

**WILDLIFE AND WILDLIFE HABITAT OF
AMERICAN SAMOA. I.
ENVIRONMENT AND ECOLOGY**

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U.S. Fish and Wildlife Service
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Foreword

A survey of the status of the wildlife and wildlife habitat of American Samoa, an unincorporated Territory of the United States, was recommended by administrative officials of the U.S. Fish and Wildlife Service (FWS) in the early 1970s. Environment Consultants, Inc. (ECI), based in Dallas, Texas, was selected to conduct a 2-year survey with A. Binion Amerson, Jr., as Principal Investigator. The contract was administered through the Division of Federal Aid in FWS Region I, Portland, Oregon.

The primary objectives of the survey were (1) to define the major ecosystems and to inventory their physical components, vegetation, and wildlife constituents; (2) to prepare maps of these ecosystems; (3) to identify any threatened or endangered species of wildlife; and (4) to recommend wildlife management opportunities and needs. The report of the survey was to be in two parts. The first was to be a non-technical account suitable for wide general distribution; the second was to include the technical aspects of the data and data gathering, with accounts of the wildlife species. This volume represents the first part of ECI's report.

The final report submitted by ECI contained more than 1,200 pages, 200 figures, and 110 tables, many of the latter several pages long. The FWS felt that the report was too lengthy for publication in the form submitted. The task of editing and condensing ECI's report into publishable form, without altering its essentials, was assigned to Richard C. Banks, National Fish and Wildlife Laboratory, FWS, Washington, D.C. Claudia J. Angle assisted with revision of the figures, and Linda Wolfe retyped most of the text.

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Wildlife and Wildlife Habitat of American Samoa.

I. Environment and Ecology

by

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Abstract

A survey of the status of the terrestrial vertebrate wildlife and the wildlife habitat of American Samoa was conducted from 15 June 1975 to 21 December 1976. Data were collected from 42 study plots in 16 vegetation communities and habitat types on the seven islands, and from 98 linear survey routes between the study plots.

American Samoa consists of five volcanic islands and two atolls in the Tropical climatic zone. The volcanic islands were originally covered with Tropical Rain Forest, much of which is now highly disturbed. There is a small cloud forest zone. Plantation land, rain and ridge forests, secondary forest, and village land now make up most of the habitats. One species of amphibian and 15 of reptiles occur in American Samoa. The avifauna includes 54 species. There are seven species of mammals. Undisturbed habitats are most used by the native wildlife, whereas introduced species are most abundant in disturbed areas.

Threatened and endangered wildlife species and habitats are identified, and possible programs for their protection are discussed.

Introduction

American Samoa, in the Southwest Pacific (Fig. 1), is an unincorporated Territory of the United States administered by the U.S. Department of the Interior. Although American Samoa has not been subjected to apparent, extensive wildlife habitat degradation, population growth from 5,000 in 1900 to 29,190 in 1975 has precipitated development pressures which could lead to adverse environmental impacts. Knowledge of local biotic systems is therefore necessary so that planners can protect and enhance the valuable natural environment of these islands.

In the early 1970s, administrative officials suggested that a thorough field inventory and assessment of the plant and wildlife constituents of the seven islands of American Samoa (Fig. 2) was necessary. Such a survey would serve as a threshold for investigations on specific wildlife conservation problems, provide facts needed by administrators in making judgments on conservation issues, and identify threatened or endangered species living on the islands.

History of the Project

In December 1973 the U.S. Fish and Wildlife Service (FWS) issued a request for proposals for a survey of the wildlife and wildlife habitat of the islands of American Samoa. Environment Consultants, Inc. (ECI) was selected as the contractor. The project officially began on 20 March 1975. During the first 3 months of the project, spent in preparation for the intensive field survey, all pertinent literature was assembled and reviewed. The resultant bibliography of Samoan wildlife and wildlife habitat incorporated more than 200 entries; an additional bibliography of about 400 articles relevant to Southwest Pacific island ecology was also compiled.

In June 1975, ECI established an office in Pago Pago, on Tutuila Island. The first several weeks in Samoa were used for reconnaissance of the islands and selection of community type study plots. The quantitative inventory of wildlife and wildlife habitats was begun on 15 June 1975 and continued for 18 months, through 21 December 1976.

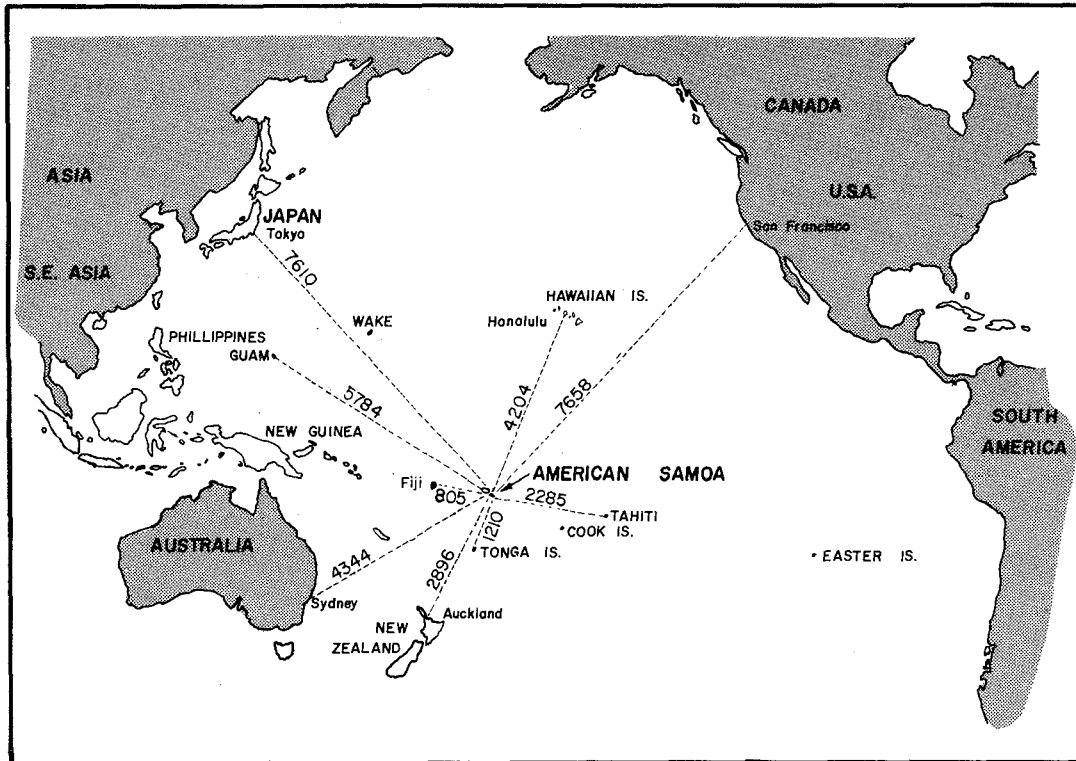


Fig. 1. General location of the islands of American Samoa. Distances to other locations are shown in km.

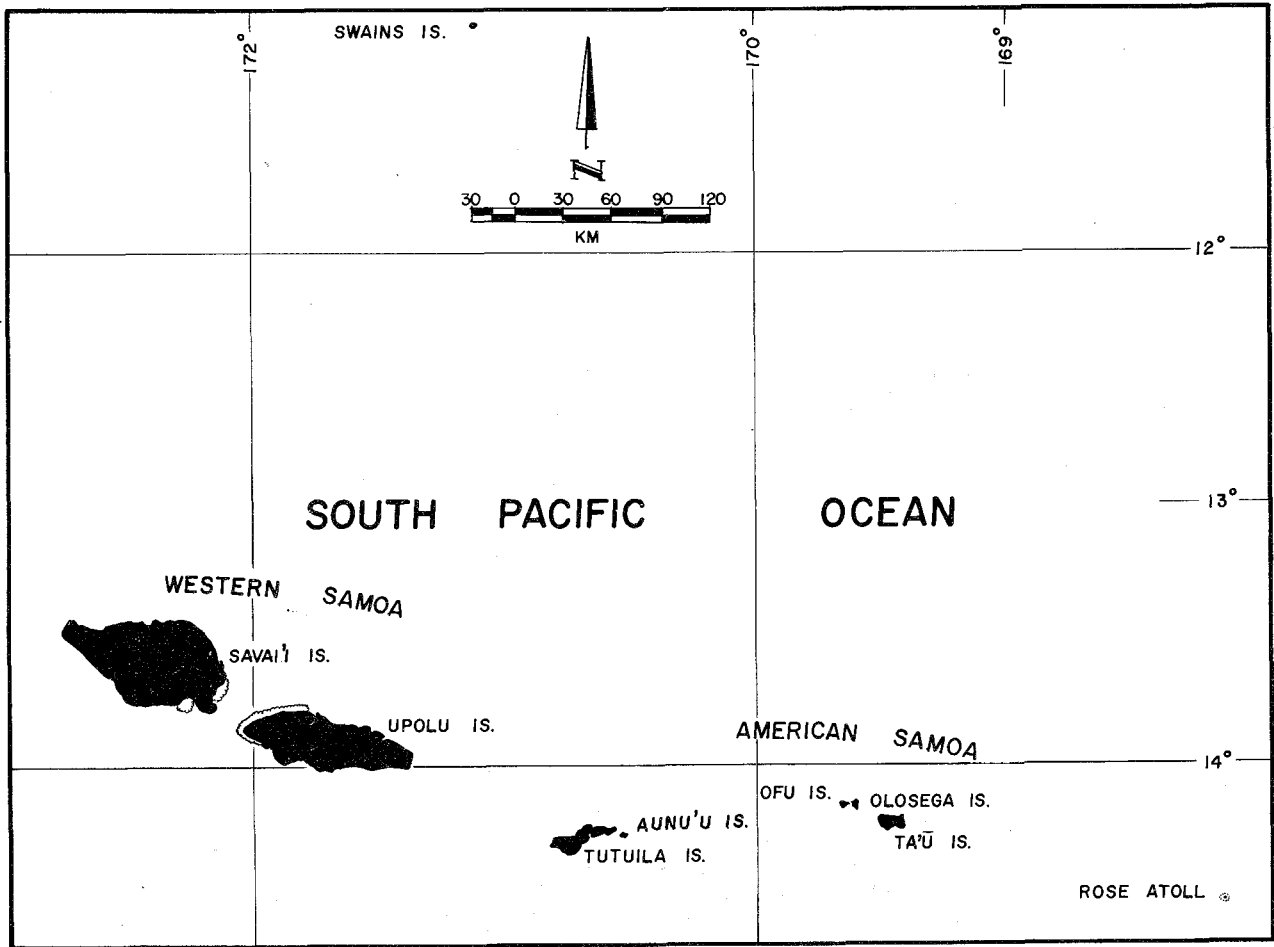


Fig. 2. Regional setting of the islands of American Samoa and their relationship to Western Samoa.

Objectives of the Study

Because relatively little quantitative data regarding wildlife and wildlife habitat of American Samoa existed at the inception of this project, it was necessary to establish objectives which would maximize collection of the most important information within the time and funding limitations of this project. The primary objectives were to:

1. Define the major ecological types (plant communities) which collectively make up American Samoa by:
 - a. describing each community generally in terms of soils, moisture, light, slope, elevation, and other physical factors;
 - b. identifying the plant species, with special emphasis on the vascular flora, which characterize each community type; and
 - c. identifying the wildlife species present in each community, noting seasonal occurrence and approximate population density for each wildlife species. Wildlife was defined to include mammals, birds, reptiles, and amphibians.

2. Prepare maps of American Samoa showing the distribution of the ecological types.
3. Describe the roles of disturbance and succession as determinants of the existing plant and animal communities.
4. Identify and record the status of any species (plant or animal) threatened with extinction or extirpation, and to describe the factor(s) responsible.
5. Identify management opportunities and options for the wildlife and wildlife habitat of American Samoa, and describe future research needs.

A secondary objective of the study was to determine the effects of Polynesian rat predation on birds and turtles at Rose Atoll National Wildlife Refuge.

Samoaan Scientific History

The scientific history of American Samoa is important because the cumulative efforts of many previous explorers, historians, and scientists established the benchmark of knowledge from which this study commenced. Perhaps of

even greater relevance, the sequence of exploration and settlement of the islands played a key role in the evolution of the original ecosystems to the present patchwork of floral and faunal communities documented in this report.

Two complete histories of American Samoa have been written by Gray (1960) and Gilson (1970). The following summary only highlights Samoan political history. The primary intent is to provide an overview of the scientific exploration of Samoa, and to suggest the interrelations between its inhabitants and their natural environment. Specific accomplishments of various expeditions are discussed in the later biological sections.

Discovery and Early Exploration

Early Polynesian discovery.—The first inhabitants probably were descendants of people who migrated from Southeast Asia to Indonesia, New Hebrides, and Fiji, before

coming to American and Western Samoa. The exact date of arrival is unknown, but by 600 B.C. Polynesians had already established themselves on the eastern tip of Tutuila Island (GAS 1976). These settlers introduced many animals and plants, including the chicken, pig, and coconut palm. Slash-and-burn agriculture, a major contributor to the destruction of Samoa's native forests, was practiced by the early settlers.

Around 1200 A.D., Samoa was invaded by Tongans (from islands to the south), and for about 200 years, all of Samoa except for Ta'ū Island was ruled by Tonga. After the Tongans were driven out, the people of Upolu and Savai'i (Western Samoa) and Tutuila frequently clashed. People of the Manu'a Group—Ofu, Olosega, and Ta'ū Islands—took little interest in these affairs and remained politically separate for several hundred years.

European discovery.—Samoa was discovered on 18 June 1722 by the Dutch merchant-explorer, Captain Jacob Rogge-

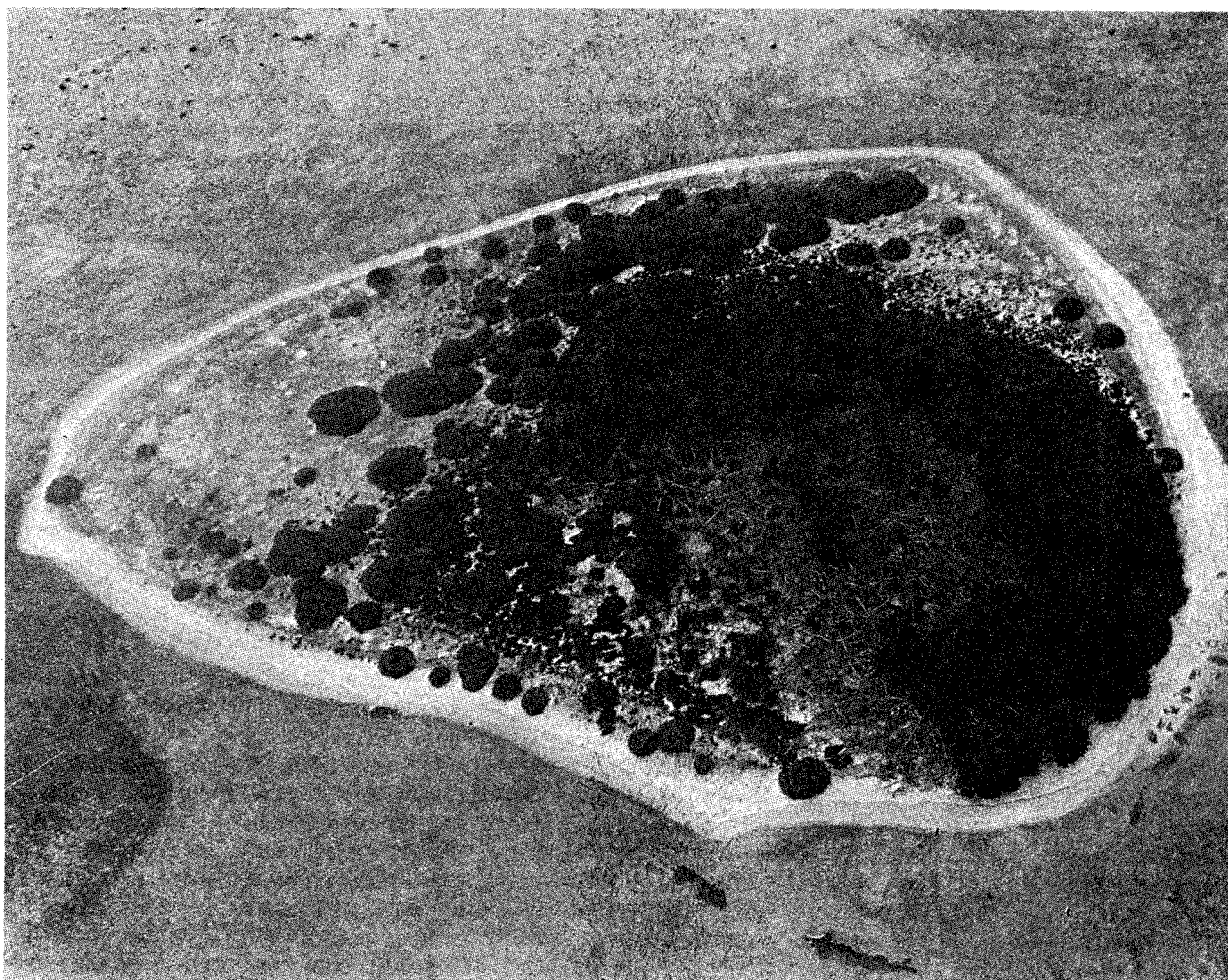


Fig. 3. Aerial view of Rose Island, Rose Atoll, showing *Pisonia* forest and coconut palms. The die-off of *Pisonia* is shown (1975 photo).

veen. His two ships visited Ta'ū first, then sailed west to Ofu and Olosega, and finally left without landing. Because Roggeveen fixed the position of the three islands inaccurately, the islands remained unknown for nearly another 50 years. In May 1768, the French navigator, Louis A. de Bougainville, sighted the Manu'a Group. Fruits were taken aboard at Ofu and Olosega before the ships sailed westward to Tutuila and Upolu. Bougainville (1772) described the islands as "clothed to the summit with trees laden with fruit, on which wood-pigeons and green, rose and different coloured turtle doves reposed." These were the first written observations about the plants and animals of Samoa. Various British and French ships visited Samoa in the late 1700s. In December 1787, the French explorer, Jean Francois la Perouse, first sighted the Manu'a Group and subsequently landed at A'asu and Fagasa villages on Tutuila. Plant specimens were collected, despite the fact that 12 Frenchmen were killed in a massacre at A'asu.

Rose Atoll, because of its closeness to Ta'ū Island and its enormous seabird colonies which provided a valuable source of food, was often visited by the people of the Manu'a Group. On 21 October 1819, the Frenchman, Louis de Freycinet (1826) discovered Rose Atoll (Fig. 3). His observations included both animals and plants but primarily emphasized physical, nautical, and meteorological information. Swains Island, about 320 km north of Tutuila, was originally part of the Tokelau Islands, whose people visited it irregularly. Swains Island was settled in 1856 by the American trader, Eli Jennings, and his Samoan wife, who developed the island into extensive coconut (copra) plantations. Jennings' citizenship eventually linked Swains Island to American Samoa and the family still owns the island.

United States explorations.—Although whaling ships sometimes entered waters around American Samoa, the first American expedition to visit Samoa, led by Capt. Charles Wilkes, USN, stopped at Rose Atoll and Tutuila Island in late 1839. Wilkes headed a group of scientists participating in the United States Exploring Expedition (USEE). They collected vast amounts of data, including scientific specimens, charts, and drawings from many of the Pacific islands. In 1872, Capt. Richard Meade, USN, of the USS Narraganset arrived on Tutuila, entered into an agreement that prevented other nations from claiming Pago Pago Harbor, and authorized the establishment of a naval coaling station within the harbor. A second agreement six years later, involving all of Tutuila, remained in effect until 1900.

United States Possession

Navy control.—During the late 1880s, many nations sought island bases in the South Pacific. Competition increased until 1899 when England, Germany, and the United States entered into a treaty whereby Germany gained control of what is now Western Samoa, and the United States gained control of what is now American Samoa. After the treaty was ratified, President McKinley directed the U.S. Navy to establish authority in American Samoa. The United States flag

was officially raised on 17 April 1900—the date is now known as "Flag Day," an official holiday in American Samoa. Four years later, when the king of the Manu'a Group formally ceded those islands to the United States, they also became the responsibility of the U.S. Department of the Navy. This control continued until 1951.

The first Christian missionaries—from the London Missionary Society—arrived in the early 1830s and played an important part in the early scientific exploration of the islands. Between 1860 and 1890, two of these missionaries, the Rev. J. S. Whitmee and the Rev. T. Powell, and a German physician, E. Graeffe, collected both plant and animal specimens. During the late 1800s and early 1900s, professional European botanists (F. Reinecke, K. Rechinger, F. Vaupel, and B. Hochreutiner) and ornithologists (O. Finsch, G. Hartlaub, and M. Mitchell) also explored the Samoan Islands. Mitchell's *Birds of Samoa* was printed by the London Missionary Society in Western Samoa in 1909. This book was followed in 1932 by J. S. Armstrong's *Hand-list to the Birds of Samoa*, a result of the London School of Tropical Medicine Research Expedition to Western Samoa.

Since the early 1900s, scientific exploration of the islands has been dominated by American scientists. In 1906, D. S. Jordan and A. Seale produced *The Fishes of Samoa* from investigations by the U.S. Bureau of Fisheries. An expedition by the Carnegie Institution of Washington investigated Tutuila and nearby areas from 1917 to 1920. Important contributions to knowledge about the marine life and geology of American Samoa were made by Carnegie scientists R. T. Chamberlin, R. A. Daly, C. B. Lipman, A. G. Mayor, and W. A. Setchell. Setchell's botanical work on Tutuila in 1920 resulted in the first published account of the flora and vegetation of this island (Setchell 1924). Other botanists, including E. Christophersen in the 1930s and C. Chistensen and T. G. Yunker in the 1940s, also published important accounts of the flora.

The Whitney South Sea Expedition of the American Museum of Natural History visited American Samoa in 1923 and 1924. Burt and Burt (1932) summarized information concerning the reptiles collected by the Whitney scientists. Birds collected in Samoa and elsewhere in the Pacific formed the basis for Ernst Mayr's *Birds of the Southwest Pacific* (1945).

During the early 1920s, Ta'ū Island was the site of Margaret Mead's anthropological study that resulted in her book *Coming of Age in Samoa*. This popular scientific book, first published in 1928, made Samoa a household name throughout the world. Lowell D. Holmes, another anthropologist, began studies in Manu'a during the early 1950s which resulted in two books (Holmes 1958, 1974); his research is continuing today.

The U.S. Geological Survey carried out investigations in American Samoa between 1941 and 1943 that produced important geology papers by Stearns (1944) and MacDonald (1944). Studies in 1964 by the Hawaii Institute of Geophysics at the University of Hawaii resulted in major contributions

on the geology of the Manu'a Group by McCoy (1965), Stice (1968), and Stice and McCoy (1968).

During the early 1960s, personnel at the Pacific Scientific Information Center of the Bernice P. Bishop Museum, Honolulu, Hawaii, became interested in the bird life of Samoa, perhaps influenced by brief observations there by Allan Keith in 1957 and William Dunmire in 1960. In 1963, Myrtle J. Ashmole assembled summaries of all available bird information into a *Guide to the Birds of Samoa*. The Pacific Ocean Biological Survey Program (POBSP) of the Smithsonian Institution used Tutuila as a refueling stop during its ecological studies of the islands of the Central Pacific from 1963 to 1969. Observations and collections made on Tutuila and Swains Island, as well as at sea, produced worthwhile contributions to the knowledge of the reptiles, birds, and mammals of this area. Some of these data, especially reptile and mammal specimen information, are reported here for the first time.

U.S. Department of the Interior control.—On 29 June 1951 the administration of the Territory was transferred by Presidential Executive Order 10264 to the U.S. Department of the Interior. After that date, civilian governors were appointed by the Secretary of the Interior. In late 1976, the people of American Samoa voted in favor of electing their own governor. Today, the "Fono" or Samoan Legislature, composed of 18 senators elected by the county councils, and 20 representatives (plus a delegate from Swains Island), governs according to a Territorial Constitution approved in 1960 and revised in 1967.

In 1972 the people of American Samoa, conscious of the need to protect the natural beauty and ecology of their islands, through the Fono authorized the formation of an Environmental Quality Commission and the hiring of a Government Ecologist. On 5 July 1973 a cooperative agreement between the Government of American Samoa and the Fish and Wildlife Service, U.S. Department of the Interior, set aside Rose Atoll as a National Wildlife Refuge. In 1975, an American Samoa Recreation Area Development Plan was issued (GAS 1975), which, in addition to providing recreational facilities, identified National Historic Landmarks and National Natural Landmarks.

Procedures

An ecosystem approach to data collection was selected because it provided the greatest amount of interpretable data per unit of field effort within the constraints of this survey. The various biological communities and their associated physical environments function together as distinct ecosystems which provide convenient units of study. The ecosystem approach is a broad one, and its principal advantage as a working concept is that it emphasizes obligatory relationships, interdependence, and causal affiliations among system components.

Literature review, air photography interpretation, and field reconnaissance were used to define and map the ecosystems of American Samoa. At least one study plot was estab-

lished within each natural ecosystem to provide a quantitative basis for descriptions of each biological community and its physical environment. Linear surveys were conducted between the study plots and elsewhere on the islands to obtain qualitative and semi-quantitative data on the geographical and ecological variations associated with the different community types.

Study plots.—In the original plan, the wildlife and wildlife habitats of American Samoa were to be studied in a series of study plots, one for each of the 13 major community types adapted and modified from Setchell (1924). After field work began, however, it became evident that the original sampling scheme was insufficient, since more community types were present than anticipated. Further sampling of intermediate types was required to identify the relationships among the communities. In addition, replicate plots were needed to reduce errors due to small sample size and to obtain a better representation of the mosaic character of the tropical rain forest. A total of 41 study plots was finally established (Figs. 4, 5).

The vegetation of American Samoa can be divided into 10 natural and 6 disturbed community types.

Rock strand—The usually sparse herbaceous vegetation of rocky shores, dominated by grasses and succulents.

Sand strand—The herbaceous vegetation of sandy shores, dominated by creeping vines. This and the rock strand are collectively referred to as "littoral strand."

Littoral scrub—The scrubby vegetation of the seaward margin of the littoral forest and of windswept coastal slopes.

Coastal marsh—The herbaceous vegetation of low, flat coastal wetlands, dominated by sedges and ferns.

Mangrove forest—The forest in swampy, saline, coastal areas, dominated by salt-tolerant "mangrove" species.

Littoral forest—The forest on the rocky or sandy shore, dominated by one or more of several widely distributed trees that are tolerant of salt spray.

Rain forest—The high forest which predominates from the littoral or coastal forest up to the cloud forest and montane scrub. The lower elevations are referred to as low-land rain forest and the higher elevations as montane rain forest.

Ridge forest—The forest on steep ridges, similar in species composition (but not in structure) to the rain forest.

Cloud forest—The dense, wet forest at high elevation, characterized by cloudy conditions and abundant epiphytic growth.

Montane scrub—The scrubby mountain vegetation on areas of poor soil or steep cliffs.

Village land—The land in villages, towns, schools, and industrialized areas.

Pasture land—The grassy or herbaceous vegetation maintained for cattle raising.

Plantation land—Coconut, banana, and taro cropland away from the immediate vicinity of the villages.

Kula fernland—The fern-dominated vegetation on periodically burned coastal bluffs.

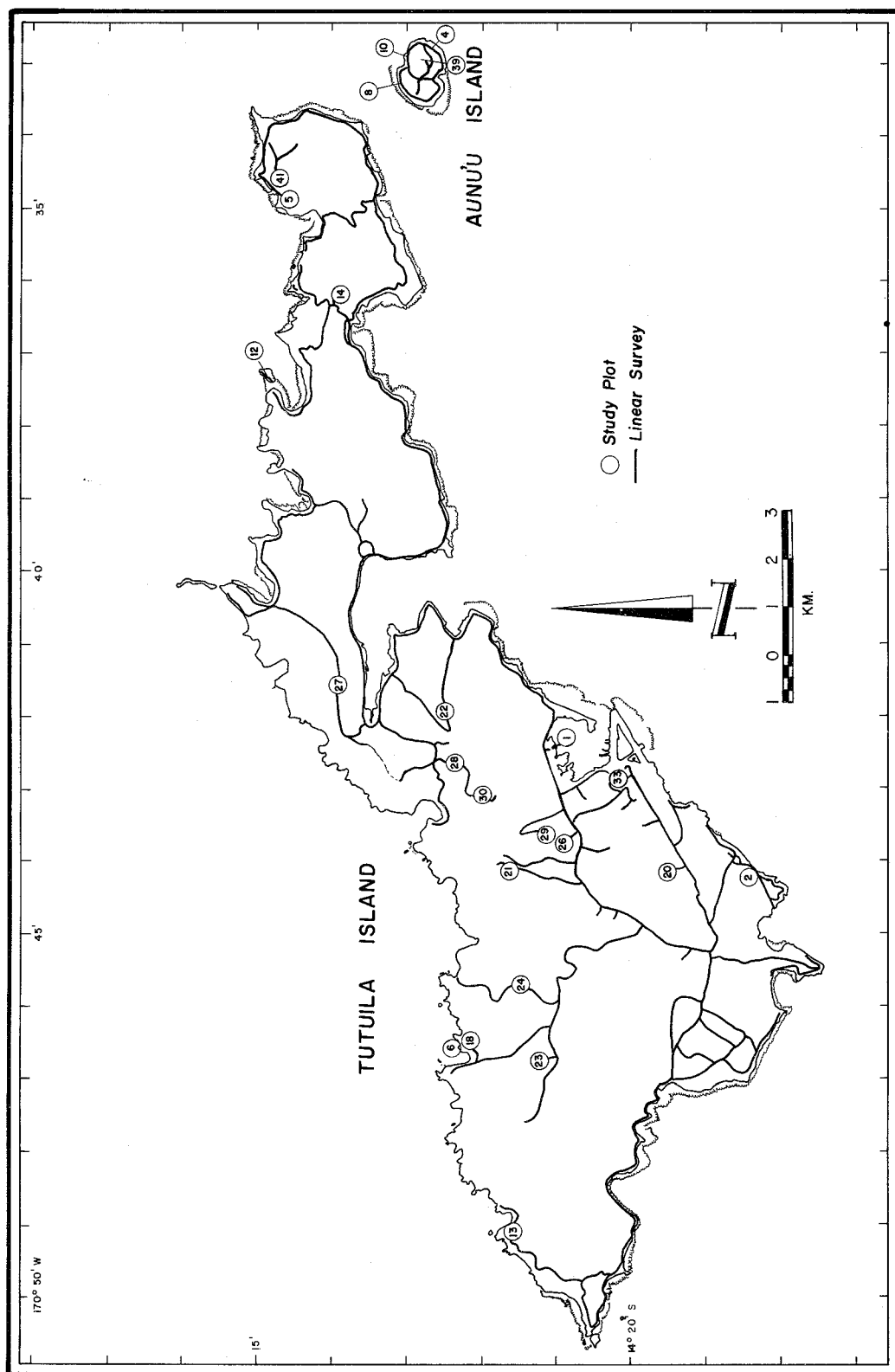


Fig. 4. Location of community study plots and linear surveys on Tutuila and Aunu'u islands.

Secondary forest—The disturbed forest on abandoned plantation land, found in various stages of development.

Disturbed coastal marsh—The disturbed vegetation of low coastal wetlands, mainly planted in taro.

After selection of the 41 community-type study areas, plots of 1,000 m² were marked off. These plots were subdivided into 10 subplots (or smaller quadrats) for ease of recording data. Detailed descriptions and locations of the 41 plots and the locations of permanent markers are given by Amerson et al. (1982).

Samples, measurements, and observations of microclimate, soils, and vegetation were taken in the plots to permit later analysis of ecosystem relationships. To define the biological habitat at each plot, trees and saplings were measured and their heights estimated. The ground cover of the plots was sampled by estimating the area covered by each species in subplots. Vine and climbers in the forest were sampled for frequency and relative abundance, and the presence of epiphytic plants was noted. The extent of vegetation sampling effort is summarized in Table 1.

Detailed wildlife surveys also were conducted in each of the major community types (Table 1, Figs. 4, 5). Wildlife data obtained from each plot included lists of animal species observed, marking and recapture information, and field notes containing observations on density, breeding, and food habits.

Linear surveys.—In addition to work in the 41 community type study plots, extensive qualitative and semi-quantitative observations were made by using 98 linear surveys (see Amerson et al. 1982: Table 2) covering 236 km. Total mileage of the 173 replicate linear surveys was 431 km. Several of these surveys were made by walking, and some were driven. This method was most applicable for covering large areas on a frequent basis and for providing qualitative data to establish distribution patterns of wildlife and wildlife habitat. Linear survey data consisted primarily of notes concerning identification, abundance, distribution, diversity, and density, and on the relationships of species to geological, soil, or climatic factors.

Reptile and amphibian collections and observations were made at many locations in addition to the study plot and linear survey areas. Observations of seabirds were made during three trips to Rose Atoll and one trip to Swains Island.

Voucher specimens.—Specimens of 290 flowering plant species and 67 fern species were collected. Identifications were verified by consulting the U.S. National Herbarium, National Museum of Natural History, Smithsonian Institution, the University of Hawaii Herbarium, and the Bernice P. Bishop Museum Herbarium, Honolulu. Voucher specimens of 29 species of birds, 5 species of mammals, 14 species of reptiles, and 1 species of amphibian were collected. Identifications were verified by consulting the collections at the National Museum of Natural History, Smithsonian Institution. These specimens and all supporting data are deposited in the U.S. National Museum of Natural History, Washington, D.C.

Physical Environment

Although the geography, geology, oceanography, and climate of the American Samoan islands have been relatively well studied, soils, microclimates, and land-use patterns are less well documented. The following sections of this report describe the physical setting of American Samoa from data obtained from literature accounts (Daly 1924; Stearns 1944; MacDonald 1944, 1968; McCoy 1965; Stice 1968; Stice and McCoy 1968) and from field surveys conducted as part of the present project.

Geography

American Samoa is located about 14° South Latitude and 170° West Longitude and is comprised of seven islands whose total land area is about 197 km². The islands are mountainous and covered with jungle; they have steep shorelines, rather narrow fringing reefs, and thick sediment aprons. The elongate Samoan Island group is a northwest to southeast volcanic chain about 4,180 km southwest of Honolulu and about 925 km northeast of Fiji (Figs. 1, 2). Included in this chain from west to east are the islands of Tutuila, Aunu'u, Ofu, Olosega, Ta'u, several offshore islets, and Rose Atoll. Another island within the political jurisdiction of American Samoa, Swains Island, is about 320 km north-northwest of Tutuila. The Tokelaun name for Swains Island is "Olosenga" (Bartholomew 1922; Office of Geography 1956; Su'apa'ia 1952; National Geographic Society 1974). Although Burt and Burt (1932) listed "Olosenga" as a Whitney South Sea Expedition collecting site for lizards, the specimens came from Olosega, not Swains.

The Samoan Islands lie along the crest of a submarine ridge that trends approximately S 70° E, roughly perpendicular to the oceanic trench called the Tonga Deep (Fig. 6). The Samoan Ridge is apparently the surface expression of a large, regional sea-floor fault along which volcanoes have erupted, forming various island groups.

The islands of American Samoa range in size from about 142 km² for Tutuila, which is the largest, to 0.04 km² for Rose Atoll, the smallest. Ta'u has the maximum elevation of 966 m; Rose Atoll and Swains Island are flat and rise less than 9 m above mean sea level. The topography, notes on size and maximum elevations, and locations of villages, mountains, and other significant features of the islands are shown in Figs. 7-9.

Geology

Massive, often violent volcanic eruptions along a submarine fault provide the common origin of the major American Samoan islands and other nearby islands. Each major island is the peak of a volcanic mountain built from the sea floor to a height well above sea level by voluminous lava flows that occurred during the Pliocene, more than 2 million years ago. These mountains rise about 4.5 km to

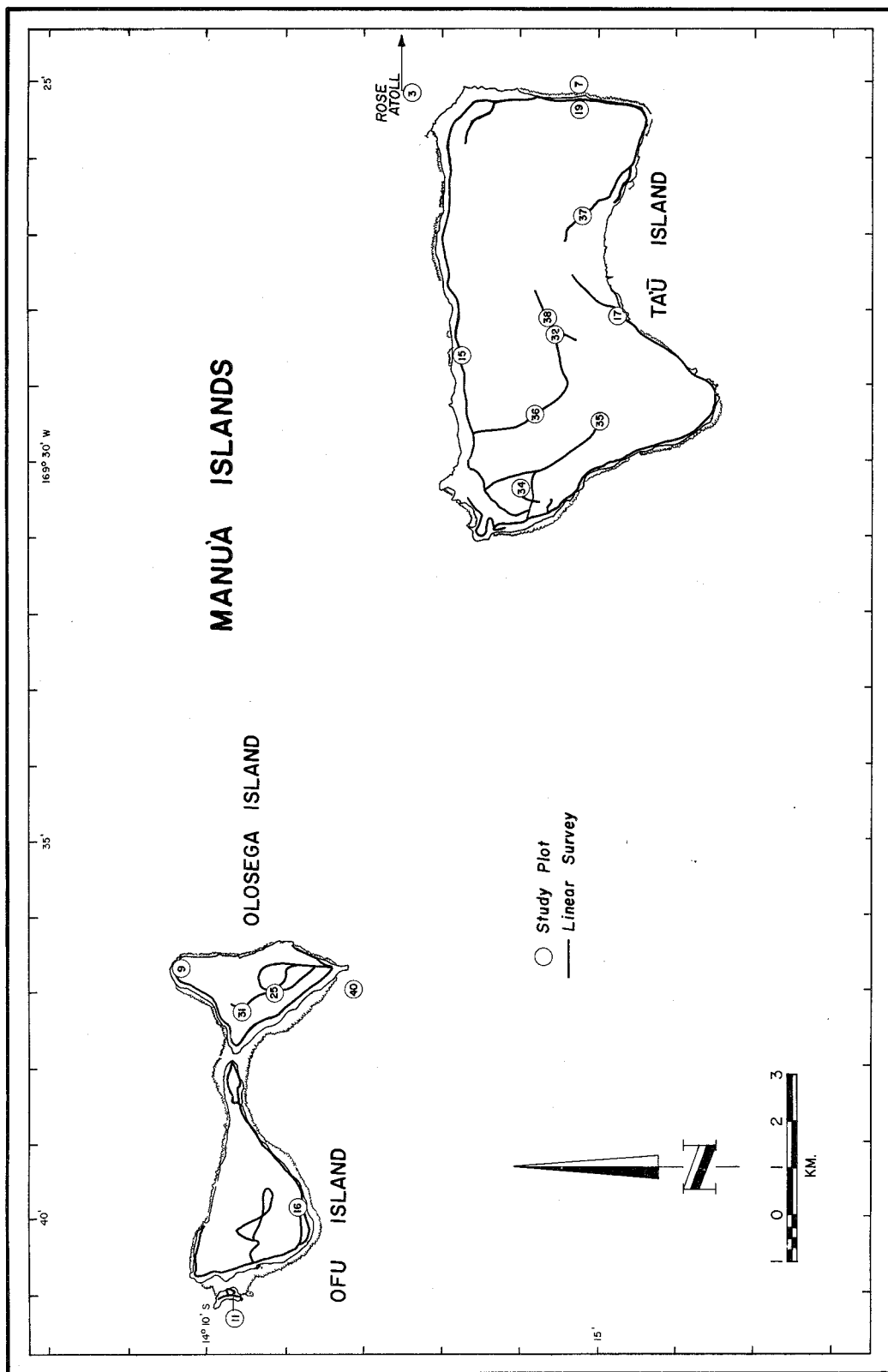


Fig. 5. Location of community study plots and linear surveys on Ofu, Olosega, and Ta'u islands.

reach the ocean surface. The original volcanic activity was followed by surface lava extrusions and the collapse of basin-shaped, volcanic depressions called calderas. After a period of erosion, renewed volcanism began in the late Pleistocene, less than 1 million years ago, and continues to the present. Geologically Recent lava flows or cone formations have been described for each of the islands (Stearns 1944; Kear and Wood 1959; Stice and McCoy 1968). Historical records have documented eruptions and accompanying seismic activity in the Manu'a group in 1866 and on Savai'i of Western Samoa as recently as 1911.

Tutuila Island.—Most of the rocks on Tutuila are gray to black basalt, textures of which depend on the rate of cooling of the original lava. Compacted volcanic fragments form a rock called tuff which, with Recent basalts, comprises the large flat plain on the southwest side of the island. The large reef fringing Pago Pago Harbor consists almost entirely of slightly compacted calcareous silt and sand, except at the surface where there is a veneer of coral, coralline algae, and coral sand (Stearns 1944).

Tutuila, with its rugged terrain and deeply embayed coastline, is exemplary of a cyclical history of erosion followed by submergence. The extensive, nearly flat plain between Nu'uuli and Leone is built of Recent lava and tuff laid down on the submerged reef. The river valleys are deep, as on most other tropical basaltic islands. Although the higher peaks are covered with scars of landslides, the evidence is largely hidden by the lush vegetation.

Pago Pago Valley, which nearly bisects the island, was eroded in weak tuffs along the foot of the Pago caldera wall before drowning and forming Pago Pago Bay. The small streams near Point Nelson enter the sea in hanging valleys because the waves cut away the coast faster than the streams could cut downward. The lagoon at Nu'uuli was caused by the shoaling of water by the Recent Leone lava flow and the subsequent formation of a sandy hook known as Coconut Point. The large canyon that drains into this lagoon probably owes its concentration of drainage to the original form of Matafao Peak. Another unusually large and flat-floored valley, Malaeimi Valley, northeast of Mapusaga probably was derived from a stream that eroded inland from the rim of the Pago caldera, somewhat as Pago Pago River did.

Dense feldspar (trachyte) plugs, which are very resistant to erosion, form most of the sharp and prominent peaks on Tutuila such as Matafao and Pioa (Rainmaker) mountains. Most of the basaltic lavas are too thin and irregularly laid down to result in sharp peaks; however, Tuasivitasi and Taumata are typical of ridges resulting from resistance to erosion by massive andesite lavas. The only flat upland surface on Tutuila is the swampy top of Taputapu Volcano (Aoloaofou), which appears to be a relic of the original surface (Stearns 1944). Cape Matatula, the northeastern tip of Tutuila, is a dense, columnar basaltic lava throat which has been etched by wave erosion from the softer cinder bed materials that once surrounded it. Many of the small islets and promontories around Tutuila are similarly formed,

dense, crater fills.

Aunu'u Island.—During the Recent geologic time period, volcanic eruptions from a north-south fissure near Tutuila formed the tuff cone which is now Aunu'u. These were relatively shallow submarine eruptions that occurred on fringing reefs of Tutuila Island. Aunu'u is thus built on top of the drowned reef and sedimentary deposits of Tutuila, and it is located within 1.3 km of Tutuila. The prevailing southeast trade winds and waves which sweep around Aunu'u have built a broad flat of coral sand a few feet above tide level on the western side of the island.

Ofu and Olosega islands.—Ofu and Olosega are within 137 m of each other and are discussed together because their geologic formation was simultaneous. These two islands are a complex of volcanic cones that have been buried by lava from two merging flows. One lava shield is centered off the northwest coast of Olosega near Sili Village, and the other at A'ofa on the northern coast of Ofu. Older cones, approximately aligned along the crest of the Samoan Ridge, include a cinder cone at Tauga Point on northwestern Ofu, a nearby tuff cone at the western end of the beach at Samo'i, a composite cone exposed in the cliff behind To'aga on southeastern Ofu, an explosion cone at Fatuaga Point on eastern Ofu, and another tuff cone at Maga Point on the southern tip of Olosega.

During an extensive period of inactivity between eruptions, deep valleys were carved out and a sea cliff about 90 m high formed around the islands. After the sea cliff was formed, two or three thick lava flows (down old valleys on the southwest side of Ofu) formed Nu'upule Rock and the ridges behind Ofu Village. Nu'utele and Nu'usilaelae islets, off the west end of Ofu, are remnants of a Recent tuff cone. Collapse of a caldera apparently caused the embayment of southeastern Ofu and southwestern Olosega. A Recent shift in sea level is indicated by the exposed beach rock now being eroded in many places around the islands. All sediments except the beach rock are unconsolidated and appear to be of Recent origin.

The stream valleys on southwestern Ofu and southeastern Olosega extend away from the collapsed summits of the former volcanoes in a radial drainage pattern. As intermittent streams, they drain the remaining portion of the caldera and empty into the sea along the coastal cliffs. Because these islands are both lower in elevation and smaller in area than nearby Ta'u, there is considerably less rainfall and resultant runoff. The streams are therefore neither as large nor as numerous as those on Ta'u. The stream valleys are all geologically young and shallow.

The high cliffs along the northern and southern coastlines, originated by faulting or collapse, have been modified by landsliding and subsequent removal of slide debris by wave action. The numerous fan-shaped landslides and fresh scars in the cliffs above indicate that this process is continuing.

Ofu and Olosega are encircled by a narrow fringing coral reef only 485 m offshore at its widest point near Ofu Village. Both large, deep channels and shallower, narrow channels

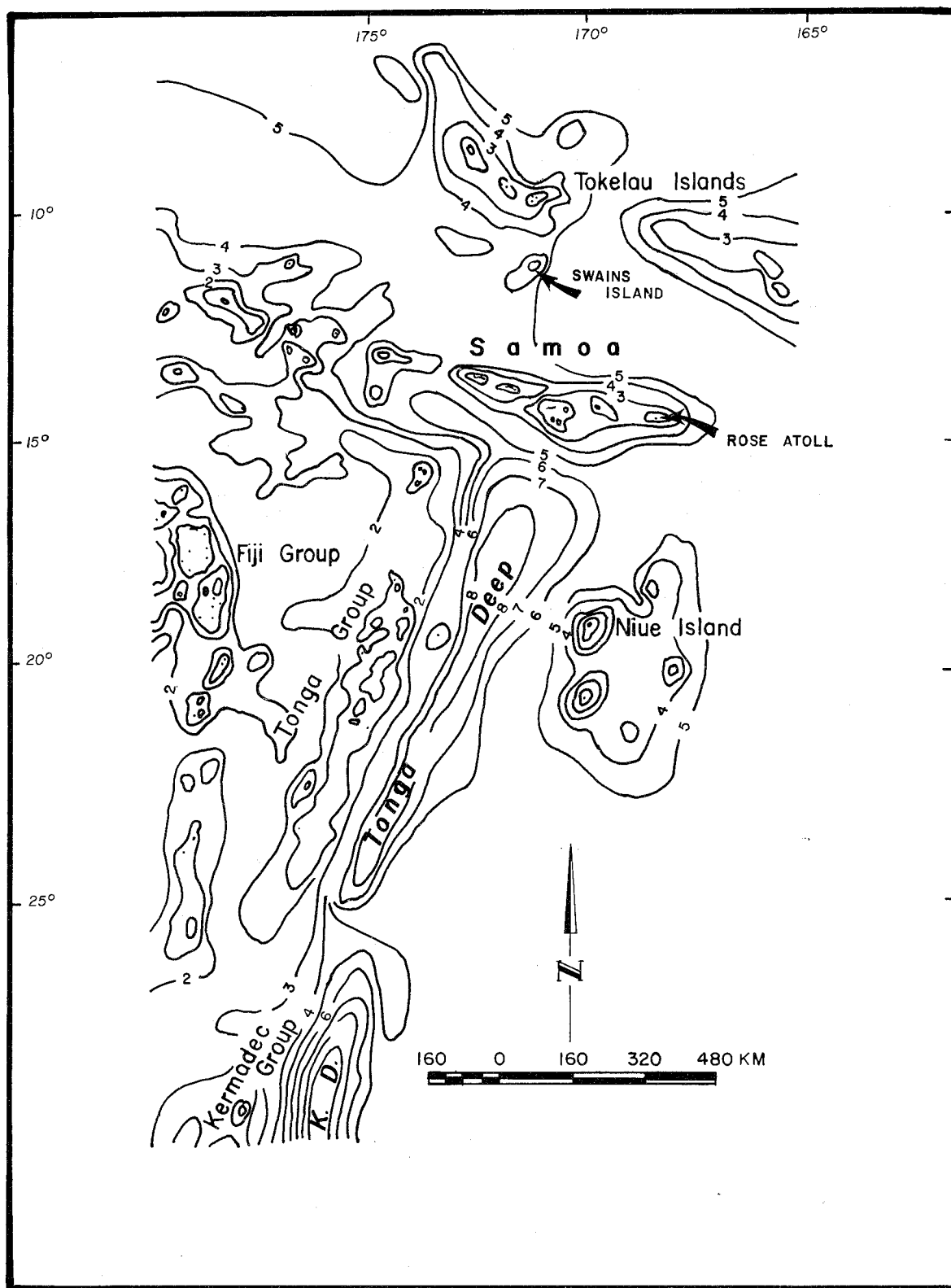


Fig. 6. Relationship of Samoan islands to regional ocean depths; numbers indicate depth in thousands of meters (adapted from Daly 1924).

are cut into the reef front. The surge channels have sand floors, extend out to depths of about 20 m, and are often as wide as 8 m.

Ta'ū Island.—Basaltic lavas that built the main shield volcano forming Ta'ū Island are exposed in the spectacular 425 m escarpment on the southern side of the island, Lata Mountain. The summit of the original volcanic shield collapsed to form a caldera; somewhat more explosive eruptions from cinder cones within the caldera and on the northern flanks of the volcano continued to build up the island.

The radial drainage pattern of the original Lata shield is still present, although somewhat modified by faulting and later volcanism. Avatele, Matautu'ao, and Au'auli streams have cut deep valleys into pre-caldera lava flows where apparently no later volcanism has occurred. The lowermost 305 m of Laufuti Stream on the southern coast is the only perennial drainage on Ta'ū Island. None of the streams on the island is sufficiently mature to have a floodplain; alluvium is present only in the narrow stream beds. Many of the stream beds contain boulders up to 3 m in diameter.

Most of the coastline on Ta'ū consists of beaches less than 30 m wide. Vegetation usually extends to within a few feet of the water because the tidal range is low and reefs protect the shore from most storm waves. Beach rock is extensively exposed, both above and below present sea level along many of the beaches, and is being eroded. Beach material varies in grain size from sand to gravel, but most of the material is fine to medium sand. At Faga, Ma'efu, and a few other areas, cobbles and boulders are cemented in a matrix of medium to coarse sand.

On the south-central coast of Ta'ū the sea cliff in places rises as high as 365 m, but on the northwestern coast the cliff is buried. Ta'ū Village is built on a terrace 3-4.5 m above sea level. Terraces at this elevation are also found at Faleasao, Faga, Saua, Tufu, Amouli, and Si'ufa'alele. On the southern part of Ta'ū, these terraces are composed of sand and coral shingle, but elsewhere they are made up entirely of sand. Hurricane waves top these terraces and may, in part, be responsible for their construction.

A nearly continuous fringing coral reef exists around Ta'ū. Nowhere is the reef front more than 210 m from shore. The reef flat contains calcareous sand, coral, and coralline algae in patches, whereas the frontal edge of the reef is composed of prolific colonies of corals and algae. At various places along the reef front there are surge channels up to 8 m wide and 4.5 m deep (Stice and McCoy 1968).

Rose Atoll.—The geologic formation of Rose Atoll (which includes Rose Island and Sand Island) has not been well documented. Apparently the two islands of Rose Atoll were built in the late Pleistocene on a volcanic basement that may at one time have been a shield volcano similar to others in the Samoan Ridge chain. Rose Atoll lies on a trend of S 70° E, as do other islands on the ridge. Today, Rose Atoll is composed of coral with sand beaches about 3 m above sea level. Emerged reef remnants indicate about a 1.5 m drop in sea level since they were formed.

Swains Island.—Swains Island may have a geologic history similar to that of Rose Atoll. However, it is not part of the Samoan Ridge and stands as an isolated island about 320 km north-northwest of Tutuila. The orientation of sea bottom highs in that area is similar to the trend of the Samoan Island chain, which may suggest initial rifting and venting of basaltic volcanic material. Swains Island is similar to Rose Atoll in structure, but may contain a greater amount of volcanics in its surface core. These surface core volcanics indicate that the island may be younger than Rose Atoll and may not have experienced as much volcanic core erosion. Both Swains Island and Rose Atoll are rimmed by coral reef material with lagoonal centers. During periods of intense wave activity from hurricanes, waves washing onto these islands after their morphology and vegetative cover.

