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NATURAL HISTORY OF MOPELIA ATOLL, SOCIETY ISLANDS

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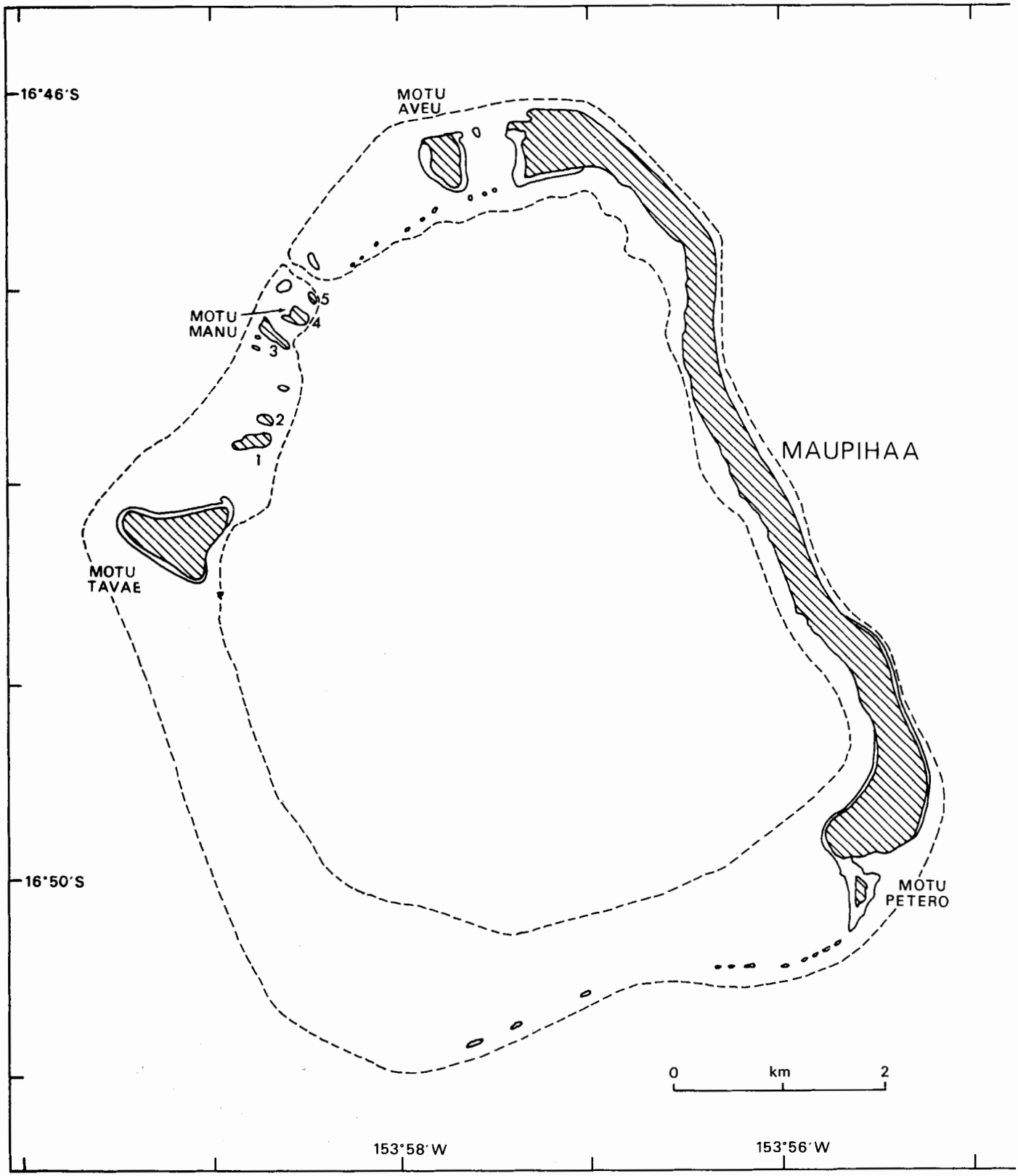

Fig. 1. Mopelia (Maupihaa) Atoll. (Adapted from Guilcher et al., 1969, by permission).

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INTRODUCTION

The archipelago of the Society Islands, in the South Pacific, includes principally high volcanic islands, with fringing or barrier reefs, but also a number of outlying atolls: Tetiaroa, due north of Tahiti, Tupai or Motu-Iti, north-northwest of Bora-Bora and, at the west end of the volcanic chain, Maupihaa or Mopelia, Scilly or Fenua Ura or Manuae, and Bellingshausen (often spelled Bellinghausen) or Motu One. The latter (15°48'S, 154°32'W) is quite small, about 5 km in diameter, and there is no opening in its triangular reef. Scilly is larger (about 15 km NNW-SSE) with several islets on the east side, and a great reef awash at the western end. There is only a small boat passage across the southwest reef, and it is a fearful thing to watch a whale-boat threading its way through it up-current, as water on a falling tide runs out of the lagoon. Mopelia (16°46'S, 153°58'W) is intermediate in size between the other two, about 8 km in diameter, and has a narrow pass through the NW reef. Its size and its pass were two of the reasons why it was chosen as the site of their studies by a group of French geographers during the summer of 1963 (Guilcher 1965, Guilcher et al., 1969). I was in Tahiti on my way to the Marquesas Islands when their group was assembling, and was so fortunate as to join their well-organized expedition for the visit to Mopelia. For this opportunity I am very grateful to the principal investigators, Professors A. Guilcher, L. Berthois and F. Doumenge, as well as to the many persons who provided logistic and other support for their work, and whose contributions are acknowledged in Professor Guilcher's papers. I planned to study the vegetation and make collections, as complete as possible, of the land flora, with observations on other aspects of land ecology as time and circumstances permitted.

The aims of the expedition itself were to study the morphology of the reefs, as well as the sediments and circulation of the lagoon. Preliminary papers have been published by Berthois and Guilcher followed

by an extensive report (Guilcher et al., 1969). Here only a sketch of the geology and geography will be included, considered as substratum and environment so to speak for the plant life.

HISTORY

Mopelia was discovered by Captain Wallis July 30, 1767 (Hawkesworth 1: 492, 1773) who described it as follows: "We ... could find no anchorage, the whole island being surrounded by breakers. We saw smoke in two places, but no inhabitants. A few cocoa-nut trees were growing on the lee-part of it, and I called it LORD'S HOW'S [HOWE'S] ISLAND. It is about ten miles long, and four broad, and lies in latitude 16°48'S. longitude, by observation 154°13'W." Later that day, he saw more low islands, and next day examined them and named them Scilly. Bellingshausen was discovered and so named by Kotzebue in March 1824 during his second voyage through the Pacific (Kotzebue, 1830: 255). He had missed the other two atolls.

On his second voyage, Captain Cook sailed by Mopelia of which he writes (1961, p. 430) in his entry for Monday June 6, 1774: "At 11 AM Saw How Island discovered by Captain Wallis which at Noon extended from west to NW distant one League, it is one of those low reef isle's of about 4 Leagues in circuit, the Most land lies on the NE part, the reef extends a good way to the SW and West and hath upon it some little islets. I think Captain Wallis found on the NW side a Channell in within the reef, but whether of a depth sufficient for Shiping or no I know not. The Inhabitants of Uliethea [Raiatea] speak of an uninhabited Isle which they call Mopeha lying to the west to which they go at certain Seasons for Turtle, perhaps this may be the Very Same. Captain Wallis saw upon it Smoaks, signs of inhabitants or people we saw none. Lt. 16°48', Longitude 154°18' West." Forster's account of the same visit (1777, 1: 161) describes it thus: "It is very low, consisting of coral ledges, which enclose a lagoon ... Several birds, called boobies, were seen in the neighbourhood of this little isle, which was to appearance uninhabited."

Turtles and birds were still in evidence when Mopelia's best-known visitor and resident, Count Felix von Luckner, arrived, July 29, 1917 with his famous raider, the Seeadler, originally an American clipper. The orchids, birds of paradise and glow-worms with which von Luckner has been accused of adorning Mopelia (Eggleston 1953: 107-108) were in reality provided by Lowell Thomas (1927: 225) in his fanciful translation of the count's works. In point of fact, von Luckner's description of Mopelia is factual and his attempt to describe the gorgeous play of colors in an atoll lagoon as good as any. His book includes photos of the reef and of the coconut plantation, and a sketch map. The Sea Devil's luck, however, was to run out here when, on Aug. 2, 1917, a great wave lifted his ship onto the reef (the exact sequence of events is disputed by Jourdain, 1973 and Clifford, 1977) and after camping on the atoll for three weeks, he left with 5 others in one of the lifeboats. Two weeks later, the rest of the crew seized the French schooner La Lutèce and escaped, her own crew and the Seeadler's prisoners

remaining on Mopelia until rescued early in October together with the 3 Tahitians who had been collecting turtles on the atoll. Von Luckner revisited the site of the wreck in 1938, but could not land (1951: 334). He died in Sweden in 1966 at age 84. During the 1950's the remains of the Seeadler were still conspicuous just south of the pass, and in 1956 Ralph Varady (1958) could still find some on the reef and in the copra workers' village. In 1963, only a few rusted remnants were visible.

Whether Mopelia ever had a permanent population is not known. According to Cook it was in 1774 a dependency of Raiatea, visited at intervals to collect turtles. At the time of the Seeadler wreck, the atoll had been leased to a Papeete company, Grand, Miller et Cie, whose 3 employees were making copra and raising pigs and chickens as well as collecting turtles.

Later, Mopelia was leased, with its two neighbors, to the Compagnie française de Tahiti and entirely planted to coconut palms, and contract personnel from the Society, later from the Austral, Islands, were installed to make copra and visited every few months by schooner. In 1963, the "village" included close to 40 persons including many children, together with a Polynesian weather observer and his family. In 1960 Pierre Vérin (1961) started some archeological surveys on Mopelia and located ancient sites and some fish hooks.

Other than casual visits described in popular books (Eggleston, Varady) and Vérin's work, the only account of Mopelia is that of Papy (1954-1956) who made a brief visit in the late 1940's and published the first botanical study of the atoll. No collections, however, survive (Papy, personal communication 1964), so that those of 1963 appear to be the only ones available. A member of the Whitney South Sea Expedition of the American Museum of Natural History (New York), Ernest H. Quayle, visited two of the three western atolls in Dec. 1921-Jan. 1922 on the "Curieuse". His destination was really Scilly, and there he spent most of his time, observing and preserving birds, and also collecting plants which I have seen in the Bishop Museum and other herbaria. Scilly was then something of a dependency of Mopelia, and the little "Pastime" commuted between the two. Quayle landed on Mopelia on Dec. 18 for 3 days, but collected no plants. None of his observations were ever published, although the leader of the Expedition, Rollo Beck, wrote a number of popular articles in Natural History as well as papers on birds. The American Museum of Natural History, Division of Birds, however, holds typed and bound copies of the notebooks of Quayle, Beck and others, and has been most generous in making them available to me and to others, for which many thanks.

According to Thibault (personal communication, 1974), Mopelia was later visited by other ornithologists, D. Blackstone in 1972 and himself on Oct. 5 and 6, 1973.

Marine molluscs were studied and collected on Mopelia's reef and lagoon by Harald Rehder, on April 27, 1973. He later also examined Scilly and Bellingshausen (personal communication).

CLIMATE

A weather station was established on Mopelia after World War II, and moved in 1958 from the lagoon shore, where the coconut plantation interfered with visibility and wind observations, to the ocean side where the instruments find a more open situation. This is at the north tip of the main islet. There exist now almost continuous records for about 30 years. Data are published monthly, and yearly summaries issued by the Service Météorologique of French Polynesia. These and other sources (d'Hauteserre, 1960) were used in the following brief description of climatic conditions. The help of Bryce G. Decker and F. R. Fosberg in summarizing the data is gratefully acknowledged.

