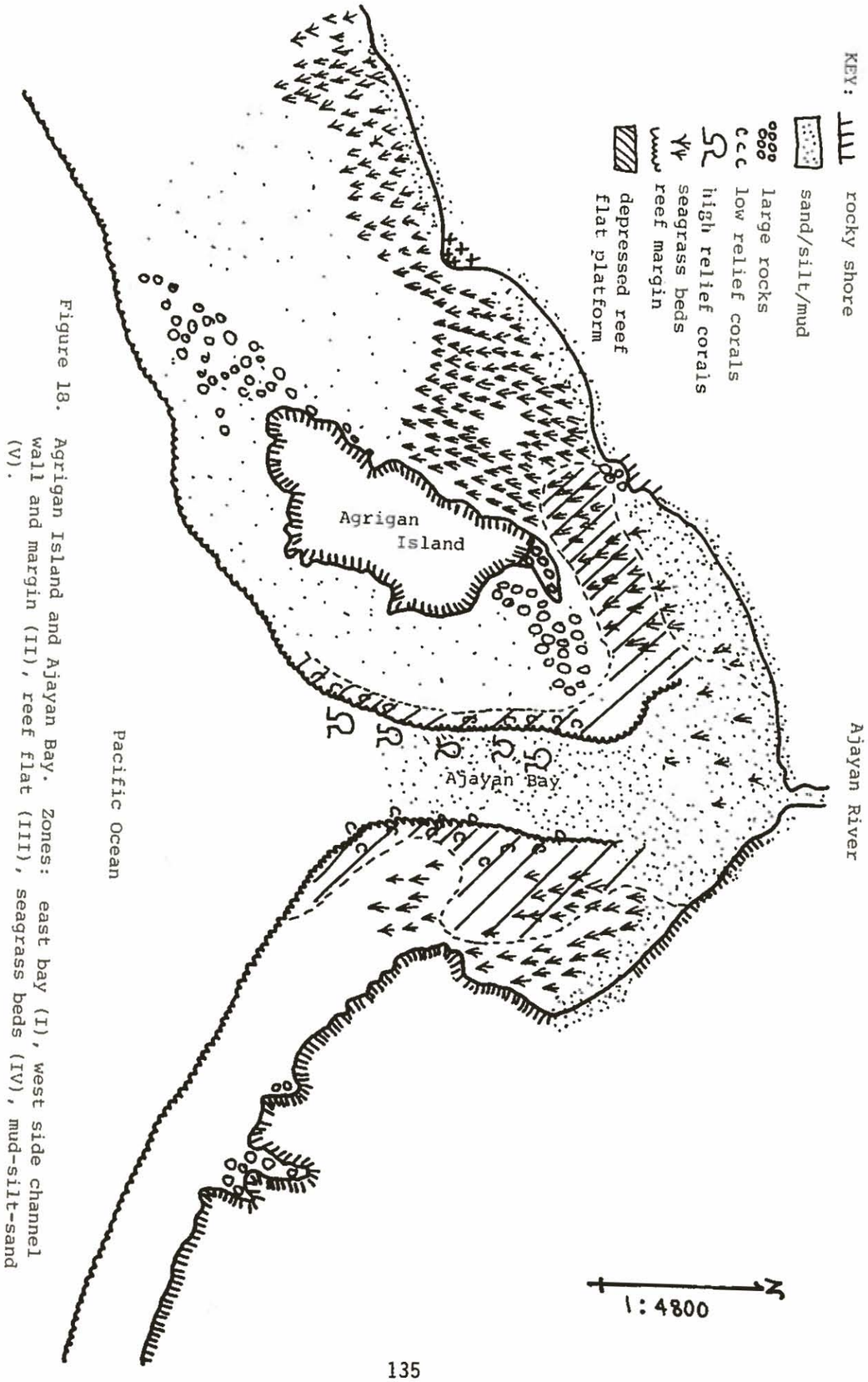


Figure 18. Agrigan Island and Ajayan Bay. Zones: east bay (I), west side channel wall and margin (II), reef flat (III), seagrass beds (IV), mud-silt-sand (V).

A diverse and abundant fish community exists which appeared to be fairly homogeneous. Of particular concern were the presence of numerous stone fish (Synanceia verrucosa). Eight individuals were seen along both sides of the channel around the upper reef margin and flat.

The reef flat (Zone 3) on the west side was largely depauperate due to frequent exposure during low tides. Patchy areas of Schizothrix, Boergesenia, Dictyosphaeria, Dictyota, Lobophora, Turbinaria, Gelidium and Jania species comprised the major algal genera observed.

A few scattered corals were observed in water filled crevices and holes. The macroinvertebrate community was rich but not particularly diverse. Gastropods, holothurians and crabs were the dominant forms.

The seagrass beds (Zone 4) at Ajayan are among the most extensive and beautiful on Guam. At the time of the study, the tide was low and about 15 centimeters of water covered the Enhalus beds. These beds provide food and protection for juvenile fishes and many invertebrates. In addition to the seagrass, several algal genera were also abundant, e.g., Dictyota, Padina, Halimeda and Avrainvillea species notably. The holothurians Holothuria atra and H. leucospilota, and the gastropod Trochus niloticus were also abundant.

The inner bay (Zone 5) was composed of alluvial silt and mud deposits, grading into a sand plane. The seagrass, Halophila minor, covered the floor in addition to the algal genera, Schizothrix, Avrainvillea and Halimeda.

No corals or macroinvertebrates were observed. The fish Zanclus cornutus was seen in large schools.

No threatened or endangered species are known for Ajayan Bay.

CONCLUSIONS AND RECOMMENDATIONS

Ajayan Bay provides the physiographic setting for a variety of community types. Though less strikingly beautiful than some other pristine areas, it is readily accessible and a popular place for fisherman, skin divers and picnickers. The fringing reef channels and seagrass beds are of particular importance for preservation.

The following recommendations are suggested for Ajayan Bay:

1) that this area be established as a natural sanctuary in which no coral harvesting be allowed.

2) that fishing be allowed only by special permit.

3) that swimming, snorkeling and SCUBA diving activities be retained.

4) that special care be taken to preserve the seagrass beds.

5) that the adjacent wetlands also be included in any preservation plan.

Table 36. Checklist of benthic algae observed at Ajayan Bay. Zones: east bay (I), west side channel wall and margin (II), reef flat (III), seagrass beds (IV), and mud-silt zone (V).

SPECIES	ZONES I	II	III	IV	V
CYANOPHYTA (blue-green algae)					
Anacystis sp.	x				
Microcoleus lyngbyaceus	x	x		x	x
Schizothrix calcicola	x	x	x	x	x
S. mexicana	x	x			
CHLOROPHYTA (green algae)					
Avrainvillea obscura				x	x
Boergesenia forbesii			x		
Boodlea composita		x			
Caulerpa filicoides	x	x			
C. racemosa	x	x		x	
C. serrulata	x				
Chlorodesmis fastigiata	x	x			
Codium edule		x			
Dictyosphaeria versluysii	x	x	x		
Halimeda gigas		x			
H. macroloba					x
H. opuntia	x	x		x	
H. velasquezii		x			
Neomeris annulata	x	x		x	
Rhipilia orientalis	x				
Tydemannia expeditionis		x			
Udotea argentea	x	x			
U. geppi		x			
Valonia ventricosa		x			
PHAEOPHYTA (brown algae)					
Dictyota bartayresii		x			
Dictyota divaricata	x	x	x	x	
Lobophora variegata	x	x			
Padina jonesii	x				
P. minor		x			x
P. tenuis		x		x	x
Sargassum polycystum				x	
Turbinaria ornata	x	x	x	x	
RHODOPHYTA (red algae)					
Actinotrichia fragilis	x	x			
Amphiroa foliacea		x			

Table 36. (continued)

SPECIES	ZONES I	II	III	IV	V
Amphiroa fragilissima		x			
Amphiroa sp.		x			
Asparagopsis taxiformis	xx				
Ceramium sp. 1	x	x			
C. sp. 2	x	x	x		
Cheilosporum sp.	x				
Desmia hornemanni		x			
Galaxaura filamentosa		x			
G. oblongata	x				
Gelidium pusillum			x		
G. divaricatum			x		
Halymenia durvillaei		x			
Hydrolithon sp.			x		
Hypnea sp.		x	x		
Jania capillacea			x	x	
Mastophora rosea		x	x		
Polysiphonia sp.		x	x		
Porolithon onkodes		x	x		
SPERMATOPHYTA (seagrasses)					
Enhalus acoroides				xx	
Halophila minor				x	xx

Table 37. Checklist of corals observed at Ajayan Bay. Zones: east bay (I), west side channel wall and margin (II).

SPECIES	ZONES I	ZONES II
ANTHOZOA		
ASTOCOENIIDAE		
Stylocoeniella armata		x
THAMNASTERIDAE		
Psammocora contigua		x
P. nierstraszi		x
P. profundacella		x
P. verrilli		x
P. sp. 1	x	
P. sp. 2	x	
POCILLOPORIDAE		
Stylophora mordax	x	x
Pocillopora damicornis	x	x
P. danae		x
P. elegans	x	x
P. eydouxi		x
P. ligulata		x
P. meandrina	x	x
P. setchelli		x
P. verrucosa		x
ACROPORIDAE		
Acropora humilis	x	x
A. hystrix		x
A. kenti		x
A. nasuta		x
A. surculosa		x
A. wardii		x
Astreopora gracilis		x
A. listeri		x
Montipora ehrenbergii		x
M. elschneri		x
M. foveolata		x
M. lobulata	x	x
M. patula		x
M. socialis		x
M. tuberculosa	x	x
M. verrilli		x
M. sp. 1		x
M. sp. 2		x
M. sp. 3		x
M. sp. 4	x	

Table 37. (continued)

SPECIES	ZONES I	ZONES II
AGARICIIDAE		
Pavona clavus		x
P. divaricata		x
P. frondifera		x
P. maldivensis		x
P. minuta		x
P. sp. 1		x
P. varians		x
P. repens	x	x
P. (P.) pollicata		x
P. (P.) obtusata	x	x
PORITIDAE		
Porites lobata	x	x
P. lutea	x	x
P. murrayensis		x
P. (S.) convexa		x
P. (S.) horizontalata		x
P. (S.) iwayamaensis		x
Alveopora sp.		x
FAVIIDAE		
Favia matthai		x
F. pallida	x	x
F. russelli		x
F. stelligera		x
F. sp.	x	
Favites virens		x
Plesiatstrea versipora		x
Goniastrea parvistella		x
G. pectinata		x
G. retiformis		x
Platygyra pini		x
P. rustica		x
Leptoria phrygia		x
Hydnophora microconos		x
Leptastrea purpurea		x
L. transversa		x
L. sp.		x
Cyphastrea sp.		x
OCULINIDAE		
Galaxea fascicularis		x

Table 37. (continued)

SPECIES	ZONES I	ZONES II
MUSSIDAE		
Lobophyllia costata		x
Acanthastrea echniata		x
A. sp.		x
HELIOPORIDAE		
Heliopora coerulea	x	x
ALCYONIIDAE		
Sinularia sp.		x
HYDROZOA		
MILLEPORIDAE		
Millepora dichotoma		x
Millepora platyphylla	x	x

Table 38. Checklist of common macroinvertebrates observed at Ajayan Bay.

SPECIES

MOLLUSCA

GASTROPODA

Cantharus undosus
Cerithium morus
C. nodulosum
Conus pulicarius
Coralliophila violacea
Cypraea carneola
C. moneta
Drupa morum
D. ricinus
Drupella cornus
Latirus sp.
Morula granulata
M. uva
Nerita plicata
N. polita
Patella sp.
Strombus mutabilis
Thais tuberosa
Trochus niloticus
Vasum turbinellus

BIVALVIA

Pinctata margaritifera
Tridacna maxima

ECHINODERMATA

ECHINOIDEA

Echinostrephus aciculatus
Echinothrix calamaris
E. diadema

HOLOTHUROIDEA

Actinopyga mauritiana
Holothuria atra
H. leucospilota
Stichopus chloronotus
Synapta maculata

OPHIUROIDEA

Ophiocoma erinaceus

ARTHROPODA

CRUSTACEA

Etisus dentatus
Grapsus grapsus
Percnon sp.

Table 39. Checklist of fishes observed at Ajayan Bay.

SPECIES

ACANTHURIDAE

Acanthurus glaucoparieus
A. lineatus
A. nigrofuscus
A. olivaceus
A. pyroferus
A. triostegus
A. xanthopterus
A. sp. 1
A. sp. 2
Ctenochaetus striatus
C. sp.
Naso lituratus
N. sp.
Zebrasoma flavescens
Z. scopas

APOGONIDAE

Apogon sp.
Archamia fucata
Cheilodipterus isostigma
C. macrodon

AULOSTOMIDAE

Aulostomus chinensis

BALISTIDAE

Balistes bursa (=Sufflamen bursa)
Rhinecanthus aculeatus

BLENNIDAE

Aspidontus taeniatus
Cirripectes variolosus
C. sp.
Meiacanthus atrodorsalis
Plagiotremus tapeinosoma

CANTHIGASTERIDAE

Canthigaster bennetti
C. margaritatus
C. solandri
C. valentini

CARANGIDAE

Caranx melampygus

CHAETODONITIDAE

Chaetodon auriga
C. bennetti
C. citrinellus
C. ephippium
C. lunula
C. mertensii
C. melannotus
C. ornatissimus
C. punctato-fasciatus
C. reticulatus
C. trifasciatus
C. ulietensis
C. unimaculatus
C. vagabundus
Centropyge flavissimus
Heniochus acuminatus
H. chrysostomus
Pygoplites diacanthus

CIRRHITIDAE

Paracirrhites arcatus

GOBIIDAE

Acentrogobius sp. 1
A. sp. 2
Amblygobius albimaculatus
Bathygobius fuscus
Cryptocentrus sp.
Ptereleotris microlepis
Taenioides limicola
Valenciennea strigata
"Goby" sp. 1
"Goby" sp. 2

Table 39. (continued)

SPECIES

HOLOCENTRIDAE

Adioryx diadema
A. microstomus
A. spinifer
Myripristis sp. 1
M. sp. 2
M. sp. 3

KYPHOSIDAE

Kyphosus sp.

LABRIDAE

Cheilinus chlorourus
C. rhodochrous
C. trilobatus
Epibulus insidiator
Gomphosus varius
Halichoeres margaritaceus
H. marginatus
H. nebulosus
H. sp. 1
H. sp. 2
Labroides bicolor
L. dimidiatus
Stethojulis bandanensis
S. sp.
Thalassoma hardwickei
T. lutescens
T. quinquevittatas
T. trimaculatus

LETHRINIDAE

Gnathodentex aureolineatus

LUTJANIDAE

Aphareus furcatus
Lutjanus fulvus
L. kasmira
L. sp.

MONACANTHIDAE

Amanses carolae
Cantherhines pardalis
Oxymonacanthus longirostris

MULLIDAE

Mulloidichthys samoensis
Parupeneus bifasciatus
P. cyclostomus
P. pleurotaenia
P. trifasciatus

NEMIPTERIDAE

Scolopsis cancellatus

OSTRACIONTIDAE

Ostracion cubicus

PEMPHERIDAE

Pempheris oualensis

POMACENTRIDAE

Amblyglyphidodon curacao
Abudefduf coelestinus
A. sordidus
Amphiprion melanopus
Chromis atripectoralis
C. caeruleas
C. margaritifer
Dascyllus aruanus
D. trimaculatus
Glyphidodontops traceyi
Plectroglyphidodon dickii
P. johnstonianus
P. lacrymatus
P. leucozona
Pomacentrus vaiuli

Table 39. (continued)

SPECIES
Stegastes albifasciatus
S. nigricans
PRIACANTHIDAE
Priacanthus cruentatus
SCARIDAE
Scarus ghobban
S. sexvittatus
S. sordidus
S. sp. 1
S. sp. 2
S. sp. 3
SCORPAENIDAE
Pterois antennata
Synanceia verrucosa
SERRANIDAE
Cephalopholis urodelis
SIGANIDAE
Siganus argenteus
S. spinus
SYNODNTIDAE
Synodus sp.
TETRAODONTIDAE
Arothron sp.
ZANCLIDAE
Zanclus cornutus

AREA XI:
FADIAN POINT AREA

The northeast coast of Guam extending approximately 32 kilometers from Pago Bay to Pati Point is characterized by gentle to steep cliffs and sea-level cut benches of varying widths. There is no fringing reef development. Many of the benches are up to 30 meters in width exhibiting rimmed terrace pools (above sea-level) and shallow moat development to the shoreward side. A representative windward bench area was selected between Fadian and Toguan Points (Fig. 19). The area is remote and accessible only during calm seas either by "bench walking" or boat. The surrounding land is privately owned.

No previous survey has been done for this area with respect to the marine biotic community. An excellent physiographic description is given by Randall and Holloman (1974).

The Guam Environmental Protection Agency water rating for the Fadian Area is "A" - recreational. No point source discharges have been identified for the area (Shidel, 1977).

For purposes of this discussion, the study area was divided into four zones: (1) the inner bench including nips, moat and rimmed terrace pools, (2) the bench margin and face, (3) submarine terrace and slope, (4) submarine channel walls. Tables 40-43 list those organisms observed at the study site.

The inner bench was characterized by a concave nip to the shoreward side, a shallow moat 2-10 meters wide and a variable series of shallow rimmed terrace pools extending to the bench margin (Fig. 20). The rimmed terrace pools were approximately one meter higher than the depressed inner moat area. In general, the greater the wave assault, the greater the height and development of the rimmed pools. The moat water is generally impounded and dependent on sufficient wave action for replenishment.

The most dominant biotic component of this zone was the algae. The cyanophytes *Calothrix* and *Schizothrix* species covered much of the moat floor which was smooth and largely free of sand and rubble deposits. *Gelidiella acerosa*, *Bryopsis pennata*, *Cladophora fascicularis* and *Turbinaria ornata* were also abundant.

Due to frequent exposure, the bench was largely devoid of corals. A few small *Pocillopora*, *Favia* and *Porites* colonies were observed in the deeper holes and pools.

All fish observed in Zone 1 were less than 3 cm in length. Acanthurids and blennies were common in the moat and pool areas, occurring in water only 3-5 cm deep.

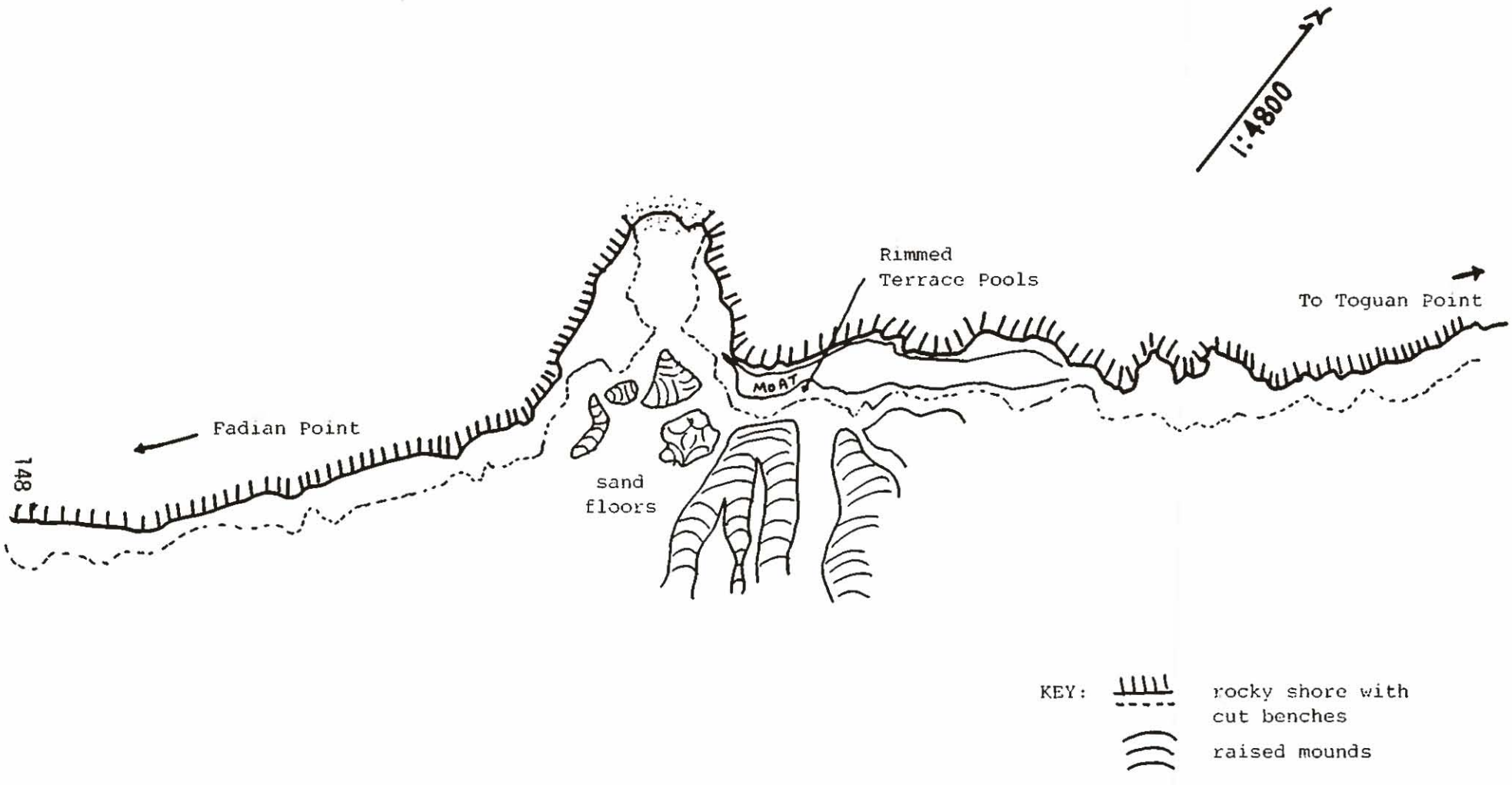


Figure 19. Fadian Point area exhibiting windward cut benches and rimmed terrace pools.

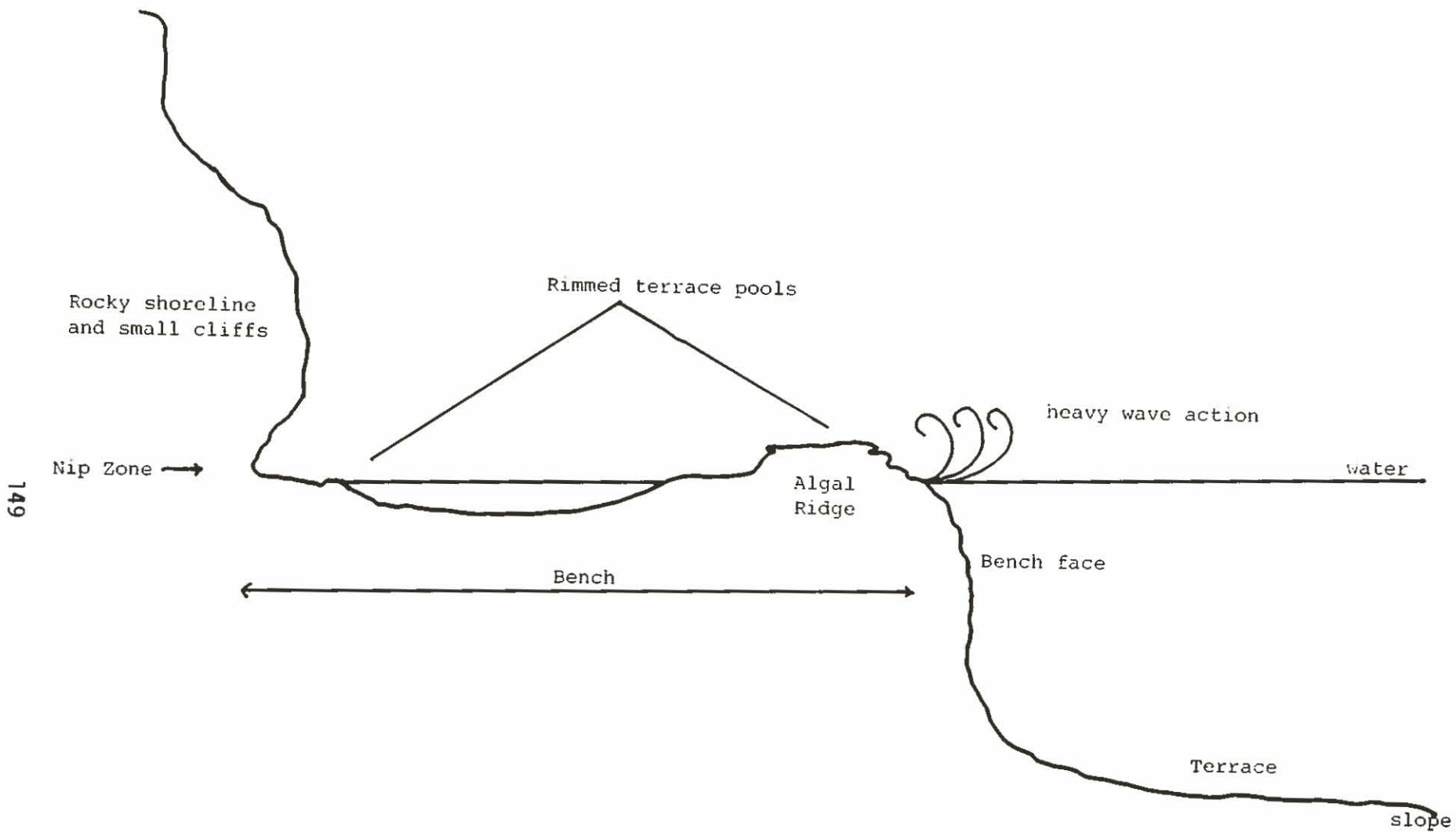


Figure 20. Generalized profile of typical windward cut benches and rimmed terrace pools.

An abundant, but not particularly diverse, array of gastropods were noted. A few echinoderms were also found in the moat and deeper pools.

The bench margin and face (Zone 2) are constantly wave washed. The bench margin was covered by a thick and colorful mat of algae giving way to a scoured and eroded margin face. Gelidiella acerosa, Dictyosphaeria, Ectocarpus, Sargassum, Turbinaria and Mastophora species were visually dominant on the margin while only Mastophora and Chlorodesmis were found in protected crevices along the margin face.

The submarine terrace and slope (Zone 3) consisted of massive surge channels and fissures grading into a spur and groove system at the bench face. Of particular interest was the presence of a parallel channel directly opposite the bench face with intersecting perpendicular projecting channels. These averaged approximately 5-7 meters deep shoreward and gradually flattened out at approximately 18 meters on the outer submarine terrace and slope.

The shoreward submarine terrace was scoured with only local patches of low relief corals, i.e., Acropora, Porites and Millepora species.

Turf algae dominated this zone. Callithamnion marshallensis and Ceramium sp. covered most of the terrace.

Seaward, the coral community improved with the presence of coral ridges and mounds. Porites, Acropora and Astreopora were abundant. A more diverse algal and fish community was also apparent.

The submarine channels (Zone 4) were markedly different from the surrounding surge exposed areas of the terrace. The algal community was particularly striking with fleshy forms visually dominating. Large expanses of the green alga Caulerpa racemosa several meters in diameter were not uncommon. The red algae Galaxaura, Halymenia and Desmia were also abundant. In addition, the red alga Yamadaella sp. was observed for the first time on Guam. This alga resembles a small Galaxaura.

Frondiose corals were abundant, providing an increased number of habitats for fish and invertebrates. Acanthurids and kyphosids dominated. In general this zone was rich but not terribly diverse with respect to fish. Only one species of pomacentrid was observed.

No threatened or endangered marine species are known to inhabit this area.

CONCLUSIONS AND RECOMMENDATIONS

The windward cut benches and rimmed terrace pools of northeast Guam provide the setting for several interesting marine community types. The Fadian area is a typical representative though any area along this sector is suitable. Heavy seas and poor accessibility throughout most of the

year preclude this area for recreational consideration.

The following recommendations are suggested for the Fadian area:

1) that this area be established as a natural sanctuary on scientific purposes only.

2) that care is taken to prevent the construction of outfalls or dumps in the area except by special permit.

3) that the area be protected from quarrying or any other destructive land use practices.

Table 40. Checklist of benthic algae observed at the Fadian Point area study site.

SPECIES	ZONES I	II	III	IV
CYANOPHYTA (blue-green algae)				
Anacystis sp.	x			
Calothrix sp.	x	x		
Microcoleus lyngbyaceus			x	x
Schizothrix calcicola	x		x	x
S. mexicana	x		x	
CHLOROPHYTA (green algae)				
Bryopsis pennata	x			
Caulerpa filicoides	x			x
C. racemosa			x	xx
Chlorodesmis fastigiata			x	x
Cladophora fascicularis	x	x		
Cladophora sp.	x	x		
Codium edule				x
Dictyosphaeria cavernosa	x	x		
D. versluysii	x	x		
Halimeda gigas				x
H. macroloba	x		x	
H. opuntia	x		x	x
H. velasquezii				xx
Neomeris annulata	x		x	x
Rhipilia orientalis			x	x
Udotea geppi				x
PHAEOPHYTA (brown algae)				
Dictyota divaricata				x
Ectocarpus breviarticulatus	x			
Lobophora variegata			x	x
Padina minor			x	
Sargassum cristaefolium	x			
Sphacelaria tribuloides	x			
Turbinaria ornata	x		x	
RHODOPHYTA (red algae)				
Amphiroa foliacea				x
A. fragilissima	x	x		
A. sp.		x		x
Asparagopsis taxiformis			x	
Callithamnion marshallensis			xx	x
Ceramium sp.				x

Table 40. (continued)

SPECIES	ZONES I	II	III	IV
Corallina sp.				x
Desmia hornemanni				x
Galaxaura marginata			x	x
G. oblongata			x	x
Gelidiella acerosa	x	x		
Gelidium pusillum	x		x	x
Halymenia durvillaei				x
Hypnea pannosa				x
Jania capillacea	x			x
Jania tenella				x
J. sp.				x
Liagora sp.	x	x		
Mastophora rosea		x	x	x
Mastophora sp.		x	x	x
Peyssonelia rubra				x
Polysiphonia sp.			x	x
Pterocladia parva			x	x
Rhodymenia sp.				x
Yamadaella sp.			xx	xx

Table 41. Checklist of corals observed at the Fadian Point area study site.

