

RESULTS OF THE ARCHBOLD
EXPEDITIONS. NO. 75

SUMMARY OF THE FOURTH
ARCHBOLD EXPEDITION
TO NEW GUINEA (1953)

L. J. BRASS

BULLETIN
OF THE
AMERICAN MUSEUM OF NATURAL HISTORY
VOLUME 111 : ARTICLE 2 NEW YORK : 1956

**SUMMARY OF THE FOURTH ARCHBOLD EXPEDITION TO
NEW GUINEA (1953)**

RESULTS OF THE ARCHBOLD
EXPEDITIONS. NO. 75



*SUMMARY OF THE FOURTH ARCHBOLD
EXPEDITION TO NEW GUINEA
(1953)*

L. J. BRASS

*Associate Curator, Archbold Collections
The American Museum of Natural History*

BULLETIN
OF THE
AMERICAN MUSEUM OF NATURAL HISTORY
VOLUME 111 : ARTICLE 2 NEW YORK : 1956

BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Volume 111, article 2, pages 77–152, figure 1, plates 10–21

Issued September 17, 1956

Price: 1.50 a copy

CONTENTS

INTRODUCTION	83
Organization	84
Acknowledgments.	85
GENERAL SURVEY OF THE AREA.	88
Physiography and Geology.	88
Climate	90
Exploration	91
Development	93
THE NATIVE PEOPLES	97
Economy and Sustenance	97
Some After-Effects of the Second World War	100
PREVIOUS COLLECTIONS	101
ITINERARY AND ROUTES	104
COLLECTING STATIONS	121
MAJOR PLANT COMMUNITIES	148
RESULTS OF THE EXPEDITION	150
REFERENCES	150

INTRODUCTION

THE FIRST OF THE Richard Archbold expeditions to New Guinea took place in the Territory of Papua in 1933-1934, when examination was made of a strip of territory extending from Hall Sound on the south coast to the summit of Mt. Albert Edward (4030 meters) on the central range, and work also was carried out at Rouna on the Astrolabe Range close behind Port Moresby, and on the Oriomo River lowlands between the Fly River and the Dutch border (Archbold and Rand, 1935). The second or 1936-1937 expedition, likewise in Papua, was particularly concerned with the Fly River from the coast to near its source, and with the Wassi Kussa area, west of the Fly; further work was done at Rouna, and the late G. H. H. Tate made a mammal reconnaissance survey of mountain localities as far inland as Kagi, on the Kokoda Trail (Rand and Brass, 1940). The third expedition took place in Dutch territory in 1938-1939 as a joint undertaking with the Netherlands Indies Government known officially as the Indisch-Amerikaansche Expeditie naar Nederlandsch Nieuw-Guinea (Archbold, Rand, and Brass, 1942). This expedition was transported and supplied by air from a base at Hollandia. Its principal fields of operation were the northern slopes of the Snow Mountains (Oranje-Nassau Gebergte) from the Balim River (1600 meters) to Lake Habbema (3225 meters) and Mt. Wilhelmina (4750 meters), and the lowlands and mountains of the middle Idenburg region. The big, heavily populated high valley of the Balim River, which towards the end of the Second World War became well known as the "New Guinea Shangri-La," was discovered and explored. In 1948, the Archbold Cape York Expedition extended the program of biological explorations, which had been started 15 years earlier in New Guinea (Brass, 1953), to include northeastern Australia.

The expedition presently being reported upon had for its geographical coverage far eastern parts of Papua: chiefly the Cape Vogel Peninsula, a cross section of the country between Collingwood Bay and the crest

of the central range at Mt. Dayman (2987 meters), and Goodenough Island in the D'Entrecasteaux group. Mapamoiwa, on the northwestern part of Fergusson Island, was visited briefly, and small collections were made there. In line with the previous expeditions of the series, the purpose of this one was the collection and ecological and distributional study of mammals, reptiles, and amphibians, fresh-water fishes, insects and spiders, and of plants. Because the avifauna of the area is already fairly well known, very few birds were taken. A collection of the ectoparasites of mammals was made for the Army Medical Service Graduate School, in Washington, D. C., and materials for antibiotics research were sent to Chas. Pfizer and Company of New York.

The project was aided by a contract between the Office of Naval Research, Department of the Navy, and the American Museum of Natural History, NR 160-198. The Arnold Arboretum of Harvard University assisted financially and received the plant collections. The zoological collections are deposited in the American Museum of Natural History. By agreement, in return for permissions granted and assistance offered, the Administration of the Territory of Papua and New Guinea will receive duplicate specimens of insects for the collections of the Department of Agriculture, Stock and Fisheries, duplicates of vertebrate animals for a museum which is to be established in Port Moresby, and a set of the plant collections for deposit in the Forest Herbarium at Lae.

Personnel consisted of L. J. Brass, leader and botanist; Hobart M. Van Deusen, mammalogist; Geoffrey M. Tate, general zoological collector; and Kenneth M. Wynn, in charge of transport and supplies. For two weeks, while on the Cape Vogel Peninsula, the party was joined by R. D. Hoogland, botanist of a resources survey group of the Commonwealth Scientific and Industrial Research Organization (Australia), at that time preparing for field work in Papua.

Wynn was engaged locally in Papua. Nine natives of Fergusson Island and Goodenough

Island were employed as field helpers in zoology and botany, and two as cooks and camp orderlies.

The mammal names cited were supplied by Hobart M. Van Deusen. Most of the botanical names rest on sight identifications made by me in the field, the exceptions being several determinations of herbarium material by Dr. Lily M. Perry of the Arnold Arboretum. Identifications in other groups are acknowledged in the text or in footnotes.

ORGANIZATION

Permission for the expedition to operate in Papua was obtained in advance from the Australian Government and the Administration of Papua and New Guinea, through the Department of State in Washington and the United States Embassy at Canberra.

The outline of a working plan was submitted to the Administration in advance, leaving open the choice of a principal mountain objective on the mainland. Mount Dayman was decided upon after an aerial reconnaissance, for which purpose, and the conclusion of preliminary arrangements for our project, I arrived in Papua about two weeks before the other members of the scientific party.

Our itinerary was planned to take the best advantage of the seasons for travel in the mountains and as much as possible for collecting. Thus, by beginning in the Cape Vogel area late in March towards the end of the wet season, we were able to see this low-rainfall area at its best, and the topography of the country was such that flooding after heavy rains could not seriously interfere with field work. By moving into the mountains about the middle of May, we had before us what on previous experience we could expect to be the best two months of mountain weather, namely, June and July, for activities on the upper parts of Mt. Dayman. After examination of the lowlands between Mt. Dayman and the sea at Collingwood Bay, generally favorable weather conditions could still be expected in September, October, and November on both the upper and lower levels of Goodenough Island.

An early and most satisfactory arrangement was made for Messrs. A. H. Bunting Limited, merchants, traders, and planters,

to act as local agents for the expedition in Samarai, the commercial center of eastern Papua. Field equipment, collecting gear, and complete collecting supplies were purchased in New York and sent by sea to Samarai three months before the date planned for the commencement of field work. "Buntings" saw to the recruitment of the natives we needed as permanent hands, and they were able to supply all foodstuffs and sundry stores. Perishable bulk supplies for use inland, such as rice, flour, dried green peas, and sugar, we had specially packed in 5-gallon gasoline drums. These, besides being watertight and, when sealed with spots of solder, more or less pilfer-proof, made convenient loads for porters. Painted bands of different colors indicated the contents of the containers to illiterate handlers. When empty, the drums were again useful for gifts and trade in inland localities.

As items of native trade and payment for services we carried little but tobacco, newspapers, and salt. Money, while in demand on the coast of the mainland, was not of much use inland there or on Goodenough Island, except as "big pay" for special purchases and services. Payment for native garden produce in inland localities on both the mainland and Goodenough Island was nearly always expected to be at least in part in salt. Sticks of extremely strong, black, trade-twist tobacco, and newspaper for rolling the tobacco into cigarettes, were in insatiable demand wherever we went and had to be carried in considerable quantity for the remuneration of porters, purchase of zoological specimens, and general trade.

Small vessels, engaged chiefly in carrying copra and recruiting native labor, were available for coastwise transport on a daily charter basis or at set rates for cargo and passengers. In the absence of roads and airdromes in the areas in which the interests of the expedition lay (see p. 95), native porters, carrying loads of 40 pounds on the lowlands and as little as 30 pounds on the worst mountain trails, were relied upon for inland transport.

The parachuting and dumping of supplies from aircraft to exploration parties is now common practice in the eastern territories of New Guinea. In our case the advantages

of this method were considered outweighed by the disadvantages, such as the necessary subordination of all else in the choice of camp sites to the requirements of the transport system in that camps be located near some open place suitable for a dropping ground or that such an opening be cleared in the forest; the virtual necessity of being provided with two-way radio for the direction of supplying aircraft; the consideration that ours was not the usual eat-to-live proposition but a matter of the transportation of valuable collections and equipment out, as well as of bringing supplies in to a party; and that in the opinion of government officers recently familiar with the general area, native carriers might be expected to volunteer in numbers sufficient for the needs of our party. Journeys of only a few days would be involved, usually at intervals of two to four weeks, so that the supply of porters would not be a constant drain on local populations with food gardens to make and cultivate, and feasts and dances to attend. It was therefore decided to rely upon volunteer porters procured locally, rather than to employ a permanent carrier force.

Every effort was made to reduce to a minimum the weight to be carried while keeping the party well provided for and maintaining a long-term high level of working efficiency. Important in this were special items of equipment, including lightweight tents of Egyptian cotton measuring nearly 10 feet square, and flies 18 by 20 feet, which weighed less than 20 pounds each and could be rolled into small space. Regulation native rations of unpolished rice, wheatmeal, dried green peas, canned beef, sugar, tea, beef dripping, salt, soap, tobacco, and matches weighed about 15 pounds gross per man per week. Our own food was reckoned at about 20 pounds weekly per man. With full equipment, and provisions and collecting supplies for a month, the weight to be transported was approximately 2000 pounds. The greatest number of carriers used at any one time was 70.

With an eye to the health of the party, native garden produce was obtained whenever possible, and as a rule the activities of the mammal department brought in an abundance of fresh meat relished by native personnel. Government regulations required that

natives employed in the mountains be warmly clothed, the issue for altitudes of 5000 feet and over being two good flannel shirts and four blankets apiece. We were well stocked with medical supplies, but seldom drew upon them other than for the treatment of tropical ulcers and malaria. Those of us who took aralen regularly found it completely effective in malaria suppression in the field, although the vivax type of the disease appeared some four to 11 months after our return to the United States.

ACKNOWLEDGMENTS

Many whom we would thank for interest in our project, and help towards its success, must be anonymous. Sometimes among the natives, names were not even known. A chief or other headman whose influence was of real importance might be heard addressed only by his title of rank or office. The native communities we had contact with were invariably friendly and usually inclined to regard us as guests rather than as intruders who could conceivably become a nuisance in their territory. Always there was intense interest in our doings. We seldom felt disappointment in the cooperation received, and there was only one instance of theft by village people.

Anonymous, too, must be most of the government officers, business people, and missionaries, who, wherever we went, received us most hospitably and did everything possible to forward our aims. Relations with the European residents in general could not have been more pleasurable.

To Mr. (formerly Brigadier) D. M. Cleland, Administrator of Papua and New Guinea, we are grateful for permission to carry out our plans and for assistance offered which, fortunately, for the most part was not needed.

Mr. S. A. Lonergan, Government Secretary, did much to smooth our way, as did Mr. Claude Champion, Assistant Government Secretary, under whose genial and competent guidance our business with the various departments was arranged.

In Samarai we had the ready assistance of Mr. M. J. Healy, District Commissioner, who as a patrol officer had accompanied our party on the Fly River in 1936 and thus had firsthand knowledge of our methods and needs. As

officers in charge of Baniara Government Station, first Patrol Officer A. R. M. Skewes, and later Patrol Officer Peter O'Sullivan, placed us heavily in their debt for hospitality and assistance while we were in the area under their control. And to Patrol Officer R. K. Greeney, then in charge of

difficult ascent of Mt. Simpson to his credit, Father Cruttwell, in correspondence, had given information invaluable in the formulation of our plans.

In Samarai, Mr. Robert F. Bunting, principal of the firm of A. H. Bunting Limited, Mr. G. E. Miller, manager, Mr.

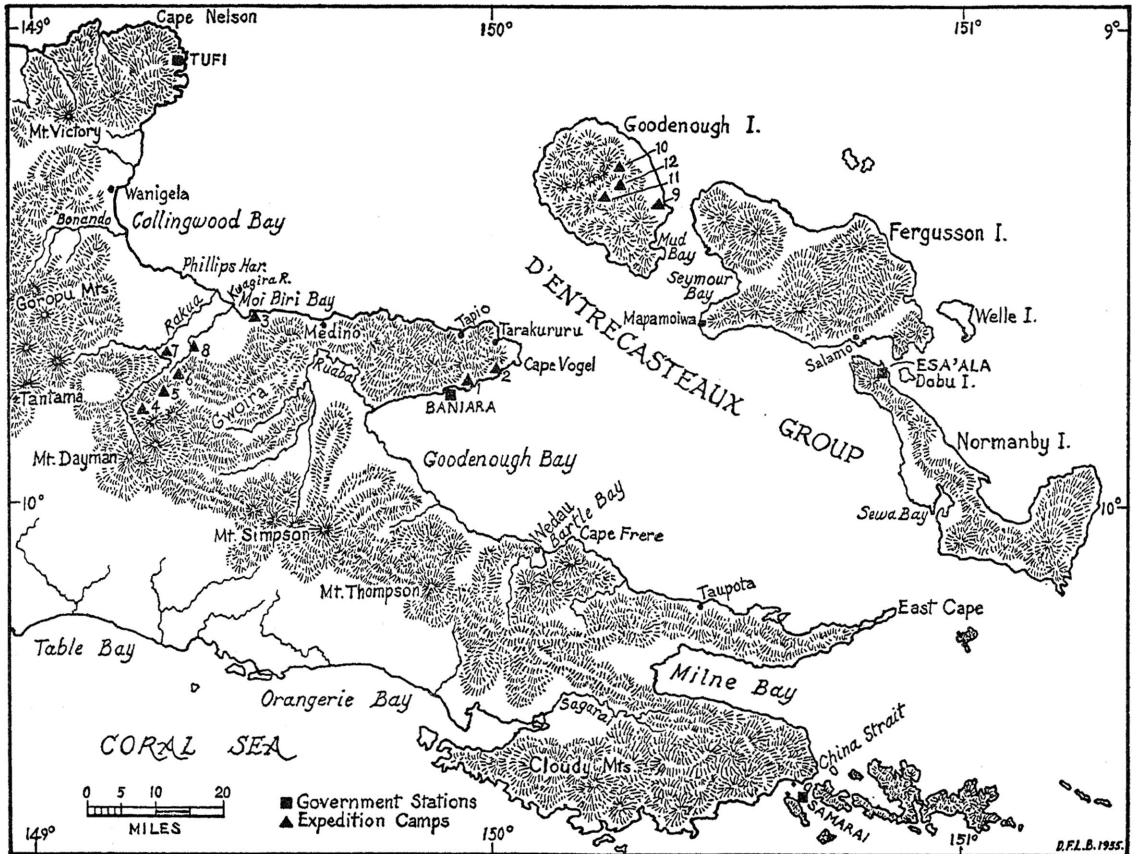


FIG. 1. Map of eastern Papua and the D'Entrecasteaux group of islands, showing working areas of the Fourth Archbold Expedition to New Guinea. Mountain features of the mainland and positions of the Mt. Dayman camps are approximate. Camps: 1, Menapi; 2, Dabora; 3, Baiawa; 4, Top Camp, Mt. Dayman; 5, Number 2 Camp, Mt. Dayman; 6, Number 3 Camp, Mt. Dayman; 7, Biniguni Camp, Gwariu River; 8, Peria Creek, Kwagira River; 9, Bolu Bolu; 10, Wakonai; 11, Top Camp, Goodenough Island; 12, Number 2 Camp, Goodenough Island.

Esa'ala Government Station, we owed an excellent start in our relations with the people of Goodenough Island.

Much regretted during our visit to Papua was the absence in England on leave of the Rev. N. E. G. Cruttwell, priest in charge of the Anglican Mission at Menapi. A pioneer missionary inland, and a botanist with the

Edward Wilson, Mr. Russell Webster, Mrs. Ailsa Hall, and others of the staff did more than function very understandingly and efficiently as our general business agents, local bankers, suppliers of stores, arrangers of boat transport, and everything else that a party isolated in the bush depends upon from supporters back at the base. We were the

house guests of Mr. Bunting and Mr. Miller during our stays in hotel-less Samarai. More than that, we felt ourselves made a part of an organization which operated with an extraordinarily advanced appreciation of personality factors in staff and customer relationships.

Finally, there are the men of the party in the field, without whose wholehearted support the project would have been impossible of achievement. Geoffrey Tate, who saw to the purchasing and business management in New York, and after six months in the field went down very critically ill, with a paralytic stroke and had to be repatriated; Hobart Van Deusen, ideal companion through all the expedition, whose remarkably successful methods of field work prospered the collections immensely; Ken Wynn, who had the most exacting task of all in supplying us with food

and the materials with which to prosecute our work and in whose arrangements there was never a major breakdown.