Winds and storms: Mopelia can be described as a moist, rather hot and not very windy atoll. It is in the tradewind region, with prevailing winds from the two eastern quadrants, those from the NE occurring more than one-half of the time. A minor component, usually less than 10% in a year, is from the western quadrants. Calm weather prevails between 10 and 30% of observations for most years.

Wind speeds are preponderantly between 2 and 7 meters per second, in some exceptional years up to 20% between 7 and 14 m/sec, usually much less. The arrows of the wind roses of the U. S. Navy Pilot charts are usually for Beaufort strength 3 (4.4 m/sec) or 4 (6.7 m/sec), but indicate 1% gales (over Beaufort 8 or 16.9 m/sec) 1% of the time for the ocean square 10-20°S, 150-160° W.

Hurricanes (= typhoons, cyclones) are uncommon in SE Polynesia, especially so in the west of the area, but strong winds and storm waves can affect coral atolls. Hurricane Emma (Feb.-March 1970) passed closer to Mopelia than most storms. In April 1977, hurricane Robert, passing within 200 km SW of Mopelia on the 19th, brought heavy rains, strong winds and rough seas throughout the Society Islands. Tropical depression Diana (16-20 Feb. 1978) passed very near Mopelia bringing record rains (676 mm for the month) and cutting down copra production on Scilly and Mopelia. One of the hurricanes of the extraordinary 1983 season, Rewa (Reva), at one point was headed west in the direction of Mopelia and the other two western atolls. The people on them (19 on Mopelia) were picked up by ships (March 11), but returned the next day after Rewa abruptly changed course just north of Tupai and turned SE.

Temperatures: Mopelia has an equable tropical maritime temperature regime in which temperatures change more between day and night (5° range in June, 6.2 in Dec. & Jan.) than from season to season. They range in absolute from 20° C to about 35° C but average 24 to 28° C, with a mean temperature for the warmest month, March, of 27.6 and for the coolest, August, of 25.5 (= annual range of 2.1°).

Rainfall: Precipitation ranges, annually, between 909 (1972) and 2519 mm (1979), with a mean of 1823 mm (1953-1980). Two-thirds of the rainfall occurs during the warmest season November-April, the wettest month being December (average 268 mm) and the driest July (62 mm). There can

be great variation from year to year with record rainfall in January 1965 of 693 mm and record low in July 1963 of 0. There are usually 10-20 or more rainy days per month, with an absolute 24 hours maximum in December 1971 of 211 mm, and 155 mm, September 1969, for the dry season. Absolute minimum in wet season, March 1962 and November 1961 both with 20 mm.

Other factors: Factors which change little over the year include relative humidity, sea level atmospheric pressure, and sunshine and cloudiness. Relative humidity shows a mean daily value of 80% every month of the year with mean daily maxima between 86 (August) and 90 (January, February) and absolute daily maxima of 100 for all months; mean daily minima 66 (September) to 71 (February), absolute recorded minima, 55 (March) and 36 (August). Atmospheric pressure at sea level changes very little throughout the year, except for the minima which may indicate the passage of major storms. For instance, during the stormy weather of December 1971, a low of 995.6 mb was recorded at Mopelia. Sunshine and cloudiness: In the mean, the sky is about 1/2 obscured by clouds at all standard hours of observations, but the sun is completely obscured all day only about 11 days per year. Visibility is estimated by observers to be equal or superior to 20 km on 340 days of the year.

GEOGRAPHICAL SETTING

Mopelia is a small atoll, somewhat trapezoidal, with the corners corresponding fairly well to the points of the compass, the N-E and W-S sides being longer than the other two. The reef is continuous except for the narrow pass located about half-way between the west and north corners. It is narrowest along the NE side of the atoll, where its surface is covered by a continuous strip of dry land, the main islet. The south tip of this strip, just beyond the E corner of the atoll is prolonged by a small sandy islet, Petero. Near the north tip of the main islet, and separated from it by a shallow bay, is Aveu islet, at the north corner of the reef. There is another larger islet, Tavae, at the west corner of the atoll, and between it and the pass a number of very small islets are scattered on the lagoon side of the W-N reef. For our present purposes, the larger ones are numbered 1 to 5, no. 4 being labelled Motu Manu on the chart and no. 5 lining the pass. There is no dry land, except perhaps for some patches of rock to be discussed below, on the W-S and S-E parts of the reef, and they were not examined by me.

The most striking aspect, as one approaches Mopelia from the east, is the occurrence on the reef flat, like a sidewalk above a street, of a higher rock surface which, from a distance, seems very regular in height, one meter or more above the reef flat. This would appear to be an older reef surface, planed and locally dissected. Where it touches on the islets, it becomes an important type of substratum for land plants. It is broken into patches of varying sizes, the largest of which stretch between the main islet and Aveu, lining the oceanward side of both islets, and along both sides of the pass. Similar, but more scattered patches are strung along the S-E reef flat, and what seems to be the same rock forms patches at the south tip of Petero islet and beyond, and along the ocean side of the main islet at the east corner of the atoll.

The lagoon of Mopelia is rather deep, locally reaching 40 meters. It was studied in detail and mapped by Guilcher et al. (1969). Some coral patches come up very close to the surface of the water. As in coral island lagoons everywhere, the color of the water varies with the depth, the bright blue of the southern part locally gives way to shallower green areas, passing to very pale as the shores are approached. The lagoon shores of the islets are almost everywhere sandy. There is a patch of incipient beachrock on the lagoon shore of Tavae islet, but it barely emerges. Some rocky shores occur on the main islet forming small points jutting into the lagoon.

SUBSTRATUM

On an atoll such as Mopelia, the whole above-water land area is formed of organic limestone, skeletons and fragments of tests of marine animals and plants. This material may be solid fossil reef with corals in position of growth, with interstices and openings filled in with clastic fragments, still loose or cemented, or lithified into breccias or conglomerates. Much of the islet sediment forms unconsolidated piles of debris, the texture of the organic fragments ranging from sand to pebbles, cobbles and small boulders in variously sorted or unsorted mixtures, and either water-worn and rounded or angular and sharp.

The bare surfaces, whether lithified or loose, are generally blackened by endolithic blue-green algae, which are said to contribute to weathering by disintegration and subsequent solution of the rock surfaces. Wherever loose sand is not densely covered by vegetation the surface centimeter or so is caked, stuck together by a mass of blue-green algae of several kinds to form a friable, or when wet, gelatinous, crust, also of a dark, usually gray color.

Around much of the periphery of the land area a platform or ledge of island conglomerate is exposed, protruding from beneath the mass of unconsolidated material, and locally extending across the reef to form patches and blocks on the reef flat. Such a platform possibly extends across all or most of the islets, underlying the loose overburden or soil. It was not possible to investigate this by digging or boring test holes in the time available.

Along the seaward windward coast is a broad low beach ridge of clastic material, mostly coarse in texture, with some sand and much shingle thrown up against it as beaches.

On atolls generally, and strikingly so on Mopelia, there is very little soil formation. Generally some humus accumulates in the surface, darkening it. In coarse sediments this humus tends to fill the interstices and form a matrix which contains quantities of plant roots, and undoubtedly nourishes the plants.

Inland the soil tends to be sandy, mixed with larger coral fragments. Here, where humus would normally accumulate to form good soil for plant growth, periodic clearing of undergrowth and burning of trash, coconut leaves, and litter, keeps what little humus could be expected from building up in any quantities. The surface layers are darkened, but with low organic content, grayish to "milk-chocolate" color, soon changing downward to pale coral sand and gravel. This soil profile, called the "Shioya Soil Series" in Micronesia, is notoriously deficient in certain minor but essential nutrients, judging by analyses of Shioya samples from the Marshall Islands. This is most likely the case on Mopelia, too.

In the tropics generally, litter of leaves and other plant debris decomposes very rapidly and even good soils tend to be rather thin. In

atolls, under some trees, the litter remains for some time and is especially noticeable in pure stands of Tournefortia, Guettarda, Suriana and especially Pandanus. Very thin layers of discolored "soil" occur under the litter.

In one or two places, especially in the interior of Motu Manu, are small areas of phosphatic soil, such as is called the Jemo Series in Micronesia, found under Pisonia groves inhabited, at least formerly, by large numbers of sea-birds. The soil profile includes, under leaf litter, often stained with guano, a top layer of acid raw humus of partly decomposed Pisonia leaves and twigs, then a layer of crumbly or sub-lithified coral sand altered or partly altered to calcium phosphate, brown with white speckles and light in weight, this overlying unaltered coral sand. Areas of the "Jemo" phosphatic layer may exist elsewhere on the atoll, marking the sites of former Pisonia groves, but very difficult to distinguish, when exposed and weathered, from ordinary coral rock.

Normally differences in soil are indicated, at least roughly, by differences in vegetation. Here on Mopelia most such indications are eliminated by the conversion of the land to coconut plantation. However, Pisonia groves, when relatively pure stands, may indicate "Jemo" phosphate. Suriana almost surely indicates sand or loose gravel, while Pemphis almost as reliably indicates consolidated limestone rock.

One more thing should be mentioned. In places, if holes are dug in the interior unconsolidated areas, buried soil profiles are encountered, indicated by darkened horizons covered with lighter, fresher sediments. These apparently originate when severe storm-waves carry large amounts of beach sediments into the interior, spreading unweathered layers on top of a developed soil. This phenomenon is common on many atolls, and shows up in some profiles on Mopelia. Animal activity also creates some mixing and turning over of the soil. Earthworms occur on atolls, but in very small numbers, and most of the disturbance of land surfaces results from the burrowing of land crabs, and locally probably coconut crabs, as observed on Motu Aveu where fairly large holes, exposing "milk chocolate" soil, were common under Tournefortia trees, and where soil layers became mixed when the holes collapsed.

LAND VEGETATION

The overriding characteristic of the vegetation of Mopelia is that most of it, especially inland, is very profoundly disturbed, coconut palms having been planted everywhere. In 1963 the only traces reminiscent of what the original inland vegetation may have been like could be found at the southern end of the main islet and on Tavae islet. Unfortunately, the latter, by far the most interesting part of the atoll, could only be examined on 2 short visits when boat transportation was available. From these areas, it appears that the atoll must have been originally covered by a tall mesophytic forest consisting of a locally varying mixture of a few species. There may have been a lower story of saplings, smaller trees and tall shrubs, and in the ground cover mostly shade-loving ferns. This forest would be comparable to that in the central or southern Marshall Islands, though perhaps not as luxuriant as that known in the southernmost (and wettest) of these atolls, as could be expected from a comparison of rainfall data.

The shore vegetation of Mopelia has undoubtedly been much less affected by human intervention than the inland forest, but it is also less characteristic of a particular atoll or group of atolls because it is less influenced by the variables in the substratum and the climate (mostly rainfall), the effects upon it of winds and salt-spray being pre-eminent.

The principal plant communities may be described in general terms, and local variants discussed in a more detailed account of the various parts of the atoll.