Soils

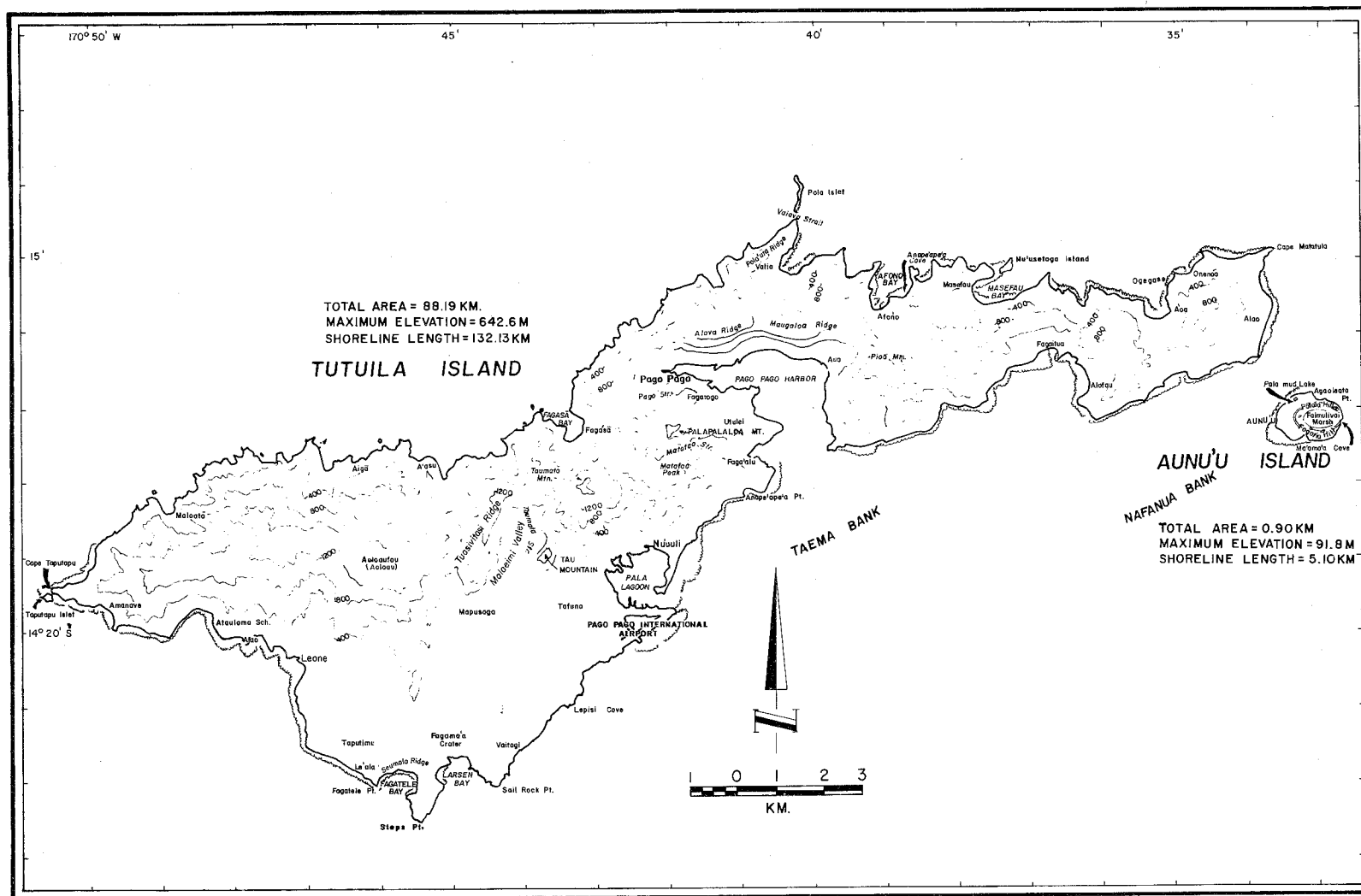
Soil formation may be expressed as the product of weathering and leaching on surface and near-surface parent materials. The weathering action in soil formation is strongly influenced by environment and time, and by the resistance of the parent material. In addition to time of exposure, soil formation is governed by temperature, rainfall, drainage, and vegetation cover. Most soils in Western and American Samoa are classified as latosols. The combination of the weathering and leaching characteristics of latosols results in soils which generally have little silica, high concentrations of iron and aluminum, and relatively low fertility.

General Description of the Soils of American Samoa

The volcanic landscape of American Samoa is made up of a wide variety of features, from high plateaus to coral strands, in which different soils would be expected to develop. Because the soils of American Samoa closely resemble those of Western Samoa, the soil terminology developed by Wright (1963) for Western Samoa has been used in this study.

Latosolic soils (a term suggested by Kellogg 1949) formed from weathered basalts are the primary soils in the Samoan Islands; the name Samoa has been used for this major soil suite. The basic tuffs, another distinctive primary soil parent material in Samoa, also give rise to a major soil suite, named Vini Tuffs. No soil surveys have been conducted on Aunu'u, Ofu, Olosega, Ta'ū, or Swains Island. Therefore, only generalizations can be made about soils on islands other than Tutuila and Rose Atoll.

Tutuila Island.—A simplified classification of the soils series for Tutuila (Table 2) indicates parent material and slope conditions favorable to the formation of a specific soil type. The soils of Tutuila are generally of the Samoan and Vini major soil suites. Within the major Samoan classification, the minor group most widely represented is Fagaloa; within the Vini major soil suite, the prominent soil types are Tafau and Leone. There is only minor development of soils belonging to other soil suites (Fig. 10).



Rose Atoll.—The surface of Sand Island and the base (north) part of Rose Island are apparently composed of unaltered or slightly altered limestone debris, largely algal in origin, which is considered to be a Fusi soil type. The soil within the *Pisonia* grove on Rose Island is quite different and has been the subject of study by Lipman and Shelley (1924). A general profile may be reconstructed: *Top layer*, a rich, chocolate-colored humus of considerable depth near the southern end of the grove; *Intermediate layer*, a dark brown, loose, porous mass, very light in weight, to a depth of several feet; *Bedrock*, a compact, fine-textured, pure calcium carbonate, without structure; pure white and fairly soft, fitting the description of a coquina unit. Lipman and Shelley regarded the intermediate layer as an intermediate product in the decomposition of the bedrock. With the addition of humus to this intermediate layer, a surface layer of fine-textured, shallow organic soil was formed.

The investigations of Lipman and Shelley (1924) revealed an unusually high concentration of water-soluble salts in the soil. They regarded the *Pisonia* tree as "one of the most salt-tolerant plants of which we have record at present." The toxic effects of the salts may be mitigated by the high content of organic matter, but the concentration may be significant in connection with the limited number (seven) of plant species on the Atoll.

In a bacteriological study of soil samples, Lipman and Taylor (1924) found that the numbers of organisms were enormously higher in the humus-rich soil in the *Pisonia* forest, much lower in the soil where *Boerhavia* and *Portulaca* were growing, and extremely low where there was no vegetation. Both nitrite- and nitrate-producing bacteria are present in all the soils, and their nitrifying activity is more or less proportional to the amount of organic matter in the soils.

Other islands.—Based on geology and topography, it can be generalized that the dominant soil type on Aunu'u is Tafua derived from the volcanic tuffs. On Ofu, Olosega, and Ta'u, most soils are probably the Tafatafa, Papaloa, and Lata types derived from basalts. The soils on Swains Island are similar to the recent coral and alluvial materials developed at Rose Atoll.

Relationship of Soils and Vegetation Communities

By comparing the soil-plot locations with the soil classifications for Tutuila Island and using the results of laboratory tests of soil samples, some relationships between soils and vegetation communities can be identified tentatively (Table 3).

The sand strand, littoral scrub, coastal marsh, mangrove forest, and most types of littoral forest have developed on Recent soils produced by wave action, gravity, stream erosion, and deposition. Because these Lalovi and Loga soils are among the more fertile of those in American Samoa, the natural vegetation communities growing there are subject to destruction for agricultural purposes. The coastal forests have developed on younger volcanic soils (Vini clays) weathered from tuffs. The rock strand vegetation is situated

on the Tafatafa soils of little-weathered volcanic lava flows. The lowland rain forest, montane rain forest, ridge forest, cloud forest, and montane scrub communities have all developed on soils of weathered volcanic rocks such as basalt and andesite. In American Samoa most of these soils have developed on steep terrain and have low fertility.

Some general conclusions seem warranted on the basis of existing data. Since most of the soils belong to the Latosol classification, they have essentially no horizons of accumulation in which nutrients are concentrated by addition. They tend to show textural profiles inherited from the parent rock, differential clay formation, or loss of clay from the upper solum. Latosols often exhibit horizons of concentration of iron oxide, alumina, carbonate, or other substances as a result of the removal of silica from the soil system. The presence of occasionally high concentrations of chlorides, potassium, sulfates, and other salts may be related to the proximity of the soil to the marine environment. Although the volcanic landscapes of American Samoa present a wide variety of circumstances in which soils would be expected to develop, about 72% of the total landmass consists of basaltic steepland soils with very shallow profiles and low levels of fertility.

Climate

According to the widely accepted Köppen climatic classification, American Samoa is in the Tropical Climate Zone, characterized by average monthly temperatures of more than 18°C (64.4°F), no winter season, and abundant annual rainfall that exceeds annual evaporation. American Samoa falls into the Tropical Rain Forest subclassification. Weather during this study (Fig. 11) closely approximated average conditions based on long term weather data (U.S. Department of Commerce 1956-76) from a permanent weather station at Pago Pago International Airport.

The general climate, largely controlled by the ocean temperature, is modified by local factors such as elevation to produce microclimatic conditions that affect the distribution of vegetation. Table 4 summarizes weather records taken in several study plots in the course of this study.

Land Use

Very few natural processes can alter existing ecosystems to the extent or in such a short time as the activities of man. In American Samoa, dominated by rugged terrain, the pressure for use of relatively flat land is great. The total land area of the islands is 196.7 km². The islands contain only 40.4 km² of developable land, which is that 20% of the total landmass with slopes less than 30%. Historically, the developable land, which is largely found around the coastlines and along major stream valleys, has been used for village sites and subsistence agriculture.

Of all the islands, Tutuila is both the most developed and the most heavily populated. Pago Pago is the major commer-

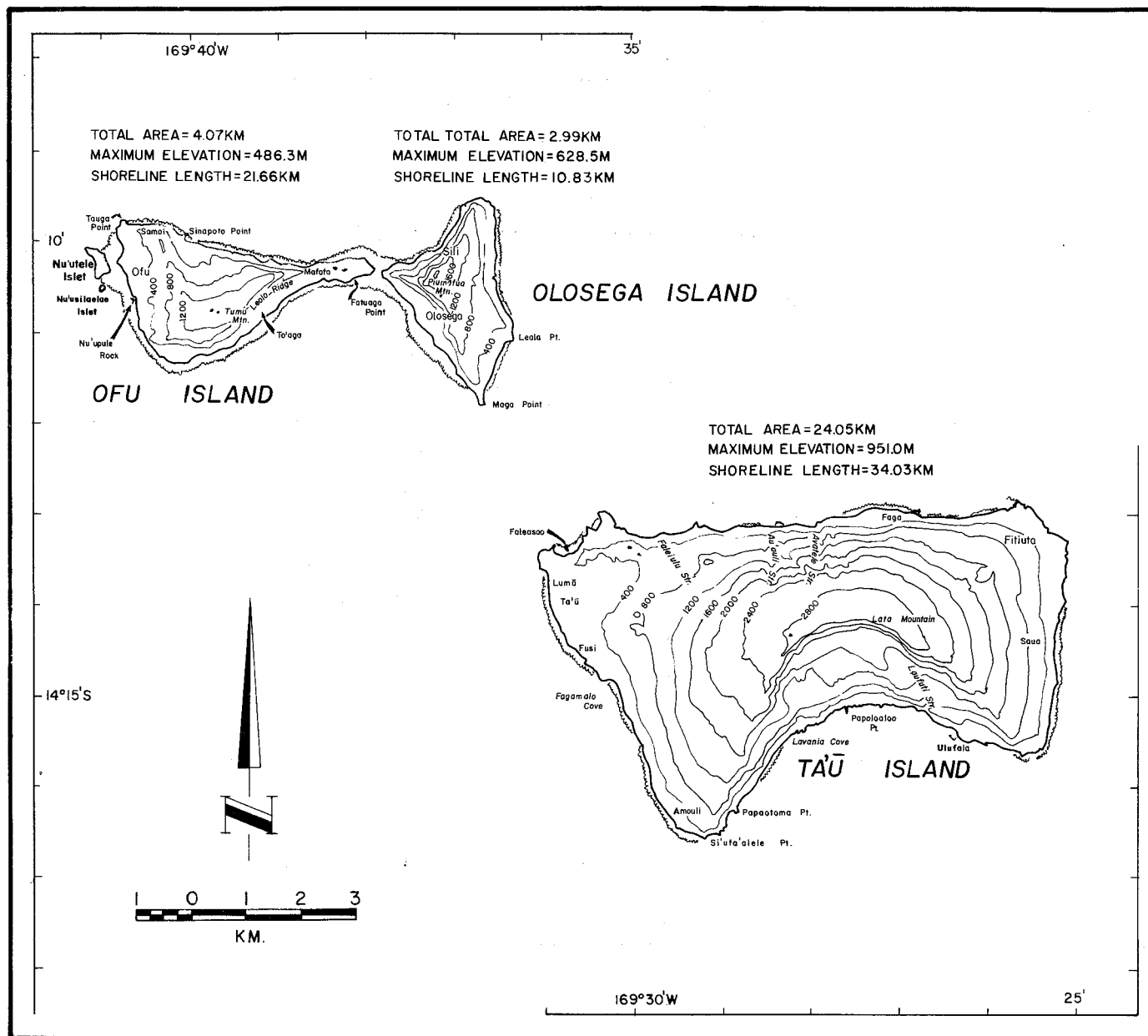


Fig. 8. Map of Ofu, Olosega, and Ta'ū islands, showing topography and place names. Contour lines are marked in feet.

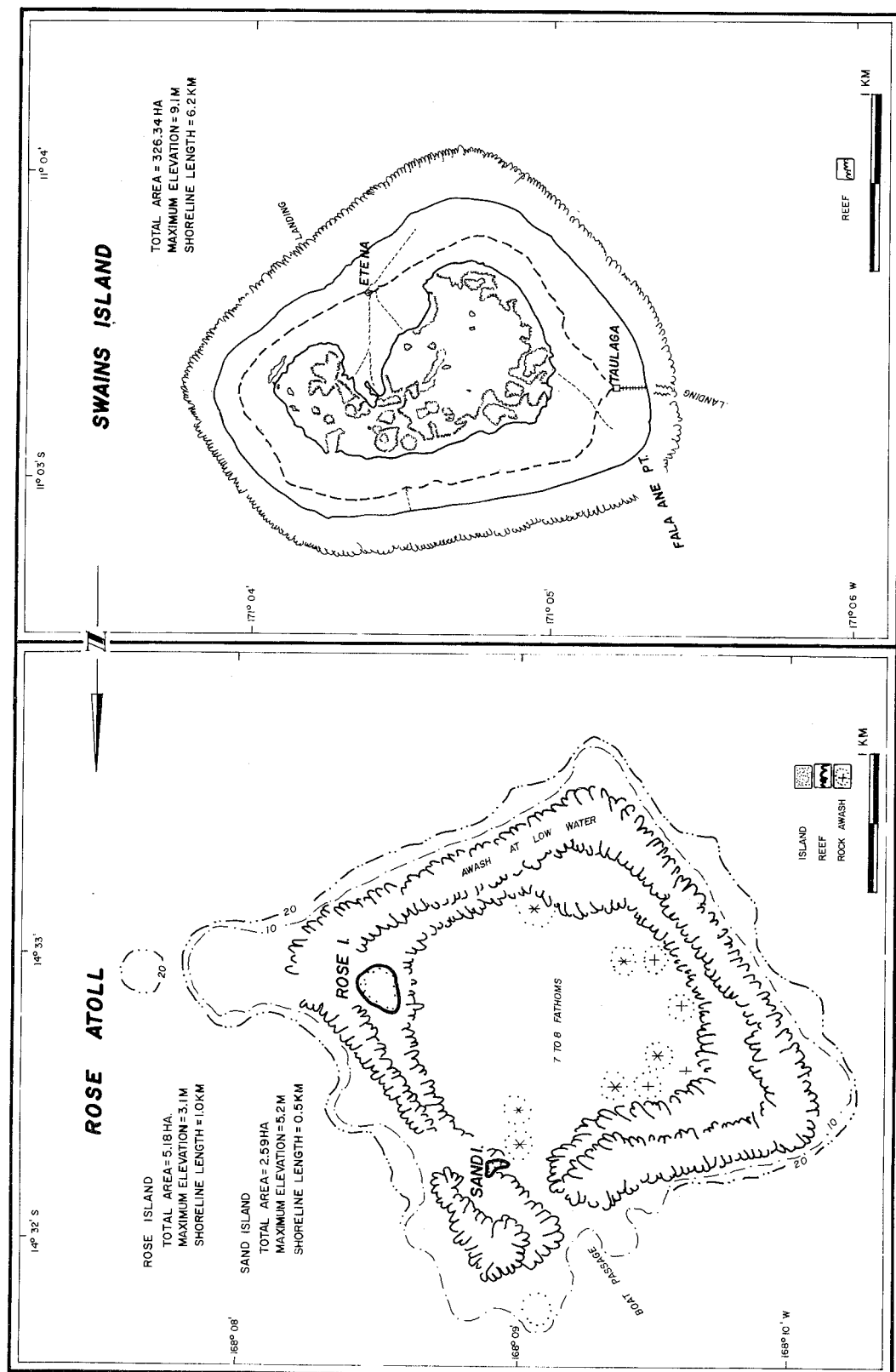


Fig. 9. Maps of Rose Atoll and Swains Island.

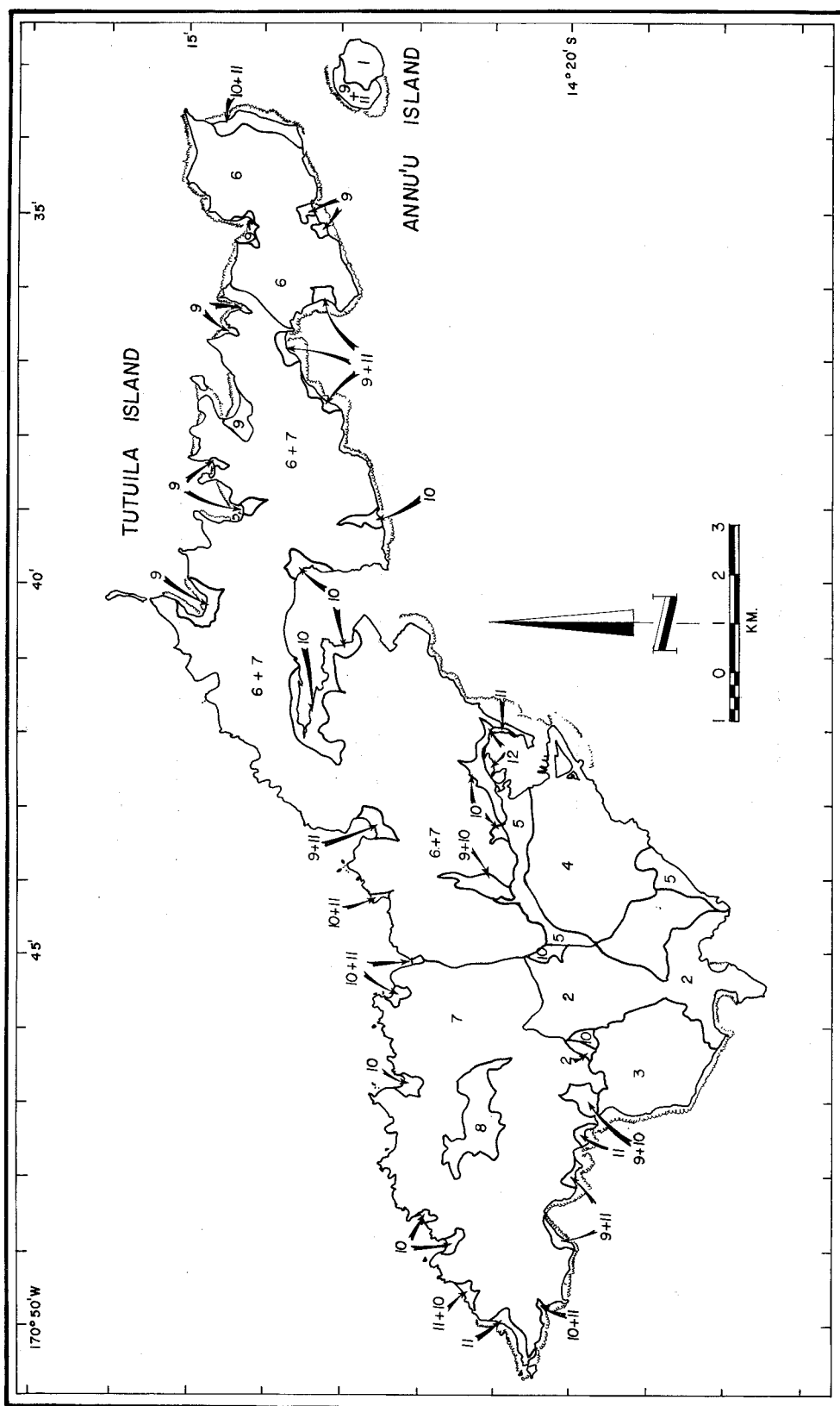


Fig. 10. Classification of soils on Tutuila Island; adapted from Wright (1963).

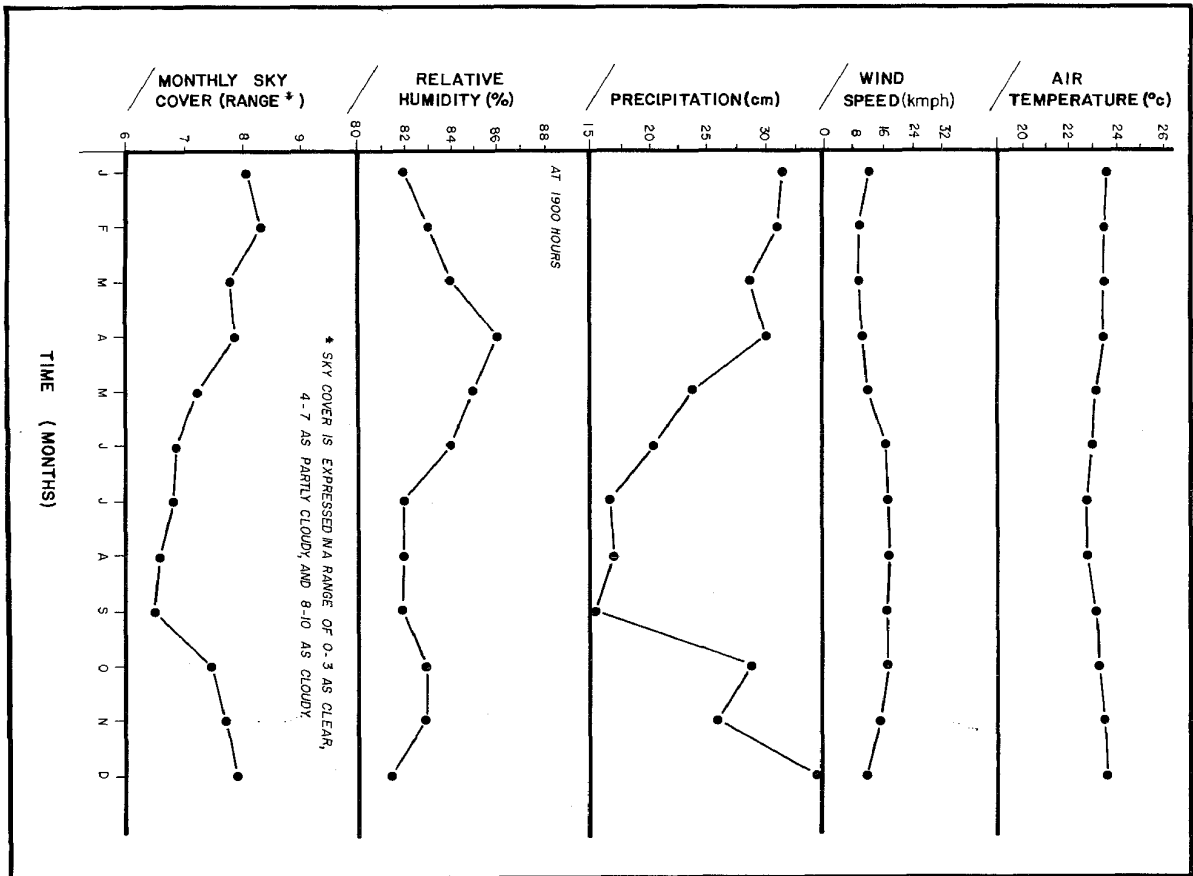


Fig. 11. Historical weather data (1956-76 monthly averages) for Pago Pago International Airport, Tutuila Island.

cial and industrial center of American Samoa, and this area contains about one-third of the present population. Because of the steep topography, the majority of the populace resides near the seacoast on relatively flat areas (Fig. 12); there is only one mountain village (Aoloaifou on Tutuila) in American Samoa. After World War II, a large portion of the population of Tutuila migrated to the United States. In turn, many people from Ofu, Olosega, and Ta'ū moved to Tutuila, leaving the Manu'a Group relatively less populated than formerly. Only a small percentage of the land there is developed.

Most residential development on the islands is in small,

low-density villages near the coast. Fishing and subsistence agriculture are the basis of livelihood, and village expansion is rather limited. The villages consist of irregularly spaced houses and roads, a communal open space or "village green," cooking areas behind the villages, and boat storage areas. In some areas of rapid development the village green is not provided or is being taken over by village expansion. In recent years developments have extended along the roads in linear patterns.

The Tafuna/Leone Plain on Tutuila is the single largest area of flat, developable land in American Samoa. A U.S. Government complex here includes the government-run air-

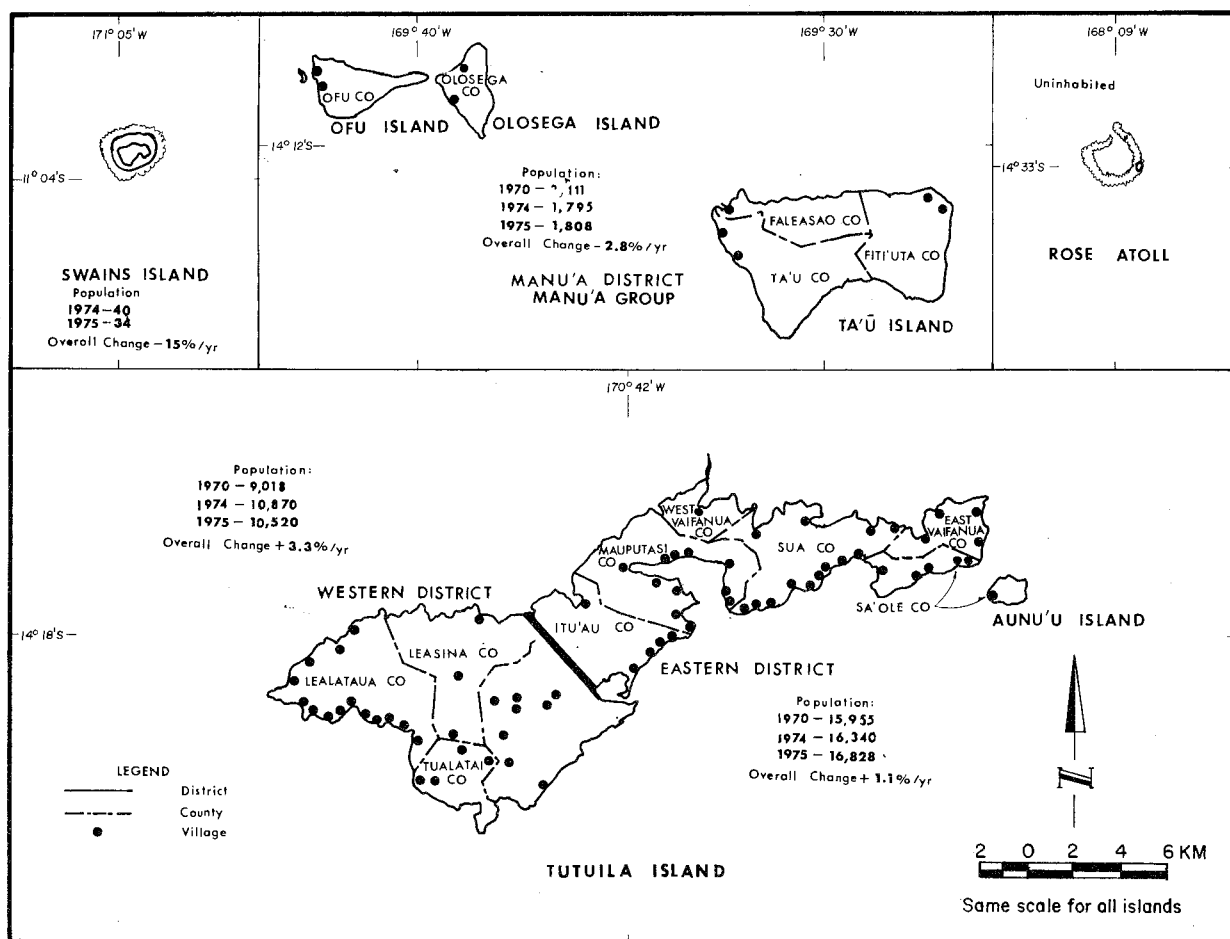


Fig. 12. Population distribution and locations of villages on the islands of American Samoa.

port, employee housing, a solid waste disposal facility, warehouse buildings, and a power plant. A new industrial park is being developed on the plains north of the airport.

Village cropland and plantation land are located near the villages on the gentle slopes away from the coast and can usually be reached easily by foot trails. Irregularly shaped plots in the natural forests are cleared and planted with food crops such as taro, yams, bananas, breadfruit, and coconuts. Coconuts and other fruits, as well as plants harvested for fiber and other uses (e.g., *Pandanus*), also are grown on the steeper slopes. On Aunu'u, taro is grown in the coastal marsh. On Swains Island, coconuts, a few bananas, and other crops are grown; there are about 324 ha of coconut palms.

One aspect of land use that is generally disturbing to the natural areas is the cycle of "slash-and-burn" agriculture. Undisturbed forested areas are cleared of heavy vegetation and planted in taro. Full sunlight is necessary for its growth, but the clearing practice also causes leaching of the already poor soil. Fertilization of these areas is not cost-effective, and soil nutrients are exhausted after several years. Taro pro-

ducers, therefore, simply abandon these areas and clear new ones, leaving the disturbed areas to be covered by vines and secondary forests.

Biological Environment

Plants

Botanical History

The botanical history of Samoa began with the famous French explorer la Perouse in 1787. The ship's botanist collected specimens on Tutuila, but barely escaped with his life during a massacre at A'asu. This sparse botanical information, however, was lost when the ill-fated expedition met disaster shortly afterwards on the Vanikoro Reef in Melanesia.

The late 1700s and the early 1800s was an age of exploration, and many expeditions carried naturalists to collect animals and plants. Samoa was out of the mainstream of exploration, however, and it was not until 1838 that a south seas expedition (under Dumont d'Urville) visited Samoa. In

the following year, The United States Exploring Expedition visited Samoa, closing out the first phase of the botanical history of Samoa. Many specimens were collected by the USEE, and the information obtained gave the first picture of the flora of Samoa.

The second phase in the botanical history of Samoa (1860-1890) was characterized by extensive collections by amateur European botanists. The most famous of these were J. S. Whitmee and T. Powell—both missionaries from the London Missionary Society—and a German physician, E. Graeffe. The two missionaries did not record collection sites, which led to much confusion in trying to determine the ranges of species.

The third phase (1893-1911) was marked by extensive collecting by professional European botanists. In 1898, F. Reinecke published the first flora of Samoa based on his collections and those of Graeffe. In 1905, the Australian botanist, K. Rechinger, made extensive collections, and several years later (1908) published his results along with the first general account of the vegetation of Samoa. The year 1905 was important for Samoan botany, because the German, F. Vaupel, and the Swiss, B. P. G. Hochreutiner, were also collecting in Samoa at that time.

The most recent phase of the botanical history of Samoa is principally dominated by American botanists. The earlier botanists, except Whitmee and Powell, had devoted nearly all their efforts to Western Samoa. But, in 1924, W. Setchell of the University of California at Berkeley published his accounts of the species and vegetation of Tutuila. The largest collection of Samoan specimens until the present study was made by E. Christophersen, a Norwegian working for the Bernice P. Bishop Museum of Honolulu. His two-volume work (1935, 1938) is still the most comprehensive on the flora of Samoa. In addition, Christophersen (1934) summarized the early botanical exploration of Samoa. In 1945 and 1946, T. G. Yuncker published the first accounts of the flora of Manu'a, and in 1943 C. Christensen published a list of ferns of Samoa.

Little has been done on botany in Samoa since World War II. Wright (1963) provided the most detailed description of the vegetation in a book on the soils of Western Samoa, but even this is superficial and brief. Thus, at the time of the present inventory, there existed no up-to-date account of the flora of American Samoa, and only the most rudimentary description of the structure of vegetation communities. The present inventory of the flora of American Samoa deals only with the vascular plants; for non-vascular plants, one must consult Setchell's (1921, 1924) work on algae, and Dahl's (1972) and Schultze-Motel's (1974) work on mosses.

Origin of the Flora

Almost 93% of the 490 plant species found in the undisturbed habitats in American Samoa are indigenous or native (Table 5). Only 36 introduced plant species have become naturalized (Table 5) and the undisturbed habitats are overwhelmingly dominated by the indigenous species.

There are 314 species of flowering plants that are indigenous to American Samoa (Tables 5,6). Most of these plants have an Indo-Malaysian affinity. Most Samoan species are also found in Fiji. The flora also includes a small Austral element, with several genera (e.g., *Melicytus* and *Weinmannia*) mainly distributed in temperate areas of the southern hemisphere. The affinity of the Samoan flora to that of eastern Polynesia is much less than it is to that of Melanesia.

Species Composition

An island-by-island distribution and a list of all the species of vascular plants reported to be native to or naturalized in American Samoa (with the exception of ruderal plants) are presented in Appendix I; they are categorized according to life form and are in alphabetical order. Because common English names have not been given to most plant species, only Samoan names, when they are known, are given. A summary of the number of species in major plant groups identified during the present study on each island is presented in Table 7. An annotated checklist of the vascular flora of American Samoa is given by Amerson et al. (1982).

Factors Influencing the Distribution of Vegetation

Before the arrival of man, most of American Samoa probably was covered with dense forests, except on coastal marshes, areas of montane scrub, and steep, windswept coastal or mountain slopes. The only disruptive process to affect the forest was an occasional hurricane. The warm climate and heavy rainfall enhanced luxuriant plant growth and favored a wide variety of species. With such constant conditions, there was little opportunity for secondary forest species or "weeds" to thrive. Even if they had been able to reach Samoa by various means of long-distance dispersal, suitable habitats were generally not open to them.

All this changed when the Polynesians settled in Samoa. They soon cleared the coastal forest for villages and plantations. Coastal marshes were probably the first vegetation to be disturbed, since the marshy flat land near the coast was excellent for growing taro. As the population grew, so did the pressure on the forest. More forest was cleared to plant coconuts, bananas, and taro. Because of the limited fertility of the land, crops like taro could be grown for only 2 or 3 years before returns diminished and a new field was cleared. This "slash-and-burn" agriculture, leaving the land fallow for years, destroyed more and more primary forest over the years, and resulted in increases in the amount of secondary forest.

Later, with the introduction of Western material culture and religious practices to Samoa, exports were needed to purchase Western goods. Additional land was cleared for coconuts, which were needed to produce copra for export. The only types of vegetation that were not exploited were the cloud forest, littoral scrub, littoral strand, and montane scrub. The cloud forest was too wet, cold, and far from villages to be used. The montane scrub was on soil too poor and steep for cultivation.

Recently, the emigration of Samoans to the United States has somewhat alleviated population pressure on the land. The population of Manu'a has been steadily decreasing; people have moved to Tutuila as well as to the United States. Also important is the fact that Federal money pouring into American Samoa has allowed the inhabitants to become dependent upon imported food to such an extent that copra is no longer exported and, until the last year or two, taro was imported from Western Samoa. Today, the price of taro is high, and with new roads into the interior, more forest land has been cleared to plant this crop.

The spatial change from one community to another may be gradual or abrupt; when the change is gradual, the distinctiveness of the two types is somewhat obscured. Such changes are usually in response to a change of one or more environmental factors. Environmental factors may be divided into edaphic (soil) and climatic factors. The first four of the following factors are edaphic, the last three climatic.

Soil water.—The soil water is dependent upon rainfall, topography, community structure, and a number of other biological and physical factors. A major difference between littoral forest and coastal marsh, or between ridge forest and rain forest, is the amount of soil water present.

Salinity.—The salt concentration of the soil is an important factor in coastal areas. For example, mangrove trees are dominant in, and restricted to, marine coastal areas.

Mineral composition.—The mineral composition of the soil is particularly important on Pioa and Matafao mountains on Tutuila. The soil there, derived from the rock trachyte, is poor, allowing a distinctive group of species to dominate the montane scrub community.

Physical factors.—The depth and particle composition (sand, silt, or clay) have major effects upon the vegetation and species composition in the community. The differences between the types of littoral forest are principally due to variations in the substratum.

Rainfall.—Rainfall in American Samoa is not as critical as it is on many other islands, since no part of Samoa, except for Rose Atoll and Swains Island, receives less than 225 cm of annual rainfall. The amount of rainfall, however, does have a direct effect on soil water and humidity. High rainfall promotes the luxuriant growth of epiphytes.

Temperature.—Temperature, like rainfall, is directly influenced by elevation. The difference in temperature from the summit of Ta'u Island to the nearby coast is about 5.6°C (10°F).

Wind.—The effect of wind is important in exposed coastal areas (such as Maga Point on Olosega), where it causes stunted scrub forests and littoral scrub communities. The wind-borne salt spray also has an important effect on coastal vegetation.

Descriptions of Community Types

The plants of American Samoa belong to the Tropical Rain Forest classification of worldwide vegetation. Natural forest is characterized by tall, broadleaf evergreen trees with

several crown layers, abundant woody vines called lianas, and ubiquitous epiphytes such as ferns, orchids, mosses, and lichens. Within this broad classification exists a mosaic of plant communities made up of assemblages of plant species reflecting differences in conditions of slope, elevation, microclimate, soil type, and exposure to sea water. Plant communities, more than soils or topographic conditions, indicate the boundaries of the ecosystems in American Samoa (Table 8).

The plant communities of American Samoa are described on the following pages, with references to environmental factors, physiognomy (structure), and floristic composition (Table 9). As mentioned earlier, the differences between these communities are sometimes subtle and gradual. Some of the communities are divided on the basis of either extreme habitat differences (rock and sand strands) or gradual elevation changes (lowland to montane rain forest). Two communities are divided into subcommunities that have a similar aspect but are distinguished on the basis that different species dominate the vegetation. The floristic differences are caused by habitat differences that are sometimes subtle.

Littoral strand

The littoral strand is composed mostly of herbaceous vegetation growing on coastal rocks and sand. This usually narrow zone commonly is found on the seaward margin of the littoral forest and scrub. Littoral strand is usually not recognized as a separate type; it occupies a transition zone between the forest and the sea. Although described here separately, it is included with littoral forest on the vegetation maps.

When found on rocks, the littoral strand is called "rock strand" and when on sand, "sand strand." Setchell (1924) listed these respectively as "recent lava flow association" and "sand formation," but the terms do not exactly correspond. His "recent lava flow association" includes what in this report is called littoral forest. Wright (1963) does not list anything corresponding to sand strand, and for rock strand he uses the more inclusive term "littoral scrub on spray-swept rocky coastline."

Rock strand.—Rock strand (Fig. 13) is found on coasts with exposed lava rocks. Generally, however, if the lava rocks are separated from the ocean by a strip of coral rubble, littoral or coastal forest prevails. Rock strand also is found on the numerous small rocky islets within, or occasionally beyond, the reef. The rock strand species may be mixed with coastal and littoral forest trees on the larger islets. In some areas where the rock strand is broad, a zonation of species parallel to the shore is often evident with the hardier, more salt-tolerant species closer to the ocean (Fig. 14).

The rock strand habitat probably is subjected to the harshest conditions in Samoa. To survive these conditions, plants must tolerate dry conditions, high temperatures, salt spray, or occasional inundations by salt water. A number of plants in the rock strand (*Portulaca* spp., *Sesuvium portulacastrum*) are succulents. Like the species found in the littoral forest, many rock strand species have buoyant seeds that are



Fig. 13. Littoral rock strand near Amanave, Tutuila Island (photo by W. A. Whitstler).

dispersed by flotation in sea water.

The major species of rock strand plants are *Acrostichum aureum*, *Boerhavia diffusa*, *Cyperus polystachyos*, *Fimbristylis cymosa*, *Ipomoea pes-caprae*, *Ischaemum murinum*, *Lepturus repens*, *Paspalum distichum*, *Portulaca lutea*, *Portulaca oleracea*, and *Sesuvium portulacastrum*. Other characteristic plants of lesser importance are *Capparis cordifolia*, *Cassytha filiformis*, *Clerodendrum inerme*, *Cynodon dactylon*, *Cyperus javanicus*, *Cyrtandra samoensis*, *Gardenia taitensis*, *Hedyotis biflora*, *Hedyotis foetida*, *Leucas flaccida*, *Portulaca australis*, and *Vigna marina*. Some uncommon or rare species are limited to this habitat; examples are *Gardenia* and *Leucas*.

Sand strand.—The sand strand (Fig. 15) is found on sandy shores protected by a reef. It is usually very narrow in extent, except on low atolls such as Rose. The sand strand species, like those of the rock strand, must be xerophytic, salt-tolerant, and able to withstand high temperatures. Most of the species are dispersed by buoyant, salt-tolerant seeds, and

many are succulent or have a creeping habit.

The major species of sand strand plants are *Boerhavia diffusa*, *Boerhavia tetrandra*, *Canavalia rosea*, *Fimbristylis cymosa*, *Ipomoea pes-caprae*, *Lepturus repens*, *Portulaca lutea*, *Portulaca oleracea*, *Triumfetta procumbens*, and *Vigna marina*. Less important species characteristic of the sand strand are *Euphorbia atoto*, *Ipomoea macrantha*, *Sida samoensis*, *Stenotaphrum micranthum*, *Suriana maritima*, and *Thuareaa involuta*.

Littoral scrub

The littoral scrub is the shrubby vegetation that grows on exposed coastal shores and slopes. The difference between littoral scrub and the rock and sand strands is sometimes obscure, but in general the vegetation of the littoral strand is herbaceous. The difference between a windswept littoral forest and littoral scrub vegetation is also occasionally indistinct, but in the forest, the dominant species are low, wind-swept trees.

Four subcommunities are found in the littoral scrub, dis-

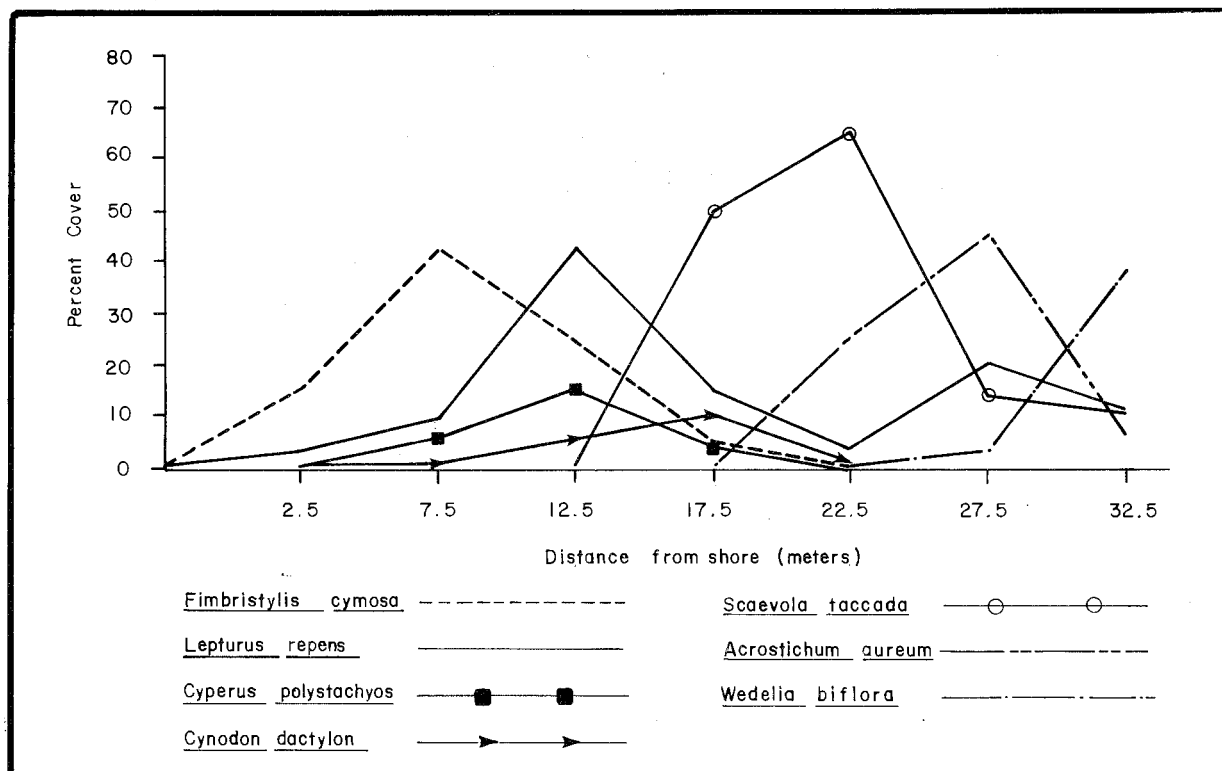


Fig. 14. Zonation of species in Vaitogi rock strand vegetation, Tutuila Island.

tinguished mainly by the difference in dominant species. The plants in these subcommunities have similar requirements for bright sunlight, the ability to grow on poor sandy or rocky soil, and a tolerance of salt spray. Like other maritime types of vegetation, most of the species have buoyant, salt-tolerant seeds.

Wedelia subcommunity.—The *Wedelia* subcommunity is found on rocky windswept slopes with shallow soil. The largest area of this subcommunity is on Maga Point, the southern tip of Olosega Island (Fig. 16). In a series of 20 quadrats (2 x 2 m), the following species (with estimated cover) predominated: *Wedelia biflora* (82%); *Ficus scabra* (7%); *Canavalia sericea* (6%); *Microsorium scolopendria* (2%); and *Scaevola taccada* (1%).

Scaevola subcommunity.—This subcommunity is also found on Maga Point. It does not cover as large an area as *Wedelia*, but probably replaces the *Wedelia* in more wind-swept or more rocky areas. At Maga Point, in a series of 5 quadrats (2 x 2 m), the following species (with estimated cover) predominated: *Scaevola taccada* (90%); *Wedelia biflora* (1%); *Ipomoea littoralis* (1%).

Scaevola forms the major vegetation on many low atolls in the Pacific. On Swains Island, a large open area is dominated by *Scaevola*. This species has never been recorded at Rose Atoll, even though conditions there appear to be favorable for it.

Sophora subcommunity.—The *Sophora* subcommunity is very restricted in distribution. The major species, *Sophora tomentosa*, grows mixed with other species on sandy beaches. In American Samoa it is found only along the south coast of Ofu, at the tip of Nu'uuli Peninsula on Tutuila, and near the south coast of Aunu'u.

Caesalpinia-Gossypium subcommunity.—This subcommunity occurs only on a windswept coastal slope on the north side of Aunu'u Crater; in fact, the two species for which this subcommunity is named have been collected nowhere else in American Samoa. The major species (including two littoral tree species) forming this scrubby subcommunity (with estimated cover) are: *Caesalpinia bonduc* (25%); *Gossypium hirsutum* (20%); *Grewia crenata* (15%); *Microsorium scolopendria* (10%); *Hibiscus tiliaceus* (10%); *Alyxia stellata* (8%); *Bothriochloa bladhii* (5%).

A narrow zone of shrubs often grows under the seaward edge of the littoral forest. The shrubs are limited seaward by the tides and landward by the shade of the littoral forest. On higher rocky islets the littoral scrub species mix with forest and rock strand species.

Other characteristic littoral scrub species not mentioned above are *Desmodium umbellatum*, *Premna obtusifolia*, *Clerodendrum inerme*, *Colubrina asiatica*, *Allophylus cobbe*, *Acalypha grandis*, *Pemphis acidula* (Swains Island only), *Acronychia retusa*, and *Tephrosia purpurea*. Of these

species the first four are very common and the last two are very rare.

A similar windswept scrub was observed at Saua on the east coast of Ta'ū. It consisted of trees less than 1 m high, vines, and littoral shrubs growing on coral rubble on the margin of the littoral forest. The major species (with estimated cover) were: *Hibiscus tiliaceus* (28%); *Wedelia biflora* (23%); *Pisonia grandis* (14%); *Hernandia sonora* (8%); *Ipomoea pes-caprae* (3%); *Vigna marina* (3%); *Mikania micrantha* (3%); *Barringtonia asiatica* (1%); *Clerodendrum inerme* (1%).

Coastal marsh

Coastal marsh consists largely of sedges and ferns that dominate in poorly drained coastal areas. This vegetation was referred to by Wright (1963) as "lowland rush and reed swamp." Coastal marshes are usually found in shallow depressions, and are separated from the shore by a slightly higher land barrier which, in a natural state, is covered by littoral forest. They appear to be the result of sedimentation and gradual filling of shallow lagoons, possibly related to long-term changes in sea level. Most lie at elevations below 3 m. The soil in a coastal marsh is nearly always saturated,

but unlike that of the mangrove forest, the soil water is fresh or only slightly brackish. The coastal marsh has no direct contact with the sea and tidal effects are minimal.

In American Samoa, coastal marshes are found on all the islands except Rose Atoll. The total area of coastal marsh is about 41 ha. The only large, relatively undisturbed coastal marsh in American Samoa is in Aunu'u Crater. Aunu'u Crater is somewhat anomalous in that its elevation is higher than normal (5.8 m) and it was formed not by sedimentation in a lagoon but from poor drainage in the low-lying crater. Two zones are readily distinguishable. Along the margins of the central pond and in the eastern half of the marsh, the vegetation consists almost exclusively of the swamp fern *Acrostichum aureum*, reaching a height of 2-3 m. Covering the western half of the marsh is a mixture of *Cyclosorus interruptus* and *Eleocharis dulcis*, an association that is mostly 1-2 m high. It is difficult to assess the relative dominance of these two species. *Eleocharis* seems to be relatively more numerous (by stem count), but because it is leafless it has less cover and biomass than *Cyclosorus*. The cover in a series of 10 quadrats (2 x 2 m) in the Aunu'u marsh was estimated to be 93% *Cyclosorus* and 7% *Eleocharis*. The few other plants found in the undisturbed marsh were minor in importance.



Fig. 15. Littoral sand strand dominated by *Ipomoea pes-caprae* on the west side of Ta'ū Island (photo by W. A. Whistler).

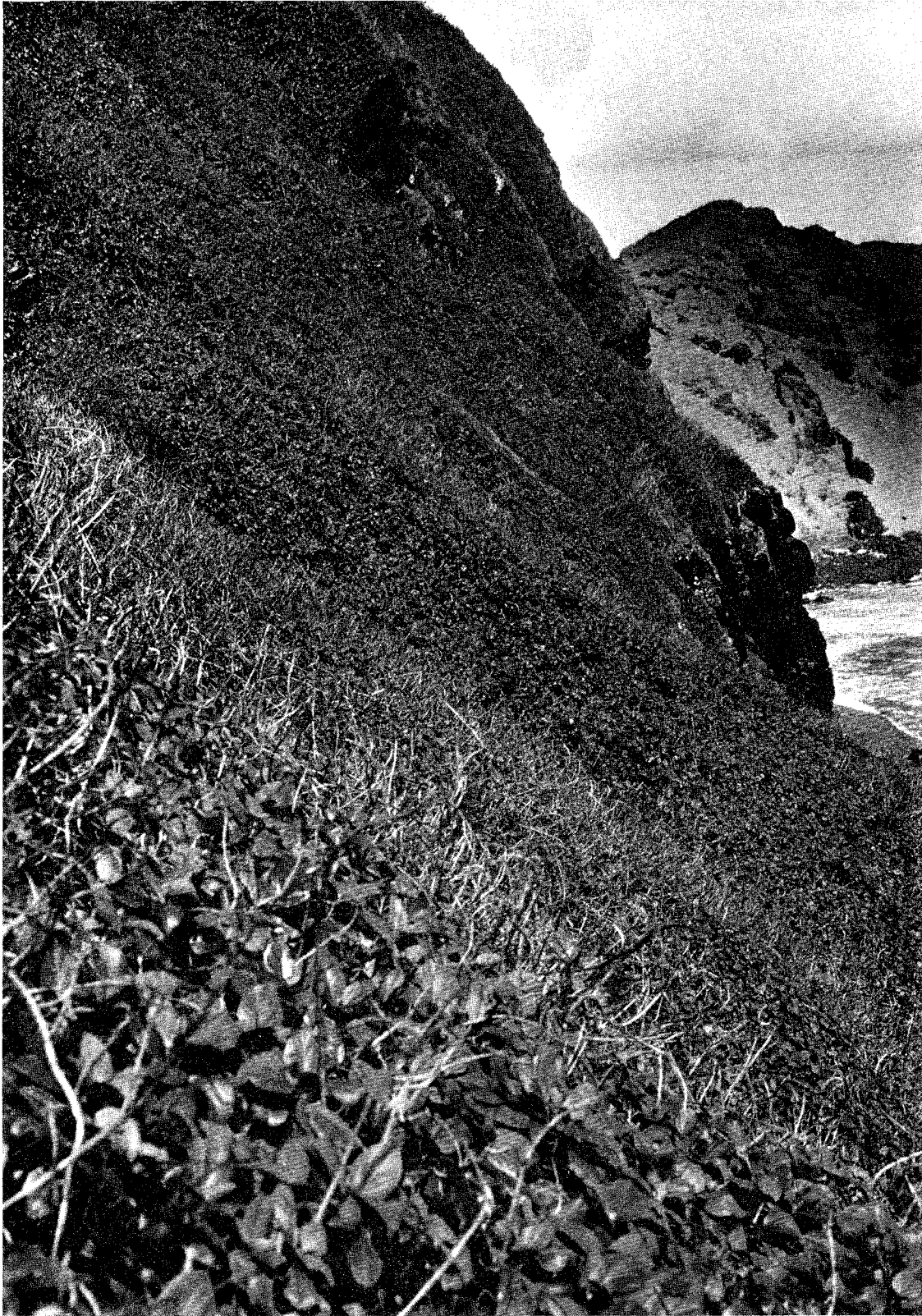


Fig. 16. Littoral scrub (*Wedelia* subcommunity) on Maga Point, Olosega Island (photo by W. A. Whistler).