SPECIES	ZONES I	II	III-IV
ANTHOZOA			
ASTROCOENIIDAE			
Stylocoeniella armata		x	x
THAMNASTERIIDAE			
Psammocora sp.		x	
POCILLOPORIDAE			
Stylophora mordax		x	x
Pocillopora verrucosa		x	x
P. sp. 1	x		
P. sp. 2		x	
ACROPORIDAE			
Acropora irregularis			x
A. nana			x
A. nasuta			x
A. palmerae			x
Astreopora sp.			x
Montipora ehrenbergii			x
M. sp. 1			x
M. sp. 2			x
AGARICIIDAE			
Pachyseris speciosa			x
Pavona sp.			x
PORITIDAE			
Alveropora sp.			x
Goniopora sp.			x
Porites lutea	x		x
P. sp. 1	x		
FAVIIDAE			
Favia russelli	x	x	x
Favis sp.			x
Goinastrea retiformis	x		x

Table 41. (continued)

SPECIES	ZONES I	II	III-IV
Platygyra sp.			x
Cyphastrea sp.			x
CARYOPHYLLIIDAE			
Euphyllia sp.			x
ZOANTHIDAE			
Zoanthus sp.			x
ALCYONIIDAE			
Cladiella pachyclados			x
Lobophytum pauciflorum			x
Sinularia sp.			x
HYDROZOA			
MILLEPORIDAE			
Millepora platyphylla			x

Table 42. Checklist of common macroinvertebrates observed at the Fadian Point area study site.

SPECIES	ZONES I	III
MOLLUSCA		
GASTROPODA		
Cerithium sp.	x	
Conus flavidus	x	x
C. marmoreus	x	x
C. rattus	x	x
Cypraea sp.	x	
Drupa morum	x	x
D. ricinus	x	x
Drupella cornus		x
Morula uva		x
Strombus mutabilis	x	x
S. sp.		x
Trochus sp.		x
Turbo argyrostomus	x	
Vasum turbinellum	x	
BIVALVIA		
Chama sp.	x	
Donax sp.	x	
Septifer bilocularis	x	
Tridacna maxima		x
T. squamosa		x
ECHINODERMATA		
ECHINOIDEA		
Echinometra mathaei		x
Echinometra oblonga		x
Echinothrix calamaris	x	x
E. diadema	x	x
HOLOTHUROIDEA		
Actinopyga mauritiana	x	
Holothuria atra	x	
ARTHROPODA		
CRUSTACEA		
Stenopus hispidus	x	

Table 43. Checklist of fishes observed at the Fadian Point area study site.

SPECIES	ZONES I	III	IV
ACANTHURIDAE			
Acanthurus glaucopareius		x	
A. guttatus	x		x
A. lineatus		x	x
A. nigrofuscus		x	
A. olivaceus		x	
A. pyroferus		x	
A. triostegus	x		x
A. xanthopterus		x	
Ctenochaetus striatus		x	
Naso lituratus		x	
N. unicornis		x	
APOGONIDAE			
Cheilodipterus sp.	x		
BLENNIDAE			
Meiacanthus atrodorsalis		x	
"Blenny" sp. 1	x		
"Blenny" sp. 2	x		
BALISTIDAE			
Balistes bursa (=*Sufflamen bursa*)		x	
B. chrysopterus (=*S. chrysoptera*)		x	
CANTHIGASTERIDAE			
Canthigaster bennetti		x	
C. solandri	x		x
CARANGIDAE			
Caranx melampygus		x	
CHAETODONTIDAE			
Chaetodon auriga		x	
C. citrinellus			x
C. lunula	x		x
C. ornatissimus		x	
C. quadrimaculatus		x	

Table 43. (continued)

SPECIES	ZONES I	III	IV
C. reticulatus		x	
C. trifasciatus		x	
C. ulietensis		x	
Forcipiger flavissiums		x	
Pomacanthus imperator		x	
Pygoplites diacanthus		x	
CIRRHITIDAE			
Paracirrhites forsteri		x	
GOBIIDAE			
Eviota sp.	x		
HOLOCENTRIDAE			
Adioryx spinifer		x	
Myripristis sp.		x	
KYPHOSIDAE			
Kyphosus sp.			x
LABRIDAE			
Bodianus axillaris		x	
Cheilinus rhodochrous		x	
C. trilobatus		x	
Coris gaimard		x	
Halichoeres hortulanus (=H. centriquadrus)		x	x
H. margaritaceus		x	x
Labroides dimidiatus		x	
Thalassoma lutea		x	
T. quinquevittata		x	
T. sp.		x	
Xyrichthys taeniourus		x	
MULLIDAE			
Parupeneus bifasciatus		x	
P. cyclostomus		x	
P. trifasciatus		x	
NEMIPTERIDAE			
Scolopsis cancellatus			x

Table 43. (continued)

SPECIES	ZONES I	III	IV
PEMPHERIDAE			
Pempheris oualensis		x	
POMACENTRIDAE			
Glyphidodontops glaucus	x		
G. leucopomus	x		x
Plectroglyphidodon leucozona		x	
Pomacentrus vaiuli		x	
POMADASYIDAE			
Plectorhincus chaetodonoides		x	
SCARIDAE			
Scarus sordidus		x	
S. sp. 1		x	
S. sp. 2		x	
SIGANIDAE			
Siganus spinus	x		x
ZANCLIDAE			
Zanclus cornutus		x	

AREA XII:
TARAGUE-SCOUT BEACH AREA

The north coast of Guam extending between Ritidian and Pati Points consists of intermittant long stretches of beach with a wide reef flat platform and convex algal ridge. The entire area lies within Andersen Air Force Base Military Reservation and, with the exception of a single military access road, the area is largely restricted to use by military dependents. Heavy surf and strong rip currents, especially near the larger surge channels, makes boat access and swimming dangerous most of the year.

A small section of East Tarague Beach, near Scout Beach was selected (Fig. 21). The area was chosen because of its well developed convex algal ridge and reef flat platform development, typical of northern Guam.

No previous study has been conducted for this area with respect to the marine biotic community. Randall and Holloman (1974) provide an excellent physiographic description. Portions of their report are incorporated below.

The reef flat platform consists of a poorly defined inner zone on which numerous scattered remnant patches of limestone occur. The middle consists mostly of a thin veneer of sand covering an irregular limestone platform. In many places columnar limestone projections (often a meter or more in height) protrude through this veneer. Much of the platform is exposed during low tide. Corals are restricted to the moat and depressed crevices that retain water. The margin consists of a well defined convex algal ridge and a massive spur and groove system, cut in places by large surge channels.

The Guam Environmental Protection Agency water rating for this pristine area is "AA" - conservation. No point source discharges are known in the immediate area.

The study site was divided into three zones: (1) inner reef flat and moat, (2) algal ridge, and (3) submarine terrace. Tables 44-47 lists those species observed during the study.

The cyanophytes Microcoleus and Schizothrix along with Ectocarpus, Lobophora and Turbinaria dominated the inner reef flat and moat.

The holothurians Holothuria atra and Actinopyga echinites were also abundant.

Corals and fish were limited to a few of the deeper pools and crevices in the moat.

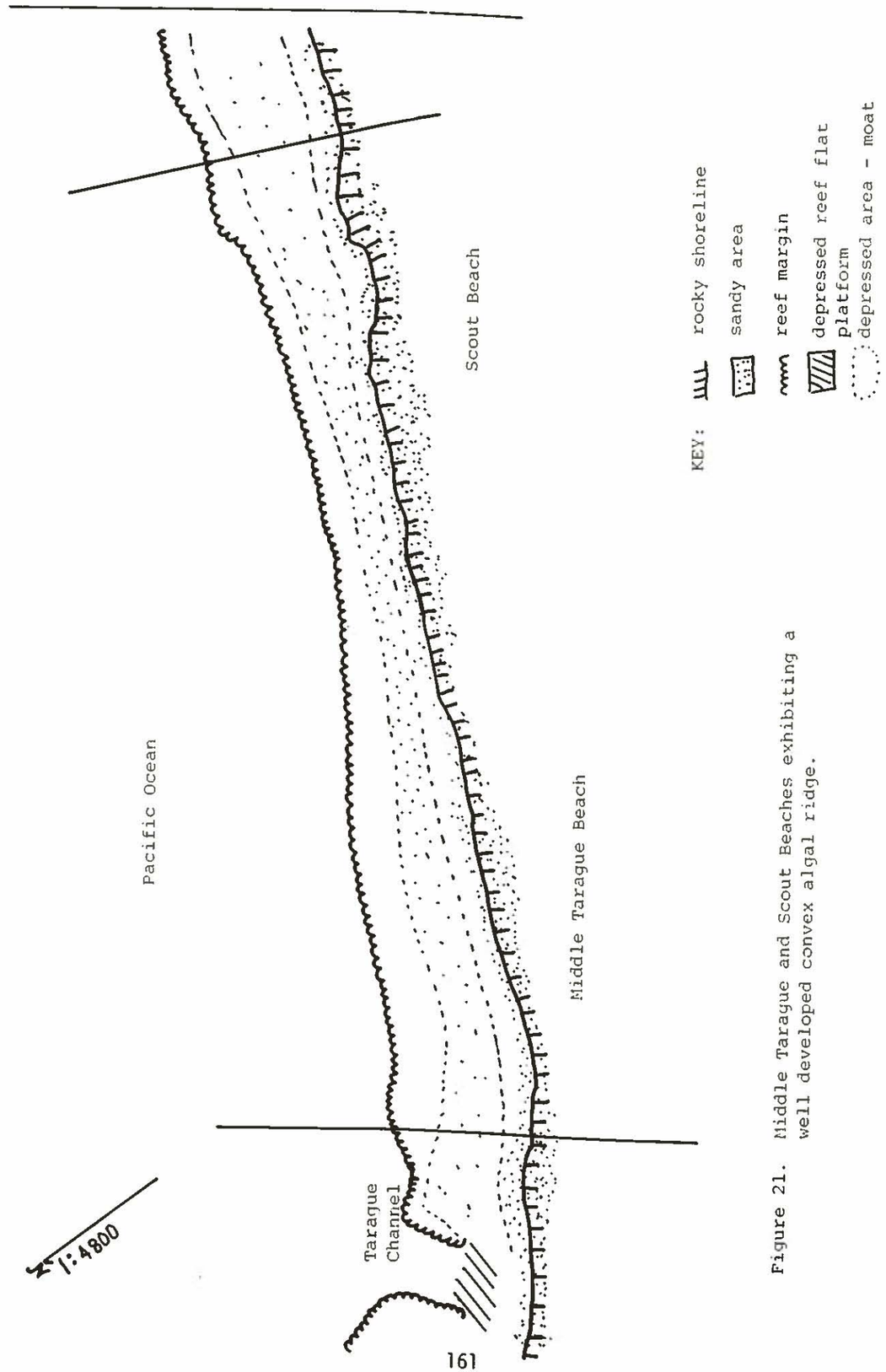


Figure 21. Middle Tarague and Scout Beaches exhibiting a well developed convex algal ridge.

The algal ridge (Zone 2) is of the convex type as opposed to a cuestal type observed at the Uruno-Ritidian area. In contrast to the depauperate conditions of Zone 1, Zone 2 was covered by a thick (5-10 cm) algal mat. Gelidiella acerosa, Acanthophora spicifera, Dictyosphaeria and Bryopsis species were dominant although numerous other genera were also observed.

The submarine terrace (Zone 3) was characterized by a massive spur and groove system grading into a more rolling topography. The coral community was predominantly low relief due to heavy wave action, but very dense. Pocillopora, Acropora, Montipora and Millepora species were all well represented. Deep sand channels bisected massive coral covered ridges.

The fish community was rich but not particularly diverse, while the algal community was characterized by large fleshy types including Halymenia, Galaxaura and Desmia species.

No threatened or endangered species have been identified for this area.

CONCLUSIONS AND RECOMMENDATIONS

The Tarague-Scout Beach area is a popular recreational spot for military dependents. A well developed convex algal ridge and channelized submarine terrace are typical of northern Guam. Although the reef flat itself is only sparsely populated in comparison to other pristine areas, the convex algal ridge more than compensates for this deficiency.

The following recommendations are suggested for the Tarague-Scout Beach area:

1) that this area be established as a natural sanctuary in which no coral harvesting, net fishing or other such activity be permitted.

2) that swimming, snorkeling and SCUBA diving activities be retained.

Table 44. Checklist of benthic algae observed at Tarague-Scout Beach area.

SPECIES	Terrace & Slope	Reef Flat	Margin (algal ridge)
CYANOPHYTA (blue-green algae)			
Anacystis sp.		x	
Calothrix sp.		x	x
Microcoleus lyngbyaceus	x	x	x
Schizothrix calcicola	x	x	
CHLOROPHYTA (green algae)			
Boodlea composita			x
Bryopsis pennata			xx
Chlorodesmis fastigiata	x	x	x
Cladophora fascicularis			x
Dictyosphaeria versluysii			xx
Halimeda gigas	x		
H. opuntia		x	
H. velasquezii	x		
Neomeris annulata	x		
PHAEOPHYTA (brown algae)			
Dictyota bartayresii	x		
D. divaricata	x		
Ectocarpus breviarticulatus			x
Lobophora variegata	x	x	
Padina minor	x	x	
Sargassum cristaefolium			x
Turbinaria ornata		x	x
RHODOPHYTA (red algae)			
Actinotrichia fragilis			x
Acanthophora spicifera		x	
Ceramium sp. 1			xx
C. sp. 2			x
Corallina sp.	x		x
Desmia hornemanni	x		
Galaxaura marginata	x		
G. oblongata	x		
Gelidiella acerosa	x		xxx
Gelidiella sp.			xx
Gelidium divaricatum	x		x
G. pusillum	x		x

Table 44. (continued)

SPECIES	Terrace & Slope	Reef Flat	Margin (algal ridge)
Halymenia durvillaei	x		
Hypnea pannosa	x		x
Jania capillacea		x	
Jania tenella		x	
Mastophora sp. 1	x	x	x
Mastophora sp. 2	x		x
Pterocladia parva	x		

Table 45. Checklist of corals observed at Taragüe-Scout Beach study site.

SPECIES	Terrace & Slope	Reef Flat
ANTHOZOA		
POCILLOPORIDAE		
Pocillopora damicornis	x	x
P. setchelli	x	
P. sp. 1	x	
P. sp. 2		x
ACROPORIDAE		
Acropora humilis	x	
A. nana	x	
A. nasuta	x	
A. palmerae	x	
A. sp. 1	x	
A. sp. 2		x
A. sp. 3		x
Montipora sp. 1	x	x
Montipora sp. 2	x	
FAVIIDAE		
Favia sp.	x	
Plesiastrea versipora	x	
Cyphastrea sp.	x	
ZOANTHIDAE		
Palythoa sp.	x	
ALCYONIIDAE		
Sinularia sp.	x	
HYDROZOA		
MILLEPORIDAE		
Millepora platyphylla	x	x

Table 46. Checklist of common macroinvertebrates observed at Tarague-Scout Beach area.

Species	Terrace & Slope	Reef Flat
MOLLUSCA		
GASTROPODA		
Cerithium morus		x
C. nodulosum	x	x
Conus chaldaeus	x	x
C. ebraeus	x	
C. sponsalis	x	x
Cypraea carneola	x	
Drupa clathrata	x	
D. morum	x	
D. ricinus	x	
Drupella cornus	x	
Lambis sp.		x
Patella sp.	x	
Thais tuberosa	x	
Trochus niloticus	x	x
Vasum turbinellus	x	
BIVALVIA		
Tridacna maxima	x	
ECHINODERMATA		
ASTEROIDEA		
Culcita novaeguineae	x	x
Linckia laevigata		x
L. multifora	x	x
L. pacifica	x	x
ECHINOIDEA		
Echinometra mathaei	x	x
Echinostrephus aciculatus	x	x
HOLOTHUROIDEA		
Actinopyga echinites		x
A. mauritiana		x
Bohadschia argus		x
Holothuria atra		xx
H. cinerascens		x
H. leucospilota		x
Stichopus chloronotus	x	x
ARTHROPODA		
CRUSTACEA		
Grapsus grapsus		x

Table 47. Checklist of fishes observed along the terrace and slope zones at Tarague-Scout Beach area.

SPECIES

ACANTHURIDAE

Acanthurus glaucopareius
A. guttatus
A. lineatus
A. nigrofuscus
Ctenochaetus striatus
Naso brachycentron
N. lituratus
N. unicornis

BALISTIDAE

Rhinecanthus rectangulus

BLENNIIDAE

Cirripectes variolosus

CHAETODONTIDAE

Chaetodon quadrimaculatus
C. reticulatus
Pomacanthus imperator

CIRRHITIDAE

Cirrhitus pinbulatus
Paracirrhites forsteri
P. hemisticus

KYPHOSIDAE

Kyphosus sp.

LABRIDAE

Anampses caeruleopunctatus
Halichoeres marginatus
Labroides dimidiatus
Thalassoma amblycephalus
T. fuscum
T. quinquevittata

LUTJANIDAE

Lutjanus fulvus
Monotaxis grandoculis

MULLIDAE

Parupeneus bifasciatus

POMACENTRIDAE

Abudefduf saxatilis
Glyphidodontops leucopomus
Plectroglyphidodon dickii
P. leucozona
P. phoenixensis

SCARIDAE

Scarus sordidus
S. sp.

SUMMARY TABLE

Table 48. Summary of key information for selected pristine marine communities. Symbols: XXX = very diverse, XX = moderately diverse and X = fairly diverse.

	AREA	Principle physiographic features	Possible alternative sites	Fish	Algae	Corals	Inverts.	GEPA	Pt. dis.	Special
I	Uruno-Ritidian	fringing reef with well developed cuestal algal ridge.	further south along coastline	XX	XX	XX	XX	AA	-	-
II	Double Reef	patch reef and adjacent fringing reef	Anae patch reef	XXX	XX	XX	XX	AA	-	-
III	Haputo Beach	fringing reef	Double reef, plus any of the south bays	XXX	XXX	XX	X	AA	-	-
IV	Luminao	barrier reef	Cocos	XX	XX	XXX	XX	A	-	-
V	Sasa Bay and Atantano River mangroves	mangrove wetland area	Cocos	-	X	-	X	A	-	mangrove assoc. organisms
VI	Orote Submarine Cliffs	submarine cliffs	NONE	X	X	X	X	A	-	cryptic & deep water organisms
VII	Anae Island Patch Reef	patch reef	Double Reef	XX	XXX	XXX	XX	AA	-	extremely rich corals
VIII	Cetti Bay	estuary and fringing reef	Sella, Achugao, Fouha	XX	XX	XX	XX	AA	-	soft corals
IX	Cocos Area	estuary, fringing reef, barrier and patch reefs barrier reef channels, mangroves, seagrass beds	NONE	XX	XXX	XXX	XXX	A	25+	unique area

Table 48. (continued)

	AREA	Principle Physiographic features	Possible alternative sites	Fish	Algae	Corals	Inverts	GEPA	Pt. dis.	Special
X	Ajayan Bay	fringing reef channel and seagrass beds	Ylig	XX	XXX	XX	XX	A	-	
XI	Fadian Point Area	windward cut benches with rimmed terrace pools	anywhere north to Pati Pt. or between Talofofo and Inarajan	XX	XX	XX	XX	A	-	
XII	Tarague-Scout Beach	windward fringing reef with well developed convex algal ridge.	anywhere between CE Beach and Ritidian Point	X	XX	X	X	AA	-	

ACKNOWLEDGEMENTS

The author wishes to express special thanks to two individuals whose help in the field made this report possible; Michael J. Gawel, corals and fishes and Richard E. Dickinson, macroinvertebrates.

Thanks also go to R. H. Randall, L. G. Eldredge, R. T. Tsuda, and S. S. Amesbury who made their personal libraries and notes available to me, as well as providing comments on manuscript preparation.

Other helped in numerous ways. Thanks to Bureau of Planning, the Guam Environmental Protection Agency, Aquatic and Wildlife Resources, marine technician J. Eads and secretary Terry Balajadia.

REFERENCES

Coastal Zone Management. 1977. TanoTasi (Newsletter) 2(1).

Dickinson, R. E., and R. T. Tsuda. 1975. A candidate marine environmental impact survey for the potential development of the Uruno Point reef area on Guam, Mariana Islands. Univ. Guam Mar. Lab., Tech. Rept. 19. 50 p.

Emery, K. O. 1962. Marine geology of Guam. U. S. Geol. Sur. Prof. pap. 403B. 76 p.

Guam Environmental Protection Agency. 1975. Guam water quality standards. GEPA policy. 17 p.

Jones, R. S. and J. A. Chase. 1975. Community structure and distribution of fishes in an enclosed high island lagoon in Guam. Micronesica 11(1):127-148.

Moore, P., L. Raulerson, M. Chernin, and P. McMakin. 1977. Inventory and mapping of wetland vegetation in Guam, Tinian and Saipan, Mariana Islands. Univ. Guam Biosci. 253 p.

Nature Conservancy. 1975. The preservation of natural diversity: a survey and recommendations. U. S. Dept. Interior. 212 p.

O'Connor, H. J. 1974. Important aspects of the Endangered Species Act of 1973. U. S. Dept. Interior. 10 p.

Odum, E. P. 1971. Fundamentals of ecology. W. B. Saunders Co., Philadelphia. 574 p.

Randall, R. H., and J. Holloman. 1974. Coastal survey of Guam. Univ. Guam Mar. Lab., Tech. Rept. 14. 404 p.

Randall, R. H., R. T. Tsuda, R. S. Jones, M. J. Gawel, and R. Rechebei. 1975. Marine biological survey of the Cocos barrier reefs and enclosed lagoon. Univ. Guam Mar. Lab., Tech. Rept. 17. 159 p.

Randall, R. H., and L. G. Eldredge. 1976. Atlas of reefs and beaches of Guam. Coastal Zone Mgmt. Sect., Bur. Planning, Guam. 191 p.

Shidel, L. 1977. Point source discharges in the coastal waters of Guam. Guam EPA Spring Rept. 23 p.

University of Guam Marine Laboratory. 1977. Marine environmental baseline report commercial port, Apra Harbor, Guam. Univ. Guam Mar. Lab., Tech. Rept. 34. 96 p.

U. S. Bureau of Sport Fisheries and Wildlife. 1973. Threatened wildlife of the U. S. Dept. Int. Res. Pub. 114. 551 p.

U. S. Federal Law 93-205. 1973. Endangered Species Act. U. S. Statutes 884 (93rd Congress). 21 p.

Wilder, M. J. 1976. Estuarine and mangrove shorelines. P. 157-191. In R. H. Randall and L. G. Eldredge, Atlas of reefs and beaches of Guam. Coastal Zone Mgmt. Sect., Bur. Planning, Guam.

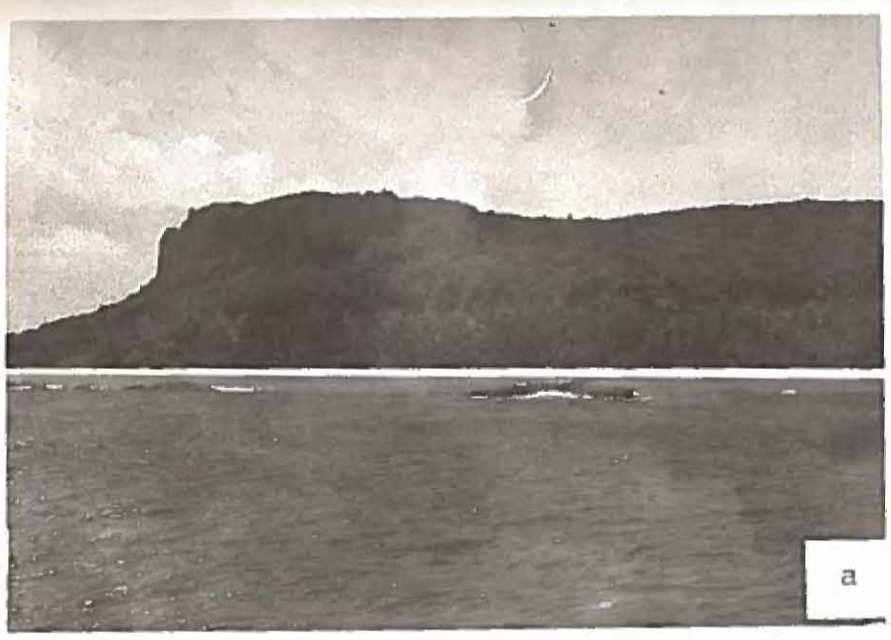
PLATE I

Fig. a. AREA I - Uruno/Ritidian Area showing an exposed cuestal algal ridge in the foreground.

Fig. b. AREA III - View of Haputo Beach and fringing reef from north rim.

Fig. c. AREA IV - Luminao Barrier Reef viewed from the western end of Glass Breakwater.

Fig. d. AREA V - East Sasa Bay mangroves.



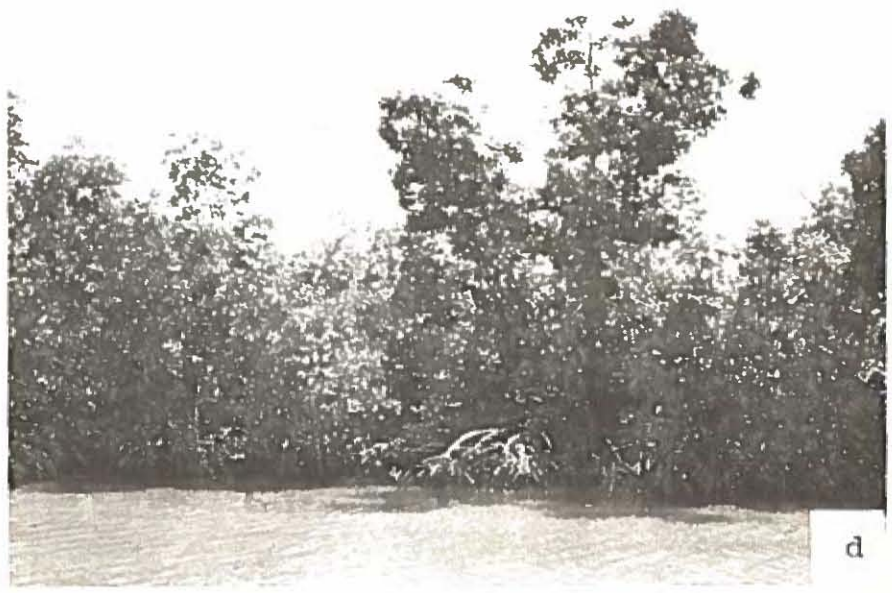


PLATE II

Fig. a. AREA VI - Orote Cliffs

Fig. b. AREA VII - Millepora species.

Fig. c. AREA VII - Massive ridges of Porites, typical of the Anae area.

Fig. d. AREA VII - Porites pinnacle.

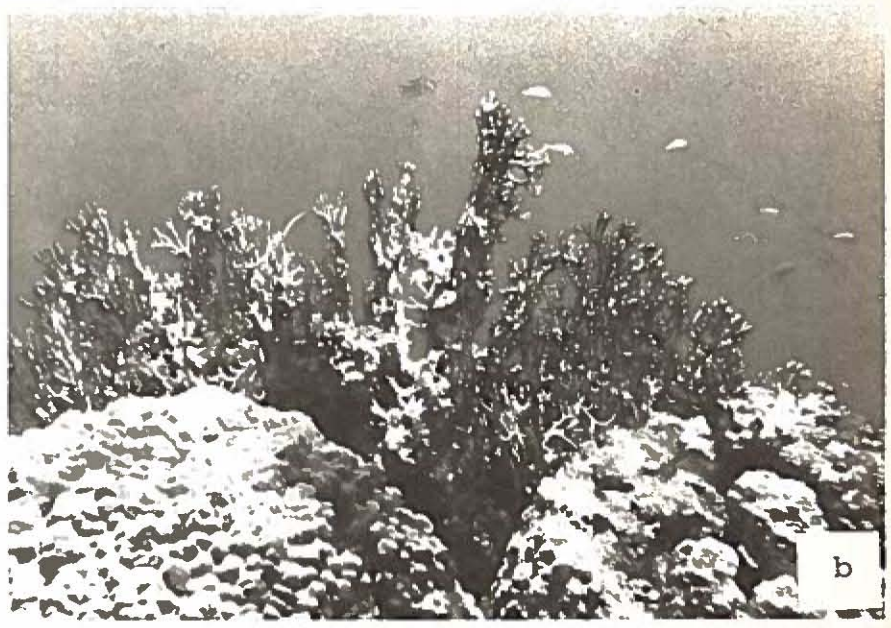


PLATE III

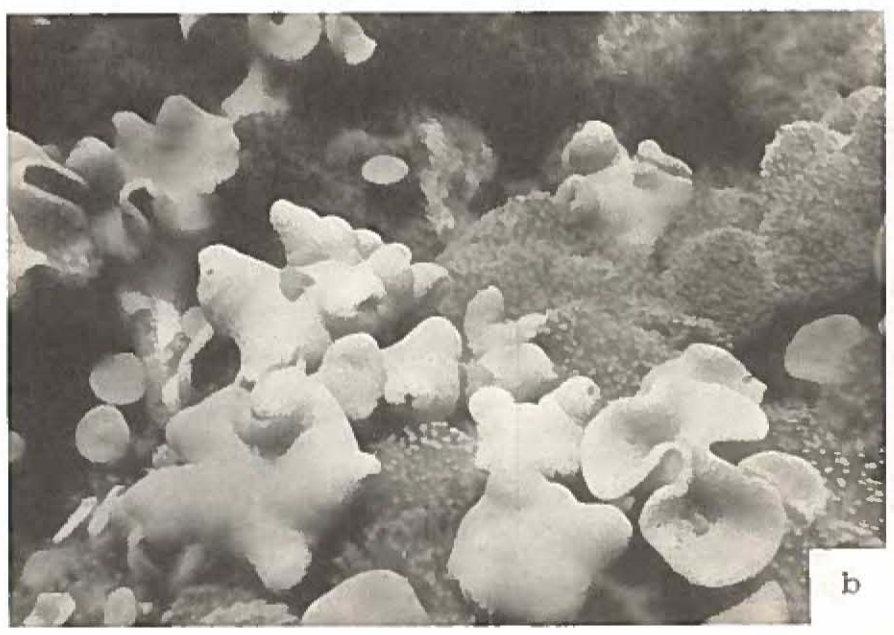
Fig. a. AREA VIII - Cetti Bay viewed from Route 4.

Fig. b. AREA VIII - Soft coral patch. Some of these areas were several meters square.

Fig. c. AREA X - Exposed seagrass beds west of Agrigan Island, Ajayan Bay.