Ocean shores: Except on the most arid atolls, the ridges of sand or coral rubble that rise on the ocean shores, especially to windward, usually support a scrub of salt- and drought-resistant shrubs about 2-3 meters in maximum height. This is a relatively constant type, with minor local variations in stature and species composition, throughout the Indo-Pacific tropics on atolls and barrier reef islets, with a similar but floristically different vegetation on Caribbean and Gulf of Mexico coral islands. In the Pacific atolls, this strip of scrub, which has been especially well described in the Marshall Islands, includes Scaevola sericea as a principal component, together with Tournefortia argentea and Suriana maritima and various other species in smaller amounts. On Mopelia on the windward seaward side, that is, along the long N-E main islet, this typical scrub is well developed. Where the Scaevola, Suriana and Tournefortia are rather open, there are locally creeping woody vines of the widespread Indo-Pacific Triumfetta procumbens and scattered clumps or spreading shrubs of Timonius polygamus (Rubiaceae) endemic to South Polynesia. Like Scaevola it has shiny bright green leaves very resistant to winds and salt-spray. On the seaward slopes of the beach-ridges, this marginal scrub generally forms a very even cover, with prostrate, scattered Scaevola and Timonius at the top of the beach, becoming closed, denser and taller landward with a very smooth profile resulting from wind-shearing by the prevailing trades laden with salt-spray. In fact, this scrub belt forms a sort

of wind-break against the worst of winds and salt effects and behind it more mesophytic and taller vegetation may occur. So it is on Mopelia where immediately behind this scrub, on the top or on the landward slope of the ridges, there is a strip with taller Scaevola and much Guettarda speciosa laced with the orange stringy stems of the parasite Cassytha filiformis.

On more leeward shores, the beach ridges are less high, and slope very gently toward the intertidal reef flat, forming a beach of small gravel or sand. On such slightly sloping surfaces typical atoll vegetation consists of scattered clumps of herbaceous salt-resistant species, or spreading prostrate herbs or small woody plants. On Mopelia this type is well developed on the ocean side of Tavae islet where it includes mainly tufts of Lepturus repens, small depressed plants of Portulaca and, somewhat more inland, Heliotropium anomalum. These pioneer species may also occur in pockets of sand or small gravel on rocky pavements. Immediately behind this zone of scattered herbs rises a strip of low forest, often of pure Tournefortia argentea with much leaf litter beneath.

The rocky platforms lining some of the islet shores are occupied by Pemphis acidula, forming low prostrate mat-like shrubs or large densely branching trees in a pure stand, with every possible intermediate aspect.

Lagoon shores: The vegetation of these shores is more variable, as are the shores themselves. In the case of an immense lagoon, such as some in the Tuamotus, the vegetation may be much exposed to the weather and a scrub fringe similar to that on the ocean side may protect the inland forest. This does not occur on Mopelia. On the less disturbed smaller islets (on Tavae), the lagoon and channel edges of the vegetated land bear forest of Tournefortia, Guettarda, with some Pandanus and Pisonia, or scrub forest or tall scrub of the same species (on bird islands, Aveu, Petero). Along most of the main islet, the lagoon shore is very narrow and the coconut plantation extends to the edge of the water in many places.

Mangrove vegetation and sea grass beds are quite lacking.

Vegetation inland: On very small islets such as the bird islets and Petero, the strand scrub forest "fills" the whole land area, with some coconut palms in the middle; elsewhere, except for traces of the original forest, the coconut plantation covers the whole interior with undergrowth in various stages of clearing and regrowth.

There are no marshy areas and no taro swamps, which is not surprising on a small atoll where there may never have been a permanent aboriginal population. The only other aspect of the vegetation consists of the few poor gardens and planted shrubs and trees of the village and the Station, with their cortege of introduced weeds.

In his study of the land vegetation of the Society Islands, Papy (1956: 182-183) gave a generalized section from ocean to lagoon of the

southern end of the main islet of Mopelia: 1. sandy beach with Lepturus repens, 2. scrub of Scaevola and Pemphis and on the beach crest Heliotropium, 3. forest of Tournefortia, Guettarda and Pandanus with lianas and ferns, 4. forest of Pisonia with Boerhavia tetrandra, and 5. scrub of Scaevola and Pemphis. Like many other observers, Papy thought that Pisonia favored a soil richer in organic matter and guano, when in reality, this type of soil forms under the Pisonia.

Description of islets:

Motu Aveu: This is a land area about 0.6 km long and a half or third as wide, oriented transversally on the north reef of the atoll, a half km or less west of the NW end of the main islet. The north (ocean) side is a wide strip of elevated reef rock, densely covered by tall Pemphis scrub which gets shorter northward toward the sea, where the reef rock is separated by erosion into a number of remnants of various sizes, the larger covered by Pemphis. The sandy, larger part of the islet is planted to coconuts, but on the west side along the width of the reef are numerous Tournefortia trees and some Cordia subcordata.

Islets on NW reef, between pass and Motu Tavae: A half-dozen remnants of the older slightly elevated reef platform, with sand and gravel accumulations, plus many small rocks are scattered SW of the pass. Their vegetation is very impoverished, but richer on the larger islets. The species present are obviously those that can stand exposure to sun, wind and salt-spray, with accumulated guano and other effects of roosting and nesting sea-birds. Pemphis acidula scrub is the most obvious and frequent component of the vegetation mosaics, found on otherwise bare rock or rock with a thin cover of sand, even on some tiny rock remnants. Where the accumulation of sand and gravel is thicker, Pemphis may be wholly or partly replaced by other species such as Tournefortia argentea, Scaevola sericea, and, on larger islets, Pisonia grandis. On the one or two largest islets, a few coconut palms are planted and Portulaca, Boerhavia, Lepturus, and Achyranthes are common. On Motu Manu, itself, is a Pisonia grove with a raw-humus layer and phosphatized limestone debris.

Motu Tavae: This triangular wooded islet, about 1 km on its long side, is situated at the westernmost point of the atoll reef. It is, mostly, an accumulation of coral sand and gravel, lined along the north shore by old, much eroded and pitted, slightly elevated "fossil" beach-rock. The lagoon shore, a gently sloping sandy beach, shows some incipient beach rock, locally still soft, but passing to the older, higher beds northward. At the western extremity the beach rock is lined then replaced with an exposure of eroded conglomerate reef platform, slightly above sea-level, extending out westward to a line of platform remnants near the reef-edge. On some of the platform rock at the western point of the island there is Pemphis scrub, with a few outlying Pemphis bushes on rock surfaces.

Most of the islet surface is covered by a forest, locally very dense, of large Tournefortia, Guettarda, Pisonia, Cordia, Hibiscus

tiliaceus, Pandanus tectorius and Morinda trees with sparse patches of coconut palms here and there, connected by paths for gathering nuts for copra making. The ground cover, especially in openings, includes Portulaca, Boerhavia, Thuarea, Achyranthes and Polypodium and other ferns. Around the edges of this forest is an interrupted fringe of small Suriana and Tournefortia with Lepturus on sand at top of beach. In openings and thin places in the forest Scaevola, Suriana, and Timonius are common, with Polypodium, Asplenium, Lepidium, and Ipomoea macrantha. Near the west end is a thin sand and gravel area just back of the shore with Lepturus and Heliotropium anomalum, and several bushes of Ximenia americana in edges of forest. Around a copra shed and house is an opening with semi-weedy vegetation of Cyperus, Triumfetta, Vigna marina, Euphorbia hirta and planted Hibiscus tiliaceus. The latter species, somewhat inland, forms tangled jungle-like patches.

Motu Tavae in 1963 was the least altered by man of all the non-rocky land on Mopelia.

Mopihaa (Mopelia) or Main Islet: The principal land area on Mopelia Atoll is a long, narrow strip of land, about 8-9 x 0.3-0.5 km, lying on the east reef of the atoll. It is essentially a deposit of coral gravel and sand lying on a reef platform surface slightly elevated to about 1 m above low tide level. This platform extends out from under the loose deposits of the islet at various places around the periphery, especially around the two ends, which form slight hooks, following the curves in the reef (see map). Along the east side, especially, a beach ridge of sand to mostly coarse gravel and cobbles has been thrown up by wave action.

Keeping in mind the profound disturbance of the original vegetation and the resulting likelihood of rapid change in aspect if the character of human interference varies, we can distinguish the following vegetation types along the ocean shores. This is the least disturbed vegetation on Mopelia and it reflects well the variation in exposure and substratum. On the windward (N and N-E) side, that is, the ocean shore of the main islet, there is hardly any sandy substratum. At the Meteorological Station (ocean shore opposite the village) which served as expedition base camp, the cobble beach ridge is topped by a dense strip of tangled Scaevola bushes about 1-1.5 m high with stunted Tournefortia trees rising above them. The oceanward slope of the ridge has a very open scrub of prostrate Scaevola, with some very long branches, almost like runners, and isolated small (a meter at most) Tournefortia plants, many of them rather leafless. Scattered small plants of Suriana maritima are also present. Much of the white cobble ground is exposed. The slope passes to pebbles and eventually to a beach of coarse sand, but is then bare of plants except for a gray to black crust of algae identified by Jan Newhouse as Calothrix confervicola, Phormidium submembranaceum and Anacystis montana. Farther south-east where the island juts somewhat into the ocean, the cobble ridge is highest, perhaps 3 m above the level of the reef, and the fringe of shore vegetation better developed. There is a wide strip of Scaevola shrubs, up to 2 m tall, and of Suriana, the profile illustrating beautifully the wind-shearing

effect of the prevailing trades. Oceanward, the strip passes smoothly to lower, then prostrate,plants of Scaevola mixed with scattered ones of Timonius polygamus with 4- or 5-pointed corollas and round purple berries. This plant was described from the Tuamotus, where it is very abundant.

The open prostrate scrub on the upper slope of the cobble ridge includes also scattered plants of Tournefortia under a meter in height, and often leafless, and, especially where a little sand fills a hollow, the long spreading branches of prostrate Triumfetta procumbens. There are no herbaceous plants in the vegetation fringe of the windward shore. Along the southern half of the main islet the beach ridge is narrower, lower and of smaller cobbles and pebbles, and passes more rapidly to a beach of coarse sand. There the strip of vegetation is almost pure tall Suriana, 2 or more meters in height, with a carpet of its small golden-brown leaves covering the ground.

On the outer parts, where the rock platform protrudes from beneath the sand and gravel, the vegetation almost abruptly changes to a scrub forest or scrub of small-leafed, intricately branched Pemphis acidula, varying in places with exposure down to a creeping, mat-like dwarf scrub. In large parts of the periphery, both on seaward and lagoonward sides, the Pemphis vegetation, often reaching tree-size, is the first impression beneath the coconut forest, that the visitor gets on approaching the island. Pemphis resembles Suriana in appearance, but the leaves are stiffer, grayer green, the twigs are stiff and harsh, and the flowers are white instead of yellow.

In some areas, especially toward the south end, where the coconut palms are either sparse or absent, inward from the beach ridge, a scrub forest of Tournefortia occurs, occasionally of sizeable trees. On the lagoon side, where the beach ridge is absent, this Tournefortia forest may be found on the shore, or directly back of the Pemphis. It may in places be mixed with, or replaced by Guettarda, Pandanus, Morinda, and Pisonia, with some rather tall (2 m) Scaevola, in varying mixtures. With this and into the coconut plantation Timonius may be found in an open shrub layer. All may be tangled with extensive vines of Ipomoea macrantha bearing large white flowers.

Where the lagoon shore is of sand and lacks protruding old reef platform, the vegetation immediately along the shore may be a tall fringe of Suriana, sometimes hard to distinguish at a distance from Pemphis except that it is likely to be greener.

Inland, between the lagoon-coast vegetation just described and the seaward beach ridge, the entire flat, gravelly, and sandy area the full length of the islet has been converted to coconut plantation. This is theoretically kept clear of all vegetation except an open to continuous herbaceous layer of Stenotaphrum, Eragrostis, Lepturus, Tacca, Polypodium, and in less dense areas, other, mostly weedy, herbs. Actually, one observes different areas in all stages of regrowth of woody species including most of those mentioned above except Pemphis,

Suriana, and Tournefortia, which thrive better along the coast. The luxuriance of the woody regrowth depends largely on how long the area has remained uncleared. A few large trees, especially Guettarda, are apparently purposely left standing in the plantation, but not many.