Our "boys" were the so-called Gosiagos, nine from Fergusson Island, two from Goodenough Island. We had had over 70 from the same communities with us on the Fly River. The later generation we found, despite some prognostications to the contrary, just as reliable, quick-learning, and likable as their fathers had been. The one exception to this was paid off at the first opportunity. Outstanding among the boys was "Kim," our number-one cook, a native of Goodenough Island properly known as Gapodia Aboakera, who, perhaps in part from the status he derived as the preparer of our meals, exercised an authority over the native staff which, though seldom used, in times of emergency left no doubt as to his qualities of leadership.

GENERAL SURVEY OF THE AREA

THE TERRITORY WITH WHICH we are concerned lies between the 149th and 151st degrees of east longitude and the 9th and 11th degrees of south latitude. In the present administrative organization of Papua, the areas in which we actually worked are included in the Milne Bay District, the headquarters of which are at Samarai, on Dinner Island in China Strait. On the Cape Vogel Peninsula and in the Collingwood Bay-Mt. Dayman series of working localities we were within the boundaries of Baniara Sub-District, controlled from Baniara, on Mosquito Island in Goodenough Bay. Goodenough Island was in Esa'ala Sub-District, with headquarters at Esa'ala on Normanby Island.

PHYSIOGRAPHY AND GEOLOGY

Much of the area on the mainland east of the 149th meridian is occupied by the mountains of the main central range, although extensive marginal lowlands or tracts of low hills front the western parts of both coasts and especially the north coast. The Cape Nelson Peninsula, very little known biologically but not a part of our working territory, consists of an isolated group of volcanic mountains attaining altitudes of 1655 meters in Mt. Trafalgar and 1869 meters in the quiescent volcano, Mt. Victory. The 149th meridian cuts across the Mt. Suckling-Goropu Mountains massif of the central range on which peaks rise to as high as 3670 meters. East of this the range loses altitude in an irregular dip towards the forked tail of the gigantic bird-like reptile which the outline of New Guinea suggests on the map, and the only high peaks are 2986-meter Mt. Dayman and 3040-meter Mt. Simpson.

Run-off is short and stream flow rapid. The only sizable rivers are the Ruaba and the Rakua, emptying into Goodenough Bay and Collingwood Bay, respectively. After reaching the lowlands behind the north coast, many of the rivers and smaller streams which rise on the Goropu Mountains and Mt. Dayman broaden into wide channels, then narrow

again upon approach to the sea. This peculiarity is well seen on the Australian military 1-mile maps published during the Second World War and based principally on aerial photographs. It would seem to have been first reported by Winter (1900) for a river (the Uiaku?) which rose on the Goropu and flowed to the head of Collingwood Bay, and was seen by him in January, 1899. "You emerged from dense forest," he wrote, "into a stony, sandy waste, covered with boulders, and sparsely strewn with logs and driftwood. That portion of it which we could see up and down had a straight course, and was about a mile long by 300 yards wide. This species of avenue was fringed on each side with rows of dead or dying trees. Through it ran two streams in shallow channels." The fast-running water "was the colour of liquid mortar, and it seemed to be charged with as much earthy matter as it could hold in suspense. . . . This outlet cut through the dense forest must, I think, be of recent formation . . . caused by a large body of water travelling with great velocity. . . . Nothing but a great mass of water, moving very rapidly, could, I think, have kept such a course for such a distance. Landslips are common on the lofty Garopo Range. A landslide blocking up the mouth of one of the great gorges would easily account for the accumulation and the sudden breaking out of a very large body of water." On subsequent observation from shipboard, Winter remarked that "one of the deepest gorges in the Garopo Range debouches close to the head of this remarkable water channel." In 1953 we observed that the Rakua River, fed by both Goropu and Mt. Dayman waters, has a stretch of this type of torrent bed about 6 miles long and up to at least a quarter of a mile wide. The transportation of immense quantities of boulders and gravel by what would appear to have been cataclysmic water action of the Gwariu River, a Mt. Dayman feeder of the Rakua, is discussed elsewhere (see p. 135).

The Geological Map of Australia and New Guinea (1952) represents about one-third of

the Papuan mainland east of the 149th meridian and one-half of the D'Entrecasteaux group of islands as occupied by Mesozoic and Palaeozoic metamorphics of the central mountain system, associated with which are a few small occurrences of granitic rocks. Quartzose and micaceous schists have been collected from the summit and slopes of Oiamadawa'a, one of the high peaks of Goodenough Island (see p. 93). We found at 1500-1550 meters on the island exposures of a rock of the aplite or micro-granite family,¹ and at the eastern foot of the mountains the rock had the appearance of gneiss. Mount Dayman has been thought to be a Pleistocene volcano, but more needs to be known about the geology of this mountain. Gravel we collected in the short Kwagira River, which heads on Mt. Dayman, consisted of diorite, gabbro and reef quartz, cherts, silicified siltstones, and a phyllite. The country rock at 1550 meters on the northern slopes of the mountain has been determined as a dense mudstone or shale, and a phyllite was present. At an altitude of 2030 meters in the bed of the upper Gwariu River, which occupies an interior high valley surrounded by the culminating peaks of Mt. Dayman, a collection of gravel and shingle gave samples of a probable diorite, reef quartz, a phyllite, and, to be sure, a compressed tuff, "rock types which are commonly associated with the metamorphics of the central mountain chain." A sample from the summit of Maneau Peak of Mt. Dayman (a reputed 9163 feet or 2790 meters) was described by Taylor as "an ultra basic igneous rock which has been subjected to fairly severe selective alteration probably of the autometamorphic type. It contains about 60% of monoclinic pyroxene and much chloritised material. Sphene and quartz epidote veins are present. It is not possible to say from this specimen whether the rock is of intrusive or extrusive origin."

The Cape Vogel Peninsula and the southern lowlands of Collingwood Bay appear on geological maps as upper Tertiary sediments, with local volcanic deposits of the same age.

¹ The rock specimens collected by the expedition were reported upon at the Bureau of Mineral Resources, Geology and Physics, Canberra, chiefly by Mr. G. A. Taylor, who holds the post of Volcanologist, Territory of Papua and New Guinea.

One of our specimens from Menapi, on the south coast of the Peninsula, was a fossiliferous limestone regarded by Mr. I. Crespin as Pleistocene in age. In the opinion of Taylor, a sample of the prevailing rock at Baiawa on the south coast of Collingwood Bay appeared to be a "tuffaceous greywacke of comparatively recent origin."

Mount Victory is believed to have erupted and devastated a large area of the surrounding country between about 1870 and 1880. The event is still spoken of by local natives, and fumaroles are still active in the crater area.² A series of four explosive eruptions from several vents at the base of the Goropu Mountains took place between December, 1943, and August, 1944 (Baker, 1946). Eyewitnesses tell of a pall of black dust which hung over much of eastern New Guinea after one of the eruptions. From Mt. Dayman we could see, at the foot of the mountains towards the Goropu, a pale, bare area which was said to have been devastated by these recent volcanic activities.

In economic geology, our limited area figures early but ingloriously in the history of Papua. The earliest efforts to win underground wealth in the Territory were in gold. The first gold rush, in 1878, took place in the Port Moresby hinterland, where values proved unattractive. Ten years later the first discovery of payable gold was made on Sudest Island, in the Louisiades Archipelago, east of our boundaries. This, and rich finds on not far distant Misima Island, led to great activity in prospecting in far eastern Papua. On the mainland, a little gold was won in the mountains behind Bartle Bay as early as 1894. But the only discovery of any importance in our area was at Gibara, in Milne Bay, proclaimed a goldfield in 1899, and again the scene of some mining activity in 1953.

Sulphur deposits have long been known in a lowland area of hot springs, fumaroles, and salt lakes on Seymour Bay, Fergusson Island. Stanley (1923, p. 45) mentions one estimate of 42,000 tons of sulphur available on the surface, but over the years local interests have failed to find a profitable market for the product. In 1915 Sideia or Basilisk Island, one of the Moresby group near

² Letter from G. A. Taylor, dated January 13, 1953.

Samarai, showed promise of development in copper mining and was proclaimed a mineral field, only to be abandoned after a short period of unsatisfactory prospecting.

Prospecting and drilling for oil has taken place on the Cape Vogel Peninsula, where natural gas blows and brine springs occur. It is stated in the 1927-1928 annual report for Papua (Smith, 1929, p. 47) that strong flows of gas and showings of oil were obtained in the first bore of the Vogel (Papua) Petroleum Company, in which the tools were lost in silt and cavings at 1005 feet. Funds would appear to have run out before much progress could be made with a second well.

The most recent stir in mining in our area occurred in 1951, when licenses were granted by Government for drilling and testing for tin on Goodenough Island. So far as can be ascertained, no work was done by the licensees.

CLIMATE

A great preponderance of rain forest in the vegetation cover indicates for most of our area high average temperatures and at least moderately heavy annual rainfall fairly well distributed through the year. Seasonal variation in temperature is small, though not unimportant as regards living comfort on the lowlands. Temperatures below about 60° F. are experienced only in the mountains, where, at the higher elevations, frosts may be expected throughout the year. At the moderate altitude of 2230 meters on Mt. Dayman, we recorded in May a low of -1° C. (30° F.). Mean annual temperature at Samarai is 80° F., mean monthly maximum 89° F., mean monthly minimum 73° F., absolute maximum 102° F., absolute minimum 64° F., and annual range 6° F.¹ The 102° absolute maximum, apparently the highest temperature ever recorded in eastern New Guinea, is open to doubt.

Rainfall for the coastal lowlands, for which alone a few records are available, varies

greatly in local amount and in seasonal distribution. The driest season over most of the area, and the "cool season," is the period of southeast trade winds, from about May through October. The northwest monsoon, operating from about December to April, brings ample rains everywhere in normal years, and is in general the season of most abundant rains. But for the localities of highest recorded rainfall, Samarai with 117 inches and Gili Gili in Milne Bay with 108 inches (Smith, 1927), the seasons are reversed, and most rain falls in the southeast season. It is the trade wind rains that determine the climate, whether wet or relatively dry. Samarai lies close to a windward coast backed by mountains. Milne Bay is open to the strike of the trades and hemmed in to north, south, and west by mountains high enough to influence precipitation. Two extensive dry areas occur along the north coast. One of these reaches from about Taupota northwest to close to the head of Goodenough Bay, a stretch of coast where steep, grassy mountains rise from the sea in northwest and southeast alignment, and at Doubina (near Wedau) average annual rainfall is only 53 inches. The second dry area takes in the Cape Vogel Peninsula and a coastal and near-coastal belt west to Moi Biri Bay, in which low hills, but no mountains, lie across the path of the prevailing winds, and rainfall at Baniara is about 65 inches.

Residents of the country hold that unusually strong trade winds have the effect of lessening rainfall for the season, while light and intermittent trades characterize unusually wet years. Annual rainfall varies within rather wide limits, and in dry areas it tends to be erratic. Occasional droughts occur, with crop failures, and in the lower rainfall areas great suffering has in the historic past resulted from shortage of food during such times. Famines affecting the dry areas of the mainland and parts of Goodenough and Fergusson Islands are recorded for 1900 and 1912. An epidemic of dysentery followed the drought of 1912, with disastrous effects on ill-nourished populations, and it was estimated that in the D'Entrecasteaux group alone at least 500 people died (Higginson, 1912).

¹ Samarai temperature data from Isadore L. Dordick, "Climate and work in Australian New Guinea," *Acta Tropica*, vol. 10, p. 237, 1953. Dordick's cited source is: "U. S. Weather Bureau. (1943). Weather Summary for H. O. Publ. No. 276. Naval Air Pilot New Guinea. Washington: Hydrographic Office, U. S. Navy Dept., p. 108."

The statement has often been made that Papua is free from hurricanes. Meek (1913, pp. 97-98), however, has related his experiences in Milne Bay in the "famous hurricane of 1898," which "was so severe that sea-birds were cast up dead on the beach, and trees uprooted in all directions." This occurred in December. Its effects on Fergusson Island, as seen the following June, were described by Le Hunte (1900): "The trees on the mountains and the seashore showed clear signs of the havoc wrought against them by the hurricane . . . the centre of it passed over this part, and the vegetation looks as if a vast fire had passed over it." In April, 1952, the Louisiades Archipelago was battered by a hurricane in which eight lives were lost and very extensive damage was done to houses, coconut palms, and gardens (Anon., 1952).

EXPLORATION

No important land exploration took place in our area before 1888, when the Protectorate of British New Guinea, proclaimed four years earlier over what is now the Australian Territory of Papua, was formally annexed to the Crown and Dr. (afterwards Sir) William MacGregor appointed Administrator. As early as 1606 Luis Vaes de Torres, Portuguese navigator in the service of Philip III of Spain, had sailed westward along the south coast without making a landing. Louis Antoine de Bougainville, on a voyage of discovery around the world, examined some of the south coast in 1768 and named Orangerie Bay. All the north coast of our area from East Cape westward was examined in 1873-1874 by Captain John Moresby in the "Basilisk." Moresby at that time discovered China Strait and Milne Bay. He also made a running survey of the western coasts of the D'Entrecasteaux group of islands, which had been sighted in 1793 by the French navigator whose name they bear.

MacGregor's 10 years of administration was a period of almost continuous exploration carried out by MacGregor himself and a very small staff of officers. These explorations combined geographical discovery with the establishment of government authority, and through the interests of MacGregor, and such men in Australia as C. W. De Vis in zoology and Baron Ferdinand von Mueller in botany,

very important collections were made, especially in birds, insects, and plants. Biological exploration under government auspices reached in that term a peak which has not been equaled or approached under any subsequent administration. A fascinating record of discovery and scientific results is contained in the annual reports on British New Guinea for the period.

MacGregor's own explorations in our area were confined to the coastal districts and to short trips inland. The first attempt at exploration of the higher mountains took place in 1891, when a party consisting of M. H. Moreton (leader), A. Gibb Maitland (geologist), and R. E. Guise (biological collector) went in from Phillips Harbor in Collingwood Bay and reached an altitude of 7733 feet at "Disappointment Rock" on what was thought to be Mt. Suckling (Moreton, 1893). From modern maps and a route map which accompanied Moreton's report, it is clear that actually the party was on the slopes of the Goropu Mountains, which rise from the northern coastal plain, while Mt. Suckling is approached from the south coast. One of the principal objects of the expedition was to ascertain whether the slopes of the great mountain range "were likely to be of any use for the cultivation of the vine" (MacGregor, 1893). Guise collected about 40 bird skins and a few plants. Geological observations were published by Maitland (1893). It would appear that until the present time both the Goropu and Mt. Suckling remained unclimbed by white men, although it has long been known that natives hunt high on these mountains. In 1953 we saw smoke rising from what to all appearances must have been hunters' grass fires on the summits of peaks of the Goropu (see p. 116).

In some old reports the Goropu Mountains are referred to as Mt. MacGregor, a name now long out of use. There has been a certain tendency to discard European geographical names in favor of native names learned as exploration proceeded.

In February of 1894 MacGregor dispatched Guise (in charge) and W. E. Armit on an expedition to examine Mt. Dayman, or Mt. Maneao, as it was called. This time the avowed economic interest was a search for the source of jade used by natives of some

coastal tribes for making stone axes. Guise, assisted by nine guns in the hands of native hunters, collected birds. Armit collected plants and helped with the birds. The approach was from Moi Biri Bay on the north coast. With boiling-point apparatus broken, aneroid out of order, and hampered by much rain and sickness including dysentery and malaria, the party reached the summit grasslands and camped there for 10 days. It seems certain from Guise's report on the expedition that none of the summit peaks was climbed. A highly interesting collection of more than 200 bird skins, from altitudes up to 8000 feet, according to the labels, was reported on by De Vis (1894). A few plants of a collection doubtfully "very large," as described by Guise, were mentioned by Mueller in appendices to the Annual Report for the year.

Confusion exists in the literature as regards the common identity of Mt. Dayman and Mt. Maneau, a situation discussed on page 111. Mount Dayman was named in honor of a lieutenant of the British survey ship "Rattlesnake," which visited the south coast in 1849 in command of Captain Owen Stanley. The following variations in spelling of the native name are culled from literature: Maneau, Maneao, Maneáo, Maneco, Manae-ao, Manaeawa.

The first and only recorded ascent of a main peak of Mt. Dayman, prior to our visit in 1953, would appear to have been made at some time between 1908 and 1912 by Dr. W. M. Strong (1916), who in those years served first as Medical Officer to the Northern Division of Papua, then as Resident Magistrate for the North-Eastern Division.

With regard to Mt. Simpson, named for another lieutenant of the "Rattlesnake," Higginson (1922) noted that it was reported to have been climbed "many years ago," but he considered this open to doubt. So far as I can determine, the first European ascent of this very steep and narrow high peak was made by Acting District Officer G. F. Nielsen and the Rev. N. E. G. Cruttwell in October, 1947.¹ Nielsen described the actual summit as a razorback, "a mere twenty feet in width,"

and while on top he was disturbed with thoughts of what might happen to the patrol if a severe earth tremor should occur. The climb was made from the northwest via Taubadi village. Cruttwell collected and sent to Kew about 30 plants from elevations above 2400 meters. A native name for Mt. Simpson, in use in the Baniara district, is Matawani.