Fig. d. AREA XI - Fadian Point Area cut benches.


a


b


c

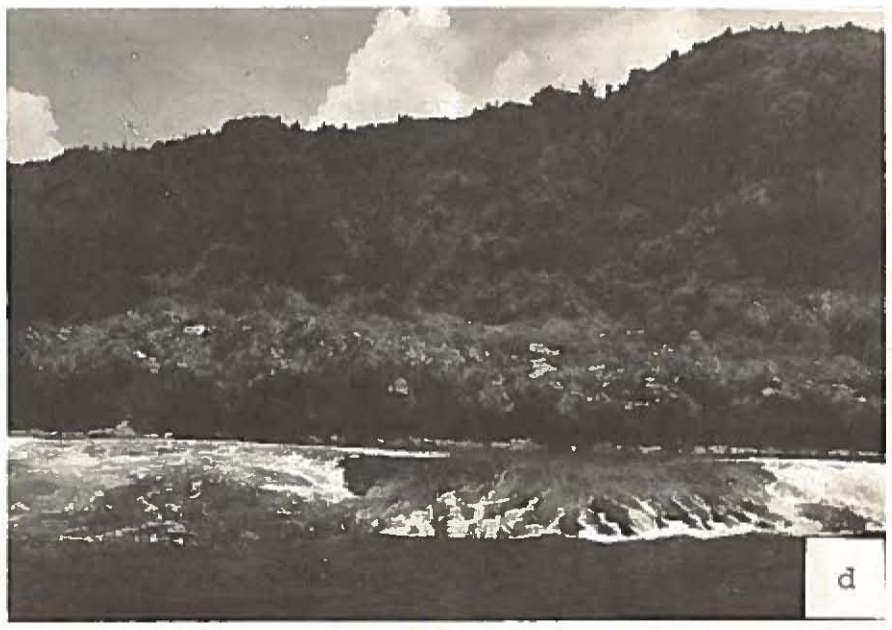

d

PLATE IV

Fig. a. AREA XI - Fadian Point Area cut benches and rimmed terrace pools showing moat.

Fig. b. AREA XI - Typical sand channel.

Fig. c. AREA XI - Close up of sand channel wall covered with the green alga Caulerpa racemosa.

Fig. d. AREA XII - Exposed convex algal ridge. The area shown is completely covered with the red alga Gelidiella acerosa.

PLATE V

Fig. a. AREA IX - Aerial view of Cocos Barrier Reef. (Courtesy of R. H. Randall)

A CHECKLIST OF CHAMORRO NAMES OF MARINE FISH, SHELLFISH, AND CRUSTACEANS

by

Patrick D. McMakin

Coastal Management Section
Bureau of Planning
Agana, Guam

October, 1977

Introduction

Most of the Chamorro names were recorded in field study with numerous informants. Further fieldwork will undoubtedly record additional names. The list was compiled to assist the layman in identification of species from technical reports that solely contain Latin names. The Chamorro system of taxonomic classification does not necessarily follow Latin taxonomy. In some cases, a single species may have several names to delineate growth stages. In other cases, one name is applied to numerous species within a single family.

Marine Fish

Taxonomic Classification	English Name	Chamorro Name
Acanthuridae	Surgeonfishes, Tangs	
Acanthurus gahhm	Surgeonfish	Hugupau
A. glaucopareius	"	"
A. guttatus	"	Hamokan
A. leucopareius	"	Guagnas
A. lineatus	"	Hiyuk
A. nigrofuscus	"	Hugupau
A. olivaceus	"	"
A. triostegus	Barred Surgeonfish	Kechu
Ctenochaetus striatus	Surgeonfish	Hugupau
Naso hexacanthus	"	Guasa
N. lituratus	"	Hangun
N. unicornis	Unicornfish	Tataga
Zebrasoma flavescens	Yellow Tang	Ababang Amariyu
Alopidae	Thresher Sharks	
Alopias pelagicus	Thresher Shark	Haluoo, Agnu
Apogonidae	Cardinalfishes	
Apogon spp.	"	Lansi
Cheilodipterus macrodon	"	"
Aulostomidae	Trumpetfishes	Badyak, Hangkut Abaniku
Balistidae	Triggerfishes	
Balistoides conspicillum	Triggerfish	
Balistoides viridescens	"	Pulunun-Sasadu
Balistes spp.	"	Pulunun
Melichthys spp.	"	"
Odonus niger	Blue Triggerfish	"
Pseudobalistes flavomarginatus	Triggerfish	Pulunun-Sasadu
P. fuscus	"	Pulunun
Rhinecanthus aculeatus	"	"
R. rectangulus		Pulunun-Lago
Suffamen chrysoptera	"	Pulunun
Belonidae	Needlefishes	Pulus, Badyak
Blenniidae	Blennies	Maching

Bothidae	Flounders, Flatfishes	
Bothus sp.	Flounder	Tampat
Canthigasteridae	Sharp-backed Puffers	
Canthigaster spp.	Puffer	Botati, Faha
Canangidae	Jacks	
Caranx sp.	Skipjack,	Ii (sm.),
	Jack Crevalle,	Tarakitiyo (med.),
	Horse Mackerel	Tarakito (lg.),
		Mamulon (ex.lg.)
Decapterus pinnulatus		Achuman
Scomberoides sancti-petri		Hagi
Trachurops crumenophthalmus	Mackerel	Atulai
Chaetodontidae	Butterflyfish	Ababang
Chaetodon lunula	Spotted Butterflyfish	Ababang Lonnat
Chaetodon sp.	Striped Butterflyfish	Ababang Rayao
Forcipiger flavissimus	Butterflyfish	Ababang
Chanidae	Milkfishes	
Chanos chanos	"	Bangus, Pulang Aguas
Dasyatidae	Rays	
Dasyats sp.	Stringray	Hafula
Diontidae	Porcupinefish	
Diodon hystrix	Spiny Puffer	Tituka
Dussumieridae	Round Herrings	
Spratelloides delicatulus	Herring	Aletses
Eleotridae	Gudgeons	
Eleotris fusca	"	Atut
Elopidae	Tarpons	Pulan
Engraulidae	Anchovies	
Stolephorus buccaneeri	Anchovy	Faya
Thrissina baelama	"	"
Exocoetidae	Flyingfishes	
Cyselurus ruescens	"	Gaaga
Fistularidae	Cornetfish	Badyak
Gobiidae	Gobies	Maching
Hemiramphidae	Halfbeaks	Anko, Hankut
Holocentridae	Squirrelfishes	
Adioryx sp.	"	Suksuk
Holocentrus sp.	"	Chalak
Myripristis spp.	"	Suksuk
sp.	"	Sagamelon

Kuhlidae	Flagtails	Umatan, Atingyet
Kyphosidae	Pilotfishes	
Kyphosis cinerascens	Pilotfish	Guili
K. vaigiensis	Pilotfish	Guili Puengue
Labridae	Wrasses	
Anampses spp.	"	Aaga
Cheilinus celebicus	"	"
C. chlorourus	"	"
C. fasciatus	"	Aaga, Palaksi, Gaddas
C. rhodochrous	"	Aaga
C. trilobatus	"	Lalatsa-Mamati
C. undulatus	"	Tangisun
Cheilio inermis	"	Aaga
Choerodon anchorago	"	"
Coris aygula	"	"
Cymolutes lecluse	"	"
Epibulus insidiator	"	"
Gomphosus tricolor	"	"
Halichoeres spp.	"	"
Hemigymnus spp.	"	"
Iniistius pavonius	"	"
Labrichtys cyanotaenis	"	"
Labroides spp.	Cleaner Wrasses	"
Lepidaplois axillaris	Wrasse	"
Macropharyngodon pardalis	"	"
Pseudocheilinus sp.	"	"
Stethojulis spp.	"	"
Thalassoma spp.	"	"
Wetmorella ocellata	"	"
Xyrichthys taeniourus	"	"
Leiognathidae	Soapys, Ponyfishes	
Gazza achlamys	Soapy	Kajao
Gerres spp.	"	Guaguas
Leiognathus equulus	"	Kajao
Lutjanidae	Snappers	
Gnathodentax aureolineatus	Snapper	Salagai
Lethrinus spp.	"	Mafute
Lutjanus argentimaculatus	"	Tagafi Sadok
L. gibbus	"	Fafaet
L. kasmira	Blue and Yellow Snapper	Funai
L. gohar	Snapper	Tagafi
L. monostigmus	"	Kakaka
L. fulvis	"	"
L. vaigiensis	"	Bua
Caesio caerulaureus	"	Bonita
Monotaxis grandoculis	"	Matanhagon
Scolopsis cancellatus	"	Sihig
Gaterin diagrammus	"	Lagu
Monacanthidae	Filefishes	
Oxymonacanthus longirostris	Filefish	Hagonfa Ha

Mugilidae	Mullets	
sp.		Aguas (sm.), Laiguan (lg.)
Mullidae	Goatfishes	
Mulloidichthys auriflama	Goatfish	Tiao (sm.), Sanmoniti (lg.), Sanmoniti Manining
M. samoensis	"	Sanmoniti
Parupeneus cyclostomus	Yellow Goatfish	Sanmoniten Amariyu
P. spp.	Goatfish	Sanmoniti
Upeneneus vittatus	"	Sanmoniten Acho Sanmoniten Leau
Muraenidae	Moray Eels	
Enchelynassa cannina	Moray Eel	Titugi
Gymnothorax spp.	"	"
Rabula fuscomaculata	"	"
sp.	"	Hankmang
Ophichthidae	Snake Eels	
Myrichthus colubrinus	Snake Eel	Hagman-Lisado
M. maculosus	Snake Eel	Hagman-Lisado
Ostraciontidae	Boxfishes, Cowfishes	
Ostracion cubicus	Boxfish	Danglon, Torillo
Ostracion meleogris	Cowfish	Torillo
Lactoria cornutus	"	"
Platacidae	Batfishes	
Platax orbicularis	Batfish	Fanihin Tasi
Polynemidae	Threadfins	
Polydactylus sexfilis	Threadfin	Boka Dulce
Pomocentridae	Damselfishes	
Abudefduf septemfasciatus	Banded Damsel	Fohmo, Doddo
A. spp.	Damselfish	Fohmo, Fomho
Amphiprion bicinctus	"	Fohmo Gadudog
A. melanopus	"	"
Dascyllus spp.	"	Fohmo
Pomacentrus spp.	"	"
sp.	"	Fohmo Payao
Priacanthidae	Bigeyes	
Priacanthus spp.	Bigeye	Mamagas
Scaridae	Parrotfishes	
Leptoscarus vaigiensis	Parrotfish	Palaksi
Scarus spp.	"	Lagua
sp.	"	Atuhon
Scombridae	Tunas	
Acanthocybium solandri		Tosun
Neothunnus macropterus	Yellowfin Tuna	Kacho
Sarda chilensis	Bonito	Bonita
Thunnus thynus	Bluefin Tuna	Kachug Apaka

Scorpaenidae	Scorpionfishes	
Pterois spp.	Scorpionfish	Nufoo, Nufu Pabo
Scorpaenodes spp.	"	Nufoo, Nufu
Synanceia verrucosa	"	Nufoo
Serranidae	Groupers, Seabass	
Epinephelus spp.	Grouper	Gadao
sp.	"	Gadao Pentu
sp.	"	Gadao Maluslus
sp.	"	Fafahid
Siganidae	Rabbitfishes	
Siganus punctatus	Rabbitfish	Hiting Fade
Siganus spinus	"	Manahak (sm.), Dagi (sm.-med.), Seyun (med.), Hiting (lg.)
Siganus spp.	"	Seyun
Sphyraenidae	Barracudas	
Sphyraena barracuda	Barracuda	Alu
Sphyraena spp.	"	"
Sphyrnidae	Hammerhead Sharks	
Sphyrana lewini	Hammerhead Shark	Kiluus
Synodontidae	Lizardfishes	
Synodus spp.	Lizardfish	Pipipu
Tetraodontidae	Smooth Puffers	
Arothron hispidus	Puffer	Botaten Malulasa
A. spp.	"	Botati
Zanclidae	Moorish Idols	
Zanclus canescens	Moorish Idol	Ababang Gupalao
Zanclus cornutus	"	"

Shellfish

Taxonomic Classification	English Name	Chamorro Name
Cypraedae	Cowries	
Cypraea spp.	Cowrie	Karakot
Neritidae	Nerites	
Nerita albicilla	Nerite, Rock Snail	Pedis
Strombidae	Conchs	
Lambis crocata	Spider Conch	Toro
Strombus giberulus	Humped Conch	Dogas
S. luhuanus	Blood-mouthed Conch	Dogas Dangkulo
Tridacnidae	Giant Clams	
Tridacna maxima	Fluted Clam	Himu
Trochidae	Top Shells	
Trochus niloticus	Trochus	Aliling
Turbinidae	Turban Shells	
Turbo atgyrostoma	Turban	Aliling
Veneridae	Clams	
Grafrarium tumidum	Clam	Tapun

Crustaceans

Taxonomic Classification	English Name	Chamorro Name
Grapsinae	Grapsid Crabs	
Grapsus grapsus	Shore Crab	Hagahof
Paguridae		
Birgus latro	Coconut Crab	Ayuyu
Coenobita spp.	Hermit Crab	Dukduk, Umang
Palinuridae		
Panulirus pencillatus	Crayfish, Lobster	Mahongang
Portunidae	Portunid Crabs	
sp.	Blue-green Swimming Crab	Alimasak
Xanthidae	Rock Crabs	
sp.	7-11 Crab	Panglao Oro
Cardisoma carnifex	Land Crab	Panglao
Scylla serrata	Mangrove Crab	Admangao
Uca spp.	Fiddler Crab	Hagui, Lelente

Bibliography

Bryan, E.H. "Fishes of Guam." Guam Recorder; Vol. 15, No. 9 through Vol. 16, No. 9; Dec., 1938-Dec., 1939.

Eldredge, L. and Tansy T. Inside the Reef; Pacifica Graphic, Agana, Guam; 1973.

Jones, R. and Larson, H. A Key to the Families of Fishes as Recorded From Guam; University of Guam Marine Laboratory; Technical Report No. 10; May, 1974.

Kami, H.T. "Checklist of Guam Fishes: Supplement 1." Micronesica; Vol. 7, Nos. 1 and 2; July, 1971; pp. 215-228

Kami, H.T., Ikehara, I.I., and DeLeon, F.P. "Checklist of Guam Fishes." Micronesica; Vol. 4, No. 1; June, 1968; pp. 95-130.

Larson, Helen. "Some Fishes Commonly Encountered in The Shallow Areas of Guam." Unpublished list, no date.

BEACH ACCESS ON GUAM

by

Robert Gomez

for

Coastal Management Section
Bureau of Planning
Agana, Guam

October, 1977

Introduction

Beaches on Guam have three possible means of access: horizontal access along the shoreline, perpendicular access from primary and secondary roads on the island side and access from marine waters. The seaward side offers only a few points of access because of the fringing reef which surrounds most of the island. At a few sites, there are natural channels on the reef through which small boats can pass. Inarajan Bay, Umatac Bay, and Ylig Bay all have direct access. These points are used mostly as passage for small fishing boats desiring to reach open water. Nimitz Beach at Agat has a channel through the reef which is also used as passage. Sella Bay has frequently used direct access to the beach from the open water. Beaches have a more direct access from the inland side. For example, The inland access to Sella is either horizontal along the shoreline from Umatac or from Nimitz Beach during low tides. The perpendicular access is a foot trail from Route 4. Therefore, points of access from marine waters require no direct manmade controls to be left open. For management purposes, the horizontal access and perpendicular access are the areas of concern.

In order to consider management of points of access it is necessary to define the term beach, recognize the importance of beach use, identify problems and recommend proposals for management. This report seeks to address these points.

Definition of Beach

Guam's shoreline has been divided into four physiographic types: rocky shoreline, beaches, low-lying shoreline which supports mangrove vegetation and manmade or altered shoreline (Randall and Eldredge, 1976). Beaches comprise 31% or 58 km (36 miles) of the shoreline. These areas are sections of the shore which are covered with unconsolidated sand or gravel. Beach material may include boulders, organic rubble, gravel, coral, shells, foraminifera, sand, silt or clay. Three working definitions of beach are:

1. A shore covered with unconsolidated sand or gravel (Hawaii Coastal Zone Management, 1975 Technical Report No. 4.)

2. An accumulation of unconsolidated deposits along the shore with their seaward boundary being at the low-tide or reef flat platform level and extending in a landward direction to the strand vegetation or first change in physiographic relief of topographic shoreline. (Randall & Eldredge, 1976).

3. A land of water area, or combination thereof, under the jurisdiction of the Department of Parks and Recreation, used by the public for recreation and fishing purposes. (GovGuam Code Sect. 134353 (2)).

The first definition fairly well satisfies the popular conception of a beach. The second definition is satisfactory for scientific and engineering purposes. This definition, however excludes areas with beach deposits, which are separated from the low-tide mark or reef flat by low terraces of limestone. The third definition is limited to beach properties owned or leased by the Government of Guam and maintained as recreation areas by the Department of Parks and Recreation. There is a fourth definition which can legally affect Guam's beaches. This definition is the one for ocean shore.

> ... the land between the low waterline and a series of lines connecting angle points located at a distance of twenty-five (25) feet inland from the two (2) feet contour line as established and described by the U.S. Coast and Geodetic Survey. The angle points shall be so selected as to secure maximium parallelism of the twenty-five (25) feet setback line with a two (2) feet contour. (GovGuam Code Sect. 13453 (1)).

For management purposes these definitions for beaches and the definition of ocean shore have to be considered. Guam's situation is such that all beaches, with the exception of military beaches and the beaches on Cocos Island, have no consistent control by private owners on their availability and use. This suggests that to establish management objectives, the working definition utilized for beaches should be the definition with the broadest scope: a shore covered with unconsolidated sand or gravel. The non-federally owned areas on Guam which satisfy the conditions of the above definition are the ones that should eventually be managed by the Guam Coastal Management Program.

Use of Beaches

Guam's beaches are used mainly for recreation. (Swimming, relaxation, nature observation, shell collecting and fishing). Culturally, beaches are the sites for family gatherings (picnics) or cooperative fishing during seasonal fish runs. Beaches for family gatherings are not limited to public beaches maintained by the Department of Parks and Recreation. In addition to family activities, beaches are natural sites for relaxation and recreation. The recreational complex includes sunbathing, nature observation, wading, picnicking, swimming, surfing, skin diving, scuba diving and other sports. The beaches on Tumon Beach and Bile Bay are commonly used as launching sites for small sailboats.

The CZM Land-Use Opinion Survey depicted 64% of the population using beaches and parks on at least a monthly basis. This percentage does not include tourists. In a Bureau of Planning tourism survey of Japanese visitors, 66.4% of the respondents rated Guam's beaches as good.

Demands for beach properties for residential use or high-density utilization of property for this specific purpose is minimized by land prices and current development controls. In high-density areas, (Tumon Bay and Tamuning) private residences, apartments, condominiums and hotels are directly adjacent to beach areas. In the south, (Ipan, Inarajan, and Merizo), private residences are continuning to develop. Extensive commercial utilization of property adjacent to beaches exists in random strip development from East Agana through Piti. None of these commercial uses requires shoreline siting. The majority of these commercial establishment should be centrally located elsewhere to enhance public and visual access as well as the natural environment.

Beaches as a source of sand for construction purposes has been a persistant problem. Sandmining is being done by individuals either as a source of sand for their own use or for small-scale commercial purposes. The sand is usually taken from undeveloped beach areas in Ipan, Inarajan and Merizo. On occasion, some sand is taken from developed areas along Tumon or Agana Bays.

Identification of Problems

Beaches present two problem areas which require active management. The first set of problems pertains to availability, and the second pertains to access.

Availability

The island has 58 kilometers of beach strand. (See Map 1 and Appendix 1) Approximately 16 kilometers is under military control and not available to the civilian population. The U.S. Navy has opened four of their six recreational beach areas to the civilian population. (See Appendix 2). The U.S. Air Force has kept all of their beach areas restricted. The military recreational beach areas are only available to base personnel or persons in possession of a gate pass, which allows them access to the beach. While this situation is a beach availability problem for the civilian population, its management is not within the scope of the Guam Coastal Management Program. The remaining 38 kilometers of beach present other problems which the program can potentially manage.

Guam has traditionally had an "open shore" policy. Originally, the policy was unwritten, but with rapid urbanization the Guam Legislature found it necessary to make a statement regarding retention of the "open shore" policy, Government of Guam Code (Sect. 17203), the Seashore Protection Act (P.L. 12-108) and the Territorial Beach Act, all as amended, address this policy. Section 17203 of the Zoning Law has the intent of preventing construction on Guam's beaches and keeping them clear of obstructions. The same section of the law, reinforced by the Seashore Protection Act, has discouraged private property owners from building obstructions which isolate sections of beach, preventing horizontal access. The Subdivision Law requires that any subdivision proposal have, within its plan and implementation, access to beaches and recreational areas. This section does not necessarily apply to the development of a single lot.

Geographically, the 38 kilometers of beach is available to the residents of Guam. However, the CZM Land-Use Opinion Survey showed 79% of the respondents answering yes to the question: "Should there be more beaches and swimming areas?" The question was interpreted to mean developed beaches. At present, the Department of Parks and Recreation maintains four beach parks. In addition, one is in the process of being developed and one is owned by the U.S. Navy, but licensed to the Government of Guam; a total of six. The U.S. Navy maintains two beaches open to the public; NCS Beach and Hoover Beach (USO Park). The Draft Guam Comprehensive Outdoor Recreation Plan (1977) lists ten more sites as potential beaches (See Appendix 3). Cocos Island has two beaches maintained by private owners and requiring a fee to use the docks for landing. For the most part, these beaches are used by tourists, though they are open to the public as well.

A developed beach refers to a beach with facilities for picnics, games, and general recreation, as well as trash and grounds maintenance. The Department of Parks and Recreation is the primary agency responsible for maintenance and development of beach availability for the public. A Guam Coastal Management Program management phase would initially coordinate with the Department of Parks and Recreation in maintaining and developing further the availability Guam's beaches.

Availability of beaches can be lessened by a lack of aesthetic appeal. Beaches have a natural appeal but because of trash and litter many beach areas are left along. The CZM Land-Use Opinion Survey showed 75% of the respondents claiming the beaches to be littered and dirty. This situation exists on almost all beaches, except for those maintained by the military or private developers.

Related to the above is the potential lack of availability which can occur if private land owners close beach areas to the public. Private owners are beginning to discourage beach users (mostly by use of fences and signs) from areas near their property because of the litter, destruction to property, and desire for the status of having a private beach.

Access

Inland access to beaches is of two types: along the shoreline (horizontal access) and access from primary and secondary roads (perpendicular access). Currently the "open shore" policy allows people to use reef flats, rocky shores and beaches with few manmade obstructions to discourage them. It is possible, during low-tides, to walk from Nimitz to Merizo and thus reach all beaches in the area. Similarly, other long stretches of shoreline with beach areas have access. Exception are beaches adjacent to military property, though the stretch of beach north of NCS, which is undeveloped, has horizontal access.

Primary and secondary roads are generally parallel to the shoreline (See Map 1). Perpendicular access is considered from points on these roads. From East Agana to Piti Marine Drive, the island's main road, is almost adjacent to the shoreline. Access points exist where off-road, parking can be achieved. All of the developed beaches have parking lots and access through the recreational fields. The Tumon Bay resort area has access from hotel parking lots and the Ypao Beach parking lot. The only hotel that requires passage through the hotel to the beach is the Okura Hotel. Beaches in the Alupang area have two access inroads from Camp Watkins Road, that end at the beach edge. There are no parking facilities available. The areas along Trinchera Beach in East Agana have some picnic facilities, but no parking area except for off-road parking. The same is true in West Agana and Asan. East Agana has some commercial establishment that block all perpendicular access besides adding point source pollution and litter to the beaches. The beaches along Anigua are similar to East Agana. Anigua has Marine Drive which can offer access to the beach. Strip development prevents the beaches from exhibiting their natural appeal. Both Sella and Cetti Bays have a developed foot trail from Route 4. The beaches between Sella Bay and Nimitz Beach have no open perpendicular access. There is a dirt road, almost unpassable during the rainy season, to Facpi Point; however, this road requires permission from the owner of the property leading to the beach.

The beaches along Bile Bay in Merizo have access through private property, whether developed or not. The owners are seldom reluctant to offer access, but they prefer that permission be sought first. Their condition is usually that after use the public cleans up any litter they may have generated. Areas in Agat and Inarajan are beginning to close perpendicular access with fences or chained dirt drive ways. These areas are undeveloped or developed for family use.

Functional Agency Responsibilities

Section 303 of the Federal CZM Act requires the local Guam Coastal Management Program to preserve, protect, develop and where possible, to restore or enhance, the resources of Guam's beaches. To meet this objective, a comprehensive management program is required. The scope of the program consists of the following agency responsibilities:

1. The Department of Parks and Recreation: to enhance the planning development and maintenance of the outdoor recreational environment, to include parks, marinas, historical sites and scenic overlooks for enjoyment and enrichment of the people of the Territory

2. The Department of Public Works: to minimize the amount of village, industrial and agricultural solid waste to be dispcsed of and minimize pollution.

3. Guam Environmental Protection Agency: to restore protect and enhance where appropriate the natural and manmade environment.

4. The Bureau of Planning: to enhance the effectiveness and efficiency of government programs by undertaking comprehensive land-use and physical planning, by coordinating such planning within and between levels of government and assuring the compatibility of proposed facility construction and the government's general plan.

These functions are supported by the Subdivision and Development Review Committee. This Committee reviews project proposal from a technical standpoint and submits its recommendations to the Territorial Planning Commission before a decision is made.

The policy for Public Access as stated in the Land-Use Element of the Comprehensive Development Plan is: Ensure the public right or unrestrected access to all territorial ocean shores, recreational areas, parks, scenic overlooks, conservation areas, and areas under the control of the Territory of Guam; and to encourage through cooperation with the Federal Government, access to those areas under Federal control which should be available to citizens of Guam.

Recommendations

To implement the above stated policy, the Guam Coastal Management Program (CZM) must concerated on the management activities which enable other agencies to operate within the scope of a Beach Management Program in achieving their goals and objectives. The major problem of availability consists in having Territorial beaches developed, elimininting the litter and preventing sand-mining.

The Development of Territorial beaches is one of the main functions of the Department of Parks and Recreation. The Draft Comprehensive Outdoor Recreation Plan demonstrated that the department has recognized this primary objective. It may not be necessary for CZM to become committed to this task.

Under the conditions of the Federal CZM Act, the local CZM Program can initially assist in funding improvement projects or management capability.

Currently, the Department of Parks and Recreation has no consistent maintenance program to keep beaches clean and to prevent vandalism. The CZM Program can aid this department by developing a maintenance program to follow-up any beach development project, both existing and proposed.

Removal of trash is within the function of the Department of Public Works. Currently, there is no program to have collection points in undeveloped areas. The CZM Program can aid by developing a program to have such points and collection of trash thoughout the island along both primary and secondary roads.

To maintain beaches as natural ecological systems is fairly well controlled by the environmental laws and enforcement of these laws by the Guam Environmental Protection Agency. With continued funding and provision of sufficient capable personnel, the 208 Program or Areawide Wastewater Treatment Plan should adequately eliminate sources of pollution and enhance the appeal of many beach areas.

The maintenance of points of access to the beaches should be the main objective of a CZM Beach Management Program. To achieve this objective, the CZM Program will be required to have means by which the traditional "open shore" policy is maintained and to have specific areas which offer passage to beaches. A major obstacle in maintaining the "open shore" policy litter and destruction to private property. Territorial beach maintenance and trash collections would aid in removal of this obstacle, but will not necessarily eliminate the cause. There is a need to have a strong public education program and legal enforcement that beach users will consciously respect the island's natural resources. The "open shore" policy can also be maintained by controlling the construction of developments which restrict access to the beaches. This involves continued support and participation in the Subdivision and Development Review Committee and its compliance with the objectives of the Land-Use and Community Design Elements of the Comprehensive Development Plan.

Points of access are available at all Territorial beaches. The development of new Territorial beach parks will present more points of access. If the plan of the Department of Parks and Recreation is fully implemented, the Territory will have a total of 14 beache parks, (one of the sites to be developed is the expansion of Ypao Beach). These beaches extend to the major beach areas on the eastern, southeastern, southern and southwest sections of the island. (See Map 1).

Access points through private property can be open in either of two ways. One is for the Government of Guam to obtain right-of-way. The Government of Guam is authorized to obtain access to beaches by P.L. 12-209. The means for obtaining the right-of-way are purchase, exchange, condemnation the obtaining of easements. The second method is to maintain the "open shore" tradition and have private owners allow the public to use their property under owner's conditions. Attitudes expressed by owners in Inarajan and Merizo give evidence that this means is possible.

Currently, there is in the planning stage two large parks which could give access to the major beaches on Guam, other than military beaches. One park is the National Historic War in the Pacific Park. This park is being developed simultaneously with the Asan Urban Renewal project. The second park being planned is the Seashore Park which includes the entire southeast portion of Guam's shoreline. These plans should both be implemented. (See Map 2).

Access to military beaches should be obtained by strong coordination efforts between the Government of Guam and military.