None of the vegetation except the Pemphis which grows on bare limestone rock can be said to be undisturbed, or natural in any accepted sense of the word. Disturbance is continuous and all vegetation may be regarded as pioneer or successional.

The village of the plantation workers is located at the north end of the main islet, in a bend of the lagoon shore. Almost directly opposite, across the land strip and just inland from the ocean beach ridge is the Meteorological Station, in a fenced yard. Both sites are shaded by planted and other trees, including Casuarina, Hibiscus, Calophyllum, and the various households tend little gardens. None of these appeared particularly flourishing in 1963. In spite of soil brought from Tahiti, the substratum seemed very poor and the plants unhealthy. They were perhaps also overly shaded by coconut palms. It must be remembered also that the people came from the Austral Islands, where conditions are quite different.

In addition to species included in the list of plants below, I noted the following: a red-flowered Hibiscus rosa-sinensis or a hybrid ornamental, sweet potatoes said to be of 2 varieties, a Capsicum with erect red fruit, 2 sickly tomato plants, small manioc plants (Manihot esculenta), a seedling mango (Mangifera indica) and avocado (Persea americana), and a tiny "mape" (Inocarpus edulis), "ti" (Cordyline fruticosa), Pedilanthus tithymaloides. None of these plants seemed likely to survive long, although a few belong to species which can grow on atolls with care. Other vegetables had been tried but had died. I was told that many Calophyllum trees had been knocked down, as well as some "miro" (Thespesia populnea), a species which I did not find anywhere.

Motu Petero: This is a tiny patch of sand and gravel, with an extension east and south of reef-platform, cut at its edges by erosion into small remnants. On this rock is a low dense cover of Pemphis scrub. Inside the Pemphis zone on the east and south is an expanse of sand with Suriana scrub. On the main body of the islet are a few planted Cocos with Tournefortia, Pisonia and Guettarda, forming a small patch of forest, with a fringe of small Tournefortia and Suriana around its west and north sides.

Between the S tip of the Main islet and Petero, and inside the protective barrier formed by older reef-rock remnants, stretches a low muddy flat usually free of water, in places somewhat elastic underfoot and covered with a putty-like layer of cyanophyceae ranging in color from dirty yellow to orange-brown and green below. When drier, this area feels sandier and the blackish crust of algae forms lumpy masses or curls in scaly patterns. Guilcher et al. (1969: 45) have compared this area to a small "sebkha" or desert drying salt hard pan. Here I collected Schizothrix calcicola and Calothrix confervicola (det. Jan Newhouse).

Of the slightly elevated reef remnants strung along the reef edge from Petero islet westward to the southernmost of the atoll, the last one, investigated by Guilcher et al. had a vegetation of Pemphis, Portulaca and Lepturus (personal communication).

MARINE VEGETATION AND FLORA

Observations made by the geographers on the role of algae in the formation of the Mopelia reefs were reported by Guilcher, Denizot and Berthois (1966) and repeated in Guilcher et al.. (1969: 31). The authors consider that the pink outer reef crest is essentially veneered and cemented by Porolithon onkodes, rather smooth or only slightly undulating, and P. craspedium, more irregular or convoluted in surface, and found in slightly quieter situations. The Porolithon spp. become thicker when they overhang or even bridge over the edges of surge channels. The role of other algae in the reef flat is also described.

I made only a few casual observations and collections of marine algae as I walked across shallow reef flats from motu to motu. On the reef flat, around Motu Aveu, I noticed bouquets of Halimeda sp. on sandy substratum. Halimeda micronesica (det. Roy Tsuda) was collected under rocks on the reef near the Meteorological Station, as was Turbinaria ornata. Large pebbles on the reef were encrusted with a red alga (Cruoriopsis sp.?).

Obviously much work is needed on the marine flora of Mopelia, as indeed on the fauna.

FAUNA

Because nothing has been published as yet on the fauna of Mopelia, except for notes on the birds (Thibault, 1974; Holyoak, 1974), I will mention briefly the animals I saw during my stay. Among the fish, I only noted the small yellow sand sharks with a black spot on the dorsal fin (Carcharhinus melanopterus) cruising lazily in the shallow lagoon near Tavae islet or on the reef, and some flat fish (Bothus sp.) camouflaged on the shallow reef flat.

We were told by the plantation workers that green turtles were caught in some number, arriving in Sept.-Oct. into the lagoon and on beaches. They said they took about 200 a year, all females; one person who had lived on Scilly for a number of years reported that turtles were much more numerous there, and that many were taken, possibly too many. A skink was extremely abundant in the plantation and elsewhere, the larger ones having an azure stripe on the tail (Emoia cyanura). Two geckos were common also, one of them especially so in buildings. Lizard eggs were observed in assorted hiding places such as cracks in cupboards and drawers, old coconuts, under tree bark or even under small rocks on the ground. I collected Lepidodactylus lugubris, Emoia cyanura and Cryptoblepharus boutonii (determined by George Zug, who also kindly gave me the names in current use for all the lizards).

During his visits to Mopelia and Scilly atolls, E. H. Quayle observed and collected reptiles and his specimens were identified by Ortenburger (1923): a sea turtle, Chelonia mydas (as C. japonica), from Scilly; geckos, Gehyra mutilata (as Peropus mutilatus) from Mopelia, Gehyra oceanica from both atolls, Lepidodactylus lugubris from Scilly, and skinks, Lipinia noctua (as Leiolopisma noctua), Emoia cyanura and Cryptoblepharus boutonii (as C. poecilopleurus), all from both atolls.

According to Legand (1950:172), turtle eggs were collected and the young turtles raised in pens on Mopelia for later release. This experiment lasted only for a short time.

Birds were very abundant especially on the smaller motus. The reef heron occurred near the shore, or even far out on the reef flat at the edge of the surf, on the Main islet and off Aveu. I saw 5 together near Petero, on the reef, 2 dark gray-blue, 2 white and one with blue spots, all with yellow legs. Elsewhere I had noticed only one or 2, all white or all dark, but the spotted phase was also mentioned by the weather observer ("le météo") from Bora-Bora, who called the herons "otu'u." Other shore birds included curlews (Numenius tahitiensis) called kivi by the workers and golden plovers (Pluvialis dominica fulva) seen foraging on the lagoon shore or walking in the plantation. Also on shore, some yellow-legged grayish birds which may have been wandering tattlers (Heteroscelus incanus).

Of land birds I saw only a few mynah birds (Acridotheres tristis) in the village, and a long-tailed bird in a coconut palm which must have been the New Zealand cuckoo (Eudynamis taitensis). Quayle, in 1921, observed the vini (Vini peruviana) in small numbers on Mopelia, but it was nowhere to be seen in 1963. Chickens were kept in the village.

Seabirds: several species were present in large numbers.

Frigate birds (Fregata sp.) were observed flying and chasing boobies and tropic-birds to steal their fish. They were nesting in Pemphis trees and one very small naked chick and some downy young were observed, as well as one with white neck and breast and rusty head sitting in a tree. Many more birds could be seen but the nests could not be inspected.

Brown boobies (Sula leucogaster) were seen mostly around the bird islets on the NW side. Their nests, on sand or small gravel, were large, sometimes 10-15 cm thick, and made up of coconut husks, branches or plants of Portulaca, twigs and leaves of Pisonia and Tournefortia, and contained eggs or naked and downy chicks. Red-footed boobies (Sula sula rubripes) nest in the Pemphis shrubs or trees between Motu Aveu and the main islet and on the lagoon side of the main islet; on Petero islet, they sat in Pemphis but also in Tournefortia trees. The largest number were on Motu Tavae and the various bird islets, with large chicks and dark colored flying juveniles. I could not look into the nests for eggs or small chicks.

Red-tailed tropic-birds (Phaethon rubricauda) were fairly numerous on Mopelia. The plantation workers pulled out their red tail feathers and showed me large bunches of them. The birds were seen flying but mostly sitting in nests on Motu Manu and Motu Tavae. Large chicks, downy with white and black speckled wings and a strong black beak, sat under low Tournefortia tree branches, waiting for parents. On Motu Tavae, downy chicks, some very small, were hidden under large roots or horizontal tree limbs. To reach them, the parent birds had to crawl and drag themselves through tangled vegetation from their landing and taking off areas in the open.

Among the terns, the sooty terns (Sterna fuscata) were the most abundant, roosting and nesting in open areas among all the bird islets. A large colony with eggs sat on islets 1 and 2, another with eggs and tiny chicks on the next 2 islets and along the edges of Motu Manu and along the Pass.

The brown noddies (Anous stolidus) were not observed nesting. They flew over the lagoon and reefs or sat on reef remnants along the shore near Motu Aveu and S of Petero, all pointing into the wind.

The crested tern (Thalasseus bergii) fished singly or in small groups, patroling the lagoon shores of the main islet. A few were seen sitting on rocks S of Petero. Between bird islets 2 and 3, they sat on an open gravel bank, black crest erect, with one or two small chicks.

The most familiar and inquisitive of all the birds, the fairy terns (Gygis alba) occurred in small groups near Motu Manu and other bird islets. One at least had a downy chick in camouflage plumage, digging its sharp claws into the branch where it had hatched. The fairy terns flew over the reef and lagoon, and fluttered in the plantation and near buildings, visiting and examining everything.

Rats were present, as evidenced by holes chewed in fallen coconuts. I only saw 2, one on Motu Manu, and on Motu Tavae a small brownish one with a long tail which I took to be Rattus exulans, the Polynesian rat.

The plantation workers kept a number of pigs, wandering about the village and the plantation. Some had been given an armload of Portulaca sp. to eat. There were a dog and a cat or two.

Among land invertebrates, commonly seen insects were: mosquitoes (including Aedes polynesiensis), flies, including a bright metallic green one in grassy areas, wasps with small papery nests, ants, small moths, a black butterfly with blue spots (Hypolimnas sp.?) from Cordia, dragon flies with thick red bodies, beetles, a delicate green grasshopper and cockroaches. I observed many small spiders, an isopod, diplopods and a few earthworms. A few of these were collected but not yet named. Scolopendra morsitans is reported to be present, but I did not see it. Hermit-crabs were very common, I collected at least 2 species of Coenobita. The large red ones in their Turbo shells often piled up in the shade or among roots of shrubs, especially Tournefortia and could be found climbing up to 1 m or more in the trees. Coconut crabs (Birgus latro) were reported.

From an old coconut and dark soil and litter under Guettarda I collected tiny land molluscs (all det. H. A. Rehder): Assiminea sp., Lamellidea pusilla (Gould), Gastrocopta pediculus (Shuttleworth), Opeas gracile (Hutton), and Opeas oparanum (Pfeiffer). With these were 2 marine gastropods: Bittium zebrum (Kiener) and Mitrella rosida (Reese).

Marine Mollusca

by Harald A. Rehder, Smithsonian Institution

The following list of 64 species comprises all the species collected by my wife Lois and me on Mopelia, or recorded from there by Dautzenberg and Bouge (1933). These authors listed 27 species as occurring on this atoll. I have marked with an asterisk those species listed by them that we did not find during our brief stay on Mopelia of only one day in April 1973. I have cited in the synonymy of certain species the names given by Dautzenberg and Bouge that are not now in current use.

It goes without saying, of course, that this list is in no way complete, as more extensive collecting would considerably increase it.

Patella (Scutellastra) flexuosa Quoy & Gaimard
Patella stellaeformis var. tuamotuensis Gould (emend.)