Le Roux (1935) credits R. E. Guise and W. E. Armit with a climb, in 1894, to 5200 feet on Mt. Victory, "from where it was noticed that the mountain was belching forth smoke (or vapor)."² I can find no other reference to this climb and no record that the summit of this or any neighboring peak on the Cape Nelson Peninsula had been reached.³ A reading of Guise's report on Mt. Dayman reveals, however, the source of a probable error on the part of Le Roux, for at an altitude of 5200 feet on Mt. Dayman by their faulty aneroid Guise and Armit had a view of Mt. Victory, which was described as "covered by steam."

For the very mountainous D'Entrecasteaux group, no reference is available to the ascent of any of the heights which on Normanby Island attain a maximum of 1097 meters in the Prevost Range and on Fergusson Island 2072 meters in Mt. Kilkerran. On Goodenough Island, however, the more lofty and conspicuously rugged peaks, running up to 2545 meters in Mt. Vineuo of the maps (see p. 118), and grassy on top, have enticed the efforts of several white men. The first to gain the summit of a major peak on Goodenough would appear to have been W. E. Armit, on May 31, 1894. The published record of the feat, so far as discovered, is singularly poor for that period of usually well-reported explorations but leaves no room for doubt. From MacGregor (1894) we learn merely that "Mr. Armit went to the highlands of Goodenough Island." And again, on page 38 of the same Annual Report: "About a score of carriers were engaged here [Dobu Island] to take Mr. Armit to examine the highlands of

² Translation from the Dutch by Jacqueline van Til Miller.

¹ Patrol Report Baniara No. 3, 1947/1948, by G. F. Nielsen, A. D. O. (unpublished), contains an account of the ascent. On file at Department of District Services and Native Affairs, Port Moresby.

³ A resources survey party of the Commonwealth Scientific and Industrial Research Organization (CSIRO) planned to examine Mt. Victory and Mt. Trafalgar as part of its itinerary in 1954, but no report on its activities is available.

Kwaibwaga (Goodenough Island). One of the village policemen was there performing a sentence for adultery, and he was attached to the party as interpreter." With this no doubt very valuable addition to his personnel, Armit, on evidence gleaned from a tabulated report by Rands (1894) on rock specimens received from MacGregor, proceeded to climb "Oiamadawaka," "Oiamadawata," "Oimadawata," or the "Northern Peak of Goodenough Island," and collect, on May 31 and June 6, various specimens of mica schist and quartzose schist, some of which bore on the labels his initials, "W. E. A."¹ Armit's peak, presently called Oiamadawa'a, is 7090 feet or 2160 meters high and the lowest, northernmost, and also the easternmost of an approximately east-west chain of five main peaks situated north of the center of the island. In 1912, Oiamadawa'a was climbed by Diamond Jenness, an anthropologist later well known for his work on the Eskimo and the Canadian Indian tribes. Clement H. Rich, then an assistant resident magistrate, made the ascent on a wager in mid-1951; starting by launch from Wataluma on the north end of the island and landing at Vivigani, he reached the summit of the peak, lit a signal fire, and returned to Wataluma within 48 hours! Another ascent on which information is available was made on July 6-7, 1954, by Father C. G. Abbott of the Catholic Mission, whose approach was by a fairly direct route from Wataluma.² It would appear that the four less easily accessible and higher craggy main peaks of the island have yet to be climbed by a white man.

DEVELOPMENT

The inauguration and growth of the white man's authority in Papua have been perhaps best summarized and evaluated by Mair

¹ It often happened that scientific collections communicated by MacGregor bore, so far as can be ascertained from published reports on them, no indication as to who actually made the collection. Many collections thus attributed to MacGregor were made by other men.

² Information on the ascents of Jenness, Rich, and Abbott is contained in letters to me from these gentlemen dated, respectively, February 14 and March 14, 1955, November 5, 1954, and March 14, 1955. Casual reference to Jenness' ascent is made in Jenness and Ballantyne (1920, p. 152).

(1948). When the field is narrowed to our area, warfare and raiding between village or larger communities are things of the past, and cannibalism, with the exception of occasional ritualistic acts, has been stamped out. Instrumental in the early phases of the transformation were punitive actions, first by warships called upon to attempt punishment for the seizure of trading and recruiting vessels and the murder of white men on the coasts, later by small parties of armed native constabulary, commanded by white officers, whose role was peaceful penetration backed by the strength and ability to overcome resistance to the imposition of government authority and the introduction of white man's law and order. "Pacification by government was generally a bloodless process." Of great influence, too, were Christian missions, but only very recently has mission activity been extended to the peoples of the mountains of our area.

Since the first impact of European enterprise, the east end of the mainland and the D'Entrecasteaux group of islands have been important sources of native labor. The area did not escape the attentions of the "black-birders" who carried off manpower for the sugar-cane plantations of Queensland, although it suffered much less than New Britain, New Ireland, and the Louisiade Archipelago, in the limited part of this notorious trade that was carried out in New Guinea waters and became illegal and ended in the 1880's. The D'Entrecasteaux group supplied much of the labor for the prospecting and mining of gold in the Louisiades, which began in 1888 and still continues on a small scale. The same peoples were extensively employed between about 1895 and 1910 on several alluvial goldfields in the northeastern part of the Papuan mainland. Commenting on those times, Monckton (1922) wrote of the small, wiry men of Goodenough Island as "liars, treacherous and subtle, but at the same time brave and capable of great attachment to any person for whom they have a regard . . ." who "proved to be the best porters that New Guinea could furnish for the deadly work of carrying in the Northern Division." Since then, the "Gosiago" or "Gosiagu" (probably from their *kusebo*, a word of affectionate greeting) men of Fergus-

son and Goodenough Islands, and certain mainlanders, especially from inland, have been largely recruited, the active, intelligent islanders being in special demand as rubber tappers.

Christian missions, and also traders, were established on the coast before the existence of any settled form of government to afford them protection from peoples reputedly unsurpassed for truculence and barbarity. First in the mission field was the London Missionary Society (L.M.S.), headed here by the Rev. James Chalmers (*in* Chalmers and Gill, 1885), who in 1877 established Polynesian teachers in several localities in the China Strait-East Cape area and a head station in the vicinity of South Cape. Next was the Anglican Mission in 1891. With headquarters at Dogura, in Goodenough Bay, its area includes all the north coast westward from Awaiama (or Chads) Bay, a few miles from East Cape, and since the war native teachers have been established in a number of mountain villages in the Gwoira and inner Denewa country. Also in 1891, the Methodist Mission, with headquarters on Dobu Island (later moved to Salamo on Fergusson Island), began work in the D'Entrecasteaux group and on the mainland at East Cape. This mission extended its work to Goodenough Island in 1898, in charge of a white minister at Mud Bay on the southern end of the island. The Kwato Extension Association, founded by elements of the L.M.S. in 1918, with headquarters on Kwato Island near Samarai and territory on adjacent parts of the mainland including Milne Bay, combines religious instruction with trades training and commercial enterprise in sawmilling, boat-building, and trading.

A feature of missionary endeavor in Papua, arranged by MacGregor, is an agreement on working areas by the original Protestant organizations. While generally observed and successful in keeping conflict to a minimum, the system, by setting up virtually safe preserves, would appear to have had the effect of dulling initiative and slowing the work to which the missions are dedicated. Under other circumstances the mission organizations may have been exposed to pressures compelling more adequate financial support and staffing than has often been forthcoming

for the work now long in hand. Recently in our area the Roman Catholic Mission of the Sacred Heart has been stepping into gaps and establishing stations, including one at Wataluma on the north end of Goodenough Island. In 1953 the Seventh Day Adventists were securing land for missions on coasts of the mainland, for many years claimed, and to some extent worked, by old missions.

The principal commercial production and native trade in our area are in coconuts and the dried product, copra. Second in agricultural exports, but in quantity rather small, is para rubber, planted principally in the Sagarai Valley and on the Mamai River, on the south coast. Small amounts of trochus shell (*Trochus niloticus*) and green snail shell (*Turbo marmoratus*) are taken from the sea, and formerly there was production in pearls and pearl shell, and a little trepang fishing. Gold mining, the only mineral production, has never amounted to much (see p. 89), although probably there are few corners that have not been "tried" with pick and shovel and prospecting dish. Lumbering and sawmilling have never been important, and in 1953 not enough sawn timber was being produced to meet local demands. In that year a sawmill, larger than any other in the area, was opened at Waikaiuna, a little south of Sewa Bay on Normanby Island, primarily for the supply of building materials for Samarai.

Though not unimportant, native trade copra (see p. 98) amounts to only a small fraction of the plantation product. The principal areas for coconut planting are on the south coast and in Milne Bay, where several large estates are situated. There are numerous, mostly small, plantations on the mainland and islands within easy reach of Samarai, only one of consequence on all the north coast of the mainland in our area, and six or seven of various sizes in the D'Entrecasteaux group, including one large property in Sawataitai Bay on Normanby Island. A number of small ships, usually rated on the number of bags of copra that can be crammed into their holds rather than on tonnage or measurements, are constantly on the move, picking up copra at plantations and trading stations and bringing it to Samarai for shipment to Australia, the United Kingdom, and markets elsewhere.

Coconut plantations commonly run enough cattle to furnish beef for native labor and white staff and at the same time to help to keep down grass and brush between the plantation rows. Given a market and a breed of stock suitable for the conditions, possibilities for cattle raising on a fairly large scale would appear to exist in the dry belt that embraces the Cape Vogel Peninsula and extends west to the longitude of Baiawa on Moi Biri Bay. We saw, on and near the coast, good kangaroo-grass (*Themeda triandra*) country watered by small streams. Extensive tracts of thinly peopled, undulating land, well grassed and watered and consisting in parts of fertile-appearing black soil, are reported to occur farther inland. The grassy Ilakai Valley, at an approximate elevation of 3000 to 3500 feet at the head of the Ruaba River, is said to have the appearance of good pastoral land. There the scope would be much more limited and the climate wet subtropical.

Samarai, the only port of entry east of Port Moresby and the second most important commercial center in Papua, is the metropolis for an area much exceeding our present limits and including the Louisiades Archipelago, Woodlark Island, and the Trobriands. It is very picturesquely situated on a reef-fringed island of about 50 acres, well planted with shady trees and colorful shrubs, and lying amidst an archipelago of larger, hilly, wooded islands close under the dark mountains of the mainland. In 1942, in the exercise of a scorched-earth policy and evacuation before the advance of the Japanese into this part of the Pacific, all installations likely to be of military value and most of the residences of the little town were destroyed. Rebuilding was well forward in 1953. Big ships could tie up at the new wharf, and the three large business firms had nearly completed imposing new premises. About 90 Europeans lived on the island.

As hub of the eastern end of Papua and the outlying islands, commercially and administratively, Samarai enjoyed a flying-boat service linking it weekly with Port Moresby and Rabaul and fortnightly with Esa'ala on Normanby Island. Round-trip steamers with passenger, mail, and cargo runs terminating in Sydney called about every week or 10 days. Radio-telegraph facilities maintained

touch with the outside world. There were radio-telephone communication with Port Moresby and a two-way radio system giving contact with all government stations in the administrative district.

The interior of our area remains undeveloped and empty of resident Europeans. No government station has been placed inland; only native missionaries are stationed there. All trading stations are on the coast, and all plantations are either coastal or on coastal lowlands. Vehicular roads are non-existent, if we except those on plantations, short lengths in the vicinity of some missions, and such remnants of military roads as are still trafficable in Milne Bay and on the eastern side of Goodenough Island, where bases were situated during the last war. No need is judged sufficient for airdromes inland, and none exist. The one operative landing strip on the coast, in occasional use by light airplanes, is at Wedau (near Dogura) in Goodenough Bay.

Order is maintained by a system of administrative patrols carried out at irregular and, owing to shortage of personnel, often long intervals. These patrols, in our peaceful area, consist usually of one white officer, a non-commissioned officer, and several men of the Armed Native Constabulary, a native medical orderly, and a suitable number of local porters carrying from village to village. Government is represented on the local level by village constables responsible for the enforcement of native regulations, reporting breaches of the peace, and when possible effecting the arrest of serious offenders. The village policemen are uniformed but unarmed. They are provided with handcuffs, but, as a precaution against the abuse of authority, the keys for the handcuffs are kept at the government station, which may be distant several days' walk from the village of the policeman and the scene of the contemplated arrest.

A recent development in native authority is the appointed village councillor, dating from about 1925, while the beginning of the village policeman system was in 1892. Like the village policeman, the councillor is a man of recognized standing in the village or group of hamlets he represents. He is a man of that community. In practice, though without

designated authority, he sometimes dominates the village policeman and tells him what to do. In theory, he represents the people and advises them in government matters, helps to settle disputes and grievances without recourse to processes of law, and assists government officers and advises them on native customs. In short, he functions, ideally, in a dual role as counsel to his own people and to government. With one or two exceptions, the village policemen and councillors met with on our expedition were good, helpful men.

An important responsibility of the village policeman is the maintenance of paths by which government patrols travel from village to village, and the building and repair of native-style resthouses for officers, and barracks for their police, in the principal villages or in villages a day's journey apart on recognized routes of official travel. Labor for these works, and carrying for government parties, are compulsory on the native.¹ Be-

¹ The native pays no taxes since the abolition of a pre-war head tax of up to 20 shillings a year on adult males of effective working age in areas where cash income was considered earnable either locally or by signing on for work elsewhere. On the principle of no taxation without representation, the European is exempt from income tax and, as does the native, pays only indirect taxes in the form of ad valorem duties on imported goods.

sides administrative patrols, there are routine visits by medical patrols. The government "roads" and resthouses facilitate all travel, official and unofficial, in this part of New Guinea where one still does not fly but goes either by boat along the coast, walks, or makes usually brief use of native canoes for transport. The roads and resthouses we could take advantage of were mostly in good usable condition and a boon to our party.

Passing mention has been made of medical patrols. Their chief concern is probably the treatment of yaws. The one patrol of this kind we saw in seven and a half months in the field was in charge of a European Medical Assistant. Officers of this classification had charge of native hospitals located at Baniara for that subdistrict and at Mapamoiwa for the D'Entrecasteaux group. Native medical orderlies did duty at scattered medical aid posts. The one fully qualified medical man in our area was stationed at Samarai, in charge of government hospitals for natives and Europeans. It should be mentioned that all medical and hospital services, excepting those provided locally by missions or required by law of employers of native labor, were a function of the government, free to natives and available at very nominal cost to Europeans.

THE NATIVE PEOPLES

THE PLETHORA OF tongues and peoples characteristic of New Guinea obtains in our area. "Tribes" speaking languages of the two great groups represented in New Guinea, Papuan and Papuo-Melanesian, comprise the native population, the former for the most part being inhabitants of the mountains of the mainland, while the latter occupy chiefly coastal districts on the mainland and have the islands to themselves.

Special studies by anthropologists have been few and rather local. Seligmann (1910) conducted researches in Milne Bay and Bartle Bay in 1904, Pösch (1907) for two and a half months on Cape Nelson and in Collingwood Bay and Goodenough Bay in 1905, Jenness (Jenness and Ballantyne, 1920) on Goodenough Island and western parts of Fergusson Island for a year in 1911-1912, Malinowski (1915) among the Mailu people of the south coast for six months in 1914-1915, and Fortune (1932) on the Dobu Islands for seven months in 1927-1928. The early annual reports of the Administration carry a number of vocabularies and observations on material culture, customs, and tabus of various peoples, contributed by government officers.

The greatest single instrument of change following the advent of the white man has probably been the introduction of cutting tools of steel to a country which knew only stone-age implements. Various changes notwithstanding, the traditional social structure has not been greatly altered by contact with European culture, and there is wide adherence to old techniques, methods, and beliefs.

ECONOMY AND SUSTENANCE

The native peoples live by a subsistence economy based on shifting agriculture, supplemented by hunting, fishing, and gathering. The principal food crops are yams, taro, and sweet potatoes, the latter apparently of recent introduction on Goodenough Island (Jenness and Ballantyne, 1920, p. 30). Bananas of native cooking varieties rank as a staple on the Cape Vogel Peninsula and are an important subsidiary crop everywhere else; sweet "eating" kinds, apart from re-

cently introduced varieties such as Cavenish and Gros Michel, have usually an exotic flavor best described as of New Guinea. Sugar cane in a number of varieties is planted by all peoples and chewed as a refresher. Seeded breadfruit is commonly grown for its seeds. The green vegetables of the gardens are mostly taro leaves, pumpkin and sweet-potato tips, and the mucilaginous young leaves of *Hibiscus manihot*. Among food plants recently introduced, sweet cassava has become an important root crop in some localities. English potatoes have won a measure of acceptance by mountain villagers of the northern slopes of Mt. Simpson. Also appreciated among recent introductions of the white men are pumpkins, field corn (always allowed to become old and hard), tomatoes, limes, oranges, pineapples, papayas, and mangoes. An inferior native mango (*Mangifera minor*) grows in the lowland rain forests.