Fig. 17. Disturbed coastal marsh and plantation on Aunu'u Island, showing coconut and banana trees in the background and taro plants in the foreground (photo by A. B. Amerson, Jr.).

The only undisturbed coastal marsh in Samoa with different vegetation is on Swains Island, where a small patch of marsh is located on the north side of the brackish water lagoon which has only recently lost its connection to the sea. The vegetation is dominated by *Paspalum distichum* and *Eleocharis geniculata*.

With the possible exception of the lowland rain forest, the coastal marsh on American Samoa is the community most disturbed by man (Fig. 17). Its location on the coast, where nearly all the villages are found, and its ideal conditions for growing taro have led to its destruction. The largest disturbed coastal marshes in American Samoa are behind the village of Aunu'u (7.7 ha) and at Lumā, Ta'u (17.7 ha) (but see Whistler 1976). The taro fields behind Aunu'u Village are probably the best in Samoa, with extensive canals and paved walkways. Smaller disturbed coastal marshes are found at Vatia and Alao on Tutuila, on the south tip of Ofu, behind the village of Olosega, and at Fusi on Ta'u.

When coastal marshes are abandoned after taro cultivation, they become dominated by a number of weedy wetland plants. The major species are *Ludwigia octovalvis*, *Rhynchospora corymbosa*, *Coix lacryma-jobi*, and *Paspalum orbiculare*. These weedy species are often mixed with *Acrostichum*, *Eleocharis*, and *Cyclosorus*. Such disturbed marshes would

probably revert to natural vegetation if they were left undisturbed for a long period of time and if the water regime of the sites had not been significantly altered.

Mangrove forest

The mangrove forest is one of the few types of vegetation in Samoa thoroughly dominated by a single tree species, *Bruguiera gymnorrhiza*, the oriental mangrove. A mangrove is a tree that lives in saturated salty soil, usually produces breathing roots or aerial roots, and often reproduces viviparously (by means of seeds that germinate while still on the tree).

The mangrove forest (Fig. 18) is primarily a tropical type of vegetation, but it reaches into the subtropics in Bermuda (32°N) and into the temperate zone at Chatham Island (44°S). In American Samoa, mangrove forests grow only on Tutuila and Aunu'u. They were once much more extensive than they are today, but whole forests in Pago Pago, Fagatogo, Faga'alu, and Utulei villages have been eliminated by man. The major mangrove forests now found are at Nu'uuli (Pala Lagoon), Maséfau, Aunu'u, Leone, and Aoa villages. Minor patches of mangrove remain at Aua, Vatia, and Alofau villages; the total area of mangrove forest in American Samoa is about 91.0 ha. Using a different ap-



Fig. 18. Mangrove forest near Nu'uuli, Tutuila Island (photo by W. A. Whistler).

proach, Whistler (1976) obtained a figure of 52.5 ha of actual forest cover in this swampy habitat.

The habitat that mangroves occupy is rather restricted. Mangroves are found on muddy shores of sheltered lagoons, mudflats, and along estuaries where sedimentation is occurring. The factors critical to the mangrove forest are the soil and the water. Mangroves are halophytes, found only in brackish or salt water conditions. In Samoa, mangrove forests are found from slightly below the high tide mark to an elevation of about 1.5 m. The soil is usually muddy or covered at high tide by seawater, and the oxygen content is low.

Bruguiera gymnorhiza is a large, spreading tree up to 15 m high, forming a more or less continuous canopy. Trees in the forest are well spaced. In the center of the mangrove forest, only *Bruguiera* is found; these are mostly mature trees, with few or no saplings. At the Nu'uuli mangrove forest plot, there were just over 4 trees per 100 m²—the fewest for any type of forest vegetation in American Samoa.

Another species of mangrove found in Samoa is the red mangrove, *Rhizophora mangle*. It is a smaller species, rarely reaching a height of 5 m and is found on the margins of the mangrove forest as a pioneer species. *Rhizophora* apparently requires more sunlight than *Bruguiera*, and cannot compete

with it when a forest is established. A large stand of pure *Rhizophora* grows along the west side of the Nu'uuli Peninsula.

On the margins of the mangrove forest, several other species are found, such as *Inocarpus fagifer*, *Hibiscus tiliaceus*, *Xylocarpus moluccensis*, and *Erythrina fusca*. The two latter species are rare; *E. fusca* has been collected only once in American Samoa (at Leone, in 1929), and *X. moluccensis* is found in small numbers only at Nu'uuli and Aunu'u.

Epiphytes are relatively few on *Bruguiera* trees because of the dryness of the bark and the effects of salt spray. The common epiphytes are *Antrophyum plantagineum*, *Asplenium nidus*, *Bulbophyllum longiscapum*, *Davillia solida*, *Dendrobium biflorum*, *Dendrobium vaupelianum*, *Ephemerantha comata*, *Hoya australis*, *Humata banksii*, *Microsorium scolopendria*, *Ophioglossum pendulum*, *Phreatia graeffei*, and *Vittaria rigida*.

Vines are noticeably absent, since there are no species that are able to grow in the muddy saline soil. Only one species of vine, *Hoya australis*, was observed, and it was growing as an epiphyte. Ground cover is absent except for seedlings of *Bruguiera*. In places these are dense, but before reaching a height of 50 cm almost all seedlings die in the shaded muddy soil. When a *Bruguiera* tree dies or is cut for firewood, the



Fig. 19. Littoral forest at Vaitogi, Tutuila Island, showing *Pandanus* in the background and *Scaevola* in the foreground.

open spot in the canopy allows light to reach the ground, which sometimes results in a small thicket of *Bruguiera* saplings competing with each other to reach the canopy.

On the margins of the mangrove swamp, large clumps of the swamp fern *Acrostichum aureum* are often found. These ferns are also common in the coastal marsh, but are unable to withstand the salinity and shade in the mangrove forest. Another plant found on the margins of the mangrove forest is *Paspalum distichum*, a grass that is common along estuaries and in sunny coastal areas.

Littoral forest

The term littoral forest refers to any forest vegetation growing on rocky or sandy shores. This type of vegetation has been referred to by Dahl (1976) as "atoll/beach forest," by Rechinger (1908) as "strand forest" ("strandwald"), by Setchell (1924) as "rock or sand strand," and by Wright (1963) as "littoral forest." The major factor determining its distribution and extent is the sea. The tree species in the littoral forest have several general characteristics in common:

they require bright sunny conditions; they are normally dispersed by means of buoyant, salt-tolerant seeds (or are carried attached to seabirds); they are widespread on tropical shores across the Pacific and Indian oceans; and they are tolerant to salt spray and wind. None of the species is tolerant of standing water or frequent incursions of salt water. Inland from the shore, bright light conditions are reduced, soil becomes richer, maritime influence decreases, and littoral forest is replaced by coastal forest or lowland rain forest.

The littoral forests in American Samoa are of four types, based upon which of one or more tree species dominates. Species composition is influenced primarily by the type of substratum.

Pandanus subcommunity.—The simplest type of littoral forest is the *Pandanus* subcommunity, found on rocky shores unprotected by reefs. The area most representative of this type previously existed along the Vaitogi coast of Tutuila (Fig. 19), but much of it has recently been destroyed by plantations and by a road running through it. Other areas are found on the northeast corner of Ta'ū seaward from the

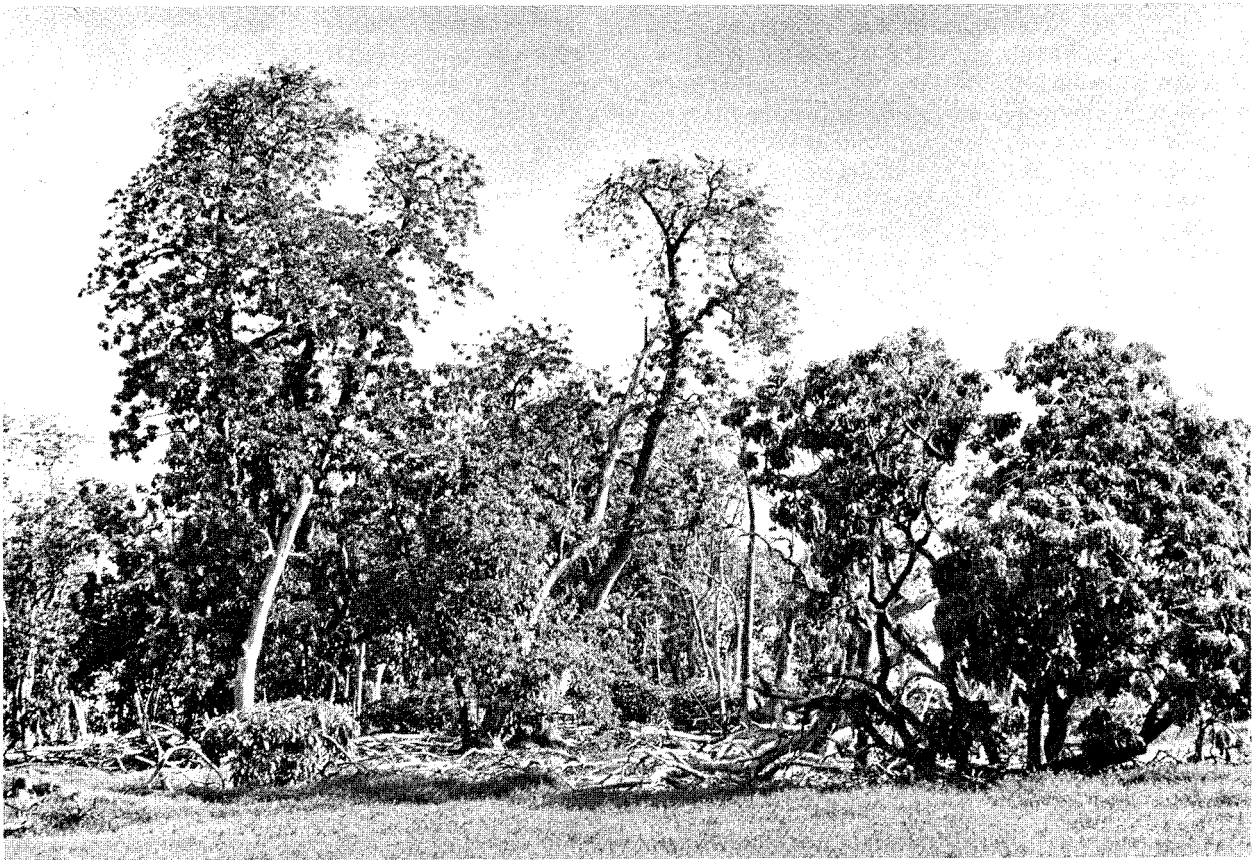


Fig. 20. Littoral forest (*Pisonia*) on Rose Island, Rose Atoll, showing older living and dead trees in center and younger living trees at right of center.

village of Fitiuta, and at Ma'ama'a Cove on the east side of Aunu'u. The latter area is probably the least disturbed of the sites, but is small in extent.

When undisturbed, the *Pandanus* subcommunity is dominated by *Pandanus* spp. These trees, rarely more than 4-6 m high, form a dense thicket that excludes nearly all ground cover and any other tree species. Epiphytes and vines are also conspicuously absent. In areas of extreme winds, such as at Fitiuta, these trees are shorter and show obvious effects of the wind. The site at Vaitogi is disturbed and open, and is not typical of a natural *Pandanus* subcommunity. The atypical site was used as a study plot because it was described by Setchell (1924). There is a more typical, undisturbed, site on Aunu'u.

Pisonia subcommunity.—The dominant species in this type of littoral forest is *Pisonia grandis*. This tree, found from tropical Africa to eastern Polynesia and Micronesia, is spread by sticky fruits that become attached to seabirds. *Pisonia* thrives on sandy shores and islands, particularly in soil enriched with guano from the seabirds.

The best example of a *Pisonia* subcommunity in American Samoa is on Rose Island, where it forms a dense stand of trees up to 23 m high. The number of trees in the study plot averaged 16.1 per 100 m² with a total basal area of 2.43 m² per

100 m². No ground cover plants can survive the dense shade in this *Pisonia* forest. In recent years, what has been called a "*Pisonia* dieback" has affected the center of the stand (Fig. 20). The cause of this dieback is unknown, but is thought to be drought or disease. In October 1976 the *Pisonia* was regenerating and starting to cover the barren central portion again.

Pisonia grows elsewhere in American Samoa—in the mixed littoral forest, for example—but nowhere else was it observed to be the dominant forest species.

Barringtonia subcommunity.—The *Barringtonia* subcommunity is completely dominated by *Barringtonia asiatica*, a littoral species distributed from Madagascar to eastern Polynesia. These trees grow mainly on rocky coastal shores and slopes, and on shores covered by coral plates and rubble.

Barringtonia is one of the biggest trees in Samoa, with diameters at breast height (dbh) up to 160 cm and heights to 15 m. It branches near the base, sending out many huge limbs that spread to form a broad canopy overhanging the shore. Three sites of *Barringtonia* forest were studied in American Samoa—Onenoa and Aigā on Tutuila and one on Aunu'u. These sites had between 5.7 and 6.9 trees per 100 m² and 0.50-0.57 m² average basal area per 100 m². The latter figure

excludes the data from Onenoe because the basal area there was uncharacteristically high. The Onenoe sampling was done in a 10 m wide strip along the coast. The huge trees grew in just this confined area, spreading out over the ocean on one side and over a narrow strip of disturbed vegetation on the other, behind which a steep hill was immediately adjacent. The other two plots were measured over a more representative sample on more level ground.

The *Barringtonia* subcommunity differs from the other three types of littoral forest in that it often extends inland. It grows on steep rocky coastal slopes, and on Aunu'u forms a beautiful forest on a gentle slope isolated from direct contact with the sea. The *Barringtonia* subcommunity has an open forest floor, and the trees are widely spaced. The dense shade of the uniform canopy allows few seedlings or small trees to survive on the forest floor. The ground cover is light; the principal species are *Asplenium nidus*, *Epipremnum pinnatum*, *Ipomoea macrantha*, and *Barringtonia* seedlings. Climbers are few, consisting of *Epipremnum pinnatum*, *Derris trifoliata*, *Mucuna gigantea*, *Ipomoea macrantha*, and *Hoya australis*. Epiphytes also are few, consisting mostly of *Asplenium nidus*, *Dendrobium tokai*, and *Dendrobium vaupeianum*.

Mixed littoral subcommunity.—The mixed littoral subcommunity grows where, for physical or other reasons, none of the three preceding species attains dominance. The major tree species in this type of forest are *Barringtonia asiatica*, *Calophyllum inophyllum*, *Erythrina variegata*, *Guettarda speciosa*, *Hernandia sonora*, *Hibiscus tiliaceus*, *Messerschmidia argentea*, *Pandanus tectorius*, *Pisonia grandis*, *Thespesia populnea*, and *Terminalia catappa*. Minor tree species found in the mixed littoral association include *Cerbera manghas*, *Cordia subcordata*, *Ficus scabra*, *Grewia crenata*, *Gyrocarpus americanus*, *Morinda citrifolia*, *Premna obtusifolia*, *Terminalia samoensis*, and *Vitex trifolia*.

The finest example of mixed littoral subcommunity in American Samoa is found on the southern half of the east coast of Ta'u. The dominant species are *Barringtonia*, *Hernandia*, and *Pisonia*. A 100 m section of this forest, viewed from the beach, is diagrammed in Fig. 21. This forest has an even canopy with individual trees up to 11 m high. The ground surface consists of coral plates and coral rubble, and ground cover averages less than 10%; the two dominant ground cover plants are *Asplenium nidus* and *Ipomoea macrantha*. Climbers are few, mostly *Ipomoea macrantha* and *Hoya australis*; epiphytes are mostly *Asplenium nidus*.

A mixed littoral subcommunity also is found on undisturbed, or long-since disturbed, portions of Swains Island. The dominant species is *Hernandia sonora*, with smaller numbers of most of the other trees typical of mixed littoral subcommunities. The dominant tree on most of Swains Island is the coconut palm, an introduced species which in nature cannot compete with other species of the littoral forest. Thus, it is likely that any coconuts found in a littoral forest were planted or became established when the site was disturbed.

The littoral forests have been largely destroyed by man. This is particularly true of sandy coastal areas, nearly all of which have been cleared and used for villages or coconut plantations. The rocky and steep coastal areas, such as those on the north coast of Tutuila and the east coast of Olosega, and the coral rubble areas, such as the east coast of Ta'u, are relatively undisturbed.

Coastal forest

The coastal forest is the natural forest found in coastal regions, lying immediately inland from the littoral forest but with an entirely different species composition. Unlike the littoral species, most coastal forest species do not have seawater dispersed seeds. Other authors do not make specific mention of this type of vegetation. In Wright's (1963) classification it would probably be in "primary high forest of lowlands," and in Setchell's (1924) it would be in the general classification of "forest formations."

The coastal forest is found mostly on coastal slopes and cliffs. The trees are rarely more than 12 m high and require a certain amount of salt tolerance to be able to withstand the salt-laden sea breezes. Little stratification is evident. The vegetation on coastal ridges changes with increasing elevation and distance from the ocean. At some point in the gradual change the coastal forest becomes a lowland ridge forest.

During the survey, four sites of coastal forest were studied (plots 9-12). The major tree species at these sites are listed here, with the average relative dominance: *Syzygium clusiaefolium* (16%); *Diospyros samoensis* (14%); *Erythrina variegata* (13%); *Diospyros elliptica* (11%); *Barringtonia asiatica* (8%); *Intsia bijuga* (7%); *Terminalia catappa* (5%); *Syzygium inophylloides* (5%); *Syzygium dealatum* (3%); *Calophyllum inophyllum* (3%).

The most characteristic species of the coastal forest are *Syzygium clusiaefolium* and *S. dealatum*. *Erythrina*, *Barringtonia*, *Terminalia*, and *Calophyllum* are species usually associated with the littoral forest. *Intsia* is an odd case because, except for a single tree seen at Tafuna, it was recorded only from Nu'usetoga Islet at Masefau Village, Tutuila. There it was the dominant species, but it is rare elsewhere. Other less important tree species are *Allophylus cobbe*, *Arytera samoensis*, *Calophyllum samoense*, *Ficus scabra*, *Garuga floribunda*, *Guettarda speciosa*, *Hernandia sonora*, *Hibiscus tiliaceus*, *Inocarpus fagifer*, *Phaleria disperma*, *Planchonella costata*, *Planchonella linggenensis*, *Psychotria insularum*, and *Sterculia fanaiho*.

The number of vines and climbers in the coastal forest is small. The most common vines are *Alyxia bracteolosa*, *Alyxia stellata*, *Entada phaseoloides*, *Epipremnum pinnatum*, *Gynochthodes ovalifolia*, *Hoya australis*, *Jasminum didymum*, *Mucuna gigantea*, and *Piper graeffei*. The most common of these are *Epipremnum* and *Piper*. The tree trunks are relatively free of climbers and epiphytes because the required moist conditions are lacking. The more common epiphytes are *Asplenium nidus*, *Davallia epiphylla*,

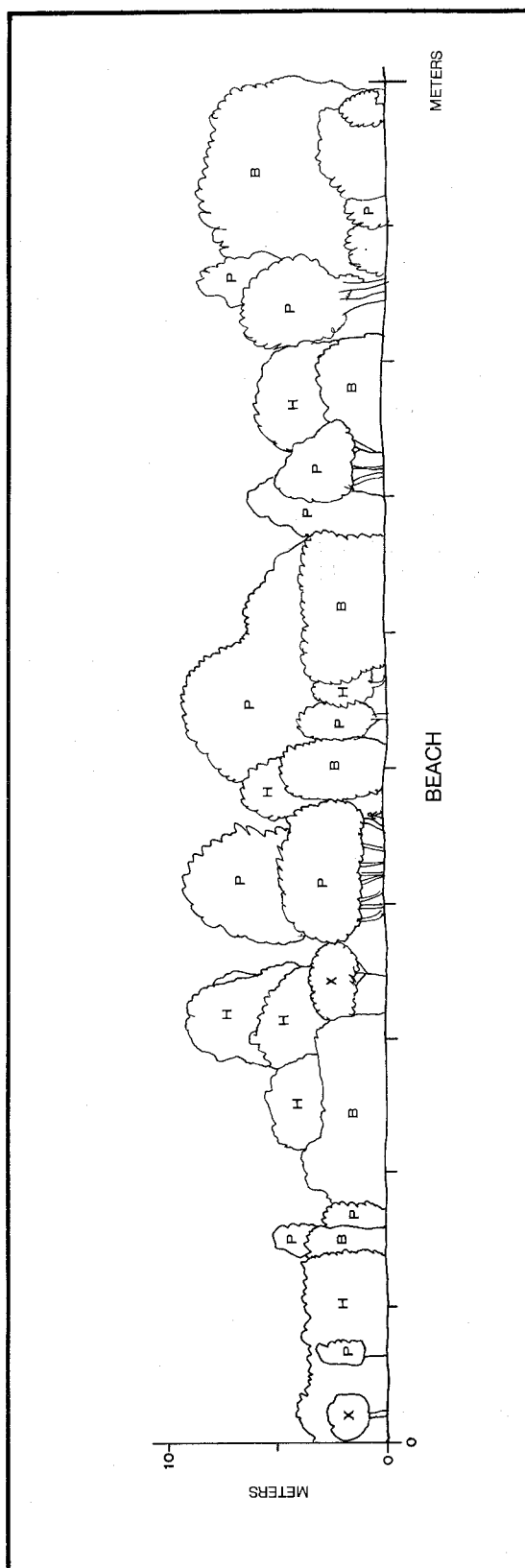


Fig. 21. Diagram of 100 m section of mixed littoral subcommunity on beach on Ta'u Island. B, *Barringtonia aquatica*; H, *Hernandia sonora*; P, *Pisonia grandis*; X, *Pandanus tectorius*.

Dendrobium tokai, *Dendrobium goldfinchii*, *Humata heterophylla*, *Microsorium scolopendria*, *Procris pendunculata*, and *Taeniophyllum fasciola*.

The ground cover of the coastal forest is sparse compared with most other types of forest vegetation. At the Masefau coastal forest (plot 12) the ground cover averaged only 14%, consisting of the following species in descending order of importance: *Asplenium nidus*, *Davallia epiphylla*, *Freycinetia* spp., *Microsorium scolopendria*, *Asplenium falcatum*, and *Dioscorea bulbifera*.

Rain forest

Rain forest is the natural vegetation of most of Samoa. It originally covered most of the flat to gently sloping land away from the immediate coast. At the lower elevations, on steep slopes and coastal cliffs, it blends into the coastal forest, and it blends into the littoral forest on the shore.

The rain forest can be divided into montane and lowland portions. The lowland rain forest (Fig. 22) covers the lowlands and foothills; montane rain forest is found on the gentle slopes and plateaus of higher elevations. This division is somewhat artificial since the difference is only a gradual change in species composition with increasing rainfall and elevation.

The montane rain forest of Samoa cannot be equated with the vegetation called montane rain forest in the literature. Usually this term refers to the tropical forest at elevations above 1,100-1,300 m (Richards 1952), which is greater than the highest elevation in American Samoa. This means that all of the rain forest in American Samoa is comparable to the "tropical rain forest" of the literature. The term "foothills" is sometimes used in reference to rain forest, but that term generally includes the lowland ridge forest as well.

The rain forest in American Samoa ranges from about 3 m to about 610 m in elevation. It receives from 254 to 635 cm of rainfall each year, with no dry season. The soil is relatively wet and supports a lush growth of ground cover. The forest reaches a height of 25-28 m, with a few trees a little taller. The tallest trees are *Terminalia richii*, *Calophyllum samoense*, *Ficus prolixa*, and *Ficus obliqua*. The latter two species are giant banyan trees. Stratification is often present, with canopy trees 18-28 m tall, and a layer of understory trees 6-18 m high. Even so, stratification is not as obvious as in rain forests elsewhere with much taller trees.

It is difficult to indicate the dominant trees in the rain forest of American Samoa because species composition depends greatly upon elevation. The occurrence of members of species pairs of *Dysoxylum* and *Myristica* is a good criterion of change from lowland to montane rain forest. At increased elevation in the rain forest, *D. samoense* and *M. fatua* are replaced by *D. huntii* and *M. hypargyrea*. The following list includes the major tree species found in the rain forest, those with an asterisk (*) being the overall dominants: **Dysoxylum huntii*, *Myristica hypargyrea*, *Syzygium samoense* (highest relative dominance at higher elevations); *Alphitonia zizyphoides*, *Bischofia javanica*, *Buchanania*

merrillii, **Calophyllum samoense*, **Canarium samoense*, *Canthium merrillii*, *Elaeocarpus tonganus*, *Neonauclea forsteri*, **Planchonella torricellensis*, *Rhus taitensis*, *Terminalia richii* (relative dominance unaffected by elevation); **Dysoxylum samoense*, and **Myristica fatua* (highest relative dominance at lower elevations).

Other common to occasional tree species of lesser importance in the rain forest are *Canarium harveyi*, *Citronella samoensis*, *Elaeocarpus ulianus*, *Endiandra elaeocarpa*, *Fagraea berteriana*, *Flacourtia rukam*, *Garcinia vitiensis*, *Hernandia moerenhoutiana*, *Hibiscus tiliaceus*, *Inocarpus fagifer*, *Litsea samoensis*, *Macaranga stipulosa*, *Syzygium inophylloides*, and *Syzygium samarangense*. The small species of the understory are *Aglaiia samoense*, *Antidesma spaerocarpum*, *Calycosia sessilis*, *Casearia* sp., *Disopyros samoensis*, *Ficus godeffroyi*, *Hedycarya denticulata*, *Meryta macrophylla*, *Psychotria forsteriana*, *Psychotria insularum*, and *Sacropygme pacifica*.

More vines and climbers are present in the rain forest than in any other type of forest. More than 90% of the larger trees are draped with vines. The most common vine and climber species in estimated order of importance are *Lomagramma cordipinna*, *Piper graeffei*, and *Raphidophora graeffei*. The less common are *Alyxia bracteolosa*, *Entada phaseoloides*, *Faradaya powellii*, *Freycinetia* spp., *Gynochtodes ovalifolia*, *Hoya pottsii*, *Mucuna gigantea*, and *Mucuna* sp.

Epiphytes are also abundant in the rain forest, but not as luxuriant or as numerous as in the cloud forest. The following are the common epiphytic flowering plants, all orchids except *Procris*: *Bulbophyllum samoanum*, *Coelogyne lycastoides*, *Dendrobium biflorum*, *Dendrobium vaupelianum*, *Diplocaulobium fililobum*, *Liparis longipes*, *Oberonia equitans*, *Procris pendunculata*, *Phreatia graeffei*, and *Phreatia stenostachya*. The following species are common epiphytic ferns: *Antrophyum alatum*, *Antrophyum plantagineum*, *Asplenium falcatum*, *Asplenium nidus*, *Davallia epiphylla*, *Microsorium scolopendria*, *Polypodium emersonii*, *Pyrrosia adnascens*, *Vaginularia angustissima*, and *Vittaria rigida*.

Ground cover in the montane rain forest is abundant, averaging 64% in the three sites (plots 22-24) studied. The dominant species is often *Lomagramma cordipinna*. This fern is also the most common climber. It grows along the ground, and when it encounters a tree it becomes a climber. Other common ground cover plants are *Angiopteris evecta*, *Asplenium cuneatum*, *Asplenium feejeense*, *Asplenium nidus*, *Bolbitis lonchophora*, *Calanthe hololeuca*, *Calanthe triplicata*, *Cyathea* spp., *Diplazium harpeodes*, *Dryopteris* spp., *Heliconia paca*, *Lindsaea decomposita*, *Microsorium scolopendria*, *Nephrolepis biserrata*, *Polypodium samoense*, *Tectaria stearnsii*, *Trichomanes boryanum*, and *Zingiber zerumbet*. All of these are ferns except *Calanthe* (ground orchids), *Heliconia* (a banana-like plant), and *Zingiber*.

In open or disturbed areas of the rain forest, ferns, vines, and shrubs soon take over. The most common shrub is the

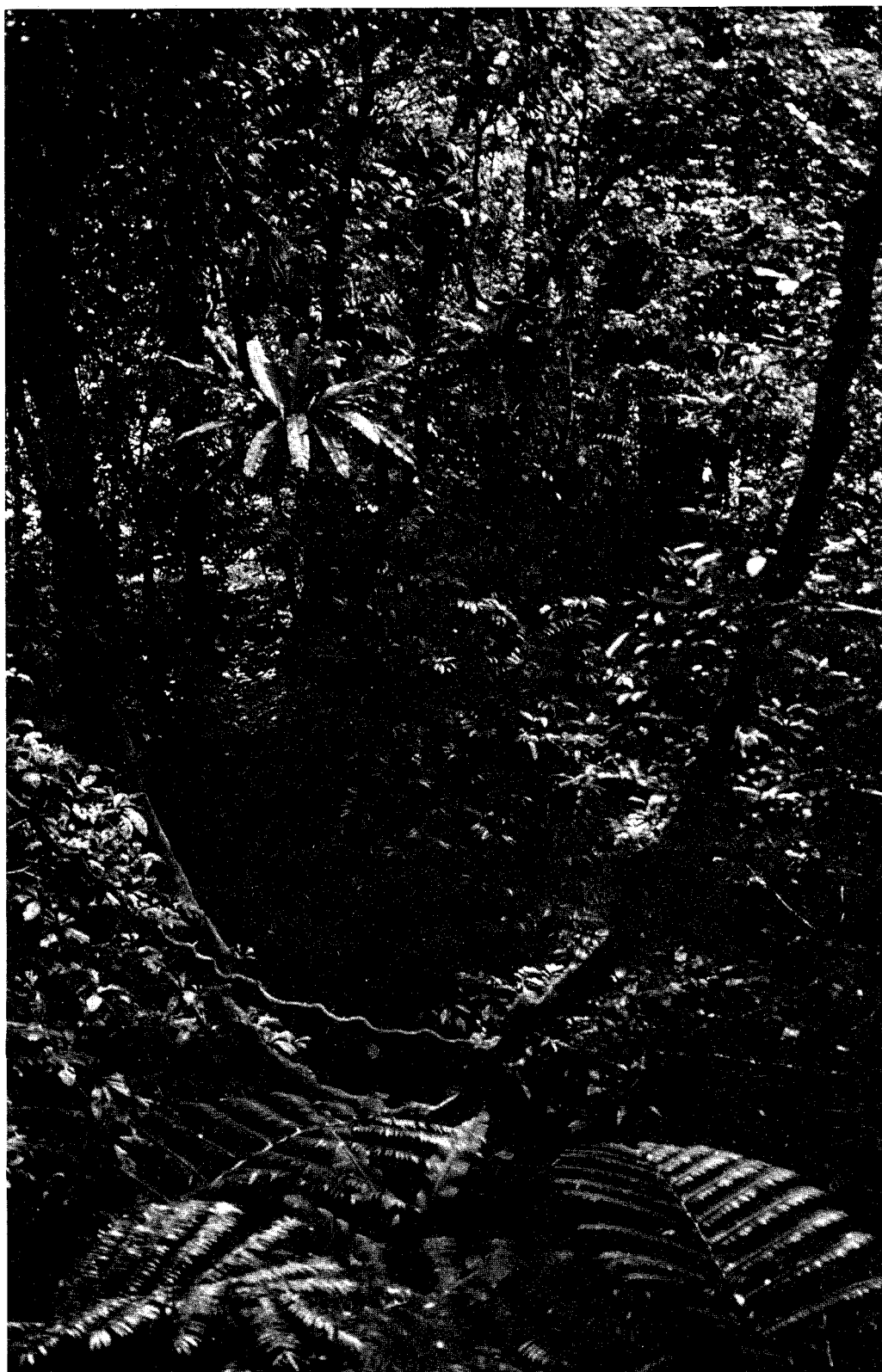


Fig. 22. Lowland rain forest near Malaeimi Valley, Tutuila Island (photo by A. B. Amerson, Jr.).

also on Ta'u

noxious weed *Clidemia hirta* (Koster's Curse), found only on ~~Tutuila~~. The most common vine is *Mikania micrantha* (mile-a-minute weed), and the most common ferns are *Nephrolepis hirsutula* and *Dryopteris* spp. In some places, particularly where the canopy is broken, seedlings of various primary or secondary forest tree species may be abundant.

The vegetation along the sides of streams is similar to surrounding vegetation. The main difference is that often there are many small to medium-sized *Barringtonia samoensis* trees along streams. This difference is not significant enough, however, to warrant describing these areas as riparian or streamside vegetation types.

Ridge forest

The ridge forest, by definition, is the forest growing on ridges. At low elevations it blends into the coastal forest and at higher elevations it blends into the montane scrub. The degree of slope is the main factor distinguishing ridge forest from rain forest. Ridge forests receive amounts of rain comparable to the rain forest at similar elevations, but because of the slope and exposure, runoff is higher and soil moisture is lower, and this is reflected in the smaller amount of ground cover. Setchell (1924) included the ridge forest under "ridge and summit formations," but neither Wright (1963) nor Rechinger (1908) mentioned this type of vegetation. With some justification, ridge forest could be considered a subdivision of the rain forest.

The dominant ridge forest species are similar to those in the rain forest, but a number of less important species are found almost exclusively in the ridge forest, perhaps because of the more intense light conditions on the steep slopes. Another major difference between the rain and ridge forests is in the height and density of the trees. Trees of the ridge forest rarely reach a height of 12-15 m whereas trees reach twice that height in the rain forest. The typical density of trees more than 2.5 cm dbh in the ridge forest is 30 to 52 trees per 100 m², whereas in the rain forest the density of trees of this size is only 12 to 18 trees per 100 m². In the ridge forest, tree heights are probably lower because of wind exposure or the shallower, poorer, drier soil conditions, and the tree density is probably higher as a result of better light conditions in the understory.

It is not practical to divide the ridge forest into subtypes, but species composition differs somewhat with varying elevations. The following list contains the major tree species (overall dominants are marked with an asterisk): **Dysoxylum huntii*, **Myristica hypargyrea*, *Trichospermum richii* (greatest relative dominance at higher elevations), *Alphitonia zizyphoides*, *Baccaurea taitensis*, **Canarium samoense*, **Crossostylis biflora*, **Diospyros samoensis*, *Elaeocarpus tonganus*, *Elattostachys falcata*, *Erythrospermum acuminatissimum*, *Myristica fatua*, *Palaquium stehlinii*, **Planchonella linggenensis*, *Rhus taitensis* (relative dominance unaffected by elevation), **Calophyllum samoense*, *Planchonella costata*, *Syzygium dealatum*, **Syzygium inophylloides* (greatest relative dominance at

lower elevations). Three species—*Erythrospermum*, *Crossostylis*, and *Baccaurea*—are particularly characteristic of the ridge forest.

The following tree species are of lesser importance in the ridge forest: *Buchanania merrillii*, *Canarium harveyi*, *Cyathea* spp. (tree ferns), *Elaeocarpus ulianus*, *Garcinia vitiensis*, *Glochidion ramiflorum*, *Hibiscus tiliaceus*, *Litsea samoensis*, *Mammea glauca*, and *Syzygium samarangense*. Small trees or shrubs are *Aglaiia samoensis*, *Calycosia sessilis*, *Gymnosporia vitiensis*, *Ixora samoensis*, *Meryta macrophylla*, *Polyscias samoensis*, and *Psychotria insularum*.

The numbers of vines and climbers is considerably less in the ridge forest than in the rain forest. The most common five, in estimated order of importance, are *Freycinetia* spp., *Hoya pottsii*, *Lomagramma cordipinna*, *Alyxia bracteolosa*, and *Piper graeffei*. The most important difference between these and the major vines of the rain forest are the addition of *Freycinetia*, *Hoya*, and *Alyxia* (all relatively xerophytic species) and the loss of *Raphidophora graeffei* as dominant species. Other vines found in the ridge forest are *Faradaya powellii*, *Gynochtodes ovalifolia*, *Hoya australis*, *Hoya betchei*, *Jasminum didymum*, *Medinilla samoensis*, and *Santaloides samoense*.

Epiphytes are much less common in the ridge forest than in the rain forest. The following are the most common flowering plant species (all are orchids except *Procris*): *Bulbophyllum samoanum*, *Bulbophyllum longiscapum*, *Coelygne lycastoides*, *Dendrobium biflorum*, *Dendrobium vaupelianum*, *Ephemerantha comata*, *Phreatia graeffei*, and *Procris pedunculata*. Epiphytic ferns common to occasional in the ridge forest are: *Antrophyum alatum*, *Asplenium falcatum*, *Asplenium nidus*, *Davallia epiphylla*, *Nephrolepis biserrata*, and *Pyrrosia adnascens*.

Ground cover is moderate at the three ridge forest sites (plots 26-28), averaging 47%. This percentage is less than in the rain forest, but more than in most of the other forest types. Dominant species are *Asplenium nidus*, *Lomagramma cordipinna*, *Dryopteris* spp., *Nephrolepis biserrata*, *Davallia ephiphylla*, and *Microsorium scolopendria*. The relative cover of *Lomagramma* is significantly lower in the ridge forest than in the rain forest.

Cloud forest

The cloud forest, growing in American Samoa only on the summits of Mt. Piumafua (Olosega) and the higher elevations of Ta'u, derives its name from the fact that the forest is usually enshrouded by clouds in the daytime. The warm, moist trade winds cool when ascending the mountains, causing condensation of the moisture which forms the clouds. It is a rare day when the top of Ta'u is cloud-free.

On Olosega, the lower margin of the cloud forest is at an elevation of about 550 m. On Ta'u, with a much larger area and higher summit, this lower margin is probably around 670 m. These figures are somewhat arbitrary because the cloud forest grades into the montane rain forest below it without



Fig. 23 Cloud forest on Lata Mountain, Ta'u Island (photo by W. A. Whistler).

definable boundaries.

The annual rainfall in the cloud forest is probably in excess of 1,015 cm as estimated during the present study. There is no dry season, and year-round humidity within the forest remains high. The soil is constantly wet, which allows for a heavy growth of ground ferns and orchids. The mean maximum temperature is about 22–26 °C (72–78 °F), and the mean minimum is 17–20 °C (62–68 °F); these are several degrees lower than temperatures at lower elevations, and there is little seasonal variation.

The height of the cloud forest canopy is usually not more than 11 m—less than half the height attained by the rain forest canopy. When undisturbed, the cloud forest canopy is rather continuous, although not dense. On Ta'ū, the Mt. Lata canopy (Fig. 23) seems anomalous because it is open with a high proportion of tree ferns present. Tree ferns require a considerable amount of light for establishment and growth. This open aspect of the Mt. Lata cloud forest may be a result of extreme climatic conditions (e.g., high rainfall) or possibly of a hurricane in the recent past which leveled the original cloud forest. Because of the low stature of the cloud forest trees, no stratification is present.

The dominant tree species in the cloud forest are those adapted to the high rainfall and cooler temperatures. These species are found almost exclusively in the cloud forest or montane rain forest and do not grow at lower elevations. The dominant species are listed, with the estimated dominance averaged from two plots (Mt. Lata and Mt. Piumafua): *Syzygium samoense* (22%); *Weinmannia affinis* (14%); *Astronidium pickeringii* (14%); *Dysoxylum huntii* (10%); *Fagraea berteriana* (8%); *Syzygium samarangense* (6%); *Reynoldsia lanutoensis* (1%). The dominance for *Reynoldsia* is generally much higher; it was uncharacteristically infrequent at the one Ta'ū site, and this species does not grow on Olosega. The average dominance of the tree ferns (*Cyathea* spp.) was 17%, but the basal area (the criteria for dominance) of these broad-based plants does not give an accurate basis for comparison. The following small trees are common in the cloud forest: *Ascarina diffusa*, *Medusanthra samoensis*, *Meryta macrophylla*, *Psychotria garberiana*, *Sarcopygme pacifica*, and *Streblus anthropophagorum*. In American Samoa *Ascarina* and *Streblus* are found only in the cloud forest of Ta'ū.

A significant characteristic of the cloud forest is the abundant growth of epiphytes. Mosses and liverworts cover nearly every available branch, often making the branch or trunk appear several times its actual size. Epiphytic orchids and ferns also are abundant. Among the epiphytic orchids are *Appendicula bracteosa*, *Diplocaulobium fililobum*, *Epiblastus sciadanthus*, *Glomera reineckea*, *Phreatia graeffei*, and *Pseuderia ramosa*. Epiphytic ferns include *Asplenium nidus*, *Dryopteris davallioides*, *Humata serrata*, *Hymenophyllum formosum*, *Hymenophyllum polyanthos*, *Lomagramma cordipinna*, *Oleandra neriiformis*, *Polypodium emersonii*, *Polypodium tenuisectum*, *Trichomanes apiifolium*, *Trichomanes dentatum*, *Trichomanes intermedium*, and *Trichomanes saxafragoides*.

The ground cover is abundant, particularly in the Mt. Lata cloud forest. At the surveyed plot, the ground cover was estimated to be more than 50%, and was dominated by the following ferns: *Dryopteris davallioides* (16%); *Cyathea* sp. (7%); *Dryopteris* sp. (5%); *Asplenium multifidum* (2%); *Blechnum vulcanicum* (2%); *Lomagramma cordipinna* (2%).

The dominant flowering plant of the ground cover at the Ta'ū site (plot 32) was *Freycinetia storckii*, which averaged about 13%. This *Pandanus*-like climber, with its inch-thick stems covered with epiphytes, forms a dense tangle between trees, making the area virtually impenetrable without a bushknife. On Olosega the *Freycinetia* does not form this impenetrable tangle, although it is an abundant climber in the trees. With the exception of *Freycinetia*, vines and climbers on Ta'ū are few and insignificant. Numerous species of ground orchids are found in the cloud forest, including *Calanthe hololeuca*, *Cryptostylis alismifolia*, *Habenaria tradescantifolia*, *Habenaria vaupelii*, *Liparis stricta*, *Malaxis samoensis*, *Moerenhoutia heteromorpha*, *Phaius tankervilleae*, *Zeuxine sphaerochila*, and *Zeuxine* sp.

Montane scrub

The montane scrub consists of low scrubby vegetation at higher elevations. Trees are few and scattered, and the ground cover is dense with a greater biomass than the trees. Two major types of montane scrub have quite different species compositions.

The first, and by far the more significant, type of montane scrub is found on the peaks of old trachyte plugs on Tutuila. This type of vegetation is described by Setchell (1924) as part of "summit and ridge formations." It grows principally on Pioa (Rainmaker), Matafao (Fig. 24), and Tau (east of Malaieimi) mountains. Although the rainfall is undoubtedly high on these peaks, Setchell calls this a xerophytic formation. The flora of these peaks is not, however, composed of xerophytic species. The steepness and poor soil of the peaks probably is responsible for this peculiar type of vegetation. As the steepness decreases, the vegetation changes to ridge forest.

The montane scrub on Tutuila consists of scattered trees less than 4.5 m high. The number of species found in the montane scrub is small compared to other types of forest vegetation. The major species are listed below, roughly in order of relative dominance. Those species that are almost exclusively limited in American Samoa to montane scrub are marked with an asterisk: **Pandanus reineckei*, **Rapanea myricifolia*, **Syzygium brevifolium*, **Astronidium samoense*, **Spiraeanthemum samoense*, **Metrosideros collina*, **Eurya japonica*, *Weinmannia affinis*, *Syzygium samoense*, **Alstonia godeffroyi*, and *Homalium whitmeanum*.

Other species growing in the montane scrub are *Acronychia richii*, *Anacolosa lutea*, *Astronidium navigatorum*, *Baccaurea taitensis*, *Calophyllum samoense*, *Canthium barbatum*, *Crossostylis biflora*, *Cyrtandra geminata*, *Descaspermum fruticosum*, *Dysoxylum huntii*,

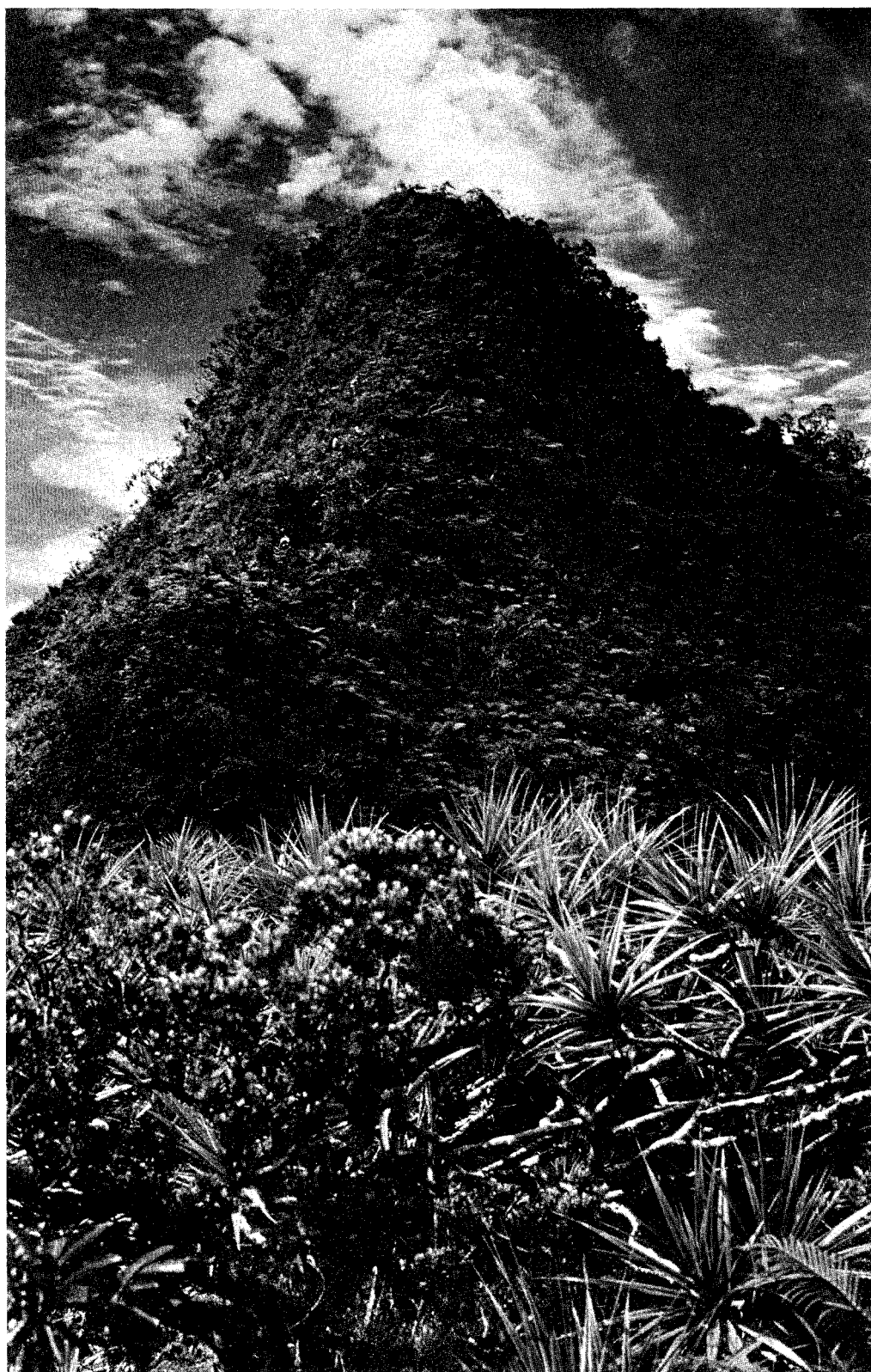


Fig. 24. Montane scrub on Matafao Peak, Tutuila Island (photo by W. A. Whistler).

Erythrospermum acuminatissimum, *Fragraea berteriana*, *Garcinia vitiensis*, *Hernandia moerenhoutiana*, *Ixora samoensis*, *Pandanus whitmeeanus*, *Psychotria insularum*, *Trichospermum richii*, and *Wikstroemia foetida*.

Epiphytes are common on the few trees in the montane scrub. Tree trunks are densely covered with cushions of moss. Vines and climbers are relatively unimportant, except for those species that are part of the ground cover. In a series of 10 quadrats (2 x 2 m) on Matafao, the following species (with the estimated cover) were dominant: *Dipteris conjugata* (22%); *Dicranopteris linearis* (20%); *Machaerina falcata* (20%); *Freycinetia storckii* (10%); *Duvallia epiphylla* (8%); *Pseuderia ramosa* (5%); *Blechnum vulcanicum* (3%); *Oleandra neriiiformis* (3%); *Paspalum orbiculare* (2%); *Scleria polycarpa* (2%).

The second type of montane scrub is found on Ta'ū Island, where there is no typical ridge forest. The richer soil on Ta'ū allows the montane scrub to blend into cloud forest. Montane scrub covers most of the steep cliff from the upper plateau to the summit of the south side of the island. The major factors on Ta'ū causing montane scrub are probably wind and steep terrain.

The montane scrub on Olotania Crater of Ta'ū has scattered trees like that on Tutuila, but the species are those of the surrounding cloud forest. In a transect of 5 quadrats (5 x 5 m), the following species (with the estimated cover) predominated: *Blechnum vulcanicum* (51%); *Dicksonia brackenridgei* (21%); *Freycinetia storckii* (7%); *Ascarina diffusa* (7%); *Paspalum conjugatum* (4%); *Reynoldsia lanutoensis* (2%); *Cordyline fruticosa* (2%). *Reynoldsia* and *Ascarina* are dwarf trees or saplings. The species on this list, with the exception of *Blechnum* and *Freycinetia*, are entirely different from those of the Matafao list. This ground cover is not unique to the montane scrub on Ta'ū, but is basically a concentration of the common ground cover species of the surrounding cloud forest.

The steep cliffs below the summit of Lata and Olotania are covered with what could be classified as montane scrub. Although no survey of the cliffs was made because of their steepness, the dominant species appear to be *Freycinetia storckii* and tree ferns (*Cyathea* and *Dicksonia*), with few trees present.

Cultivated land

The cultivated land in Samoa can be divided somewhat artificially into village land, plantation land, and pasture land. The difference between the first two is obscured by the fact that villages are often within plantations.

Village land.—The village land in Samoa, except for that on the Tafuna/Leone Plain and in the recently opened land at Aoloaifou on Tutuila, is all on the coast. Most of the coastal villages are on small bays, with very little flat land available for cultivation. In the villages the ground is often sandy and sparsely covered with grass (Fig. 25). Major crop trees include coconuts, breadfruit, and bananas. In addition,

many ornamental plants are grown for their showy leaves or pretty flowers. Taro is usually grown in marshy land, if available, or on nearby hillsides.

Plantation land.—The plantations consist mostly of coconuts, bananas, and taro. Extensive areas behind the villages are planted in coconut and taro. Coconut is less important to Samoans today than formerly, since copra is no longer exported from American Samoa. Many coconut plantations are now being overgrown by secondary forest. Few new coconut plantings were observed during the present survey. Because of the increasing cost of taro in 1975-76, primary or mature secondary forests were rapidly being leveled for taro cultivation around Aoloaifou and A'asufou, Tutuila.

Pasture land.—The only pasture land is in Malaeimi Valley and at the government-run Taputimu farm. There is no natural grassland in American Samoa.