APPENDIX 1. BEACH STRAND INVENTORY

	Place Name	Length (meters)	Width (meters)	Ownership	Inland Access	Comments
1.	Amantes Pt.-Biji Pt.	594	1-15	Private	None	
2.	Fafai Beach	366	8-32	Private	Secondary Road	
3.	Gogua Beach	220	310	Private	Through Okura	Also known as Gun Beach
4.	Naton Beach	1775	8-27	Private	Secondary Road	
5.	Ypao Beach	671	5-8	GovGuam	Secondary Road	
6.	Hospital Pt.	40			None	Developing into a beach strand.
7.	Alupang Island	27		Gov Guam	None	
8.	Dungcas	846	3-8	Private	Secondary Road	
9.	Dungcas-Trinchera Gap	1844	3-16		Through Private Property	
10.	Trinchera Beach	693	3-16	Gov Guam	Marine Drive	
11.	Naval Cemetery	175	16	GovGuam	Marine Drive	Padres Palomo Park
12.	Agana	1619	3-16	GovGuam	Marine Drive	
13.	Anigua-Pigo	213	3-12		Graded & drained through private property	Fonte River
14.	Adelup	667	3-19	GovGuam		Adelup School
15.	Asan	594	319	Private	Marine Drive	
16.	Asan Pt.	853	6-19	Private	Marine Drive	Commercial & residential block access
17.	Piti	1585	10-20	Federal	Marine Drive	Asan Invasion Beach
18.	Tapungan Channel	149	3-10	Federal	Marine Drive	USO Beach & Santos Park
19.	Hotel Beach	244		Federal	Paved Road	Beach still developing
20.	Atantano River	1020		Federal	Restricted	
21.	Orote Peninsula #1	80	3-10	Federal	Restricted	
22.	Orote " #2	202	3-16	Federal	Restricted	
23.	Orote " #3	65	3-16	Federal	Restricted	
24.	Gabgab Beach	524		Federal	Base Pass	A rocky shoreline w/sand deposit
25.	Tipalao Beach	236		Federal	Base Pass	
26.	Dadi Beach	1330	2	Federal	Base Pass	
27.	Rizal Beach	1330	2	Federal	Primary Road	With parking lot
28.	Togcha Beach	1505	15	Private	Primary Road	
29.	Salinas Beach	1505	15	Private	Primary Road	
30.	Gaan Pt.	1909	19	Private	Primary Road	
31.	Bangi Pt.	1909	19	Private	Dirt Road	Keep out sign
32.	Chaligan	1798	23	Private	Primary Road	
33.	Nimitz Beach	1798	23	Federal	Primary Road	With parking lot marine access
34.	Taleyfac River	1798	23	Private	Dirt Road	
35.	Taelayag Beach	1402	15	GovGuam	Dirt Road	Blocked
36.	Sagua Beach	1006	27		Foot Trails	
37.	Facpi	1062	12		Foot Trails	

38.	Achugao Pt.	472	12		Foot Trails	
39.	Sella Bay & Abong	1457	34	GovGuam	Foot Trails	
40.	Cetti Bay	610	3-16	Private	Foot Trails	Marine Access
41.	Fouha Bay	100			Foot Trails	
42.	Umatac Bay	229	23	GovGuam	Primary Road	
43.	Machadgun Pt.	457		Private	None	A rocky shoreline w/sand
44.	Mamatgun Pt.	457		Private	Dirt Road	Chained closed
45.	Toguan Bay	966	9	Private	Primary Road	Rocky shoreline
46.	Ajmo Beach	381	9	Private	Primary Road	Rocky shoreline. Access across private property
47.	Bile River South	53	5-14	Private	Primary Road	Access across private property
48.	Pigua River	136	5-20	Private		Access across private property
49.	Cocos Island	1871	5-25	Private	None	Marine access
50.	Cocos Sand-Islet	118	34		None	Marine access
51.	Pigua Beach-Ada	975	1-5	Private	Primary Road	
52.	Aang Beach	1303	3-10	Private	Primary Road	
53.	Liyog River mouth	137				Rocky & shoreline
54.	Ayajan Bay	213	124	Private	Primary Road	Sectioned off w/fences
55.	Aga Bay	122	3-5	Private	Primary Road	Across private property
56.	Guijen Pt.	701	5-15	Private	Primary Road	Across private property
57.	Atao Beach-Acho Pt.	610	15	Private	Dirt Roads	
58.	Acho Pt.	427	20	Private		Fences
59.	Agfayan Bay	118	20	Private	Primary Road	
60.	Inarajan Bay & Guae	67-8	2-60	Private		Marine access
61.	Pauliac Bay	457	1-20	Private	Foot Trails	
62.	Perez Beach	412	to 50	Private	Primary Road	
63.	Asiga Beach	107		Private		No access
64.	Asalanso River mouth	141	15	Private		Across private property
65.	Talofofo Bay	335	46	GovGuam	Primary Road	
66.	Ipan Pt.	100	30	GovGuam	Primary Road	
67.	Cruz Beach	123	42	Private	Dirt Road	
68.	Jones Beach	823	42	Private	Closed access	Moylan & Corn Beach
69.	Ipan Beach	480	23	GovGuam	Park	7th. Day Adv. Cemetery
70.	Togcha	427	15	Private	Dirt Road	
71.	Ylig Bay	290	27	Private	Dirt Road	Marine access
72.	North Ylig	109	15	Private	Dirt Road	
73.	Tagachan	118	30	GovGuam	Park	
74.	Pago Bay	1543	15	Private	Dirt Road	
75.	Tagua Pt. Mouth	4938	69	Federal	Restricted	
76.	Taragüe	572	61	Federal	Restricted	
77.	Jinapsan	2065	38	Private	Through AAFB	

78.	Ritidian	1562	46	Federal	Restricted
		1734	46	Federal	Restricted
		255	23	Federal	Restricted
79.	Uruno Beach	2804	34	Private	Through Base
80.	Falcona Beach	594	27	Private	Through Base
81.	Haputo Beach	310	19	Federal	Restricted
82.	Hilaan-Tanguissan Pt.-NCS	412	38	Federal	Secondary Road to NCS

APPENDIX 2.

	NAME & LOCATION	B.O.R. CLASS	OWNERSHIP	FACILITIES & SIZE	CONDITION OF FACILITIES & REMARKS
Beaches	Gab Gab Beach NAVSTA	III	U.S. Navy	700 LF of Beach: 6 acres	Fair, typhoon repairs required
	Polaris Pt. Beach NAVSTA	II	U.S. Navy	200 LF of Beach: 0.5 acres	Fair
	Cocos Island NAVSTA	III	U.S. Navy (Licensed to GovGuam)	1200 LF of Beach 16 acres	Unknown
	RizalBeach MASDELCO, NAVSTA	II	U.S. Navy (Licensed to GovGuam)	700 LF of Beach: 10 acres	Good
	Hoover Beach Schroeder Jct. NAVSTA	II	U.S. Navy (USO)	450 LF of Beach: 2.5 acres	Very Good
	NAVCAMS Beach NAVCAMS WESTPAC	III	U.S. Navy	600 LF of Beach: 6 acres	Fair
Total Beaches				6 Beaches 3850 LF, 41 Acres	

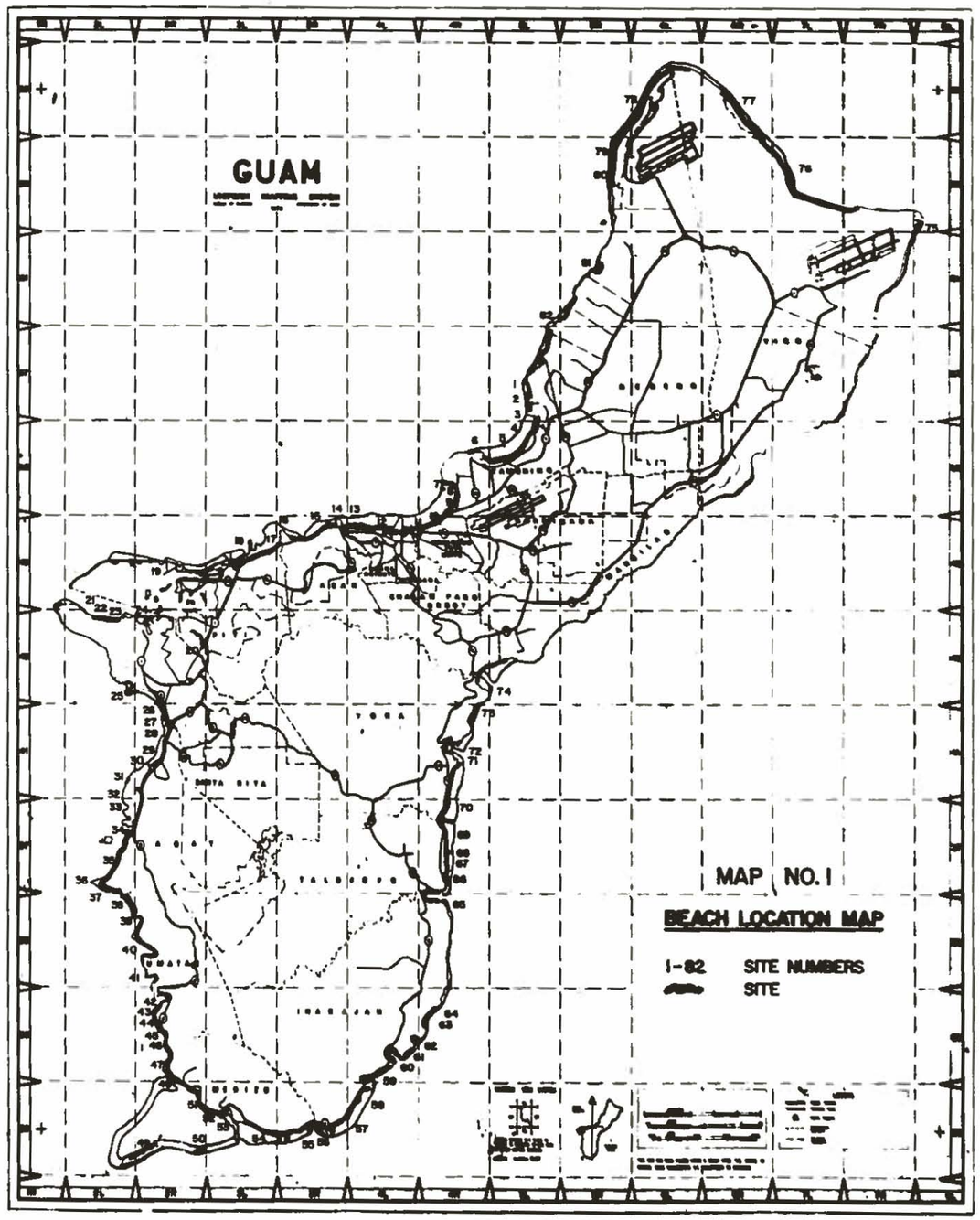
Source: Inventory
Guam Navy Recreational Facilities
Guam M. I.
March, 1977

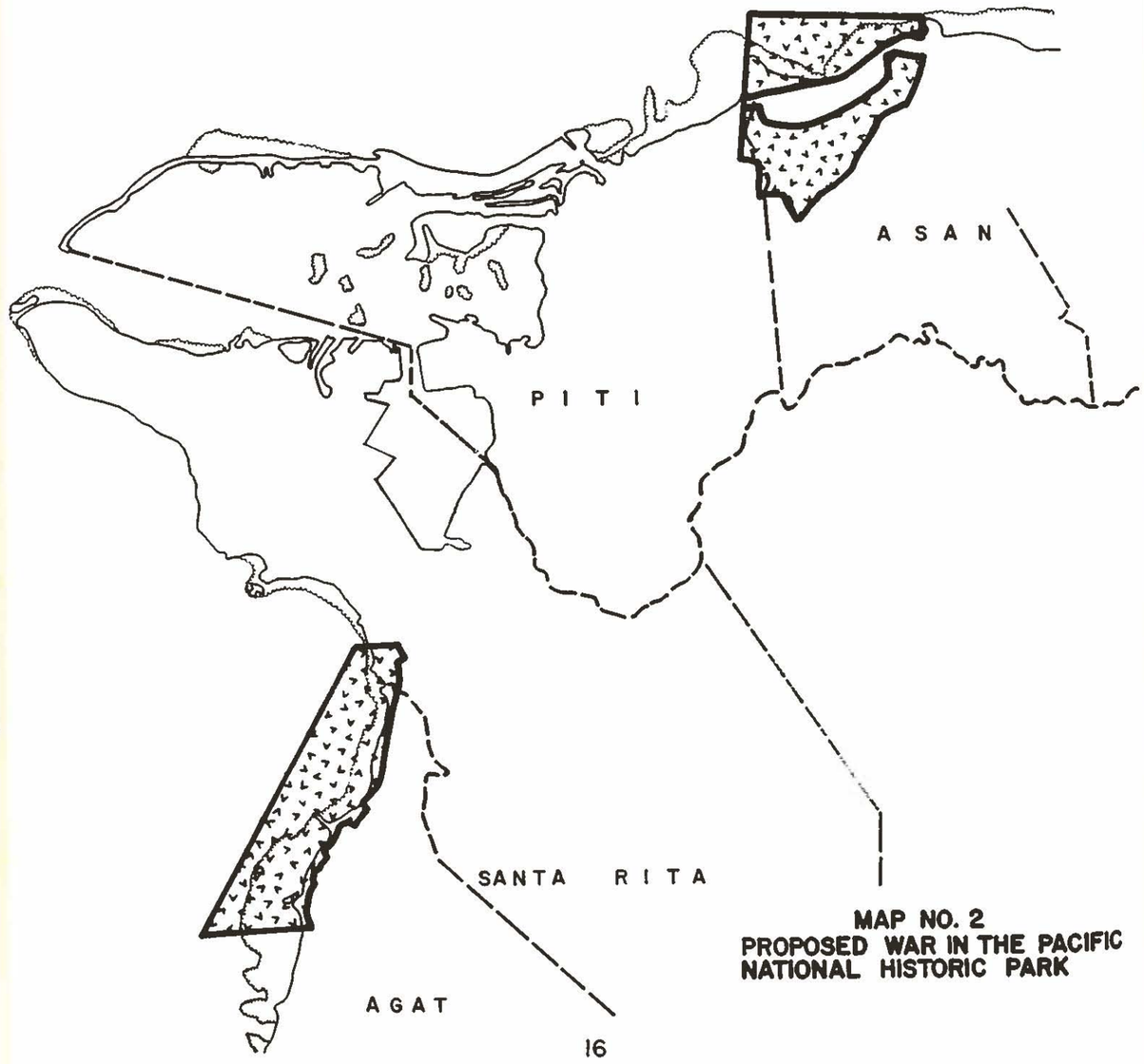
APPENDIX 3. PUBLIC OWNED POTENTIAL RECREATION AREAS

Name & Location Beaches & Marinas	Ownership	BOR* Class	Natural Beauty	Potential Uses: Historic Sites	Scenic Area	Swimming	Picnicking	Camping	Hiking or Riding	Nature Study	Marina	Competitive Sports	Evaluation
Haputo Beach	Military	V	1			3	1	1	1	2			A
Hilaan Beach	Military	III	2			1	2	2	2	2			B
Tanguissan Pt. North & South	Military	III	1			2	1	3	3	3			
Ypao Bay	Territory	II	2			1	1				1		B
Agana Bay	Territory	I	3	3		1	2				1	2	B
Glass Breakwater	Military	II	2			3	1						B
Piti Channel	Military	II	2			2	3		3		1		C
Agat Bay	Territory	II	3			2	2		3		2	1	C
Bangi Point North & South	Territory	VI	2	1		2	2		2				B
Sella Bay	Territory	V	2	1		3	1	2	1	1			B
Cetti Bay	Territory	V	1			3	1	1	1	1			A
Fouha Bay	Territory	III	2	1		3	2	2	2	1			A
Umatac Bay	Territory	II	2	1		2	2				2	2	B
Cocos Island	Military	III	1			1	1	1	3	2			B
Merizo Lagoon	Territory	II	2	3		2	2			3	1		A
Dealey Beach	Territory	II	3			2	2		3				B
Taogam Beach	Territory	III	1				1	3	3				C

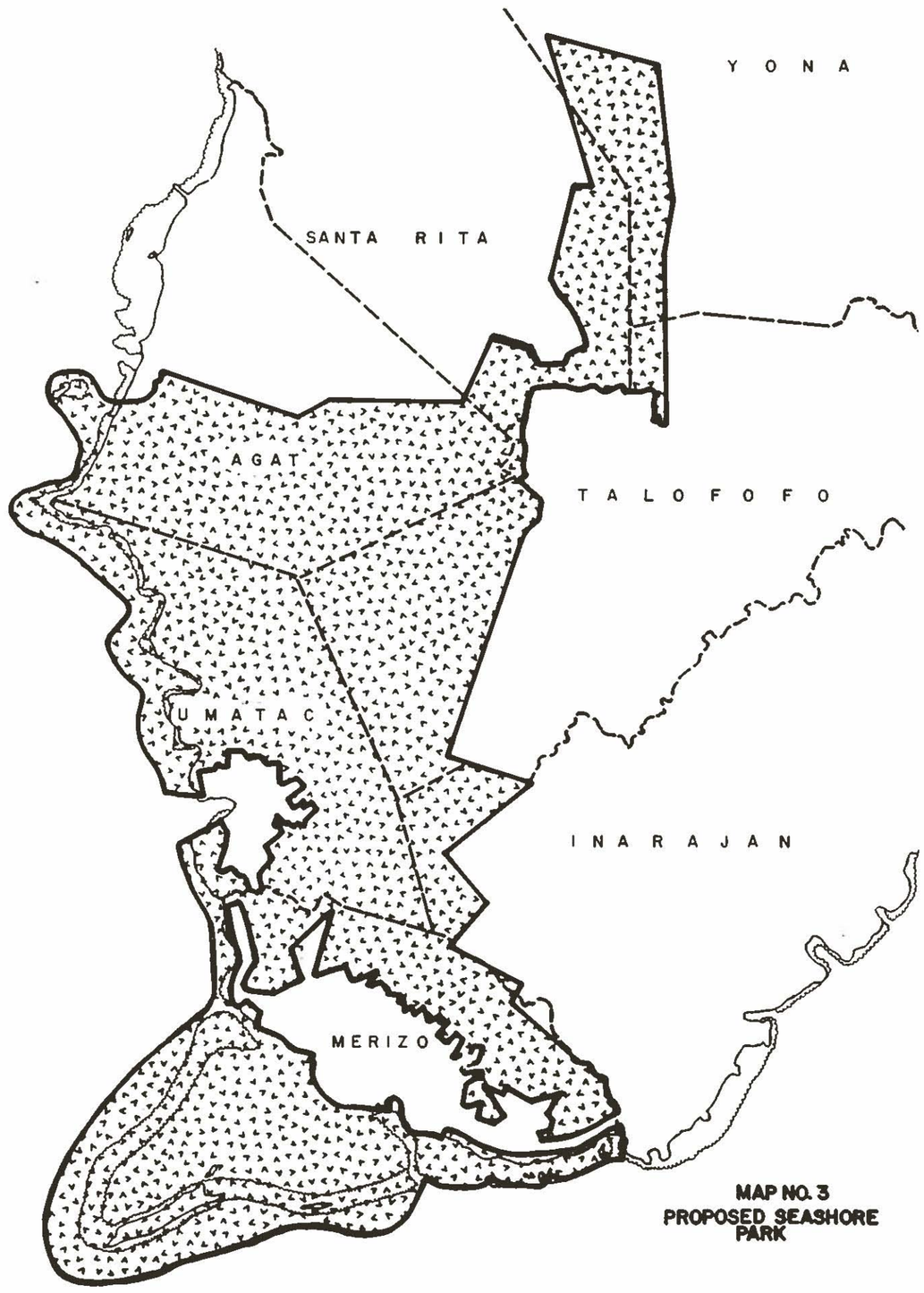
Source: Department of Parks and Recreation
(Draft) Comprehensive Outdoor Recreation Plan, 1977

* Federal Bureau of Outdoor Recreation





MAP NO. 2
PROPOSED WAR IN THE PACIFIC
NATIONAL HISTORIC PARK



MAP NO. 3
PROPOSED SEASHORE
PARK

BIBLIOGRAPHY

Armstrong, John, et.al.
Coastal Zone Management: The Process of Program Development, 1974. Coastal Zone Management Institute, Sandwich, MA.

Bureau of Planning
Analysis of Results: CZM Land Use Opinion Survey,1977. Coastal Management Section, Bureau of Planning, Government of Guam, Agana, Guam.

Bureau of Planning
(Draft) Land-Use Plan. 1977, Government of Guam, Agana, Guam.

Department of Commerce
Outdoor Recreation on Guam, 1973, Department of Land Management, Agana, Guam.

Department of Parks and Recreation
(Draft) Guam Comprehensive Outdoor Recreation Plan, 1977, Agana, Guam.

Ditton, Robert B. and Mark Stapheus
Coastal Recreation: A Handbook for Planners and Managers. 1976, Office Coastal Zone Management, NOAA, Washington, D.C.

Gawel, Michael J.
Guam Coastal Planning Bibliography, 1976, Seagrant Publication UGSG 76-07, Marine Laboratory, UOG for Guam Coastal Management Section, Bureau of Planning, Agana, Guam.

Mak, James and Walter Miklius
Guam's Visitor Industry: an Economic Assessment, 1977. Economic Planning Division, Bureau of Planning, Agana, Guam.

Moberly, Dr. Ralph
Beaches: A Component of the Coastal Zone. 1975, Technical Supplement No. 4, Hawaii Coastal Zone Management Program, Honolulu, Hawaii.

Ownes, David W. and David J. Bower
Public Use of Coastal Beaches. 1976. Center for Urban and Regional Studies, University of North Carolina, Chapel Hill, N.C.

Randall, R. H. and J. Holloman.
Coastal Survey of Guam, 1974, University of Guam Marine Laboratory Technical Report No. 14, Agana, Guam.

Randall, R. H. and L.G. Eldredge.
Atlas of the Reefs and Beaches of Guam, 1976, University of Guam Marine Laboratory Technical Report for the Coastal Management Section, Bureau of Planning, Agana, Guam.

12th Guam Legislature
Bill No. 425: An Act to Establish a Territorial Commission on Government Organization and Economy and to Authorize Appropriation. 1975, Agana, Guam.

SHORELINE EROSION ON GUAM:

A POSITION PAPER

PATRICK D. MCMAKIN

GUAM COASTAL MANAGEMENT PROGRAM, BUREAU OF PLANNING

JUNE, 1977

Introduction

In response to Section 305(b) (9), Rules and Regulations 902.19 of the Coastal Management Act of 1972, increased nationwide emphasis on the management of shoreline erosion problems is a major objective of many Coastal Zone Management programs. This paper addresses the extent of natural force and man-induced shoreline erosion on the island of Guam and represents the Guam Coastal Management Program's position concerning the amount of emphasis needed, locally, in relation to the unique factors that formulate our resource planning objectives.

Shoreline Classification

Comprised of 212 square miles of land area, the entire island of Guam is considered to be a coastal zone. There are 116.5 miles of shoreline circumventing the island. To address existing or potential shoreline erosion problems, the immediate coastline or ocean-land interface is classified into rock coastline, sandy beaches, mangrove mudflats and river estuaries.

Rocky Coastline

The rocky coastline constitutes 62% of Guam's shoreline, approximately 72.5 miles. It is characterized by steep slopes, cliffs, headlands, uplifted limestone terraces, benches cut into limestone or into volcanic rock slightly above sea level and low exposed beach rock. The cut benches are the most extensive type of rocky coastline on Guam and have been formed by erosion of the adjacent elevated rocky shores, often with secondary construction by marine worms and algae or rims forming pools on top of the benches. Indentations, called "nips", formed by extremely slow erosion of limestone rock by algae, limpets and chitons, are typically present at the existing and at previous sea levels. In some parts of the southwest coast volcanic lava formations occur at the shoreline adjacent to eroded flat lava benches at sea level, similar in shape to the coral reef flats. Small areas of low rocky shoreline, consisting of reef limestone and beach rock raised slightly above high tide level are scattered through certain beach areas in all parts of Guam. Noticeable shoreline change is practically non-existent along the rocky shore with the exception of slumping or fracturing of parts of steep slopes and cliffs due to solution, earthquakes, or storm waves. This occurrence is unpredictable and limited to areas that are not developed on the northeast and northwest coast and minor localities in the southeast of Guam. No serious, immediate or emminent problems exist in the rocky coastline areas.

Sandy Beaches

The sandy beaches of Guam comprise approximately 31% of the shoreline or 35.9 miles. They are sloping landforms composed of unconsolidated sand, gravel, broken shells, coral and foraminifera. They are characterized by high permeability and volcanic detrital or reef bioclastic composition, or a mixture of the two. They extend landward from the water's edge to a distinct break in the landform or to a point where terrestrial vegetation covers the substrate. They extend seaward as far as the sandy bottom is appreciably affected by tide, currents and wave movements. Most of the sandy beaches of Guam are protected from the erosive effects of average weather conditions by an expanse of shallow reef flat that extends seaward to a reef front or fringing reef that suppresses

the force of all but the largest of storm waves. During typhoons, an excess buildup of sand is lifted from the floor of the reef flat and a sandy beach may be expanded further inalnd. Erosion of beach areas during storms is minimal and limited to small areas where a channel or reef cut allows storm waves to penetrate the reef flat buffer zone. Post-typhoon redistribution of sand can naturally correct limited adverse effects.

The major potential for erosion of sandy beaches exists with the influence of man. The practice of sandmining for construction, landfill and golf course purposes has degraded several beach areas in terms of ecological complexity, aesthetic appearance and recreational potential. Increased enforcement and study of alternative sources of sand resources are current methods utilized to deter this activity. Since the inception of Guam's Coastal Management Program, and coordination of enforcement and public information programs--the incidence of sandmining has considerably diminished.

Until recently, Guam was free of the erosive effects of beach groins perpendicular to longshore currents. The past year has seen the construction of the first concreted groin on a sandy beach along Cocos Island--a southern offshore portion of a barrier reef lagoon with longshore currents affecting sand formation. The effects have been a noticeable sand buildup on one side of the groin with a subsequent sand loss on the opposite side. This groin, the base of a small boat pier, was constructed without the required federal and local permits. Improved field inspection, coordination of regulatory enforcement and ongoing research are seeking to modify this dock to encourage the retention of natural beach processes, inhibit shoreline erosion and discourage future proliferation of beach groins, seawalls or jetties. Public participation, federal and local enforcement, field inspection, the Guam Coastal Management Seashore Reserve Plan and Comprehensive Land-Use planning (including delineation of areas of particular concern) are the measures utilized in meeting this objective.

Mangrove Mudflats

The appendix to the Atlas of the Reef and Beaches of Guam contains maps and description of mangrove areas. The U. S. Army Corps of Engineers has also conducted studies to define the nature of the mangrove communities. Presently, mangrove mudflats are represented in only two locations on Guam. An extensive stand of several mangrove species has been increasing in size along 4.5 miles of the inner shore of Apra Harbor along the central western coast. Apra Harbor is the island's major deep-water port and is characterized by a breakwater that was built upon the barrier reef of a natural lagoon. The expanse of mangroves has noticeably increased in the past ten years because increased sedimentation from inland erosion, carried by the Laguas, Agueda and Atantano Rivers, has increased the mudflat area. The mangroves themselves further assist in the buildup of shoreline area. The Apra mangroves are rarely frequented by man, except to catch mangroves crabs. They are encompassed by federally-owned property, restricted areas and are classified as wetlands. Shoreline erosion is non-existent in this area, rather shoreline buildup is in effect.

The other area of mangrove shoreline is along the extreme southern coastline between Merizo and Inarajan along the inner area of the Cocos Lagoon. The strand of mangroves fringes 3.5 miles of shoreline and assists in shoreline stabilization. These mangroves have proved extremely resistant to typhoon

winds and waves and represent a unique ecological community. The only potential for shoreline degradation would occur if the mangroves were removed to enhance visual and public access. Due to their limited occurrence on Guam and ecological importance, the Coastal Managment Seashore Reserve Plan discourages this possibility. The U. S. Army Crops of Engineers may also protect mangroves communities through their permit system controlling developments in wetlands.

River Estuaries

Approximately forty rivers constitute the surface drainage pattern that covers the southern half of the island. Thirty-three of these have mouths at the seashore and nine of these have extensive estuarine areas. Major rivers flow into shoreline embayments that are most often the site of urban village centers because of the relatively flat terrain that borders the coastline river mouths. Inland erosion is a persistant problem and clouds many estuaries with pollution. However, shoreline erosion is only a problem at Talofofo Bay along the southeast coast of Guam. In a detailed project report entitled, Talofofo Beach, Territory of Guam, published in June, 1974, the COE defined the nature of shoreline erosion in this area and outlined a plan for shore protection. The plan has never been implemented. The following description is adapted from their report.

Talofofo Bay

The shoreline at Talofofo Beach changes with the wet and dry season. During the dry season, the river flow is relatively low and a sandbar develops at the northern side of the river mouth. The sandbar diverts a great deal of riverine material to the beach area. In addition, sand from offshore deposits is carried by waves, through the reef opening in the bay, onto the shore. During the wet season, the river flow increases and increased deposit of riverine material occurs, however, since the tradewinds are low, a smaller amount of sand is transported by wave action. During the wet seasons, the incidence of typhoons or tropical storms is the erosive factor at Talofofo Bay. Shoreline above five feet which is eroded by stormwave action does not build back. Since the early 1940's 1.6 acres of land have been claimed by shoreline erosion. A revetment, at an initial (1974) cost of $525,000 with an annual charge of $29,900 for interest, amortization and maintenance would be required to implement the selected plan. Based on the extent of the problem, the economic feasibility and existence of higher priority needs, the plan will most likely never be implemented.

Additional Considerations

In addition to Federal Coastal Zone Management interest in shoreline erosion, the U. S. Congress passed the Shore Erosion Control Demonstration Act (Public Law 93-251, Section 54) in 1974. This act gave the COE authorization to initiate a shore erosion control demonstration program, and created the Shore Erosion Advisory Panel. The Advisory Panel, through the COE District Engineer, Hawaii Office, invited Guam to submit site location proposals. The Bureau of Planning, in consultation with the University of Guam Marine Laboratory, and the Guam Envirionmental Protection Agency concluded that no existing sites on Guam warrant study for demonstration projects.

Conclusion

Numerous shoreline studies by the Guam Coastal Management Program, COE, University of Guam Marine Laboratory, and Guam Environmental Protection Agency have defined the nature of shoreline resources and extent of shoreline erosion. Only one problem area has warranted study for consideration of shore stabilization. Primarily as a result of the unique characteristics of Guam's shoreline, further emphasis, funding, and study is of low priority. On an island the size of Guam, future problems concerning shoreline erosion can easily be recognized and considered for study. Currently, shoreline erosion areas are not a geographic area of particular concern on Guam.

References

U. S. Department of the Army, Pacific Ocean Division, Corps of Engineers, December 1973. Final Environmental Statement, Shore Protection, Talofofo Bay, Territory of Guam.

June, 1974. Detailed Project Report, Shore Protection, Talofofo Beach, Territory of Guam.

January, 1975. Guam Water Resources Development.

Randall, R. H., and J. Holloman, 1974. Coastal Survey of Guam. University of Guam Marine Laboratory. Technical Report No. 14.

Randall, R. H., L. G. Eldredge and M. J. Wilder, 1976. Atlas of the Reefs and Beaches of Guam. Coastal Zone Management Section, Bureau of Planning.