Corn, or maize (*Zea mays*), is not extensively planted nor apparently much relished. A few plants grown scattered through a garden of other crops are all that will be seen, and one gains the impression that it is a recent introduction. No doubt this is true of some strains, but it is of interest to note that on the voyage of the "Rattlesnake" in 1849, Macgillivray (1852, vol. 1, p. 247) reported "Indian corn" on the Calvados Islands in the Louisiades. (The "Rattlesnake," by the way, carried for distribution to the natives a large supply of "useful seeds" procured from the "government garden at Hobart Town," by Captain Owen Stanley.) In 1873, Captain Moresby (1876) of the "Basilisk" found maize on the newly discovered islands of the Moresby group, in Milne Bay, and on Fergusson Island. He (*op. cit.*, p. 217) commented on the occurrence in Milne Bay: "I never saw Indian corn used as food, nor did it appear to be cultivated in large quantities." Possibly, the first introduction of maize in these parts was made by Marists, the first missionaries in the general region, who had a station on Murua (Woodlark) Island in the Louisiades from 1847 to 1852 (Murray, 1912, p. 129).

The regular trading expeditions of seafaring communities of natives of the islands and the mainland would offer a means of dissemination.

Conditions appear ideal for the cultivation of the avocado as a village food crop, but this highly nutritious and easily grown fruit, which in recent years has become an important food of the natives in some rain-forest areas in West Africa, seemingly awaits introduction into native cultivation in our area.

Sago meal manufactured from the starchy pith of the sago palm (*Metroxylon rumphii*) is by far the most important food obtained from a non-cultivated plant. In some other parts of New Guinea sago is the staple fare of large, vigorous populations of lowland peoples, but here it is more of a standby, available to most communities in only limited quantities and drawn upon when, between crops or in drought years, there is not much to eat in the gardens. The palm is big and thick-stemmed, spiny or unarmed, and inhabits swamps and wet ground of the lowlands and lower mountains. Often in our area it occurs in small, isolated clumps and may be thought to have been planted. The palm is cut just before the flowers open on the great terminal, candelabra-like inflorescence. Its high yield, estimated at 100 to 300 pounds of dry meal from a single trunk, gives it great value as a food reserve in the districts where need is balanced by the availability of the palm. The sour smell of the sago "mills," where the pith is chipped into small pieces, squeezed out in water, and strained into settling vessels made from the leaf sheaths of other palms, is familiar to most travelers in lowland New Guinea.

A native in his own territory, or in an environment approximating it elsewhere in the country, can usually find something in the forest, or even in predominantly grassy areas, which will afford him a few bites to eat. Available in season are numerous fruits and seeds often as not unpalatable to a white man and seldom occurring in large quantity. One of the most important of these is the *okari* "nut," produced by a large tree of the rain forests (*Terminalia kaernbachii*) common locally on lowlands and lower mountain slopes. We found the nuts being gathered in substantial quantity from May through July by the natives of the northern foot of Mt.

Dayman. Of very good flavor, especially when deviled and eaten hot, and three or four times the size of a Brazil nut (*Bertholletia escelsa*), the *okari* would be well worth introduction to other tropical countries.

Another nut of worth is the rich oily seed (the size of an average almond but clavate in shape) of a species of *Pandanus* found in the higher mountains. We picked up old empty shells of a big-seeded pandan in native camp sites above 2000 meters on Mt. Dayman, and it was ascertained that the seed, or the plant, was called *tangata* by the Daga people of Bonenau and *anai* by the Daga of Biniguni (see p. 108), that it grew wild in the mountain forests and ripened its fruits about October, and was not cultivated. The *tangata* or *anai* seeds were produced by a large *Pandanus* which we later found common in moist, sheltered gullies in the mossy forest at 2000 to 2200 meters on the mountain. Notches cut on the stilt-roots, and sorcery signs, indicated the interest of visiting natives in the trees. Although not supported by a botanical voucher, the evidence indicated the presence here, in the far eastern mountains of the mainland, of one of a group of big-seeded pandans which in more central parts of New Guinea are so important as food plants to the great populations of the high valleys that they have been called the "coconuts of the mountains" (Brass, 1941b; Dubuy, 1954).

Coconuts, of course, are a very important planted food crop on the coasts and wherever else they can be grown, and on Goodenough Island we found old palms fruiting well at 640 meters above sea level. The natives drink the fluid of the young "nuts." But the most use is made of the grated kernel or endocarp of the mature nut, or, rather, a milky product obtained by squeezing the grated kernel in water, in which the staple roots or bananas are boiled, in old-time clay pots or the less beautiful but more durable plain or enameled metals of the trade stores. The natives oil the hair and skin by rubbing on the grated kernel.

Coconuts as a cash crop are responsible for a present trend of some coastal people to neglect their gardens and to make up the consequent deficiency in traditional native foods by the purchase of rice, wheat flour, and also canned meats and fish from traders established locally or cruising the coasts in small

ships. For about 30 years, beginning in 1903, a native regulation of government, not always enforced, required each able-bodied man of the coastal villages to plant every year so many seedling coconut palms. Some individuals and communities established small plantations voluntarily. Today, with copra bringing the high price of fourpence a pound on the beach, a result of the coconut planting is the ability of certain coastal peoples to adopt, temporarily at least, a somewhat altered standard of living, but doubtfully better unless there is an improvement in the supply of animal proteins.

Generally, the native diet is amply belly-filling, but it may be short in qualities conducive to stamina and resistance to disease. The great deficiency in the diet is in proteins, especially animal proteins, the only large existing source of which is the sea. But it is found (on the coasts of the Cape Vogel Peninsula and eastern Goodenough Island, for example) that the coastal people are not always good fishermen or good canoemen and may give the impression of bush people recently come down to the salt water. The resources of the sea, therefore, are not much more than sampled by some quite large communities of the coasts.

The only domesticated animals, if we except an occasional cat, are pigs, a few chickens, and a few dogs, the last often pitifully emaciated and mangy. Domesticated pigs, unless stolen (and there is much trouble over pig stealing), are reserved for special trade, such as bride price or for ceremonial meat exchanged under complicated sets of rules and values. An owner seldom if ever eats his own pig. Wild pigs are hunted throughout the land. Also commonly hunted because of their useful size are wallabies and bandicoots, the arboreal cuscus and related marsupials, and, among birds, the great flightless cassowary. Tabus on the eating of various animals apply to totem groups, in some peoples at least. Individuals, through inborn horror or aesthetic flinchings, will not eat snakes. But in general the native, given privacy, will consume almost anything in the nature of animal food that comes his way by collecting or the chase. He is, however, primarily an agriculturist or gardener and seldom more than an indifferent hunter, and the amount of meat he obtains is small.

Important in the living of the people are tobacco and betel nut. Tobacco in New Guinea has been discussed at length by Riesenfeld (1951), whose opinion that the introduction of the plant to the area of our coverage is rather recent is borne out convincingly, if patchily, by the literature of exploration. Good tobacco of cigar-leaf type is grown, usually in odd corners in the villages, but if a native has the choice, his preference is for the very strong black twist tobacco, manufactured in Virginia, which has become a standard article of trade and currency. The seed of the betel-nut palm (*Areca*) is highly prized as a stimulant and narcotic. The chewing of the nut, with leaves or bark of the betel pepper (*Piper betle*) and lime calcined from coral or the shells of mollusks, produces a state of mild tipsiness which often leads to loud talk and squabbles. The slender, graceful palms are planted in and about the villages and in the food gardens. There is considerable trade in betel nut from localities where conditions specially favor the growth of the palm or the nuts are of superior quality, for example, the Biniguni area at the northern foot of Mt. Dayman.

The introduction of steel axes and big knives has greatly lightened the labor of the men in clearing the forest for cultivation, fencing the gardens to keep out marauding pigs, house building, and the making of canoes. Big knives, used in weeding the gardens, materially facilitate this time-consuming work, which is mainly a task of the women. The hoe has not been adopted as an implement of cultivation. The steel axe has supplanted not so much the stone axe, which was used for splitting timber, but the stone adze, with which trees were frilled round and round with downward strokes until they fell. The only radically new tool in agriculture is the big knife, with a blade up to 18 inches in length, which serves a multitude of uses in daily life. The old, tried methods of growing crops are retained.

Land-clearing operations are carried out chiefly in the trade-wind season, when patches of forest are felled and the logs and debris sufficiently cleaned up, stacked, and burned, in time for planting with the first useful rains after the dry season. This is usually in September or October, when thunderstorms are a feature of the weather pattern.

Where grasslands are cultivated, as in the dry belt of Goodenough Bay and on parts of Goodenough Island, the ground is turned over in the initial step of preparation by teams of men, helped occasionally by women, using long digging sticks. Cultivation practices differ with the crops grown, and many distinctive variations of widespread basic methods are in local use. Under a common rotation system, the new garden is first planted to the main crop of the people concerned, say, yams or taro, and after the digging of this is begun, about June or July of the following year, miscellaneous plantings of sweet potatoes, pumpkins, sugarcane, papayas, and so on, are put in. After about two years of cultivation the garden is abandoned and soon is claimed by second-growth forest or reverts to grass.

Irrigation has been practiced from time immemorial by the villages of Wamira, Wedau, and Boianai on the dry south coast of Goodenough Bay. As described by Bishop Newton (1914), mountain streams are dammed and the water is carried for distances of up to 3 or 4 miles in canals and aqueducts, one canal being in places dug into the sheer face of a cliff. From Lyons (1927) we have a description of the Wamira irrigation scheme and aqueduct and a traditional account of their origin and building.

SOME AFTER-EFFECTS OF THE SECOND WORLD WAR

During the war, from the time of the Japanese advance in 1942 until late in 1945, a large proportion of the able-bodied men, as in much of Papua, were either recruited voluntarily or impressed to meet military operational demands for labor. Some of these men served as porters and stretcher bearers in support of Australian troops in the grim jungle fighting of the Kokoda Trail. Later they worked on the construction of military installations and in the production of strategic plantation rubber. Other men enlisted voluntarily in special native fighting units of the Australian Army for service in New Guinea. In our area an important military base was situated in Milne Bay, and an airfield at Vivigani on Goodenough Island. The only fighting of consequence took place in Milne Bay for a few days in August and

September, 1942. However, nearly all the European population was evacuated to Australia, leaving plantations and missions abandoned except for native caretakers.

In the confused period after the war, when civil authority was being reestablished following several years of military administration by ANGAU, and experienced officers were lamentably few, strong elements of the native population of Goodenough Bay and the Cape Vogel Peninsula banded together to set up a "government" of their own and defy existing authority. Led by an ex-government clerk, who had been dismissed for embezzlement, the organization was called the Wedau Development Company, or a similar high-sounding name. Several thousand pounds in cash were collected from "shareholders" who, after the ring was broken, recovered only about two-thirds of their money.

In view of this background and adjustments still being made after the war, continuing post-war scarcity of goods, and inflated prices, it was perhaps to be expected that our arrival, seemingly rich in possessions strange even to those who had seen so much during the war, should stimulate ideas of cargo cult. To those who followed the philosophy, we were thought to be only an advance party preparing the way for great numbers of other Americans expected to arrive soon after us with shiploads of all manner of manufactured goods to be given away to the native population. There were vivid memories in the country (not confined to the native mind) of the lavish equipment and supply of the United States forces during the war and the prodigal way in which these assets were said to have been dispersed to all comers.

Only in the coastal districts of the mainland did we have evidence of stirrings of cargo cult. A curious development gave rise to a story that had us associated in some way with the proceedings of the Anglican Mission. At Easter there had been great activity by the mission in putting up big wooden crosses in the villages in its territory. The story ascribed to us the erection of a cross on the top of Mt. Dayman and our watching it regularly through the night with one of our 500-candlepower pressure lanterns!

PREVIOUS COLLECTIONS

EXCEPT IN BIRDS AND Lepidoptera, only a rather small amount of biological field work has been done in our area, yet a listing of collectors in all fields, known to be incomplete, comprises the not inconsiderable number of 42 names. Thirteen of these workers functioned in zoology, 18 in botany, while 11 collected both animals and plants.

In the enumeration of the more significant collections, some of the earlier ones are included principally for their historical interest. A degree of ambiguity has been necessary in the evaluation of collections in a diversity of fields, in not one of which to my knowledge, except recently in botany by van Steenis-Kruseman (1950), has any comprehensive study of the results of explorations been published.

There have been several phases of activity in biological exploration, in our limited area and in Papua as a whole, in which leadership was held by: (1) the naturalists of early British survey ships, who as a rule stayed close to their boats at landing places; (2) the emissaries of scientific institutions and professional dealers in Europe, including Britain; (3) government officers appointed for their competence as naturalists by the first Administrator, Sir William MacGregor, who, no doubt wisely in view of excesses practiced by certain individuals of the second category, opposed unofficial exploration in the territory under his charge; (4) representatives of American and British scientific institutions in a period in which, after the MacGregor heyday in biology, government interests in science turned chiefly to anthropological researches for guidance in administrative policies and to geology as an aid to mining enterprise; (5) biologists of the Allied military forces of the Second World War, who made various collections, some small, others important, in line of duty with medical and forestry units or in pursuit of personal interests as opportunity occurred; and (6) the contemporary, post-war period marked by greatly increased Australian participation in a field in which European and American investigators are still active.

Most of the earliest field workers had interests in both zoology and botany and often also in anthropological collecting. First in our area, apparently, was John Macgillivray, naturalist of the "Rattlesnake," which carried out surveys in this general region in 1849 and 1850, but chiefly in the Louisiades Archipelago. Dr. R. N. Comrie, surgeon of the "Basilisk," collected at least insects in 1873 and 1874 and probably paid attention to other groups. Andrew Goldie, a collector of living plants for S. B. Williams of London and herbarium material for von Mueller in Melbourne and also a zoological collector of note, made several visits to the southern and southeastern coasts of the mainland beginning in 1877, and in company with Karl Hunstein in 1882 made the first collection of birds from the D'Entrecasteaux group on a visit to western parts of Fergusson and Normanby Islands. Lamberto Loria, Italian ethnographer, assisted by Amadeo Giulianetti, in 1889-1890 and again in 1891-1896, made, principally for Genoa, important zoological and botanical collections from far eastern parts of the mainland and neighboring islands, including Goodenough and Fergusson.

In birds, the great collections made by Albert S. Meek (1913) for Lord Walter Rothschild's Tring Museum, and now in the American Museum of Natural History, stand out far above all others. Meek worked in our area at various times from 1894, when he spent four months at Nadi on Fergusson Island, until about 1913. His most important localities besides Fergusson Island were Goodenough Island, where he collected for six weeks in 1896-1897 before being removed by Government for his own safety, and Milne Bay, where five months were spent in 1898-1899. At Nadi, Meek was assisted by Gulliver and W. B. Barnard and Harry Barnard, and on Goodenough Island by his younger brother, W. G. Meek. Best known of his assistants were the brothers Eichhorn, Albert and George, who continued collecting for Tring after Meek's retirement. Another collector of birds and insects for Rothschild,

A. S. Anthony, in July and August of 1895 spent about two months on a trip from Amazon Bay on the south coast to somewhere in the mountains of the main range and back to the coast at Orangerie Bay (Rothschild and Hartert, 1896).

In bird collections, apart from the very earliest and those of Goldie and Hunstein, Loria and Giulianetti, Meek and the Eichhorns, and Anthony, who was a half-caste, special notice should be given to a very valuable collection of over 200 skins brought from altitudes up to about 2400 meters on Mt. Dayman by Guise and Armit in 1894 (see p. 91) and sent to De Vis in Brisbane by MacGregor. With interests primarily in birds, the Whitney South Sea Expedition of the American Museum of Natural History, operating from the schooner "France," worked in our area at times between November, 1928, and the middle of 1929. Hannibal Hamlin, then leader of the expedition, spent about a month in the mountains behind Dawa Dawa in Milne Bay, and with a Samoan hunter camped four nights at an elevation of 580 meters behind Mud Bay, "in the same site used by the brothers Eichhorn four or five years ago, as far as I can make out from the natives. They stayed six weeks collecting birds and butterflies."¹ F. Shaw Mayer, on one of his many expeditions to New Guinea to collect live birds and study skins of birds and mammals, visited the north slopes of Mt. Simpson and the east and northeast slopes of the Maneau Range in 1940. Before that, and more briefly in 1935, Shaw Mayer had collected in the Faralulu district on the western part of Fergusson Island. The 2400-meter altitude of Guise and Armit is the highest at which birds have been collected in our area. Hamlin collected up to about 1200 meters on Goodenough Island.

Important collections of insects were made by Loria and Giulianetti, and apparently by W. Micholitz, a collector of living plants for J. Sanders and Sons of St. Albans, who in 1894-1895 visited Normanby Island, the Cloudy Mountains of the southern mainland coast, and the Stirling Range and other

localities in the Milne Bay area. While making anthropological studies on Goodenough Island in 1911-1912, Diamond Jenness collected three or four hundred butterflies and moths for the Pitt-Rivers Museum of Oxford. MacGregor (1912) mentions, without any name or date by which it might be traced, "the finest collection of beetles obtained in any part of New Guinea" as having been made at a police camp which was occupied "for some time on top of the island" of Goodenough "a good few years ago," when the natives showed fight. Meek and the Eichhorns amassed enormous collections of insects for Tring, paying special attention to butterflies and moths. Twenty thousand specimens of Lepidoptera were collected at Meek's Milne Bay camp alone.