Kula fernland

The kula fernland is an unnatural type of vegetation that may be described as a fire-climax vegetation. The kula fernland sites were originally fortifications on the coastal bluffs, built for protection against marauders; repeated clearing and burning on and around these sites (to maintain a clear field of view) leached and impoverished the soil. Today, only xerophytic grasses and ferns survive on the kula because forest trees are unable to colonize the inhospitable soil. The main reason for persistence of kula fernland today is the periodic burning by natives. Setchell (1924) referred to this type of vegetation as "*Pteris Bald*," but this term is incorrect because no species of *Pteris* (a fern genus) is found there. Wright (1963) mentions this type of vegetation and uses the Samoan name (tula) ("kula" in the vernacular) which means "bald." Kula fernland is found in only two locations in American Samoa—one above Onenoa village (Fig. 26), and another smaller one on a bluff beside Afao village; both are on Tutuila.

Vegetation in the kula fernland is dominated by herbaceous plants, with only scattered small shrubs present. The dominant species (with estimated cover) in a series of 10 quadrats (2 x 2 m) at Onenoa, Tutuila, were: *Dicranopteris linearis* (55%); *Paspalum orbiculare* (5%); *Chrysopogon aciculatus* (5%); *Glochidion ramiflorum* (2%).

Other plants found in the survey with less than 1% estimated cover were *Imperata cylindrica*, *Desmodium heterocarpon*, *Scleria polycarpa*, *Emilia sonchifolia*, *Melastoma denticulatum*, and *Nephrolepis hirsutula*. At the time of the last survey (12 November 1976) part of the Onenoa site had recently been burned.

Secondary forest

The secondary forest in American Samoa comprises the largest area of forest vegetation and includes all those stages of forest that have become established after agricultural land has been abandoned. If secondary forest remains undisturbed long enough, it will revert to a forest that is virtually in-

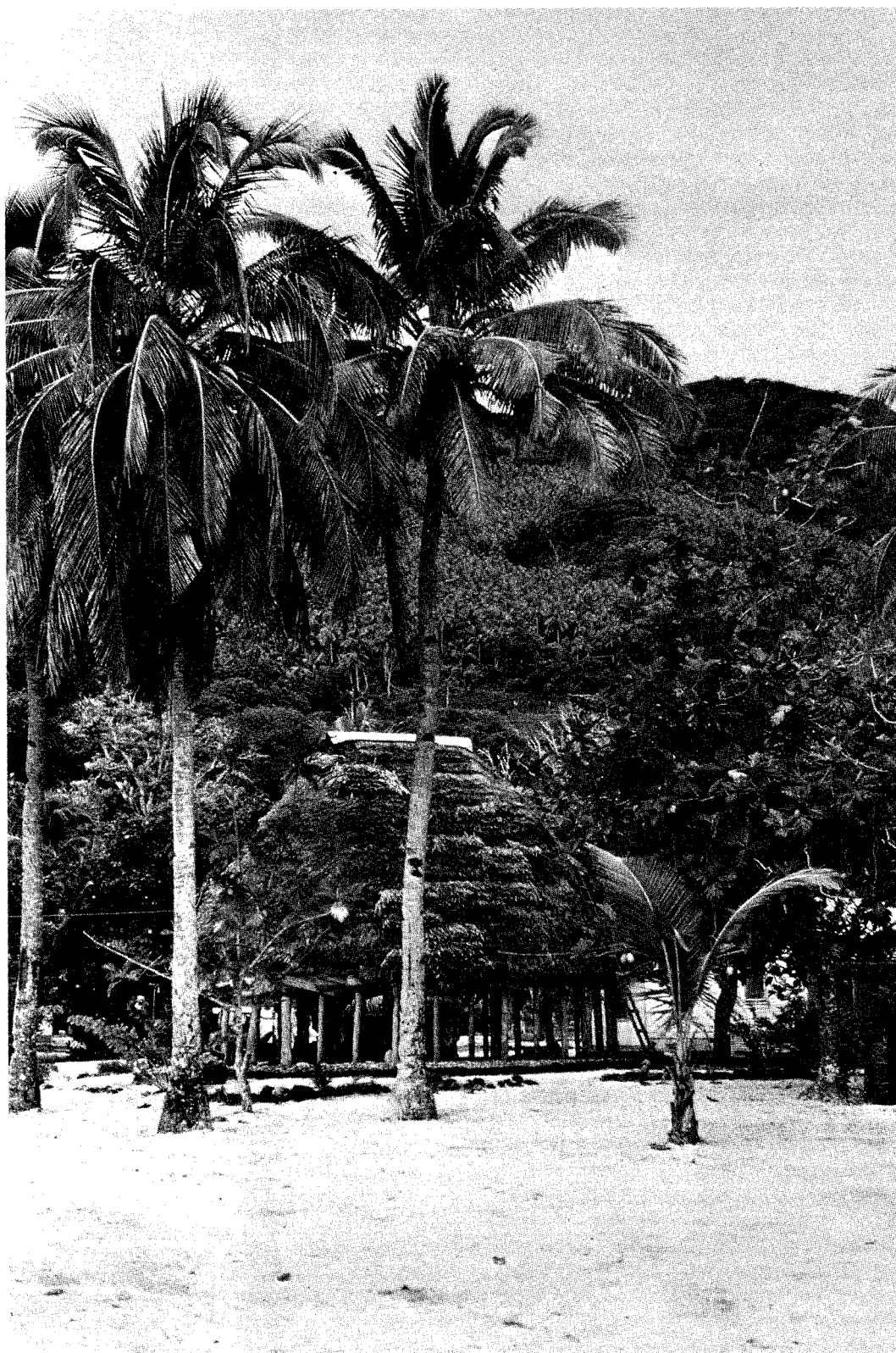


Fig. 25. Village land, showing typical old-style native house, on Ofu Island (photo by A. B. Amerson, Jr.).



Fig. 26. Kula fernland near Onenoa, Tutuila Island (photo by W. A. Whistler).

distinguishable from primary or virgin forest.

The first stage of plant succession in an abandoned field consists of a variety of weedy herbs and shrubs. These species have readily dispersed seeds and require abundant sunlight for growth. These weeds are eventually shaded out by secondary forest tree species, which also usually have small, readily dispersed seeds. Some of these trees may be small or medium in size, but they too are eventually shaded out by taller secondary forest tree species. Older secondary forest may become completely dominated by huge *Rhus taitensis* trees with diameters approaching 2 m. At the Laufuti site (plot 37 on Ta'ū) the *Rhus* trees had a dominance of 80%. A similar tree is *Alphitonia zizyphoides*. At the Faleiulu (plot 36 on Ta'ū) secondary forest, these two species had a total dominance of 74%.

The best way to determine whether a forest is primary or secondary is to analyze the species composition. The major secondary forest species, with their average dominance (calculated from plots 34-37) are: *Rhus taitensis* (34%); *Cyathea* spp. (18%); *Alphitonia zizyphoides* (10%); *Dysoxylum samoense* (6%); *Neonauclea forsteri* (4%);

Bischofia javanica (3%); *Hibiscus tiliaceus* (1%); *Fagraea berteriana* (1%).

Other secondary forest species of lesser importance are *Cananga odorata*, *Carica papaya*, *Euodia samoensis*, *Flacourtia rukam*, *Glochidion cuspidatum*, *Glochidion ramiflorum*, *Inocarpus fagifer*, *Kleinhovia hospita*, *Leucaena leucocephala*, *Macaranga harveyana*, *Macaranga stipulosa*, *Maoutia australis*, *Melochia aristata*, *Morinda citrifolia*, *Pipturus argentea*, *Pometia pinnata*, *Psidium guajava*, *Tarenna sambucina*, and *Trema orientalis*.

At low elevations, as in a coastal area, the sequence of succession involves somewhat different species. Nearly all of the Tafuna area has been cleared of its native (primary) forest. Some of the land near the airport is reverting to secondary forest. The first stage of succession consists of weedy herbs and shrubs which are apparently replaced by dense thickets of *Leucaena leucocephala*. Another important secondary species is *Macaranga harveyana*. At the secondary forest study plot next to the airport (plot 33) this species had a dominance of 19% but was being replaced by primary forest species.

In general, trees of the mature secondary forest have small seeds. When they germinate, they soon deplete their meager food reserve and die. In contrast, most primary forest trees have relatively large seeds with food reserves that allow the seedlings to wait longer for a break in the canopy; with a little light to grow, they eventually ascend into the canopy. Eventually the primary forest species dominate, and the mature secondary forest species are eliminated. The secondary forest species are mixed with primary forest species in proportions directly related to the age of the forest.

At the small patch of primary forest near the golf course at Tafuna, signs of man's disturbance are evident, and the size of this patch is rapidly decreasing. The seedlings and saplings that predominate on the forest floor are *Pometia pinnata*, which is uncommon elsewhere in American Samoa.

Island Accounts

The following accounts describe the vegetation of the seven islands of American Samoa. The number and kinds of vegetation or plant communities on an island are largely a function of the topography of the island. Five islands are volcanic; four "high islands" reach elevations of about 494 to 966 m and one is about 93 m. Two islands are atolls with an elevation of less than 9 m. Table 1 presents all types of communities found on the seven islands.

Tutuila Island.—Tutuila is the most rugged of the islands in the Samoan Archipelago. It is made up of weathered peaks and numerous ridges and valleys. Only two areas of flat land exist, the Tafuna/Leone lava plain and a montane plateau at Aoloaifou. Because of the heavy population pressure on Tutuila, little primary forest remains. Because the maximum elevation of Tutuila is only 653 m, it has no cloud forest. The highest peaks, known geologically as trachyte plugs, consist of poor soil on weathered rock. These peaks—Tau, Matafao, and Pioa—are covered with undisturbed montane scrub vegetation and are generally not appropriate for agricultural uses. Numerous ridges lead up to the peaks and mountains; they are covered with ridges forest unlike that on any of the other islands. Although the dominant species of this ridge forest are similar to those in the surrounding montane rain forest, the high density of trees and several characteristic small tree species in the ridge forest serve to distinguish it from rain forest.

Most of the interior of Tutuila is covered by a patchwork of secondary forest mixed with primary or primary-like forest on the steeper, more inaccessible slopes. Most of the remaining primary forest on Tutuila is on the central portion of the north coast. At the two ends of the island, coconuts and secondary forest predominate.

Much of the north coast of Tutuila consists of steep slopes and ridges extending down to the almost reefless shore. Here, many ridges and slopes, especially those not adjacent to villages, are covered with little-disturbed coastal forest. Most of the small valleys, however, are covered with coconuts or with secondary forest. Several valleys on the north coast contain sites of abandoned villages where vegetation is returning

to a natural state.

The lowland rain forest on the Tafuna/Leone plain has been removed except for several small patches. Even these patches are being cut down by people homesteading on the village land in spite of the fact that the rocky soil is poorly suited for agriculture. In the area around Aoloaifou, primary forest is being cleared to make room for taro plantations. The only remaining pasture land in American Samoa, outside of the Agriculture Department farm at Taputimu, is in the Malaieimi Valley.

Only two areas of coastal marsh remain on Tutuila, at Vatia and Alao, and both of these consist of taro patches and secondary marsh vegetation. Originally, large areas of mangrove forest were present, but much has been destroyed and replaced with villages after land reclamation. No trace is left of the mangrove forests at Pago Pago, Fagatogo, Utulei, and Faga'alu villages. The largest remaining mangrove forests are at Nu'uuli, Masefau, Aoa, and Leone villages.

In summary, Tutuila is the largest and most varied of the islands of American Samoa. All of the community types are found here, with the exception of cloud forest and possibly a pure *Pisonia* subcommunity. All of the coastal marshes on Tutuila are severely disturbed.

Aunu'u Island.—The island of Aunu'u off the southeast end of Tutuila is, except for the atolls, the smallest of the inhabited islands of American Samoa. Because of the island's low elevation and exposure to the sea, none of the montane plant communities found on the high islands is present. Aunu'u does, however, have all of the maritime plant communities—littoral rock and sand strand, littoral scrub, coastal marsh, mangrove forest, littoral forest, and coastal forest.

Most of the non-swampy land on Aunu'u was originally covered by coastal forest. This forest now survives only on the ridges and steep coastal slopes on the eastern half of the island. Most of the original forest has been replaced with coconut plantations.

A large part of Aunu'u Island is flat and waterlogged. The marshy area behind the village was formerly an extensive coastal marsh; little of the original vegetation remains, and the area is now under intensive taro cultivation (Fig. 19). The coastal marsh in the crater, however, is the largest and least disturbed marsh in American Samoa. On the north part of the low-lying western half of the island is a mangrove forest which surrounds a unique mud lake. Adjacent to this forest is a stately littoral forest, the seaward margin of which is made a scrubby thicket by the effects of the sea and winds.

On the east end of Aunu'u at Ma'ama'a Cove is a small, dense patch of *Pandanus* littoral forest which is the least disturbed of any in American Samoa. Just to the north and south of this is a magnificent *Barringtonia* forest covering flat to gently sloping terrain. Such habitat is usually occupied by coastal forest or lowland rain forest, but in this area the *Barringtonia* completely dominates. *Barringtonia* is not normally found this far inland because its seeds are usually dispersed by seawater. Perhaps the soil and other conditions

in this area are suitable for *Barringtonia*, which may have become established when high tides or a hurricane washed seeds inland.

Ofu Island.—Ofu is the most disturbed of the high islands of American Samoa. Originally covered with coastal to montane rain forest, it is now largely covered by coconut plantations and secondary forest. Undisturbed montane rain forest is limited to a small patch on Tumu Mountain. Most of the active coconut plantations cover the west-facing slope of the island. The considerable amount of secondary forest indicates that pressure on the land is decreasing. Ofu lacks cloud forest.

Steep slopes along the north shore and south side of Ofu are clothed in undisturbed lowland rain forest. Rock falls have created slopes of boulders and rock fragments in some places. These talus slopes are covered with lowland rain forest and secondary forest species that have successfully invaded and survived on the slope after rockfalls and landslides. The north and south sides of the island merge toward the east end to form a sharp, steep ridge which is covered with scrubby coastal forest trees. Although it is a ridge, the species composition is not typical of ridge forest (as found on Tutuila), but rather resembles coastal forest.

On the south tip of the island there is a disturbed coastal marsh just north of the Ofu airport runway. Along the south coast is a disturbed littoral forest which includes a large amount of *Sophora tomentosa*; it is one of only three places where this species is found in American Samoa. This coastal area was probably used more in the past than it is today; because of decreasing population and its distance from the village, it has become somewhat neglected.

Ofu is also the island where feral pigs have caused the most damage to the vegetation. Hunting pressure has let up so much (possibly because of the decreasing human population) that the increase in the number of pigs has made them a nuisance. Semi-wild pigs are kept and fed on Nu'utele Islet, off the west coast near the main village. This islet is heavily planted in coconut, but is in a state of neglect. The small amount of native vegetation remaining on the islet consists of some coastal forest on the ridge and some rock strand on the sheer cliffs of the western side.

Olosega Island.—Olosega is similar to Ofu in size, and contains many of the same vegetation types. The island consists of a large mass of rock rising up to Piumafua Mountain at 639 m. The island is surrounded by steep coastal cliffs, but the central portion is a gradually sloping plateau.

All but the steepest parts of the coastal cliffs are clothed in scrubby coastal forest and lowland rain forest vegetation. Because of the steepness of the slopes, this vegetation is mostly in a natural state. The lower part of the plateau is covered with coconut plantations. With increasing elevation, coconuts are gradually replaced by secondary forest. A small amount of montane rain forest surrounds a small undisturbed cloud forest at the top of Piumafua Mountain. The top of the mountain is often enveloped by clouds.

At Maga Point on the south tip of Olosega the coastal

forest gives way to windswept littoral scrub dominated by *Scaevola* and *Wedelia* subcommunities. At the extreme south end, the rock is so steep and the soil so thin that only sparse vegetation can survive, forming typical rock strand vegetation.

Between Olosega Village and the steep slopes behind it lies a coastal marsh that is completely converted to the cultivation of taro. Like the rest of Manu'a, Olosega lacks mangrove forest, pasture land, and kula fernland.

Ta'u Island.—Ta'u is the highest island in American Samoa, with an elevation of about 966 m. The summit is covered by a dense cloud forest that has apparently not been disturbed by man, but that appears to have been disturbed in the recent past by a hurricane.

Although Ta'u, with very few villages, now has the lowest population density of any of the high islands of American Samoa, many of the slopes and plateaus of the lower elevations are covered with mature secondary forest. These areas have probably been disturbed for many years and reflect the effects of the former higher population density of the island. Most of the northwest quarter of Ta'u is still covered with coconut plantation. At higher elevations, the coconuts, found in a dense secondary forest, are being crowded out by the secondary forest trees. Above this forest, a large area of undisturbed montane rain forest gradually changes at higher elevations to cloud forest.

Along the east coast of Ta'u, where a wide shelf of coral rubble blends into the talus slopes at the base of the cliffs, there is a beautiful lowland rain forest. On its seaward margin, it merges into a relatively undisturbed littoral forest.

The west coast of Ta'u is highly disturbed and consists of a narrow strip of secondary forest and coconut palms. At the southwest and southeast corners, littoral scrub is found on the windswept slopes. The western half of the north coast has steep cliffs clothed in coastal forest.

Behind Lumā Village, a large coastal marsh is surrounded on three sides by steep cliffs. This coastal marsh is now covered by taro fields which produce a surplus of taro that is shipped to Tutuila.

Ta'u is a shield-shaped dome, the southern half of which is gouged out to produce a majestic amphitheater with sheer cliffs from the summit down to two almost inaccessible sloping plateaus. These sheer cliffs are covered with a scrubby vegetation that is best described as montane scrub.

In summary, Ta'u lacks mangrove forests, the *Pisonia* and *Barringtonia* associations of the littoral forest, and ridge forests. Of the disturbed vegetation types, it lacks both pasture land and kula fernland. Ta'u has the largest proportion of natural vegetation of all the high islands of American Samoa.

Rose Atoll.—Rose Atoll consists of a reef with two sandy islands. Rose Island, the only vegetated island in the atoll, has the least and simplest vegetation of any of the islands of American Samoa. Rose Island has an elevation of about 3 m; Sand Island is even lower. The flora of Rose Island consists of only seven species and two plant communities—sand

strand and littoral forest. The sand strand is dominated by *Boerhavia tetrandra* and *Portulaca lutea*; the littoral forest is a dense grove of *Pisonia* trees as high as 18-21 m, with scattered *Messerschmidia* trees on the north half of the island (Fig. 27).

Because the entire atoll has been designated a National Wildlife Refuge, Rose Island is relatively undisturbed except for a concrete marker, a U.S. Fish and Wildlife Service Refuge sign, and a small number of introduced coconut trees. These palms, however, are not thriving on the sandy island.

Recently there has been a mysterious dieback of *Pisonia* trees on Rose Island. The dieback left the center of the littoral forest denuded of vegetation and littered with fallen, dead *Pisonia* trees. The destruction appears to have been gradual rather than catastrophic (S. N. Swerdloff, personal communication). The most probable causes for the dieback are a plant disease, an insect attack, or a drought affecting the salinity and water lens (water table) below this part of the *Pisonia* forest. It may now be only an academic question, since the dieback has apparently ended and no additional trees were found to be dying at the time of 1975-76 visits to the island.

Swains Island.—Swains Island was originally covered with littoral forest. The dominant species were *Pisonia*, *Hernandia*, *Pandanus*, *Neisosperma*, *Calophyllum*, and possibly,

Barringtonia and *Cordia*. The original vegetation has been almost totally removed and replaced with coconut plantations that now cover the island.

Until recently, the production and exportation of copra were major activities on Swains, and several hundred Tokelau Islanders were employed for this purpose. Now, however, copra is no longer exported, and fewer than 40 inhabitants remain on the island. Coconut trees are slowly being replaced by littoral forest species, chiefly *Hernandia* and *Pandanus*. Undergrowth in the coconut areas consists of a dense, nearly impenetrable growth of bird's-nest ferns and young coconut trees.

The brackish lagoon on Swains Island apparently has been isolated from the sea only in recent times. A small patch of coastal marsh, dominated by *Paspalum distichum* and *Eleocharis geniculata*, survives along the northern edge of the lagoon. This is the only place that this species of *Eleocharis* has been reported in Samoa.

Scaevola is the dominant plant in the littoral scrub vegetation of Swains Island. It grows along the seaward margin of the littoral forest, as well as on one large inland area. Sparse sand strand vegetation is found on the beach.

In summary, the only types of natural vegetation present on Swains Island are sand strand, mixed littoral forest, littoral scrub, and coastal marsh.

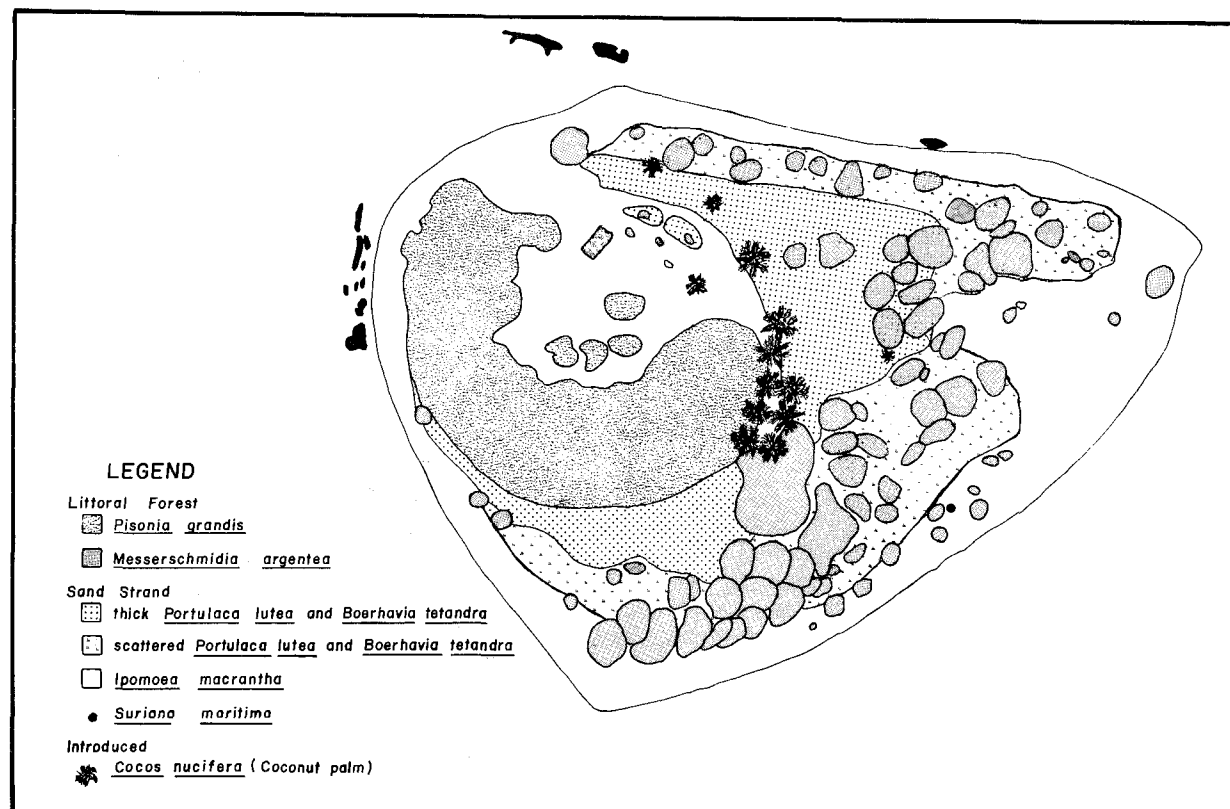


Fig. 27. Distribution of vegetation community types on Rose Island, Rose Atoll.

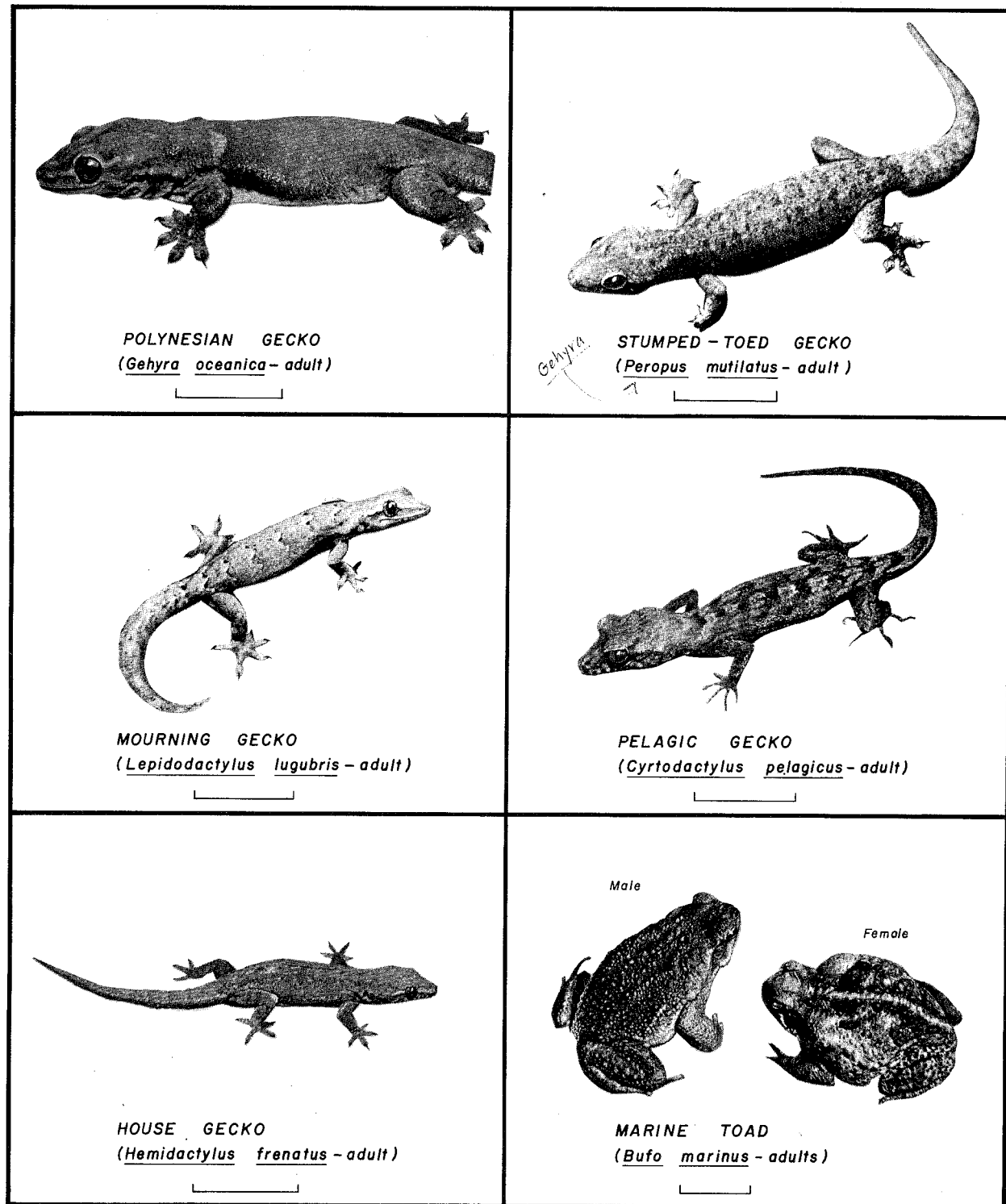


Fig. 28. The five species of geckos and the marine toad in American Samoa (photos by T. D. Schwaner). Scale indicates 2.5 cm.

Amphibians and Reptiles

Although only 16 species of amphibians and reptiles (Table 10) are found in American Samoa, their total numbers are such that they are, by far, the most abundant of the vertebrates. They are found from the ocean to deep forests, and in houses and buildings they are accepted as the best natural household insect exterminators available. Species accounts for each of these, giving specific distributional and ecological information, are included in the companion volume of this report (Amerson et al. 1982).

Herpetological History

Historically, the herpetofauna of American Samoa is poorly known. Previous major references to species of reptiles and amphibians are listed chronologically in Table 11, which also gives new distributional records from the present study. Early explorers in American Samoa reported sea turtles (Wilkes 1845; Girard 1858; Graeffe 1873) and a gecko (Mayor 1921) on Rose Atoll. Girard (1858) gave detailed descriptions of many reptiles now known from American Samoa, but his locality references were to "Samoa," believed to be Western Samoa, without specific mention of the American Samoan islands. It was not until the Whitney South Sea Expeditions in the 1920s that systematic collections of reptiles from American Samoa were made. Burt and Burt (1932) summarized these data in the primary publication that discusses the American Samoa herpetofauna. Their report lists several lizards (skinks and geckos) from Tutuila, "Olosega" (= Olosega), and "Manua" (= Ta'u). In the 1960s, lizard specimens were collected from Tutuila and Swains islands by scientists of the Pacific Ocean Biological Survey Program (POBSP) of the Smithsonian Institution. Clapp (1968) noted four lizards he found on Swains Island, but his report of the black skink, *Emoia nigra*, was in error (R. B. Clapp, personal communication).

Some significant herpetological collecting in American Samoa has not previously been reported. Lt. H. C. Keller, a Naval physician stationed in American Samoa in 1917-18, made extensive collections of both insects and reptiles, which were deposited in the U.S. National Museum. Unfortunately, no dates of collection accompanied his 105 reptile specimens, which include the only known moth skink (*Lipinia noctua*) from Ta'u Island and the first Pacific boa (*Candoia bibroni*) from American Samoa. Other specimens were taken by L. P. Schultz in 1934, L. A. Jackowski in 1939, and Lowell D. Holmes in 1954. Undoubtedly there are other unreported specimens in foreign museums.

Previous herpetological collections known to us total 442 specimens. In the present study, 986 specimens of 14 species were collected.

New Records

The present study resulted in 52 new distribution records for the 16 species of herpetofauna found in the islands of American Samoa (see Amerson et al. 1982). Seven species—the pelagic gecko (*Cyrtodactylus pelagicus*), house gecko

(*Hemidactylus frenatus*), stump-toed gecko (*Peropus mutilatus*), Micronesian skink (*Emoia adspersa*), Lawes skink (*Emoia lawesii*), moth skink, and Pacific boa—are records for all of American Samoa. Of the remaining 45 records involving 15 species, 41 are specimen records for individual islands and 4 are sight (or questionable) records for individual islands (Tables 11, 12).

Biogeography

Of the 16 species of reptiles and amphibians (Figs. 28-30) in American Samoa, 14 are presumed to be native, but none is found only on these islands. The marine toad (*Bufo marinus*) was intentionally introduced on Tutuila in 1953 (GAS 1953) and on Aunu'u later. The house gecko is believed to be a relatively recent accidental introduction, so far found only on Tutuila.

With the possible exception of Lawes skink, most of the species of reptiles found in American Samoa are also found in Western Samoa, Tonga, and Fiji. Since no attempt has been made to analyze geographic variation of the lizards collected during this study, or to compare that variation with collections from other island groups, the origins of the American Samoan herpetofauna are only speculative at this time. Brown (1957) indicated that the herpetofauna of Central Polynesia, including American Samoa, appears to have complex origins involving species that crossed ocean barriers from both the eastern and western Pacific.

Ecological Distribution

The ecological characteristics and distributions of the terrestrial reptiles and amphibians of American Samoa are summarized in Tables 13 and 14. Of the diurnal skinks, four are large and three are small. Three of the four large skinks (the black, Samoan, and Lawes) share the same habitat; they are found together only on a single island, Ta'u. Lawes and Micronesian skinks are both semi-fossorial (i.e., burrowing or spending considerable time under rocks or coral rubble) and are not found together on any island studied. The black skink, mostly a terrestrial species, and Lawes skink are found together on Olosega. The black skink and Samoan skink, a semi-arboreal species (i.e., spending much time in trees, but also foraging on shrubs and on the ground at the base of trees), are found together on Tutuila. In all habitats where they live together, the large skinks appear well separated ecologically with respect to preferred times of activity, microhabitat, and food. Similarly, of the smaller species, the azure-tailed skink apparently occupies a macrohabitat separate (farther inland) from that occupied by the snake-eyed skink when the two are found on the same island. The azure-tailed skink is also separated from the moth skink by microhabitat differences, the latter preferring to hide under tree bark.

All five species of geckos found in American Samoa are of different sizes (Table 13). The largest (Polynesian) and the smallest (mourning) are found in the widest range of habitats and live together on all of the islands studied. The pelagic gecko occupies a more restricted habitat in the littoral forest.

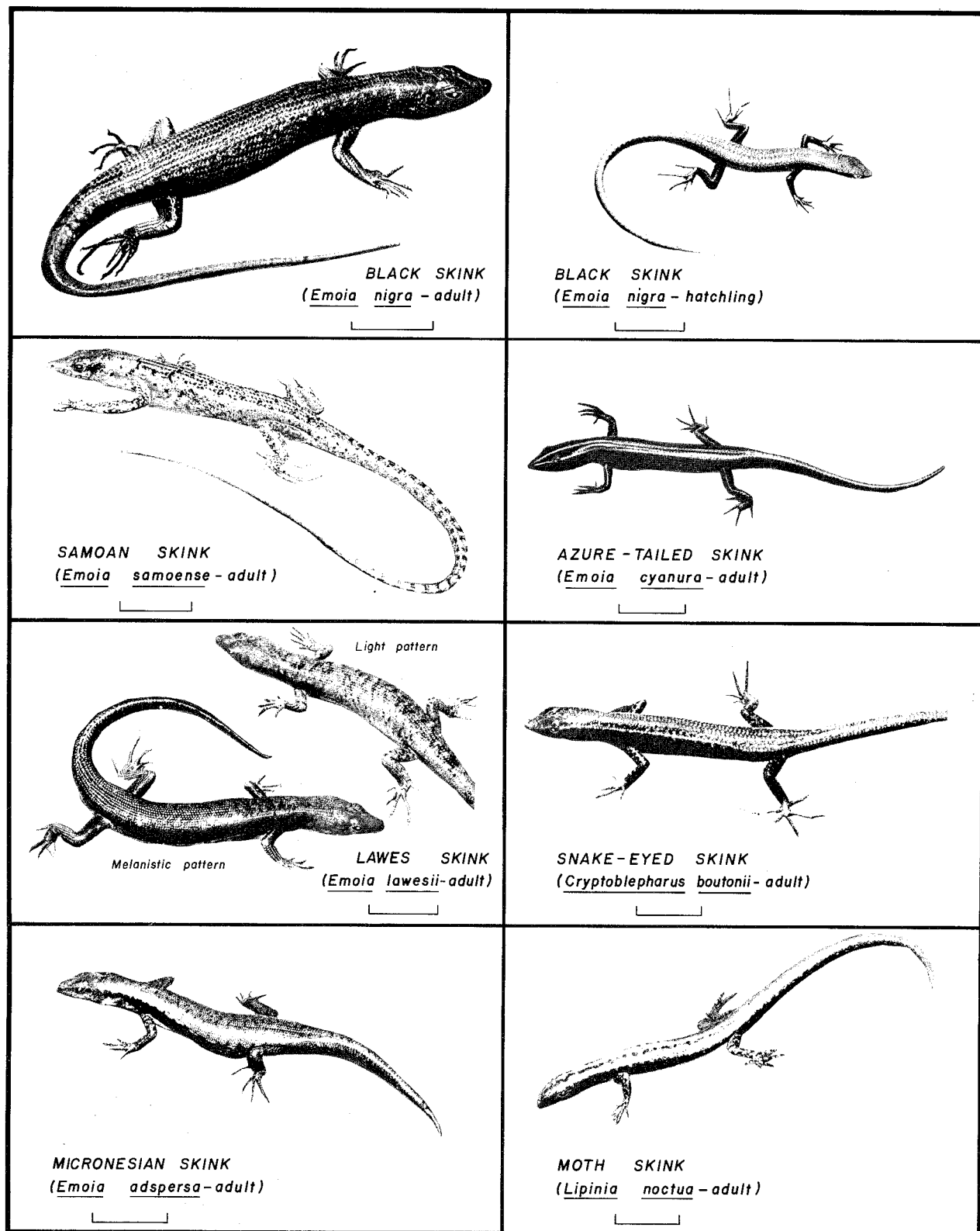


Fig. 29. The seven species of skinks found in American Samoa (photos by T. D. Schwaner). Scale indicates 2.5 cm.

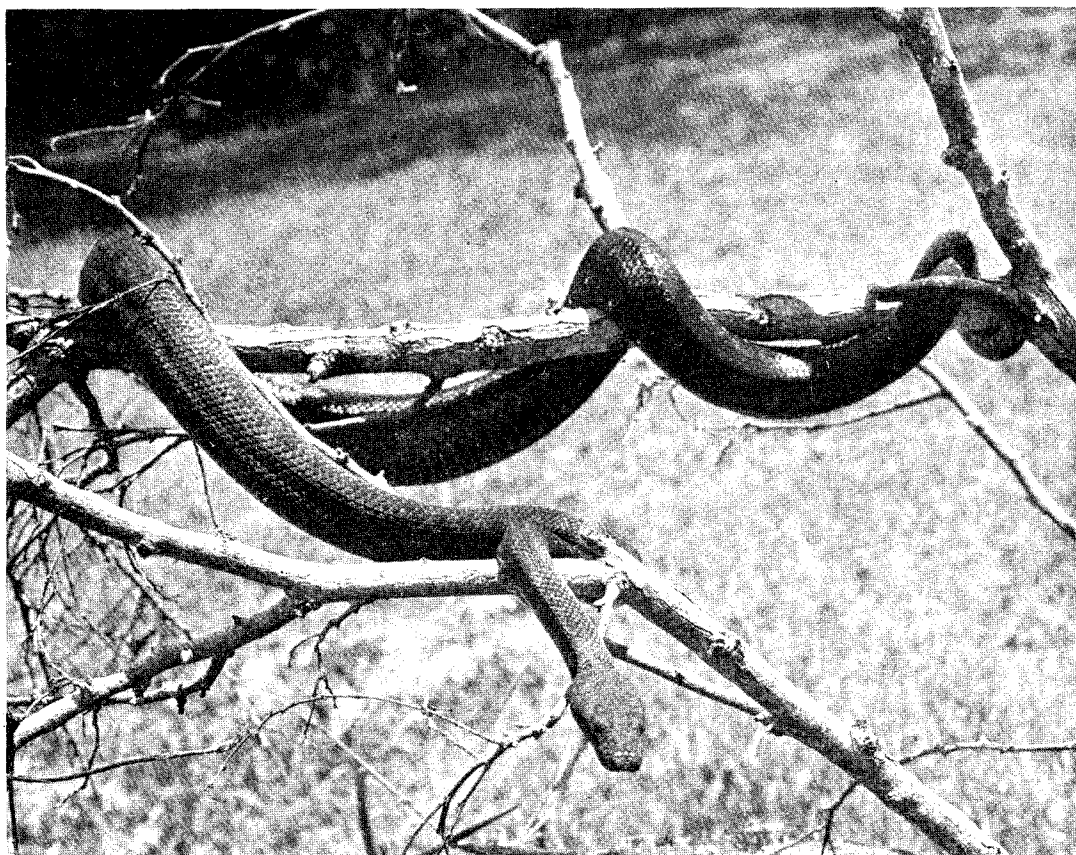


Fig 30. Living specimen of the Pacific boa, *Candoia bibronia*, from Ta'ū Island.

Although it is fairly abundant on Ta'ū, the pelagic gecko also appears to be restricted in its activity (Amerson et al. 1982). The house gecko and the stump-toed gecko inhabit only buildings of rather recent origin.

Island Distribution

The distribution of the amphibians and reptiles (Table 12) shows that the number of species is highly correlated with ecological and geographical factors on the islands. Comparison of these distribution data with data on the number of plant species on each island also indicates that the number of amphibian and reptile species increases with increasing habitat complexity or, presumably, with greater resource availability.

Tutuila Island.—Thirteen species of amphibians and reptiles have been recorded from Tutuila Island (Table 12); two are introduced. All but the two species of turtle breed on Tutuila. The introduced marine toad is found in all habitats except montane scrub and kula fernland; it is more prevalent in lowland areas than in the highlands. The introduced house gecko is known only from Tutuila. The black and hawksbill turtles have recently been recorded in very small numbers in Pago Pago Harbor and in the waters surrounding Tutuila.

Aunu'u Island.—Of the eight species of amphibians and

reptiles from Aunu'u Island (Table 12), seven are native and one is introduced. The introduced marine toad was observed throughout the island. Black turtles were reported occasionally to lay eggs on the sand beaches along the Agaoleatu Point area on the north side of the island, but these reports are unconfirmed.

Ofu Island.—Eight species of reptiles have been recorded from Ofu Island (Table 12). Local inhabitants reported that the black turtle previously nested in small numbers on the sand beaches along the southeast shore, and turtles have been reported offshore in recent years.

Olosega Island.—Of the nine species of reptiles recorded from Olosega Island (Table 12), the black turtle, which reportedly nested in small numbers on the sand beaches, has not been recorded in recent years.

Ta'ū Island.—Twelve species of reptiles have been recorded from Ta'ū Island (Table 12). In the past the black turtle is reported to have bred on the isolated sand beaches, especially along the east, south, and west beach areas. In all of American Samoa, the Pacific boa is found only on Ta'ū; it primarily inhabits the littoral forest along the south shore and, secondarily, the plantation land along the west coast.

Rose Atoll.—Four species of reptiles are known from Rose Atoll (Table 12). The black turtle and hawksbill turtle

nest on both Rose and Sand islands. The two geckos are known only from Rose Island, where they are primarily associated with the human disturbances.

Swains Island.—Seven species of reptiles have been recorded from Swains Island (Table 12). In the past the black turtle is reported to have bred on the sand beaches; in recent years it has only been observed offshore, where it is occasionally captured for food and for the shell. In American Samoa, the Micronesian skink is known only from Swains Island.

Populations

Population estimates for reptiles and the amphibian were made by using density data obtained from study-plot inventories and transect surveys. Densities at each study plot, or along each transect, were extrapolated from direct counts of individuals for a given time (usually 1 hr) in a 100 m² quadrat or along transects of various lengths, often along forest paths, road cuts, and forest edges. Total population estimates were computed by converting density per 100 m² to density per acre and multiplying by the total acreage of each habitat on the islands sampled. Both density and total population estimates must be considered rough approximations, and are most useful for making comparisons with populations of other wildlife species in American Samoa. The total population of all species is about 37,000,000.

The estimated herpetofaunal population densities, and total population estimates, in the various community types on all islands are summarized in Table 15. Estimates were prepared only for the eight species with large enough samples. Plantation land contains all species for which estimates could be made and exhibits the highest species diversity of any habitat sampled. The total population density, as well as the individual densities of all species listed (except the Polynesian gecko), is highest in these disturbed, rather open environments. The higher density of the Polynesian gecko in littoral forest than in plantation land results from the classification of the Rose Atoll vegetation as littoral forest, even though the collections were made at disturbed areas.

The total population estimate for all lizards sampled in plantation habitats (30,847,800) is five times the number of lizards estimated in all other habitat types combined, even though the area of plantation land is only about 34% of the land area of American Samoa. Thus, most of the American Samoan lizards are judged to be species whose ecological requirements and physiological tolerances are highly adaptable to the colonization of disturbed, open, or edge habitats.

Littoral forest and adjacent edge habitats contained the second highest densities and the second greatest species diversity. All the species sampled were at least present in littoral forest, which may indicate that this is the primary natural habitat of most of the native reptiles of American Samoa. Densities in littoral forest were higher than or similar to adjacent littoral scrub habitats. One exception is the Samoan skink; the density of this species in littoral forest (0.95/100 m²) was less than in other, more forested habitats,

and the species was absent in littoral scrub.

The contrast in population densities between the edge and the interior of the mangrove forest was marked, as might be expected because of the severe tidal inundation in the forest. Densities of species at the edge, where tidal inundations did not occur, were 18 times greater than within the forest.

Coastal marsh habitat (a mat of ferns and sedges on Faimulivai Marsh) contained only the azure-tailed skink. Basking lizards were observed particularly at the interior edge of the mat along the water line. A single marine toad was collected in the same habitat; several others were observed. Although small winged insects appeared to be relatively abundant in the sedge and fern growth, only a small lizard like the azure-tailed skink would be able to procure them from the dense mat. It was also noted that temperatures at the mat surface were low and fairly stable, possibly a contributing factor in the absence of "sun-loving" species such as the other skinks from this habitat.

Coastal, ridge, and rain forests contained similar numbers of species. The marine toad probably inhabits coastal forest on Tutuila, but it was not encountered there, possibly because of sampling bias. A specimen was collected near a slow-moving stream in the rain forest at 365 m, but the density of toads in forested habitats is very low (0.1/100 m²). The apparent absence of the Polynesian gecko in rain and ridge forests may relate to its arboreal and nocturnal habits. The total density in coastal forest is higher than in ridge and rain forests, but the species diversity is higher in rain forests than in coastal forest (Table 15).

In rain forest edge habitats, which might be termed secondary forests since they involve thinned areas near road cuts, overall species density is higher than both rain forest and coastal forest combined. Whether these differences are significant, or a result of inadequate sampling in dense forest, is a matter of conjecture. The Samoan skink was sighted, although in low density, in *Freyrcinetia storckii* at the edge of montane scrub/cloud forest on Lata Mountain at 915 m. However, the overwhelming evidence of denser populations in plantation and littoral forest habitats than in natural forests at higher elevations suggests that few lizards live in the high-elevation habitats.

Further evidence of the preference of certain lizards for open habitats is the presence of the azure-tailed skink and the black skink in montane scrub at the top of Matafao Peak at 640 m. Both of these species and the Samoan skink were observed in ridge forest on Matafao Peak. The combined density of the azure-tailed skink and the black skink in the ridge forest is lower than in the montane scrub (Table 15).

No historical population data from American Samoa exist for comparisons with the species sampled. Elsewhere, Alcalá and Brown (1967) meticulously sampled *Emoia atrocostrata* in mangrove habitats in the Philippine Islands. There that species was found in densities of 400 to 600 per hectare. The average density of the black skink, the most comparable species in American Samoa from the standpoint of activity and size, in similar habitat is 520 to 780 per hectare.

Birds

The diversity of species makes birds the richest segment of terrestrial wildlife in American Samoa. More species of birds are found than all reptiles, amphibians, and mammals combined (Table 16).

On arriving in Samoa, however, there appears to be a dearth of bird life. Armstrong (1932) wrote: "There are no friendly gulls to accompany the ships into port, and on landing none of the familiar town birds, such as the sparrow, starling, or minah [sic] are to be seen along the streets; the fact is, nearly all the native birds belong to the bush or swamp, while the sea-birds are of the timid type that frequent the lonely sandbanks or rocky islets at the edge of the reef, away from human habitation."

Ornithological History

Although Europeans discovered the five main islands of American Samoa in 1722, no mention was made of the bird-life until the French navigator Bougainville (1772) arrived in May 1768 and saw "wood-pigeons and green, rose and different coloured turtle-doves" on the islands. In 1839 the USEE visited the islands and listed four bird species from Tutuila (Peale 1848; Cassin 1858). German interests brought several scientists to the islands in subsequent years—Finsch and Hartlaub (1867), Graeffe (1870), Hartlaub and Finsch (1871), Whitmee (1875, 1876), and Finsch (1876a, 1876b) made valuable contributions. During the late 1800s and early 1900s, British and New Zealand interest resulted in books on Samoan birds. Mitchell (1909) gave brief descriptions as well as the Samoan, English, and scientific names of 44 bird species. Armstrong (1932) gave full descriptions, distributional records, and ecological habitat data, as well as Samoan, English, and scientific names.

R. H. Beck and J. G. Correia, with the Whitney South Sea Expedition, collected birds on Tutuila Island in October and November 1923, on Anunu'u, Olosega, and Ta'u islands and Rose Atoll in December 1923, and on Ofu and Olosega islands in January 1924. Birds collected in Samoa were reported in 12 papers published from 1923 to 1952 in the *American Museum Novitates*. Mayr (1945) summarized the Whitney Expedition's findings and other ornithological information into a handbook that is still indispensable.

Important contributions in the 1950s include Yaldwyn's (1952) report on observations in Western Samoa and Sachet's (1954) summary of information on Rose Atoll. Other observations were made and reported by Keith (1957) and Dunmire (1960). In 1963, Ashmole summarized information on the birds of Western and American Samoa, giving brief descriptions, distributional records, and ecological notes.

Members of the POBSP visited the Samoan Islands several times from 1963 to 1965. Clapp and Sibley (1966) reported on 21 species of birds from Tutuila, giving population and ecological data. Clapp (1968) gave similar observations on 16 species of birds from Swains Island based on six visits in 1966

and 1967. From POBSP data and other records, King (1967) listed 14 breeding seabird species for the Samoan Islands, not differentiating American Samoa. Papers by Gould (1974a, 1974b), King (1974), Crossin (1974), and Gould et al. (1974) summarize POBSP at-sea observations around American Samoa for four seabird species.

The most recent general work is duPont (1976), listing 70 species of birds from the Samoan Islands (except Swains Island) giving descriptions, color illustrations, distributional records, and some ecological notes.

Specimens

In this study, 104 specimens of 29 species of birds were collected (Table 17). Along with those taken by earlier workers, at least 445 specimens of 32 species are known to exist in collections in the United States. Data on some specimens taken by the POBSP are reported here for the first time.

A number of distributional records were established in this survey (Table 17). The Tahiti petrel and lesser frigatebird were first reported breeding in Samoa and the gray-backed tern was first found nesting in American Samoa. The friendly ground dove was found for the first time in American Samoa. Many other first reports or first breeding records for individual islands were obtained (Amerson et al. 1982).

Faunal Composition

A checklist of the birds of American Samoa is presented in Table 16. Fifty-seven species are included. At least three species, the rufous night-heron, the white-browed rail, and the white-throated pigeon, are thought to result from errors of identification. The 54 validly listed species belong to 13 orders, 21 families, and 38 genera. For purposes of discussion, these species are considered in two general categories: 24 are classed as seabirds, and 30 are waterfowl, marsh, and land birds. The distributional status of all species is shown in Table 18.

Seabirds.—The 24 seabird species can be grouped (Table 18) into resident breeders (19 species), migrants (2), and visitors (3). Many of the seabirds are not well known to the Samoan people; the petrels, shearwaters, and storm-petrels are the least known. Their numbers are small and their nests are well hidden in the isolated higher mountainous areas. Only one of the two tropicbird species is well known. Samoans apparently do not distinguish between the three species of boobies, and use the same name for all. Similarly, the great and lesser frigatebirds are not distinguished. The sooty and gray-backed terns are virtually unknown, and the brown and black noddies have the same name.

Waterfowl, marsh, and land birds.—The 30 species of waterfowl, marsh, and land birds in American Samoa are here grouped (Table 18) into resident breeders (20), migrants (7), visitors (1), and introductions (2). Most of the resident breeders are well known to the Samoan people. All have Samoan names except the sooty rail and Fiji shrikebill; the former species is extirpated and the latter is restricted to the deep bush of the Manu'a Island Group.

Most Samoans do not distinguish among the six migrant shore birds. The one land bird migrant, the long-tailed cuckoo, is well known. The one visitor species, the cattle egret, is a potential breeder in American Samoa; it has become established on other islands in the Pacific. The two introduced species are the red-vented bulbul and the rock dove. The bulbul is well established, but the dove (or common pigeon) is found in small numbers and may not become established.

In addition to the birds discussed in this report, the Muscovy duck, goose, and chicken are found on the islands as domesticated birds; some may occasionally live in a feral condition. Peacocks were introduced in the past but no longer occur. Exotic parrots are sometimes kept as cage birds, and the potential for the establishment of exotic species exists.

Biogeographical Affinities

As early as the mid-19th century, Wallace (1860, 1876) recognized that a distinctive fauna existed in the Polynesian area. With increased exploration in the Pacific, knowledge of the bird fauna of the various island groups increased. Mayr (1941a, 1941b) was able to analyze the bird fauna of the Southwest Pacific, to define its borders, and to determine its origin and affinities. For purposes of analysis he grouped the birds under four headings—seabirds, migrants and winter visitors, introduced birds, and native land and freshwater birds. His groupings are used for the following discussion.

Seabirds.—Seabirds were probably the earliest birds to reach American Samoa. The seabird fauna of the islands apparently has ancestral affinities to (1) the Central Pacific and Polynesia, (2) the region of Malaysia, Melanesia, and Micronesia, (3) the Australia-New Zealand area, and (4) circumtropical areas. No seabirds are endemic to Samoa; most all breed on nearby islands.

Species of seabirds that are restricted in their distribution to Polynesia (including the Central Pacific) include the Tahiti petrel, collared petrel, Christmas shearwater, white-throated storm-petrel, gray-backed tern, and blue-gray noddy. As pointed out by Baker (1951), the many islands of the Pacific offer homes for various forms of seabirds, apparently resulting in considerable speciation.

Four species have reached Samoa from Malaysia, Melanesia, and Micronesia. The Audubon's shearwater, black-naped tern, brown-winged tern, and crested tern are restricted in their breeding ranges primarily to the western Pacific and Indian oceans. The Audubon's shearwater and crested tern have extended their breeding ranges into the South-central Pacific.