Turbo (Senectus) setosus Gmelin

Astralium confragosum (Gould)

Littorina (Littoraria) coccinea (Gmelin)

*Littorina (Littorinopsis) scabra (Linné)

Tectarius grandinatus (Gmelin)
Tectarium (Echinella) bullatum Martyn

Nerita plicata Linné

Rhinoclavis cedonulli (Sowerby)

Cerithium alveolus Hombron & Jacquinot

Cerithium columna Sowerby

Cerithium salebrosum Sowerby

Cerithium nesioticum Pilsbry & Vanatta

Sabia conica (Schumacher)

Strombus mutabilis Swainson

Cypraea caputserpentis Linné

Cypraea moneta Linné

Cypraea obvelata Lamarck

Cypraea maculifera Schilder

Cypraea depressa Gray

Cypraea ventriculus Lamarck

Bursa granularis Röding

*Cymatium mundum (Gould)

Thais (Thalessa) armigera (Link)

Drupa ricinus (Linné)
Ricinula ricinus var. arachnoides Lamarck

Drupa morum Röding
Ricinula horrida Lamarck

Drupa (Ricinella) clathrata Lamarck
Ricinula clathrata var. miticula Lamarck

Drupa (Drupina) grossularia Röding
Ricinula digitata Lamarck

Morula granulata Duclos
Sistrum tuberculata Blainville

Morula uva (Röding)

Muricodrupa fenestrata (Blainville)
Muricodrupa cariosa Wood

*Pascula species
Sistrum cavernosa Reeve

This is not Pascula ochrostoma (Blainville) but an undescribed species found in Micronesia and Polynesia.

Maculotriton serriale (Laborde)
Colubraria digitalis Reeve

Pollia undosa (Linné)

Peristernia nassatula (Lamarck)

*Mitra mitra (Linné)
Mitra mitra-episcopalis Linné

Mitra (Strigatella) litterata Lamarck

*Vexillum (Pusia) emiliae Garrett

*Vasum ceramicum (Linné)

Conus ebraeus Linné

Conus chaldaeus Röding

Conus miliaris Hwass

Conus nanus Sowerby

Conus sponsalis Hwass

Conus aristophanes Sowerby

Conus lividus Hwass

Conus miles Linné

Conus catus Hwass

*Conus pulicarius Hwass

Conus tulipa Linné

Conus canonicus Hwass

*Conus coronatus Gmelin

*Terebra crenulata Linné

Terebra maculata Linné

Arca zebra Bruguière

Hyotissa numisma (Lamarck)

Isognomon perna (Lamarck)

Isognomon concisum (Conrad)

Chama cf. spinosa Broderip

Chama species

Codakia (Epicodakia) bella (Conrad)

Tridacna maxima Röding

Gafrarium pectinatum (Linné)

Arcopagia (Scutarcopagia) scobinata (Linné)

Macoma (Scissulina) dispar (Conrad)

TERRESTRIAL FLORA

General observations

The native flora of Mopelia seems fairly typical for a coral atoll, though perhaps rather impoverished, as do those of the other two westernmost atolls of the Society Is., Scilly and Bellingshausen. The species present are all to be expected, with no surprises. 85 species are reported here from Mopelia, 35 of them probably native. The weed-flora of 30 species is large and indicates intense human influence. The planted species, 15 in number, are surprisingly few but reflect the transient nature of the human population.

More species could probably be found, both native and exotic, especially considering that I had very little time on one of the richer islets, Tavae. Some atoll species have a very limited or spotty distribution, and can easily be missed during a brief survey.

It is curious that so few of the phytogeographically interesting plants of the coral islands of eastern Polynesia are present on Mopelia. Digitaria stenotaphrodes, Timonius polygamus, Heliotropium anomalum, and Solanum uporo are all present, but as many others that might have been expected, were not found. Among those missing may be mentioned Sesbania coccinea, Nesogenes euphrasioides, Terminalia samoensis, Nervillia aragoana and Hedyotis romanzoffiensis. Mopelia, like the other four Society Islands atolls, apparently lacks any trace of elevated limestone, which might add a further set of species not usually found on low atolls.

A further visit to Mopelia would be desirable to examine more thoroughly areas not well covered in 1963, and to observe and assess any changes in the flora, additional weeds, or plants that have disappeared, and other effects of 20 more years of human activities.

Systematic List

In the following list, I have cited all the plants I collected or observed on Mopelia in 1963. All my specimens are deposited in the U.S. National Herbarium in Washington (US), with almost complete sets of duplicates at the B. P. Bishop Museum in Honolulu (BISH) and the Paris Herbarium (P). Another set, left in Tahiti, was destroyed by insects. An asterisk * before a name indicates that the plant was introduced by human activities.

I have in preparation a chapter on the plants of Scilly Atoll intended for a volume, edited by B. Salvat, on his research team's study of that island in January 1979. In addition to the plants then observed and cited in a preliminary report, that enumeration will include those listed by Papy (1956: 180-183) and the only specimens extant, collected by E. Quayle in Dec. 1921 - Jan. 1922. Considering how little has been published on the three atolls, I decided to include here with the Mopelia plants abbreviated records from the Scilly list, and sight records made on Bellingshausen Atoll by Pickering in Dec. 1839 and by Papy.

BRYOPHYTA

Calymperes quaylei Bartr.

Scilly (coll.).

Calymperes tuamotuense Bartr.

Main islet, south tip, Sachet 977.

Common on some tree trunks and on ground. Only seen sterile and dried.

Leucophanes cf. albescens C.M.

Main islet, south tip, Sachet 978.

On a coconut trunk. Silvery, seen only sterile and dried.

PTERIDOPHYTA

POLYPODIACEAE

Asplenium nidus L.

Motu Tavae, Sachet 975.

Common locally, mostly growing on piles of coconut husks in forest, coral ground.

Scilly (sight).

Nephrolepis hirsutula (Forst. f.) Presl

Main island, between village and middle of length of islet, Sachet 908.

Occasional in large clumps along road, in coconut plantation. This growing on pile of husks.

Polypodium scolopendria Burm. f.
Polypodium phymatodes L.

Main islet, in coconut plantation, coral ground, Sachet 959.

Very common everywhere.

Scilly (coll.), Bellingshausen (Pickering).

PHANEROGAMIA

PANDANACEAE

Pandanus tectorius Park.

Main islet, south tip, Sachet 979.

Keys found under tree. Found everywhere.

Scilly (sight), Bellingshausen (Pickering, Papy).

POACEAE (GRAMINEAE)

*Cenchrus echinatus L.

Main islet, in coconut plantation, coral ground, Sachet 929.

One small patch along road.

Scilly (sight), Bellingshausen (Papy).

Digitaria stenotaphrodes (Nees) Stapf

Main island, between village and middle of length of islet, Sachet 910.

Common along road and cuts in coconut plantation. (Also just back of strand.)

*Eragrostis tenella (L.) Beauv.

Main islet, in coconut plantation, coral ground, Sachet 928.

Common in ground cover.

Lepturus repens (Forst. f.) R. Br. var. repens

Main islet, Sachet 990.

Common on sand or gravel, planted in village. Tufted, spike-joints about 1 mm thick, glume acuminate but scarcely subulate, 7-8 mm long.

Scilly (sight), Bellingshausen (Pickering, Papy).

Lepturus repens var. subulatus Fosb.

Main islet, in coconut plantation, coral sand, Sachet 923.

Common in ground cover.

*Saccharum officinarum L.

Main islet, a few sickly plants cultivated in imported soil.

*Sporobolus fertilis (Steud.) Clayton

Main islet, in coconut plantation, coral ground, Sachet 925.

Occasional in ground cover and on roadside.

Stenotaphrum micranthum (Desr.) Hubb.

Main islet, in coconut plantation, coral ground, Sachet 926.

Common in ground cover.

Thuarea involuta (Forst.) R. & S.

Main island, between village and middle of length of islet, Sachet 907.

Occasional in patches along road through coconut plantation.

Scilly (coll.), Bellingshausen.

CYPERACEAE

Cyperus javanicus Houtt.

Motu Tavae, forming large patch in clearing around buildings, Sachet 914.

Fimbristylis cymosa R. Br. var. pycnocephala (Hbd.) Kük. ex F. Br.

Main islet, in coconut plantation, coral ground, Sachet 961.

Very common in paths (also at top of beaches). Has compact, button-like head, styles with either 2 or 3 branches, predominantly 3, achenes mostly trigonous, smooth.

Scilly (coll.).

ARECACEAE (PALMAE)

*Cocos nucifera L.

Planted over most of main islet and some smaller ones.

Scilly, Bellingshausen (Papy, but absent in 1839 according to Pickering).

LILIACEAE s. l.

*Crinum asiaticum L.

Main islet, Sachet 984.

Planted in village, forming hedge.

Scilly (sight).

TACCACEAE

Tacca leontopetaloides (L.) O. Ktze.

Main islet, in coconut plantation, coral ground, Sachet 963.

Common locally in undergrowth.

Scilly (sight).

MUSACEAE

*Musa sp.

Main islet, several plants seen, with one tiny bunch of bananas; in village.

Scilly (sight).

CASUARINACEAE

*Casuarina equisetifolia L.

Main islet, in coconut plantation, coral ground, Sachet 936.

Planted as hedge at Weather Station, on ocean side.

MORACEAE

*Artocarpus altilis (Park.) Fosb.

Main islet, Sachet 967.

A few trees planted near village.

URTICACEAE

Laportea ruderalis (Forst. f.) Chew

Main islet, in coconut plantation, Sachet 942.

Common locally in ground cover.

Scilly (coll.), Bellingshausen (Pickering).

OLACACEAE

Ximenia americana L. var. americana (det. R. deFillips 1968)

Motu Tavae, Sachet 913.

Two plants seen at edge of forest, perhaps planted.

NYCTAGINACEAE

Boerhavia tetrandra Forst. f.

Main islet, Sachet 968.

Occasional in ground cover in coconut plantation, coral ground.

South tip, Sachet 970.

Common in ground cover in coconut plantation and dense forests.

Scilly (coll.), Bellingshausen (Pickering, Papy).

Pisonia grandis R. Br.

Main islet, in coconut plantation, coral ground, Sachet 962.

Occasional, remaining among coconut palms.

Bellingshausen ? (Pickering).

AMARANTHACEAE

Achyranthes velutina H. & A.

Main islet, south tip, Sachet 971.

Common in undergrowth in coconut planation and dense forests; coral ground.

Bellingshausen (Pickering).

*Amaranthus viridis L.

Main islet, Sachet 966.

Only a few plants seen in yard.

PORTULACACEAE

Portulaca johnii v. Poelln.

Main islet, south tip, Sachet 973.

Common in ground cover in recent plantation and dense forest; coral ground.

Portulaca spp.

Scilly (sight), Bellingshausen (Pickering, Papy).

LAURACEAE

Cassytha filiformis L.

Main islet, in coconut plantation, coral ground, Sachet 958.

Very common everywhere.

Scilly (coll.), Bellingshausen (Pickering, Papy).

HERNANDIACEAE

Hernandia sonora L.

Main islet, in coconut plantation, coral sand, Sachet 915.

Only one tree seen near ocean shore at edge of plantation.

BRASSICACEAE (CRUCIFERAE)

Lepidium bidentatum Montin
Lepidium piscidium Forst.

Main islet, in coconut plantation, Sachet 940.

Occasional in undergrowth, Main islet, south tip, Sachet 976.

Diseased plants forming occasional patches.

Scilly (coll.), Bellingshausen (Pickering, Papy).

FABACEAE (LEGUMINOSAE)

*Albizia lebbeck (L.) Benth. ?

Main islet, Sachet 980.

A few individuals planted in weedy area around village in coconut plantation; coral ground.

*Crotalaria incana L.

Main islet, in coconut plantation, coral sand, Sachet 919.

In weedy area, near village, occasional.

*Crotalaria verrucosa L.

Main islet, in coconut plantation, coral ground, Sachet 935.

Occasional in weedy area near village.

*Desmodium incanum DC.