A few mammals were taken incidentally by some of the earlier collectors and such men as Meek, and Hamlin and R. H. Beck of the Whitney South Sea Expedition. Shaw Mayer made, for the British Museum, a small but very interesting collection on Fergusson Island in 1935. The only sizable collection of mammals prior to our expedition was a fine lot of nearly 200 taken by Shaw Mayer on the mainland in 1940, chiefly from a base at Enaena on the northern slopes of Mt. Simpson (Laurie, 1952).

Van Steenis (1950b) estimates that 18,300 numbers of plants have been collected in the Territory of Papua, or only eight numbers for each 100 square kilometers of area. For the D'Entrecasteaux group, his figures are 200 numbers collected and a density index of six per 100 square kilometers. No large collection had been made in any part of our area up to the time of our visit. Since the 1870's and early 1880's, when the Rev. Samuel MacFarlane and the Rev. James B. Chalmers of the London Missionary Society collected a number of plants, mostly for Melbourne, missionaries have been prominent in botanical field work in far eastern Papua. Some of the classic fern collections of the Rev. Copeland King of the Anglican Mission came from our area, although most of his long residence from 1893 to 1918 was at Ambasi, on the north coast considerably west of our boundary. The Rev. R. Lister Turner of the London Missionary Society collected between 1924 and 1930 and sent to

¹ Hannibal Hamlin's unpublished diary for November 19 to 23, 1928, in Department of Birds, the American Museum of Natural History.

Brisbane about 140 plants from Fife Bay on the south coast. Especially important gatherings numbering about 300 up to October, 1951, were made for Kew by the Rev. N. E. G. Cruttwell, mostly from the mountains of the Gwoira country and some from the summit of Mt. Simpson. Another important collection of mountain plants, made by Armit on Mt. Dayman in 1894, is men-

tioned above (p. 92). The most noteworthy war-time collection would appear to be that of Lindsay S. Smith of the Queensland Herbarium, who, as a lieutenant on attachment as botanist to a forestry unit of the New Guinea Forces, in 1945 spent a month or more in the Milne Bay area and on the Stirling Range.

ITINERARY AND ROUTES

IN JOURNEYING TO New Guinea, Tate and Van Deusen went by ship from New York via the Panama Canal to Sydney, thence by air to Samarai. I flew from Washington to Honolulu by MATS (Military Air Transport Command), from there to Sydney by Pan American Airways, and on to Port Moresby and Samarai by Qantas Airways, arriving a week before the other members of the party from the United States.

Our return to New York was not according to plan. Tate, on account of his illness, had to be flown home via Sydney, Singapore, and London as a cot case, accompanied by Van Deusen, while I closed affairs in Papua, then returned by the way I had come.

Descriptions of principal collecting localities are reserved for the section following this. Given here are descriptions of routes and minor collecting localities, and the numbers of mammals (M), herpetological specimens (H), fresh-water fishes (F), insects (I), and plants (P) collected in all localities.

MARCH

On March 3 I arrived in Port Moresby, where several days were spent in interviews with government officers and the examination of patrol reports on areas in which we were interested. The reports of patrolling officers often are very valuable and as a rule the only sources of recorded information on local conditions in the Territory. Unfortunately, all or most of the original records of explorations on file in Port Moresby were destroyed by Japanese air bombings during the war. Only a few of those considered most important had been published in annual reports of the administration, and elsewhere.

AERIAL RECONNAISSANCE OF MT. DAYMAN

On March 9 I went on to Samarai from Port Moresby, normally a flight of less than two hours by four-engined Sandringham flying-boat, which made the trip weekly. But on this occasion, through the courtesy of Qantas, the airplane was diverted from its

regular course along the south coast to give me a view of the eastern parts of the central range of mountains. The weather was clear at first.

Viewed from the southeast, where we changed course to cross the range close to the west of Mt. Dayman at an altitude of about 2350 meters, Mt. Suckling (3420 meters) and the Goropu Peaks (up to 3670 meters) seemed like prominences on the rim of a great volcanic crater, breached in our direction, and showing sheer faces of gray rock on its inner walls. The upper levels of the massif were grassy, and much bare rock appeared on the summits in general above about 3000 meters. In a relatively low place between the Goropu Peaks and Mt. Dayman, perhaps 2000 meters in altitude and called Tantam (properly Tantama) Tableland, the range had a broad, flattish, but much gullied top and was heavily forested. An *Araucaria* protruded prominently and in quantity above the Tantama forests.

Mount Dayman was seen to be a massive, isolated peak dropping off very steeply in gray rock to the east. To the south it had a rather smooth, humpbacked, rocky, grassy, and shrubby or scrubby summit slope and below that plunging contours completely forested. A deep high valley with wet grassy bottom and a widening stream cleft the western side of the mountain, then turned in a northerly direction. Rising white cumulus clouds blotted out the north slopes and soon the summit, as we rounded the mountain towards the east. But enough had been seen for me to determine the presence of much good forest below extensive summit grasslands, and the south slopes of the mountain and the top of the range were completely forested. The northern slopes and approaches from the north remained uncertain quantities. Tall *Araucaria* trees rose conspicuously above the other trees of the forests uppermost on the slopes. A lake on the summit grasslands of the northeastern part of the mountain was observed by others on the plane, but not by me.

In the extremely rugged Gwoira country,

immediately to the east of Mt. Dayman, a considerable area of very steep, razorback ridges, several thousand feet high, carried a grassy covering of a startling pale green. This area appeared to be almost completely deforested, presumably by native population, although the slopes were precipitous indeed for cultivation, and no gardens or villages were in evidence. Southerly, and east again, the mountains appeared to be mainly forested. By this time (between 9 and 10 A.M.) most of this area was under cloud, above which only the sharp summit of Mt. Simpson (3040 meters) protruded.

Tate and Van Deusen arrived in Samarai on March 16. Four days later, with personnel complete, collecting supplies for six months and food for two months, we left Samarai for the Cape Vogel Peninsula on the auxiliary ketch "Govilon." A sturdy 55-footer, skippered by a native, the "Govilon" had a reputed speed of five knots. The 32 miles to East Cape was done in eight hours, against a slight northeaster and a set of current most of the way. We tied up for six hours of the night at a small wharf at Wedau, made a brief call at Baniara Government Station, and dropped anchor off Menapi during the afternoon of March 21, about 32 hours out of Samarai.

At Menapi, Patrol Officer Skewes had had the village constable repair the government resthouse for our accommodation, build a house for our boys, a store house and a latrine. When we landed, some stores and botanical paper supplies were tipped into 2 fathoms of water through inept handling and the capsizing of one of the small outrigger canoes that we used to unload the "Govilon."

On March 27, Wynn departed on a land reconnaissance of Mt. Dayman, having with him one of the Gosiagos, and a local native (one Patrick of Banapa village) as guide for the first part of the journey.

APRIL

Menapi remained the base for field work throughout this month. Minor named collecting localities in the neighborhood were Baniara, on Mosquito Island, about 4 miles to the west; Abuaro, on the mainland shore opposite Baniara; Okawabero River, about 1½ miles to the west and northwest; Arorara

River, 1½ miles northeast and north; and Banapa, about 3 miles to the east of Menapi base.

From April 7 to 10 Van Deusen and I used as a subsidiary camp the government resthouse at Kirikirikona, near Dabora, on the coast about 6 miles east of Menapi. We were put ashore there by a local small vessel, the "Ruru," engaged in trading for copra, which had been chartered to meet Wynn on the coast of Collingwood Bay. Extensive limestone caves at Tapitapipi, an hour's walk inland, were examined in part, principally for bats. Open grasslands, which occupy much of the far eastern part of the Cape Vogel Peninsula, were botanized to near Wabubu village, on the tip of the Peninsula. Other collections were made on Neara Point, 1 mile to the southwest of Kirikirikona resthouse. Van Deusen, accompanied by Tate, revisited the caves on April 15, going to Dabora on the "Ruru," and walking back to Menapi along the coast (M 267, H 1, P 72).

WYNN'S LAND RECONNAISSANCE OF MT. DAYMAN

On his journey from Menapi, Wynn reached Medino village in Collingwood Bay on the "Ruru" on March 27. Traveling thence by canoe along the coast to Baiawa village and to a landing place up Moi Biri Creek, he walked inland via Kwagira village and on March 30 reached Biniguni village, at the foot of Mt. Dayman. Securing there three local men as carriers and guides, next day he followed a native path up steep, forested slopes and in seven hours reached an altitude of 1550 meters. Another day of five hours, including rests, brought him to 2230 meters, where camp was made in a grassy hollow, and a rough bark shelter was built to provide better protection from the cold than was afforded by a waterproofed nylon fly. From this camp the summit of Maneau Peak of Mt. Dayman was reached in less than two and a half hours over grasslands on the morning of April 2. The return journey from the 2230-meter camp to Biniguni was done, with few stops, in the very fast time of five hours and 20 minutes.

Wynn's would appear to have been the second recorded ascent of a main peak of Mt. Dayman by a European (see p. 92). It

was made in good weather. His report on the mountain was very encouraging. The route he had followed was practical for the transport of our party and shorter than any other approach from the coast. The track was steep most of the way and considerably overgrown by underbrush in parts of the forests below the grasslands, but the latter conditions could be improved by cutting. Good relations had been established with the village people below the mountain, who offered to carry for us, and it was estimated that enough porters would be available for our purposes. Taro and other native foods were plentiful there. This very successful trip ended with Wynn's return to Menapi on the "Ruru" on April 10.

From April 17 to May 1 our party was pleasantly augmented and botanical efforts were materially assisted by a visit from Dr. R. D. Hoogland (see p. 83).

MAY

Having received a two-month's replenishment of stores beforehand, packed collections for shipment to Samarai for storage, and organized and packed supplies for the work ahead, we left Menapi (M 217, H 356, F 71, I about 27,000, P 407) May 5 on the auxiliary ketch "Jessie," bound for Baiawa in Collingwood Bay. An important addition to our party was Interpreter Diwowan, a Daga mountain man of Bonenau village on the southern slopes of Mt. Dayman, lent to us temporarily by Patrol Officer Sullivan, who had recently taken over the administration of Baniara Sub-District. Being unacquainted with the difficult waters of Collingwood Bay, the owner-skipper of the "Jessie," Mr. Norman Evennett, took on board as pilot a Menapi native named Ananias.

As we chugged up Goodenough Bay towards Cape Vogel, in the calm of early morning after days of strong, showery, south-east weather with rough seas, the mountains, including the high peaks of Mt. Simpson and Mt. Dayman, stood out very clear and blue to the south and southwest. A nine-hour run around the Cape and along the coast of Collingwood Bay brought us to Medino village, where we anchored for the night in 6 fathoms of water.

The south and north coasts of the Cape Vogel Peninsula presented rather striking

contrasts, the more irregular hills of the former being in general rain-forested eastward from the largely grassy hills of Menapi, while on the north coast grassland and savanna predominated, and the forests had a drier appearance, as if developed under a distinctly lower rainfall. At first almost entirely sandy beach, the immediate shore line of the south coast became next a succession of beaches and cliffed headlands of honey-combed limestone, and for the last 3 or 4 miles almost a continuous line of low cliffs. The broad tip of the Peninsula presented long stretches of beaches backed by numerous planted coconut palms and some sizable villages, also shorelines of a limestone table raised little above the sea. From the "corner" at Kibirisi Point to about a mile past Mukawa on the north coast the grassy hills rose steep-to from a generally sandy beach line behind which there appeared to be a terrace, generally narrow and elevated only 2 meters or so above high-water mark.

Tapio, on Tapio Bay, was a special point of interest. Higher there than anywhere else on this coast of the Peninsula, the hills rose to about 240 meters in Castle Hill, which culminated in a conspicuous perpendicular high face of gray limestone facing the sea. The hills thereabouts carried a considerable amount of closed forest on slopes probably for the most part too rocky to cultivate. We had information about, and one of us later visited (see p. 115), caves high on the western slopes of Castle Hill and about half a mile from the coast. One high-ceilinged cave, variously reported as up to half a mile deep, had recently been examined as a possible source of bat guano. There are said to be a good anchorage for small craft in Tapio Bay and very extensive savannas inland.

Mangroves fringed the coast from a little west of Tapio to Medino and beyond to at least the mouth of the Kwagira River, a distance of about 30 miles and an unusual extent of mangrove for a coast of dry hills on which the prevailing vegetation is grassland or savanna. Along this coast are a great many small coral islands, mangrove-covered or not, some of them very close inshore, which offer numerous places of shelter for small vessels in all weathers. There is an irregular shore reef. Small craft can generally find plenty of water close in to the shore, although

farther out the sea is much obstructed by reefs and coral patches.

At Medino, where a small creek entered a little bay cluttered with submerged coral, the mangrove fringe of the usual *Rhizophora-Bruguiera* community was roughly 200 meters wide and the trees 6 to 12 meters tall. Inside a mouth so filled with coral that entrance with a dinghy was difficult at low tide, Medino Creek deepened into a narrow, dark waterhole of fresh water infested with crocodiles. On the banks of the creek, on a narrow foreland between the mangroves and the steep rise of undulating grassy hills which extended far inland, stood a village of perhaps 20 houses, shaded by coconuts and occupied by a not very prepossessing people. Wallabies (*Protemnodon agilis*) were reported to be especially plentiful on the grassy ridges behind Medino.

For the 10 miles from Medino west to Baiawa the hills, rising close to the coast, have a remarkably even elevation of about 50 or 60 meters and carry extensive grasslands and savannas. This part of the coast is dominated by the great bulk of the Mt. Dayman part of the central range, the foothills of which come to within 6 miles of the sea at the indentation called Moi Biri Bay, on the east shore of which the village of Baiawa is situated. The "fir trees" of the maps, prominent on the low coast near Kewansasap village at the western entrance to Moi Biri Bay and on Fir Tree Point, are a species of *Casuarina*, growing in very tall pure stands.

Landing at Baiawa on May 6 we established ourselves, with about two tons of cargo, in the government resthouse, which was to serve as our storage depot for the next four months. At dawn next day Wynn began the transport of supplies inland, departing for Moi Biri landing and Biniguni with 65 carrier loads stacked on the rickety platforms of six outrigger canoes. The scientific party carried out field work at Baiawa while this preliminary transport was under way (M 36, H 15, F 2, I about 1000, P 93).

ASCENT OF MT. DAYMAN

Having sent 40 loads to Moi Biri landing the evening before to be left unguarded but covered with a fly, Van Deusen, Tate, and I

saw the resthouse doors closed with elaborate lashings of vines (which any intending thief could have cut if he did not feel like climbing over the doors) and left Baiawa early in the morning of May 12. We had on five canoes 14 loads of gear, 10 Gosiagos, and 14 Baiawa men who had offered as carriers.

In 30 minutes, mostly of poling across wide shore reefs in the lower end of Moi Biri Bay, the canoes entered a muddy mangrove creek of the same name bearing about 10 points south of west from the village of Baiawa. This in all probability was the Forewa, or "Mobiri," Creek up which in 1894 Guise and Armit went a mile or so in whaleboats at the start of their journey in to Mt. Dayman. A mud bar shallowed the entrance to the creek, which soon narrowed so that it was arched over by the grotesque mangrove forest and barely wide enough for the canoes, which scraped over submerged logs and had to be steered carefully to avoid entanglement of the outriggers with mangrove roots looping into the banks. In from the coast, *Rhizophora* mangroves grew fully 25 meters tall, and long, forking adventitious roots hung free from some branches 15 meters or more above the mud. Half an hour up the creek we came to the first slight rise of ground, then a garden house. In an hour and three-quarters after leaving Baiawa we reached the landing place where, on the high left bank, about 5 meters above the mud of the creek, we found our advance cargo safe and 24 people from Kwagira and Borovia villages waiting to carry for us.

Kwagira village, at 20 meters elevation¹ on the left bank of the Kwagira River, was reached in an 80-minute walk behind the carriers, some of whom were returned to bring up loads left at the landing. Garden houses of the Kewansasap people and good plantings of taro and bananas were passed soon after we left the canoe landing. Much of the cleared track or "government road" was muddy, and travel would have been bad after heavy rains. The primary vegetation to near Kwagira was chiefly sub-climax rain forest developed on low-lying, poorly drained land. A succession of slight gravelly rises,

¹ All altitude records of the expedition are from aneroid barometer readings, as far as possible averaged and corrected to sea level.

beginning about a mile from Kwagira, carried a more mature type of forest, and good alluvial lands along the river were occupied by gardens and various stages of rain-forest second growths. The village of about 12 houses was pleasantly situated on the eroding high bank of the river, which there was a clear stream running 15 to 30 meters wide in long gravelly rushes and slow pools. Breadfruit and mangoes and coconut and betel-nut palms grew plentifully in the village, also crotons and other gay shrubs for ornament. The beautiful pale purplish plumes of a very tall wild sugar-cane (*Saccharum*) made a striking display in grassy clearings and in the river flood bed. From an unsubstantial small resthouse on the bank of the river, fine views of the Goropu peaks and Mt. Dayman were obtained, although we were too close under Dayman for its upper parts to be visible. The Kwagira people made good tapa cloth. They seemed quiet and inoffensive and did much to help in our transport problems until at the time of their annual taro feast in July they had to be ostracized for stealing a case of canned beef which Wynn, when short of carriers on a transport trip, had left in the village resthouse.