Two species, the white-necked petrel and slender-billed shearwater, have restricted breeding grounds in the Australia-New Zealand-Kermadec Islands area and migrate through Samoan waters on their way to feeding grounds in the far North or Central Pacific. Although large numbers of these birds move through the Samoan area, they rarely stop.

Most of the seabirds found in American Samoa have circumtropical ranges. These include the wedge-tailed shear-

water, both tropicbirds, the three boobies, both frigatebirds, the sooty tern, brown noddy, and white tern.

Migrants and visitors.—The six species of shorebirds that annually migrate south to American Samoa breed in the Northern Hemisphere. Four species—ruddy turnstone, bristle-thighed curlew, bar-tailed godwit, and wandering tattler—breed in the northwestern or Arctic portion of Alaska. The golden plover breeds in Arctic Asia and in Arctic Alaska, and the sanderling is a circumboreal breeder. Routes of migration have been discussed by Stickney (1943), Baker (1951), Mayr (1953), and Thompson (1973). Most of the shorebirds reaching Samoa probably use the Nearctic-Hawaiian Flyway.

The long-tailed cuckoo annually migrates north to various island groups in the Southwest Pacific. The cattle egret, a visitor, is from Eurasia and Africa but is now almost worldwide in distribution.

Introductions.—The introduced birds now found in American Samoa originated in Asia and Europe. One of these introductions—the red-vented bulbul—from India is very successful and may be competing for food and nesting space with native species. The Eurasian rock dove is less successful.

Waterfowl, marsh, and land birds.—Mayr (1941a) considered Samoa to be a part of the Polynesian Subregion of the Australian Region. He defined this subregion as comprising "all the tropical and subtropical islands of the Pacific Basin which indicate by their impoverished fauna that they have had no recent continental connection (after the early Tertiary) and which derived the major part of their fauna directly or indirectly from the Papuan Region or jointly from Australia and the Papuan Region." Mayr further divided the Polynesian Subregion into four districts: Micronesia, Central Polynesia, Eastern Polynesia, and Southern Melanesia. The Samoan Islands were placed in the Central Polynesia district. Baker (1951) slightly redefined Mayr's Pacific Basin districts (Fig. 31), but kept Samoa in Central Polynesia.

Mayr (1941a, b) characterized the bird fauna of Central Polynesia as being comparatively rich (considering the distance from the nearest continent), and as having very few recently arrived foreign elements. Of the 12 endemic genera and subgenera found in this district, only two, *Pareudiastes* and *Didunculus*, are restricted to Samoa. As to the origin of the Samoan bird fauna, Mayr (1941a) concluded that the Papuan (or Melanesian) Region was by far the largest contributor, either by way of the Solomon Islands or by way of Santa Cruz Island or the New Hebrides; all the endemic elements belong to this fauna. The Malaysian Region contributed very little, except perhaps *Porphyrio porphyrio*, the purple swamphen. The Australian element is weak. As to the lack of grassland and open-country bird species in Samoa, Mayr suggested that lack of suitable habitat in Samoa, rather than distance, prevented their colonization. Finally, Mayr suggested that the bird fauna which developed first in Central Polynesia has since spread to Micronesia, Eastern Polynesia, and even Southern Melanesia.

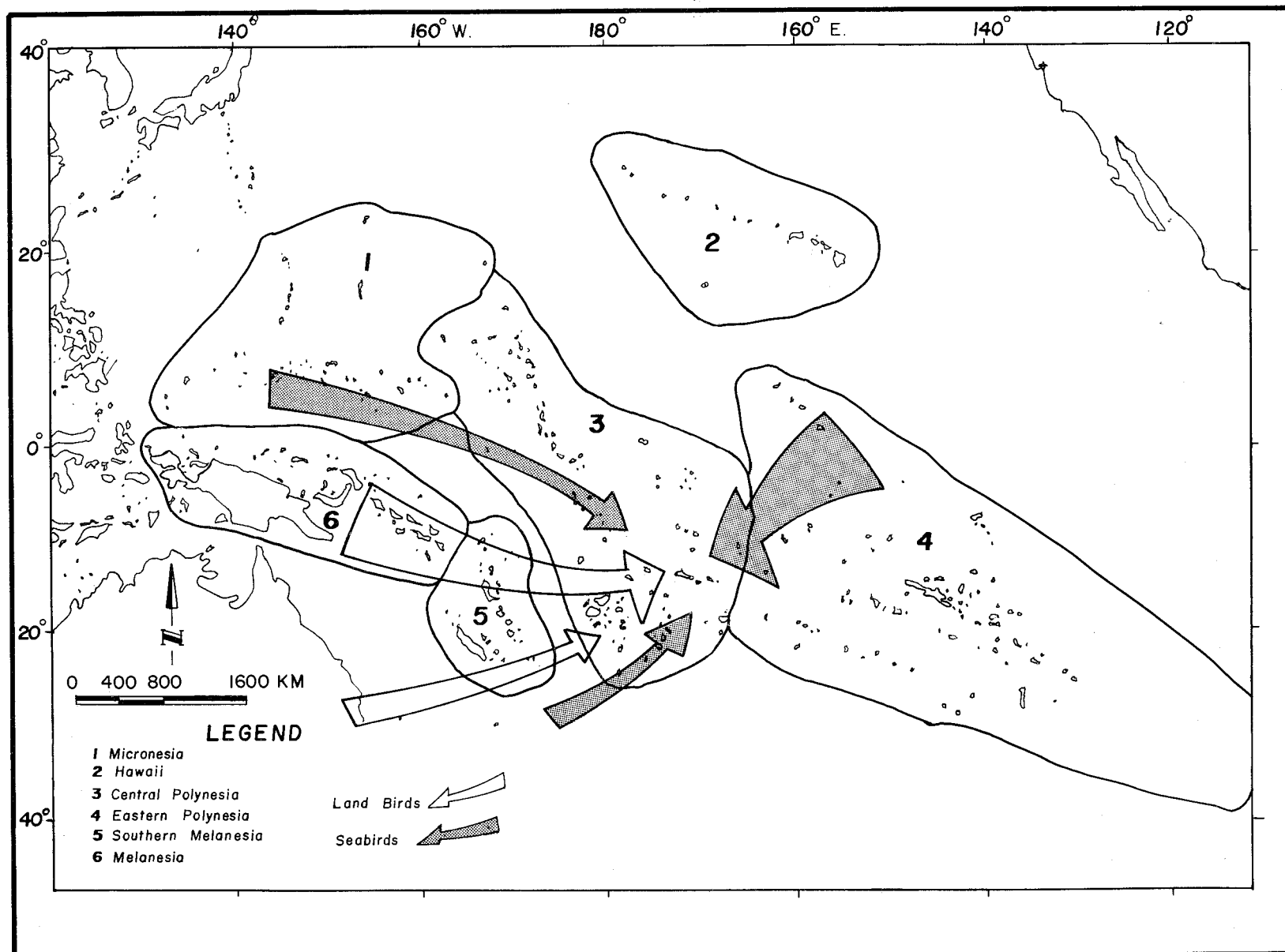


Fig. 31. Origin of Samoan land birds and seabirds; division of the islands of part of the Pacific Basin is from the standpoint of the distribution of land and freshwater birds (adapted from Mayr 1941a, 1941b, and Baker 1951).

Although the present inventory concerned only American Samoa, one cannot overlook Western Samoa when discussing the biogeographical affinities of the avifauna since those islands are larger and have more diverse habitat, and thus can support more bird species. None of the biogeographical studies, to date, has compared the bird fauna of American Samoa with that of Western Samoa. American Samoa has 54 species of birds (present study), whereas Western Samoa has approximately 67 species (duPont 1976). This comparison is misleading because the present study identified many new records for American Samoa and, if a comparable inventory were made in Western Samoa, the number of species recorded there might increase. Thus, a comparison of the endemic genera, species, and subspecies living on both island groups (Table 19) is more meaningful than a comparison of total species.

As pointed out earlier, two genera, both monotypic, are endemic to Samoa. *Pareudiastes pacificus*, the Samoan wood rail, is (or was) found in both American and Western Samoa. *Didunculus strigirostris*, the tooth-billed pigeon, is restricted to Western Samoa. Of the 10 Samoan endemic species, 7 are found only on Western Samoa, 3 are found on both American and Western Samoa, and none are found solely on American Samoa. Of the 23 endemic subspecies, 11 live only on Western Samoa, 7 are found in both American and Western Samoa, and 5 are restricted to American Samoa.

Ecological Distribution

The distribution and abundance of island birds, in general, depends on five main factors—availability of land, nesting habitat preference, feeding habitat preference, abundance of food, and disturbance by man. General discussions of these factors have been presented by Wynne-Edwards (1935), Murphy (1936), King (1967), Lack (1971), Gould (1974a), and Amerson (1975), and will not be repeated here except with regard to their relevance to American Samoa.

Table 20 identifies the presence of the bird species in the various plant community types. This distribution is largely a function of the nesting and feeding requirements of the birds as they relate to habitat characteristics. The following discussion summarizes these faunal preferences.

Seabirds.—In contrast to land birds, seabirds depend on the land for nesting and on the ocean for food, usually small fish and squid. Seabirds in American Samoa can select either an atoll island or a volcanic island for nesting. Five species nest only on atolls, seven nest only on the volcanic islands, and seven species nest on both types of islands (Table 21). Atolls offer three nesting habitats—ground, shrubs, and trees; volcanic islands offer rocky cliffs in addition. Of the 19 breeding species, 12 nest on or in the ground or on cliffs, 5 nest on trees or shrubs, and 2 nest on a combination of the four habitat types.

Feeding habitat preferences of Samoan seabirds can be classed as coastal or inshore (including harbors, beaches, and lagoons), offshore (including shallow areas, areas near islands, or both), and pelagic (truly oceanic). Overlap in

preference may occur and species may vary seasonally in the distance they feed from shore, but Table 21 is useful in predicting where the species may be found feeding. Two species feed in coastal waters, 11 feed primarily in offshore waters, and 11 feed primarily in pelagic waters.

Waterfowl, marsh, and land birds.—These species depend on the land for both nesting and food. None occurs only on atolls but 20 species are exclusively on volcanic islands and 9 use both (Table 22). On both island types, feeding habitats can be divided into coastal areas (reef, beach, marsh, and mud flats), ground (grass, bare ground, and forest floor), trees (including shrubs), and air. Because of the coastal elements and lack of ecological habitat diversity on atoll islands, it is not surprising that, of the species that use both island types, most feed in coastal areas. Conversely, none of the species that uses only volcanic islands feeds exclusively in coastal areas; all use inland areas and feed on the ground, in trees, or in the air.

Island Distributions

Tutuila Island.—Forty species of birds have been recorded from Tutuila Island (Table 18). Of these, 27 are classed as native resident breeders, 2 are potential resident breeders, 9 are migrants and visitors, and 2 are introductions. Of the 27 resident breeding species, 12 are seabirds and 15 are waterfowl, marsh, and land birds.

Of the resident species of seabirds, eight are known breeders. Prominent seabird colonies are located on the north shore at Pola Islet and the adjacent Pola'uta Ridge, and on the south shore along the steep sea cliffs at Fagatele Bay and Larsen Bay near Steps Point. The breeding status of four species (Table 18) is not known because their nesting habitat was inaccessible to the survey team.

The sooty tern breeds on Rose Atoll and occasionally visits Tutuila. It is a potential breeding species, perhaps at the seabird colony on the top of Pola Islet. The brown-winged tern has also been recorded, and is a potential breeding species on Pola Islet.

Fifteen marsh and land bird species are known to breed or to have bred on Tutuila; 13 presently breed. The cardinal honey-eater is restricted, in American Samoa, to Tutuila. Two former breeding species are considered to have been extirpated; the mao has not been seen or heard on Tutuila in recent years, and the Samoan wood rail supposedly bred on Tutuila in the past although some authors question its occurrence on the island.

Six migrant shorebirds frequent the shoreline and grassy inland areas of Tutuila. In addition, a migrant land bird, the long-tailed cuckoo, regularly frequents the forested areas of the island. The cattle egret has been recorded as a vagrant.

Of the introduced species, the red-vented bulbul, perhaps introduced as a caged bird about 1958, now breeds throughout the inhabited and disturbed areas of Tutuila. The rock dove population was once quite large on Tutuila but was extirpated; two individuals now exist from recent introductions.

Aunu'u Island.—Twenty-seven species of birds have been recorded from Aunu'u Island (Table 18). Of these, 19 are native resident breeders, 4 are potential resident breeders, and 4 are migrants. Of the resident breeding species, 6 are seabirds and 13 are waterfowl, marsh, and land birds.

Six seabird species now nest on Aunu'u. White-tailed tropicbirds nest in the holes in bird's-nest ferns and the larger trees on the north and south ridges of the island. Brown boobies, gray-backed terns, blue-gray noddies, brown noddies, and white terns nest on the sheer rock cliffs located on the north, east, and south coasts. Four additional seabird species are potential breeders.

Only 10 waterfowl, marsh, and land birds now nest on the island. The Australian gray duck, many-colored fruit dove, and Pacific pigeon are thought to have nested on Aunu'u previously, but do not do so presently because of destruction of habitat, hunting pressures, and possibly predation by rats.

The four migrants on Aunu'u are three shorebirds and the cuckoo. The shorebirds frequent the coastline and Pala (Mud) Lake whereas the cuckoo prefers mangrove swamp, plantation land, and secondary forests.

Ofu Island.—Twenty-nine bird species are known from Ofu Island (Table 18). Of these, 21 are native resident breeders, 4 are potential breeders, and 4 are migrants. Of the resident breeding species, 6 are seabirds and 15 are marsh and land birds.

Nu'utele Islet, located just west of Ofu Village, is the breeding place for five of the six seabirds known to nest on Ofu. Brown boobies, blue-gray noddies, brown noddies, and white terns nest on the sheer rock cliffs. Red-footed boobies previously nested in trees on the isolated north tip of the islet. White-tailed tropicbirds, brown noddies, and white terns nest inland on trees. Three additional seabird species are potential breeders.

Of the 15 marsh and land birds that are known to breed on Ofu, 13 are thought to be breeding now. Two former breeding species, the many-colored fruit dove and the Fiji shrikebill, have not recently been recorded from the island and are either extremely few in number or have been extirpated. Blue-crowned lorries are found in American Samoa only in Manu'a. The Australian gray duck was reported in the past, but no recent records exist.

Three of the four migrant species are shorebirds which frequent the coastline and airport runway areas. The fourth, the long-tailed cuckoo, prefers the forested portion of the island.

Olosega Island.—Of the 29 species of birds recorded from Olosega Island (Table 18), 20 are native resident breeders, 5 are potential breeders, and 4 are migrants. The 20 resident breeders include 5 seabirds and 15 marsh and land birds.

Maga Point, at the southeastern tip of Olosega, is the major breeding area for seabirds on the island. Brown noddies nest on the sheer rock cliffs, and white terns nest inland on trees. No seabirds were found in the cloud forest. Four additional seabird species are potential breeders.

Fifteen marsh and land birds have been known to breed on

Olosega, but only 13 presently breed there. As on Ofu, the many-colored fruit dove and Fiji shrikebill have not recently been observed and are probably extremely few in number or extirpated. The Australian gray duck was recorded in the past, but no recent records exist. Shorebirds make up three of the four migrant species and frequent the shoreline. The long-tailed cuckoo inhabits the forested areas.

Ta'u Island.—In all, 35 species of birds have been recorded from Ta'u Island. Of these, 25 are native resident breeders, 5 are potential breeders, and 5 are migrants (Table 18). The resident breeders consist of 10 seabirds and 15 marsh and land birds.

The ten breeding seabirds include two species of gadfly petrels (Tahiti and collared petrels), two shearwaters (Christmas and Audubon's), and the white-throated storm-petrel. These birds nest in burrows and, in Samoa, they require cloud forest, dense montane rain forest, or montane scrub for nesting. In addition, they require undisturbed conditions for successful breeding. Ta'u is the only island of American Samoa that has these features, on Lata Mountain.

Five other breeding seabird species also are found on Ta'u. White-tailed tropicbirds nest in tree holes in the forests. Brown noddies have scattered colonies throughout the forest, but they, as well as black noddies and white terns, predominately nest in the littoral and coastal forests along the isolated south side of the island. In addition, blue-gray noddies nest in small numbers on the rock cliffs of the southwest tip. Four seabird species are potential breeders; a fifth potential breeder, the wedge-tailed shearwater, has not been recorded from the island but has been seen offshore, and the montane scrub of Ta'u is similar to that used on Tutuila.

Although 15 resident marsh and land birds are known to have bred on Ta'u Island, only 13 nest there now. The sooty rail is thought to be extirpated from Ta'u, and the many-colored fruit dove and a potential breeder, the Australian gray duck, have not been recorded in recent years. Ta'u has three breeding land birds that do not live on Tutuila or Aunu'u islands—the sooty rail, blue-crowned lory, and Fiji shrikebill. In addition, two breeding species, the white-collared kingfisher and the Polynesian starling, are subspecifically different from their counterparts on Tutuila and Aunu'u.

Four regular migrant shorebirds have been recorded from the coastline and grassy areas of Ta'u. The long-tailed cuckoo prefers the forested areas.

Rose Atoll.—Twenty-one species of birds are known from Rose Atoll; 13 are native resident breeders (12 seabirds and 1 marsh bird) and 7 are migrants. Eleven seabird species nest on Rose Island (Figs. 32, 33). The gray-backed tern and the brown noddy nest on the ground at Sand Island. The black-naped tern is a potential breeding species for Rose Atoll.

The reef heron also nests on Rose Island in the hollowed bases of *Pisonia* trees. It feeds along the shoreline of Sand and Rose islands and on the exposed reef at low tide. The seven migrants include six shorebirds and one land bird (Table 18).

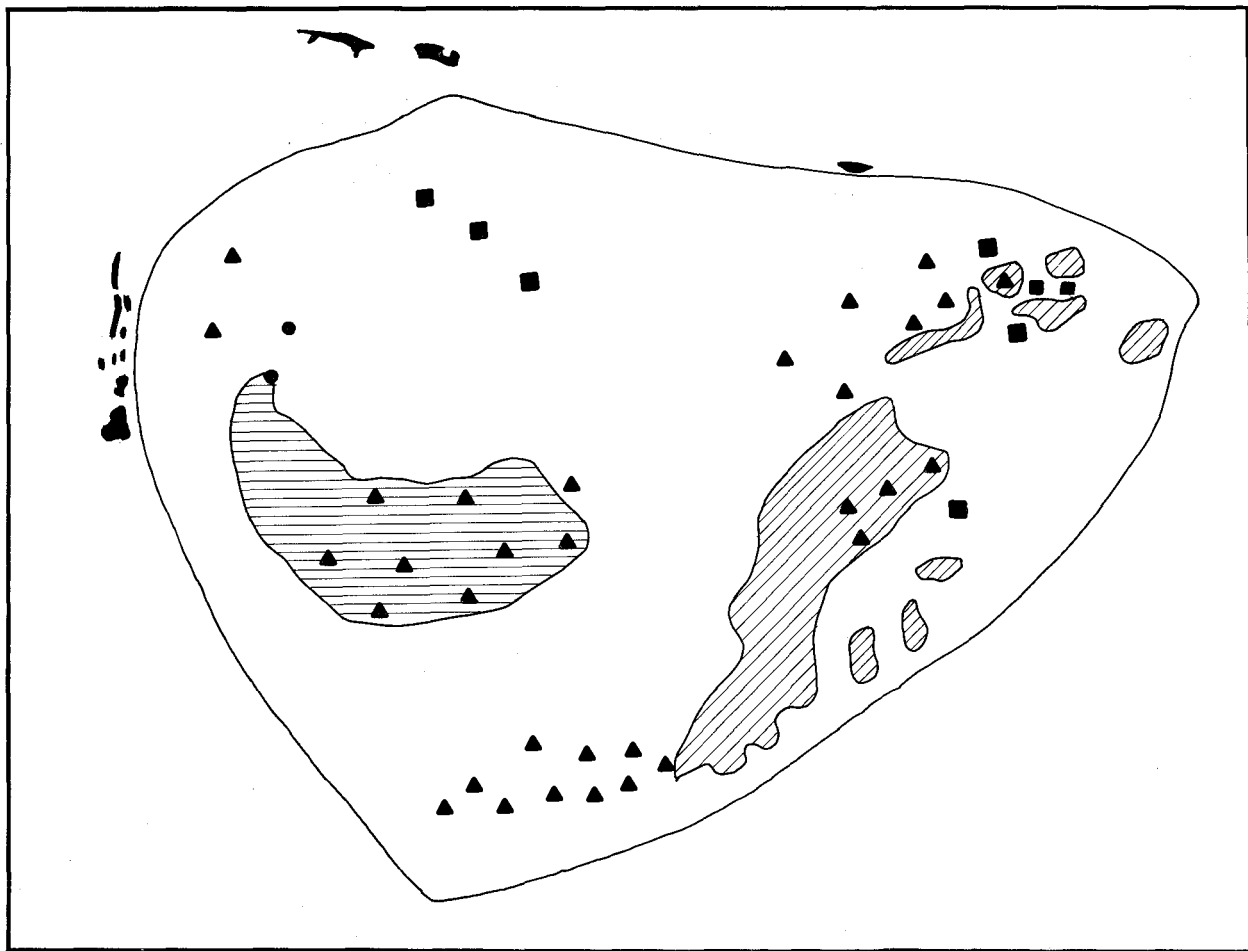


Fig. 32. Nesting distribution of tropicbirds, herons and terns on Rose Island, Rose Atoll. Ground nesters: diagonal slash, sooty tern; squares, brown noddies; triangles, red-tailed tropicbird. Tree nesters: horizontal ruling, white tern and black noddies; circles, reef herons.

Swains Island.—Nineteen bird species have been recorded from Swains Island (Table 18). Of these, five are native resident breeders, eight are potential breeders, and six are migrants. Four of the five resident breeders are seabirds; the fifth is a marsh bird.

Although 11 seabirds are known from Swains Island, only four now breed there. Of the seven additional seabird species, all are considered potential breeders; six of these breed in the Samoan area. The black-naped tern is thought to be a visitor from the Tokelau Islands; habitat is available for it to breed on Swains Island.

Eight waterfowl, marsh, and land birds have been recorded from Swains. The reef heron breeds in isolated areas of the plantation lands; it feeds at low tide on the exposed reef and in the shallow portion of the central lagoon. The Australian gray duck is known from old records; it is still a potential breeder in the marshy areas of the central lagoon.

The main reason for the predominance of potential breeders (eight species) over actual breeders (five species) is probably the disturbed nature of Swains Island. If the

number of human inhabitants remains small and secondary forest is allowed to grow, perhaps some of these potential breeders will nest. The lack of fruit-, seed-, and insect-eating species is probably because Swains Island was originally covered by littoral forest plant species that provided few edible fruits or seeds or their associated insects.

Six migrants are known at Swains Island, five shorebirds and the long-tailed cuckoo.

Populations

Population estimates for bird species were made on the basis of data obtained from study-plot inventories, linear surveys, colony examinations, and at-sea observations. Measurements of relative abundance were possible among species on each island or within each habitat type. Population estimates for seabirds were usually made by direct counts at colonies and are therefore relatively accurate. Total populations of waterfowl, marsh, and land birds are extrapolated from study plot densities and are considered to be reasonable approximations.

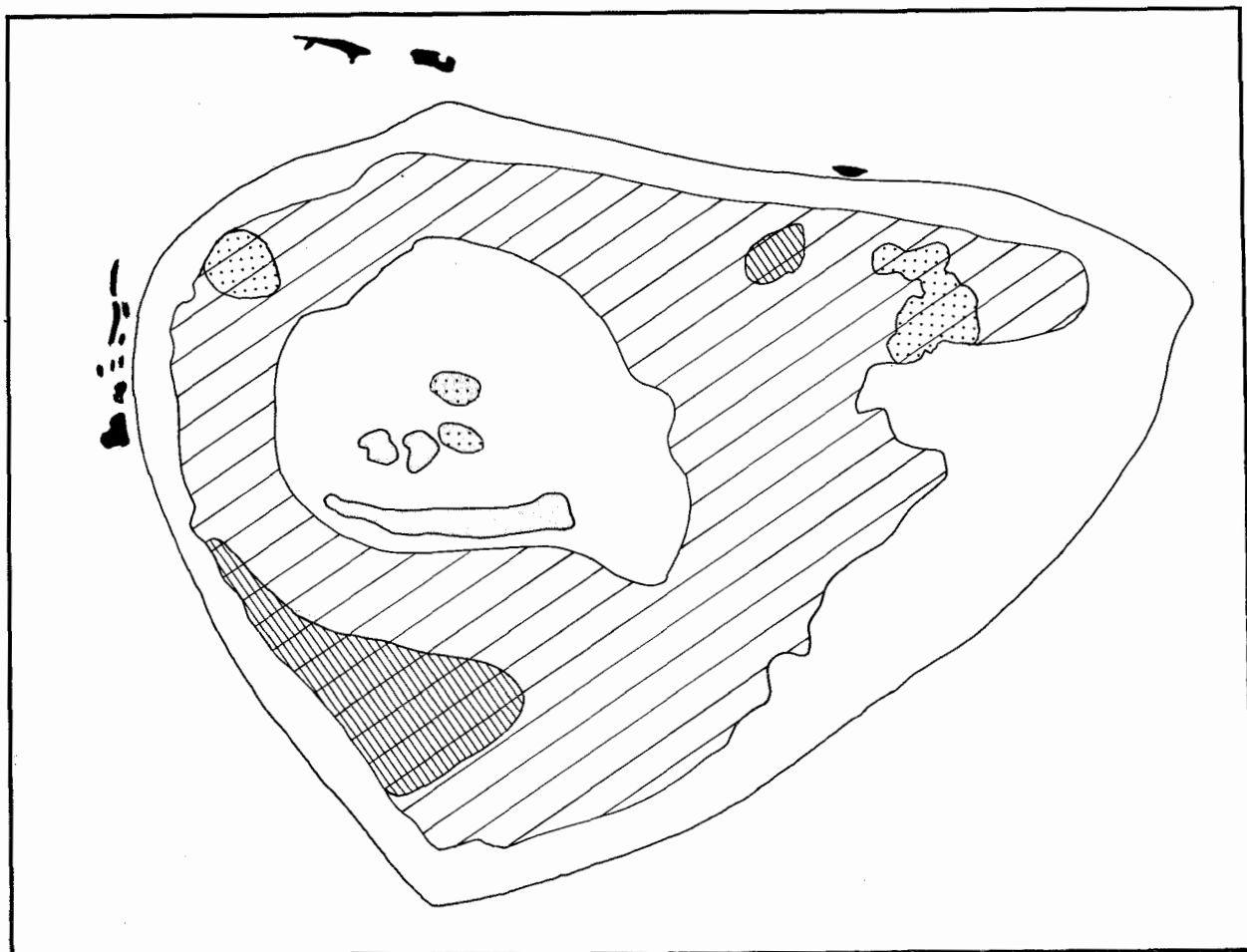


Fig. 33. Nesting distribution of boobies and frigatebirds on Rose Island, Rose Atoll. Ground nesters: narrow rule, blue-faced booby; wide rule, brown booby. Tree dwellers: light stipple, red-footed booby; dark stipple, great and lesser frigatebirds.

Seabirds.—The total seabird population of American Samoa is estimated to be about 350,000 individuals of 21 bird species. Rose Atoll, with a resident population of 312,000 birds, has by far the largest seabird community (Table 23). Of the other islands, only Tutuila and Ta'u have populations exceeding 10,000.

The sooty tern, confined almost entirely to Rose Atoll, comprises more than 85% of the entire seabird population of American Samoa. The brown noddy, white tern, black noddy, red-footed booby, and white-tailed tropicbird are other important constituents of the seabird community.

Abundance estimates obtained from observations at sea generally confirmed the conclusions drawn from seabird colony population estimates. During three trips to Rose Atoll and one trip to Swains Island, observations of seabirds were made along 870 km during about 73.6 daylight hours. A total of 2,278 seabirds of 22 species was observed. It can be generally stated that seabird abundance on the ocean is greatest in the vicinity of Tutuila.

Although most seabirds are present in American Samoa

throughout the year, they occur in greater numbers during the dry southern winter (April through September) than in the wet southern summer (October through March). Ten species of boobies, frigatebirds, tropicbirds, and terns breed during the southern winter; their breeding season may extend into the early part of the southern summer. Two species (a petrel and a tern) breed primarily during the southern summer; five other shearwaters and petrels also probably breed during this period. Two species (a tropicbird and a tern) breed year-round.

Waterfowl, marsh, and land birds.—Densities of 22 species of waterfowl, marsh, and land birds were computed from seasonal observations in 35 community type study plots (Table 24). The greatest density for an individual species was 37 birds/0.4 ha for the wattled honey-eater in the mangrove forest. Average densities of all birds within a community type ranged from a high of 110/0.4 ha in the mangrove forest to a low of 6/0.4 ha in Swains Island plantation land.

Total populations of waterfowl, marsh, and land bird species were approximated by multiplying study-plot den-

sities for a given habitat by the total acreage of that habitat on all islands on which the species occur. The results are only gross estimates because bird densities vary within habitat types and not all bird species were observed at the study plots. The estimated population of waterfowl, marsh, and land birds on all islands of American Samoa exceeds 2,200,000 individuals (Table 24). Species with the largest populations are the wattled honey-eater (545,520), white-rumped swiftlet (349,530), Samoan starling (334,405), and ~~crimson-crowned~~ fruit dove (326,550).

Several species are found in very limited number in American Samoa. Only 35 Australian gray ducks and 100 friendly quail doves were estimated to inhabit the islands. Other land species with populations of less than 1,000 include the purple swampphen, ruddy turnstone, and wandering tattler.

Because the study plots encompassed such a small portion of the total American Samoa land mass, a more comprehensive estimate of relative abundance was derived from linear survey data. Relative abundance of species of waterfowl, marsh, and land birds was determined from observations made during 98 linear surveys. Abundance (average number of birds per km) data for each of the five large islands (Table 25) shows that the five most predominant species have rankings identical to those obtained from the study-plot population estimates. Most other abundance rankings are substantially similar, and where different, the linear survey data are believed to be more accurate.

Mammals

The sparsity of native mammals in American Samoa (Table 26) is typical of South Pacific islands located at a great distance from a continent. Because mammals have few natural means of dispersal across wide expanses of water, their diversity on islands decreases with distance from their points of origin. The only terrestrial mammals native to American Samoa are bats. When the early Polynesians settled, they probably introduced the dog and the Polynesian rat (Titcomb 1969).

Mammalian History

Mammals in American Samoa were first recorded in 1839 by scientists of the U.S. Exploring Expedition (Peale 1848; Cassin 1858). Mayor (1924c) reported an abundant "small brown-gray rat" at Rose Island in 1920. The American Museum's Whitney South Sea Expedition (1921-1939) and Archbold Expedition (1942) studied animals throughout the South Pacific; the resultant publication (Carter et al. 1945) is still the only comprehensive book on mammals for the entire area. More recently, the Pacific Ocean Biological Survey Program of the Smithsonian Institution collected mammals at Swains Island (Kirkpatrick 1966) and Tutuila Island (first reported here).

Before the present study, at least 53 specimens of 5 species of bats and rodents had been collected. During the present in-

ventory, 44 specimens of 5 species were collected. Thus, in all, at least 97 specimens of 6 species have been collected (Table 27).

The house mouse and the roof rat are here reported for the first time in American Samoa. Other records for various islands are shown in Table 27.

In addition to the species discussed here, a species of mouse-eared bat, *Myotis insularum*, has been described from Samoa; only a single specimen is known and its origin is uncertain. Domestic mammals in American Samoa include the dog, cat, horse, cow, and pig. There may be a few feral dogs and cats on some islands, but only the pig has established feral populations that are significant to the native wildlife. Marine mammals occur in the waters of American Samoa from time to time, but are beyond the scope of this study and are mentioned only briefly.

Biogeographical Affinities

Both native mammals of American Samoa are also found in Western Samoa, where a second species of flying fox is also found. It is thought that these bats reached Samoa from Melanesia by way of southern Melanesia and islands in between. Fruit bats are an Old World group; their easternmost extent in the Pacific is Tonga and American Samoa. The sheath-tailed bat also reaches its easternmost distribution in the Pacific in American Samoa (Carter et al. 1945).

The Polynesian rat and the pig presumably were carried to Samoa from the East Indies by early human migrants. The roof rat and Norway rat were transported by the vessels of traders and explorers and might have been introduced at any time, but their limited distribution suggests that they, along with the house mouse, are relatively recent introductions.

Ecological Distribution

The bats are found only on the volcanic islands; food and habitat requirements prevent them from residing at Rose Atoll and Swains Island. The distribution of the flying fox is seasonally influenced by ripening fruits. This is also true for the sheath-tailed bat, since much of its insect food is attracted to flowers and ripening fruit.

Human disturbance of bat populations is significant, since hunting pressure and habitat destruction are great. Samoans frequently hunted flying foxes for food in the past, and many are shot because of the damage they do to plantation fruit. Destruction of forest trees reduces food sources and roosting sites. Human disturbance in caves also greatly influences the breeding success of the insectivorous bats.

The Polynesian rat is found on all the islands, but the house mouse, roof rat, and Norway rat are found only on islands that have a seaport (Tutuila, Aunu'u, and Ofu). Mammal distribution by habitat type is shown in Table 28.

Island Distributions

Tutuila Island.—All species of mammals known in American Samoa have been recorded from Tutuila. The flying fox is found throughout the island. The main roost is at

Fagatele Point; smaller roosts are scattered elsewhere. Sheath-tailed bats were found roosting in shallow caves along the south shore, especially at Sail Rock Point and Anape'ape'a Point. The major roost is in the two large caves on the north shore at Anape'ape'a Cove in Afono Bay.

The Polynesian rat, although present throughout the island, is more prevalent around village and plantation lands. The roof rat and house mouse live in the village land and surrounding areas. The Norway rat, recorded previously but not observed during this study, may occur in the Pago Harbor area.

Aunu'u Island.—The flying fox has a large roosting colony on the isolated southeast slope of Fogatia Hill; these bats range throughout the island. The sheath-tailed bat is thought to roost in caverns on the north rocky cliffs of Pofala Hill; it may also visit Aunu'u from nearby Tutuila. Both the Polynesian rat and roof rat are found throughout the island; they are especially prevalent in village and plantation lands, as well as around the coastal marshes.

Ofu Island.—The flying fox ranges throughout the island; its roosts are found on Nu'utele Islet and on the cliffs along the south coast. Sheath-tailed bats roost in caverns along the Sinapoto Point area on the north coast and in the caves on Nu'utele Islet. The Polynesian rat and the roof rat are the only rodents on Ofu. The Polynesian rat is found throughout the island, and the roof rat is found around Ofu village and the airport.

Olosega Island.—The flying fox is found throughout Olosega Island; roosts are located in the trees along the rock cliffs above Olosega and Sili villages and along the east coast, north of Leala Point. Small numbers of sheath-tailed bats roost in a cave located on the rock cliff above Sili village. The Polynesian rat is especially prevalent in the village and plantation lands.

Ta'u Island.—Flying foxes are found throughout the island, except perhaps in the cloud forest, and even there they fly over. Roosts are found in several localities, most notably in the plantation land above Fagamalo Cove and in the lowland rain forest above Papaotoma Point. The sheath-tailed bats apparently roost in caves along the south coast somewhere above Lavania Cove. A known roosting cave just above the water's edge at Lavania Cove has recently been destroyed by an earthquake.

The Polynesian rat is found throughout the island except for the upper portions of the montane rain forest, cloud forest, and montane scrub. With a small boat harbor soon to be constructed at Fusi, it is probable that the roof rat and Norway rat will be introduced, if adequate preventive measures are not taken.

Feral cats and pigs live on Ta'u; pigs are especially prevalent in the secondary forest along Faleiulu Stream.

Rose Atoll.—The one terrestrial mammal known from Rose Atoll, the Polynesian rat, lives primarily in the *Pisonia* forest and under the *Messerschmidia* shrubs. It feeds on seeds, bird eggs, and perhaps birds and their young, as well as

on insects and perhaps turtle hatchlings. Nests are in burrows in the vegetation or in rotten portions of the *Pisonia* trees.

Polynesian rats were discovered on Rose Island in 1920 by Mayor (1924c) and have been observed on each visit since. In the early 1970s, FWS personnel became concerned about the rat population on Rose Island and its possible predatory effects on the seabirds and turtles of the Atoll, then a candidate for the National Wildlife Refuge System. A one-day/night rodent survey was conducted in November 1971 by FWS personnel (Nass 1971). Nass found no evidence of rat predation on bird eggs and chicks, or on turtle eggs, even though several thousand rats were estimated to be present.

During a November 1974 visit to Rose Atoll National Wildlife Refuge, Government of American Samoa's Marine Resource personnel and FWS personnel observed Polynesian rats attacking two of six turtle hatchlings (Sekora 1974). This was the first evidence of predation by rats on turtles at Rose Island.

We found no evidence of predation by rats on sea turtles during our three visits in 1975-76. Although eggs or young of eight species of seabirds were present on Rose Island, no evidence of rat predation on seabirds was observed. Some rats were observed feeding on freshly broken sooty tern eggs, but no egg-breaking activities by rats were recorded. Four shorebird species (golden plover, ruddy turnstone, bristle-thighed curlew, and sanderling) were observed actually breaking the eggs.

The lack of rat predation observations in 1975-76 may be accounted for by the small numbers of Polynesian rats present in that period. Although rats were observed both day and night throughout the vegetated portion of the island, only small numbers were caught in live traps and only a few marked individuals were retrapped. The density was estimated to be about 55 rats per 0.4 ha and the total population to be about 220 individuals. This compares closely with the population estimate of several hundred in November 1974 by Sekora (1974) but is lower than the "several thousand" noted in November 1971 (Nass 1971).

Swains Island.—The Polynesian rat is common on the island, and feral pigs are found in the extensive coconut plantations.

Populations

Densities of five species of mammals were computed from seasonal observations in 14 community study plots (Table 29). Total populations of four mammal species were approximated by multiplying the density in a habitat by the acreage of that habitat on all islands on which they occur. The population estimate for the Polynesian rat is considered the most accurate of those for rodents. Although limited capture-recapture data were obtained for all rodent species in all plots, density was computed (Jolly 1965) only for the Polynesian rat in three types of habitat. Comparative density estimates for the Polynesian rat in the remaining types of habitat were derived by multiplying the average number per acre by a conversion factor obtained from the three com-

puted estimates. Because of the nocturnal feeding behavior of the sheath-tailed bat, observations of numbers in the study plots was impossible. On the assumption of equal distribution throughout all habitats (excluding cloud forest and montane scrub), the total population estimated from roosting colony examination was divided proportionately among the habitats. The resulting density figures are only gross estimates. The estimated size of the population of the five predominant mammals on all of the islands of American Samoa exceeds 2,400,000 individuals (Table 29).

The 98 linear surveys did not provide reliable abundance data for rodents or insectivorous bats. Although rodents were occasionally observed during the linear surveys, the study-plot trap data are considered to be more accurate. Only small numbers of insectivorous bats were seen, and data from colony examinations are considered to be more accurate. Thus, the linear surveys provided abundance data only for the flying fox, whose overall abundance was found to be 1.7 bats/km. This species was more prevalent in the Manu'a Group (Ofu 3.0 bats/km, Olosega 2.5, Ta'u 3.9) than on Tutuila (0.9) and Aunu'u (1.8).

Community Relationships

The relationships among the various components of the wildlife and wildlife habitat (including physical factors) are of the utmost importance in understanding the structure and function of ecosystems. Several generalizations can be made from the characteristics of the ecosystems (Table 30) of American Samoa. Although annual temperature differences on the islands are not great, they are generally related to differences in elevation. Soil moisture conditions are highly regulated by soil type, and dry soils are found from very low elevations to the highest ridges. All of the islands receive bright sunlight but, because of varying soil conditions, ground cover vegetation is controlled to a greater degree by the density of forests (which are highly dependent on soil moisture) than by sunlight. The cloud forest canopy receives less sunlight than any of the other forest canopies because of the heavy cloud cover associated with it.

Diversity of Ecosystems

With regard to plants, the drier communities, such as littoral strand, littoral scrub, and montane scrub, are subjected to the harshest conditions and contain the fewest species. The forest communities with more equitable conditions have greater species diversity. One exception to the usual greater diversity in the forests of American Samoa is the mangrove forest, which often contains only one or two tree species because most other species cannot colonize the saline habitat.

Of the 14 species in the herpetofauna, 11 species are found in littoral forest (Table 14.) The second most diverse community for amphibians and reptiles is plantation land (8 species); village land contains 7 species and rain forests have

6 species. The marine toad, introduced to Tutuila and Aunu'u, and the azure-tailed and black skinks are the most widely distributed species with regard to habitat types.

The greatest number of bird species (Table 20) was found in littoral strand (21) and littoral forest (20). Rain forest, secondary forest and coastal forest contained 18 species. The kula fernland and high-elevation communities (cloud forest and montane scrub) generally had fewer bird species than did the other communities (fewer than 10 each). The wattled honey-eater is the most abundant and widely distributed bird on the five main islands of American Samoa. Other abundant species on the main islands are the white-rumped swiftlet, Samoan starling, and crimson-crowned fruit dove.

Although only seven species of mammals are found on the islands, every community except montane scrub, cloud forest and kula fernland harbors at least two species (Table 28). Of the undisturbed communities, the rain forest is inhabited by the most mammal species (five) and the ridge forest contains four species. In the disturbed communities, plantation land and village land are each inhabited by six species. The sheath-tailed bat and Polynesian rat are the most widely distributed mammals in the islands.

Six community types, three of which are disturbed, each contain as many as one-third of the vertebrate species in American Samoa—littoral strand, littoral forest, rain forest, secondary forest, plantation land, and village land. At the other extreme, the cloud forest harbors ten species and the kula fernland only eight species (Table 30).

In summary, when considering both plants and animals, it is evident that the most diverse ecosystems on American Samoa are the rain forest, littoral forest, ridge forest, and secondary forest. Of the recently and continuously disturbed areas, plantation and village lands are most diverse.

Variation in Plant Communities

Vegetation at any particular place generally changes through time, usually proceeding gradually from very simple plant communities on barren areas to more complex communities and ultimately to the establishment of a relatively stable plant community referred to as the climax vegetation. This process of succession can be reinitiated if the climax vegetation is altered by disturbances such as fire, landslides, hurricanes, slash-and-burn agriculture, or by climatic or geomorphic changes.

Environmental Factors

The nature of a given plant community is a function of the region's overall vegetation structure, time, disturbance, and various physical environmental gradients. In American Samoa the key environmental factors are soil moisture, elevation, and slope. Because the existing gradients may be gradual, the changes in plant communities may also be gradual, obscuring boundaries and blending community types. However, some useful generalizations are possible regarding the physical controls of the distribution of vegeta-

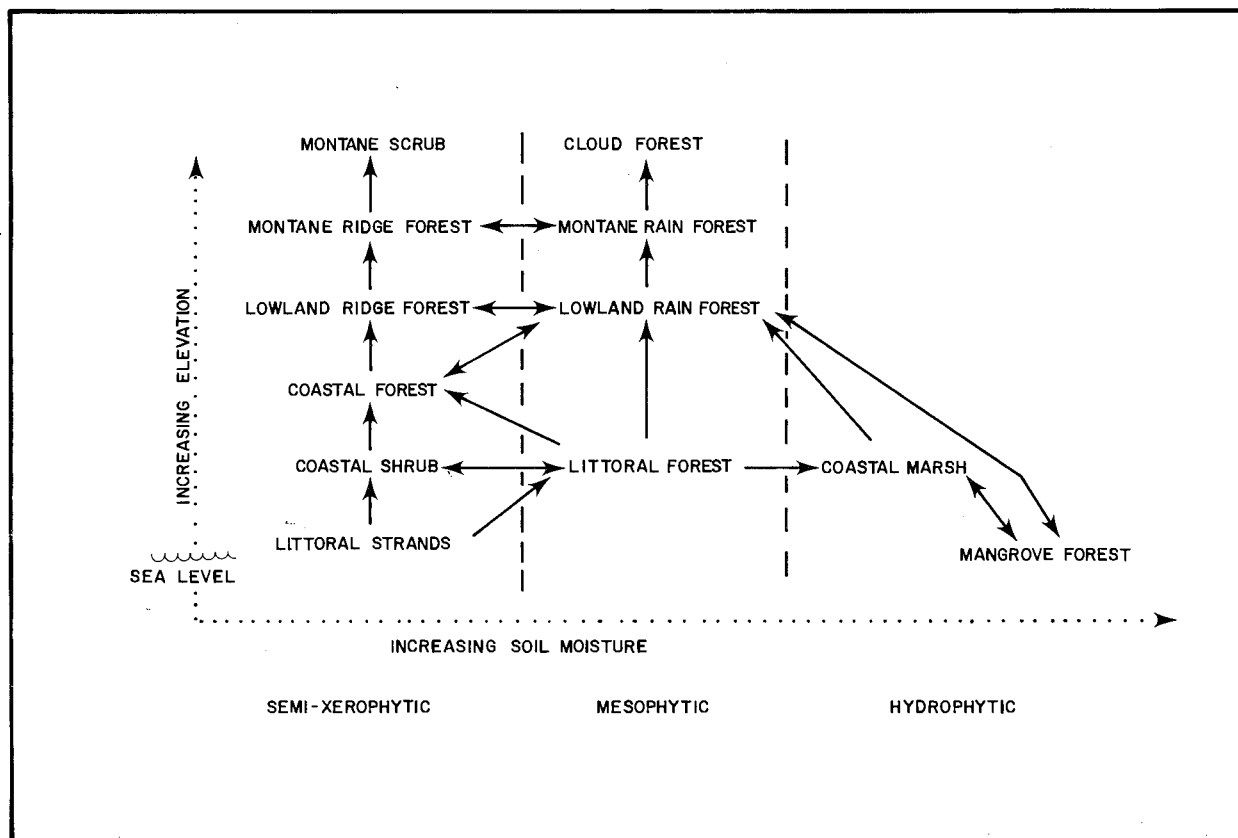


Fig. 34. Generalized distribution pattern of natural vegetation communities in American Samoa. Horizontal arrows indicate a gradient of increasing soil moisture, vertical arrows indicate changes with elevation, and diagonal arrows indicate that both soil moisture and elevation conditions are altered.

tion communities and the probable change from one type to another.

General relationships among community types, elevation, and soil moisture are shown in Fig. 34. A cross-sectional view of a hypothetical island showing an idealized arrangement of the American Samoan ecosystems is presented in Fig. 35. Elevation and precipitation generally increase along the vertical scale, but soil moisture is generally less in the communities on the left half of the figure.

Disturbance

The natural vegetation covering most of American Samoa is rain forest. The areas not originally covered by rain forest are those subject to extreme environmental conditions such as poor soil (montane scrub), salinity of ground water (mangrove forest), salt spray (littoral strand and forest), or decreased light (cloud forest). The only major natural disturbances to the vegetation in Samoa are infrequent hurricanes, and tropical storms which average about two per year.

The cloud forest on Ta'ū appears to have been damaged severely within the past 20 years by a hurricane.

Most disturbances and alterations of the environment of American Samoa are now caused by man, largely by clearing land for villages and plantations. On Tutuila about 11% of the land surface is covered by plantations and villages or industrial land. In addition to the clearing, damage is being done to the vegetation by road and landfill construction. New roads on Alava Ridge and from Aua to Afono villages have resulted in serious potential erosion problems. New roads intended merely for transportation sometimes open up marginal agricultural land to overexploitation. For example, a road built several years ago to the village of Aoloaifou resulted in clearing for more village land and plantations in what was previously primary and secondary forest. The destruction of mangrove forest and filling of the swamps for village use has caused the virtual disappearance of once abundant mangroves in Pago Pago Harbor.

An additional, although minor, disturbance occurred

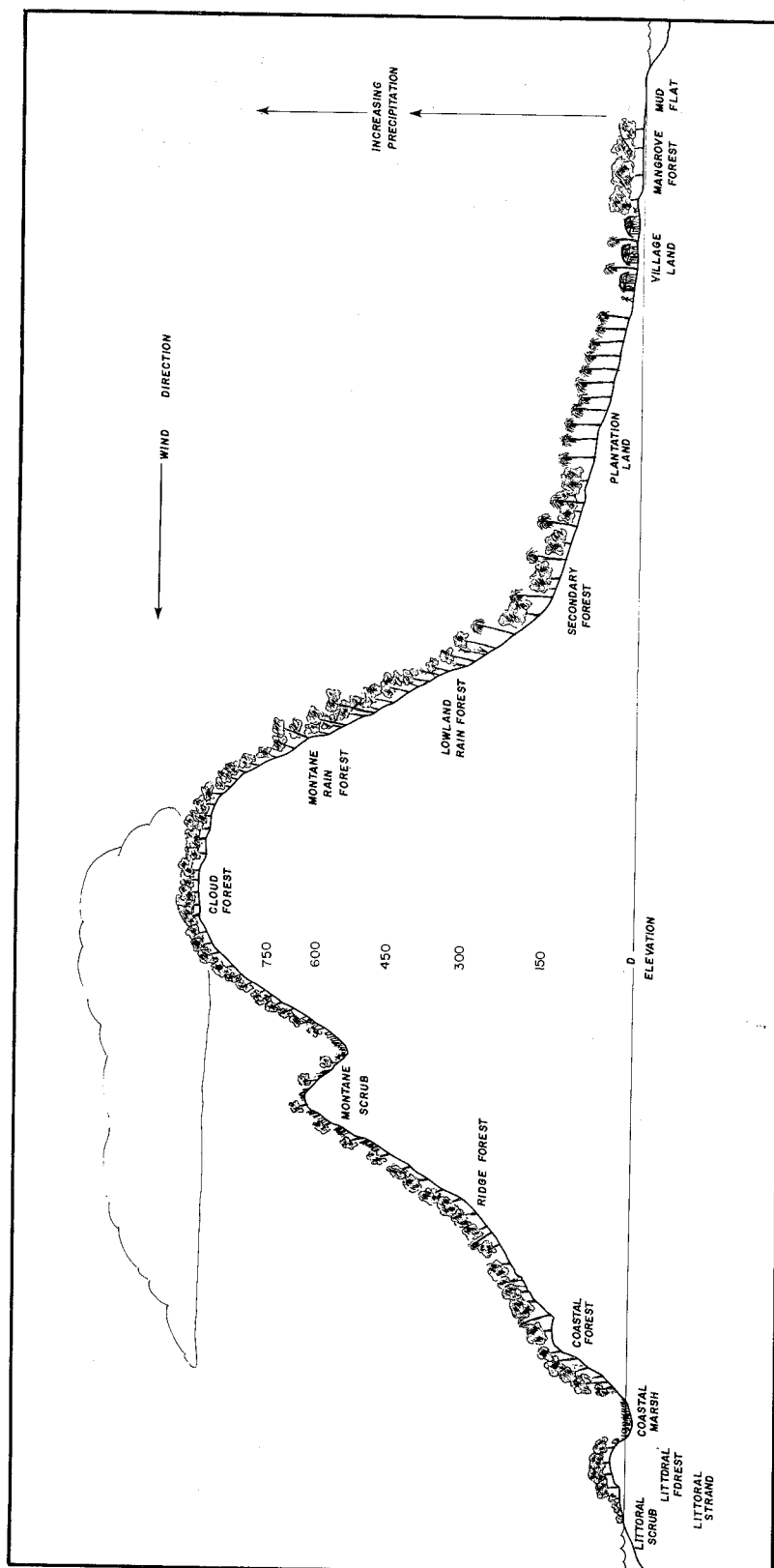


Fig. 35. Schematic diagram of a high island of American Samoa, showing the relationships of the vegetation types. Elevation is shown in meters.

decades ago when fortifications were constructed on coastal bluffs for defense against marauders from other villages or islands. Although the amount of such land is large in some areas of Western Samoa, the only significant site of the resultant kula vegetation in American Samoa is at Onenoa on the northeastern coast of Tutuila. This site is still subjected to periodic burning.

Succession

There is usually a discernible pattern to the changes in vegetation when an altered habitat is left undisturbed for a long time. If not too severely disturbed, the vegetation will tend to return to a composition and structure similar to that of the original. With knowledge of successional trends, it is possible to predict the changes that will occur. The major types of vegetation and the disturbances and successional patterns associated with them are discussed in the following paragraphs. Some of the vegetation studies during this inventory were conducted specifically to document successional stages. Future researchers may resurvey the marked plots to see what changes have occurred since the original survey.

Littoral strand.—The sand strand and rock strand vegetation occupy the harshest habitat in American Samoa. Because the few species found here are herbaceous, the vegetation will reestablish itself in a relatively short time after disturbance in all but the most extreme cases. The littoral strand species are actually pioneer species, that is, the first species to inhabit an area. This vegetation may be considered a successional stage that is perpetuated by the harsh conditions of the coast. The habitat occupied by the littoral strand is one of the least disturbed by man and probably will remain so.