DAVID B DOAN
CERTIFIED PROFESSIONAL GEOLOGIST

EXPLORATION AND MAPPING
ENGINEERING GEOLOGY
WATER AND MINERALS
ANALYSIS AND EVALUATION

5635 BENT BRANCH ROAD
BETHESDA, MARYLAND 20016
301 - 229-3237

RESOURCES AND PROJECTIONS:

AVAILABILITY OF SAND AS FINE AGGREGATE

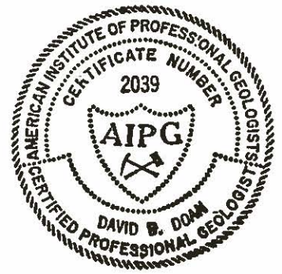
FOR ENGINEERING CONSTRUCTION

IN GUAM

A Report to the Bureau of Planning

Government of Guam

Agana, Guam 96910



1 October 1977

SUMMARY

PORTLAND CEMENT CONCRETE, AS WELL AS OTHER MIXES FOR PLASTERS, PARGING, AND FINISHING, EXERT RIGOROUS REQUIREMENTS FOR THE APPROPRIATE CONSITIUENTS, PRIMARILY COARSE AND FINE AGGREGATE PRODUCED FROM NATURALLY OCCURRING ROCK MATERIALS. THIS STUDY OF GUAM'S RESOURCES CONCLUDES THAT AMPLE RESERVES OF ROCK TYPES ARE AVAILABLE FOR A VARIETY OF ULTIMATE ENGINEERING USES, BASED ON PROJECTIONS OF GUAM POPULATION GROWTH FOR THE PERIOD 1975 TO 2000, AND THAT THERE IS NO JUSTIFICATION FOR USING SAND FROM GUAM'S BEACHES OR FROM THE OFFSHORE LAGOONAL AREAS IN ORDER TO MEET EXPECTABLE AND CONTINUING REQUIREMENTS FOR AGGREGATE. IN PARTICULAR, THE VERY LARGE RESOURCES OF GRANULAR LIMESTONE SHOULD BE INCREASINGLY UTILIZED FOR FINE AGGREGATE.

TABLE OF CONTENTS

PREFACE

The following report is the result of investigations in engineering geology and economic geology. It is not intended to be a rigorous study of the economics or the industry of Guam and should not be read as such. Rather, it aims at providing a basis for further consideration, and the projections offered here are illustrative of the overall demand/availability/cost envelope that can be anticipated for fine aggregate based upon simple but probably dependable growth-rate data currently projected in various agencies of the Government of Guam.

In carrying on this study great reliance was placed on the writer's past geologic experience in the Marianas from 1949 to 1951 as well as the knowledgeability of others. Thanks are due several who aided in the present work, including Messrs. Paul Suba, Primo Cristi, and Tom O'Brien of Hawaiian Rock Products, Inc., for extensive discussions of reserves, operations, and markets for quarried materials; Messrs. Frank and Tom Perez of Perez Bros., Inc., for similar review of their operations; Mr. Jeff Busha, Guam Government Public Works, for information on aggregate characteristics and uses in Guam; Messrs. David Bonvouloir and Mike Gawel, Bureau of Planning, for assistance in ways too numerous to cite specifically, and Mr. Paul Souder, Director of the Bureau of Planning, Government of Guam, for an overview of current conditions in Guam. Any shortcomings in this report are exclusively the responsibility of the writer.

INTRODUCTION

Guam needs dependable sources of fine aggregate, primarily sand, for a variety of construction needs now and in the future. Because of the geological nature of the island, little or no quartz sand (SiO_2) is available. By the same token, the potential availability of fine calcareous aggregate ($CaCO_3$) also called "coral sand" or "limesand" by some engineers, is very promising in certain areas of the island both inland and along the coast. Utilization of some sources, however, particularly from Guam's beaches, would probably represent unacceptable damage to an outstanding aesthetic resource.

Engineering standards and economics have dictated the crushing of calcareous material comprising the emerged coralline limestones of Guam for commercial aggregate up to the present time. It has been known for some time, however, that several promising sources exist inland for essentially pit-run calcareous sand requiring in many cases only screening and washing. Although there has been a weak market for this material (TYPE B, Granular limestone, of this report) it is a significant resource whose properties and use are discussed in the following pages.

As a result of concern on the part of the Government of Guam Bureau of Planning, an investigation was undertaken of Guam's resources and requirements for fine aggregate in the local construction industry. Following checks of existing literature, field work commenced on 29 May 1977 and continued until 16 June, including discussions with representatives of business and officials of the Government of Guam.

It is implicit in the following work that any or all extraction of the limestone resources of Guam should be consistent with the best

use of the land, minimum environmental disturbance, and compatible with considerations of ownership, accessibility, and potential future uses of the sites of extraction.

What is Portland Cement?

Although it has been known since Biblical times that certain natural materials such as lime and volcanic ash when ground together and moistened would 'set up' into a cement useful for engineering purposes (e.g. pozzolan cement) it was not until around 1720 in England that it became known that certain proportions of clay and silica mixed with limestone, ground fine, and roasted at high temperatures would result in a hard, strong cement (Bates,1960) superior to anything theretofore. Such cements would harden underwater as well as in air and became invaluable in civil works, then and now.

Today we know that roasting, or calcining, the appropriate mixtures of lime, silica, and magnesia [$CaCO_3$ - SiO_2 - MgO] followed by fine grinding gives rise to a large variety of cements and plasters. Perhaps the commonest, called portland cement after its early and wide use in England is now a principal construction material throughout the world because of its utility and permanent strength. The formula is exact and the manufacturing process is stringent in order to produce the substance which will give the best strength and other properties responsive to industrial specifications.

Portland Cement Concrete:

Mixing of portland cement with water initiates a set of net-exothermic reactions involving hydration of calcium and the release of alkalies, or the oxides of sodium and potassium , which to some extent attack all other silicates and silica minerals. Because portland cement ordinarily contains both fine aggregate (sand) and coarse aggregate (pebbles) for strength upon hardening, it is critical to the ultimate quality

of the concrete that there not be a deleterious chemical reaction between the aggregate and the newly released alkalies. Moreover, any aggregate introduced into the mix must be clean and free of surface coatings of salt, other common chlorides, and oxides and hydroxides characteristic of weathering processes in rocks. A common problem is surface "dirt" or clay particles from soils, which normally can be washed off during processing of the aggregate. In any case the ultimate strength of the concrete depends upon the absence of impurities as well as an absolute stability during the 2 or 3 weeks that it is setting up and hardening.

Aggregate, Fine and Coarse:

Fine aggregate, generally of sand size but in any case passing through a screen with 1/4-inch holes, is uniformly graded or sized and quite commonly composed of quartz particles or, less commonly, "limesand" or calcium carbonate particles as is the case in Guam.

Coarse aggregate is of a size retained on a 1/4-inch screen and can range in size up to several inches depending on the type of concrete, and tends to vary somewhat more in composition than fine aggregate because of the greater variety of geologic materials of gravel size occurring in nature, although some rocks such as the harder limestones in Guam lend themselves very well to crushing and sizing.

An important property (Krynine and Judd,1957) of all aggregate is its typical particle shape in relation to workability of the fresh concrete, or "...the ease with which it can be placed, and the degree to which it resists segregation". Round aggregate particles afford good workability, but sharp, angular fragments cause poor or difficult workability, particularly in plastering or parging, and result in what is called a harsh mix. Such a mix can require changes in the proportion

of cement to aggregate needed for good concrete.

Soundness, for workability and strength of the concrete, and absorptive characteristics of the aggregate in relation to water, are important to the tenacity of the bond between the aggregate particle and the wet cement paste as the latter undergoes the chemical changes of hardening into cement.

Alkali - Aggregate Reactions:

Portland cement concrete may be seriously affected and weakened if made with aggregate consisting of siliceous limestone; opaline or chalcedonic cherts; glassy volcanic extrusives or lavas particularly if already devitrified; micaceous metamorphic rocks contain hydromica clays; and any rocks containing opal, chalcedony, tridymite, or very greatly microfractured quartz. Alkalies produced during hardening will attack the susceptible aggregate particle chemically to form compounds that cause distension and rupture of the concrete as it hardens, resulting in gradually enlarging fissures reaching to the surface of the material emplaced and virtually destroying strength over a period of time (Krynine and Judd, ibid.)

FINE AGGREGATE IN GUAM

Natural Aggregate Materials

Because of the general geologic situation of the island, Guam possesses several natural rock materials and unconsolidated deposits that conceivably could be utilized for the production of fine aggregate. Four basic types are recognized, as follows:

1. TYPE A Hard limestone

2. TYPE B Granular limestone ("sugar coral")

3. TYPE C Beach sand

4. TYPE D Lagoon deposits

Although all four types are capable of being processed into fine aggregate, various problems and considerations relating to extraction, processing, and availability combine to complicate their free utilization without regard to technical, economic, or environmental constraints.

Type Characteristics:

An engineering appraisal of each of the foregoing types in terms of fundamental physical characteristics is presented below:

TYPE A: Hard limestone

Massive, compact, partly to entirely recrystallized, white to tan or, rarely, light-brown limestone, generally including many coral heads bonded by calcareous algae; occurs mainly as the upper ramparts of coastal cliffs.

TYPE B: Granular limestone

Massive to indistinctly bedded, compact and well lithified to entirely friable, homogeneous, even grained, buff to white detrital limestone composed dominantly of fine- to medium-grained calcareous sand conspicuously lacking finer (particularly silt-sized) particles; occurs near the base of Barrigada Hill and extensively in the northern plateau of the island. This material is popularly called "sugar coral".

TYPE C: Beach sand

Stratified to chaotic, discontinuous, veneering to deep (25 feet or more) beach and embayment deposits of entirely unconsolidated granular calcareous materials consisting of fragments of shells, corals, algae, and other reef organisms; admixed or contaminated in many places by terrigenous detritus, clays, and living organisms or

or fragments thereof. Occurs in many places around the shoreline of the island.

TYPE D: Lagoon deposits:

Submerged unconsolidated, granular, calcareous present marine deposits ranging from limey silt to sand, pebble, cobble, and large coral-head material in the shallow areas of larger lagoons, commonly admixed with clays and organic material; ranges in known thickness to more than 50 feet; occurs primarily along the west coast south of Asan Point, Apra Harbor, north of Facpi Point, and Cocos Lagoon.

Extractive Methods:

TYPE A, Hard limestone, requires extensive drilling and blasting for removal, but generally breaks well and supports vertical faces, with little or no slumping and sliding. Drainage is rapid in broken rock but slower where massive, downward to the water table which commonly is a very few feet above sea level. Drainage control may be required in pit floors. Overburden is thin.

TYPE B, Granular limestone, can be removed in most places by power tools and equipments, but in some places displays a hard recrystallized surficial crust 1 to 5 feet thick which may extend much deeper along fault zones. Thus in these places drilling and blasting may be necessary initially in order to reach the friable granular material amenable to power tools. The material separates well, will support a vertical face, and will ravel more than it will slide or slump. Drainage is generally rapid downward internally to the water table near sea level; surface drainage control is seldom necessary but pit floors will support standing water in heavy rains. Overburden

is thin in most places except in topographic swales where additional soil may have been washed in.

TYPE C, Beach sand, can be removed easily with hand tools or power equipments, but is entirely loose and generally will not support a stable slope steeper than 1:1, with natural slopes very much less. Drainage is internal and rapid with no drainage control required. Overburden, where it occurs in some coastal coves or embayments, consists of 1 to 4 feet of dark clay.

TYPE D, Lagoonal deposits, can be removed by dredge or dragline bucket mounted either ashore or afloat on a barge. Slopes and drainage are not a consideration in these underwater deposits. Blasting with shaped charges may be desirable in a few places. Waves and currents must be dealt with at all times.

Processing and Treatment:

TYPE A, Hard limestone, requires primary and secondary crushing to yield 1/4-inch minus concrete sand or fine aggregate according to ASTM (American Society for Testing Materials) standard specifications (Krynine and Judd, ibid.). Screening is necessary for extraction of this and other size fractions for both coarse and fine aggregate. Washing removes deleterious fines, dust, and clay particles that may be present.

TYPE B, Granular limestone, where extractable with power tools, has been sold as pit-run material (no processing) for miscellaneous purposes. For fine aggregate, however, the material in its typical condition would probably not require either primary or secondary crushing but would tend to disaggregate from the knocking and abrasion during screening, which would be the primary treatment. Following

sizing, the material would have to be washed in order to be suitable for fine aggregate, otherwise a normal 6-bag(cement)/yard mix would probably increase to 8 bag/yard and result in expensive concrete. The typical product, however, should be a clean, sound aggregate approximating a fine sand and have a specific gravity in the range from 2.42 to 2.45 (Cristi,1977, personal communication) versus a standard specification minimum of 2.40.

TYPE C, Beach sand, generally would not require crushing or screening but would require washing to a degree not commonly achieved in order to produce a minimum quality fine aggregate for good concrete. Because of associated fines (primarily clays) and organic matter, some of it difficult to separate from the calcareous particles, long-term deleterious reations can be expecting in concrete utilizing this type of aggregate without adequate, and expensive, processing. Where used for parging or plaster, deterioration could be conspicuous and costly.

TYPE D, Lagoon deposits, suitable primarily for fill or stabilizer for subgrade, might not require crushing provided the ratio of lump material, coral heads, boulders, and intercalated coral-algal masses to fines is low enough to be economically productive and not harmful to the screening equipment. However, the proportion of clays, fines, and slowly decomposable organic material, although extremely variable vertically or stratigraphically within the lagoonal deposits, is great enough that these lagoonal deposits might require a period of drying out or insolation by being spread in the sunlight for some length of time prior to a vigorous washing treatment. For uses such as fill, sub-base or sub-base stabilizer, or even base course, neither drying in sunlight nor washing would be necessary. Aggregate for con-

crete, however, must be essentially clean.

Economics of Production:

TYPE A, Hard limestone, processed into fine aggregate is selling in Guam as of June 1977 in the range of $4.80 per cubic yard FOB the plant from two major producers. Price responds primarily to the intensity of extractive operations, particularly the necessity for drilling and blasting, and secondarily to the ease and rapidity of processing.

TYPE B, Granular limestone, offered as pit run straight from the quarry presently sells for $1.50 per cubic yard or slightly less, but in a condition not suitable for use as fine aggregate. It is rather cautiously estimated (Cristi, ibid.) that the same material, if extractable by power equipment and washed and screened, would sell for around $4.00 per ton FOB the plant. This price would have to reflect production from established reserves as compared with prospecting for, and producing from, new pits or quarries where hard recrystallized portions of rock near the surface might need to be removed first.

TYPE C, Beach sand, although being offered at $10.00 per cubic yard from time to time by one producer when available from construction excavation, could probably be produced for sale FOB the producing site for $1.00 per ton, assuming 25 cubic feet per ton, as pit run including no processing or treatment. Such material, although acceptable to the occasional small-job contractor because of its widely known lack of harshness in spreading or plastering, would not in most cases meet cleanliness requirements as fine aggregate for portland cement concrete. Even if thoroughly washed, difficult for such fine particle sizes, the organic matter associated with boring organisms, algae, and fungi in

is ordinarily not totally removable even if dead, and can result in a lack of bonding between the aggregate particle and the cement paste. The most effective treatment is not only a matter of money but of time, in that long exposure to sunlight and drying is probably as cheap and effective as anything. Thus washing might result in a price FOB of $2.00 per ton, but for many or most beach sands there would be some doubt as to cleanliness and ultimate suitability for concrete.

TYPE D, Lagoon deposits, involve two sets of economics in projecting costs and consequent pricing of material suitable for fine aggregate, namely the true cost of dredging and the costs of treatment. Assuming fairly heterogeneous material as recovered, it would be necessary in all probability to schedule at least one crushing cycle, washing, and screening, which would in 1977 result in a price of $4.75 to $5.00 per ton FOB the plant assuming lifting costs (extraction) to be no more expensive than the quarrying of similar material on land.

Utilization of lagoon deposits, however, need not be considered in the light of the availability of the other candidate materials, particularly TYPE A and TYPE B. Therefore, in the absence of dredging submerged materials for their own sake, it is presumed that removal is for some other purpose, some civil work that has its own value, justification, and budget. Therefore the actual lifting costs to be applied to the final product could work in either one of two ways: (1) the addition of a marginal cost increment because of the considerable cost of submarine excavation and engineering compared to excavation operations on land, or (2) the subtraction of a significant increment of cost due either to the economies of scale in sustained production or else the engineering, budgetary, and social value of getting rid on site of the material produced. These potential cost fluctuations, in the absence

of specific examples, are not easily ponderable, but an estimate based on the foregoing would be $3.75 to $7.50 per ton FOB the treatment site for lagoon deposits put into a form suitable for fine aggregate.

A final problem, however, is that of residual organic matter as described above under TYPE C, Beach sand. Even in the form of fine aggregate, the material could possess doubtful bonding properties.

Standards of Utilization:

From all of the foregoing the question arises as to what kinds of fine aggregate are suited to what types and uses of portland cement concrete. A simple and tentative classification is suggested more or less as follows:

I Permanent, high-strength, high load-bearing concrete, suitable for foundations, structures, and pavements.

II Permanent, low- to moderate-strength, low load-bearing concrete suitable for drains, sewers, curbs, waterfront, and low-elevation masonry.

III Shortlife (10 years or less) low-strength, low- to non load-bearing concrete suitable to temporary or remedial use, repair of facades, filling but not strong bonding of cracks, fractures, etc.

IV Medium-life self-load or non load-bearing mixes suitable for plasterings, pargings, finishings, and ballast.

These four categories of portland cement concrete mixes can be matched against the four potential types of fine aggregate in the following way, in terms of a yes/no overall rating of suitability of each type of aggregate against each of the types of concrete defined above:

Aggregate	Concrete Mix			
	I	II	III	IV
TYPE A Hard limestone	YES	YES	YES, but costly	YES, but fine grind is harsh
TYPE B Granular limestone	YES	YES	YES	YES, but semi-harsh
TYPE C Beach sand	NO	NO	YES	YES
TYPE D Lagoon deposits	NO	NO	NO	YES, harsh

Table 1.

Suitability of various types of aggregate for defined categories of portland cement concrete.

From the above it is notable that TYPE A, Hard limestone, is best suited for the permanent construction of concrete in categories I and II. TYPE B, Granular limestone, is suitable for all four types of concrete mix. TYPE C, Beach sand, is not suitable for permanent construction but is best suited of all types of aggregate for plastering and finishing, provided the risk of cosmetic damage is accepted as a result of gradual deterioration. TYPE D, Lagoon deposits, within reasonable economic

limitations on time and cost of treatment, is conditionally suitable, although harsh, for plastering and finishing but probably too expensive for remedial and repair work of concrete category III.

Availability

(SEE MAP)

TYPE A, Hard limestone:

This rock type is distributed largely around the periphery of the island from Orote and Cabras Island northward along coastal cliff ramparts to Ritidian Point and Tarague, where a large concentration occurs, and then around to Pati Point and southward through and excellent concentration from Mt. Santa Rosa to Campanaya Point, and thence discontinuously southward along the windward coast to Pauliluc Bay. Total exposure is conservatively estimated to be about 18 square kilometers (6.9 square miles) on land owned by the Dept. of Defense, local authority, and private sources. Accessibility in generally over rough stony land and rocky terrain toward sheer coastal cliffs or along steep coastal slopes. Physical restrictions are not significant, although some lands are probably not open to prospecting and development because of ownership. Environmental constraints are, at this time, minor to nonexistent, reflecting the semi-isolated character of most of the exposures in relation either to habitation or common public perception of landscape. Established reserves in the series of quarries from Fadian Point northward, and Cabras Island, can probably be measured and proven at roughly 10 million tons, with probable reserves in the same quarries approximately 40 million tons. Possible reserves would be in the range of 3 to 10 times probable reserves.

TYPE B, Granular limestone:

This material is widely distributed in the limestone plateau of north Guam, being exposed at the surface in a large circular pattern roughly approximating the main loop of highways north of Wettengel Junction, and extending southward to surround Barrigada Hill on its north, east, and south sides. Total exposure is nearly 50 square kilometers (19 1/4 square miles) on land owned by private sources, the Dept. of Defense, and local authority. Accessibility is generally easy from existing roads at the surface, and much more TYPE B, Granular limestone, is encountered at absolute elevations of 70 to 80 meters (230 to 262 feet) or more above sealevel where exposed in Hawaiian Rock Products' quarry between Fadian and Taguan Points, about 1250 meters (4100 feet) southeast of the nearest surface exposure. Moreover, the cutting of a new road near Mt. Machanao down through the cliffed terraces to Ritidian Point reveals new sedimentary sections not previously exposed during mapping by the USGS in 1951 - 1955 (Tracey, et. al., 1959) in which Barrigada limestone (TYPE B, Granular limestone) occurs. Physical restrictions would depend primarily on ownership and, in a related sense, the presence and configuration of built-up areas, such as Dededo and Yigo. Environmental constraints would involve possible destruction of coconut plantation, generation of rock dust from processing and quarrying operations, and local influencing or modification of the basal groundwater body in north-central Guam if quarrying is extended to depths in excess of perhaps 300 or 400 feet. Reserves were estimated at 750,000 tons at the old Harmon Quarry at the east end of Harmon Field (Tracey, et al., 1959, ibid.) the only active quarry extracting TYPE B, Granular limestone, at that time. Today an 80-foot vertical face is exposed at

Hawaiian Rock Products quarry, several kilometers from the Harmon area, that is several hundred feet wide and of unknown dimension laterally straight into the working face, according to officials of the company. The present writer expects that reserves are 5 million tons at this quarry site and an equal amount at Perez Bros. quarry at Fadian Point, with probable reserves of double each amount, or a total of 20 million tons, in the immediate vicinity of lands presently acquired by both companies for quarrying operations. Beyond all this, however, is the fact that possible reserves, island wide, would have to be on the order of 100's of millions of tons based on the known 540-foot (165-meter) geologic thickness of this material (Tracey, et al., ibid.) and the extremely large exposure area. For example, just one square foot of surface exposure implies as much as 25 tons of TYPE B, Granular limestone, beneath the surface. New prospecting should enable the establishment of very many potential quarry sites.

TYPE C, Beach sand:

These deposits are in relatively small patches around the periphery at and above the shoreline, restricted in area and depth by the configuration of enclosing rocks, reefs, and cliffs, in most of the coastline of Guam except in the zone beginning north of Pago Bay and extending northward around Pati Point to the east end of the Tarague Beach. Quantities of this material are small absolutely and relatively smaller than the other three types of potential fine aggregate. Ownership is diverse, including private sources, local authority, and Dept. of Defense, but a shift in public perception of the intrinsic value of these beaches is underway which may well culminate in their coming under the protection of Federal and/or local authority. Access-

ibility is generally easy from existing roads and physical restrictions are few to the exploitation of the material. From the environmental standpoint, however, Guam's beaches are an aesthetic resource of great importance, inseparable from the fundamental attractiveness of the island for travel and tourism, and this does not mention their very considerable scientific value. These beach sediments do not replenish rapidly if removed, unlike the quartzitic sands of many continental coastlines. Restoration of the Guam sands takes place slowly as the shells of minute free-floating and reef-dwelling organisms accumulate above the waterline. In this context it is cynical to discuss reserves, but as a matter of record pits both at Tumon and Tarague Beaches showed probable reserves in their immediate vicinities of more than 100,000 tons each. Without doubt this 200,000 tons total can be multiplied by 1 or 2 orders of magnitude for the entire island, but when the beaches are gone they will not restore themselves soon. In some cases they may not restore themselves at all.

TYPE D, Lagoon deposits:

These materials occur offshore along the west coast of Guam near Asan, in outer and inner Apra Harbor, of Taleyfac, and in Cocos Lagoon. All in all probably 12 to 14 square kilometers (4.6 to 5.4 square miles) occur in these locations, but thicknesses are not well established, being perhaps 50 feet (15 meters) in many places. Ownership is problematical. Apra Harbor is under control of the Dept. of Defense, but otherwise local authority would seem to govern. Cocos Lagoon is scientifically and aesthetically valuable and should be put under protection from exploitation. Accessibility is by marine floating equipment and physical restrictions are largely a matter of weather,

sea, and surf. Environmental damage by dredging would be inconsequential within Apra Harbor but very great in Cocos Lagoon. The Asan and Taleyfac localities would require professional investigation and reporting of the environmental impact of submarine dredging and extraction. Reserves in all four localities would approximate 20 million tons at a minimum.

PROJECTIONS

Present Demand for Fine Aggregate:

by far the greatest demand today is for aggregate already incorporated into ready-mix concrete, rather than direct sale, reflect- the fact that overall it is less expensive to buy a portland cement concrete mix than to assemble the mix separately on site, except for small jobs and those not being inspected as to quality of concrete. Using data furnished by officials of Perez Bros., Inc., and Hawaiian Rock Products, Inc., as prepared for reporting to the Federal Bureau of Mines, it is clear that production of all rock products in Guam, including fine aggregate, has decreased by about 50 percent, or from roughly 860,000 tons in 1974 during the completion of new hotels and related construction, through 590,000 tons in 1975 to 430,000 tons in 1976, after applying certain scaling factors (Suba, 1977, personal communication). This does not indicate an economic depression, but rather the notable variability of the construction business and its related commodity throughput.

For the sake of estimation, it is necessary to derive a factor representing the proportion of fine aggregate out of the total tonnage of some 15 categories of rock products sold, including various

coarse aggregates, pit-run and crusher-run materials for base course and sub-base, bedding stone, riprap, and armor rock. Tentatively an outside factor of 50 percent to represent conservatively the ratio of fine aggregate to all other rock products. Thus for the past 3 years the consumption of fine aggregate has been equal to, or less than, the following:

1974	430,000	tons
1975	295,000	"
1976	215,000	"

Once again, 1974 was a boom year and 1976 was relatively quiet. The year 1975 is therefore selected as the projection base and the total tonnage rounded out to 300,000, a number that should discount or subsume reporting uncertainties and cyclic fluctuations in production that can be obscured by the length of the reporting period. In different words it is a value that can help define the outer limit of anticipated fine-aggregate requirements in future years when multiplied by other numbers representing growth of demand.

Growth - Rate Forecast:

Prediction of the future is attempted by businesses, government agencies, journalists, and private persons for purposes ranging from serious to frivolous, and with results varying from successful to absurd. For purposes of this report it is not easy, or even possible, to specify the role that Guam will play from now until the Year 2000, but Guam's economic and strategic positions are sensitive to world affairs. Slight variations in events can and will affect Guam's construction industry fundamentally and for better or worse, detailed analysis of which is outside the scope of this report. Instead, a

forecast can be based on projections of population growth assembled by the Bureau of Planning, Government of Guam (Bonvouloir, 1977, personal transmittal) in which the following is indicated as the net increase:

1975		2000	Increase	%
84,700	(no military)	167,500	82,800	97.76
106,700	(incl. military)	189,500	82,800	77.60

For present purposes the real growth rate would be reflected by the numbers that do not include the standard military increment of 22,000 persons, utilizing a net increase of 82,800 against a starting census of 84,700, rather than 106,700, and thus the greater of the two computable growth rates in order to stay as close as possible to maximum justifiable commodity demand rates.

Although growth rates are commonly exponential rather than arithmetic, the differences for present purposes are so slight that an arithmetic treatment is preferable. This is because the absolute difference between the two methods, year to year, is probably one order of magnitude less than the expectable swings in construction activity, from year to year, and the consequent demand for rock products.

Proceeding on the basis described, an increase in population of 82,800 divided by 25 years yields an incremental increase of 3312 persons per year, or 4 percent of the total each year for 25 years.

Future Requirements for Fine Aggregate:

Further to the above calculations, an increase of 97.76 percent on the 1975 output of 300,000 tons of fine aggregate would mean an output

of 593,280 tons in the year 2000, an overall increase of 293,280 tons per year over the entire 25 years, of an incremental increase of 11,371.2 tons per year. From this a schedule of projected cumulative net output per year can be constructed (Table 2) showing total 25-year demand upon summation, or 11,585, 639 tons of fine aggregate which would need to be produced from 1975 to 2000. At 90 pounds/cubic foot this approximates 9,535,505 cubic yards, equal to a single hole 324 x 324 feet square by 300 feet deep (roughly 100 x 100 meters by 90 meters deep) for purposes of comparison.

Table 2.

Fine aggregate: Projected Net Output Per Year and Summation of Total Demand, 1975 to 2000

Year	Whole Tons
1975	300,000
1976	311,731
1977	323,462
1978	335,194
1979	346,925
1980	358,656
1981	370,387
1982	382,118
1983	393,850
1984	405,581
1985	417,312
1986	429,043
1987	440,774
1988	425,506
1989	464,237
1990	475,968
1991	487,699
1992	499,430
1993	511,162
1994	522,893
1995	534,624
1996	546,355
1997	558,086
1998	569,818
1999	581,549
2000	593,280
TOTAL	11,585,639 Tons

Adequacy Versus Need:

How easily can a long-term requirement be met from Guam's existing resources? Eliminating TYPE C, Beach sand, and TYPE D, Lagoon deposits, for reasons discussed under Standards of Utilization (Table 1) and Availability, and also for TYPE D, Lagoon deposits, further reasons under Economics of Production, it is clear that the need for fine aggregate should be met from TYPE A, Hard limestone, and TYPE B, Granular limestone, depending upon preference and the exact utilization requirements. However, the long-term need of roughly 11.6 million tons (Table 2) can be compared with a summary of reserves of the two types of material, from the information under Availability, thusly:

	Reserves (Millions of Tons)		
	Expected	Probable	Possible
TYPE A	10	40	120 - 140
TYPE B	10	20	1000 +

In particular, TYPE B represents a tremendous alternative source if TYPE A should someday have to be diverted to use exclusive as coarse aggregate. It may be noted that the value above for probable reserves of TYPE B is limited for the sake of argument to the 20,000,000 tons exclusively in the vicinity of the two quarries described.

CONCLUSIONS

1. Fine-aggregate resources in Guam exceed foreseeable requirements between now and the year 2000.

2. TYPE B, Granular limestone, represents a good but not greatly utilized source of fine aggregate.

3. TYPE A, Hard limestone, commonly used at present for fine aggregate, itself occurs in quantities sufficient to meet probable demand between now and 2000. For plastering, parging, and finishing, however, TYPE A is very harsh and might well be replaced by TYPE B.

4. TYPE C, Beach sand, is not needed in order to meet requirements for fine aggregate and should be legally protected against exploitation.

5. TYPE D, Lagoon deposits, are not physically well suited for processing into fine aggregate for portland cement concrete, are not needed for such a use, and are unpredictable as to lifting and processing costs. Certain of these resources should also be legally protected against exploitation.

RECOMMENDATIONS

1. Use existing commercial sources of fine aggregate consisting of TYPE A, Hard limestone, and TYPE B, Granular limestone, and encourage the increased use of TYPE B, locally called "sugar coral", particularly for use in plastering, parging, and finishing.

2. Restrict the exploitation of TYPE C, Beach sand, and invoke sure legal protection of the beaches of Guam from any removal or depredation of the beach sediments, which are too valuable as an aesthetic and environmental resource to lose or squander while equivalent resources are available for the same purpose.