Wynn met us at Kwagira. With carriers for all but nine loads, we left Kwagira at 6:20 A.M. on May 13 and reached Biniguni (170 meters) at 9:45 A.M. Between the Kwagira, forded at the village, and its Peria Creek tributary, 80 minutes along the route, the country was low lying, with many muddy patches on the trail. Several flowing streams were crossed either by wading or precariously on single slippery logs, without hand-rails, which served as bridges. From the Peria, a beautiful gravelly stream in primeval forest and the site of a later collecting camp, the land rose gradually, was generally well drained, and carried splendid tall rain forest in which, at first, *ilimo* trees (*Octomeles sumatrana*) attained enormous size. Opaigwari (70 meters), a new village of six houses close to the east bank of the Rakua River, was a 45-minute walk from the Peria; Budmag, a somewhat larger village at 130 meters, 35 minutes farther on. Except for a sizable patch of induced grassland near Opaigwari, the entire route was through rain forest in various stages of development, in-

cluding, in indication of long-established native populations, a considerable aggregate of second growths between Kwagira and the Peria and in the Opaigwari-Budmag area. The Opaigwari and Budmag people had big, well-kept gardens planted mainly to taro, with yams, sweet potatoes, and bananas as secondary staple crops. Betel-nut palms grew plentifully in all three villages and supplied an important item of trade with coastal people. At Baiawa we saw Biniguni betel nut being carried to Abuaro village on Good-enough Bay, about a week of ordinary native travel from its place of origin.

Opaigwari and Budmag were the westernmost villages of the Maiva tribe; the Biniguni people, an isolated community of the Daga tribe who had migrated from the Gwoira country on the eastern slopes of Mt. Dayman (see p. 109). The Kwagira were still another people. Thus in one morning of easy travel we had contacts with three different populations, speaking different languages. The effects of betel nut on local and visiting men were plainly apparent in glassy eyes and loud voices during the afternoon of the day we arrived in Biniguni, when Wynn, in fluent Motu,¹ harangued the multitude on the subject of our carrier needs for the mountain.

Biniguni, with 20 to 30 houses, a government resthouse, and a medical aid post, was the biggest village of those parts. Although 2 or 3 miles west of what would have been a direct approach from the coast, it was well situated for a storage and transport base for the supply of our party on Mt. Dayman. The range rose in a steep escarpment only a mile to the south. And in May, when the rivers still ran strong after the wet season, there could be heard in the village the constant roar of the Gwairu, the river I had observed from the air on the west side of Mt. Dayman, which issued from the range near by in a tremendously deep and very narrow gorge, and of the Mai-u, less than a mile to the west and a principal drainage stream of the Goropu heights.

The Mai-u, which below its reception of

¹ The language of the Port Moresby area, which has become the equivalent of kitchen Kaffir and passar Malay in parts of Papua long under government control.

the Gwariu waters is the Rakua of modern maps, is from source to sea the Fir Tree Creek of old maps and reports. The Rakua is the Rako of the Biniguni Daga, whose Mai-u is the Ma-u of the 1-mile military map (No. 1675, Kwagira River sheet), whose Gwariu is the Gwadi of this map, and who apparently call the upper Gwariu the Gwasi. In 1953 the "Biniguna" of the 1-mile map consisted of only three houses. The new village, where we had our transport base, was situated approximately $1\frac{3}{4}$ miles to the northeast of the old village.

Wishing to ascend the mountain in easy stages and to improve the track for the main transport line, Tate and I, with five Gosiagos and eight carriers, left Biniguni at 7:10 A.M. on May 14 and in four hours reached an altitude of 700 meters, where we camped. Traveling first eastward, in little ups and downs on a government track parallel with the foot of the range, we came to the Ginum river or creek in 50 minutes. Although very stony with boulders and gravel of waterworn appearance, much of the land under the range had been cultivated and carried secondary forest. Coconut, betel-nut, and lime trees marked old village or garden-house sites abandoned in very recent years. In tall primary forest, greater birds of paradise (*Paradisaea apoda*) were noisy, and our natives made stops to gather, and break open for their very palatable nut, the big red fruits that lay under *okari* trees.

We came to the Ginum at a place where, having flowed along the very foot of the escarpment in a bed of loose boulders, at an altitude of about 160 meters it turned sharply towards the coast, and a long, high cascade fell to the river on its east bank. Crossing the knee-deep stream from stone to stone, we left the government track and immediately started up the mountain, climbing at first along the edge of the cascade on dangerously slippery rock. The slopes were very steep but for the most part not rocky, and we had good footing on a track which, though old, showed signs of only occasional use. A generally somewhat rubbly gray soil supported an inferior type of rain forest with rather sparse and predominantly woody undergrowth, which at least gave welcome shade from the hot sun. At 610 meters we

came to a hip-roofed shelter of *Pandanus* leaves, built by native travelers or hunters. Extensive secondary forest and the sites of several villages or hamlets, including two named Bud-awa and Umaiau, indicated a former population resident between about 500 and 700 meters on the slopes.

The Biniguni Daga had lived here before, on orders from Government according to report, they moved down to the foot of the mountain not many years ago. The father of the present chief of Biniguni led the people who first settled on these slopes. The migration took place from Bibitan in the Gwoira country soon after the murder in that area of a white prospector named Werner, who was killed and his camp looted in 1913. The leader was the first man in Bibitan to own a steel axe. Our informants were silent as to how he came to possess the axe and why his group left Bibitan and moved to the other side of the mountain. In the administrative Annual Report for 1913-1914 we learn, however, that one officer and his police patrolled for 85 days in vain pursuit of Werner's murderers. The track we were following led over the top of Mt. Dayman to Bibitan, on the eastern slopes.

Leaving our 700-meter night camp, later the site of our third collecting base on the slopes, and continuing up the mountain on May 15, in three and three-quarters hours we attained an altitude of 1550 meters and camped where Wynn had spent the first night on his ascent and where we were to have our second Mt. Dayman collecting base. At 750 meters we had entered mid-mountain forest dominated principally by oaks (*Quercus*, broadly) and *Castanopsis*. The slopes were at once noted to be more gentle and less gullied than those of the previous day. The soil was yellow and clayey. Vines were fewer in the forest, ferns abounded as ground plants, and shafts of sunlight slanted down through clear-boled, gray-barked trees fluted and often suckered at the base. It was a pleasing change from the scraggy rain forest of the lower slopes. Some long, steep pinches were encountered, but the air was cooler and travel easier. The forest underwent a succession of physiognomic and floristic changes with altitude and slope. Where narrow, the spur crest we followed became increasingly

mossy and the trees more stunted. Where broad, the spur carried good tall forest which at 1550 meters was still of mid-mountain type, containing an abundance of a *Castanopsis* with the oaks, and in which a robust scrambling bamboo grew in considerable quantity. This bamboo made its first appearance at about 900 meters. Our thirsty carriers got water from it: a few mouthfuls of clear, cool fluid from each cut internode of selected stems.

Observed water occurred close to the trail in only two places between our camps, where there were *Pandanus*-leaf huts. But we heard constantly the roar of water on our left, where the Atairo stream flowed in a very deep ravine. It would seem, though this could not be confirmed, that the ridge we followed was the Waiawaima or Pine Tree Spur of Guise's report (1894), while across the Atairo ravine to the east was Tanamgina Spur, which Guise and Armit followed on their ascent of the mountain.

An unexpected wait of a day for the main body of carriers to arrive at the 1550-meter camp gave opportunity for exploration and some botanizing in the neighborhood and additional clearing of the trail up and down from camp. The carriers had announced their intention of traveling from Biniguni to this camp in one day, and as few of the loads weighed over 35 pounds this seemed feasible. Some necessary box loads, which had to be carried on shoulder poles by two men, might have slowed travel on difficult parts of the trail, we thought, but when the carriers arrived (46 of them in charge of three village councillors and Interpreter Diwowan) the box bearers were in excellent fettle, as was the rest of the line. An early start had been made from Biniguni, and the weather held good, but for no particular reason they decided to break the journey at the 700-Meter Camp and in doing so consume, for the extra day on the road, two precious loads of rice which would have to be replaced for our mountain stocks.

On May 17 we continued up the spur to its highest point, where it merged into the bulk of the mountain at 2310 meters, then dropped down into the upper valley of the Atairo to establish our top camp at 2230 meters, after four and a half hours on the

trail behind the carriers. At 1800 meters, after a steady and rather easy ascent, the carriers rested at a *Pandanus*-leaf hut in a small opening entangled with a big scrambling fern (*Sticherus*) which made its first appearance here. And at that point the mid-mountain forest gave place to beech (*Nothofagus*) forest, the new dominants being easily recognizable by their large size, massive branches, dense foliage of small leaves, and rough dark bark. Thereafter, for two hours, the trail led through tall beech forest, usually very open underneath and with little leaf litter or moss, first in a series of ups and downs (mostly ups) on the spur crest, then in a steadier climb. *Papuacedrus*, a conspicuous large conifer, appeared in the forest at 2020 meters. At 2050 meters the first "hoop-pines" (*Araucaria*) far overtopped all other trees on the crest of the spur. A wayside hut was roofed with the bark of the two conifers instead of *Pandanus* leaves. At 2060 meters we rested in especially fine tall beech forest on the first sizable bit of fairly level ground seen on the mountain. The great clean trees, mossy lower trunks, and mossy and leaf-strewn moist ground recalled to me the more impressive parts of the famed Joyce Kilmer Memorial Forest in the mountains of North Carolina, although here filmy ferns (Hymenophyllaceae) characterized the ground flora and a dense undergrowth of scrambling bamboo filled partial openings where aged trees had fallen.

At 2150 meters the edge of the forest was reached after a stiff climb that took us out of the beech zone and into what I (1941a) have called mossy forest, and, coming out abruptly into intense sunshine on bracken-covered slopes, we surveyed a depressing spectacle of fire damage and destruction. The crest and upper slopes of the spur had been almost completely deforested. Gray stands of hundreds of very tall, straight *Araucaria* trees, killed by fire, edged the surviving forest in ravines on either side. The fires thereabouts had been fairly recent. Probably there had been several small burns, for in some places the trees had lost their branches by decay, while elsewhere the short, whorled limbs persisted and were colonized by cushion-forming bryophytes, or only scattered rotting stubs or living relic trees remained.

From the 2310-meter high point on the trail, where the view took in several square miles of terrain above the 2200-meter level, including Maneau Peak and the head of the Gwariu River valley, it could be seen that the upper parts of the whole mountain had been greatly altered by the burning of forests which must formerly have occupied all but a small fraction of the total area. Extensive forests remained, but for the most part on the more sheltered slopes and in strips in deep ravines. Grasslands of old-established appearance occupied much of the denuded ground, while bracken (*Pteridium aquilinum*) and other ferns, or a mixture of fern and grass, provided the cover on slopes which at least in some instances plainly had not been so long deforested.

Well situated in a deep, sheltered, grassy hollow near the head of the Atairo and $1\frac{1}{2}$ to 2 miles northwest from the Maneau summit of the mountain, our camp was where Wynn had made his top camp in April. Flies were rigged for the carriers, but most of them found more comfortable sleeping places in old bark shelters hidden in adjoining forest edging the stream. The temperature in the grassy hollow was 41° F. at 7:30 P.M.

During the following afternoon, Van Deusen arrived with one Gosiago and seven Pumani carriers, having traveled from Bini-guni in two days with a night stop at the 700-Meter Camp.

On May 19, with my two botanical helpers, Tomi and Bobi, and Interpreter Diwowan, I left camp at 7:25 A.M. and reached the summit of Maneau Peak at 9:15 A.M. From the camp hollow, white that morning with ground frost, a faint trail crossed the forest-fringed Atairo, then climbed very steeply through grass and stunted bracken to the crest of a razorback spur (Tanamgina?) at 2470 meters. This spur led southerly, directly for the peak. Almost dizzily narrow in places, its grassy crestline rose unevenly to 2500 meters, then dropped a little to a saddle under the peak. Lying close under the spur to the left and east was a rather extensive undulating to deeply dissected grassy high plateau sloping about northeast. To the west and southwest the entire upper valley of the Gwariu lay open except towards its point of issuance from the mountain, where the river

cut to a depth of about 1700 meters below the crest of our spur ridge in a gorge too deep and narrow for us to see into very far. The sides of the gorge and the lower slopes of most of the valley were darkly forested. Above the gorge, the bottom of this very beautiful, high, enclosed valley widened into an extensive grassy amphitheatre surrounded by peaks largely grassy but with strips of forest extending high in gullies and ravines. Except in the gorge, the streamway of the Gwariu was grassy, as if wet and boggy, or made unsuitable for the growth of trees by cold air drainage from the heights. A small blue lake on a grassy shelf across the valley, about west of our camp and at nearly the same altitude, was called Quiningan by my guide. The larger lake, called Gavaio, on the eastern part of the mountain, was not visible from our route or from the summit of Maneau Peak.

I was not prepared to find that Mt. Dayman had four main summit peaks, grouped around the head of the Gwariu Valley and all parts of the one big mountain, and that Maneau Peak was not the highest. Maneau lay on the eastern side of the upper Gwariu Valley. To the south of the valley head were peaks which my guide called Gadmarau and Mana-man, the latter sharp-pointed. Approximately southwest of the valley head was Kakatun, highest and most massive and the culmination of a long grassy spur which enclosed all the western side of the upper gorge and high valley. Near the summit of Mana-man two small grass fires were burning. According to Diwowan, the fires were lit by a hunting party from Bibitan village, which lay on an indicated bearing of about 140° magnetic from the summit on which we stood.

Likely reasons for differences in the height of Mt. Dayman on modern maps have since presented themselves. When named by Captain Owen Stanley of the "Rattlesnake" on a survey voyage along the south coast in 1849, the height of the mountain was determined as 9167 feet.¹ The 2836-meter

¹ In his "Narrative of the voyage of H. M. S. Rattlesnake," the only account of the voyage available, MacGillivray (1852) made no mention of the naming of the mountain, but it and other heights of the main range named by Stanley appear, with altitudes, on a map in volume 1.

altitude of East Indies Sheet 2 of the British War Office 1:4,000,000 map of 1928 may represent a height determined by triangulation from the north coast, for it appears in feet (9305 feet) on Sheet 3 of Map of the Eastern Part of British New Guinea published in the Annual Report of British New Guinea in 1898, a map that gives other details of the mountain which could have come only from the explorations of Guise and Armit from the north coast in 1894. The 9800-foot (or 2986-meter) altitude given on the C.9 Milne Bay Sheet of the Australian Aeronautical Map (June, 1944, reprint) and Sheet 1096 of the United States Air Force World Aeronautical Chart (fourth edition, 1949) probably is a height for Kakatun Peak determined during the Second World War, when a map error of 150 meters would be apparent to military aviators and important enough to correct, even to an approximate altitude. The 9305-foot altitude of the 1898 map is applied to an eminence on what we know as the Kakatun Ridge, on the western side of the upper Gwariu Valley, but not to Kakatun Peak itself, which is some distance south along the ridge and higher. Illegible on our copy of the map is an altitude for an unnamed peak which may be taken as Maneau Peak, but Guise (1894), in his report on the mountain, says the summit of "Maneao" is "marked on the Admiralty Chart at 9163 feet" (2790 meters).

Mount Dayman has not been more than roughly mapped. Only the northern basal slopes appear on the 4-mile and 1-mile series of Australian military maps of 1944 and 1945. The 1898 map, mentioned above, gives a good general idea of the structure of the mountain but is not accurate in detail. A map published by Strong (1916) shows "Maneao" with an altitude of 9137 feet, and "Mt. Dayman," 9305 feet, the latter in the correct position for Kakatun Peak in relation to the summit of Maneau Peak (about 217 degrees), but the valley between the peaks is not shown, and in some other respects the delineation of the mountain is so unreal that it is hard to believe the map is the work of a man who climbed Maneau Peak.

My aneroid readings for the summit of Maneau Peak averaged 2700 meters (8858 feet). Wynn had a reading of 2785 meters

(9137 feet) on April 1, and Van Deusen one of 2725 meters (8930 feet) on June 6. The highest part of the mountain visible to us from Baiawa on the north coast would appear to have been Maneau Peak. This cannot be stated with certainty, as the mountains were too obscured by haze to be seen properly after our return to the coast. But it is perhaps significant that the native name of a peak not the highest should have been applied by the early explorers to the whole mountain and, indeed, the section of the central range dominated by the mountain (Maneau Range), and that the earliest exploration of "Maneao" was carried out from the north coast.

The not always distinct path we followed from camp went over the top of Maneau Peak and on down to Bibitan village. According to Diwowan, another path led from Biniguni up over Mt. Tantama (a small eminence at the eastern end of Tantama Tableland), along the west side of the upper Gwariu Valley past Quiningan lake, then between Kakatun and Mana-man peaks, and down to the south coast. A third native track, starting from the Muta (Musa) country far to the northwest, keeps west of Biniguni, ascends the Kakatun spur ridge, then also drops to the south coast.