Littoral forest.—The amount of damage to the littoral forest in Samoa is considerable, but less than that done to the rain forest. When the littoral forest is disturbed, it is usually for the establishment of coconut plantations and villages. Topography influences the extent of damage to any particular area of littoral forest; areas that are flat or gently sloping are the most disturbed, whereas those on rocky coasts or with steep slopes are less likely to be disturbed. The nature of the substrate is also important; areas of littoral forest on rocky ground are unsuitable for growing coconut palms, and are less likely to be disturbed than those with sandy shores. The least disturbed area of littoral forest found during the inventory was along the east coast of Ta'ū between Saua and Tufu Point.

Disturbed littoral forest, if left alone, will revert to its natural state. Only a few species are able to survive the unfavorable conditions of salt spray and brackish water, and the species that were found in the original forest are likely to return. However, since the littoral forest may be dominated by one of several species, it is possible that a different species of native littoral forest tree will predominate in the successional forest.

A good example of succession in littoral forest was found on Swains Island. The neglected coconut plantation was

slowly being replaced by littoral forest; the most common species was *Hernandia sonora*. However, there is renewed economic activity and the owner is planning to harvest coconuts commercially (Wallace Thompson, personal communication) and it is likely that the succession will come to an end as the plantation is renewed.

Coastal marsh.—Except for the rain forest, coastal marshes are the most disturbed of the vegetation types in American Samoa. Nine areas of coastal marsh are found in American Samoa (including one on Swains Island) and all but one are severely damaged and disturbed (Whistler 1976). They are extensively used for taro cultivation. The undisturbed marsh, which is also the largest one, is located in Aunu'u Crater and is dominated by *Cyclosorus interruptus*, *Acrostichum aureum*, and *Eleocharis dulcis*. Disturbed marshes are usually dominated by *Rhynchospora corymbosa* and *Ludwigia octovalvis*, two species that seem unable to invade undisturbed marsh. They are probably unable to compete with the two ferns and *Eleocharis*, which produce a dense underground network of stolons or rhizomes. It is likely that disturbed marshes could revert to the original vegetation. However, all the sites visited were still being disturbed, so no series of successional stages could be determined.

Mangrove forest.—The major disturbance to mangrove forests in the past was probably the cutting of trees for firewood, and clearing and filling for village land. Although mangroves are used less for firewood today than in the past, damage is still being done by land reclamation. Unlike that from other types of disturbance, damage from landfill is permanent. The mangroves that once were found in a number of places in Pago Pago Bay are probably lost forever.

When *Rhizophora* is cut, it rapidly replaces itself; it is a shrubby pioneer species and can avoid excessive or permanent damage from cutting. *Bruguiera*, however, grows to be a huge tree that completely dominates the mangrove forest; damage to these trees is serious since they take decades to reach their large size. Swampy coastal areas, if left alone, would probably revert to the original vegetation, since only the two mangrove species are able to colonize the inhospitable habitat.

Rain forest.—The greatest damage done to vegetation in American Samoa has been to the rain forest. Before the arrival of man, vegetation of the rain forest was stable and self-perpetuating. When trees fell in the forest, the gap was quickly filled by secondary forest or primary forest trees, depending on the size of the opening. After man's arrival, slash-and-burn (or shifting) agriculture was practiced, damaging most of the native forest. The agricultural land was abandoned after a few years and allowed to revert to forest. Given enough time, this secondary forest would return to primary forest, but usually it is not given enough time before it is cleared again and replanted.

With the coming of the European period of Polynesian history, permanent coconut plantations replaced secondary forest because copra was needed for export. Recently the coconut plantations have been abandoned and are reverting

to secondary forest. This is particularly true on Ta'ū, where secondary forest in all stages of development may be found. After agricultural use, the land is usually not too severely damaged and secondary forest will undergo an orderly change to primary forest over a long period of time. The length of time required depends on how long the land was disturbed and other factors. Given the present state of knowledge, it is difficult to estimate the age of secondary forests in Samoa.

Ridge forest.—The ridge forest in American Samoa is restricted to Tutuila. It has little economic use, since it is too steep to be cultivated and too far away from most villages. The major disturbance to which it is subjected is the cutting of trails and roads. The trail to Matafao Peak is mostly along ridges, as is the road from Fagasā Pass to the television transmitter atop Mt. Alava.

The ridge forest is important because it holds the soil on the steep slopes; failure to protect the ridge forests could lead to serious erosion problems. Until 1976, primary and secondary forest grew along Alava Ridge. During the construction of the Mt. Alava road, the normally clear water of Fagasā Bay became turbid because of the erosion and runoff from the slopes high above the bay. Disturbance from road construction was followed by clearing of much of the remaining forest near the road for planting crops. These bare areas can be seen from Pago Pago along the western part of the ridge, and they are a serious erosion problem.

Little is known about succession in the ridge forest. It is probably similar to that of the rain forest, since many of the species in the two types of vegetation are the same. It may, however, be slower because the growing conditions on the drier slopes are not as favorable. Further, erosion damages the soil structure, which may retard or prevent normal succession. The result may be bare ridges similar to the kula vegetation at Onenoa.

Cloud forest.—Cloud forest in American Samoa is limited to a small patch on top of Olosega and a large area on Ta'ū. The forest on Ta'ū appears to have been damaged within the past 20 years, possibly by a hurricane. It is atypical in that it has a high percentage of tree ferns and an open canopy. There has been little disturbance of the cloud forest by man's activity, which is limited to occasional visits by pig and bird hunters. The land is unsuited for agriculture or habitation.

The cloud forest is important as a watershed. Although there are numerous stream channels on Olosega and Ta'ū, continuously running streams are few. The cloud forest acts as a huge sponge to soak up the continuous heavy rainfall and allow the water to percolate underground to the sea. If the forest were cut or severely damaged, serious problems of erosion could result.

Little is known about succession in cloud forest. Land clearing was probably never done and storm damage is only partial, and early stages of succession would be absent. Undoubtedly, cloud forest would eventually revert to its natural condition after damage from a hurricane, but how long this would take is unknown.

One of the dominant plants of the Ta'ū cloud forest is the tree fern *Cyathea*, a typical secondary forest species. This tree fern requires light for germination and growth, and it is normally insignificant or absent in undisturbed cloud forest and rain forest. It spreads easily and grows quickly, but it is shaded out by other forest trees.

Montane scrub.—Because of its inaccessibility and unsuitability for agriculture, the montane scrub is the least disturbed of the vegetation types in American Samoa. The major damage to this vegetation comes from storms and landslides. Because of the low stature of the trees in the montane scrub, storm damage appears to be less than that done to high elevation forests. Herbaceous plants that comprise a large part of the vegetation would be relatively little affected by storms.

There is almost a total lack of successional stages in the development of montane scrub. Most of the species present are typical pioneer species that normally inhabit disturbed areas.

Habitat Preferences

A summary of habitat preferences of the wildlife in American Samoa is presented in Table 31. Most of the animal species are quite restricted (or selective) in the habitats they occupy. This may be summarized as follows:

No. of habitats occupied	1	2	3	4	5	6	7	8
No. of species	12	26	5	5	3	3	2	2

No. of habitats occupied	9	10	11	12	13	14	15	16
No. of species	2	1	2	7	0	0	3	2

Thirty-eight of the 75 animal species occur in only one or two habitats, whereas the other 37 species occur in three or more. Species that are found in small numbers and that are restricted in their habitat preference are those that may be candidates for threatened or endangered status.

Also shown in Table 31 is that most of the species prefer natural vegetation community types. Of the total of 373 habitat preferences, 205 choices (55%) are of undisturbed vegetation types, 115 (31%) are for disturbed habitats, and 52 (14%) are non-vegetation habitats such as caves, beach, reef, or at sea. Of the natural vegetation types, the most important are littoral forest, rain forest, coastal forest, and ridge forest. Among the disturbed habitats the most important are village land, plantation land, and secondary forest. The most important non-vegetative habitat is the sea and, if marine birds are excluded, the beach.

Findings and Recommendations Regarding Resource Management

A major finding of this inventory is that the natural ecological resources of American Samoa have been subjected to significant degradation and that without proper

management this trend will intensify. Much of the natural vegetation has already been destroyed or altered by human activity, and more is being disturbed each year. At present, only 36% of the land area is covered with natural vegetation; only about 38% of the tropical rain forest, once the dominant land cover, remains undisturbed. If future generations of Samoans and island visitors are to see the wildlife and vegetation that exist today, protection of selected plants, animals, and habitats must be provided.

An approach to the conservation of American Samoa's natural resources is outlined in the following pages. Plant and animal species existing in small numbers are identified, as are populations that are susceptible to extreme reductions or possible elimination. Unusual, sensitive, or endangered habitats are identified. Recommendations regarding wildlife sanctuaries, natural areas, parks, management programs, and future scientific investigations are presented. These recommendations are those of Environment Consultants, Inc., and should not be construed as the official position of the U.S. Fish and Wildlife Service.

Potentially Threatened or Endangered Species

As a result of the present inventory in American Samoa, 22 species of plants and animals are suggested as candidates for threatened or endangered status as defined by the Endangered Species Act of 1973.

Plants

Fifteen plant species apparently fit the criteria for either threatened or endangered status, by virtue of their rarity, limited distribution, and susceptibility to extinction. They are listed in alphabetical order below (with the family name in parentheses) with comments on their status.

Acronychia retusa (Rutaceae), a small tree of the littoral and coastal forest, has been collected only twice in American Samoa—on Ta'ū Island in 1975 and 1976. On each occasion, only a single tree was found.

Blumea milnei (Compositae) occurs in Melanesia as well as Samoa, but has been collected only once in American Samoa (on Ofu in 1894) and has not been collected in Western Samoa for more than 70 years. It may be unable to compete with more vigorous introduced weedy species, and it may already be gone from Samoa.

Cordia aspera (Boraginaceae) is a small tree that has been collected only once in American Samoa—on Tutuila in 1975 during this survey. A single tree was growing near the then proposed (and now constructed) road to Afono. It is rare in Western Samoa and probably in Tonga and Fiji as well.

Drypetes sp. nova (Euphorbiaceae), an as yet undescribed form, is known only from several small to medium-sized trees seen on Tau Mountain, Tutuila. The genus is otherwise unknown from Samoa.

Elatostema tutuilense (Urticaceae) is a small prostrate herb known only from the original collection in 1894, when it was found along the Matafao Stream, Tutuila.

Erythrina fusca (Leguminosae) is a medium-sized tree with showy red flowers, found in or on the margins of the mangrove forest. It has been collected only once in American Samoa.

Gardenia taitensis (Rubiaceae) occurs from the New Hebrides to eastern Polynesia. The Tahitian gardenia is a shrub, rare on coastal rocks of Tutuila. It is also occasionally cultivated for its fragrant, showy white flowers, but less so now than in the past.

Geanthus vignai (Zingiberaceae) was collected only once (on Alava Ridge, Tutuila Island) in American Samoa. It is rare in Western Samoa.

Gossypium hirsutum (Malvaceae) is a possibly native form of cotton that has been collected in American Samoa in only one location, in the littoral scrub on the north side of Aunu'u Crater (1975 and 1976). It has been collected only once in Western Samoa.

Intsia bijuga (Leguminosae), a large tree of the coastal forest, is highly prized for its wood. It was found at only two localities on Tutuila—at Tafuna and Nu'usetoga. Only one tree was seen at Tafuna, and at Nu'usetoga nearly all the trees had regenerated from stumps left from cutting years ago. It occurs from Madagascar to Samoa.

Limnophila fragrans (Scrophulariaceae) is a rare white-flowered herb found along streambeds and in coastal marshes on Tutuila and Ta'ū. It is also rare in Western Samoa and occurs in Fiji.

Manilkara dissecta (Sapotaceae) occurs on other Pacific islands but has been collected only once in American Samoa, in the coastal forest near Afono. It is also rare in Western Samoa. Another species, *M. samoensis*, is known only from the original collection made more than 100 years ago; the locality was recorded only as "Samoa."

Maoutia australis (Urticaceae), a small tree of the Pacific islands, has been collected only three times in American Samoa. Only one tree was seen during this inventory, on Ta'ū.

Pongamia pinnata (Leguminosae) has been collected only once in Samoa, near Nu'uuli, Tutuila, in 1920. It is found also in the Seychelles.

Xylocarpus moluccensis (Meliaceae), the puzzlenut tree, is a littoral or mangrove forest species that is restricted in American Samoa to a small number of individuals at two localities—Tafuna on Pala Lagoon, Tutuila, and the south coast of Aunu'u. It is also rare in Western Samoa.

Another 24 species of plants either have been seldom collected or are restricted to habitats that are not critically threatened at this time. Further study is needed to determine their status and how best to protect them and their habitats if necessary. These species are, in alphabetical order:

Acronychia richii (Rutaceae)

Anacolosa lutea (Olacaceae)

Boehmeria virgata (Urticaceae)

Canavalia sericea (Leguminosae)

Crataeva religiosa (Capparidaceae)

Cyrtandra geminata (Gesneriaceae)

Eleocharis geniculata (Cyperaceae)
Eugenia reinwardtiana (Myrtaceae)
Euphorbia reineckeii (Euphorbiaceae)
Flagellaria gigantea (Flagellariaceae)
Gymnosporia vitiensis (Celastraceae)
Gyrocarpus americanus (Hernandiaceae)
Hedyotis romanzoffiensis (Rubiaceae)
Homalium whitmeeianum (Flacourtiaceae)
Ischaemum byrone (Gramineae)
Leucas flaccida (Labiatae)
Machaerina falcata (Cyperaceae)
Mammea glauca (Guttiferae)
Phaleria disperma (Thymelaeaceae)
Sophora tomentosa (Leguminosae)
Suriana maritima (Simaroubaceae)
Tephrosia purpurea (Leguminosae)
Terminalia samoensis (Combretaceae)
Thoracostachyum lucbanense (Cyperaceae)

Twenty species of orchids, most of them epiphytes, should also be mentioned. Epiphytes, however, may easily be overlooked because of their inconspicuous appearance and their inaccessible habitat high in trees. Further study is needed to determine if they are in fact rare or if they have merely been overlooked and seldom collected. The species are: *Agrostophyllum megalurum*, *Bulbophyllum atrorubens*, *B. gibbonianum*, *B. pachyanthum*, *B. sp. nova*, *Cryptostylis alismifolia*, *Dendrobium glomeriflorum*, *Epiblastus sciadanthus*, *Eria aeridostachya*, *Erythrodites* sp., *Goodyera rubens*, *Habenaria supervacunea*, *H. vaupelii*, *Liparis caespitosa*, *L. disticha*, *Mediocalcar paradoxum*, *Nervilia aragoana*, *Taeniophyllum vitiense*, *Vrydagzynea whitmeei*, and *Zeuzine sphaerochila*.

Wildlife

One animal species found in American Samoa, the hawksbill turtle, is presently listed as endangered in accordance with criteria set forth by the Endangered Species Act of 1973. Seven other species in American Samoa may fit those criteria. In addition, 17 rare or restricted species needing further study for an accurate determination of their status occur in and around American Samoa. These species are discussed below.

Reptiles.—The hawksbill turtle, *Eretmochelys imbricata*, breeds at Rose Atoll; it has been recorded recently in Pago Pago Harbor, Tutuila (H. Sesepasara, personal communication). Recent population estimates on Rose Atoll show that this species is absent or present in very small numbers. None was observed during the 1975 and 1976 visits to Rose Atoll. Only two individuals were sighted in 1974 (Sekora 1974). Little is known about the migration of the turtle population breeding on Rose Atoll; it is possible that turtles from there regularly visit the main islands of American Samoa. Most Samoans do not distinguish between this species and the more common black turtle, and it is likely that some of the rare hawksbill turtle are killed inadvertently. A program to alert the Samoan people to watch for differences in captured tur-

tles would be useful in protecting the Rose Atoll population of this species.

The black turtle, *Chelonia agassizii*, presently breeds at Rose Atoll and has bred historically on the sand beaches of the other islands. The fact that turtles now breed only on uninhabited islands suggests that man's disturbance has affected this species. During the 1975-76 study period, various sources reported infrequent visits by the black turtle to the reefs and sand beaches of all the inhabited islands. If animals that nest at Rose Atoll are killed or captured for food, that population could be further reduced.

During three visits to Rose Atoll in 1975-76, the mean number of black turtles estimated from beach tracks was 48, and the mean number of nest pits was 401 (239 on Rose Island and 162 on Sand Island). Few turtles were seen, and some of the nest pits could have been of the hawksbill turtle.

Sekora (1974) observed Polynesian rat predation on black turtle hatchlings emerging from nests in 1974. No evidence of rat predation was found in 1975 and 1976. Study should be directed toward determining the actual effect of rat predation on both hawksbill and black turtle populations on Rose Atoll.

The Pacific boa, *Candoia bibroni*, was found only on Ta'ū Island where it is present in very small numbers; only two individuals were found. Only six specimens are known to have been collected previously on Ta'ū, from the early 1900s through 1953. The species has never been reported from the other islands. It is known from Western Samoa and from Fiji.

The snake-eyed skink, *Ablepharus boutonii*, is now known only from littoral forest on Olosega Island. It was found formerly on Tutuila and Ta'ū islands. In the 1975-76 study period, only one specimen was taken. A possible reason for the virtual absence, or presently restricted distribution, of this species is competition with the azure-tailed skink, *Emoia cyanura*, an abundant species along sea coasts.

Birds.—The Australian gray duck, *Anas superciliosa*, has been recorded historically from all the islands except Rose, and is known to have nested in the coastal marsh at Aunu'u. In this study it was found only on Aunu'u and Tutuila islands. The population is extremely small; data from the study plots yielded an estimate of only 37. Hunting pressure, rat predation, and disturbance of the preferred breeding habitat, coastal marsh, are the most probable reasons for the small population and the lack of breeding. On Aunu'u, both roof rats and Polynesian rats were trapped in the undisturbed coastal marsh in Faimulivai Marsh. Both rat species are known to feed on adult birds and their eggs and young (Kepler 1967, Norman 1975). Disturbance of coastal marsh is widespread. Of the seven coastal marshes on the high islands of American Samoa, six have been disturbed by long-time taro cultivation.

The many-colored fruit dove, *Ptilinopus perousii perousii*, a race restricted to American and Western Samoa, is now found only in a small area of the coastal forest from Afono village to just west of Vatia village on the north shore of

Tutuila Island. The population is extremely small. None was observed in the study plots and the species was recorded in only three linear surveys. In coastal forest habitat on the west side of Pola'uta Ridge, west of Vatia village on the north coast, adult and immature birds fed on fruits of the banyan trees, *Ficus prolixa* and *F. obliqua*. When coastal forest is cleared for agricultural purposes, banyan trees are usually left standing since they are nearly impossible to cut. Although the food source remains, the birds do not use it because the surrounding area is disturbed. Hunting pressure may also contribute to the present small population size and restricted distribution of this dove.

The friendly quail dove, *Gallicolumba stairi*, is known from only two specimens and several sight records in American Samoa. Before the present survey, the race *G. s. stairi* was thought to be restricted to Western Samoa. It is now known from Ofu and Olosega islands, where its population is extremely small. This species may be a recent arrival in American Samoa, but hunting pressure, rat predation, and disturbance of lowland rain forest are possible reasons for the small numbers.

White-rumped swiftlets, *Collocalia s. spodiopygia*, a subspecies found only on the high islands of Western and American Samoa, are abundant in American Samoa; the population was estimated to be 350,000 birds. However, the species is vulnerable because of its restricted nesting in dark caves. On Tutuila, the only two nesting sites, caves at Anape'ape'a Cove near Afono village, are disturbed by humans. Other small caves are scattered about Tutuila Island, but none was found to have a nesting colony of swiftlets. Minor swiftlet caves are located on Aunu'u, Ofu, Olosega, and Ta'u islands.

A subspecies of the purple swamphen, *Porphyrio porphyrio samoensis*, is endemic to the high islands of Western and American Samoa. In the latter islands the population is small; only 700 birds were estimated to exist. Hunting pressure and general disturbance of habitat are the most probable reasons for the small population. Samoans report that this species does considerable damage in plantations, digging up and destroying young taro plants, and eating bananas and other fruit. Birds are killed to protect the crops.

Several other species of birds occur in small numbers and in restricted specialized habitats in American Samoa. Although these species have extensive ranges in the tropical Pacific, further study on the status of the populations in American Samoa is warranted to determine whether local protection is necessary. These species are:

Tahiti petrel, *Pterodroma rostrata*
 Collared petrel, *Pterodroma leucoptera*
 Wedge-tailed shearwater, *Puffinus pacificus*
 Christmas shearwater, *Puffinus nativitatus*
 Audubon's shearwater, *Puffinus lherminieri*
 White-throated storm-petrel, *Nesofregatta albigularis*
 Red-tailed tropicbird, *Phaethon rubricauda*
 Blue-faced booby, *Sula dactylatra*
 Great frigatebird, *Fregata minor*

Lesser frigatebird, *Fregata ariel*
 Reef heron, *Egretta sacra*
 Banded rail, *Gallirallus philippensis*
 Gray-backed tern, *Sterna lunata*
 Blue-gray noddy, *Procelsterna cerulea*
 Fiji shrikebill, *Clytorhynchus vitiensis*

Mammals.—The sheath-tailed bat, *Emballonura semicaudata*, is now found on Tutuila, Aunu'u, Ofu, Olosega, and Ta'u islands in American Samoa, and in Western Samoa and the Fiji Islands. More than 11,000 bats of this species were estimated in the several bat caves on the main islands of American Samoa. However, the roosting caves are being disturbed by human intruders and one major roosting cave has been destroyed recently by an earthquake. The factors affecting the white-rumped swiftlet also affect this bat because the two species use the same caves.

Potentially Threatened Habitats

Habitats, as well as the individual species of plants and animals that occur in and make up the habitats, may be threatened with disturbance or destruction. Severe disturbance or loss of a habitat has as a corollary the loss or reduction of the species dependent on it. Six vegetation communities are discussed below with reference to present conditions of extent and disturbance; plants and animals found only or primarily in these habitats are noted.

Lowland rain forest.—The previously extensive lowland rain forest in the Tafuna area on the south-central portion of Tutuila Island has been reduced to several patches that are rapidly being destroyed, even the one containing survey plot 20 near the Lava Lava Golf Course. The entire remaining lowland rain forest area is extensively used by many bird species for both feeding and nesting. If this area is destroyed, a unique feature of Tutuila will be eliminated. There are no similar lowland rain forest areas on the other islands of American Samoa.

The lowland rain forest is characterized by trees 24-30 m tall, predominantly *Planchonella torricellensis*, *Dysoxylum samoense*, and *Myristica fatua*. It contains large numbers of birds, particularly nesting crimson-crowned fruit doves, wattled honey-eaters, Polynesian starlings, and white-tailed tropicbirds. Birds appear to be crowded into the area from the surrounding clearcut areas.

Coastal marsh.—All of the major coastal marshes in American Samoa have been disturbed, and all are under taro cultivation except for Faimulivai Marsh in the dormant volcanic crater on Aunu'u Island. This freshwater marsh was formerly a breeding site for the Australian gray duck. Hunting pressure, and perhaps rat predation, have kept this duck from breeding in recent years. Other bird species using this marsh include the banded rail and the purple swamphen.

Around the edges of the central pond, the vegetation consists of 2-3 m high swamp fern, *Acrostichum aureum*. Surrounding this is a mixture of a smaller fern, *Cyclosorus interruptus*, and a sedge, *Eleocharis dulcis*. These three species make up a plant community found only in coastal marsh.



Fig. 36. Mangrove forest at Pala Lagoon, Tutuila Island (photo by . B. Amerson, Jr.).

Because all the other coastal marshes are already disturbed, the destruction of Faimulivai Marsh would mean the complete disappearance of this unique plant community from American Samoa.

Mangrove forest.—Mangrove forests or swamps were once prominent features at the mouths of most freshwater streams on Tutuila. Most of these forests have been eliminated or drastically reduced in size by man; such is the case especially at Utulei, Aua, Leone, and Fagaitua villages. Mangrove forest is also found on Aunu'u, but is nonexistent in the Manu'a Group. It is important as a terrestrial habitat and as a contributor of detritus to the food chain of marine organisms.

Although three good examples of mangrove forest remain in American Samoa, none is very extensive. The largest and most important one is around Pala Lagoon on Tutuila (Figs. 18, 36). Even now, however, the northern edge of this swamp is slowly being encroached upon by landfills from Nu'uuli village. The other two examples of mangrove forest are at Masefau, Tutuila, and on Aunu'u (Whistler 1976). The latter is particularly important as it surrounds a unique mud flat called Pala Mud Lake.

These three mangrove forests are characterized by trees up to 15 m tall of *Bruguiera gymnorhiza*, with smaller *Rhizo-*

phora mangle around the open edges. The puzzle-nut tree or "le'ile'i," restricted now to a few individuals, is found only on the west side of Pala Lagoon and on Aunu'u. Bird species prevalent in the forest area include banded rail, white-collared kingfisher, wattled honey-eater, and, on Tutuila only, cardinal honey-eater. The Australian gray duck and several species of shorebirds are known to frequent the adjacent mud flats.

Montane rain forest.—Montane rain forest has been reduced severely on all the islands except Ta'u. Only patches remain on Tutuila, in the area west of Aoloaufau village and on several of the steep or inaccessible areas on the north shore.

This forest is dominated by tree species such as *Dysoxylum huntii*, *Myristica hypargyrea*, and *Syzygium samoense*. Lizards using rain forest as primary habitat are the azure-tailed skink, black skink, moth skink, and pelagic gecko. In all, ten species of birds use this as primary habitat; those most common in the area include the Pacific pigeon, crimson-crowned fruit dove, wattled honey-eater, Polynesian starling, and Samoan starling. Three bird species are or were apparently restricted to this vegetation type. The Samoan wood rail, formerly reported to breed on Tutuila, is now considered extirpated. The mao, also reported to be a former

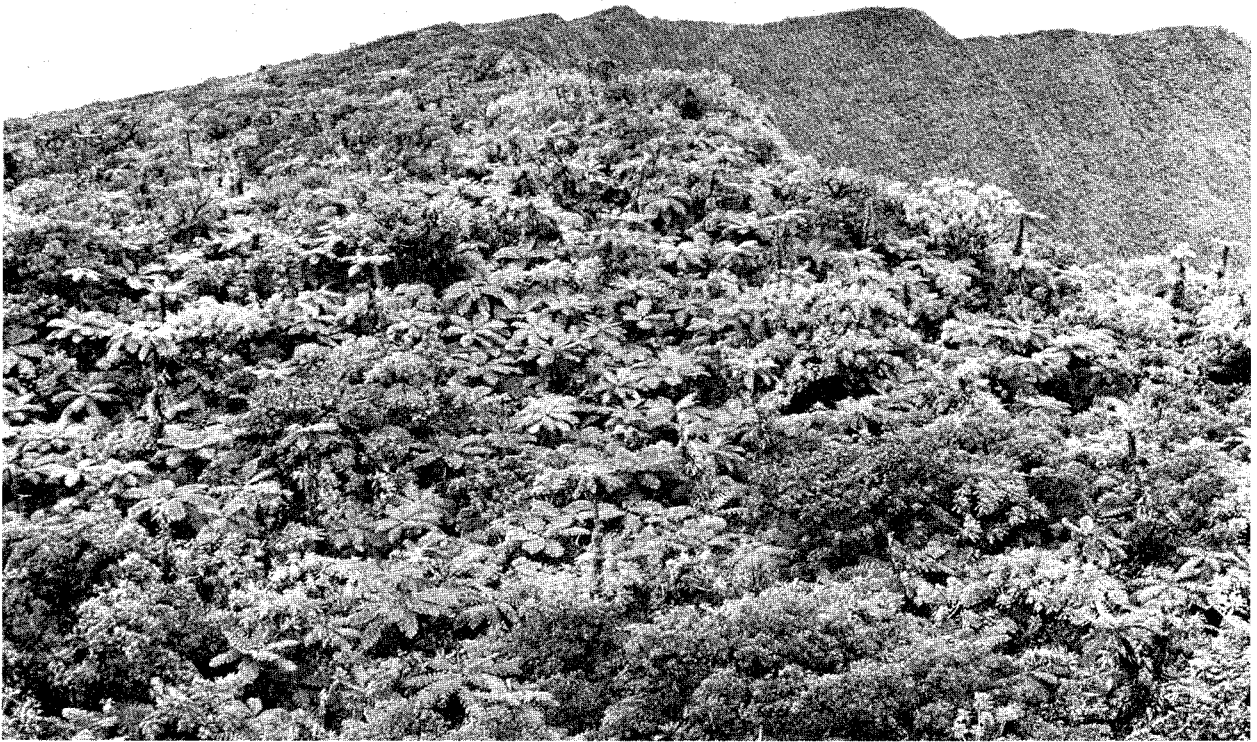


Fig. 37. Aerial view of cloud forest on Lata Mountain, Ta'ū Island (photo by A. B. Amerson, Jr.).

breeder on Tutuila, has not been recorded in recent years and is also considered to be extirpated. The Fiji shrikebill, found only in the Manu'a Group, has not been reported in recent years on Ofu or Olosega and is now found only in moderate numbers on Ta'ū. The extirpation of the Samoan wood rail and mao on Tutuila and the reduction of the Fiji shrikebill population in Manu'a are probably related to the severe reduction of montane rain forest.

Cloud forest.—Although the cloud forest, occupying the top third of Ta'ū Island and the very top of Olosega Island, is of no great commercial value and is not immediately threatened, the vegetation there does not exist anywhere else in American Samoa. The cloud forest on Lata Mountain, Ta'ū (Fig. 37) is of special importance because several bird species occur only there. Coulter (1948) earlier recognized the importance of this cloud forest. He wrote: "I lived for a month with a chief on the little island of Tau [sic] . . . in American Samoa. The chief told me about certain birds on that island, in the central mountainous part, which were almost extinct. The center of the island is some 3,000 or more feet high, thickly wooded, and could be made into a bird preserve. It is not often visited by Samoans, and only by those who hunt the birds. I believe the Samoans, if properly approached, would make it into a preserve and take pride in keeping it so."

The cloud forest is characterized by extremely high rain-

fall, warm days, and cool nights. It is usually enshrouded by clouds. The dominant tree species include *Syzygium samoense*, *Weinmannia affinis*, *Astronidium pickeringii*, and *Dysoxylum huntii*. An important characteristic of the cloud forest is the abundant growth of epiphytes; mosses and liverworts cover every available tree branch, and orchids and ferns are abundant. Birds that nest in ground burrows in the area include the Tahiti petrel, Christmas shearwater, and Audubon's shearwater, each present in small numbers.

Montane scrub.—On Ta'ū Island, the montane scrub is closely associated with the unique cloud forest. Here, the scrub exists on Olotania Crater as well as on the extremely sheer terrain south of Lata Mountain. The wall on which it grows below Lata drops almost vertically from an elevation of 966 m to 548 m. The vegetation is dominated by *Blechnum vulcanicum*, *Dicksonia brackenridgei*, and *Freycinetia storckii*, and by tree ferns (*Cyathea*). Birds nesting in burrows are the collared petrel and perhaps the white-throated storm-petrel; the former nests in American Samoa only on Ta'ū.

The Tutuila Island montane scrub is found on the peaks of old trachyte plugs, principally on Pioa (Rainmaker), Matafao, and Tau mountains. Dominant plant species unique to this area include *Pandanus reineckeii*, *Syzygium brevifolium*, and *Astronidium samoense*. Birds nesting only in the mon-

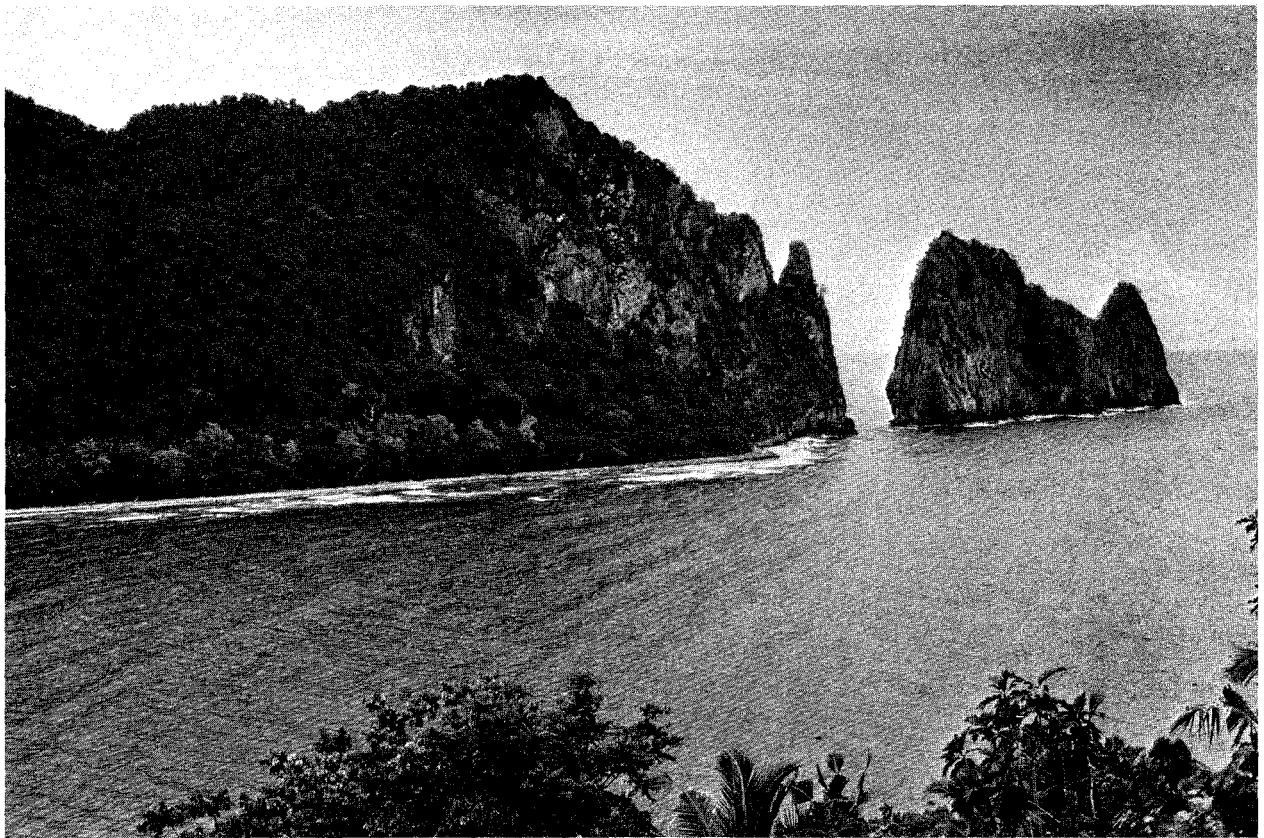


Fig. 38. Pola Islet and Pola'uta Ridge, Tutuila Island, nesting areas of eight species of seabirds (photo by A. B. Amerson, Jr.).

tane scrub of Pioa Mountain are the wedge-tailed shearwater and perhaps the white-throated storm-petrel.

Areas Important to Wildlife Protection

Several areas of American Samoa provide habitat that is particularly heavily used by wildlife. Conferring some special protective status to these areas would be a major step in preserving important segments of certain habitat types and the wildlife dependent on them.

Pola Islet and Pola'uta Ridge, Tutuila.—Pola Islet is a small isolated volcanic rock (Fig. 38) north of Vatia village on the north shore of Tutuila. Pola'uta Ridge is the mountain ridge just south of Pola Islet. The narrow strait between them is Vaiava Strait, already established as a National Natural Landmark.

Pola Islet and the top and west portions of Pola'uta Ridge are nesting sites for at least eight species of seabirds—white-tailed tropicbird, brown booby, red-footed booby, gray-backed tern, blue-gray noddy, brown noddy, black noddy, and white tern. Other possible nesters include the great frigatebird, lesser frigatebird, wedge-tailed shearwater, and white-throated storm-petrel. These seabirds number in the thousands on the islet. Many of the species, especially the frigatebirds, boobies, and noddies, have been subjected to

hunting pressure, both historically and recently, by Samoans from various north-shore villages. Hunting, conducted from a boat or canoe with shotguns or snares, both reduces the population and disrupts the breeding cycle.

Pola Islet and the lower portions of Pola'uta Ridge are covered with undisturbed coastal forest; the upper portion of the ridge is rain forest. Many land birds use the area. Of particular importance is the many-colored fruit dove in the coastal forest along the west side of Pola'uta Ridge, one of only two localities where this species was found. Other birds in the area include the crimson-crowned fruit dove, Pacific pigeon, white-collared kingfisher, wattled honey-eater, Polynesian starling, and Samoan starling.

Fagatele Point, Tutuila.—Fagatele Point is at the southwestern tip of Fagatele Bay, just west of Steps Point, the southernmost tip of Tutuila. The point is quite isolated and almost inaccessible. On the seaward side, sheer rock cliffs rise abruptly from the ocean. Seumalo Ridge, north of the cliffs, is very rocky and steep and is covered with undisturbed coastal forest. Plantation land is gradually encroaching from the north and west.

The coastal forest covering the southern tip of Seumalo Ridge at Fagatele Point is the major roosting site on Tutuila for flying foxes; thousands of these large fruit bats roost in the large trees along the ridge. Land birds using this coastal

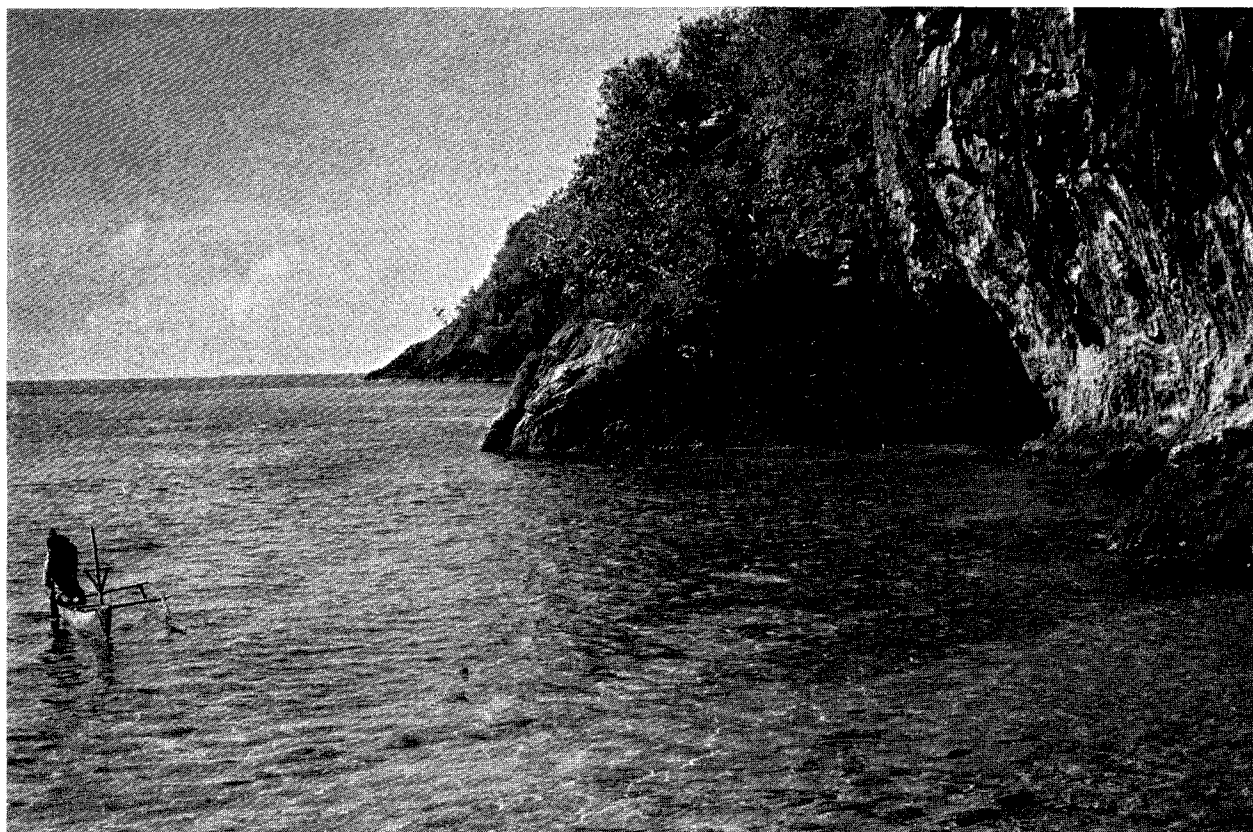


Fig. 39. Anape'ape'a Cove, Tutuila Island. Caves here provide homes for white-rumped swiftlets and sheath-tailed bats (photo by A. B. Amerson, Jr.).

forest include the crimson-crowned fruit dove, Pacific pigeon, white-collared kingfisher, wattled honey-eater, Polynesian starling, and Samoan starling.

The sheer rock cliffs on the east and west sides of Fagatele Point provide nesting space for five species of seabirds. Major colonies of the brown booby, gray-backed tern, blue-gray noddies, brown noddies, and white tern exist here. White-tailed tropicbirds, brown noddies, and white terns also nest in the coastal forest. The rich offshore waters provide small food fishes for these birds, as well as for tunas. The sea surrounding Fagatele Point has a vast and unique array of in-shore fishes and marine organisms, as well as coral formations. Leala Shoreline, just west of Fagatele Point, is already a National Natural Landmark.

Anape'ape'a Cove, Tutuila.—This cove is on the west side of Afono Bay, northeast of Afono village on the north shore of Tutuila. Anape'ape'a (swiftlet cave) Cove is the site of two caves (Fig. 39) that are the only breeding areas of the white-rumped swiftlet found during the inventory of Tutuila. The sheath-tailed bat also uses both caves as major roosting sites; at least 11,000 bats are estimated to use the caves. Human intrusion could ultimately destroy both the swiftlet and bat colonies.

Nu'utele Islet, Ofu.—Nu'utele Islet is just west of Ofu village. It is uninhabited but had, at the time of the survey,

pigs, a cow, and several cats living there. The east half is plantation land, but the west half contains coastal forest and coastal scrub. On the western side of the islet there is a sheer cliff that provides nesting sites (Fig. 40) for four species of seabirds—brown booby, blue-gray noddies, brown noddies, and white tern. Nu'utele Islet is the major nesting site for seabirds on Ofu. The coastal forest provides space for nesting red-footed boobies. Several caves have been cut by wave action under Nu'utele Islet; these provide roosting sites for sheath-tailed bats and perhaps for white-rumped swiftlets. A few land birds use Nu'utele Islet, but their breeding success is limited by the feral cats and pigs.

Faimulivai Marsh, Aunu'u.—This marsh, already a National Natural Landmark, is in the dormant volcanic crater on the west-central portion of Aunu'u Island. (Fig. 41). This marsh was discussed above (see p. 65) as a potentially threatened habitat, because of its unique plant and animal community.

Lata Mountain-Lavana Cove-Ulufala Point, Ta'u.—Ta'u Island has what are probably the most desirable characteristics for the establishment of a wildlife preservation area. The southern half of the island is uninhabited and infrequently visited. Large patches of secondary forest on the beaches attest to a larger human population and greater land pressure in the past. An area of about 1,260 ha from Lata

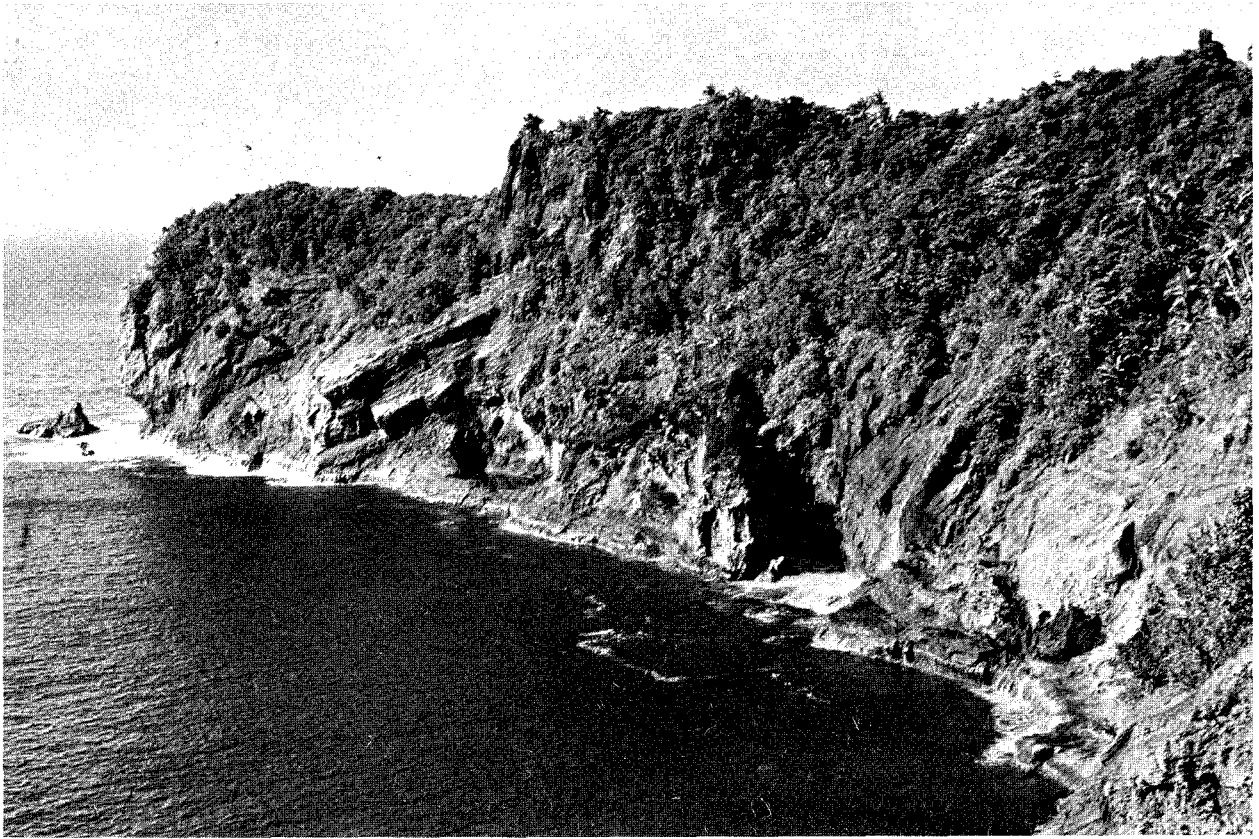


Fig. 40. West side of Nu'utele Islet, Ofu Island, showing seabird nesting areas (photos by A. B. Amerson, Jr.).

Mountain on the north to Lavania Cove on the southwest, to Ulufala Point on the southeast and the strip of coast on the east side, to Saua, includes many vegetation types—littoral strand, littoral forest, littoral scrub, coastal forest, secondary forest, lowland and montane rain forest, montane scrub, and cloud forest. In addition to the variety of plant communities, the area includes a unique avifauna (Tahiti petrel, Christmas shearwater, Audubon's shearwater, collared petrel, white-throated storm-petrel, and Fiji shrikebill) and the only species of snake (Pacific boa) found in American Samoa. Some of the most magnificent natural beauty spots in all of Samoa are here (Fig. 42). The view from the cloud forest toward the southern coast rivals many of the world's scenic wonders, and Laufuti Falls, which drops more than 300 m, is spectacular.

Tafuna Lowland Rain Forest, Tutuila.—This rain forest, east of the Lava Lava Golf Course, and containing survey plot 20, has been discussed as a potentially threatened habitat (p. 65).

Pala Lagoon Mangrove Forest, Tutuila.—The mangrove forest on the north shore of Pala Lagoon, Tutuila, contains a unique plant community that is rapidly being eliminated from American Samoa. Of particular interest in this area is the "le'ile'i" or puzzle-nut tree (*Xylocarpus moluccensis*), identified earlier as a potentially threatened species,

restricted to a few individuals on the west side of Pala Lagoon and on Aunu'u.

Nu'usetoga Islet, Tutuila.—The "ifilele" tree (*Intsia bijuga*) is common at Masefau Bay on Nu'usetoga Islet (Fig. 43); only once was it found elsewhere, at Tafuna. These trees are highly prized for their wood, which in Western Samoa is still used to make the best "kava" bowls. The major threat to the trees in American Samoa has been cutting for their wood, but with the disappearance of much of the native culture and the reduced demand for "kava" bowls and "fale" (house posts), the danger may be abated. This tiny islet has been disturbed in the past, but appears to be in disuse now. The area contains several land bird species, among them the crimson-crowned fruit dove, wattled honey-eater, Polynesian starling, and Samoan starling.

Airport Secondary Forest, Tutuila.—There are several patches of representative secondary forest near the Tafuna Airport, on Tutuila. One, on the airport perimeter, was used for survey plot 33. Because so much of American Samoa's natural forest has been disturbed, it is desirable to preserve some secondary forest. Studies on natural succession on cleared land require long-range investigations.

Airport Lowland Rain Forest and Coastal Forest, Ofu.—Northeast of the Ofu airport runway there are several patches of lowland rain forest and primary coastal forest that



Fig. 41. Faimulivai Marsh, Aunu'u Island (photo by A. B. Amerson, Jr.).

are typical of coastal areas on talus slopes. One of these slopes was used for survey plot 16. This area includes the only habitat of the friendly quail dove in American Samoa. Because of the steep slope (35-40°) and natural disturbance caused by rockfalls and landslides, the area is unsuitable for agricultural purposes. The dominant tree species are *Hibiscus tiliaceus*, *Dysoxylum samoense*, and *Terminalia catappa*. *Macaranga harveyana*, whose small seeds the friendly quail dove feeds on, is also present. Other birds in the area include the wattled honey-eater, Samoan starling, and crimson-crowned fruit dove. Polynesian rats are found in the area, and roof rats were recorded in the plantation land below and adjacent to the area.

Governor's Mansion, Pago Pago, Tutuila.—The Governor's Mansion, or Government House, is designated as a National Historic Landmark (GAS 1975). The grounds surrounding the mansion, although within village land, have been well preserved. The area is close to the hub of everyday life on Tutuila and near the heart of tourist activity. Many plant, lizard, and bird species typical of the island are found here. These grounds could be converted to a major attraction for both local residents and tourists and serve an important educational function in familiarizing people with the natural resources of the islands.

Conservation and Management Programs

Until recently, specific conservation oriented management programs for American Samoa have been lacking. Nelson (1964) recommended a forest management program, but few, if any, of his recommendations were implemented. Dahl (1970, 1973, 1976) gave detailed ecological recommendations for American Samoa. Many of his suggestions have been carried out, including the establishment of an Environmental Quality Commission and the hiring of a staff ecologist. His most important recommendation, perhaps, was for the compilation of baseline information through a comprehensive scientific inventory of the habitats, fauna, and flora of the territory.

Forests and Land Use

Nelson (1964) encouraged the development of forestry on American Samoa. A conclusion of the present survey is that forestry has minimal potential because (1) the area of remaining mature forest is limited, (2) the remaining forest is inaccessible, (3) the remaining forest is more valuable as a watershed and wildlife sanctuary, and (4) there is declining use of native timber. We believe that lumbering should be restricted to that required to meet local cultural needs.



Fig. 42. South side of Ta'u Island, showing Lavania Cove in the center, Ulufala Point on the right, and Lata Mountain (photo by W. A. Whistler).

Reforestation with exotic plant species is inadvisable. The native birds are adapted to feeding on the native fruit-bearing trees of the forest, and the replacement of these trees by exotic species may have deleterious effects on the avifauna. Natural succession should be allowed to take place whenever possible, but if reforestation is necessary, native tree species should be used.

Unwise land use can lead to serious erosion problems. Land use planning should be undertaken so that natural forests, particularly those on steep slopes, are not cut unnecessarily. Extensive land use alterations, including road construction, should require a detailed analysis of the impact on the natural environment.

Wildlife Protection

Import and export.—Samoa is unusual in the small number of introduced plant species that have invaded natural habitats. The extreme damage to the native flora of Hawaii should serve as a stark example of what, with a little foresight and care, can be avoided in American Samoa. Samoa also has a relatively small number of introduced birds, mammals, reptiles, and amphibians in natural habitats. Introduced animals that invade native habitats on islands usually compete, often successfully, with native

species for the limited food resources. Strict controls on the importation of exotic plants and animals is the best preventive measure.

Another provision for the integrity of the Samoan ecosystem would be the control of the exportation of native plant and animal species. This is particularly important for those species that might be considered threatened or endangered.

Hunting.—In 1976, staff members of the Office of Marine Resources of the Government of American Samoa were designated as U.S. Fish and Wildlife Service game wardens, but this action was taken to control entry to Rose Atoll National Wildlife Refuge. There are no hunting regulations in American Samoa. Hunting, especially for Pacific pigeons, traditionally takes place only during September and October, but this unwritten custom is not enforced. Until recently, the only regulatory agents for the territory were the police, who do not attempt to control hunting except to issue firearm permits.