3. Restrict any exploitation of Cocos Lagoon for TYPE D, Lagoon deposits, other than for bona fide scientific investigations, and restrict exploitation of any lagoon deposits, whether or not specifically mentioned in this report, pending detailed environmental impact analysis by qualified scientists.

REFERENCES CITED

Bates, R. L., 1960, Geology of the Industrial Rocks and Minerals, pp 41 - 158, Dover Publications, Inc., New York

Cristi, Primo, 1977, conferences regarding production of aggregate by Hawaiian Rock Products, Inc. during visits to their Guam office.

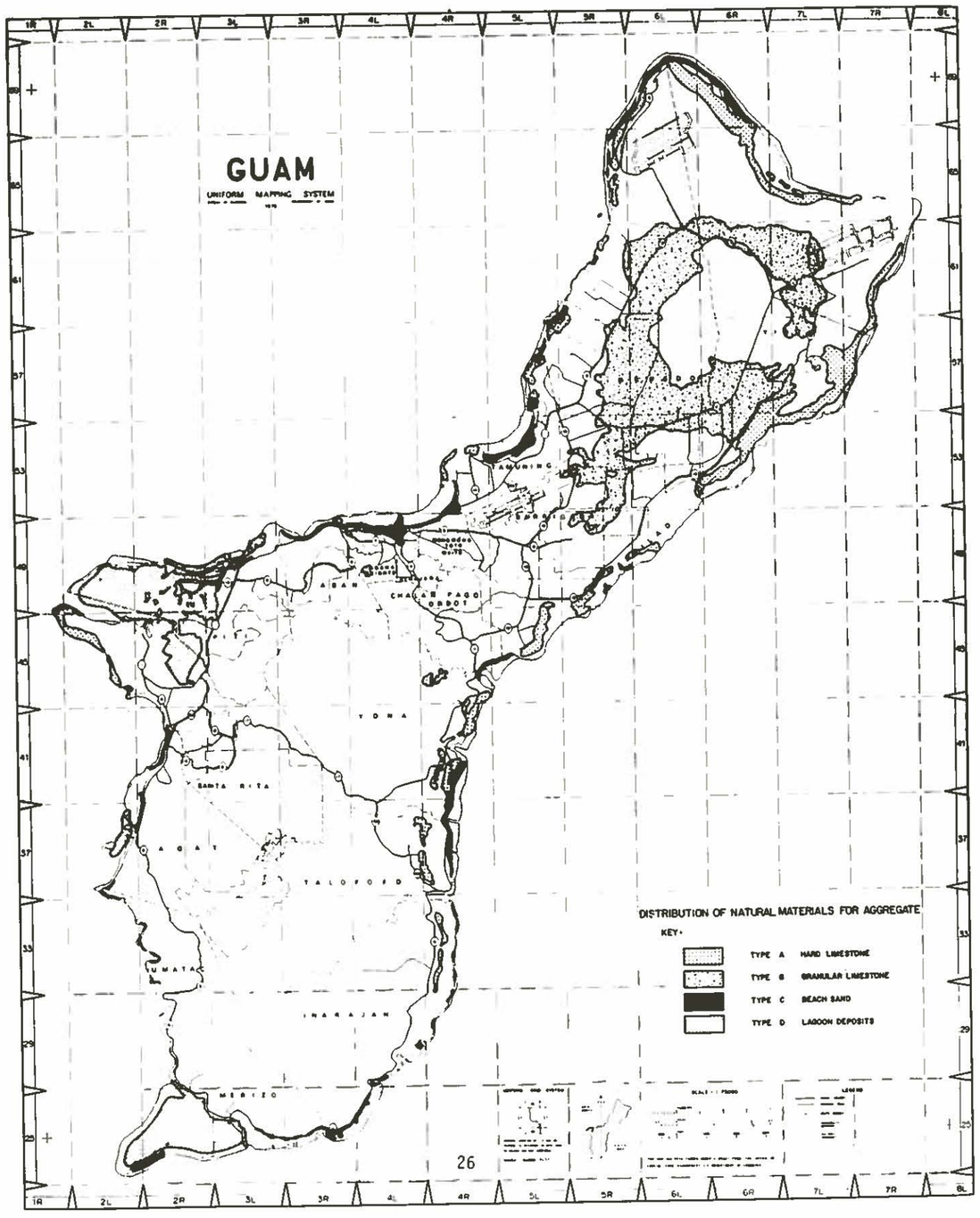
Krynine, D. P., and Judd, W. R., 1957, Principles of Engineering Geology and Geotechnics, pp 322 et seq., McGraw-Hill Book Company, Inc., New York

Suba, Paul F., 1977, conference regarding the economics of production of rock products in Guam, at Hawaiian Rock Products, Inc. office in Guam.

Tracey, J. I.Jr., Stensland, C.H., Doan, D.B., May. H.G., Schlanger, S. O., and Stark, J.T., 1959, Military Geology of Guam, Mariana Islands, Part I: Description of Terrain and Environment; Office of the Engineer, USARPAC, with personnel of the U. S. Geological Survey.

Transmittals

Bonvouloir, David, 1977, Bureau of Planning, Government of Guam, informal communication in the matter of projectable island population growth rates consisting of several projections with advice on the one most preferred by Government of Guam agencies.



A GUIDE TO THE MEDICINAL PLANTS OF GUAM

by

Patrick D. McMakin

and

Philip H. Moore

presented to the

Coastal Management Section
Bureau of Planning
Agana, Guam

1977

The printing of this document was funded by a grant from the Office of Coastal Zone Management, U.S. Dept. of Commerce. The research was conducted solely at the expense of the authors and donated to the Guam Coastal Management Program.

Introduction

The early historians, who accompanied the first colonists to the island of Guam, noted that the Chamorro islanders were a robust people who suffered few ailments that couldn't be cured with the use of native herbal medicines. The practitioners of traditional medicine were the suruhanos and suruhanas, the male and female curers. Their role has been respected as it involves a long period of apprenticeship and acceptance by a senior curer and the village community. Without a written language, the knowledge was passed down in the oral tradition and required a high degree of intellectual and perceptive abilities to master. Because Western medicine was still in a primitive state itself at the time of colonial contact, in the 15th Century, the demand for the suruhano's services persisted as a valuable resource. However, when Western medicine became highly complex and yielded positive results, the suruhanos did not disappear from the cultural system of the Chamorros. This is a result of the adaptive ability of the curers and the fact that their methods continue to yield positive results. There have adaptations to colonial domiance, but the bulk of their knowledge of medicinal plants and a theory of disease are extremely unique.

The Chamorro System of Curing

In a comparison of curers over a two year period of anthropological research observation, it has been found that they use a basic integrated system of curing that is relatively common among them and is probably similar to the system used in precontact times. By an integrated system of curing it is meant that while their methodology is comprised of separate facets, they are all considered essential to the curing process and thus no facet can be eliminated.

The use of medicinal plants is only one aspect of curing and is the dominant consideration in this ethnobotanical research. However, other aspects of the curing system should be mentioned.

The curing power is felt to flow into the patient by way of the massage, another important part of the curing process. The massage can be a vigorous pounding called matantan or the lighter malasa. The massage is thought to dislodge air bubbles and blood clots that are believed to form inside the human body. This belief is part of the dualistic theory of disease held by most curers. Pukpuk maipe or a hot swelling caused by air bubbles and blood clots can occur naturally or as a result of spirits. Areas of pain and swelling receive a concentrated massage designed to displace the obstructions in the body. The thickened blood is believed to spread out or disspate and the air bubbles are released in the form of a belch or more preferably from the gastrointestinal tract.

Pukpuk maipe or other ailments such as atmariao (mental illness) can be caused by the taotaomona spirits or (the island's ancient inhabitants). They become angered if a person overtaxes the reef or jungle environment or fails to ask permission when entering the realm of the spirits. A spirit-caused affliction can also occur when relieving one's self in the jungle and not apologizing to the unseen inhabitants. Community members feel that the suruhano has the ability to counteract the effects. To assist in warding off the influence of malevolent spirits, a mystical body lotion called palai is applied during the massage. The

JUAN CEPEDA, A WELL-KNOWN ISLAND SURUHANO PREPARES AMOT FRESKO — A CHAMORRO MEDICINE

Patients often receive dietary advice or madieta. Recommendation is usually that patients eat lean meat, vegetables and fruits and abstain from eating fatty meats, oils, butter, milk and alcoholic beverages. It is believed that fatty foods facilitate the build-up of debilitating blood clots and air bubbles while alcohol makes a sick person weaker.

Most patients receive an internal dosage of medicinal tea. Some suruhanos utilize special medicines for specific ailments and others use all-purpose combination medicines. Suruhanos usually do not experiment with plant use because it has already undergone centuries of testing and does not produce adverse reactions. Still, the knowledge of preparation is complex and should never be attempted by anyone except an experienced practitioner of native medicine. Plants ingredients are collected from a variety of plant communities. Upon entering the jungle, the suruhano asks permission from the unseen taotaomona spirits that are believed to reside in the area.

Most Chamorro medicinal plant names are unique in themselves, while others have a prefix or a suffix that denotes the part of the plant used, its size, or the area in which it is found. Many times, the use of these additions is optional and for explanatory purposes only. In other cases, they are mandatory for differentiation among similar species. Commonly heard supplements are:

Chamorro	English
Tronkun	Tree
Hagun	Leaf
Patnitus	Heart
Lasa	Bark
Hale	Root
Dangkulo	Large
Dikike	Small
Halumtano	Jungle
Tasi	Ocean

A following list contains the ingredients in the all-purpose combination medicines of Juan Cepeda and Jose Quintanilla. Also included are medicinal combinations of Maria Ncing, a Chamorro suruhana currently residing on Rota. These lists and the subsequent guide do not contain every known medicinal use of plants. Further research would undoubtedly record additional uses. The master lists can be referred to when the reader wishes to place a specific plant in the context of its association with other plants.

Unless otherwise noted, the medicinal use of plants listed in this guide were recorded by the authors. Besides having medicinal value on Guam, many of the pantropical species listed have also been reported to have medicinal value elsewhere in the Pacific region. Accompanying each picture of the medicinal plants is a botanical description, the range of the species and specific comments pertaining to the function, use or method of preparation. The fieldwork with informants, description of the curing process and recording of uses was primarily done by Patrick D. McMakin. Plant identification, description and range of species was primarily done by Philip H. Moore.

The authors would like to acknowledge the invaluable assistance of Juan Q. Cepeda Miguel Ungacta, Jose Quintanilla, Maria Ncing as well as the many other Chamorros Guamanians who assisted in this research study.

MEDICINAL PLANTS COMBINED FOR MEDICINE
OF JUAN Q. CEPEDA

Taxonomic Classification	Chamorro Name
Asplenium nidus	Galak Dangkulo
Cassytha filiformis	Mayagas
Davallia solida	Pugua Machena
Elatostema calcareum	Tapun Ayuyu
Entada pursaetha	Bayogon Dangkulo
Hedyotis foetida var. mariannensis	Paudedo
Melothria guamensis	Ahgaga
Microsorum punctatum	Galak Dalalay
Mucuna gigantea	Bayogon Dikike
Peperomia mariannensis	Potpupot
Phymatodes scolopendria	Kajlao
Piper guahamense	Pupulu n Aniti
Randia cochinchinensis	Sumak

Supplementary Ingrediants	
Erythrina variegata var. orientalis	Gaogao
Nervilia aragoana	Seiyaihagun
Vigna marina	Akangkang Marilasa

MEDICINAL PLANTS COMBINED FOR MEDICINE
OF JOSE S.N. QUINTANILLA

Taxonomic classification	Chamorro Name
Bambusa blumeana	Hale Piao
Rynchospora corymbosa	Chachachak
Phramites karka	Kariso
Sporobolus virginicus	Totoput
Zea mays	Batbas

AMOT TABADIYO, A MEDICINAL COMBINATION
FOR THE TREATMENT OF STROKE

Taxonomic Classification	Chamorro Name
Asplenium nidus	Galak Feda
Bambusa vulgaris	Patnitus Piao
Canavalia maritima	Akangkang Tasi
Cassis Sp.	Amot Tumaga
Entada pursaetha	Gayi Dangkulo
Hyptis pectinata	Mumutong Paloan
Microsorum punctatum	Galak Dalalay
Mucuna gigantea	Gayi Dikike
Canavalia sp.	Akangkang Halumtano

AMOT SAQUIYAYAS, MARIA NCING'S MEDICINE
FOR MUSCLE OR ARTHRITIC PAIN

Taxonomic Classification	Chamorro Name
Cocos nucifera	Bingan Niyok
Eleusine indica	Chaguan Kabayo
Dioscorea alata	Hagun Dago
Dioscorea esculenta var. fasciculata	Hagun Nika
Hibiscus tiliaceus	Hagun Pago
Jatropha curcas	Tubatuba
Pandanus tectorius	Bingan Aggak
Piper betle	Pupulu
Sodium chloride (salt)	Asiga
Carbon (black soot)	Tararanas

AMOT GOTPE, MARIA NCING'S MEDICINE
FOR INTERNAL INJURY

Caesalpina sappan	Sibukao
Cocos nucifera (tuba vinegar)	Tuba Binakli
Ficus prolixa	Hale Nunu
Heliotropium indicum	Bitbena

AMOT GALOBUK, MARIA NCING'S MEDICINE FOR RECTAL
INFECTIONS

Blechum brownei	Jatbas Babui
Cassia sp.	Amot Tumaga
Cocos nucifera	Lana Niyok
Euphorbia hirta	Golundrina
Phyllanthus amarus	Maigo-lalo
Physalia sp.	Tumatis Chaka
Piper betle	Pupulu
Sodium chloride (salt)	Asiga

Family Acanthaceae

Scientific Name Blechum brownei fa. puberulum

English Name

Chamorro Name Jatbas Babui

Range A Tropical American Weed

Description: This is an erect, perennial herb with short-petioled ovate leaves, rounded at the base and more less pointed at the apex. The flowers grow in dense, terminal spikes and may be white or violet. The bracts or modified leaves, at the base of the flowers, are white.

Use: This wild herb is commonly seen in the limestone forest or along the beach strand. It can be seen along the dirt road at NCS Beach. The leaf is a component of amot galobuk. It is also boiled with the other ingredients of amot labatorio, an astringent douche mixture.

Family Annonaceae

Scientific Name Cananga odorata

English Name

Chamorro Name Alangilang

Range Indo-Malaysia

Description: Cananga is a medium-sized tree with simple, alternate leaves arranged along one side of the branch so that the branch is flat. The leaves are medium green and oblong-ovate. The flowers are yellow with elongated, narrow petals, rather large and very frangrant (particularly at night). The fruit is many seeded, black and ovoid in shape.

Use: This tree was probably introduced from the Philippines where it is known as ilangilang. The scented flowers are soaked in coconut oil to make a pleasantly perfumed body lotion that is sometimes thought to ward off malevolent spirits or cure spirit-caused illnesses.

Family Aspleniaceae

Scientific Name Asplenium nidus

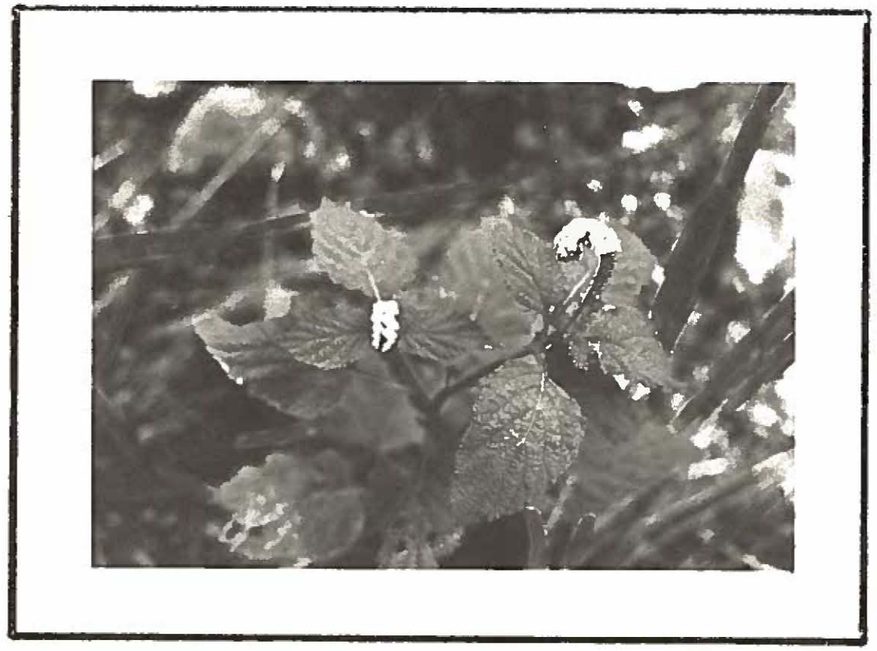
English Name Bird's Nest Fern

Chamorro Name Galak Dangkulo, Galak Feda

Range Paleotropical

Description: This is a fern with very large straplike fronds and a wide, black midrib. It grows either epiphytic or terrestrial, reaching massive proportions and the debris that accumulates around it may support other species. The spores are arranged in oblique lines toward the outer end of the frond.

Use: The leaf and root of this fern are ingredients in an all-purpose combination medicine and in amot tabadiyo.



Family Boraginaceae

Scientific Name Heliotropium indicum

English Name Wild Clary

Chamorro Name Bitbena

Range A Pantropical Weed

Description: This heliotrope is an herb with pale, grayish green leaves, usually unbranched and woody at the base. The flowers are pale violet to white and arranged along one side of a coiled axis.

Use: The leaves are included in amot gotpe. The juice from the crushed leaves is also applied to chapped lips. This herb can be seen growing wild, but is most often cultivated in backyards.

Family Celastraceae

Scientific Name Maytenus thompsonii

English Name

Chamorro Name Luluhot

Range Endemic in the Mariana Islands

Description: This is a shrub or small tree with alternate, smooth, bright green, rounded leaves. The leaf petioles are reddish and about 1.5 cm. long. The flowers are white and grow in clusters from the leaf axils. The fruit is a three-parted, light brown capsule that bursts open to discharge the seeds.

Use: This is a common shrub of the limestone community. The leaf and stem are an ingredient in all-purpose medicinal teas.

Family Combretaceae

Scientific Name Terminalia cattapa

English Name Tropical Almond, Indian Almond

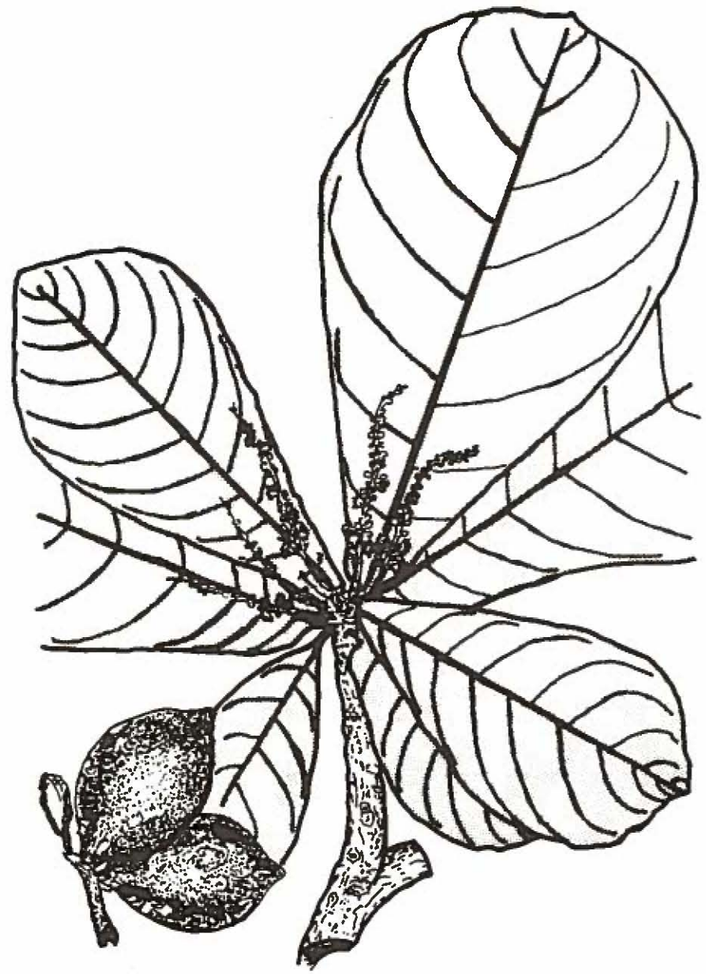
Chamorro Name Talisai

Range Pantroprical

Description: Talisai is a small to medium-sized tree with whorled, horizontal branches and large obovate, dark green leaves that are clustered at branch ends. The flowers are axillary and occur in slender spikes. The fruit is flattened or compressed and narrowly winged. The leaves often turn red before falling and at times may be badly worm-eaten.

(See following page: drawing adapted from Sproat, 1968)

Use: This tree is most often cultivated for its nutlike seed that is edible when roasted. It can also seen growing wild as it has naturalized in the different plant communities on Guam. The Chamorro medicinal use involves crushing the leaves and applying them to skin rashes to assist in healing. The same procedure is used in Palau to heal skin infections and aid in healing cuts. Salcedo (1970:14) reports that limited studies have shown that Terminalia has antibacterial properties when tested against Staphylococus aureus disease microorganisms.



TALISAI

Family Compositae

Scientific Name Eclipta prostrata

English Name _____

Chamorro Name Titimo

Range A Pantropical Weed

Description: Eclipta is a much branched, annual herb with narrow, pointed, elliptic leaves. The small white flower heads grow both terminally or from the axils of branches, usually several together.

Use: The leaf of this herb is crushed and applied to chapped lips. It is especially preferred for infants with sore mouths from feeding. It grows wild, but is often cultivated in backyards on Guam.

Family Convolvulaceae

Scientific Name Ipomoea pes-caprae ssp. brasiliensis

English Name Beach Morning Glory

Chamorro Name Alahai Tasi, Alalag Tasi

Range Pantropical

Description: This species of Ipomoea is a creeping, rather fleshy vine with large, glossy, rounded leaves that grows on sandy or rocky beaches and sometimes in open fields. The leaves are dark green and notched at the apex with petioles up to 15 cm. long. The large flowers are rose-colored and purple in the throat. The fruit is a rounded capsule containing hairy seeds.

Use: This plant is often seen growing in dense mats on sandy or rocky beaches just above the high tide mark. The leaves can be boiled into a medicinal tea used in the treatment of chicken pox or crushed and applied directly to skin abscesses to aid in healing.

Family Cucurbitaceae

Scientific Name Melothria guamensis

English Name

Chamorro Name Ahgaga

Range Mariana Islands and Ponape

Description: This is a slender, creeping vine with tendrils and thin, dark green, rounded leaves. The leaf base has a deep cleft or sinus and the margins are wavy. The small flowers are white and grow in axillary racemes. The fruit is a pale green berry that turns purple when ripe and contains many tiny seeds.

Use: This vine is becoming increasingly rare on Guam. It is only found in moist crevices in the transition zone between the coastal strand and limestone forest along the northwest coast. During the dry season, it is nearly impossible to find.

Family Cucurbitaceae

Scientific Name Momordica charantia

English Name Bitter Cucumber, Bitter Melon, Balsam Apple

Chamorro Name Admagoso

Range Southeast Asia, now widely naturalized

Description: The wild bitter melon is a climbing vine bearing tendrils, numerous forked branches and dense foilage. The leaves are heart-shaped, 3-5 lobed and up to 10 cm. wide. The flowers are yellow, solitary and grow from the leaf axils. The fruit is cylindrical, warty and orange when ripe. The seeds are covered with a red, fleshy pulp.

Use: The wild variety is the same species as the larger cultivated bitter cucumber. The fruit of the wild variety is also edible, but is rately collected as food. The wild variety is valued medicinally, as the leaf tips are collected and boiled to make a tea that is considered healthful and especially effective in the treatment of diabetes.

Family Cyperaceae

Scientific Name Cyperus rotundus

English Name Nut Grass, Edible Sedge, Chufa

Chamorro Name Chaguan Umatak

Range Pantropical Weed

Description: Cyperus rotundus is a small, perennial sedge, up to 30 cm. tall with long, narrow leaves emerging from the base. The flowering stem is triangular with spikes, consisting of 20-30 brown flowers.

Use: This common garden sedge is used in the treatment of ulcers. A tea is brewed from the plant and taken internally. This species is commonly used medicinally throughout the tropics. The root nut is edible and has a high oil content.

Family Cyperaceae

Scientific Name Rhynchospora corymbosa

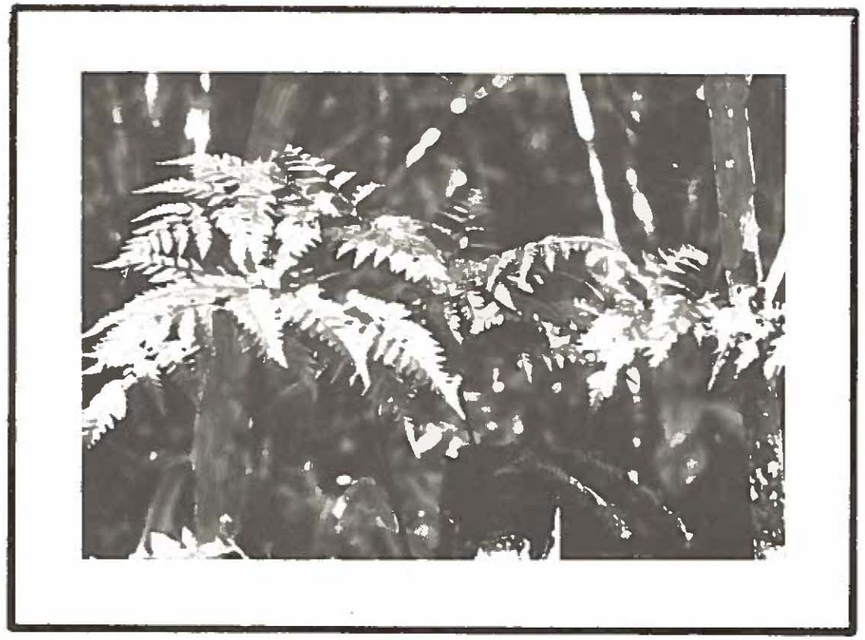
English Name Sedge

Chamorro Name Chachachak

Range Indigenous on Guam

Description: This sedge grows to a height of about 1 meter. The stems are triangular and conspicuously ribbed. The lower leaves, emerging from the base, are longer than the upper leaves. Flowering heads emerge from the upper 3-4 nodes and the inflorescence is brown, branching and flat on the top.

Use: This plant is commonly seen growing in the wet marshes of southern Guam. It is most prevalent in the Atantano River Valley and the Umatac Marsh. The leaf heart is boiled with the other ingredients in an all-purpose medicinal tea.



Family Davalliaceae

Scientific Name Davallia solida

English Name Fern

Chamorro Name Pugua Machena

Range Indigenous in Malaysia, Polynesia and Micronesia

Description: This is a common epiphytic fern with finely divided leaves and thick, creeping rhizomes. The fronds are variable in length and several times pinnate.

Use: The leaf and root are used in many combination medicines. Like most ferns, the leaves probably have a high content of the Vitamin B Complex. The ornate leaf is often used for fiesta and religious decoration on Guam.

Family Dioscoreaceae

Scientific Name Dioscorea alata

English Name Red Yam, Greater Yam, Winged Yam

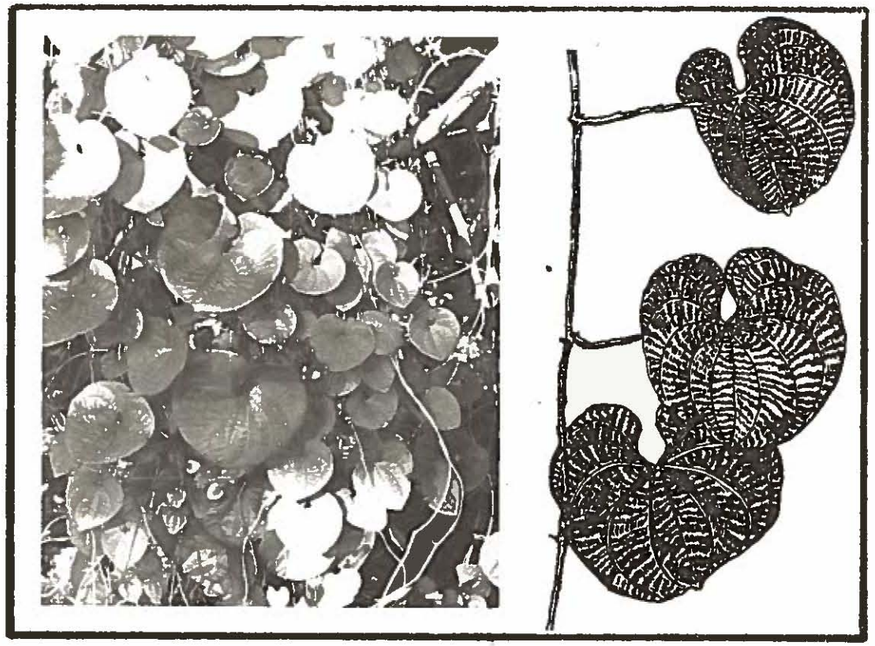
Chamorro Name Dago

Range Native to Southeast Asia, widely cultivated in the tropics.

Description: The red yam is a high-climbing vine with opposite, heart-shaped leaves and a thick, edible underground tuber. The stems are square and winged. The leaf axils often bear small aerial tubers. Male and female flowers occur separately on the branches.

(Drawing adapted from Sproat, 1968)

Use: This yam is widely cultivated, but has also naturalized in some areas on Guam. It is a popular food item throughout Micronesia, especially on Ponape where D. alata and D. esculenta are grown to mammoth proportions with prestige value attached to growing large yams. The leaves are included in amot saquiyayas, a remedy for arthritic pain.



Family Dioscoreaceae

Scientific Name Dioscorea esculenta var. fasciculata

English Name Wild Yam, Chinese Yam

Chamorro Name Nika

Range Introduced from Southeast Asia

Description: This is a tuberous vine with heart-shaped leaves that form a thick mat of vegetation growing out of a stem just under the surface of the soil. Male and female flowers grow separately from leaf axils. This species may or may not have thorns growing from the corn or underground stem.

(Drawing adapted from Sproat, 1968)

Use: This yam is cultivated on farms and has also become naturalized in the limestone forest. It was probably introduced by the precontact islanders for its edible tuber. Many species of the genus Dioscorea contain steroids and cortisone, effective in the treatment of muscle and joint ailments. The corticosteriods found in wild yam species are also used in the manufacture of contraceptive pills by pharmaceutical companies.