Main islet, in coconut plantation, coral ground, Sachet 930.

Occasional in weedy areas.

*Desmodium triflorum (L.) DC.

Main islet, in coconut plantation, coral ground, Sachet 934.

One patch seen in weedy area near village.

*Indigofera spicata Forsk.

Main islet, in coconut plantation, coral ground, Sachet 937, forming mat in open area in yard under coconuts; 938, in weedy area near village.

*Leucaena leucocephala (Lam.) deWit

Main islet, in coconut plantation, coral sand, Sachet 920.

Occasional in weedy area near village.

*Mimosa pudica L.

Main islet, in coconut plantation, coral ground, Sachet 952.

Common in weedy area near village.

*Phaseolus lathyroides L.

Main islet, in coconut plantation, coral ground, Sachet 932.

Occasional in weedy area near village.

*Rhynchosia minima DC.

Main islet, in coconut plantation, coral ground, Sachet 933.

One large clump in weedy area near village.

Vigna marina (Burm.) Merr.

Main islet, in coconut plantation, coral ground, Sachet 964.

Common near shores.

RUTACEAE

*Citrus aurantifolia (Christm.) Swingle

Main islet, one small spineless lime tree seen, said to have been brought from the Leeward Islands.

Scilly (sight).

SURIANACEAE

Suriana maritima L.

Motu Manu, on coral sand, along shore, Sachet 912.

Scilly (coll.), Bellingshausen (Pickering).

EUPHORBIACEAE

*Euphorbia hirta L.

Main islet, in coconut plantation, coral sand, Sachet 924.

Common in ground cover.

Scilly (sight).

*Euphorbia thymifolia L.

Main islet, in coconut plantation, coral ground, Sachet 956.

Local in weedy yard.

*Phyllanthus amarus Schum. & Thonn.

Main islet, in coconut plantation, coral ground, Sachet 954.

Local in weedy area near village.

Scilly? (sight).

SAPINDACEAE

*Cardiospermum halicacabum L.

Main islet, in coconut plantation, Sachet 943.

Local in weedy area near village.

*Pometia pinnata Forst.

Main islet, Sachet 987.

One small tree planted in village.

RHAMNACEAE

Colubrina asiatica (L.) Brongn.

Main islet, in coconut plantation, coral sand, Sachet 922.

Only one shrub seen in weedy area near village.

TILIACEAE

Triumfetta procumbens Forst.

Main islet, in coconut plantation, coral ground, Sachet 960.

Very common everywhere.

Scilly (coll.).

*Triumfetta rhomboidea Jacq.

Main islet, in coconut plantation, coral sand, Sachet 921.

Only one plant seen in weedy area near village.

MALVACEAE

Hibiscus tiliaceus L.

Main islet, Sachet 917.

Planted along lagoon near village, probably native on smaller islets; in coconut plantation.

Scilly (sight).

*Malvastrum coromandelianum (L.) Garcke

Main islet, in coconut plantation, Sachet 945.

Local in weedy area near village.

*Sida rhombifolia L.

Main islet, in coconut plantation, coral ground, Sachet 951.

Common in weedy area near village.

BOMBACACEAE

*Ceiba pentandra (L.) Gaertn.

Main islet, 2 small very chlorotic plants seen in village.

STERCULIACEAE

*Waltheria indica L.

Main islet, in coconut plantation, coral ground, Sachet 950.

Occasional in undergrowth, very common near village.

CLUSIACEAE (GUTTIFERAE)

Calophyllum inophyllum L.

Main islet, single tree in coconut plantation, Sachet 939.

Others apparently planted in village.

Scilly (sight).

CARICACEAE

*Carica papaya L.

Main islet, a few planted in village, bearing fruit.

Scilly (sight).

LYTHRACEAE

Pemphis acidula Forst.

Main islet, Sachet 981.

Occasional (common elsewhere on coral rock).
Scilly (coll.), Bellingshausen (Pickering, Papy).

COMBRETACEAE

*Terminalia catappa L.

Main islet, one tree, planted in village, Sachet 985.

Scilly (sight).

APOCYNACEAE

*Catharanthus roseus (L.) G. Don

Main islet, in village, seen planted in garden, a white form "pervenche".

CONVOLVULACEAE

Ipomoea macrantha R. & S.

Main islet, in coconut plantation, coral sand, Sachet 916.

Occasional, climbing over shrubs.

Scilly (coll.), Bellingshausen (Papy).

BORAGINACEAE

Cordia subcordata Lam.

Main islet, Sachet 986.

Trees planted in village, others occasional in coconut plantation.

Scilly (sight), Bellingshausen (Papy).

Heliotropium anomalum H. & A. var. anomalum

Main islet, in coconut plantation, Sachet 941.

Occasional in undergrowth. Also found in bare sand at top of beaches.

Scilly (sight), Bellingshausen (Pickering, Papy).

Tournefortia argentea L.f.

Main islet, Sachet 983.

Common at top of beach (also inside forest), on beach ridge; coral cobbles.

Scilly (coll.), Bellingshausen (Pickering, Papy).

VERBENACEAE

*Lantana camara var. aculesta (L.) Moldenke

Main islet, in coconut plantation, Sachet 944.

Occasional in weedy area near village.

*Stachytarpheta urticaefolia Sims

Main islet, in coconut plantation, coral ground, Sachet 949.

Common in undergrowth, especially near village.

Scilly (sight).

LAMIACEAE (LABIATEAE)

*Ocimum basilicum L.

Main islet, a few planted in village, Sachet 989.

SOLANACEAE

*Capsicum frutescens L.

Main islet, one plant, planted in village, Sachet 988.

Solanum uporo Dunal

Main islet, in coconut plantation, coral ground, Sachet 955.

One shrub seen; many more at south end of islet and on Motu Tavae.

Scilly ? (sight), Bellingshausen ? (Papy).

RUBIACEAE

*Gardenia taitensis DC.

Main islet, in coconut plantation, coral sand, Sachet 918.

Planted around village.

Scilly (sight).

Guettarda speciosa L.

Main islet, south tip, Sachet 972.

Common everywhere on atoll in coconut plantation and dense forest; coral ground.

Morinda citrifolia L.

Main islet, Sachet 974.

Common in coconut plantation, coral ground.

Scilly (sight).

Timonius polygamus (Forst. f.) Rob.

Main islet, in coconut plantation, coral ground, Sachet 957 (male).

Occasional in undergrowth; also on boulder fields on ocean shore, Sachet 969 (female).

Occasional on boulder field above ocean level (with Scaevola and other shrubs), also in coconut plantation.

Scilly (coll.), Bellingshausen (Pickering).

GOODENIACEAE

Scaevola sericea var. tuamotuensis (St. John) Fosberg
S. taccada (Gaertn.) Roxb.

Main islet, Sachet 982.

Very common at top of beach on beach ridge, coral cobbles; also in coconut plantation.

Scilly (coll.), Bellingshausen (Pickering, Papy).

CAMPANULACEAE

*Hippobroma longiflora (L.) G. Don

Main islet, in coconut plantation, coral ground, Sachet 948.

Occasional in weedy area around village.

ASTERACEAE (COMPOSITAE)

*Ageratum conyzoides L.

Main islet, in coconut plantation, coral ground, Sachet 946.

Local in weedy area around village.

*Bidens pilosa L.

Main islet, in coconut plantation, coral ground, Sachet 927.

Occasional along road.

*Blumea sinuata (Lour.) Merr.

Main islet, in coconut plantation, coral ground, Sachet 945a.

See Fosberg and Sachet, Micronesica 2:159, 1966 [1967].

*Elephantopus mollis HBK.

Main islet, in coconut plantation, coral ground, Sachet 953.

Occasional in weedy area near village.

*Synedrella nodiflora (L.) Gaertn.

Main islet, in coconut plantation, coral ground, Sachet 947.

Local in weedy area around village.

*Vernonia cinerea (L.) Less. var. parviflora (Bl.) DC.

Main islet, in coconut plantation, coral ground, Sachet 931.

Occasional in weedy areas.

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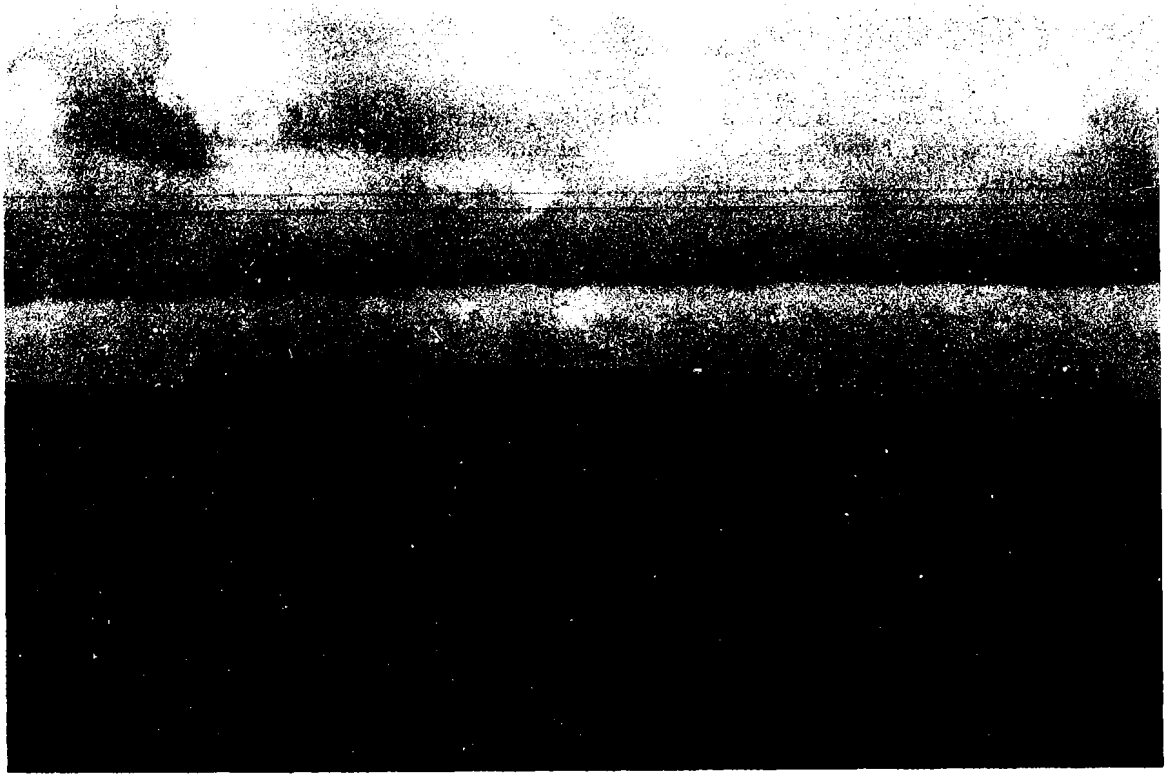


Fig. 1. View of Aveu Islet from lagoon, with emerged reef-remnants along reef to right of islet.

Fig. 2. Emerged remnants of former higher reef surface on reef between Aveu Islet and main islet, Pemphis acidula scrub on remnants in middle distance.

Fig. 3. Outer edge of reef, with surge channels between remnants of a former algal ridge. Main islet.

Fig. 4. North end of main islet, with slightly elevated consolidated platform on left, showing intertidal "notch" or "nip", and present reef surface at center and right, slightly exposed at low tide.

Fig. 5. Reef surface between main islet and Aveu Islet, showing "micro-atolls" of Porites (?) and mushroom-like remnants of former higher reef surface.

Fig. 6. Reef flat with eroded higher reef surface, deep inter-tidal notches, exposed surfaces blackened by endolithic blue-green algae, west end of Tavae Islet.