Hunting pressures on the bird life of American Samoa have been great in historic times and are still high today. Many species—primarily the brown booby, red-footed booby, white-tailed tropicbird, crimson-crowned fruit dove, Pacific pigeon, Samoan starling, Polynesian starling, and wattled honey-eater—are shot and eaten throughout the



Fig. 43. Nu'usetoga Islet on the north shore of Tutuila Island (photo by W. A. Whistler).

year. Hunting pressures, combined with habitat destruction and perhaps rodent predation, have apparently taken a heavy toll on the Australian gray duck and the many-colored fruit dove.

Legislation for better hunting regulations and enforcement is a necessary part of a program for preservation of many of the bird species in American Samoa. Such regulations should completely protect some species and should set season and bag limits on others. Regulations should permit the taking of specimens for scientific purposes under proper controls.

Public Conservation Awareness

Efforts should be made in the villages and schools to make the public aware of its biological surroundings; an appreciation and understanding of Samoan plants and animals should be encouraged. Biology classes should stress the importance of the forest and the insular ecosystem of American Samoa. Too often, examples are taken from mainland textbooks that have no relevance to the students' island environ-

ment. A public conservation awareness program could be developed by the government ecologist and implemented by the Jean P. Haydon Museum of American Samoa and the Department of Education. Exhibits could be set up in the museum to depict the wildlife species of American Samoa in their natural habitats.

Suggested Future Research

The study reported here was not designed to be the ultimate work on the wildlife and wildlife habitat of American Samoa. It does, however, provide a baseline of information for future studies, and points out the direction that some of those future studies might take.

Reinventory.—Periodic reinventories of the wildlife and habitats of American Samoa will provide information on changing conditions and populations that will allow Federal and Territorial administrators and managers to assess the effectiveness of protective or managerial actions. In any resurveys, particular attention should be given to the study plots

and community types established in this survey, so that change can be measured most effectively.

Vulnerable species.—Continued monitoring and research on plant and animal species shown by this study to be rare, restricted to particular vegetation types or habitats, or under pressure from human activities, is necessary if those species are to survive in American Samoa. Studies should be conducted of both their status and their life histories, the object of the latter being to determine the factors essential to their success and those limiting their populations.

Other flora and fauna.—A comprehensive flora of Samoa would be useful to future workers in allowing the accurate identification of the many plant species and providing a better understanding of the vegetative complexity, both requisite for management and scientific purposes. Detailed studies of the biology and ecological relationships of the wildlife species would aid in the development of the knowledge base on which successful management and protection must be predicated.

Rose Atoll National Wildlife Refuge.—This is perhaps the world's most isolated and least disturbed refuge for wildlife. As such, it serves its protective function well. Very little is known, however, of the biology of the species that occur on this island refuge. Movements, breeding cycles, reproductive success, and the effect of possible predation by introduced rodents on turtles and birds, are all deserving of study. Any research on this refuge must, of course, be undertaken in a way that minimizes disturbance to the refuge and its protected species.

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Table 1. Wildlife and wildlife habitat sampling in the study plots. X, sampled quantitatively; NA, not applicable.

Community type			Quantitative plot studies									
Plot no.	Plot name	Island	Wildlife habitat						Wildlife			
			Vegetation									
			Microclimate	Soil	Canopy trees	Saplings	Ground cover	Vines	Birds	Mammals	Reptiles	Amphibians
1	Nu'uuli mangrove forest	Tutuila		X	X	X			X	X	X	X
2	Vaitogi littoral forest	Tutuila	X	X	X				X	X	X	X
3	Rose littoral forest	Rose	X	X	X				X	X	X	NA
4	Aunu'u littoral forest	Aunu'u			X	X			X			
5	Onenoa littoral forest	Tutuila	X	X	X				X	X	X	X
6	Aigā littoral forest	Tutuila			X	X	X	X			X	X
7	Saua littoral forest	Ta'u			X	X	X	X	X		X	NA
8	Pala littoral forest	Aunu'u		X	X				X		X	X
9	Sili coastal forest	Olosega			X						X	NA
10	Pofala coastal forest	Aunu'u			X				X		X	X
11	Nu'utele coastal forest	Ofu			X				X	X	X	NA
12	Masefau coastal forest	Tutuila			X	X	X	X	X		X	X
13	Maloatā ridge forest	Tutuila			X				X		X	X
14	Alofau ridge forest	Tutuila			X	X	X	X				
15	Au'auli rain forest	Ta'u			X	X	X	X				NA
16	Ofu rain forest	Ofu		X	X	X	X	X	X	X	X	NA
17	Lavania rain forest	Ta'u			X		X	X	X		X	NA
18	Aigā rain forest	Tutuila			X	X	X	X			X	X
19	Saua rain forest	Ta'u			X	X	X	X	X		X	NA
20	Tafuna rain forest	Tutuila	X	X	X	X	X	X	X	X	X	X
21	Malaeimi rain forest	Tutuila	X	X	X	X	X	X	X	X	X	X
22	Faga'alu rain forest	Tutuila	X	X	X	X	X	X	X	X	X	X
23	Aoloau rain forest	Tutuila	X	X	X	X	X	X	X	X	X	X
24	A'asu rain forest	Tutuila			X	X	X	X	X			
25	Olosega rain forest	Olosega			X				X			NA
26	Tau ridge forest	Tutuila		X	X	X	X	X	X		X	X
27	Alava ridge forest	Tutuila			X	X	X	X	X		X	X
28	Matafao ridge forest	Tutuila		X	X	X	X	X	X		X	X
29	Tau montane scrub	Tutuila			X		X					
30	Matafao montane scrub	Tutuila			X		X		X		X	X
31	Piumafua cloud forest	Olosega			X				X			NA
32	Lata cloud forest	Ta'u	X	X	X	X	X	X	X		X	NA
33	Airport secondary forest	Tutuila			X	X	X	X	X	X	X	X
34	Luma secondary forest	Ta'u			X	X	X	X	X		X	NA
35	Fagamalo secondary forest	Ta'u			X	X	X	X	X			NA
36	Faleiulu secondary forest	Ta'u			X	X	X	X	X		X	NA
37	Laufuti secondary forest	Ta'u		X	X	X	X	X	X		X	NA
38	Olotania montane scrub	Ta'u		X	NA	NA	X	NA	X		X	NA
39	Aunu'u coastal marsh	Aunu'u	X	X	NA	NA	X	NA	X	X	X	X
40	Maga littoral scrub	Olosega	X	X	NA	NA	X	NA	X	X	X	NA
41	Onenoa kula fernland	Tutuila	X	X	NA	NA	X	NA	X		X	X

Table 2. *Classification of soil types on Tutuila Island.*

Broad soil classification	Major soil suite	Minor soil suite	Soil type	Parent material	Slope classification
Latosolic	Samoa	Puapua Mulifanua	Togitogiga	Pahoehoe	Lowland
			Tafatafa	Mixed Aa and Pahoehoe	Foothill
		Fagaloa	Papaloa	Pahoehoe and Dykes	Steepland
			Lata	Many Dykes and Pahoehoe	Steepland
	Vini	Vini	Tafua	Lithic Vitric Tuffs and Ash	Lowland
		Leone	Leone	Tuff and Ash	Lowland
Recent	Sauniatu	Leone	Leone	Basic Alluvium	Lowland
	Ma'asina	Leone	Leone	Basic Colluvium	Foothill
	Fusi	Leone	Leone	Coral Sand	Lowland
	Loga	Leone	Leone	Coastal Alluvium	Lowland
	Namoa	Leone	Leone	Alluvium and Organic	Lowland

Table 3. *Generalized vegetation and soil relationships.*

Vegetation community	Major soil suite	Soil type	Plot no.
Rock strand	Samoa Latasol	Tafatafa	2
Sand strand	Recent	Fusi ¹	
Littoral scrub	Recent	Ma'asina ¹	40
Coastal marsh	Recent	Lalovi	39
Mangrove forest	Recent	Loga	1, 8
Littoral forest	Recent	Fusi	5
Coastal forest	Vini Latasol	Vini ¹	10, 12
Lowland rain forest	Samoa Latasol	Togitogiga, Papaloa	20, 21
Montane rain forest	Samoa Latasol	Lata	22, 23
Ridge forest	Samoa Latasol	Lata, Papaloa	26, 28
Cloud forest	Samoa Latasol	Tiavi, Mafane ¹	32
Montane scrub	Samoa Latasol	Lata	29, 39

¹Probable, not verified.

Table 4. Summary of local weather data obtained during this study.

Study plot	Date	Temperature (°C)				Relative humidity (%)
		Air		Ground surface	At top of vegetation	
		Min.	Max.			
Vaitogi littoral forest	5 Mar. 1976	29	33	29-42	29-31	
	13 July 1976	22	30			
Rose Atoll sand strand	22 Oct. 1975	24	32			67-91 ¹
	6 May 1976	22	35			
Oenoa littoral (<i>Barringtonia</i>) forest	22 Apr. 1976	24	29	27-31	28-29	
	23 Apr. 1976	23	29			74
Tafuna lowland rain forest	5 Feb. 1976	25	27			
	12 Feb. 1976	21	27	26	25	
	1 July 1976	22	35			
Malaeimi lowland rain forest	31 Dec. 1975	25	27	27	27	85
	8 July 1976	21	27			
Faga'alu rain forest	20 Nov. 1975	26	28	27	28	
	11 Dec. 1975	24	25	25	24	97
	23 July 1976	20	40			
Aoloau montane rain forest	12 Nov. 1975	25	28	25	28	83
Lata Mountain cloud forest	17 Jan. 1976	14	23			
Aunu'u coastal marsh	17 Sep. 1975	27	30	30	30	69
	9 Apr. 1976	16	40	38-43	34	
Maga Point (Olosega) littoral scrub	10 July 1975	30	34	28	31	72
Oenoa kula fernland	10 Nov. 1975	41	47	32-47	41	69
Swains Island	20 May 1976	23	34			

¹In *Pisonia* forest.

Table 5. Number of native and non-native species (excluding weeds) with percentage composition of the vascular flora of American Samoa in parentheses.

Category	Flowering plants			Pteridophytes	
	Dicot species	Monocot species	Total species	Ferns and allies	Grand total
Native Species					
Endemic to American Samoa	10	1	11	2	13
	(4.1)	(0.9)	(3.1)	(1.4)	(2.7)
Endemic to both Samoas	43	25	68	13	81
	(17.7)	(23.4)	(19.4)	(9.3)	(16.5)
Non-endemic	167	68	235	125	360
	(68.7)	(63.6)	(67.1)	(89.3)	(73.5)
Total	220	94	314	140	454
Non-native Species					
Naturalized introductions	23	13	36	0	36
	(9.5)	(12.1)	(10.3)	(0.0)	(7.3)
Grand Total	243	107	350	140	490

Table 6. Numbers of indigenous plant species on each island of American Samoa.

Island	Approx. area (km ²)	Flowering plants	Ferns	Total
Tutuila	142.0	263	103	366
Aunu'u	1.5	76	11	87
Ofu	6.6	134	29	163
Olosega	4.8	148	31	179
Ta'u	38.7	201	90	291
Rose ¹	0.05	6	0	6
Swains	3.3	26	7	33
All islands	196.8	314	140	454

¹Does not include Sand Island (0.026 km²), which has no vegetation.

Table 7. Summary of the distribution of vascular plants in American Samoa.

Category	Islands							All islands
	Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose Atoll	Swains	
I. Angiospermae (Flowering plants)								
A. Arborescent								
1. Dicotyledonae	154	52	93	97	111	3	16	174
2. Monocotyledonae	6	3	3	3	3	1	2	6
B. Lianas and vines								
1. Dicotyledonae	29	13	20	17	23	1	3	34
2. Monocotyledonae	7	2	2	3	4	0	0	7
C. Herbaceous								
1. Dicotyledonae	24	7	14	17	26	2	6	35
2. Monocotyledonae								
a. Cyperaceae	10	9	5	5	9	0	3	13
b. Gramineae	16	7	7	7	14	0	2	17
c. Orchidaceae	43	3	12	20	36	0	0	58
d. Others	6	2	2	2	4	0	1	6
II. Pteridophyta (ferns)	103	11	29	31	90 ^a	0	7	140
Totals	398	109	187	202	320	7	40	490

^aIncludes 8 species whose locality was listed only as "Manu'a."

Table 8. Summary of vegetation types and land-use categories of the islands of American Samoa; all values are given in hectares.

Land classification	Islands								Percentage
	Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose Atoll	Swains	Total	
<i>Natural vegetation</i>									
Littoral scrub	14.2	0.4	4.9	8.9	38.4		1.6	68.4	0.3
Undisturbed coastal marsh		10.9					1.6	12.5	0.1
Mangrove forest	85.0	6.0						91.0	0.5
Littoral forest and strand	134.4	9.3	23.5	9.3	49.0	1.6		227.1	1.2
Coastal forest	496.9	7.5	133.1	105.2	181.0			923.5	4.7
Rain and ridge forest	3,801.6		56.3	25.1	1,263.4			5,146.4	26.1
Cloud forest				7.3	480.4			487.7	2.5
Montane scrub	85.0				67.6			152.6	0.8
<i>Disturbed vegetation</i>									
Disturbed coastal marsh	2.4	7.7	1.6	3.6	12.9			28.2	0.1
Kula fernland	1.2							1.2	<0.1
Secondary forest	3,207.9	1.6	68.0	108.5	590.0			3,976.0	20.2
Plantation land	4,781.3	87.0	357.3	186.6	1,143.6		207.6	6,763.4	34.4
Pasture land	43.7							43.7	0.2
<i>Barren areas</i>									
Village/industrial land	1,519.6	9.7	10.9	26.7	45.3		10.5	1,622.7	8.2
Water	23.5	1.2					104.8	129.5	0.7
Other		4.5				2.4		6.8	<0.1
Totals	14,196.7	145.6	655.6	481.2	3,871.6	4.0	326.1	19,680.8	
Percentage	72.1	0.7	3.3	2.4	19.7	<0.1	1.7		

Table 9. Vegetation communities on the islands of American Samoa; parentheses indicate severely disturbed or destroyed habitats.

Communities	Islands						
	Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose Atoll	Swains
Littoral strand	X	X	X	X	X	X	X
Rock strand	X	X	X	X	X		
Sand strand	X	X	X	X	X	X	X
Littoral scrub	X	X	X	X	X		X
<i>Wedelia</i> subcommunity	X	X	X	X	X		
<i>Scaevola</i> subcommunity	X	X	X	X	X		X
<i>Sophora</i> subcommunity	X	X	X				
<i>Caesalpinia-Gossypium</i> subcommunity		X					
Coastal marsh	(X)	X	(X)	(X)	(X)		X
Mangrove forest	X	X					
Littoral forest	X	X	X	X	X	X	X
<i>Pandanus</i> subcommunity	X	X			X		
<i>Pisonia</i> subcommunity						X	
<i>Barringtonia</i> subcommunity	X	X					
Mixed littoral subcommunity	X	X	X	X	X		X
Coastal forest	X	X	X	X	X		
Tropical rain forest	X		X	X	X		
Lowland rain forest	X		X	(X)	X		
Montane rain forest	X		X	X	X		
Ridge forest	X						
Cloud forest				X	X		
Montane scrub	X				X		
Cultivated land	X	X	X	X	X		X
Village land	X	X	X	X	X		X
Plantation land	X	X	X	X	X		X
Pasture land	X						
Kula fernland	X						
Secondary forest	X	X	X	X	X		

Table 10. Species list of the amphibians and reptiles of American Samoa.

Class	Order	Family	Genus and species	English name	Samoan name
<i>Amphibia</i>					
Anura					
Bufonidae					
			<i>Bufo marinus</i>	Marine toad	lagi
<i>Reptilia</i>					
Chelonia					
Cheloniidae					
			<i>Chelonia agassizii</i>	Black turtle	laumei
			<i>Eretmochelys imbricata</i>	Hawksbill turtle	laumei
Sauria					
Gekkonidae					
			<i>Cyrtodactylus pelagicus</i>	Pelagic gecko	mo'o
			<i>Gehyra oceanica</i>	Polynesian gecko	mo'o
			<i>Hemidactylus frenatus</i>	House gecko	mo'o
			<i>Lepidodactylus lugubris</i>	Mourning gecko	mo'o
			<i>Peropus mutilatus</i>	Stump-toed gecko	mo'o
Scincidae					
			<i>Ablepharus boutonii</i>	Snake-eyed skink	pili
			<i>Emoia adspersa</i>	Micronesian skink	pili
			<i>Emoia cyanura</i>	Azure-tailed skink	pili
			<i>Emoia lawesii</i>	Lawes skink	pili oua'
			<i>Emoia nigra</i>	Black skink	pili uli
			<i>Emoia samoensis</i>	Samoan skink	pili lape
			<i>Lipinia noctua</i>	Moth skink	pili
Serpentes					
Boidae					
			<i>Candoia bibroni</i>	Pacific boa	gata

Table 11. Major references to the herpetofauna of American Samoa, and new distributional records from the present study.

References	Species reported	Island
Wilkes (1845)	<i>Eretmochelys imbricata</i>	Rose Atoll
Girard (1858)	<i>Eretmochelys imbricata</i>	Rose Atoll
Graeffe (1873)	<i>Chelonia agassizii</i>	Rose Atoll
Mayor (1921)	<i>Lepidodactylus lugubris</i>	Rose Island
Burt and Burt (1932)	<i>Cryptoblepharus boutonii</i>	Olosega
	<i>Emoia lawesii</i> (erroneously reported as <i>E. adspersa</i>)	Olosega
	<i>Emoia nigra</i>	Olosega
	<i>Gehyra oceanica</i>	Tutuila
	<i>Cryptoblepharus boutonii</i>	Tutuila
	<i>Emoia cyanura</i>	Tutuila
	<i>Emoia nigra</i>	Tutuila
	<i>Emoia samoense</i>	Tutuila
	<i>Lepidodactylus lugubris</i>	Tutuila
	<i>Emoia nigra</i>	Ta'ū
	<i>Emoia samoense</i>	Ta'ū
G.A.S. (1953)	<i>Bufo marinus</i>	Tutuila
Sachet (1954)	<i>Eretmochelys imbricata</i>	Rose Atoll
	<i>Chelonia agassizii</i>	Rose Atoll
	<i>Lepidodactylus lugubris</i>	Rose Island
Clapp (1968)	<i>Emoia cyanura</i>	Swains Island
	<i>Emoia adspersa</i> (erroneously reported as <i>E. nigra</i>)	Swains Island
	<i>Gehyra oceanica</i>	Swains Island
	<i>Lepidodactylus lugubris</i>	Swains Island
Additions from the present study (but note unreported collections and erroneously reported collections, Table 12)	<i>Bufo marinus</i>	Aunu'u
	<i>Cryptoblepharus boutonii</i>	Ta'ū
	<i>Emoia lawesii</i>	Olosega, Ta'ū (questionable on Ofu)
	<i>Emoia cyanura</i>	Ofu, Olosega, Ta'ū, Aunu'u
	<i>Emoia adspersa</i>	Swains
	<i>Emoia nigra</i>	Aunu'u, Ofu
	<i>Lipinia noctua</i>	All islands (except Rose)
	<i>Gehyra oceanica</i>	All islands (except Tutuila and Swains)
	<i>Lepidodactylus lugubris</i>	All islands (except Tutuila, Rose, and Swains)
	<i>Cyrtodactylus pelagicus</i>	Tutuila, Ta'ū
	<i>Hemidactylus frenatus</i>	Tutuila
	<i>Peropus mutilatus</i>	Ta'ū, Olosega, Swains (questionable on Ofu, Tutuila, and Aunu'u)
	<i>Candoia bibroni</i>	Ta'ū
	<i>Chelonia agassizii</i>	All islands (except Rose)
	<i>Eretmochelys imbricata</i>	Tutuila

Table 12. Summary of distribution of amphibians and reptiles on the islands of American Samoa. S, specimen taken in this study; s, other specimens taken; r, reported but no specimens; F, distributional record first reported in this paper.

Species	Island						
	Tutuila	Aunu'u	Ta'u	Ofu	Olosega	Swains	Rose
<i>Bufo marinus</i>	S, s, F	S, F					
<i>Chelonia agassizi</i>	r, F	r, F	r, F	r, F	r, F	r, F	r
<i>Eretmochelys imbricata</i>	r, F						r
<i>Cyrtodactylus pelagicus</i>	S, F		S, s, F				
<i>Gehyra oceanica</i>	S, s	S	S	S	S	S, s	S, F
<i>Hemidactylus frenatus</i>	S, F						
<i>Lepidodactylus lugubris</i>	S, s	S, F	S, F	S, F	S, F	S, s	S, s
<i>Peropus mutilatus</i>	r?	r?	S, F	r?	S, F	S, F	
<i>Ablepharis boutonii</i>	S, s		s, F		S, s		
<i>Emoia adspersa</i>						S, s, F	
<i>Emoia cyanura</i>	S	S, F	S, F	S, F	S, s	S, s, F	
<i>Emoia lawesii</i>			S, F	r?, F	S, s ¹ , F		
<i>Emoia nigra</i>	S, s	S, F	S, s	S, F	S, s	²	
<i>Emoia samoense</i>	S, s		S, s				
<i>Lipinia noctua</i>	S, F	S, F	s, F	S, F	S, F	S, F	
<i>Candoia bibroni</i>			S, s, F				

¹Tail only.

²Erroneously reported in past literature.

³Earlier specimens were reported as *E. adspersa*.

Table 13. Size and ecological distribution of the terrestrial herpetofauna of American Samoa.

Adult total length (cm)	Species	Behavior/habits	Habitat
8.4	marine toad	Nocturnal/terrestrial	All habitats, rare in forests and at higher elevations
12.1	black skink	Diurnal/terrestrial	Open second growth, plantations
11.4	Samoan skink	Diurnal/semi-arboreal	Second growth, forest edge, cloud forest (Ta'u)
10.4	Lawes skink	Diurnal/semi-fossorial	Littoral forest
8.6	Micronesian skink	Diurnal/semi-fossorial	Littoral forest
5.1	azure-tailed skink	Diurnal/terrestrial	Human settlements, plantations, forest edge, second growth.
4.4	snake-eyed skink	Diurnal/terrestrial	Littoral scrub, rock strand
4.4	moth skink	Diurnal/secretive (under tree bark)	Forests, plantations, second growth
8.6	Polynesian gecko	Nocturnal/trees, rocks, buildings	Human settlements, forests
7.0	pelagic gecko	Nocturnal/semi-fossorial (rocks)	Littoral forest
5.7	house gecko	Nocturnal/buildings (single locality)	Human settlements (Tutuila)
4.8	stump-toed gecko	Nocturnal/buildings (churches)	Human settlements
4.1	mourning gecko	Nocturnal/crepuscular (trees, rocks, and buildings)	Human settlements, second growth, forests
115.7	Pacific boa	Diurnal-nocturnal/terrestrial-arboreal	Littoral forest, plantations

Table 14. Occurrence (+) of amphibians and reptiles in vegetation community types in American Samoa.

Species	Natural communities										Disturbed communities					Total	
	At sea	Littoral strand	Littoral scrub	Coastal marsh	Mangrove forest	Littoral forest	Coastal forest	Rain forest	Ridge forest	Montane scrub	Cloud forest	Village land	Plantation land	Pasture land	Kula fernland		Secondary forest
marine toad		+	+	+	+	+	+	+	+			+	+	+		+	12
black turtle	+	+															2
hawksbill turtle	+	+															2
snake-eyed skink		+	+														2
Micronesian skink						+							+				2
azure-tailed skink			+	+	+	+		+	+	+		+	+	+	+	+	12
Lawes skink						+											1
black skink		+	+	+	+	+	+	+	+	+			+	+		+	12
Samoan skink					+	+	+	+	+		+		+	+		+	9
moth skink						+		+					+			+	4
pelagic gecko						+						+					2
Polynesian gecko					+	+	+	+	+			+	+				7
house gecko												+					1
mourning gecko		+			+	+	+					+					5
stump-toed gecko												+					1
Pacific boa						+							+				2
Total	2	6	4	3	6	11	5	6	5	2	1	7	8	4	1	5	

Table 15. *Densities (no./100 m²) and rounded population estimates of the marine toad and seven lizards in selected vegetation community (habitat) types on the islands of American Samoa. Population estimates are based on habitat acreage and species distribution.*

Species	Community type					
	Mangrove forest		Mangrove forest edge		Littoral forest	
	Density	Pop. est.	Density	Pop. est.	Density	Pop. est.
Marine toad ^b			4.0	53,700	1.0	13,400
Micronesian skink ^d					+	
Azure-tailed skink	0.0 ^b		10.0 ^e	134,400	9.1 ^f	289,000
Black skink	0.8 ^b	6,800	1.5 ^b	20,200	2.44 ^l	90,500
Samoan skink	0.2 ^b	1,700	1.33 ^b	17,900	0.95 ^o	105,100
Polynesian skink			2.0 ^b	26,900	12.0 ^r	184,700
Mourning gecko					2.3 ^t	52,200
Moth skink					1.0 ^d	22,500
Total ^v	1.0	8,500	18.83	253,000	30.49	638,200

Species	Community type					
	Coastal forest		Ridge and rain forest		Cloud forest ^a	
	Density	Pop. est.	Density	Pop. est.	Density	Pop. est.
Marine toad ^b			0.1	38,000		
Micronesian skink						
Azure-tailed skink	3.13 ^g	289,000	0.75 ^h	386,000		
Black skink	0.98 ^m	90,500	0.3 ^m	154,400		
Samoan skink	1.55 ^o	105,100	0.4 ^o	202,600	1.0 ^p	48,000
Polynesian skink	2.0 ^b	184,700				
Mourning gecko						
Moth skink						
Total	7.66	669,300	1.55	781,000	1.0	48,000

Species	Community type					
	Secondary forest		Montane scrub		Coastal marsh	
	Density	Pop. est.	Density	Pop. est.	Density	Pop. est.
Marine toad ^b						
Micronesian skink						
Azure-tailed skink			3.0 ^b	45,800	0.6 ⁱ	600
Black skink			1.0 ^b	15,300	0.0 ⁱ	
Samoan skink	2.0 ^o	759,600	0.0 ^b			
Polynesian skink						
Mourning gecko						
Moth skink						
Total	2.0	759,600	4.0	61,000	0.6	600

Table 15. Continued

	Community type			
	Littoral scrub		Plantation land	
	Density	Pop. est.	Density	Pop. est.
Marine toad ^b			4.5	2,190,800 ^e
Micronesian skink			1.7	35,300
Azure-tailed skink	6.7 ^j	45,800	19.3 ^k	13,053,900
Black skink	2.6 ⁿ	17,400	2.8 ^l	1,835,700
Samoan skink	0.0 ^b		2.8 ^b	1,659,000 ^q
Polynesian skink	1.0 ^b	6,800	8.3 ^s	5,613,800
Mourning gecko			7.8 ^l	5,275,700
Moth skink			1.75 ^u	1,183,600
Total	10.3	70,000	47.25	30,847,800

Species	Community type		Total population estimate ^v
	Rain and ridge forest edge		
	Density	Pop. est.	
Marine toad ^b			2,296,000
Micronesian skink			35,300
Azure-tailed skink	8.5 ^b	3,379,700	17,540,300
Black skink	2.4 ^b	954,300	3,149,400
Samoan skink	2.0 ^b	759,600	3,571,000
Polynesian skink			6,104,700
Mourning gecko			5,327,900
Moth skink	1.5 ^b	596,400	1,802,600
Total	14.4	5,690,000	36,992,700

+ Indicates species present, but not collected

a Ta'ū only

b Tutuila only

c Based on area of littoral forest

d Swains Island only

e Tutuila and Aunu'u only

f Tutuila, Olosega, Nu'utele, Ta'ū

g Tutuila, Ofu, Ta'ū

h Tutuila, Ofu

i Aunu'u only

j Tutuila, Ofu, Olosega

k Tutuila, Aunu'u, Ofu, Ta'ū, Swains

l Tutuila, Aunu'u, Ofu, Olosega, Ta'ū

m Tutuila, Ofu, Olosega, Ta'ū

n Tutuila, Olosega

o Tutuila, Ta'ū

p Single specimen observed on Lata Mt., Ta'ū (900 m.)

q Only if trees are present

r Tutuila, Rose

s Tutuila, Aunu'u, Ofu, Olosega, Ta'ū, Swains

t Tutuila, Aunu'u, Rose

u Aunu'u, Ofu, Olosega, Swains

v Totals were calculated before rounding estimates for each habitat

Table 17. Summary of distribution of birds on the islands of American Samoa. S, specimen taken in this study; s, other specimens taken; r, reported but no specimens; F, distributional record first reported in this paper.

Species	At sea	Tutuila	Aunu'u	Ta'u	Ofu	Olosega	Rose	Swains
White-necked petrel	r, F							
Tahiti petrel	r, F			S, s, F				
Collared petrel	r			r, F				
Slender-billed shearwater	r							
Wedge-tailed shearwater	r	r?		r?				
Christmas shearwater	r, F			r, F				
Audubon's shearwater	r			r, F				
White-throated storm-petrel ^a	r	r		r, F				
Red-tailed tropicbird	r						r	s
White-tailed tropicbird	r	S, s	r, F	r	r, F	r, F	r, F	s
Blue-faced booby	r						r	
Brown booby	r	r	r, F	r, F	S, F	r, F	s	r
Red-footed booby	r	r	r, F	r, F	S, F	r, F	r	s
Great frigatebird ^b	r	r	r, F	r, F	r, F	r, F	r	r
Lesser frigatebird	r	r	r, F	r, F	r, F	r, F	r, F	r, F
Cattle egret		r, F						
Reef heron		s	r, F	S, F	S, s	r, s	S, s	r
Australian gray duck		r, s	r, s	r, F	r, F	r, F		r
Banded rail		S, s	r, F	s	s	s		
Sooty rail				s				
Purple swamphen		S, s	s	s	S, s	s		
Golden plover		S, s	r, F	r, F	r, F	s	s	S, s
Ruddy turnstone		r	r, F	r, F	S, F	s	s	s
Bristle-thighed curlew		r		r, F			s	r
Bar-tailed godwit		s					r	
Wandering tattler		s	r, F	r	r, F	S, s	s	S
Sanderling		r, F					r, F	s
Black-naped tern	r						s	r
Gray-backed tern	r	r, F	r, F				r, F	
Brown-winged tern	r, F	s, F						
Sooty tern	r	r, F					s	r
Crested tern	r, F	r, F						
Blue-gray noddy	r	S, s	r, F	r, F	r, F	r, F		
Brown noddy	r	S	r, F	r	r, F	r, F	s	S, s
Black noddy	r	r	r, F	S, F	r, F	r, F	r, F	S, s
White tern	r	S, s	r, F	r	r, F	r, F	r	S, s
Rock dove		r, F						
Many-colored fruit dove		S, s		s	s	s		
Crimson-crowned fruit dove		S, s	r, F	S, s	s	s		
Pacific pigeon		S, s	r	S, s	s	s		
Friendly quail dove					S, F	r, F		
Blue-crowned lory				S, s	S, s	s		
Long-tailed cuckoo		s	s	S, s	s	s	S, F	s
Barn owl		s	r	S, s	S, s	s		
White-rumped swiftlet		s	r, F	r	S, F	r, F		
White-collared kingfisher		S, s	r	S, s	S, s	S, s		
Red-vented bulbul		S, s						
Fiji shrikebill				S, s	s	s		
Mao		r						
Wattled honey-eater		S, s	r, F	S, s	S, s	S, s		
Cardinal honey-eater		S, s						
Polynesian starling		S, s	r, F	S, s	s	r		
Samoa starling		S, s	r, F	r	r	S, s		

^a One specimen from unspecified island in American Samoa.

^b Specimens reported from unspecified island(s), perhaps Western Samoa.

Table 18. Status of birds on and around the islands of American Samoa. B = breeder; R = recorded; ? = status questionable. Capital letters indicate status during this study; lower case letters indicate status prior to June 1975, if different than at present.

Species	Islands						
	Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	Swains
Seabirds							
<i>Resident Breeders</i>							
Tahiti petrel					B		R
Collared petrel					B		R
Wedge-tailed shearwater	B?						R
Christmas shearwater					B		R
Audubon's shearwater					B		R
White-throated storm-petrel	B?				B?		R
Red-tailed tropicbird						B	r R
White-tailed tropicbird	B	B	B	B	B	B	B R
Blue-faced booby						B	R
Brown booby	B	B	B	B	R	B	R R
Red-footed booby	B	R	R,b	R	R	B	R R
Great frigatebird	B?	R	R	R	R	B	R R
Lesser frigatebird	B?	R	R	R	R	B	R R
Gray-backed tern	B	B				B	R
Sooty tern	R					B	r R
Blue-gray noddy	B	B	B	B	B		R
Brown noddy	B	B	B	B	B	B	B R
Black noddy	B	R	R	R	B	B	B R
White tern	B	B	B	B	B	B	B R
<i>Migrants</i>							
White-necked petrel							R
Slender-billed shearwater							R
<i>Visitors</i>							
Black-naped tern						r	r r
Brown-winged tern							r
Crested tern	R						r
Waterfowl, Marsh, and Land Birds							
<i>Resident Breeders</i>							
Reef heron	B	B	B	B	B	B	B
Australian gray duck	R	R,b	r	r	r		r
Banded rail	B	B	B	B	B		
Sooty rail							b
Purple swampphen	B	B	B	B	B		
Samoan wood rail	b?						
Many-colored fruit dove	B	b	b	b	b		
Crimson-crowned fruit dove	B	B	B	B	B		
Pacific pigeon	B	b	B	B	B		
Friendly quail dove			B?	B?			
Blue-crowned lory			B	B	B		
Barn owl	B	B	B	B	B		
White-rumped swiftlet	B	B?	B	B	B		
White-collared kingfisher	B	B	B	B	B		
Fiji shrikebill			b	b	B		
Mao	b						
Wattled honey-eater	B	B	B	B	B		
Cardinal honey-eater	B						
Polynesian starling	B	B	B	B	B		
Samoan starling	B	B	B	B	B		
<i>Migrants</i>							
Golden plover	R	R	R	R	R	R	R
Ruddy turnstone	R	R	R	R	R	R	R
Bristle-thighed curlew	R					R	R R
Bar-tailed godwit	R						r
Wandering tattler	R	R	R	R	R	R	R
Sanderling	R					R	r
Long-tailed cuckoo	R	R	R	R	R	R	R
<i>Visitors</i>							
Cattle egret	r						
<i>Introductions</i>							
Rock dove	B?						
Red-vented bulbul	B						
<i>Resident Breeders</i>	27	19	21	20	25	13	5
<i>Potential Breeders</i>	2	4	4	5	5	1	8
<i>Migrants and Visitors</i>	9	4	4	4	5	7	6
<i>Introductions</i>	2	0	0	0	0	0	0
<i>Total Species</i>	40	27	29	29	35	21	24

Table 19. Endemic genera (G), species (S), and subspecies (ss) of birds found in American Samoa and Western Samoa.

Scientific names	American and		
	Western Samoa	American Samoa	Western Samoa
<i>Gallirallus philippensis goodsoni</i>			SS
<i>Porphyrio porphyrio samoensis</i>			SS
<i>Pareudiastes pacificus</i>			G,S
<i>Columba vitiensis castaneiceps</i>	SS		
<i>Gallicolumba stairi stairi</i>			SS
<i>Didunculus strigirostris</i>	G,S		
<i>Ptilinopus perousii perousii</i>			SS
<i>Ptilinopus prophyraceus fasciatus</i>			SS
<i>Collocalia spodiopygia</i>			
<i>spodiopygia</i>			SS
<i>Halcyon recurvirostris</i>	S		
<i>Halcyon chloris manuae</i>		SS	
<i>Halcyon chloris pealei</i>		SS	
<i>Lalaga maculosa maculosa</i>	SS		
<i>Lalaga sharpei sharpei</i>	S,SS		
<i>Lalaga sharpei tenebrosa</i>	SS		
<i>Turdus poliocephalus samoensis</i>	SS		

Table 19. Continued

Scientific names	Western Samoa	American Samoa	American and Western Samoa
<i>Petroica multicolor pusilla</i>	ss		
<i>Clytorhynchus vitiensis powelli</i>		ss	
<i>Myiagra albigentris</i>	S		
<i>Rhipidura nebulosa nebulosa</i>	S,ss		
<i>Rhipidura nebulosa altera</i>	ss		
<i>Pachycephala flavifrons</i>	S		
<i>Zosterops samoensis</i>	S		
<i>Myzomela cardinalis nigriventris</i>			ss
<i>Gymnomyza samoensis</i>			S
<i>Erythrura cyaneovirens</i>			
<i>cyaneovirens</i>	ss		
<i>Erythrura cyaneovirens gaughrani</i>	ss		
<i>Aplonis atrifusca</i>			S
<i>Aplonis tabuensis brevirostris</i>	ss		
<i>Aplonis tabuensis tutuilae</i>		ss	
<i>Aplonis tabuensis manuae</i>		ss	
Totals	1 G 7 S 11 ss		1 G 3 S 7 ss

Table 20. Occurrence (+) of bird species in vegetation communities type in American Samoa.

[illegible]

Table 20. Continued.

Species	Natural communities											Disturbed communities					Total
	At sea	Littoral strand	Littoral scrub	Coastal marsh	Mangrove forest	Littoral forest	Coastal forest	Rain forest	Ridge forest	Montane scrub	Cloud forest	Village land	Plantation land	Pasture land	Kula fernland	Secondary forest	
Golden plover		+										+					2
Ruddy turnstone		+										+					2
Bristle-thighed curlew		+										+					2
Bar-tailed godwit		+															1
Wandering tattler		+										+					2
Sanderling		+															1
Black-naped tern	+	+															2
Gray-backed tern	+	+															2
Brown-winged tern	+																1
Sooty tern	+	+															2
Crested tern	+																1
Blue-gray noddy	+																1
Brown noddy	+	+				+	+	+	+							+	7
Black noddy	+					+	+										3
White tern	+					+		+								+	4
Rock dove												+					1
Many-colored fruit dove							+										1
Crimson-crowned fruit dove							+	+	+				+	+		+	6
Pacific pigeon							+	+	+				+	+		+	6
Friendly quail dove							+						+				2
Blue-crowned lory						+	+	+	+	+	+	+	+			+	9
Long-tailed cuckoo		+	+	+	+	+	+					+	+	+	+	+	11
Barn owl		+	+	+	+	+	+					+	+	+	+	+	11
White-rumped swiftlet		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	15
White-collared kingfisher		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	15
Red-vented bulbul												+	+	+		+	4
Fiji shrikebill								+								+	2
Mao								+									1
Wattled honey-eater		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	15
Cardinal honey-eater		+	+	+	+	+	+	+	+			+	+	+		+	12
Polynesian starling			+	+	+	+	+	+	+	+	+					+	10
Samoan starling		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	15
Total	24	21	10	12	11	20	18	18	13	9	9	16	15	12	6	18	

Table 21. *Habitat utilization by seabirds in American Samoa*
(P = *primary habitat*; S = *secondary habitat*;
? = *questionable status*).

Species	Nesting							Feeding		
	Atoll island			Volcanic island				Coastal	Offshore	Pelagic
	Ground	Shrub	Tree	Ground	Cliff	Shrub	Tree			
White-necked petrel										P
Tahiti petrel				P					S	P
Collared petrel					P				S	P
Slender-billed shearwater										P
Wedge-tailed shearwater				P	S				S	P
Christmas shearwater				P	S				S	P
Audubon's shearwater				P					S	P
White-throated storm-petrel					P				S	P
Red-tailed tropicbird	P								S	P
White-tailed tropicbird			P				P		S	P
Blue-faced booby	P								P	S
Brown booby	P				P				P	S
Red-footed booby		P	P			P	P		P	S
Great frigatebird			P				?		P	S
Lesser frigatebird			P				?		P	S
Black-naped tern								P		
Gray-backed tern	P				P				P	
Brown-winged tern									P	
Sooty tern	P								S	P
Crested tern								P		P
Blue-gray noddy					P				P	
Brown noddy	P	S		S	S	P			P	S
Black noddy			P				P		P	S
White tern		S	P	P	S	P			P	S

Table 22. *Habitat preference and food of waterfowl, marsh, and land birds in American Samoa. P = primary island type, feeding habitat, or food source; S = secondary island type, feeding habitat, or food source.*

Species	Island type		Feeding habitat				Food source									
							Plants				Animals					
	Atoll	Volcanic	Littoral	Ground	Trees	Air	Nectar	Seeds	Fruits	Stems and tubers	Insects	Other invertebrates	Fish	Reptiles	Birds or eggs	Mammals
Reef heron	P	P	P	S								S	P			
Australian gray duck	S	P	P					P				S				
Banded rail		P	P	P							P					
Sooty rail		P	P	P							P					
Purple swampphen		P	P	P	S				P	P	S					
Samoan wood rail		P		P							P					
Golden plover	P	P	P	S							P	S			S	
Ruddy turnstone	P	P	P	S							P	S			S	
Bristle-thighed curlew	P	P	P	S							P	P			S	
Bar-tailed godwit	P	P	P	S							S	P				
Wandering tattler	P	P	P	S							S	P				
Sanderling	P	P	P	S							S	P			S	
Rock dove		P		P				P								
Many-colored fruit dove		P			P				P							
Crimson-crowned fruit dove		P			P				P							
Pacific pigeon		P			P				P							
Friendly quail dove		P		P				P			S					
Blue-crowned lory		P			P		P									
Long-tailed cuckoo	P	P		S	P						P			S		
Barn owl		P		P	S						S			S	S	P
White-rumped swiftlet		P				P					P					
White-collared kingfisher		P	S	P							P		S	S		
Red-vented bulbul		P		S	P	S					P					
Fiji shrikebill		P			P	S					P					
Mao		P			P		P									
Wattled honey-eater		P			P		P				S					
Cardinal honey-eater		P			P		P									
Polynesian starling		P			P				P		S					
Samoan starling		P			P				P		S					
Totals																
Primary	8	29	11	8	12	1	4	3	6	1	11	4	1	0	0	1
Secondary	1	0	1	9	2	2	0	0	0	0	9	4	1	3	5	0
Grand total	9	29	12	17	14	3	4	3	6	1	20	8	2	3	5	1

Table 23. Population estimates and counts of seabirds on the islands of American Samoa, summarized from colony observations. Final total is rounded. Four species with very small or unknown populations are not listed.

Species	Islands							Rounded totals
	Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	Swains	
Tahiti petrel					500			500
Collared petrel					1,000			1,000
Christmas shearwater					200			200
Audubon's shearwater					200			200
Red-tailed tropicbird						40		40
White-tailed tropicbird	2,000	10	200	500	1,000	2	2	3,700
Blue-faced booby						540		540
Brown booby	270	35	75	50	2	1,000	2	1,400
Red-footed booby	500	10	25	10	4	3,500	2	4,000
Great frigatebird	25	3	10	2	4	750	5	800
Lesser frigatebird	10	1	3	1	1	425	3	450
Gray-backed tern	125	32				14		175
Sooty tern	5					300,000	3	300,000
Blue-gray noddy	150	12	15	10	5			200
Brown noddy	5,000	100	500	250	10,000	3,700	2,000	21,550
Black noddy	200	5	10	6	5,000	2,000	300	7,500
White tern	3,000	50	100	75	1,000	550	3,000	7,800
Totals	11,285	258	938	904	18,916	312,521	5,317	350,000

Table 24. Densities (birds/0.2 ha) and rounded population estimates of waterfowl, marsh, and land birds in the vegetation community (habitat) types of the islands of American Samoa. Density figures are yearly means from 35 study plots; figures for "Plantation land (other islands)" are estimates based on data obtained for "Secondary forest." Population estimates are based on habitat acreages and species distribution. Species diversity, $H_T = 1/\sum p_i^2$ (where p_i is the proportion of all individuals of species i).

Species	Mangrove forest		Littoral forest		Coastal forest	
	Density	Pop. est.	Density	Pop. est.	Density	Pop. est.
Reef heron			3.6	4,000		
Australian gray duck						
Banded rail	2.0	900	1.0	1,100		
Purple swamphen	1.5	700				
Golden plover			2.2	2,500		
Ruddy turnstone			0.5	550		
Wandering tattler	0.5	200	0.6	700		
Crimson-crowned fruit dove	1.0	450			2.5	11,400
Pacific pigeon					1.0	4,600
Friendly quail dove						
Blue-crowned lory					3.0	6,200 ^b
Long-tailed cuckoo			1.0	1,100	1.0	4,600
Barn owl						
White-rumped swiftlet	3.0	1,300	2.0	2,200	2.7	12,300
White-collared kingfisher	10.0	4,500	3.0	3,400	1.0	4,600
Red-vented bulbul	1.0	400				
Fiji shrikebill						
Wattled honey-eater	18.5	8,300	2.7	3,000	6.3	28,800
Cardinal honey-eater	12.5	5,300 ^d				
Polynesian starling			0.1	100		
Samoan starling	3.5	1,600	1.4	1,600	2.3	10,500
Total	55.0	23,650	18.1	20,250	19.8	83,000
Species richness	10.0		12.0		9.0	
Species diversity	4.80		6.03		5.56	

Table 24. Continued

Species	Ridge and rain forest		Cloud forest		Secondary forest	
	Density	Pop. est.	Density	Pop. est.	Density	Pop. est.
Reef heron						
Australian gray duck						
Banded rail						
Purple swampphen						
Golden plover						
Ruddy turnstone						
Wandering tattler						
Crimson-crowned fruit dove	5.0	127,200			3.6	70,700
Pacific pigeon	1.1	28,000			1.3	25,500
Friendly quail dove	0.3	100 ^a				
Blue-crowned lory	1.3	8,600 ^b	1.8	4,300 ^b	2.3	8,700
Long-tailed cuckoo					1.0	19,600
Barn owl					1.0	19,600
White-rumped swiftlet	2.8	71,200			5.0	98,300
White-collared kingfisher	2.2	56,000			1.5	29,500
Red-vented bulbul					3.0	47,600
Fiji shrikebill					1.5	4,400 ^c
Wattled honey-eater	9.3	236,500	2.0	4,800	5.0	98,300
Cardinal honey-eater	1.8	33,800 ^d			2.0	31,700 ^d
Polynesian starling	1.4	35,600	1.0	2,400	1.3	25,500
Samoan starling	4.9	124,600	2.5	6,000	3.6	70,700
Total	30.1	721,600	7.3	17,500	32.1	550,100
Species richness	11.0		4.0		13.0	
Species diversity	5.79		3.68		9.90	

Species	Montane scrub		Coastal marsh		Littoral scrub		Kula fernland	
	Density	Pop. est.	Density	Pop. est.	Density	Pop. est.	Density	Pop. est.
Reef heron								
Australian gray duck			0.6	35				
Banded rail			0.5	30				
Purple swampphen			0.3	20				
Golden plover								
Ruddy turnstone								
Wandering tattler								
Crimson-crowned fruit dove			2.8	200				
Pacific pigeon								
Friendly quail dove								
Blue-crowned lory	1.0	350 ^b						
Long-tailed cuckoo								
Barn owl								
White-rumped swiftlet			0.5	30	6.5	2,200		
White-collared kingfisher					1.0	350	1.0	5
Red-vented bulbul								
Fiji shrikebill								
Wattled honey-eater	1.0	750	1.0	60	9.0	3,000	2.0	10
Cardinal honey-eater								
Polynesian starling	1.0	750						
Samoan starling	2.5	1,900	1.4	100	2.5	800	1.0	5
Total	5.5	3,750	7.1	475	19.0	6,350	4.0	20
Species richness	4.0		7.0		4.0		3.0	
Species diversity	3.27		4.29		2.77		2.67	

Table 24. *Continued*

Species	Plantation land (Swains)		Plantation land (other islands)		Total Pop. est.	Percent of est. total population
	Density	Pop. est.	Density	Pop. est.		
Reef heron					4,000	0.182
Australian gray duck					35	0.002
Banded rail					2,030	0.093
Purple swamphen					720	0.031
Golden plover	2.0	2,000			4,500	0.204
Ruddy turnstone					550	0.025
Wandering tattler					900	0.041
Crimson-crowned fruit dove			3.6	116,600	326,550	14.737
Pacific pigeon					58,100	2.621
Friendly quail dove					100	0.005
Blue-crowned lory			2.3	19,200	47,350	2.140
Long-tailed cuckoo	1.0	1,000			26,300	1.190
Barn owl					19,600	0.887
White-rumped swiftlet			5.0	162,000	349,530	15.776
White-collared kingfisher			1.5	48,600	146,955	6.625
Red-vented bulbul			3.0	70,900	118,900	5.364
Fiji shrikebill					4,400	0.197
Wattled honey-eater			5.0	162,000	545,520	24.620
Cardinal honey-eater			2.0	47,300 ^d	118,100	5.326
Polynesian starling			1.3	42,100	106,450	4.808
Samoan starling			3.6	116,600	334,405	15.094
Total	3.0	3,000	27.3	785,300	2,214,995	99.999
Species richness	2.0		9.0		21	
Species diversity	1.80		7.59			

^a Ofu, Olosega, and Ta'ū only^b Tutuila only^c Ta'ū only^d Ofu and Olosega only

Table 25. Abundance (birds/km) of waterfowl, marsh, and land birds on each of the five main islands of American Samoa, summarized from data obtained from 98 linear surveys.

Species	Islands					Overall
	Tutuila	Aunu'u	Ofu	Olosega	Ta'ū	
Reef heron	0.13	0.68	0.64	0.47	0.17	0.26
Australian gray duck		0.13				0.01
Banded rail	0.91	1.17	0.81	0.46	1.20	0.95
Purple swamphen	0.20	0.39	0.04		0.21	0.19
Golden plover	0.84	0.78	0.47	0.45	0.02	0.61
Ruddy turnstone	0.30		0.08			0.18
Bristle-thighed curlew	0.03					0.01
Bar-tailed godwit	0.03					0.01
Wandering tattler	0.35	1.28	0.02	0.33	0.07	0.33
Sanderling	0.004					0.002
Rock dove	0.004					0.002
Many-colored fruit dove	0.31					0.17
Crimson-crowned fruit dove	3.14	0.77	1.88	2.07	3.00	2.73
Pacific pigeon	0.65		0.51	0.48	0.84	0.61
Friendly quail dove			0.06			0.01
Blue-crowned lory			2.65	2.24	2.37	0.89
Long-tailed cuckoo	0.05	0.89	0.04	0.05	0.01	0.11
Barn owl	0.02		0.01		0.18	0.05
White-rumped swiftlet	4.23	1.24	4.02	2.55	4.09	3.83
White-collared kingfisher	2.25	0.69	2.12	1.01	1.74	1.93
Red-vented bulbul	1.76					0.97
Fiji shrikebill					0.04	0.01
Wattled honey-eater	6.96	2.89	5.65	4.80	6.59	6.29
Cardinal honey-eater	1.89					1.04
Polynesian starling	0.38	0.12	0.09	0.32	0.71	0.39
Samoa starling	3.72	5.74	2.44	2.14	3.53	3.61
Totals	28.158	16.77	21.86	17.37	24.77	25.194

Table 26. Checklist of mammal species in American Samoa.

Table 26. Continued

Order			Order		
Family			Family		
Genus and species	English name	Samoan name	Genus and species	English name	Samoan name
Chiroptera			<i>Mus musculus</i>	house mouse	'isumu
Pteropidae			<i>Rattus rattus</i>	roof rat	'isumu
<i>Pteropus samoensis</i>	flying fox	pe'a	<i>Rattus norvegicus</i>	Norway rat	'isumu
Emballonuridae			<i>Rattus exulans</i>	Polynesian rat	'isumu
<i>Emballonura semicaudata</i>	sheath-tailed bat	pe'ape'avai	Artiodactyla		
Vespertilionidae			Suidae		
<i>Myotis insularum</i> ^a	mouse-eared bat		<i>Sus scrofa</i>	pig	pua'a
Rodentia					
Muridae					

^aUnauthenticated record.

Table 27. Mammal specimens, mammal distribution, and summary of new records from American Samoa (X = occurrence previously known; r = first sight record for an island; s = first specimen record for an island; S = first specimen record for American Samoa).

Species	Collected specimens		Distribution						
	Previous studies	Present study	Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose Atoll	Swains
Flying fox	20	9	X	r	s	X	X		
Sheath-tailed bat	12	3	s	r	r	r	X		
House mouse		2	S						
Roof rat	1	4	S	s	s				
Norway rat	3		X ^a						
Polynesian rat	17	26	s	s	X	s	X	X	X

^aNot found in this survey.

Table 28. Occurrence (+) of mammal species in vegetation community types in American Samoa.