Maneau Peak has three summits close together and of about equal height. From the easternmost, before fast-rising clouds obliterated the lowlands, then most of the mountain features, we had a magnificent panorama of Collingwood Bay from some distance west of Fir Tree Point to Cape Vogel, and all the north coast of Goodenough Bay. The peaked top of Goodenough Island, 70 miles away, stuck out above white clouds. Mount Simpson seemed very narrow on top and very steep. The jumble of high peaks of the Suckling-Goropu complex presented a most impressive sight nearer at hand to the west and northwest. None of the visible parts of the central range had been usefully mapped. The Suckling-Goropu heights were especially confusing.

We found no water on our route from Top Camp to Maneau-top. Stunted forest reached to within about 50 meters of the summit in the heads of gullies on the Gwariu side. The runways of a small forest wallaby (*Dorcop-*

sulus vanheurni) were abundant on grasslands adjacent to forest. Deforested doubtless by fire, the summit carried an alpine grassland type of vegetation dominated by low tussock grasses and stunted bracken, with which species of *Potentilla*, *Euphrasia*, *Gentiana*, and other genera were associated as herbs, and *Vaccinium*, *Styphelia*, *Hypericum*, and *Haloragis* as small shrubs.

On the summit, where rock lay close to the surface, a small pit had been dug. The digging was old, and it appeared to be the work of a prospector for minerals.

A native shrine, of a kind common on peaks and in passes on the high mountains of New Guinea, was found in a secluded rest place where fires had been built by travelers, at the edge of the forest and close to the summit of Maneau. This interesting object, intended to propitiate the spirits of the mountain perhaps, consisted of an irregular low pile of tossed stones, with which were bits of native pottery and knotted wisps of grass and, surrounding it, a ring of white quartz fragments. The natives with me added stones and knotted grass to the accumulation. Similar shrines were observed by the Archbold expeditions on Mt. Albert Edward in 1933 and on Mt. Wilhelmina in 1938.

(Tate and Van Deusen ascended Maneau Peak on June 6, taking the eight Gosiagos who had not already made the climb. Good views and photographs were obtained only to the south and southwest. The Gosiagos cut, peeled, and carved three 6-foot poles which they planted on the three little knobs which formed the summit. A small stone cairn was built, and a list of the members of the party was placed in a plastic container in the cairn.)

The end of a very successful, if at times rather doubtful-looking, transport operation came on May 20 when Wynn arrived at Top Camp with the last of the cargo. In all, 82 loads had been carried up the mountain by porters from as near as Biniguni and as far as Bimara in the Gwoira country.

After one fruitless attempt, Wynn, accompanied by Van Deusen, succeeded on May 24 in opening a track to the bottom of the Gwariu Gorge at 1840 meters, upstream and about one and one-half hours of back

travel from camp. In an effort to gain less precipitous access to the gorge I proceeded farther up the valley on May 30, and after two hours of cutting through forest at 2200 to 2230 meters near the upper end of the gorge, descended not unduly steeply and with good footing to reach the river at 2030 meters. On a forced march, made necessary to keep warm in heavy rain, we returned to the camp from the river in 90 minutes.

JUNE

The scientific party completed work at the upper camp on Mt. Dayman on June 19 (M 271, H 132, I about 5000, P 752) and on the twentieth moved back down the Biniguni trail to establish a collecting base at the 1550-meter transport camp. Wynn, having provisioned the new camp, brought 40 carriers to Top Camp in the morning and the move was completed by 2:30 in the afternoon.

After our Gosiago boys had demonstrated proclivities for burning anything that would burn, a ban was put on their lighting of grass fires on the mountain. Unfortunately, the carriers on moving day started a conflagration on ferny slopes near the forest edge which burned so fiercely that transport was held up for the best part of an hour until the ground cooled enough for bare-footed traffic. I had set out ahead of the main party to botanize on the route and did not witness the fire. Photographs made by Tate showed, however, burning araucarias and other damage to trees which would result in a further slight retraction of the forest line on that spur of the mountain.

Fires on the grasslands of the main peaks and in the upper end of the Gwariu Valley had been numerous, though not extensive, during our five weeks' stay at the Top Camp, and we had been visited by a solitary member of a Bonenau hunting party. From this visitor we learned that his group of men and women had been camped high on the mountain for two weeks. With dogs, they had hunted wallaby, tree-climbing kangaroos (six for the trip), spiny anteaters or *Zaglossus* (two for the trip), phalangers, and bandicoots. They built benches of bark in their sleeping shelters and made small fires under them to smoke and cure the meat.

Our observations on native hunting high on the mountain appeared to indicate that it was confined to the procurement of meat for feasts by Daga people of the Gwoira country. The isolated Biniguni branch of the Daga had hunting grounds in the mountains of the Mai-u River and perhaps others that took in our 1550-Meter Camp locality on the north slopes of Mt. Dayman, but as far as could be ascertained they did no hunting on the Mt. Dayman highlands.

The village councillor of Biniguni hunted for Van Deusen for the first few days we were at the 1550-Meter Camp. An elderly man, small, wizened, but still very active, the councillor brought two dogs, and his wife with a load of taro and other garden food for the dogs and himself. In this way specimens of tree-climbing kangaroo and *Zaglossus*, which without dogs are difficult to procure, were added to the collection.

JULY

The second of two accidents which for a time imposed severe limitations on botanical collecting occurred on July 4, when my principal boy, Tomi, inflicted upon himself a great foot wound with a machete and, under Tate's first-aid direction, was carried into camp in a state of collapse from shock. Necessary surgery, under local anesthetic, was done mostly by Van Deusen. The mishap took place in the gorge or deep ravine of the Atairo, into the bottom of which, at 1370 meters, Tate had opened a collecting trail. Early in June I had dislocated a shoulder, an accident that left me partly incapacitated and for the remainder of the expedition obliged to leave collecting in the most difficult places to my boys.

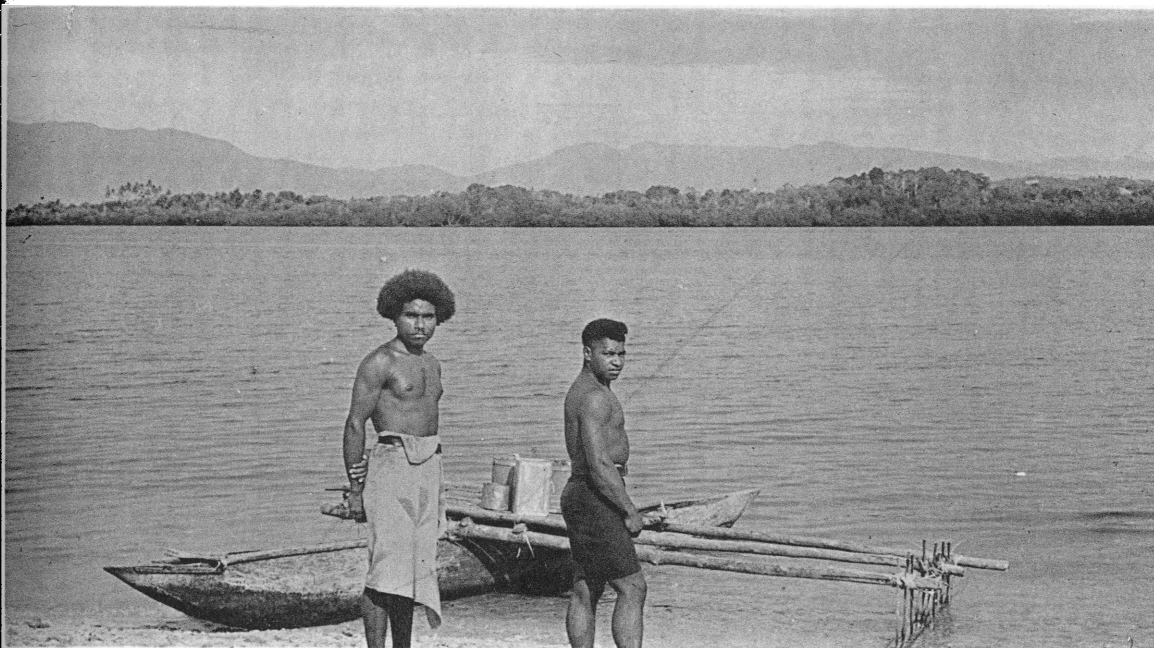
On July 12 and 13 relaying was resorted to, because of a shortage of carriers, for moving us down the slopes from Number 2 Camp (M 193, H 53, I 8300, P 420) to a third mountain collecting base already in part established by Wynn at our 700-meter transport camp. Bringing supplies from Biniguni to the new camp on the twelfth, the carriers in a very creditable performance came on to the 1550-meter camp and, having been fed, by 1:30 P.M. were on their way down the mountain accompanied by Tate and four Gosiagos. Next morning Van Deusen and I struck camp early and, while awaiting the

arrival of the carriers, started Tomi down the trail in a litter carried by four Gosiagos in relays of two. The trail was too bad for a four-man carry. Heavy rain had fallen the previous afternoon and evening, and we were scarcely on the way behind the carriers when the heavens opened again. The carriers, lightly laden, kept on in the downpour without halt. So did we, and accomplished the 850-meter descent in 95 minutes, when all Gosiagos were sent up the trail to help the struggling litter bearers. Tomi arrived in saturated condition, but his bearers had somehow managed to keep their feet on a trail miry with yellow slush, made hazardous by slippery surface roots, and in places very steep. It might be mentioned that Gosiago ideas of fellowship would not allow other natives to carry their injured fellow.

July 26 saw the end of our field work at Number 3 Camp (M 50, H 241, F 3, I 3600, P 288) and on Mt. Dayman. In leisurely travel the following morning, with Tomi limping down to the foot of the mountain and being carried the rest of the way, we reached in about two hours a camp prepared by Wynn in a locality previously unseen by us on the north bank of the Gwariu, not far below where the river emerged from its gorge. Our tents and flies, sent ahead by fast carriers, were already rigged when we arrived, and a group of women had heated cooking stones and were on the point of loading a native oven with sweet potatoes, taro, and green taro leaves to feed our 41 carriers and our boys.

This base, immediately under the escarpment of the range at about 200 meters elevation and less than a mile south of Biniguni village, we called "Biniguni Camp, Gwariu River."

The roar of waters, so all-pervasive when we climbed the mountain, was audible only at close range at this time of year. Since the middle of May, there had been much rain on the mountain, and below the mountain heavy rains, which were proclaimed unusual and were attributed to sorcery. But the condition of the rivers in July and until we left the general area in mid-September and the unmeasured rainfall we experienced on the coastal plain indicated, for mountains and lowlands alike, the dry phase of a climate characterized by definite wet and dry sea-



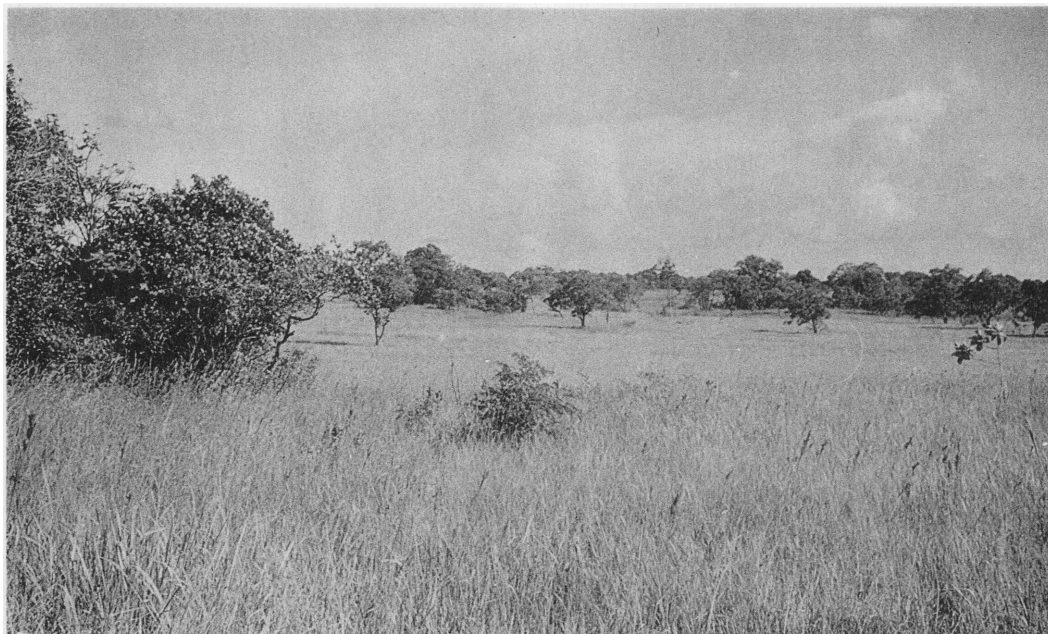
1



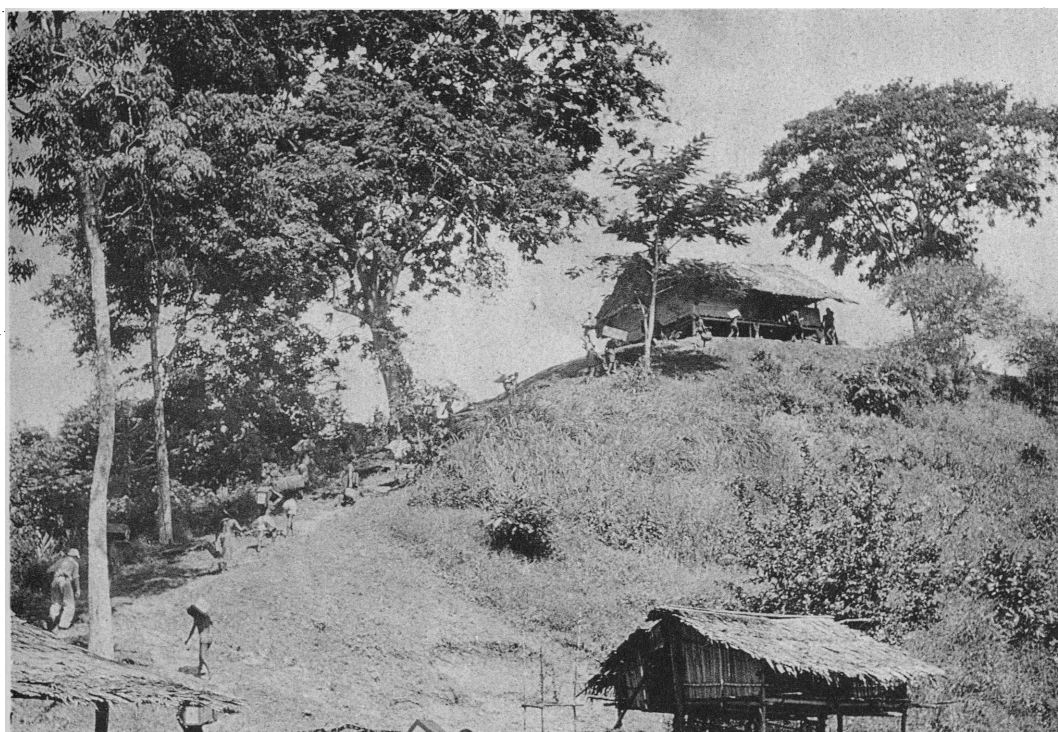
2

1. Mountains of the mainland viewed from Baniara. Western end of Mt. Simpson on left, Maneau Range and Mt. Dayman over outrigger of canoe, Goropu Mountains on far right

2. View southwest over Baniara (larger island) and Goodenough Bay from 150-meter hill behind Menapi. *perata* grassland; relic rain forest in gullies; cloud-capped Mt. Simpson in distance



1. Savannas between Dabora and Wabubu, Cape Vogel Peninsula
2. Landing place in the mangroves, Baiawa, Moi Biri Bay

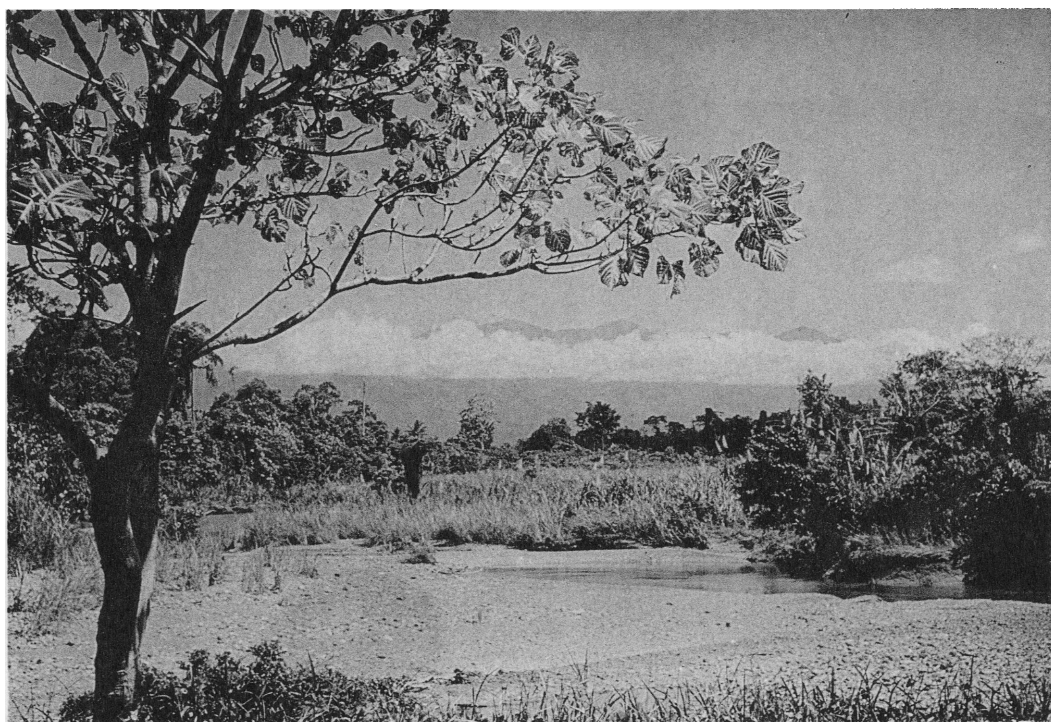


1



2

1. Government resthouse on a ridge rising behind Baiawa village
2. Expedition canoes heading east across Moi Biri Bay for Baiawa. Dark-Top Hill on right