Family Euphorbiaceae

Scientific Name Euphorbia hirta

English Name Hairy Spurge, Garden Spurge

Chamorro Name Golundrina

Range Pantropical

Description: This is an annual herb with erect stems, up to 40 cm. tall. The leaves are narrow and asymmetrical, dark green or purple above and lighter green below. The flowers are axillary and condensed or congested in rounded cymes.

Use: The leaf, stem and roots of this common backyard herb are boiled in an astringent douche mixture known as amot labatorio. It is also included in amot galobuk. A Trukese usage involves chewing the stem and applying the mixture to a centipede bite to relieve the pain. Toxic centipedes are more common in island groups other than the Marianas.

Family Euphorbiaceae

Scientific Name Jatropha curcas

English Name Physic Nut

Chamorro Name Tubatuba

Range Native to Tropical America, now widely cultiyated in the Tropics.

Description: Jatropha curcas is a tall shrub with large, three-lobed, heart-shaped leaves. The leaf blades are dull green and palmately veined. The flowers are yellowish and occur in axillary of terminal panicles. The fruit is a capsule with a 2-4 celled ovary.

Use: The leaves of tubatuba are included in amot saquiyayas a medicinal combination used to treat arthritic pain. As the name physic nut implies, the seeds are highly emetic and toxic if ingested.

Family Euphorbiaceae

Scientific Name Phyllanthus amarus

English Name Fly-roost

Chamorro Name Maigo-lalo

Range Pantropical, a native of the New World

Description: Phyllanthus amarus is a small herb with numerous small, elliptic, alternate leaves. The petioles are less than 3 cm. long. The small male and female flowers grow in few-flowered cymes from the leaf axils.

Use: This common backyard herb may be crushed and applied to chapped lips, boiled with other plants in a preparation designed to cure diarrhea or included in an astringent douche mixture.

Family Euphorbiaceae

Scientific Name Phyllanthus marianus

English Name

Chamorro Name Gaogao Uchan

Range Marianas and Western Caroline Islands

Description: This is a small shrub with few narrow branches. The small, dark green leaves are arranged along the branchlets in one plane, like a pinnate leaf. The flowers and fruits are axillary and occur in clusters along the underside of the branchlets.

Use: The glossy leaves of this low-growing shrub are included in some of the all-purpose combination medicines of local curers. When it is boiled into a tea, it is reputed to have analgesic qualities that alleviate back pains. It is generally found on limestone cliffs and terraces.

Family Gramineae

Scientific Name Bambusa blumeana

English Name Japanese Bamboo

Chamorro Name Piao

Range A native of Java, planted in many parts of Tropical Asia and introduced to Guam from the Philippines.

Description: This bamboo reaches a height of 15 meters with stems 10 cm. or more in diameter. The lower branches bear curved spines which make a thicket nearly impossible to go through. The sheath at the base of the stem is covered with brown hair and reaches a length of 30 cm.

Use: The roots of this bamboo are included in all-purpose medicinal combination. This species is not as common as B. vulgaris. The heart of the young sprouts of B. vulgaris are used in amot tabadiyo. Both species are known as piao. B. blumeana can be found in the Maina River Valley area.

Photo by Mitchell Chernin

Family Gramineae

Scientific Name Eleusine indica

English Name Crabgrass, Crow's Foot Grass

Chamorro Name Chaguan Kabayo

Range Old World Tropics

Description: This is a short grass with narrow, flat leaves up to 30 cm. long. The flower spikes are broad, 4-6 together at the top with usually, one lower on the stem than the rest.

Use: This grass is commonly considered to be a garden pest and can be easily found in weed communities or waste places. It is an ingredient in amot saquiyayas.

Family Gramineae

Scientific Name Phragmites karka

English Name Reeds

Chamorro Name Kariso

Range Tropical Africa to Malaysia and the Pacific

Description: Phragmites is very tall, jointed grass that grows in thick pure stands on swampy lands. The stems grow up to 5 meters in length and 2-3 cm. in diameter. The flowers form in loose, terminal panicles, green at first, but maturing to a light brown color.

Use: This plant seems to be a reliable indicator of freshwater in places such as at the mouth of the Sasa River. A dense stand can also be seen in the Agana Swamp or the Atantano River Valley. The young sprouts are an ingredient in an all-purpose medicinal combination.

Family Gramineae

Scientific Name Sporobolus virginicus

English Name Beach Grass, Salt Grass, Beach Dropseed

Chamorro Name Totoput

Range Tropical Countries of the World

Description: This is a short-stemmed, creeping beach grass with pointed, inrolled leaf blades that are not over 15 cm. long. The flowering spike-like panicle is pointed and rather pale.

Use: This species is tolerant of salt water and is common in marshy areas near the sea. It can be seen along the beach at Adelup School or at the mouth of the Geus River in Merizo. It is rarely seen with flowers.

Family Gramineae

Scientific Name Zea mays

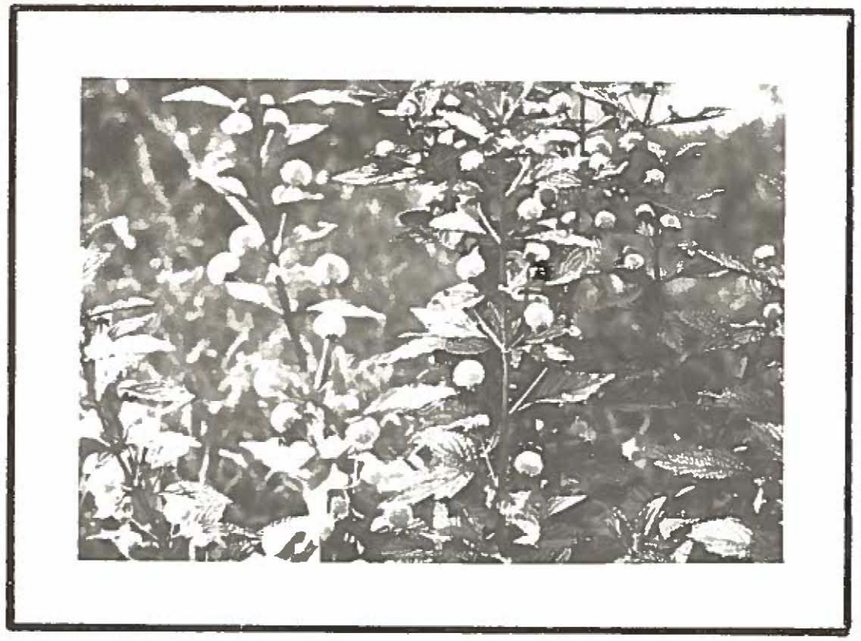
English Name Corn

Chamorro Name Mais, Batbas, Espiga

Range Mesoamerica, widely introduced as a cultigen

Description: Corn grows to a height of 2-3 meters with long, broad leaves and jointed stems. The male flowers or tassels are terminal. The female spikelets or silks grow laterally from the ear.

Use: The flower and silk of domestic corn are included in a medicinal combination. Corn is an introduced cultigen from Central America. It has long been considered a symbol of fertility by various Amerindian groups, which may partially account for its addition to a medicine in which the primary value is considered to be fertility increase. Nelson (1951:161) reports that corn silk space contains the drug maidis stigmata which functions as a demulcent. A demulcent is a substance that soothes the membranous surfaces of the digestive tract and guards against the harsh effects that other active ingredients might have on these tissues. The photograph depicts Jose Quintanilla collecting corn blossoms for medicinal use.



Family Labiatae

Scientific Name Hyptis capitata

English Name Buttonweed

Chamorro Name Batones

Range Tropical America, introduced to Guam

Description: Hyptis capitata is a coarse, low-growing herb with square stems and acute, serrate leaves. The sessile flowers are white in nearly round heads up to 2 cm. in diameter. The heads turn from green to dark brown when mature, persisting at branch ends. The seeds or nutlets are brown.

Use: This plant can be easily recognized by the dark brown heads that dry out and remain attached to the stems long after the leaves have dropped off during the dry season. It is most often seen on the savannah or at the edge of marsh communities. The local medicinal use involves crusing the leaves and applying them to cuts and abrasions for the prevention of infection and tetanus.

Family Labiatae

Scientific Name Hyptis pectinata

English Name Comb Hyptis

Chamorro Name Muntong Paloan

Range A Native of Tropical America, now a widespread tropical weed

Description: Hyptis pectinata is an herb with square, hairy stems and aromatic leaves. The leaves are broadly ovate and toothed, the edges wavy. The flower heads are white or violet and occur terminally or in leaf axils.

Use: This herb is most often seen growing in open field weed communities. The young plants are preferred for medicinal use and are given the female suffix (paloan). The mature plant becomes coarse and woody and is known as mumutong lahe. When given the male suffix, the plant is no longer valued medicinally.

Family Labiatae

Scientific Name Ocimum sanctum

English Name Sacred Basil

Chamorro Name Adbahakat

Range A Pantropical cultigen

Description: Ocimum is an aromatic herb with oblong, serrate leaves. The stems are squarish. The flowers grow in racemes from leaf axils or terminally. The fruit is a brown nutlet.

Use: The leaves and seeds of this herb are an aromatic spice. They are sometimes added to coconut oil for use as a body lotion (palai) that is thought to cure spirit-caused ailments. It is cultivated and used more often on Rota than Guam.

Family Lauraceae

Scientific Name Cassytha filiformis

English Name Love Vine

Chamorro Name Mayagas

Range Tropical regions of the world

Description: Cassytha is a parasitic, leafless vine with green, orange or yellow stems that form a tangled mass over the host plant and adjacent vegetation. The flowers are small and inconspicuous. The fruits are pea-sized.

Use: This plant is seen most often in exposed places growing over strand vegetation in full sunlight. It can also be found growing over the vegetation in almost every other community on Guam.

Family Lecythidaceae

Scientific Name Barringtonia asiatica

English Name Fish-kill Tree

Chamorro Name Puting

Range Indian Ocean and Pacific coasts in tropical areas

Description: This is a large tree with long, tapering, obovate, leathery, dark green leaves, crowded near the ends of branches. The basal leaves continually wither and drop off leaving conspicuous leaf scars along the stem. The flowers are large, occuring in erect cymes with white petals and numerous pink and white stamens. The tree blooms almost continously, but the flower are rarely seen as they open in the early morning and soon drop off. The one-seeded, fibrous fruit is square and about 10 cm. in length. The calyx is persistant and the pistil remains attached to the fruit long after the rest of the flower has fallen.

Use: This tree is most numerous near the coast, but may be found on upper terraces and escarpments on both the windward and leeward sides of the island. The inner seeds were once used to poison fish. Ironically, as the tree is used to poison fish, if a person gets poisioning from eating certain types of fish, the bark of the tree is boiled into a strong tea that is taken internally.

Family Leguminosae

Scientific Name Abrus precatorius

English Name Crab's Eye, Prayerbead, Coral Bean

Chamorro Name Kulales

Range Pantropical

Description: Abrus is a slender, branching, woody, deciduous climber. The leaves, 8-10 cm. long, are pinnately compound with many small leaflets. The flowers, in axillary racemes, are pink or white. The pods, up to 5 cm. long, contain 3-6 beadlike, glossy red seeds, each with a black spot.

Use: This vine is most often seen in the limestone forest. The attractive seed is extremely poisonous, causing blindness or death if ingested. The root is the only portion of the plant that is used medicinally. The root is reported to have a flavor similar to licorice.

Family Leguminosae

Scientific Name Caesalpinia major

English Name Wait-a-bit

Chamorro Name Pakao

Range Pantropical

Description: This is a woody climber with pinnately compound leaves and yellow flowers in terminal racemes. The stems and leaves, bearing recurved spines, make a thicket of this species, practically impossible to move through. The pods are 2-4 seeded, short, inflated and covered with prickles. The seeds are nearly round, glossy gray and about 1.5 cm. in diameter.

Use: This species is most often found at the edge of the jungle or in abandoned fields. The gray seeds of pakao are commonly used in a medicinal preparation for the treatment of diarrhea. Three of the seeds are cracked and boiled with three young fruits of lada (Morinda citrifolia) and three plants of maigo-lalo (Phyllanthus amarus). The resultant tea is very bitter and is taken internally.

Family Leguminosae

Scientific Name Caesalpinia sappan

English Name

Chamorro Name Sibukao

Range Native to India

Description: This is a small tree with long, trailing branches and large, pinnately compound leaves up to 50 cm. long. The branches are covered with curved prickles. The flowers are yellow and grow in panicles from leaf axils. The pods are hard and glossy, up to 10 cm. long and 4-5 cm. wide with a curved beak.

Use: This species is difficult to find on Guam. It is reported to grow in the Maina River area. The photograph was taken on the island of Tinian at Jone's Beach. The inner portion of the trunk contains a red dye that was once used for making ink or dying cloth. The wood is soaked in water to render the dye.

Family Leguminosae

Scientific Name Canavalia maritima

English Name Swordbean

Chamorro Name Akangkang Tasi

Range Pantropical

Description: C. maritima is creeping vine with trifoliate leaves. The leaflets are notched at the tip. The flowers are pink and pealike, the largest petal with a white spot. The pods are tan-colored, about 15 cm. long and 2-3 cm. wide. The seeds are 2 cm. long, elliptic and slightly compressed.

Use: This vine is found growing close to the sea and is similar in appearance to Mucuna gigantea. It is a common ingredient in medicinal combinations of island curers. It is rarely found with flower or fruit, but can be distinguished from Mucuna and other Canavalias because the leaf is glossier and the stems are much harder to break.

Family Leguminosae

Scientific Name Canavalia megalantha

English Name

Chamorro Name Akangkang

Range Endemic in the Marianas

Description: C. megalantha is a coarse, woody vine with alternate, trifoliate leaves and pink to purplish, pealike flowers that grow in racemes from leaf axils. The pods are pale brown, 15-16 cm. long and about 5 cm. wide with sutured ribs. The seeds are flat, elliptic and pale brown.

Use: Two or three other species of Canavalia occurr on Guam, but this one is the most common. Most of the species of Canavalia are known locally as akangkang and are used in medicinal preparations. They are all similar in appearance and difficult to distinguish if not in bloom, thus they are often used interchangeably in medicinal combinations.

Family Leguminosae

Scientific Name Cassia alata

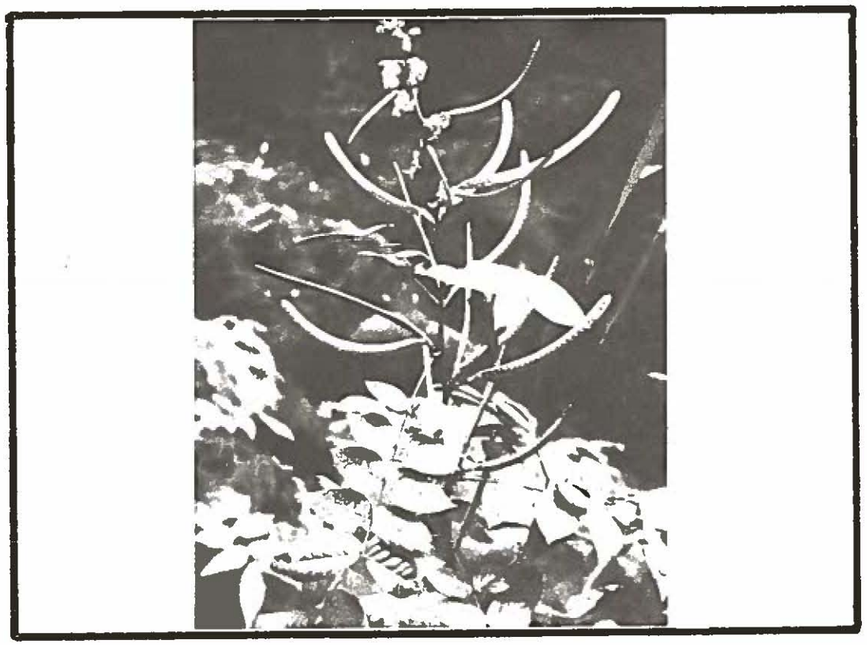
English Name Candlenut, Candlebush

Chamorro Name Akapulko, Anadose, Take-Biha

Range Introduced to many tropical countries from Central America

Description: Cassis alata is a tall shrub with large, pinnately compound leaves and large paired leaflets. The flowers are yellow and grow in a dense, crowded terminal spike. The pods are nearly black, about 20 cm. long and 1-2 cm. wide with many flat seeds.

Use: This plant is commonly seen in roadside weed communities throughout Micronesia. It was naturalized early on Guam for its medicinal use. The leaves or seeds are crushed and applied to ringworm or skin fungus for highly effective results. It serves this purpose throughout the Marianas and the rest of Micronesia. Okabe (1940) reports that the leaves and branches contain chrysophanic acid which has a laxative effect if ingested.



Family Leguminosae

Scientific Name Cassia occidentalis

English Name Coffee Senna

Chamorro Name Amot Tumaga

Range American origin, introduced in tropical regions.

Description: This is a small, weedy shrub with bright yellow flowers in racemes and compound leaves having 4-6 pairs of elliptic leaflets. The stems are ribbed and slender. The pods are narrow, up to 15 cm. long, containing many small brown seeds.

Use: This species of Cassia is commonly seen along roadsides and along the edge of marshes. Stone (1970) reports that the seeds may be used as a substitute for coffee and that a medicinal function of the leaves is antiherpetic. Two other species, C. sophera and C. tora, are also known as amot tumaga.

Family Leguminosae

Scientific Name Entada pursaetha

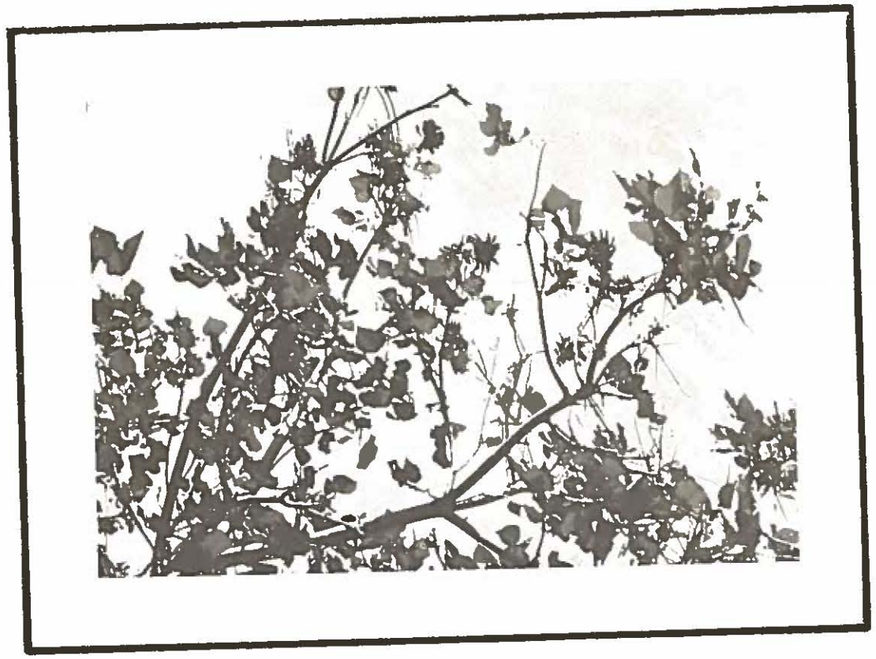
English Name Large Seabean, Snuff-box Bean

Chamorro Name Bayogon Dangkulo, Gayi Dangkulo

Range Tropical, native to Guam

Description: Entada is a large, woody, climbing vine with bipinnate leaves and small, rounded leaflets. The flowers are white. The pods are light brown, curved and up to 1 meter in length. The seeds are 4-7 cm. broad, brown, glossy and rounded or sometimes rectangular.

Use: This plant grows mostly in the southern sector of Guam, often along stream beds. The long, twisting, woody vines climb high into tree tops and unless the leaves are recognized, it is often difficult to find the pods.



Family Leguminosae

Scientific Name Erythrina variegata

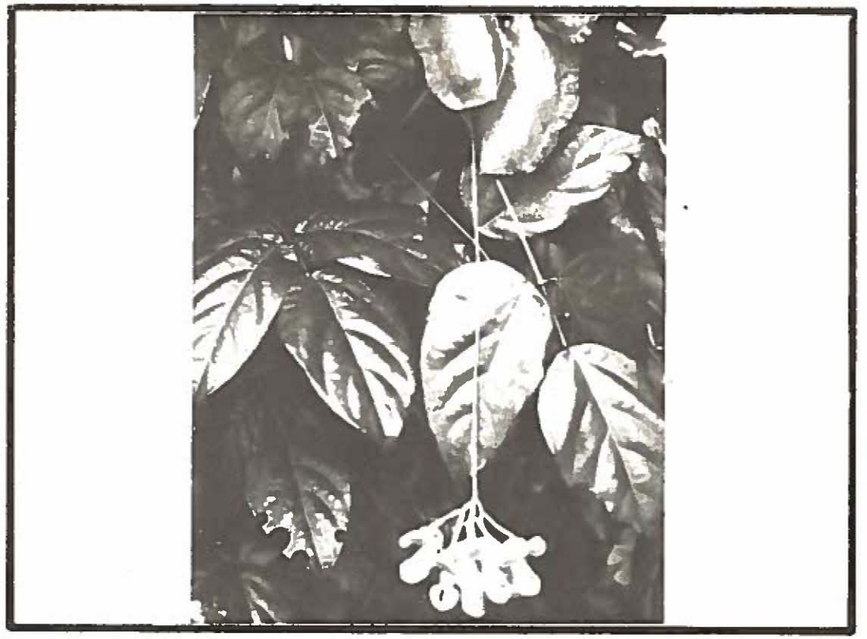
English Name Coral Tree, Tiger Claws

Chamorro Name Gaogao

Range Native of India, Malaysia and the Pacific

Description: This is a stocky, deciduous tree with trunk and branches bearing sharp prickles. The leaves are trifoliate and long-stemmed. The flowers are bright red. The pods are 15-20 cm. long, containing several red seeds.

Use: This tree is often planted for its showy flowers which appear during the dry season after the leaves have fallen. The leaves are an ingredient in an all-purpose combination medicine



Family Leguminosae

Scientific Name Mucuna gigantea

English Name Small Seabean

Chamorro Name Bayogon Dikike, Gayi Dikike

Range India to Polynesia

Description: Mucuna is a climbing vine with alternate, trifoliate leaves. The leaves are dull green and the lateral leaflets are decidedly asymmetrical. The flowers, growing in clusters from leaf axils or from the main stem, are pale green on long, hanging stems. The pods are light brown, hairy, about 10 cm. long, flat and winged along the margin. The large seeds are light brown to nearly black, rounded or nearly so and about 7 mm. thick.

Use: This species is usually found growing near the beach, but is also common in the limestone forest, some distance from the sea. It has been recorded that the seeds of Mucuna species contain L-Dopa, a drug that is effective in relieving symptoms of Parkinson's Disease. (Gwynne, 1976:44).

Family Leguminosae

Scientific Name Vigna marina

English Name

Chamorro Name Akangkang Marilasa

Range Pantropical

Description: Vigna is a creeping, perennial vine with broad, trifoliate leaves and yellow flowers. The pods are short and slightly curved with 4-5 brown seeds.

Use: This beach plant can be readily identified by its yellow flowers. Vigna has been reported as having a medicinal value in every island group in Micronesia.

Family Malvaceae

Scientific Name Abutilon indicum

English Name

Chamorro Name Matbas

Range Native to Southern Asia, now widespread as a tropical weed

Description: This is a smallish shrub with alternate, heart-shaped leaves on long petioles. The leaf blade is coarsely-toothed and hairy. The flowers are solitary and grow from leaf axils. The fruit is circular, flattened at the end and composed of 15-20 radiating carpels. It is green in the unripened state, becoming brown with maturity.

Use: The leaves are boiled into a tea that is used as an antipyretic to reduce fever. It is found growing wild and is also cultivated in backyards for home medicinal use. A large stand can be seen growing around the marshes at Sumay on the Naval Station, Guam.

Family Malvaceae

Scientific Name Hibiscus tiliaceaus

English Name Hibiscus Tree

Chamorro Name Pago

Range Pantropical

Description: Pago is a small tree with low spreading branches and smooth, gray bark. The long-stemmed leaves are rounded and heart-shaped, with several major veins and covered with downy hair. The axial or terminial flowers are large and conspicuous, bright yellow in the early morning, turning dark reddish purple before dropping off in the evening.

(Drawing adapted from Merrill, 1945)

Use: Besides being found in the limestone forest, pago is also found along muddy or sandy coasts and in mangrove swamps. A common medicinal use involves applying the crushed flowers to a skin abscess to draw out the infection. Sometimes cooked rice is added to the mixture to make the poultice adhere to the infected area.

Family Malvaceae

Scientific Name Thespesia populnea

English Name Portia Tree

Chamorro Name Binalo

Range Paleotropical

Description: This is a medium-sized three with a thick crown, commonly found close to the beach on the sheltered side of the island. The leaves are heart-shaped with a long, tapering tip, on long petioles and crowded near the ends of branches. The flowers are hibiscuslike, yellow in the morning, but turning light purple before they fall off during the day. The fruits are woody, about 2.5 cm. in diameter, flattened at the end, 4-5 celled and green in the unripened condition, turning brown or black with age.

Use: The bark of this tree is boiled into a mixture that is used as an astringent douche.

Family Malvaceae

Scientific Name Urena lobata

English Name

Chamorro Name Dadangse Ahgaga, D. Apaka, D. Machena

Range Pantropical

Description: Urena is a small shrub with palmately-lobed, hairy leaves. The flowers are pinkish or violet with one to several together in the axils. The fruit is bristly and 4-5 lobed.

Use: The leaves of this herb are used in the same manner as its close relative, Abutilon. They are boiled with water into an antipyretic tea that acts as a fever reducer.

Family Moraceae

Scientific Name Artocarpus altilus

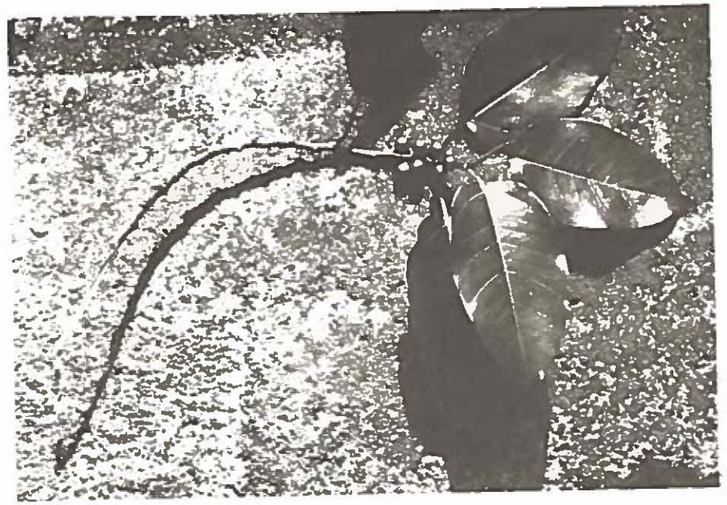
English Name Infertile Breadfruit

Chamorro Name Lemai

Range Malaysia and the Pacific

Description: Lemai is a large tree with dark green, deeply lobed leaves that are somewhat lighter green on the underside. The fruit is borne on a thick stem growing from leaf axils on small branches.

Use: This tree is a prominent member of the farm community because of its food value. The starchy fruit has long been a favorite food and was once an important staple in the islander's diet. It also has a medicinal value. The sap that emerges from the end of the leaf petiole, when freshly picked; may be applied to an eye laceration to speed the healing process.



Family Moraceae

Scientific Name Ficus prolixa

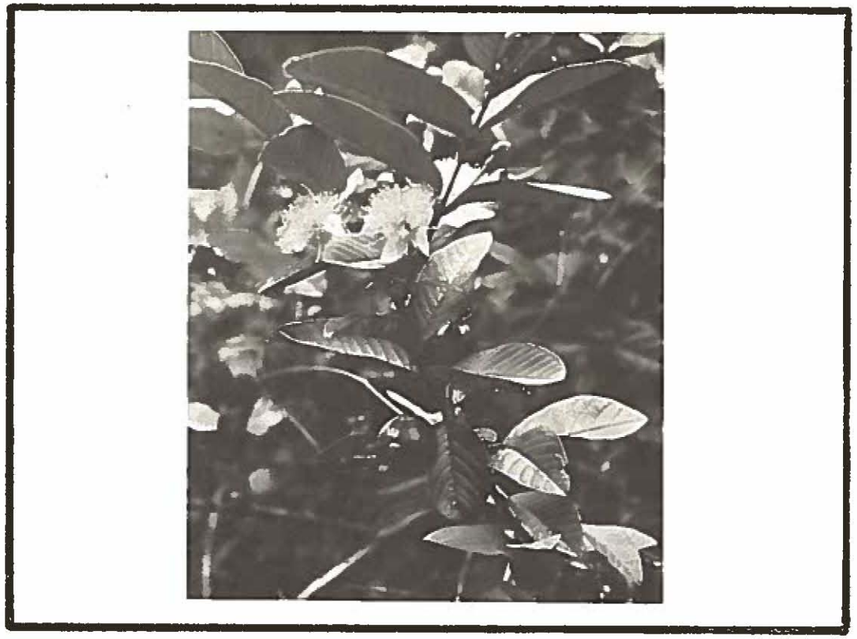
English Name Banyan, Strangling Fig

Chamorro Name Nunu

Range Pacific Islands.

Description: This is a medium to large tree with numerous prop roots. The ovate leaves are small and smooth, light green in color with a rather prominent mid-vein This is the well-known strangling fig that reaches very large proportions throughout Polynesia. The fruits are small, globose or slightly depressed and occur in leaf axils. Galls, similar in shape to the fruit, appear along the prop roots.

Use: This plant often begins life as a parasite in the crotch of a host tree. From there, a tangle of branches and prop roots surrounds the host and eventually kills it. The taotaomona spirits of the ancient people are thought to reside around the tree. For this reason, the trees are rarely removed from property. The roots are commonly used both externally and internally to stanch the flow of blood.