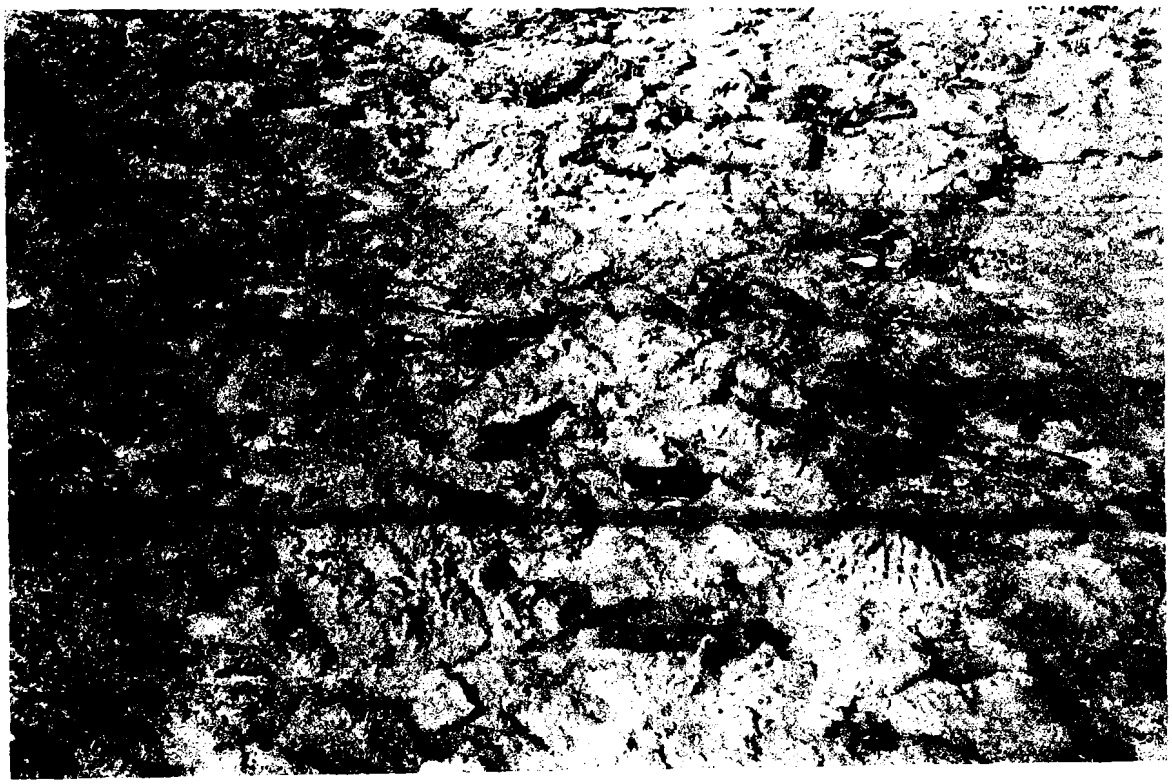


Fig. 7. Eroded surface of consolidated elevated reef-conglomerate, showing cemented corals, between main islet and Aveu Islet.

Fig. 8. Slightly submerged reef surface near Petero Islet, showing camouflaged flat-fish, Bothus sp., lying on rock surface.

Fig. 9. Bare shingle ridge or berm on northeast reef facing ocean.

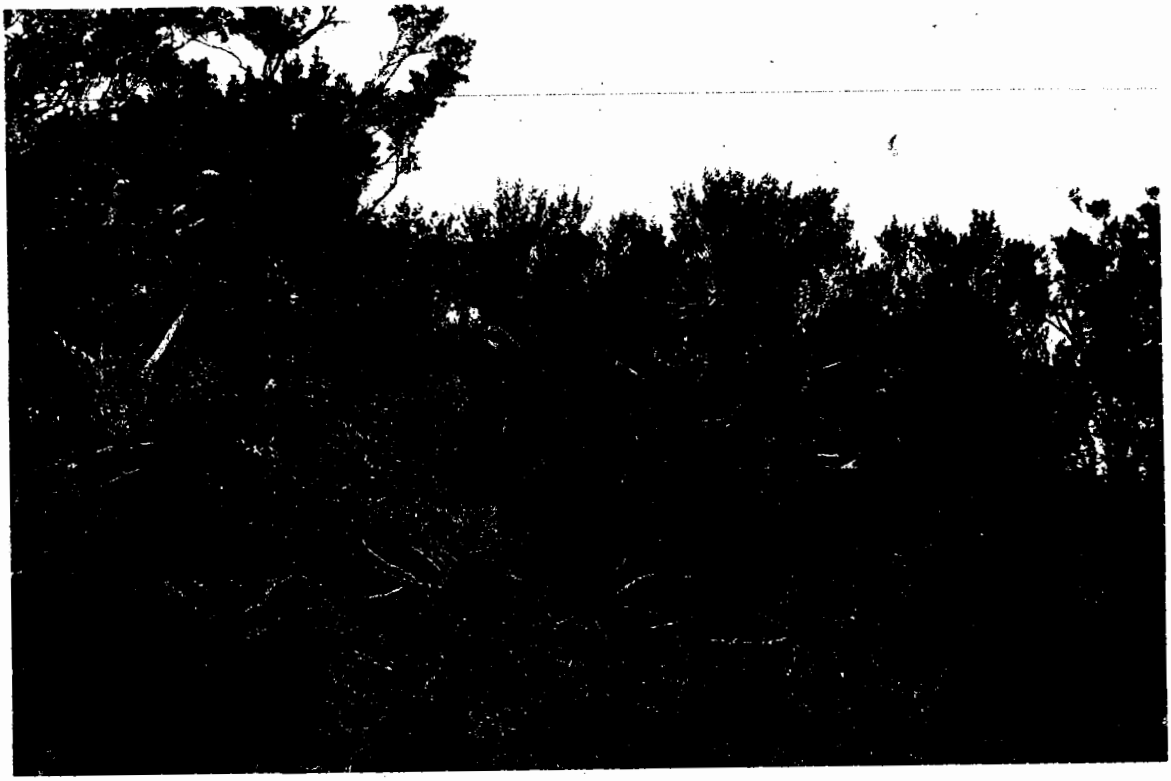
Fig. 10. Outer reef-flat and shingle beach ridge on E side of main islet, coconut plantation back of ridge, fringed by Suriana maritima and Scaevola sericea with some scattered Timonius polygamus shrubs.

Fig. 11. Abraded beach-rock beds, N shore of Tavae Islet, forest of Tournefortia and Pisonia with scattered coconut palms in background.

Fig. 12. Eroded remnants of fossil beach-rock beds with an older reef-rock remnant farther out, same locality as Fig. 11.

Fig. 13. Tournefortia argentea on sand-flat back of beach, tufts of pioneering Lepturus repens at top of coral sand and gravel beach, on Motu Manu lagoon side.

Fig. 14. Pemphis acidula forest with nesting frigate birds on Motu Manu.



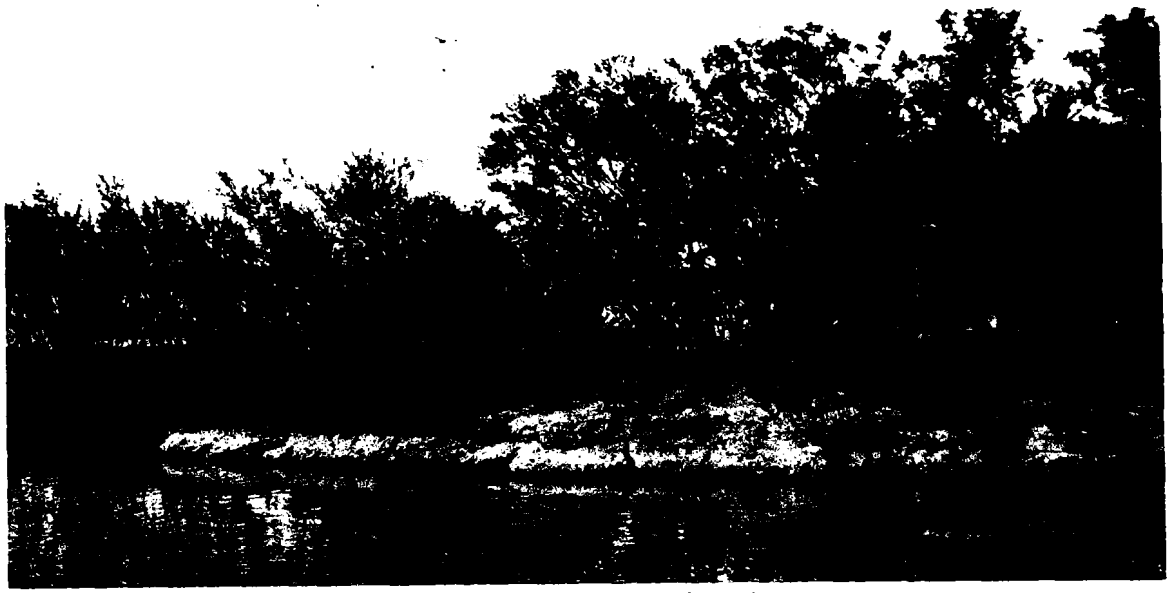
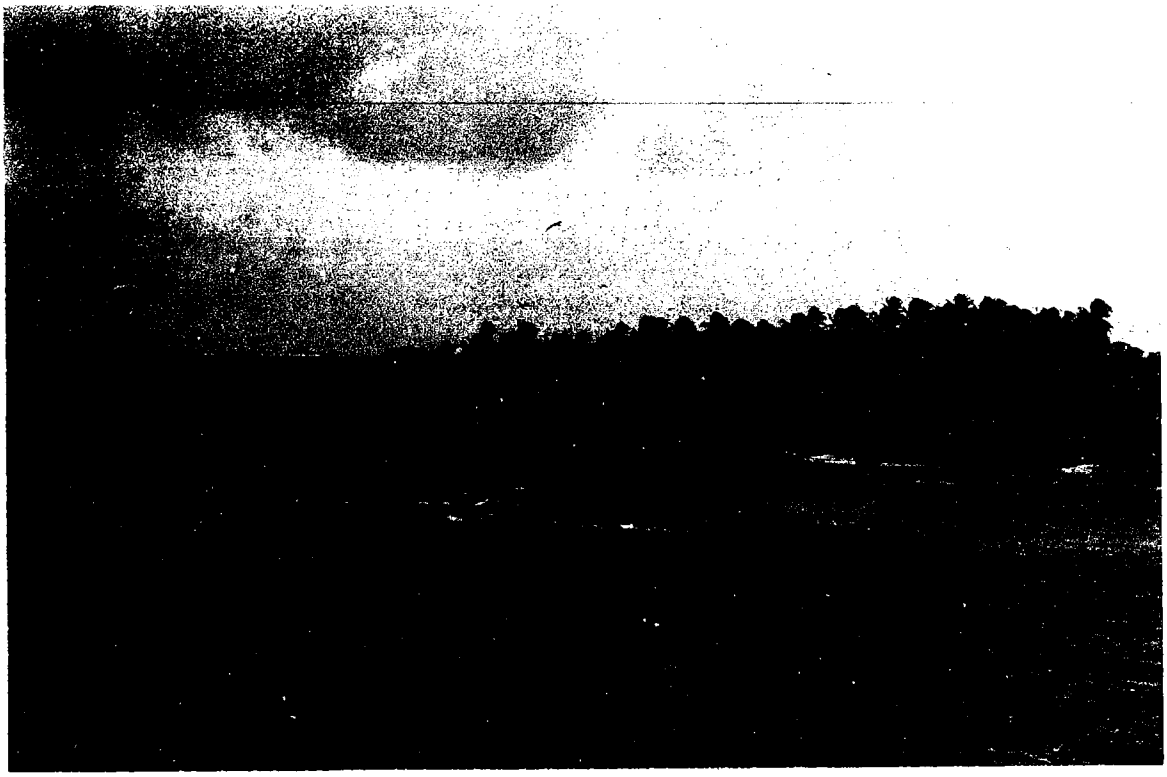


Fig. 15. Pemphis acidula forest on slightly elevated reef-rock platform on "bird islet" along pass.