Species	Natural communities								Disturbed communities					Total
	Littoral strand	Littoral scrub	Coastal marsh	Mangrove forest	Littoral forest	Coastal forest	Rain forest	Ridge forest	Village land	Plantation land	Pasture land	Kula fernland	Secondary forest	
Flying fox					+	+	+	+	+	+	+		+	8
Sheath-tailed bat	+	+	+	+	+	+	+	+	+	+	+	+	+	13
House mouse									+	+				2
Roof rat			+				+		+	+			+	5
Norway rat									+					1
Polynesian rat	+	+	+	+	+	+	+	+	+	+	+		+	12
Pig (feral)							+	+		+			+	4
Total	2	2	3	2	3	3	5	4	6	6	3	1	5	

Table 29. *Densities (mammal/0.3 ha) and rounded population estimates of rodents and bats in the vegetation community (habitat) types of the islands of American Samoa. Density figures are yearly means from 14 study plots. Population estimates are based on habitat acreages and species distribution.*

Habitat	Species									
	Polynesian rat		Roof rat		House mouse		Flying fox		Sheath-tailed bat	Total
	Density	Population estimate	Density	Population estimate	Density	Population estimate	Density	Population estimate	Population estimate	Density Population estimate
Mangrove forest									50	50
Littoral forest	39.039 ^a	29,200	0.287	160	0.143	60	0.818	600	130	40.286 30,150
Coastal forest	39.039 ^c	118,800					0.818	2,500	550	39.857 121,850
Rain and ridge forest	17.582 ^a	298,100	2.143	27,200			1.700	28,800	3,000	21.425 357,100
Secondary forest	37.156 ^b	486,700	1.750	18,850			3.000	39,300	2,350	41.906 547,200
Coastal marsh	7.688 ^b	1,000	1.000	75					25	8.688 1,100
Kula fernland									1	1
Littoral scrub	48.175 ^b	10,850							40	48.175 10,890
Plantation land (Swains)	20.572 ^a	14,100								20.572 14,100
Plantation land (other islands)	44.418 ^b	959,400	3.375	58,100			3.000	64,800	3,900	50.793 1,086,200
Pasture land	44.418 ^d	6,400					3.000	400	25	47.418 6,825
Village land	44.418 ^d	237,500	1.750	8,900	0.143	700	0.818	4,300	950	47.129 252,350
Total		2,162,050		113,285		760		140,700	11,021	2,427,816

^a Jolly (1965) method

^b Mammals/0.07 ha x 5.125

^c Estimated from littoral forest

^d Estimated from plantation land (other islands)

Table 30. Summary of characteristics of the ecosystems of the islands of American Samoa.

Ecosystems	Total area (ha)	Range of elevation (m)	Mean annual temperature (°C)	Soil moisture conditions	Soil types	Slope	Light at ground surface	Vegetation	
								Characteristic dominant species	No. of tree species in survey plots
Undisturbed (natural)									
Littoral strand	(combined with littoral forest)	0.3-6.1	26.1	Dry (saline)	Tafatafa and Fusi	Flat	Bright sunlight	<i>Fimbristylis cymosa</i> <i>Ipomoea pes-caprae</i> <i>Vigna marina</i> <i>Boerhavia</i> spp. <i>Portulaca</i> spp.	
Littoral scrub	68.4	0.3-121.9	26.1	Dry	Ma'asina	Flat to steep	Sunny	<i>Scaevola taccada</i> <i>Wedelia biflora</i> <i>Ficus scabra</i>	
Littoral forest	227.1	0.3-9.1	25.6	Dry	Fusi	Flat	Moderate shade	<i>Pisonia grandis</i> <i>Hernandia sonora</i> <i>Pandanus tectorius</i> <i>Barringtonia asiatica</i> <i>Calophyllum inophyllum</i>	17
Coastal marsh	12.5	0.3-6.1	26.1	Very wet	Lalovi	Flat	Bright sunlight	<i>Cyclosorus interruptus</i> <i>Eleocharis dulcis</i> <i>Acrostichum aureum</i>	
Mangrove forest	91.0	0.3-1.5	25.6	Very wet (saline)	Loga	Flat	Moderate shade	<i>Bruguiera gymnorhiza</i> <i>Rhizophora mangle</i>	1
Coastal forest	923.5	3.0-91.4	25.6	Moderate	Vini	Flat to steep	Heavy shade	<i>Syzygium clusiaefolium</i> <i>Diospyros samoensis</i> <i>Erthrina variegata</i> <i>Intsia bijuga</i>	46

Vegetation characteristics	Wildlife						Total vertebrate species
	Amphibians and reptiles		Birds		Mammals		
	Dominant species	Species richness ^a	Dominant species	Species richness ^b	Dominant species	Species richness ^j	
Low, scattered vegetation on coastal rocks and sand; succulents and creepers common.	marine toad black skink mourning gecko	6	Sooty Tern ^c Brown Noddy ^c Brown Booby ^c Blue-faced Booby ^c Golden Plover Wattled Honey-eater	21	Polynesian rat	2	29
Shrubs on sunny and/or windswept coastal areas.	snake-eyed skink azure-tailed skink black skink	4	Wattled Honey-eater White-rumped Swiftlet Samoan Starling White-collared Kingfisher	10	Polynesian rat	2	16
Open forest on the shore, often dominated by a single species; species dispersed by seawater flotation.	Micronesian skink azure-tailed skink Lawes skink black skink moth skink pelagic gecko mourning gecko	11	Brown Noddy Black Noddy White Tern Red-footed Booby ^c Reef Heron White-collared Kingfisher Wattled Honey-eater Golden Plover White-rumped Swiftlet	20	flying fox sheath-tailed bat Polynesian rat	3	34
Fresh to brackish water marshes on the coast; dominated by ferns and sedges.	marine toad azure-tailed skink	3	Crimson-crowned Fruit Dove Samoan Starling Wattled Honey-eater Australian Gray Duck	12	Polynesian rat	3	18
Brackish to salt water swamps on the coasts; dominated by large mangroves.	marine toad azure-tailed skink	6	Wattled Honey-eater Cardinal Honey-eater ^d White-collared Kingfisher	11		2	19
Open forest on islets and slopes near the shore; ground cover, vines, and epiphytes light.		5	Wattled Honey-eater Blue-crowned Lory ^e White-rumped Swiftlet Pacific Pigeon Samoan Starling	18	flying fox sheath-tailed bat Polynesian rat	3	26

Vegetation									
Ecosystems	Total area (ha)	Range of elevation (m)	Mean annual temperature (°C)	Soil moisture conditions	Soil types	Slope	Light at ground surface	Characteristic dominant species	No. of tree species in survey plots
Lowland rain forest	(combined with montane rain forest)	3,030-4,008	23.3-25.0	Moderate	Togiogi and Papaloa	Flat to moderate	Moderate shade	<i>Dysoxylum samoense</i> <i>Planchonella torricellensis</i> <i>Myristica fatua</i> <i>Neonauclaea forsteri</i> <i>Pometia pinnata</i>	62
Montane rain forest	5,146.4	304.8-670.6	21.7-23.3	Wet	Lata	Flat to moderate	Heavy shade	<i>Dysoxylum huntii</i> <i>Myristica hypergyraea</i> <i>Canarium samoense</i> <i>Calophyllum samoense</i>	60
Ridge forest	(combined with montane rain forest)	15.2-548.6	21.7-25.6	Moderate	Lata and Papaloa	Moderate to steep	Moderate shade	<i>Syzygium inophyllioides</i> <i>Planchonella lingenensis</i> <i>Crossostylis biflora</i> <i>Myristica hypergyraea</i> <i>Dysoxylum huntii</i>	77
Cloud forest	487.7	548.6-944.9	19.4-21.7	Very wet	Tiavī(?)	Flat to moderate	Moderate shade but usually in cloud cover	<i>Syzygium samoense</i> <i>Reynoldsia lanuensis</i> <i>Astronidium pickeringii</i> <i>Dysoxylum huntii</i>	31
Montane scrub	152.6	548.6-944.9	19.4-25.0	Dry to moderate	Lata	Moderate to steep	Sunny	<i>Pandanus reineckei</i> <i>Rapanea myricifolia</i> <i>Syzygium brevifolium</i> <i>Alstonia godeffroyi</i>	25

Vegetation characteristics	Wildlife						Total vertebrate species
	Amphibians and reptiles		Birds		Mammals		
	Dominant species	Species richness ^a	Dominant species	Species richness ^b	Dominant species	Species richness ^j	
Tall (90 ft +) shady forest of the mountains and plateaus; ground cover, vines, and epiphytes moderate.	azure-tailed skink black skink moth skink pelagic gecko	6 ^f	Wattled Honey-eater Samoan Starling Crimson-crowned Fruit Dove White-rumped Swiftlet	18 ^f	Polynesian rat	5 ^f	29 ^f
Tall (90 ft +) shady forest of the mountains and plateaus; ground cover, vines, and epiphytes moderate.		6 ^f	Wattled Honey-eater Crimson-crowned Fruit Dove Samoan Starling	18 ^f	Polynesian rat flying fox	5 ^f	29 ^f
Medium height forest with densely packed trees; found on slopes and ridges; ground cover, vines and epiphytes light to moderate.	azure-tailed skink black skink	5	Wattled Honey-eater Crimson-crowned Fruit Dove White-rumped Swiftlet Samoan Starling	13		4	22
Low forest in cloud zone, rainfall and humidity high; ground cover, vines, and epiphytes abundant.		1	Tahiti Petrel ^h Audubon's Shearwater ^h Samoan Starling Wattled Honey-eater Blue-crowned Lory ^e	9		0	10
Open, low forest with scattered trees, found on high, steep ridges and summits of "trachyte plugs"; ground cover dense.		2	Collared Petrel ^h Samoan Starling Wattled Honey-eater Polynesian Starling Blue-crowned Lory ^e	9		0	11

Table 30. Continued

Ecosystems	Total area (ha)	Range of elevation (m)	Mean annual temperature (°C)	Soil moisture conditions	Soil types	Slope	Light at ground surface	Vegetation	
								Characteristic dominant species	No. of tree species in survey plots
Disturbed									
Coastal Marsh	28.2	0.3-3.0	26.1	Very wet	Lalovi	Flat	Bright sunlight	<i>Ludwigia octivalvis</i> <i>Rhynchospora corymbosa</i> <i>Cyclosorus interruptus</i> <i>Eleocharis dulcis</i>	
Secondary forest	3,976.0	3.0-487.7	21.7-26.1	Dry to wet	Various	Flat to steep	Moderate shade	<i>Rhus taitensis</i> <i>Alphitonia zizyphoides</i> <i>Cyathea</i> spp. <i>Dysoxylum samoense</i> <i>Neonauclea forsteri</i>	63
Kula fernland	1.2	30.5-91.4	26.7(?)	Dry	Lua-tuanu'u	Flat to moderate	Bright sunlight	<i>Dicranopteris linearis</i>	1
Pasture land	43.7	15.2-91.4	26.1	Moderate	Toni-toniga	Flat	Bright sunlight	Various grasses and weedy herbs	*
Plantation land	6,763.4	3.0-457.2	21.7-26.1	Wet	Various	Flat to moderate	Moderate shade	Coconut, taro and banana	*
Village land	1,622.7	1.5-365.8 (mostly 1.5-30.5)	22.8-26.1	Dry to moderate	Various	Flat to moderate	Sunny to moderate shade	Coconut, breadfruit, and various ornamental species	*

* No plots located here.

^a From Table 14.^b From Table 20.^c Rose only.^d Tutuila only.^e Ofu, Olosega, and Ta'u only.^f Combined lowland and montane forests.^g Combined lowland, montane, and ridge forest^h Ta'u only.

Vegetation characteristics	Wildlife						Total vertebrate species
	Amphibians and reptiles		Birds		Mammals		
	Dominant species	Species richness ^a	Dominant species	Species richness ^b	Dominant species	Species richness ⁱ	
Coastal marshes used or recently used for growing taro; weedy, semi-aquatic herbs and sedges dominant.	marine toad azure-tailed skink	3	Samoan Starling Wattled Honey-eater Banded Rail White-rumped Swiftlet Purple Swamphen	12	Polynesian rat	3	18
Low to high forest on disturbed land (e.g., old plantations); reverting to primary forest; ground cover and small trees often abundant.	azure-tailed skink black skink Samoan skink moth skink	5	Wattled Honey-eater White-rumped Swiftlet Crimson-crowned Fruit Dove Samoan Starling Red-vented Bulbul ^d	18	flying fox Polynesian rat	5	28
Fern- and herb-dominated vegetation on heavily disturbed coastal bluffs and ridges.		1		6		1	8
Low grassy vegetation used for cattle grazing.	marine toad Samoan skink	4		12	Polynesian rat	3	19
Coconut plantation or shifting agriculture plots of bananas and taro.	marine toad Micronesian skink azure-tailed skink black skink Samoan skink moth skink Polynesian gecko	8		15	flying fox Polynesian rat pig	6	29
Crop trees and ornamentals planted around houses, some grassy areas.	marine toad azure-tailed skink Polynesian gecko house gecko mourning gecko stump-toed gecko	7		16	house mouse roof rat Norway rat	6	29

ⁱ Except Swains Island.^j From Table 28.

Table 31. Habitat preferences (P = primary, S = secondary) of vertebrate species of American Samoa.

Species	Non-vegetative					Vegetative										Totals							
	Natural					Natural											Disturbed						
	At sea	Reef	Beach	Rock cliff	Cave	Littoral strand	Littoral scrub	Coastal marsh	Mangrove forest	Littoral forest	Coastal forest	Rain forest	Ridge forest	Montane scrub	Cloud forest		Village land	Plantation land	Pasture land	Kula fernland	Secondary forest		
<i>Amphibians and Reptiles</i>																							
Marine toad						P	S	P	P	S	S	S	S			P	P	P		S	6	6	12
Black turtle	P	S	P			P															3	1	4
Hawksbill turtle	P	S	P			P															3	1	4
Snake-eyed skink						P	P														2	0	2
Micronesian skink										P							P				2	0	2
Azure-tailed skink							P	P	P	P		P	P	P		P	P	P	S	P	11	1	12
Lawes skink										P											1	0	1
Black skink						P	P	S	S	P	P	P	P	S			P	P		P	9	3	12
Samoa skink									S	S	S	S	S		S		P	P		P	3	6	9
Moth skink										P		P					P			P	4	0	4
Pelagic gecko										P						S					1	1	2
Polynesian gecko									S	S	S	S	S			P	P				2	5	7
House gecko																P					1	0	1
Mourning gecko						P			P	P						P					5	0	5
Stump-toed gecko																P					1	0	1
Pacific boa										P							S				1	1	2
Subtotals																							
Primary	2	0	2	0	0	6	3	2	3	8	2	3	2	1	0	6	7	4	0	4			
Secondary	0	2	0	0	0	0	1	1	3	3	3	3	3	1	1	1	1	0	1	1			
Grand totals	2	2	2	0	0	6	4	3	6	11	5	6	5	2	1	7	8	4	1	5			
<i>Birds</i>																							
White-necked petrel	P																				1	0	1
Tahiti petrel	P														P						2	0	2
Collared petrel	P													P							2	0	2
Slender-billed shearwater	P																				1	0	1
Wedge-tailed shearwater	P													P							2	0	2
Christmas shearwater	P										S				P						2	1	3
Audubon's shearwater	P														P						2	0	2
White-throated storm-petrel	P														P						2	0	2
Red-tailed tropicbird	P									P											2	0	2
White-tailed tropicbird	P									P	P	P	P				S		S		5	2	7
Blue-faced booby	P					P															2	0	2
Brown booby	P			P		P															3	0	3
Red-footed booby	P									P											2	0	2
Great frigatebird	P									P											2	0	2
Lesser frigatebird	P									P											2	0	2
Reef heron		P	P							P											3	0	3
Australian gray duck								P	S												1	1	2
Banded rail						S	S	P	P	S	S	S	S			P	P	P		S	5	7	12
Sooty rail								P													1	0	1
Purple swamphen						S	S	P	P	S	S	S	S			P	P	P		S	5	7	12
Golden plover			P														P				2	0	2
Ruddy turnstone			P														S				1	1	2
Bristle-thighed curlew			P														S				1	1	2
Bar-tailed godwit			P																		1	0	1
Wandering tattler		P	P														S				2	1	3
Sanderling			P																		1	0	1

Table 31. Continued.

Species	Non-vegetative					Vegetative															Totals		
	Natural					Natural										Disturbed					Totals		
	At sea	Reef	Beach	Rock cliff	Cave	Littoral strand	Littoral scrub	Coastal marsh	Mangrove forest	Littoral forest	Coastal forest	Rain forest	Ridge forest	Montane scrub	Cloud forest	Village land	Plantation land	Pasture land	Kula fernland	Secondary forest	Primary	Secondary	Grand total
Black-naped tern	P		P																		2	0	2
Gray-backed tern	P		P	P																	3	0	3
Brown-winged tern	P	P																			2	0	2
Sooty tern	P					P															2	0	2
Crested tern	P	P																			2	0	2
Blue-gray noddy	P			P																	2	0	2
Brown noddy	P			P		P				P	P	S	S						S		5	3	8
Black noddy	P			S						P	P										3	1	4
White tern	P			S						P		S							S		2	3	5
Rock dove																P					1	0	1
Many-colored fruit dove										P											1	0	1
Crimson-crowned fruit dove											P	P	P				S	S	P		4	2	6
Pacific pigeon											P	P	P				S	S	P		4	2	6
Friendly quail dove											P						S				1	1	2
Blue-crowned lory										P	P	P	S	S	S	P	P		P		6	3	9
New Zealand cuckoo						S	S	S	P	P	P					S	P	P	S	P	6	5	11
Barn owl						S	S	S	P	P	P					P	P	P	S	P	7	4	11
White-rumped swiftlet					P	S	S	P	S	S	S	S	P	P	S	P	P	P	S	P	8	8	16
White-collared kingfisher						S	S	P	P	P	P	S	S	S	S	P	P	P	S	S	7	8	15
Red-vented bulbul																P	P	P		S	3	1	4
Fiji shrikebill												P								P	2	0	2
Mao												P									1	0	1
Wattled honey-eater						S	S	S	P	P	P	P	P	S	S	P	P	P	S	P	9	6	15
Cardinal honey-eater						S	S	S	P	P	P	S	S			P	P	P		P	7	5	12
Polynesian starling							S	S	S	S	S	P	P	P	P					P	5	5	10
Samoan starling						S	S	S	S	P	P	P	P	P	P	P	P	P	S	P	10	5	15
Subtotals																							
Primary	24	4	9	4	1	4	0	6	7	16	14	9	7	6	5	12	11	10	0	11			
Secondary	0	0	0	2	0	9	10	6	4	4	4	8	6	3	4	4	4	2	6	7			
Grand totals	24	4	9	6	1	13	10	12	11	20	18	17	13	9	9	16	15	12	6	18			
Mammals																							
Flying fox										P	P	S	S			S	P	S		P	4	4	8
Sheath-tailed bat				S	S	P	S	S	S	P	P	S	S			S	S	S	S	S	3	13	16
House mouse																P	S				1	1	2
Roof rat								S				S				P	S			S	1	4	5
Norway rat																P					1	0	1
Polynesian rat						P	P	P	S	P	P	S	S			S	P	P		P	8	4	12
Pig												S	S			P	P	P		S	3	3	6
Subtotals																							
Primary	0	0	0	0	1	1	1	1	0	3	3	0	0	0	0	4	3	2	0	2			
Secondary	0	0	1	1	0	1	1	2	2	0	0	5	4	0	0	3	3	2	1	3			
Grand totals	0	0	1	1	1	2	2	3	2	3	3	5	4	0	0	7	6	4	1	5			
TOTALS																							
Primary	26	4	11	4	2	11	4	9	10	27	19	12	9	7	5	22	21	16	0	17	236		
Secondary	0	2	1	3	0	10	12	9	9	7	7	16	13	4	5	8	8	4	8	11		137	
Grand totals	26	6	12	7	2	21	16	18	19	34	26	28	22	11	10	30	29	20	8	28			373

Appendix I

Native and naturalized plants of American Samoa, with their Samoan names, status, and distribution. Samoan names with question marks after them are of uncertain authenticity. Status is based on the complete distribution of the species: 1, endemic to American Samoa; 2, endemic to American and Western Samoa; 3, indigenous to Samoa but not endemic; and 4, introduced to Samoa by man; a question mark indicates uncertainty. Distribution noted as (m) indicates the locality was only given as "Manu'a." An asterisk (*) indicates a new record of a tree or shrub for American Samoa.

Species	Samoan name	Status	Islands						Rose	Swains
			Tutuila	Aunu'u	Ofu	Olosega	Ta'u			
I. Angiospermae										
A. Trees and shrubs										
1. Dicotyledonae										
<i>Acalypha grandis</i>		4?	X	X		X	X			
<i>Acronychia heterophylla</i>		1	X			X	X			
<i>Acronychia retusa</i> *		3						X		
<i>Acronychia richii</i>		2	X							
<i>Aglaia samoensis</i>	laga'ali	2	X		X	X	X	X		
<i>Allophylus cobbe</i>		3	X	X	X	X	X	X		
<i>Amylothea insularum</i>	tapuna	3	X					X		
<i>Alphitonia zizyphoides</i>	toi	3	X	X	X	X	X	X		
<i>Alstonia godeffroyi</i>		2	X							
<i>Anacolosia lutea</i> *		3	X							
<i>Antidesma sphaerocarpum</i> *		2	X				X	X		
<i>Arytera samoensis</i>	lau lili'i	2	X		X	X	X	X		
<i>Ascarina diffusa</i> *	afia	3						X		
<i>Astronidium navigatorum</i>		2	X							
<i>Astronidium pickeringii</i>		2	X				X	X		
<i>Astronidium samoense</i>		2	X							
<i>Baccaurea taitensis</i>		2	X							
<i>Barringtonia asiatica</i>	futu	3	X	X	X	X	X	X		X
<i>Barringtonia samoensis</i>	falagā	3	X		X	X	X	X		
<i>Bischofia javanica</i>	'o'a	4	X	X	X	X	X	X		
<i>Boehmeria virgata</i>		3	X							
<i>Bruguiera gymnorhiza</i>	togo	3	X	X						
<i>Buchanania merrillii</i>		2	X							
<i>Calophyllum inophyllum</i>	fetau	3	X	X	X	X	X	X		X
<i>Calophyllum samoense</i>	tamanu	2	X		X	X	X	X		
<i>Calycosia sessilis</i>		2	X							
<i>Cananga odorata</i>	moso'oi	4	X	X	X	X	X	X		
<i>Canarium harveyi</i> *		3	X		X	X	X			
<i>Canarium samoense</i>	ma'ali	3	X		X	X	X	X		
<i>Canthium barbatum</i>		3	X							
<i>Canthium merrillii</i>	olasina	2	X		X			X		
<i>Carica papaya</i>	esi	4	X	X	X	X	X	X		X
<i>Casearia</i> sp. nova		1	X							
<i>Cerbera manghas</i>	leva	3	X	X	X	X	X	X		
<i>Citronella samoensis</i>		2	X				X	X		
<i>Citrus macroptera</i>	moli samoa	4	X		X	X	X	X		
<i>Clerodendrum inerme</i>	aloalo tai	3	X	X	X	X	X	X		
<i>Colubrina asiatica</i>	fisoa	3	X	X	X	X	X	X		
<i>Cordia aspera</i> *	tou	3	X							
<i>Cordia subcordata</i>	tauanave	3	X	X	X	X	X			X
<i>Crataeva religiosa</i>		3			X					
<i>Crossostylis biflora</i>		3	X							
<i>Cypholophus macrocephalus</i>	faupata	3	X					X		
<i>Cyrtandra geminata</i>		1	X							
<i>Cyrtandra longipedunculata</i>		2	X				X			
<i>Cyrtandra pulchella</i>		1	X			X	X	X		

Appendix I. Continued

Species	Samoan name	Status	Islands						
			Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	Swains
<i>Cyrtandra samoensis</i>	mōmōle'a, ?	3	X		X	X	X		
<i>Cyrtandra</i> sp. nova*		1	X						
<i>Cyrtandra</i> sp. nova*		1			X	X	X		
<i>Decaspermum fruticosum</i>	nu'anua'a	3	X		X	X			
<i>Dendrocnide harveyi</i> *	salato	4					X		
<i>Desmodium umbellatum</i>	lala	3	X	X	X	X	X		
<i>Diospyros elliptica</i>	'anume	3	X	X	X	X	X		
<i>Diospyros samoensis</i>	'au'aui	3	X	X	X	X	X		
<i>Drypetes</i> sp. nova*		1	X						
<i>Dysoxylum huntii</i>	maotamea	2	X			X	X		
<i>Dysoxylum maota</i>	maota	2	X						
<i>Dysoxylum samoense</i>	mamala	3	X	X	X	X	X		
<i>Elaeocarpus tonganus</i> *	a'amati'e	3	X		X	X	X		
<i>Elaeocarpus ulianus</i> *		2	X						
<i>Elatostachys falcata</i> *	taputo'i	3	X						
<i>Endiandra elaeocarpa</i> *		3					X		
<i>Ervatamia obtusiuscula</i>	puluvaio	3	X		X	X			
<i>Erythrina fusca</i>	lalapa, ?	3	X						
<i>Erythrina variegata</i>	gatae	3	X	X	X	X	X		
<i>Erythrospermum acuminatis-</i> <i>simum</i>		3	X						
<i>Eugenia reinwardtiana</i> *		3	X	X					
<i>Euodia hortensis</i>	usi	4	X		X	X			
<i>Euodia samoensis</i>	so'opine	2			X	X	X		
<i>Eurya japonica</i>		3	X						
<i>Fagraea berteriana</i>	pualulu	3	X		X	X	X		
<i>Ficus godeffroyi</i>	mati	2	X		X	X	X		
<i>Ficus obliqua</i>	āoa	3	X	X	X	X	X		
<i>Ficus prolixa</i>	āoa	3	X				X		
<i>Ficus scabra</i>	mati	3	X	X	X	X	X		
<i>Ficus tinctoria</i>	mati	3	X	X	X	X	X		X
<i>Ficus uniauriculata</i>		2	X						
<i>Flacourtia rukam</i>	filimoto	3?	X		X	X	X		
<i>Garcinia vitiensis</i> *		3	X		X	X	X		
<i>Gardenia taitensis</i>	pua samoa	3	X						X
<i>Garuga floribunda</i>	vivao	3	X	X	X	X	X		
<i>Geniostoma samoense</i>	laufatifati	3	X	X	X	X	X		
<i>Glochidion cuspidatum</i>	masame vao	3	X						
<i>Glochidion ramiflorum</i>	masame	3	X	X	X	X	X		
<i>Gossypium hirsutum</i> *	vavae	3?		X					
<i>Grewia crenata</i>	fauui	3	X	X	X	X	X		
<i>Guettarda speciosa</i>	puapua	3	X	X	X	X	X		X
<i>Gymnosporia vitiense</i>		3	X						
<i>Gyrocarpus americanus</i>	vili	3			X				
<i>Hedycarya denticulata</i>	fatimatao	3	X		X	X	X		
<i>Hernandia moerenhoutiana</i>	pipi	3	X				X		
<i>Hernandia sonora</i>	pu'a	3	X	X	X	X	X		X
<i>Hibiscus tiliaceus</i>	fau	3	X	X	X	X	X		X
<i>Homalanthus nutans</i>	fogāmamala	3	X		X	X	X		
<i>Homalium whitmeeanum</i> *		2	X						
<i>Inocarpus fagifer</i>	ifi	4	X	X	X	X	X		
<i>Intsia bijuga</i>	ifilele	3	X						
<i>Ixora samoensis</i>	filofiloa	3	X			X			
<i>Kleinhovia hospita</i>	fu'afu'a	3?	X	X	X	X	X		
<i>Korthasella horneana</i> *		3					X		
<i>Leucaena leucocephala</i>	lopā samoa	4	X		X	X	X		
<i>Leucosyke corymbulosa</i>	'ala'alatoa	3	X						

Appendix I. Continued

Species	Samoan name	Status	Islands						
			Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	Swains
<i>Litsea samoensis</i>	papaono	2	X						
<i>Macaranga harveyana</i>	laupata	3	X	X	X	X	X		
<i>Macaranga stipulosa</i>	patafatu	2	X			X	X		
<i>Macropiper puberulum</i>	'ava'avaaitu	3	X		X	X	X		
<i>Macropiper timothianum</i> *	'ava'avaaitu	3					X		
<i>Maesa tongensis</i>	lalamelo	3	X		X	X	X		
<i>Mammea glauca</i> *	manapau	2	X						
<i>Manilkara dissecta</i>	pani	3	X						
<i>Maoutia australis</i>		3	X		X		X		
<i>Medusanthra samoensis</i>	matamō	2	X		X	X	X		
<i>Melastoma denticulatum</i>	fualole		X		X	X	X		
<i>Melicytus ramiflorus</i> *		?					X		
<i>Melochia aristata</i>	ma'o	3	X				X		
<i>Meryta macrophylla</i>	fagufagu	3	X		X	X	X		
<i>Messerschmidia argentea</i>	tausuni	3	X	X	X	X	X	X	X
<i>Metrosideros collina</i>		3	X						
<i>Micromelum minutum</i>	talafalu	3		X	X	X	X		
<i>Morinda citrifolia</i>	nonu	4?	X	X	X	X	X		X
<i>Mussaenda raiateensis</i>		3	X		X		X		
<i>Myristica fatua</i>	'atone	3	X		X	X	X		
<i>Myristica hypargyrea</i>	'atone	3	X						
<i>Neisosperma oppositifolia</i> *	fao	3							X
<i>Neonauclea forsteri</i>	afa	3	X		X	X	X		
<i>Palaquium stehlinii</i> *	gasu	2	X				X		
<i>Pemphis acidula</i> *	gigie	3							X
<i>Phaleria acuminata</i>		3	X						
<i>Phaleria disperma</i>	sunī	3	X				X		
<i>Pipturus argenteus</i>	sogā	3	X	X	X	X	X		X
<i>Pisonia grandis</i>	pu'avai	3	X	X	X	X	X	X	X
<i>Pisonia umbellifera</i>		3	X		X		X		
<i>Planchonella costata</i> *	ala'a	3	X	X					
<i>Planchonella linggenensis</i>	ala'a	3	X	X	X	X	X		
<i>Planchonella torricellensis</i>	mamalava	3	X						
<i>Polyscias samoensis</i>	afia	2	X						
<i>Pometia pinnata</i> *	tava	3	X		X	X	X		
<i>Pongamia pinnata</i>		3	X						
<i>Premna obtusifolia</i>	aloalo	3	X		X	X	X		
<i>Psidium guajava</i>	kuava	4	X	X	X	X	X		
<i>Psychotria forsteriana</i>		3	X						
<i>Psychotria garberiana</i>		1			X	X	X		
<i>Psychotria insularum</i>	matalafi	3	X	X	X	X	X		
<i>Rapanea myricifolia</i>	saitamu	3	X						
<i>Reynoldsia lanutoensis</i>		2					X		
<i>Rhizophora mangle</i>	togo	3?	X						
<i>Rhus taitensis</i>	tavai	3	X	X	X	X	X		
<i>Sarcopygme pacifica</i>	'u'unu	2	X			X	X		
<i>Scaevola taccada</i>	to'ito'i	3	X	X	X	X	X		X
<i>Sophora tomentosa</i>	lalatai, ?	3	X	X	X				
<i>Spiraeanthemum samoense</i>		2	X						
<i>Sterculia fanaiho</i>	faga'io	3	X	X	X	X	X		
<i>Streblus anthropophagorum</i> *		3					X		
<i>Suriana maritima</i> *		3						X	
<i>Syzygium brevifolium</i>		2	X						
<i>Syzygium carolinense</i>		3	X			X	X		
<i>Syzygium clusiaefolium</i>	asi vai	3	X		X	X	X		
<i>Syzygium dealatum</i> *	asi vai	3	X	X	X	X	X		
<i>Syzygium inophylloides</i>	asi	3	X		X	X	X		

Appendix I. Continued

Species	Samoan name	Status	Islands						
			Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	Swains
<i>Syzygium samarangense</i> *	nonu vao	3	X		X	X	X		
<i>Syzygium samoense</i> *	fena vao	3	X		X	X	X		
<i>Tarennia sambucina</i>	ma'anunu	3	X			X	X		
<i>Tephrosia piscatoria</i>	'avasā	3?		X	X	X	X		
<i>Terminalia catappa</i>	talie	3	X	X	X	X	X		
<i>Terminalia richii</i> *	mālili	2	X		X	X	X		
<i>Terminalia samoensis</i>	talie	3	X						
<i>Thespesia populnea</i>	milo	3	X	X	X	X	X		
<i>Trema orientalis</i>	magele	3	X		X		X		
<i>Trichospermum richii</i>	ma'o sina	3	X		X	X	X		
<i>Triumfetta procumbens</i>	mautofutai	3		X	X	X	X		
<i>Vitex trifolia</i>	namulega	3	X		X	X	X		
<i>Weinmannia affinis</i>		3	X			X	X		
<i>Wikstroemia foetida</i>		3	X						
<i>Xylocarpus moluccensis</i>	le'ile'i	3	X	X					
2. Monocotyledonae									
<i>Cocos nucifera</i>	niu	4?	X	X	X	X	X	X	X
<i>Cordyline fruticosa</i>	ti	4?	X	X	X	X	X		
<i>Pandanus reineckei</i>	fasa	2	X						
<i>Pandanus tectorius</i>	fala	3	X	X	X	X	X		X
<i>Pandanus tutuilensis</i>	paogo	2	X						
<i>Pandanus whitmeeanus</i>	paogo	3?	X						
B. Lianas and vines									
1. Dicotyledonae									
<i>Abrus precatorius</i>	matamoso	4	X	X	X				
<i>Alyxia bracteolosa</i>	lau maile	2	X		X	X	X		
<i>Alyxia stellata</i>	gau	3	X	X	X	X	X		
<i>Aristolochia cortinata</i>	fuesā, ?	2	X						
<i>Caesalpinia bonduc</i>	'anaoso	3		X					
<i>Caesalpinia major</i>	'anaoso	3	X		X				
<i>Canavalia cathartica</i>		4?		X	X				
<i>Canavalia rosea</i>		3	X		X		X		
<i>Canavalia sericea</i>		3				X			
<i>Cassytha filiformis</i>	fetai	3			X				X
<i>Derris trifoliata</i>	fue'o'ona	3	X				X		
<i>Embelia vaupelii</i>		3	X			X	X		
<i>Entada phaseoloides</i>	fue'inu	3	X						
<i>Faradaya powellii</i>	mamalupe	2	X	X	X	X	X		
<i>Gynochtodes ovalifolia</i>		3	X				X		
<i>Hoya australis</i>	fue selelā	3	X	X	X	X	X		
<i>Hoya betchei</i>		2	X		X	X	X		
<i>Hoya pottsii</i>		3	X		X	X	X		
<i>Ipomoea littoralis</i>		4	X	X	X	X	X		
<i>Ipomoea macrantha</i>		3	X	X			X		
<i>Ipomoea pes-caprae</i>	fue moa	3	X	X		X	X	X	X
<i>Jasminum betchei</i>		3	X		X				
<i>Jasminum didymum</i>		3	X		X	X	X		
<i>Medinilla samoensis</i>		3	X			X	X		
<i>Melothria grayana</i>		2	X		X		X		
<i>Melothria samoensis</i>		3	X	X			X		
<i>Merremia peltata</i>		3	X						
<i>Mikania micrantha</i>	fue saina	4	X	X	X	X	X		
<i>Morinda umbellata</i>		3	X						
<i>Mucuna gigantea</i>	fue'inu, ?	3	X	X	X	X	X		
<i>Mucuna platyphylla</i>	fue'inu	2?					X		

Appendix I. Continued

Species	Samoan name	Status	Islands						
			Tutuila	Aunu'u	Ofu	Olosega	Ta'ū	Rose	Swains
<i>Piper graeffei</i>	fue manogi	3?	X		X	X	X		
<i>Santaloides samoense</i>		3	X		X	X	X		
<i>Vigna marina</i>	fue sina	3	X	X	X	X	X		X
2. Monocotyledonae									
<i>Dioscorea bulbifera</i>	soi	4	X	X	X	X	X		
<i>Epipremnum pinnatum</i>		3	X	X		X	X		
<i>Flagellaria gigantea</i>	lafo	3	X						
<i>Freycinetia hombronii</i>	'ie'ie	2	X						
<i>Freycinetia reineckei</i>	'ie'ie	2	X				X		
<i>Freycinetia storckii</i>	'ie'ie	3	X		X	X	X		
<i>Raphidophora graeffei</i>	tuafaga	2	X						
C. Herbaceous plants									
1. Dicotyledonae									
<i>Achyranthes aspera</i>	lau tamatama	4?	X	X	X	X	X		
<i>Achyranthes velutina</i>		4?							X
<i>Blumea milnei</i>		3				X			
<i>Boerhavia diffusa</i>	ufi'atuli	3	X		X	X	X		
<i>Boerhavia tetrandra</i>	nuna	3						X	X
<i>Capparis cordifolia</i>		3				X	X		
<i>Clidemia hirta</i>		4	X						
<i>Desmodium heterocarpum</i>		4	X		X		X		
<i>Elatostema grandifolium</i>		2				X	X		
<i>Elatostema samoense</i>		2	X						
<i>Elatostema scabriusculum</i>		1	X				X		
<i>Elatostema tutuilense</i>		1	X						
<i>Elatostema</i> sp. nova		1				X	X		
<i>Emilia sonchifolia</i>		4	X	X	X	X	X		
<i>Euphorbia atoto</i>		3	X	X	X		X		
<i>Euphorbia reineckei</i>		2	X						
<i>Geophila repens</i>	tono	3	X		X		X		
<i>Hedyotis biflora</i>		3	X		X	X	X		
<i>Hedyotis foetida</i>		3	X		X	X	X		
<i>Hedyotis romanzoffiensis</i>	kautokiaveka	3							X
<i>Leucas flaccida</i>	ogooogo sina	3			X		X		
<i>Limnophila fragrans</i>	tamole vai	3	X				X		
<i>Lindernia crustacea</i>		3	X				X		
<i>Ludwigia octovalvis</i>		4	X	X	X	X	X		X
<i>Peperomia biformis</i>		2	X				X		
<i>Peperomia reineckei</i>		2					X		
<i>Phyllanthus simplex</i>		4	X			X	X		
<i>Portulaca australis</i>		3	X	X		X	X		
<i>Portulaca lutea</i>	tamole	3	X		X			X	
<i>Portulaca oleracea</i>	tamole	4?	X			X	X		X
<i>Procris pedunculata</i>	fualole	3	X			X	X		X
<i>Sesuvium portulacastrum</i>		3			X		X		
<i>Sida samoensis</i>		3		X	X		X		
<i>Wedelia biflora</i>	ateate	3	X	X	X	X	X		
2. Monocotyledonae									
a. Cyperaceae									
<i>Cyperus javanicus</i>	selesele	3	X	X	X	X	X		X
<i>Cyperus odoratus</i>	selesele	3	X	X	X		X		
<i>Cyperus polystachyos</i>		4?	X	X					
<i>Cyperus seemannianus</i>		3	X	X		X	X		

Appendix I. Continued

Species	Samoan name	Status	Islands						Swains
			Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	
<i>Eleocharis dulcis</i>	'utu'utu	3		X			X		
<i>Eleocharis geniculata</i>		3							X
<i>Fimbristylis cymosa</i>	mutia	3	X	X	X	X	X		X
<i>Machaerina falcata</i>		3	X						
<i>Mapania macrocephala</i>		3	X				X		
<i>Rhynchospora corymbosa</i>	selesele	3?		X		X	X		
<i>Scleria lithosperma</i>		3	X	X	X		X		
<i>Scleria polycarpa</i>		3	X	X	X	X	X		
<i>Thoracostachyum lucbanense</i>		3	X						
b. Gramineae									
<i>Bothriochloa bladhii</i>		4	X	X					
<i>Cenchrus echinatus</i>	vao tuitui	4	X	X	X	X	X		X
<i>Centotheca lappacea</i>	sefa	4	X	X			X		
<i>Chrysopogon aciculatus</i>		4	X		X		X		
<i>Coix lacryma-jobi</i>	sagasaga	4	X	X			X		
<i>Cytococcum oxyphyllum</i>		4	X			X	X		
<i>Imperata cylindrica</i>		3	X						
<i>Ischaemum byrone</i>		3?	X						
<i>Ischaemum murinum</i>		3	X			X	X		
<i>Lepturus repens</i>		3	X	X	X	X	X		X
<i>Miscanthus floridulus</i>	'u	3	X				X		
<i>Oplismenus undulatifolius</i>		4	X	X	X		X		
<i>Paspalum distichum</i>		3	X	X			X		
<i>Paspalum orbiculare</i>		3	X		X		X		
<i>Schizostachyum glaucifolium</i>	'ofe	4			X	X	X		
<i>Stenotaphrum micranthum</i>		3	X			X	X		
<i>Thuarea involuta</i>		3	X	X	X	X	X		
c. Orchidaceae									
<i>Agrostophyllum megalurum</i>		3					X		
<i>Appendicula bracteosa</i>		3	X			X	X		
<i>Bulbophyllum atrorubens</i>		3	X						
<i>Bulbophyllum betchei</i>		2				X	X		
<i>Bulbophyllum gibbonianum</i>		3	X						
<i>Bulbophyllum longiscapum</i>		3	X				X		
<i>Bulbophyllum nigroscapum</i>		2	X						
<i>Bulbophyllum pachyanthum</i>		3	X						
<i>Bulbophyllum samoanum</i>		2	X			X	X		
<i>Bulbophyllum savaiiense</i>		2				X	X		
<i>Bulbophyllum</i> sp. nova		3	X						
<i>Calanthe hololeuca</i>		3	X				X		
<i>Calanthe triplicata</i>		3	X		X	X	X		
<i>Coelogyne lycastoides</i>		2	X				X		
<i>Cryptostylis alismifolia</i>		2					X		
<i>Dendrobium biflorum</i>		3	X				X		
<i>Dendrobium glomeriflorum</i>		3	X						
<i>Dendrobium goldfinchii</i>		3	X						
<i>Dendrobium tokai</i>		3	X				X		
<i>Dendrobium triviale</i>		2	X						
<i>Dendrobium vaupelianum</i>		2	X	X		X	X		
<i>Didymoplexis pallens</i>		3	X		X	X	X		
<i>Diplocaulobium fililobum</i>		2	X			X	X		
<i>Ephemerantha comata</i>		3	X				X		
<i>Epiblastus sciadanthus</i>		2					X		
<i>Eria aeridostachya</i>		3	X						
<i>Erythrodes lilyanum</i>		2				X			

Appendix I. Continued

Species	Samoan name	Status	Islands						
			Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	Swains
<i>Erythrodos</i> sp.		1					X		
<i>Glomera reineckeana</i>		2	X				X		
<i>Goodyera rubens</i>		3			X				
<i>Habenaria supervacunea</i>		3	X						
<i>Habenaria tradescantifolia</i>		3	X			X	X		
<i>Habenaria vaupelii</i>		2					X		
<i>Hetaeria oblongifolia</i>		3			X	X	X		
<i>Liparis caespitosa</i>		3?	X						
<i>Liparis disticha</i>		3	X						
<i>Liparis longipes</i>		3	X		X				
<i>Liparis stricta</i>		2			X	X	X		
<i>Malaxis resupinata</i>		3	X		X				
<i>Malaxis samoensis</i>		2	X			X	X		
<i>Malaxis</i> sp.		2?					X		
<i>Mediocalcar paradoxum</i>		2	X						
<i>Moerenhoutia heteromorpha</i>		3	X			X	X		
<i>Nervilia aragoana</i>		3	X		X				
<i>Oberonia equitans</i>		3	X		X	X			
<i>Oberonia heliophila</i>		3	X						
<i>Phaius graeffei</i>		3	X						
<i>Phaius tankervilleae</i>		3			X	X	X		
<i>Phreatia graeffei</i>		3	X			X	X		
<i>Phreatia stenostachya</i>		3	X			X	X		
<i>Pseuderia ramosa</i>		3	X				X		
<i>Spathoglottis pacifica</i>		3	X	X	X	X	X		
<i>Taeniophyllum fasciola</i>		3	X	X	X	X	X		
<i>Taeniophyllum vitiense</i>		3					X		
<i>Thrixspermum graeffei</i>		3	X				X		
<i>Vrydagzynea betchei</i>		2					X		
<i>Vrydagzynea whitmeei</i>		2					X		
<i>Zeuxine androcardium</i> (?)		2	X						
<i>Zeuxine sphaerochila</i>		2					X		
d. Others									
<i>Amorphophalus campanulatus</i>	teve	4	X				X		
<i>Aneilema vitiense</i>		3	X				X		
<i>Geanthus vignai</i>		2	X						
<i>Halophila ovalis</i>		3	X						
<i>Heliconia paca</i>	laofao	3	X						
<i>Tacca leontopetaloides</i>	masoa	3	X	X	X	X	X		X
<i>Zingiber zerumbet</i>	'ava pui	3	X	X	X	X	X		
II. Pteridophyta									
<i>Acrostichum aureum</i>	sa'ato	3	X	X	X	X	X		
<i>Adiantum capillus-veneris</i>		3					(m)		
<i>Adiantum philippense</i>		3		X					
<i>Amphineuron opulentum</i>		3					X		
<i>Angiopteris evecta</i>	gase	3	X			X	X		
<i>Angiopteris opaca</i>		3	X						
<i>Antrophyum alatum</i>		3	X			X	X		
<i>Antrophyum plantagineum</i>		3	X	X	X	X	X		
<i>Arthropteris oblitterata</i>		3	X				X		
<i>Asplenium cuneatum</i>		3	X		X		X		
<i>Asplenium falcatum</i>		3	X	X	X		X		
<i>Asplenium feejeense</i>		3	X				X		
<i>Asplenium horridum</i>		3				X	X		
<i>Asplenium insititium</i>		3					X		

Appendix I. Continued

Species	Samoan name	Status	Islands						
			Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	Swains
<i>Asplenium laserpitiifolium</i>		3	X				X		
<i>Asplenium lobulatum</i>		3	X						
<i>Asplenium marattioides</i>		3					X		
<i>Asplenium multifidum</i>		3					X		
<i>Asplenium nidus</i>	laugapāpā	3	X	X	X	X	X		X
<i>Asplenium powellii</i>							X		
<i>Asplenium tenerum</i>		3	X						
<i>Asplenium unilaterale</i>		3	X				X		
<i>Blechnum lanceolatum</i>		3	X						
<i>Blechnum orientale</i>		3	X		X	X	X		
<i>Blechnum vulcanicum</i>		3	X			X	X		
<i>Bolbitis lonchophora</i>		3	X				X		
<i>Cristella dentata</i>		3			X				
<i>Cristella harveyi</i>		3	X						
<i>Cristella parasitica</i>		3			X				
<i>Cristella subjuncta</i>		2	X						
<i>Culcita straminea</i>		3	X						
<i>Cyathea lunulata</i>	olioli	3	X						
<i>Cyathea subsessilis</i>		2	X						
<i>Cyathea truncata</i>	olioli	3	X						
<i>Cyathea vaupelii</i>		2	X				X		
<i>Cyclosorus interruptus</i>		3		X			X		
<i>Davallia epiphylla</i>		3	X						
<i>Davallia plumosa</i>		2	X						
<i>Davallia solida</i>		3	X		X	X	X		
<i>Dennstaedtia flaccida</i>		3	X						
<i>Dicksonia brackenridgei</i>		3					X		
<i>Dicranopteris linearis</i>	asaua	3	X		X	X			
<i>Diplazium dilatatum</i>		3	X						
<i>Diplazium harpeodes</i>		3	X						
<i>Diplazium petersenii</i>		3	X						
<i>Diplazium proliferum</i>		3	X						
<i>Diplazium silvaticum</i>		3	X				(m)		
<i>Dipteris conjugata</i>		3	X						
<i>Doryopteris concolor</i>		3					(m)		
<i>Dryopteris arborescens</i>		2					(m)		
<i>Dryopteris davallioides</i>		3	X				X		
<i>Dryopteris dissecta</i>		3					X		
<i>Elaphoglossum feejeense</i>		3	X						
<i>Elaphoglossum reineckei</i>		3					X		
<i>Histiopteris incisa</i>		3	X			X			
<i>Humata banksii</i>		3	X				X		
<i>Humata botrychioides</i>		3	X						
<i>Humata heterophylla</i>		3	X	X	X	X	X		
<i>Humata serrata</i>		3	X				X		
<i>Hymenophyllum formosum</i>		3	X			X	X		
<i>Hymenophyllum polyanthos</i>		3	X				X		
<i>Hymenophyllum praetervisum</i>		2	X				(m)		
<i>Hypolepis aspidioides</i>		2	X						
<i>Hypolepis tenuifolia</i>		3	X						
<i>Leucostegia pallida</i>		3			X				
<i>Lindsaea decomposita</i>		3	X			X	X		
<i>Lindsaea merrillii</i>		3					X		
<i>Lindsaea pulchra</i>		3	X		X		X		
<i>Lindsaea tenuifolia</i>		3	X						
<i>Lomagramma cordipinna</i>		3	X				X		
<i>Lycopodium carinatum</i>		3	X				X		

Appendix I. Continued

Species	Samoan name	Status	Islands						
			Tutuila	Aunu'u	Ofu	Olosega	Ta'ū	Rose	Swains
<i>Lycopodium cernuum</i>		3	X			X	X		
<i>Lycopodium phlegmaria</i>		3	X				X		
<i>Lycopodium squarrosum</i>		3	X				X		
<i>Macrothelypteris polypodioides</i>		3	X				X		
<i>Macrothelypteris torresiana</i>		3	X		X		X		
<i>Marrattia smithii</i>		3				X			
<i>Microlepia speluncae</i>		3			X		X		
<i>Microsorium scolopendria</i>	lau magamaga	3	X	X	X		X		X
<i>Nephrolepis bisserrata</i>		3	X			X	X		
<i>Nephrolepis hirsutula</i>	vao tuāniu	3	X	X			X		X
<i>Oleandra neriiiformis</i>		3	X			X	X		
<i>Ophioglossum parvifolium</i>		3					X		
<i>Ophioglossum pendulum</i>		3	X		X		X		
<i>Ophioglossum reticulatum</i>		3	X				X		
<i>Pityrogramma brackenridgei</i>		2	X				X		
<i>Pleisoneuron attenuatum</i>		3	X						
<i>Pneumatopteris bryanii</i>		2	X?						X?
<i>Pneumatopteris glandulifera</i>		3	X				X		
<i>Pneumatopteris rodigesiana</i>		3	X				(m)		
<i>Pneumatopteris transversaria</i>		3	X						
<i>Polypodium blechnoides</i>		3	X			X	X		
<i>Polypodium contiguum</i>		3					X		
<i>Polypodium emersonii</i>		3	X			X	X		
<i>Polypodium hookeri</i>		3	X						
<i>Polypodium nigrescens</i>		3	X				X		
<i>Polypodium lepidum</i>		3	X			X			
<i>Polypodium polynesianum</i>		3	X			X	X		
<i>Polypodium samoense</i>		3	X						
<i>Polypodium subauriculatum</i>		3	X						
<i>Polypodium tenuisectum</i>		3					X		
<i>Polystichum aculeatum</i>		3					(m)		
<i>Psilotum complanatum</i>		3		X			X		X
<i>Psilotum nudum</i>		3							X
<i>Pteris comans</i>		3	X			X	X		
<i>Pteris ensiformis</i>		3	X		X		X		
<i>Pteris pacifica</i>		3	X				X		
<i>Pteris tripartita</i>		3	X		X		X		
<i>Pteris vaupellii</i>		2			X				
<i>Pteris vittata</i>		3	X			X			
<i>Pyrrosia adnascens</i>		3	X	X	X		X		
<i>Schizaea dichotoma</i>		3	X		X	X	X		
<i>Selaginella christii</i>		2	X						
<i>Selaginella laxa</i>		3	X						
<i>Selaginella reineckeii</i>		2	X		X		X		
<i>Selaginella whitmeei</i>		2					X		
<i>Sphaerostephanos reineckeii</i>		2			X				
<i>Sphaerostephanos unitus</i>		3	X						
<i>Sphenomeris chinensis</i>		3				X			
<i>Tectaria chrysotricha</i>		3	X						
<i>Tectaria decurrens</i>		3					X		
<i>Tectaria setchellii</i>		3	X		X		X		
<i>Tectaria stearnsii</i>		2	X		X		X		
<i>Trichomanes apiifolium</i>		3	X			X	X		
<i>Trichomanes assimile</i>		3					X		
<i>Trichomanes bimarginatum</i>		3	X						
<i>Trichomanes bipunctatum</i>		3	X				X		
<i>Trichomanes boryanum</i>		3	X			X	X		

Appendix I. Continued

Species	Samoan name	Status	Islands						
			Tutuila	Aunu'u	Ofu	Olosega	Ta'u	Rose	Swains
<i>Trichomanes dentatum</i>		3			X				
<i>Trichomanes endlicherianum</i>		3	X		X		X		
<i>Trichomanes humile</i>		3	X			X	X		
<i>Trichomanes intermedium</i>		3	X			X	X		
<i>Trichomanes omphalodes</i>		3	X						
<i>Trichomanes pallidum</i>		3					(m)		
<i>Trichomanes saxifragoides</i>		3	X				X		
<i>Vaginularia angustissima</i>		3	X		X	X	X		
<i>Vittaria rigida</i>		3	X						X
<i>Vittaria elongata</i>		3					X		
<i>Vittaria scolopendria</i>		3					X		
<i>Weatherby accedens</i>		3					X		