Family Myrtaceae

Scientific Name Psidium guajava

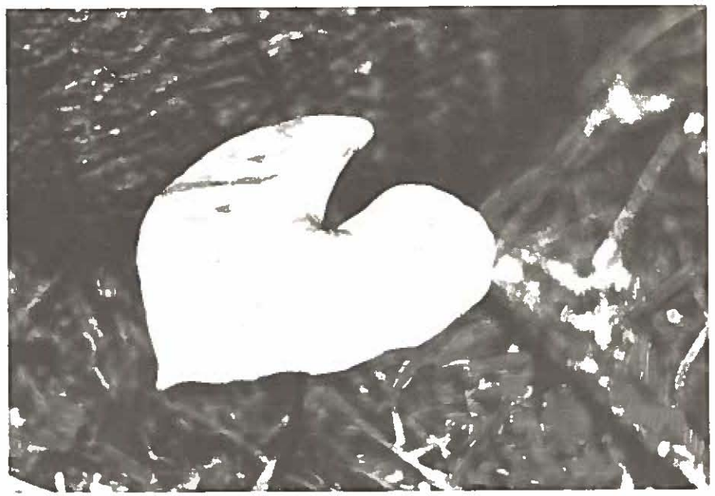
English Name Guava

Chamorro Name Abas

Range Native to Tropical America and widespread in cultivation in tropical countries. It is cultivated and has naturalized on Guam.

Description: Guava is a shrub or small tree with smooth, reddish brown bark and opposite, oblong leaves. The flowers are showy with white petals, fragrant and about 3 cm. in diameter. The fruit is about the size of a lemon, yellow when ripe and tipped with the remains of the calyx.

Use: Guava is cultivated for its edible fruit, but is also valued medicinally. The leaves are added to an astringent douche misture known as amot labatorio. Eating the fruit is thought to relieve diarrhea. When an extract of the leaves and flowers was laboratory tested, it was found to have a very effective anti-bacterial effect on some forms of disease microorganisms (Bushnell, Fukuda and Makinodan, 1950).



Family Orchidaceae

Scientific Name Nervilia aragoana

English Name Water-root Orchid

Chamorro Name Seiyaihagun

Range Indo-Malaysia, Samoa and the Pacific Islands

Description: Nervilia is a terrestrial orchid having one broad, rounded leaf attached to a long petiole. The root is an underground fleshy bulb or tuber. The flowers are green and are borne on a leafless stem. The leaf and flower seldom appear at the same time.

Use: Nervilia is becoming increasingly rare on Rota and Guam due to the predations of the introduced giant African snail and Marianas deer. The leaf and root are supplementary ingredients in amot fresko. The liquid squeezed from the root is also believed to be effective as eye drops in the treatment of pinkeye. In previous times, the roots were chewed by thirsty hunters. When added to medicinal combinations, the succulent roots have a moisturizing function.

Family Orchidaceae

Scientific Name Taeniophyllum mariannense

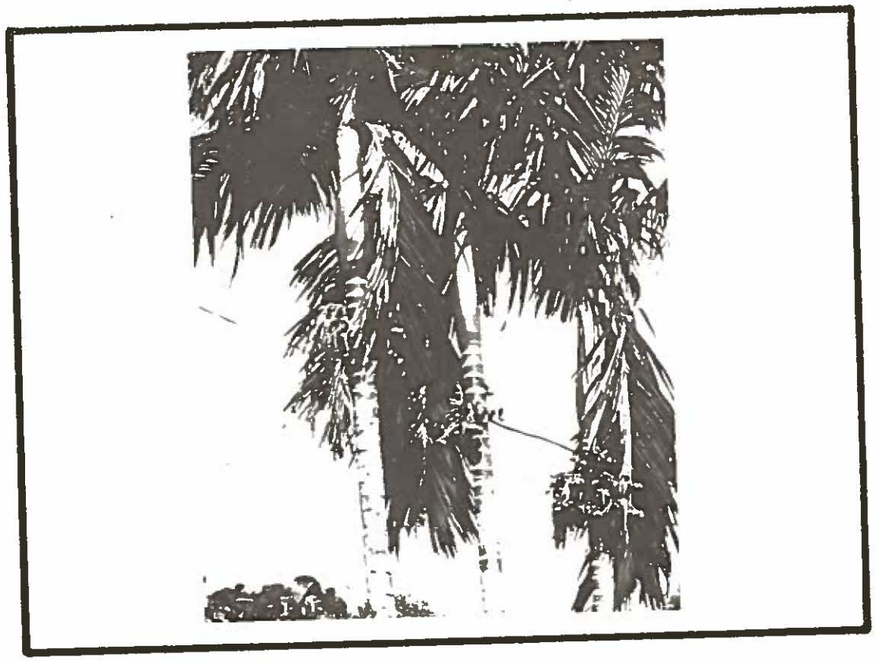
English Name Leafless Orchid

Chamorro Name Sanyeye

Range An Indo-Malaysian-Pacific species, common on Guam

Description: This orchid is stemless and leafless, growing epiphytically on the trunks and branches of trees. The spreading, creeping roots grow flat against the host plant. The flowers are tiny with white petals, usually solitary. The fruit is a short, cylindrical capsule.

Use: The roots of the leafless orchid are most often found growing epiphytically on trees in the limestone forest. The roots are crushed with water and the resultant liquid used as nose drops to cure sinus infections.



Family Palmae

Scientific Name Areca cathecu

English Name Betelnut Palm

Chamorro Name Pugua

Range Indo-Malaysia, naturalized and cultivated on Guam.

Description: Betelnut is a small, unbranched tree with conspicuous gray rings. The fronds are dark green and rather straggly in appearance. The sheaths are long and ribbed at the base. The flowering stems grow from the trunk well below the leaves. The main axis of the inflorescence branches several times with male flowers towards the tip and female flowers at the bàse. The fruit is ovoid, up to 5 cm. long, green in the immature state, turning organge as its ripens.

Use: Betelnut was naturalized early on Guam by the first inhabitants. As well as being common in the river valleys of the savannah, it is often cultivated on ranches and in home gardens. The mature seed is habitually chewed for its mild narcotic effects and astringent quality. It is often chewed with pupulu (Piper betle) and lime powder. This misture turns red when chewed and stains the teeth. The fruit contains an alkaloid known as arecoline, which acts as a vermifuge--killing intestinal parasites. The mixture fruit is crushed with pupulu and a few drops taken internally and the rest applied topically in the treatment of stroke.

Family Palmae

Scientific Name Cocos nucifera

English Name Coconut Palm

Chamorro Name Niyuk

Range East Asian or Malayo-Polynesian origin

Description: The coconut palm is a tall, unbranched, graceful palm with conspicuous leaf scars. The inflorescence are borne in leaf axils, appearing as a sheathlike bract, and open to reveal a cluster of straw-colored brachlets, each bearing flowers in groups of three. Pistilate flowers are near the base and stammite flowers toward the tip of each branchlet.

Use: This versatile tree has innumerable uses in the manufacture of material culture and in the preparation of food. Its medicinal uses are equally as impressive. The water from the green nut is a sterile, sucrose-laden solution that is used as the liquid base in many medicinal preparations. The fermented coconut sap, tuba is allowed to turn into vinegar (binakli) and used as the base of the suruhano's palai body lotion. The vinegar is an ingredient in amot gotpe. The leaf heart is also included in amot saquiyayas. The oil rendered from the ripe nut is often used in massage and to lubricate suppository mixtures. A pain-relieving remedy for toothaches is extracted by heating scraped-out shells and collecting the consensation from the inside of the shell.

Family Pandanaceae

Scientific Name Pandanus tectorius

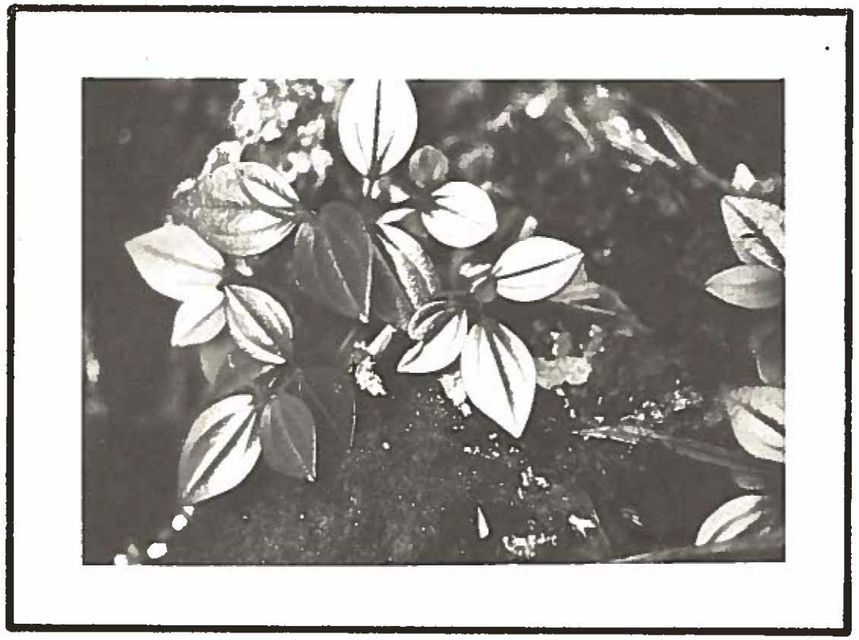
English Name Pandanus, Textile Pandanus, Screwpine

Chamorro Name Aggak

Range India, Southeast Asia, Eastern Polynesia and Micronesia

Description: This is a small tree with aerial roots and long, tapering leaves, armed along the margins and midrib with curved teeth. This pandanus varies from P. fragrans by its shorter trunk, more dense, broader crown and longer, bluish green leaves. It has not been seen to flower or fruit on Guam or Rota. It is cultivated by cuttings.

Use: This pandanus is often cultivated because the leaves arepreferred for weaving rather than the more common P. fragrans and P. dubius. The center leave heart of aggak is included in amot saquiyayas.



Family Piperaceae

Scientific Name Peperomia mariannensis

English Name Peperomia

Chamorro Name Potpupot

Range Endemic in the Mariana Islands

Description: This is a small, fleshy herb growing from pockets of soil in dissected limestone boulders. The leaves are glossy green with three veins from the base. The fruiting spikes are longer than the leaves.

Use: The leaf and stem are added to amot fresko. The primary function of adding succulent leaves is that it adds moisture to the mixture, giving it a mucilaginous consistency. The leaves are often chewed by thirsty hunters in the jungle.

Family Piperaceae

Scientific Name Piper betle

English Name Betel Pepper

Chamorro Name Pupulu

Range A native of India and eastward through Malaysia to the Pacific. It is cultivated in many tropical regions.

Description: The betel pepper is a high-climbing vine with heart-shaped, dark green, glossy leaves. The flowers are borne in narrow spikes. The fruits are rounded and imbeded in the tissue of the spike.

Use: The leaf is an aromatic that can be chewed alone for its refreshing taste, but is most often chewed with a combination of betlenut (Areca cathecu) and powdered lime that is rendered by buring coral. It is sometimes crushed with betelnut for use as a palai body lotion.

Family Piperaceae

Scientific Name Piper guahamense

English Name Wild Piper

Chamorro Name Pupulu n Aniti

Range Indigenous to Guam

Description: This is a common shrub of the limestone community. The broad, long-petioled, palmately-veined leaves grow from enlarged nodes along the green stems. The flowering spikes occur in leaf axils. The fruits are bright red and fragile when mature.

Use: The main function of this ingredient is that it gives combination medicines a fresh, aromatic flavor.

Family Polypodiaceae

Scientific Name Microsorum punctatum

English Name Strapleaf Fern

Chamorro Name Galak Dikike, Galak Dalalay

Range Paleotropical

Description: This fern may be terrestrial or epiphytic and has large straplike leaves with flat or wavy margins. The fertile fronds have small dotlike sori.

Use: This fern is most commonly found in the limestone forest. It is a common ingredient in many Chamorro medicinal combinations.

Family Polypodiaceae

Scientific Name Phymatodes scolopendria

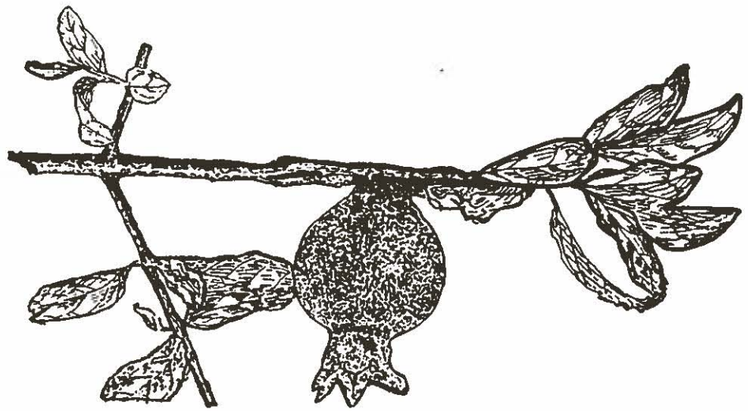
English Name Fern

Chamorro Name Kajlao

Range Paleotropical

Description: This is a terrestrial or epiphytic fern with pinnately lobed leaves that are variable in shape. Fertile fronds have scattered, lighly brown, rather large sori. This is one of the most common ferns on the island.

Use: The leaf and roots of this fern are used in many all-purpose combinations.



Family Punicaceae

Scientific Name Punica granatum

English Name Pomegranate

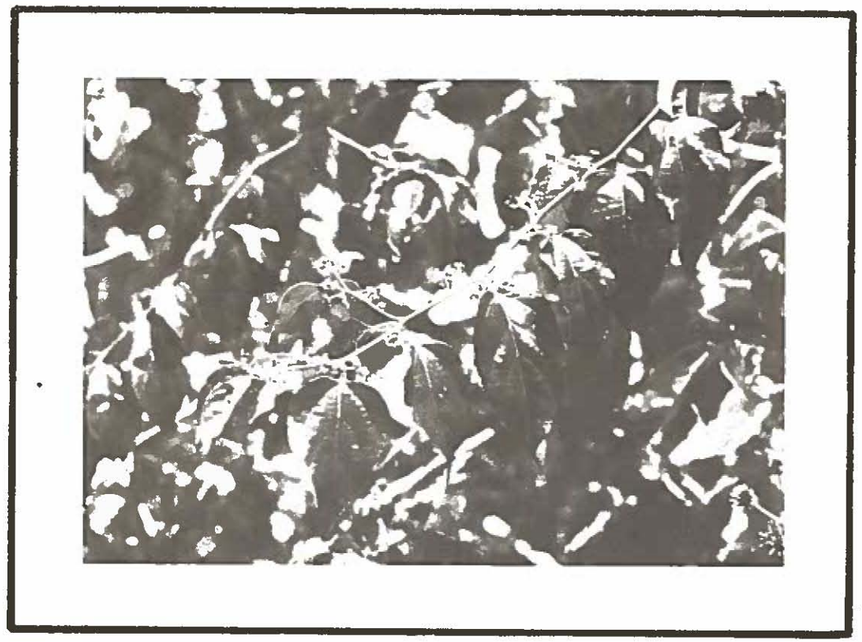
Chamorro Name Granada

Range A native of Iran, now widely grown in tropical countries for its edible pulp and attractive flowers.

Description: Pomegranate is a spiny shrub, six feet or more tall, with glossy, light green leaves. The youngest leaves are reddish. The flowers are showy, orange-red, about 2.5 cm. in diameter and grow from branch ends in a cluster of four or five. The attractive fruit is red or yellow, 5-12 cm. wide and tipped with a thick calyx. The seeds are enclosed in a pink tissue.

(Drawing adapted from Sproat, 1968)

Use: In many countries, the bark of the tree is boiled into a tea and taken internally as a vermifuge, killing intestinal parasites. However, it is not used in this capacity on Guam. On Guam, the leaves are crushed and added to a mixture of other herbs and administered as a suppository for the treatment of rectal infections.



Family Rhamnaceae

Scientific Name Colubrina asiatica

English Name

Chamorro Name Gasoso, Gasusu

Range Paleotropical

Description: Colubrina is a rambling shrub with alternate, shiny, green, dentate leaves. It is often seen growing on limestone near the beach. The axillary flowers are yellow. The fruit is pea-sized, green or dark brown when ripe.

Use: This is a common plant on Guam, especially in the northern half of the island. It forms thickets along forest borders and near the sea. The leaf is used in many local medicines. It most popular use is for a refreshing, analgesic tea that is made by crushing the fresh, young leaves with water. The tea is taken internally for the relief of headache. The leaves are also chewed by some suruhanas and the mixture applied topically as a palai body lotion during the massage.

Family Rubiaceae

Scientific Name Hedyotis foetida var. mariannensis

English Name

Chamorro Name Paudedo

Range This is a Polynesian species, the variety is endemic in Guam.

Description: This Hedyotis grows as an erect shrub with squarish stems and small, dull green, opposite leaves that are slightly winged at the base. The small, white, trumpet-shaped flowers grow terminally in many-flowered panicles.

Use: Paudedo is easily recognized by its pungent ordor when crushed. It is most often found growing under the shade of other vegetation on the cliffsides bordering the limestone forest.

Family Rubiaceae

Scientific Name Morinda citrifolia

English Name Indian Mulberry

Chamorro Name Lada

Range Tropical Asia and the Pacific

Description: Morinda is a shrub with large, opposite, dark green, glossy, elliptic leaves. The flowers are white--growing from a head in the axils of the leaves. The fruit is fleshy, many-seeded, 4-7 cm. long and looks somewhat like a small pineapple.

Use: The fruit is edible, but has an unpleasant taste and smell. Both the fruit and leaves are popularly used in medicinal remedies throughout Micronesia and Polynesia. On Guam, the immature fruits are boiled with other indredients into a vile tasting tea that is taken internally in the treatment of diarrhea and stomach cramps. Some curers wrap the leaves on sore areas of the body to relieve pain. The leaves are also used for massage on Palau by local curers known as rubak or mechas (Salcedo, 1970). In Hawaii, Morinda is known as noni and used medicinally. Levand (1963) isolated the chemical asperuloside from the fruit and found it to have an antibiotic effect on some disease microorganisms.

Family Rubiaceae

Scientific Name Randia cochinchinensis

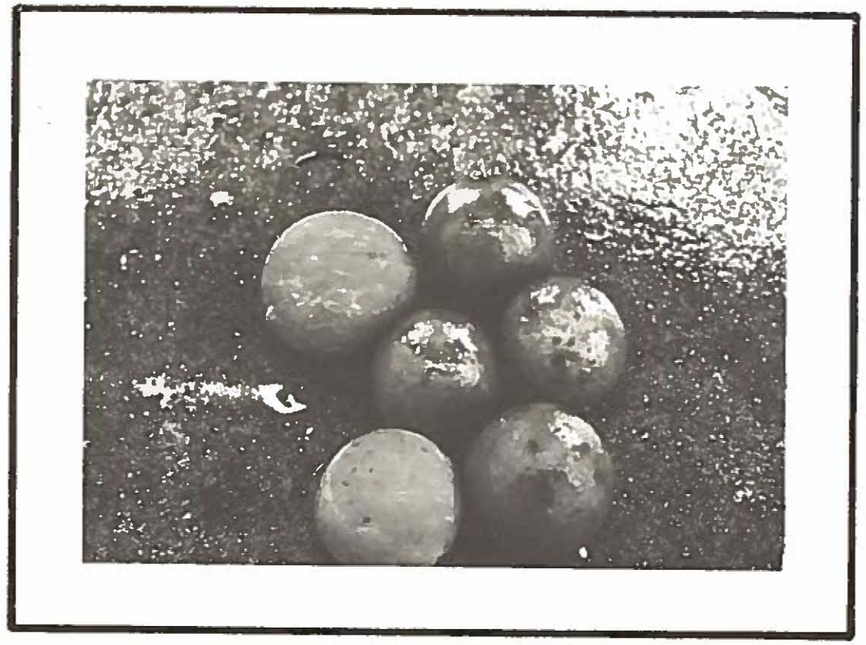
English Name

Chamorro Name Sumak

Range Tropical Asia and the Pacific Islands

Description: Randia is a small tree with smooth, glossy, dark green, wavy-edged leaves that have a leathery texture. The flowers are axillary with many together in cymes. The petals are white, long and narrow. The fruit is pea-sized and purple to black when ripe.

Use: This plant is common in the limestone community. It is often added to medicinal combinations.



Family Rutaceae

Scientific Name Citrus aurantifolia

English Name Lime

Chamorro Name Lemondemelon

Range A native of Asia, introduced to many tropical countries.

Description: This is a small, thorny tree with alternate leaves, up to 8 cm. long. The leaf margins are wavy or slightly toothed and the petioles are narrowly winged. The flowers are white and the fruit is about 5 cm. broad, greenish yellow, with a thin peel.

Use: The juice from this citrus fruit is sour and is used in cooking and for lemonade. The lemonade is believed to be a good remedy for sore throats. It has a high vitamin C content. When Bushnell, Fukuda and Makinodan (1950) tested an extract of the fruit against several disease microorganisms, it was found to be a very effective antibacterial agent.

Family Rutaceae

Scientific Name Citrus aurantium

English Name Sour Orange, Seville Orange

Chamorro Name Kahet, Lemon

Range Native of Southeast Asia, cultivated throughout the tropics.

Description: This is a small, spiny tree with ovate, dark green leaves and broadly winged petioles. The fruit is slightly fattened, rough-skinned and orange when ripe. The pulp is very sour with many seeds. The flowers are white.

Use: The rind from the fruit of this citrus and other local species of citrus is brewed into a bitter tea that is thought to be effective in the treatment of stroke. This may be an adaptive treatment as Nelson (1951:88) reports that the peel contains a component of Vitamin C that is essential in the maintenance of the walls of blood vessels. The rind of the common orange (Citrus sinensis) is used in the same capacity.

Family Solanaceae

Scientific Name Physalis angulata

English Name Cape Gooseberry

Chamorro Name Tumatis Chaka

Range Native of Tropical America, now widespread as a tropical weed.

Description: This is a smooth-leafed herb with angular stems and ovate, slightly asymmetrical, dark green leaves. The flowers are yellowish green. The fruit is ellipsoid within a baloonlike calyx that looks somewhat like a Japanese lantern.

Use: The leaves are most often crushed and applied to sore chapped lips to assist in healing.

Family Solanaceae

Scientific Name Physalis lanceifolia

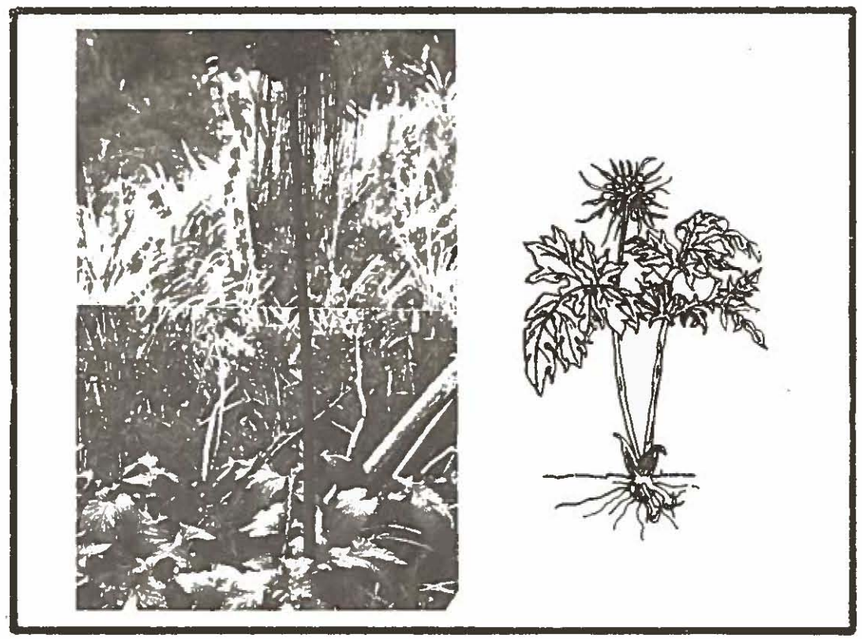
English Name Chinese Lantern

Chamorro Name Tumatis Chaka

Range Phillipines and the Pacific Islands, probably originated in Tropical America

Description: This is a smooth-leafed herb with lanceolate leaves and angular stems. The leaves are coarsely serrate and more or less acute at both ends. The flowers are yellowish and grow from leaf axils. The fruit is enclosed in a baloon-like calyx.

Use: This species of Physalis is considered to be the same plant as P. angulata in the Chamorro taxonomy and is used in the same capacity. Both species are often found together in emerging weed communities on bulldozed land.



Family Taccaceae

Scientific Name Tacca leontopetaloides

English Name Polynesian Arrowroot, South Sea Arrowroot

Chamorro Name Gapgap

Range Tropical Africa and Southeast Asia to Australia, Philippines, Micronesia and Polynesia

Description: Tacca is a perennial herb with deeply-lobed leaves and hollow stems. The flowers are greenish and grow in a terminal umbel or flat-topped cluster with long threadlike bracts at the base. The fruit is a yellow berry.

(Drawing adapted from Merrill, 1945)

Use: This herb may have been brought to Guam by the precontact Chamorro islanders. An edible starch is obtained from the tuberous root after it has been soaked, ground and dried. This flour is nearly tasteless and has a medicinal use. It is sometimes mixed with water and taken internally as a remedy designed to provide relief from nervous tension.

Family Urticaceae

Scientific Name Elatostema calcareum

English Name

Chamorro Name Tapun Ayuyu

Range Southeast Asia and the Pacific, endemic in Guam.

Description: This is a fleshy herb with asymmetrical or unequal-sided leaves. The leaves have three, more or less parallel veins--the margins wavy. The flowers grow on short-stemmed heads from leaf axils.

Use: The succulent consistency of the stem gives crushed medicines added moisture. The herb is most commonly found in damp areas of the limestone forest, but can also be found on the strand as part of the understory vegetation. It is often seen growing with a similar-looking relative, Procris pedunculata. Womersley (1973:121) reports that Elatostema species contain a stimulant which encourages hyper-activity.

Family Verbenaceae

Scientific Name Calicarpa candicans

English Name

Chamorro Name Masigsig

Range Pacific Islands

Description: This is a sprawling, woody shrub with opposite, oblong leaves, acute at the apex, medium green above and grayish white beneath. The small flowers are mauve and occur, many together, in leaf axils. The fruits are clusters of reddish berries growing close to the stem.

Use: The leaves of this strand plant are a common ingredient in the medicinal combinations of local curers. It is an ingredient in amot tinino.

Family Verbenaceae

Scientific Name Clerodendrum inerme

English Name

Chamorro Name Lodugao

Range Indo-Malaysia, Australia and the Pacific

Description: This is a trailing shrub with long, woody stems and whorled (in threes) or opposite leaves. The small flowers grow several together from leaf axils and are white with long, pink stamens. The fruit is black, consisting of four nutlets.

Use: This attractive plant grows on rocky coasts, sometimes very near the sea or at the edge of the jungle and marshes. The crushed leaves are reported to be effective in preventing the swelling of bruises when applied topically. The roots are used in the treatment of fever.

Family Verbenaceae

Scientific Name Premna obtusifolia

English Name

Chamorro Name Ahgao

Range Malaysia and the Pacific Islands

Description: Premna is a small to medium-sized tree with opposite, broadly ovate, smooth leaves, rounded or obtuse at the base. The flowers are small and greenish, occuring in many branched, crowded corymbs. The fruits are small and green, becoming purple when mature.

Use: A distinguishing characteristic of this small tree are the galls that are often present on the surface of the leaves. The tree is usually found in the limestone forest. The leaves are boiled into a medicinal tea that is reputed to have analgesic effects. This home remedy is used mostly in the treatment of backaches.

Family Zingiberaceae

Scientific Name Zingiber officinale

English Name Ginger

Chamorro Name Asngut, Mangnu

Range Native to India and China, now widespread in the tropics as an edible herb.

Description: This is a tall, smooth-leafed herb that reaches a height of 90 cm. or more. The leaves are 20-30 cm. long and about 3 cm. broad with a long sheathing base. The flowers are pinkish and borne on a long spike. The rootstock is tuberous.

Use: This is the cultivated commercial ginger that is used as a spice in cooking. The aromatic root is added to coconut oil for a palai body lotion that is believed to ward off the effects of spirits if applied before entering the jungle or cures spirit-caused ailments when applied topically. It is most commonly used in this capacity on the island of Rota.

INDEX OF SCIENTIFIC NAMES

INDEX OF ENGLISH NAMES

INDEX OF CHAMORRO NAMES

BIBLIOGRAPHY

Bushnell, O.A.; Fukuda, Mitsuno and Makinodan, Takashi. "The Antibacterial Properties of Some Plants Found in Hawaii." Pacific Science, IV, No.3, (1950), 167-183.

Gwynne, Peter, "Doomed Jungles?" International Wildlife, VI, No. 4, (1976), 36-46.

Levand, Oscar, Some Chemical Constituents of Morinda Citrifolia L. (Noni). Ph. D. Thesis, University of Hawaii, (1963).

McMakin, Patrick D. The Suruhanos: Traditional Curers on the Island of Guam. Master's Thesis, University of Guam, (1975).

Merrill, Elmer D. Plant Life of the Pacific World. The Infantry Journal, Fighting Forces Series, Washington, D.C., (1945).

Moore, Anne. "Those Who Cure." Glimpses of Guam, XIV (1974). 157-160.

Moore, Anne. "Some Aspects of Native Chamorro Medicine." Research Paper, University of Guam, (1974).

Moore, Philip H. and McMakin, Patrick D. The Plant Communities of Guam: an Ethnobotanical Survey. (1976).

Nelson, Alexander. Medical Botany. Edinburgh: E. and S. Livingstone, Ltd., (1951).

Okabe, M. "Investigation on the Medicinal Plants Found on the Palau Is.: Their Virtues and Popular Remedies. " Bull. Trop. Indust., Palau, (1940).

Salcedo, Carl. "The Search for Medicinal Plants in Micronesia." Micronesian Reporter, XVIII, No. 3, (1970).

Sproat, M.N. A Guide to Subsistence Agriculture in Micronesia. Agricultural Extension Bulletin No. 9, Saipan, Mariana Island. (1968).

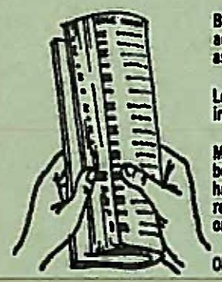
St. John, Harold. List of Flowering Plants in Hawaii, Pacific Tropical Botanical Gardens, Kauai, Hawaii, Cathay Press, Hong Kong, (1973).

Stone, Benjamin C. "The Flora of Guam." Micronesica, VI, No. 1, (1970).

Wormersley, John S. "Botanical Validification in Medicinal Plant Investigations." Regional Meeting on Medicinal Plants, Papeete, Tahiti, 12-17 Nov., 1973. Noumea, New Caledonia, (1974).

EDGE INDEX

HOW TO USE THE EDGE INDEX



Bend the book nearly double and hold it in your right hand as shown.

Locate the listing you want in the Edge Index.

Match up the 1 or 2 line symbol next to the listing you have selected with the corresponding 1 or 2 dot symbol on the page edge.

OPEN THERE.