Fig. 16. Depressed Pemphis acidula dwarf scrub on exposed rock flat between S end of main islet and Petero Islet, latter in background. This and Fig. 15 show extremes in growth habit of Pemphis.

Fig. 17. Passage between "Bird islets", eroded reef-rock surface in foreground.

Fig. 18. Bird islet no. 5 seen from Pass, with Pemphis forest on slightly elevated reef-rock surface, Monument Goëlette Zélée on rock platform in front.



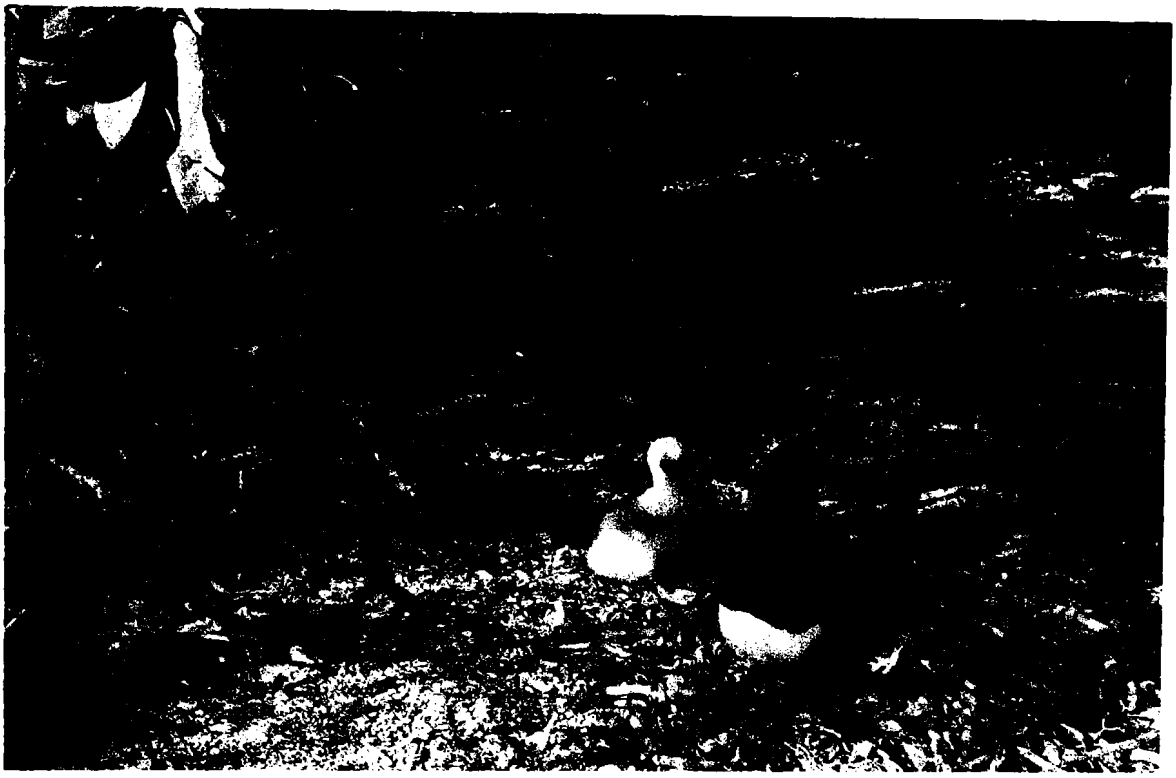


Fig. 19. Brown booby (Sula leucogaster) with downy young, nesting on ground in Tournefortia forest opening, on Bird islet no. 5.

Fig. 20. Red-tailed tropic-bird (Phaëthon rubricauda) nesting on ground in shelter of a fallen Tournefortia tree on Bird islet no. 5.

Fig. 21. Shingle beach on E (ocean) side of main islet, coconut plantation back of Suriana maritima fringe at top of beach, scattered Scaevola (prostrate), Timonius, and Suriana, on beach slope.

Fig. 22. Detail of Fig. 21: Suriana maritima and Tournefortia (back), and Timonius polygamus in foreground.

Fig. 23. Pandanus tectorius - Tournefortia argentea forest, with scattered coconut palms, top of sand beach, N shore of Tavae Islet.

Fig. 24. Old, slightly elevated rock platform, much eroded and broken up, protruding from under sand beach with Tournefortia - Pisonia - Pandanus forest on NW Tavae Islet.

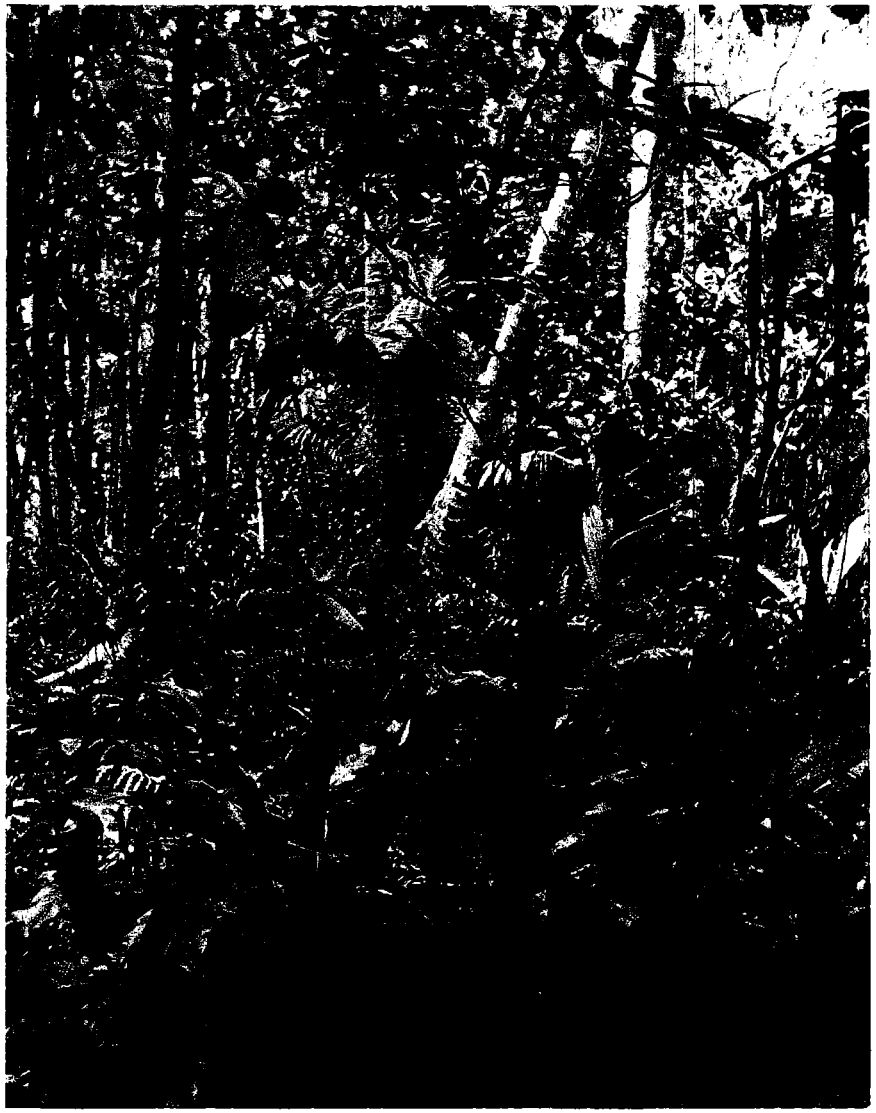


Fig. 25. Interior of Guettarta - coconut forest with ferns Asplenium nidus and Polypodium scolopendria on Tavae Islet.

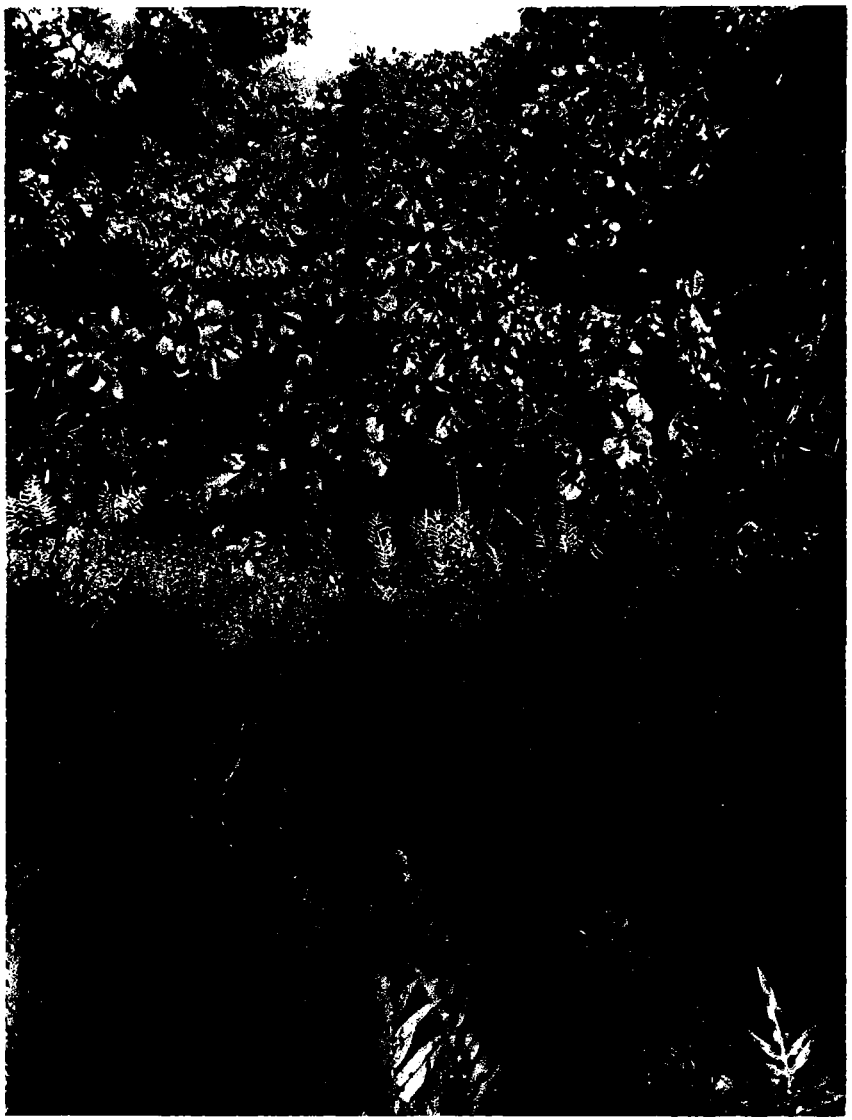


Fig. 26. Mixed broad-leaf forest with Polypodium scolopendria in opening in foreground, interior of Tavae Islet.

Fig. 27. Guettarda speciosa in foreground, Pandanus tectorius showing prop-roots and litter, interior of Tavae Islet.

Fig. 28. Sparse coconut plantation with Pandanus, interior of south end of main islet.

Fig. 29. S. end of main islet, Pisonia trees growing from fallen trunk, thick lianas of Ipomoea macrantha.

Fig. 30. Coral cobbles ridge on E (ocean) shore of main islet, with Scaevola sericea var. tuamotuensis and Suriana maritima; coconut plantation and Guettarda in background.