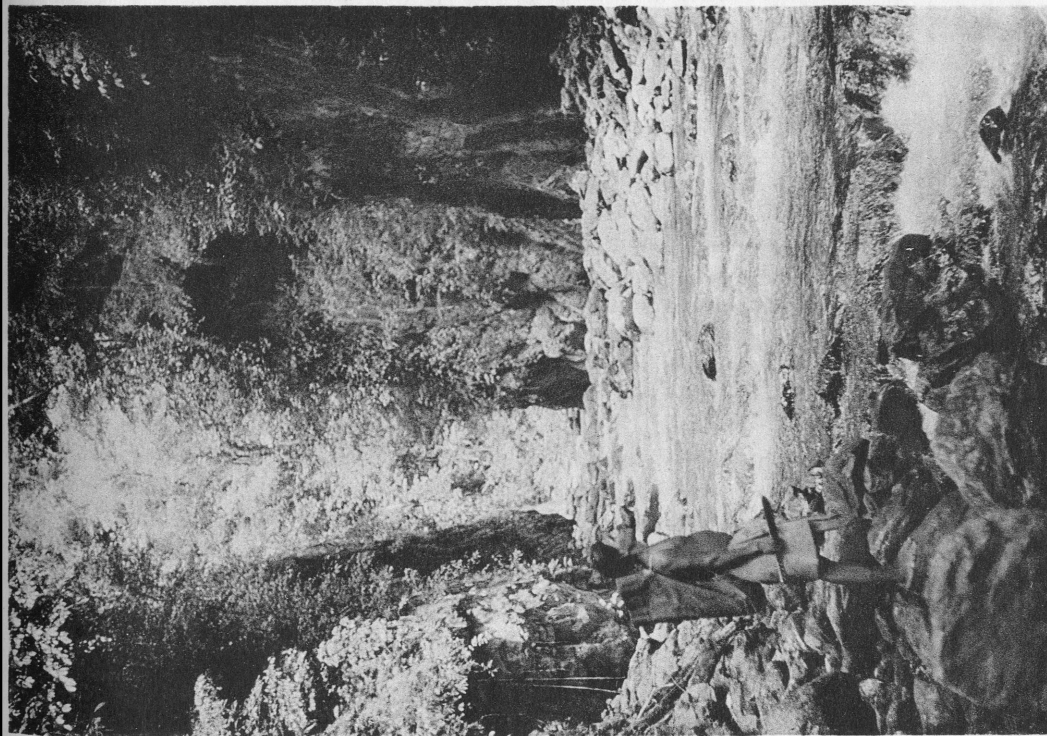
1



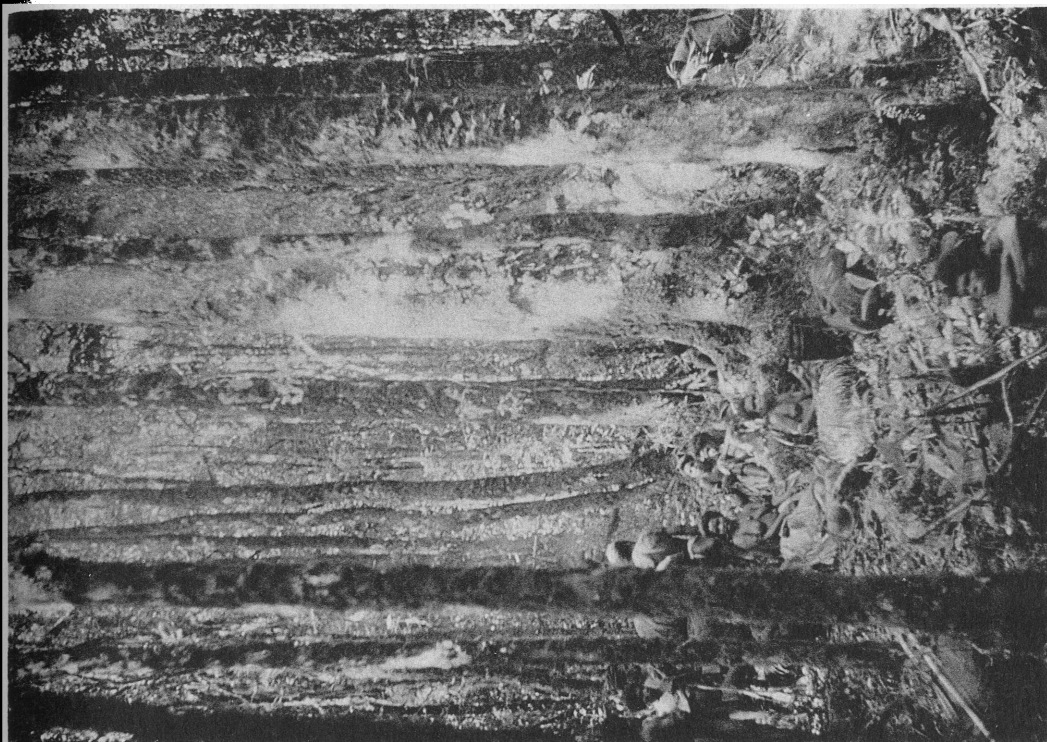
2

1. Kwagira River and Goropu Mountains, from Kwagira village. Wild sugar cane and second-growth rain forest on the river banks

2. Lower end of Gwariu Gorge and, center and left, Mt. Dayman, viewed over a native garden near Opaigwari village, Rakua River

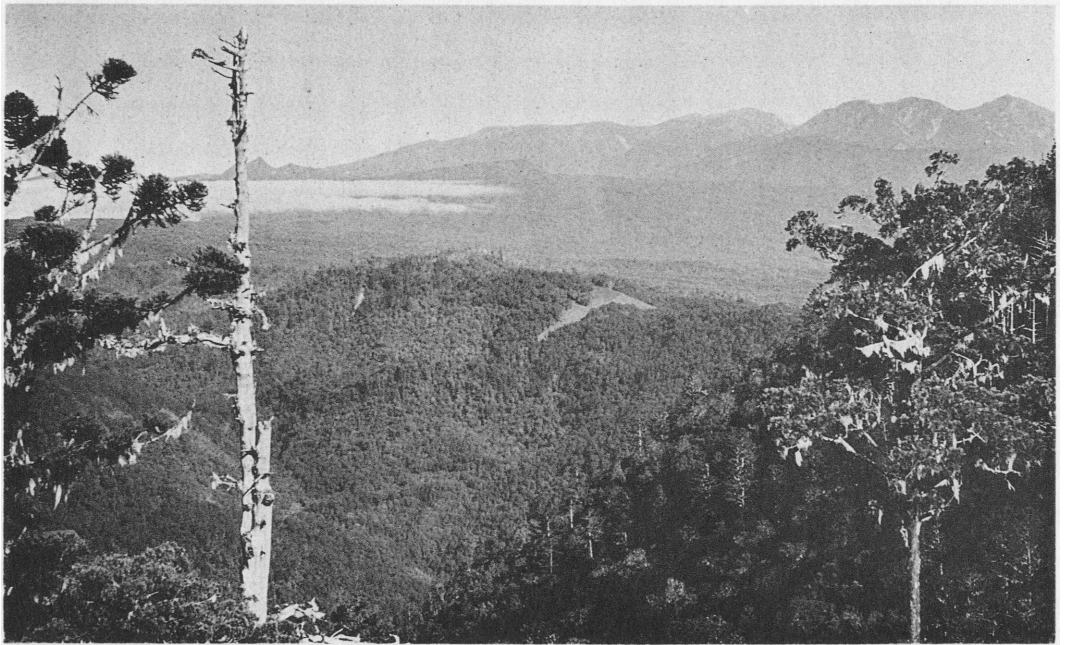


1

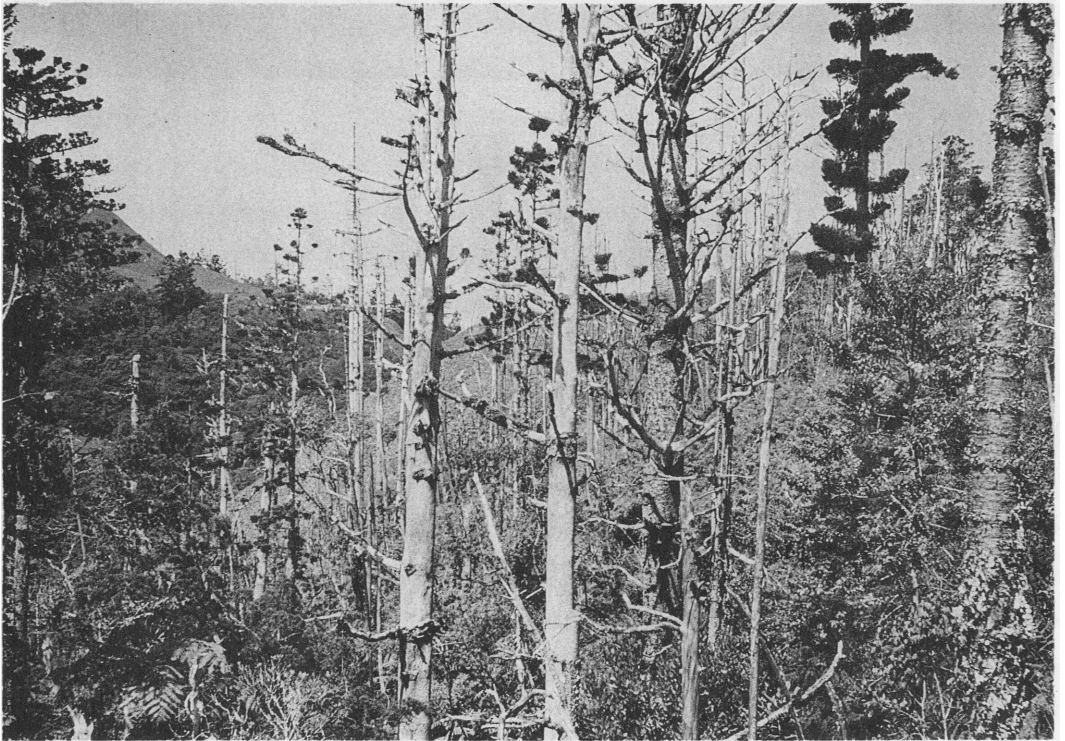


2

1. Narrow mouth of the Gwariu Gorge
2. In the beech (*Nothofagus*) forest at 2060 meters on the north slopes of Mt. Dayman



1



2

1. Mt. Suckling and (to right of deep notch on skyline) three peaks of Goropu Mountains viewed over Gwariu Gorge (not visible), Mt. Tantama, and Tantama Tableland from one-quarter mile west of Top Camp, Mt. Dayman

2. Fire-damaged mossy forest containing many dead, and some living, tall *Araucaria* trees at 2250 meters, north slopes of Mt. Dayman



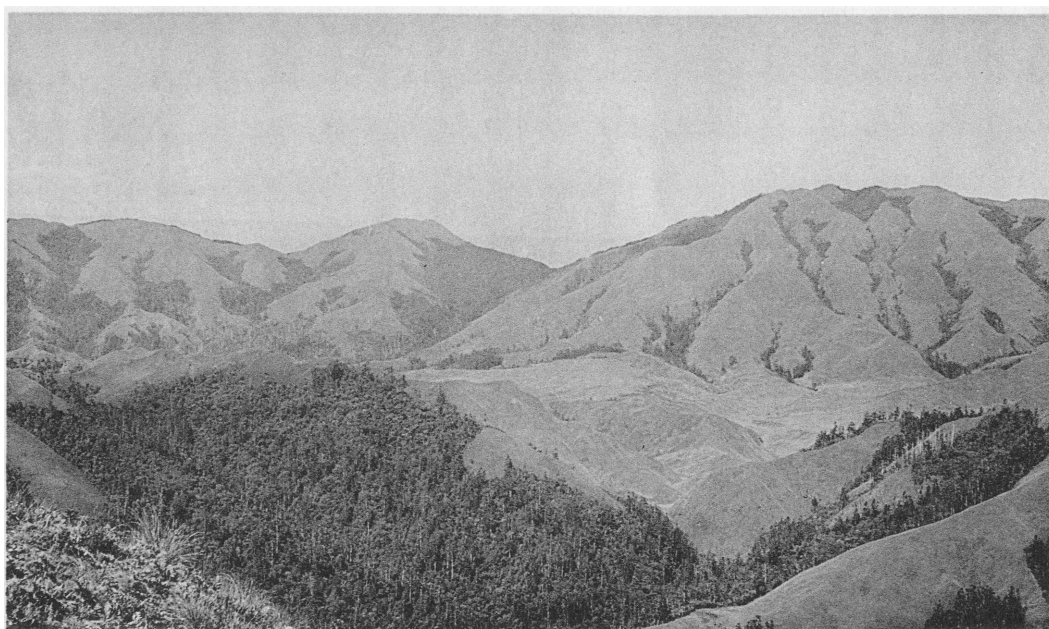
1



2

1. Top Camp at 2230 meters on Mt. Dayman. Grass and bracken slope; mossy forest edging Atairo stream

2. Maneau Peak of Mt. Dayman (right) viewed from the 2310-meter high point on trail leading to Top Camp. Site of camp hidden in bottom of the Atairo Valley below center of the picture



1



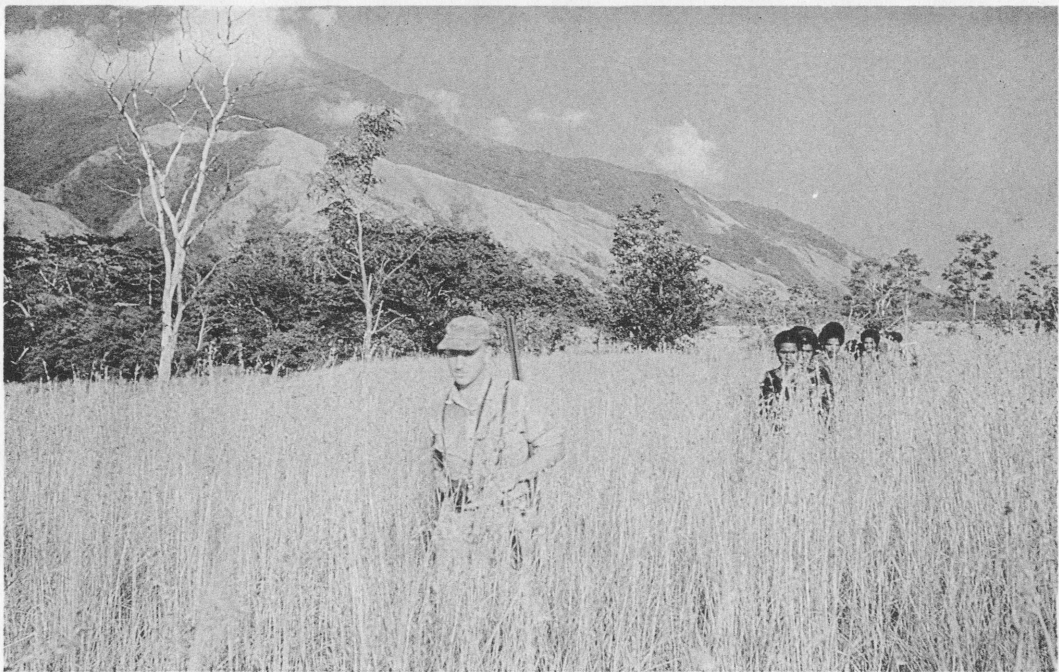
2

1. Southern and southwestern peaks of Mt. Dayman, viewed from the summit of Maneau Peak. From left: west end of Gadmarau, sharp-topped Mana-man, and Kakatun, the highest

2. Biniguni Camp and the lowlands viewed from a native garden at 250 meters on the Maneau Range escarpment. Tall *Casuarina* trees prominent in forest behind camp; betel-nut palms in foreground



1



2

1. Goodenough Island, from the south in early morning. Central peaks showing above the cloud field are Mauna (left), Natuiola, and Vineuo

2. Lowland *Albizzia procera* savanna, about 2 miles southwest of Wakonai, Goodenough Island. Van Deusen, followed by village policemen and carriers



1



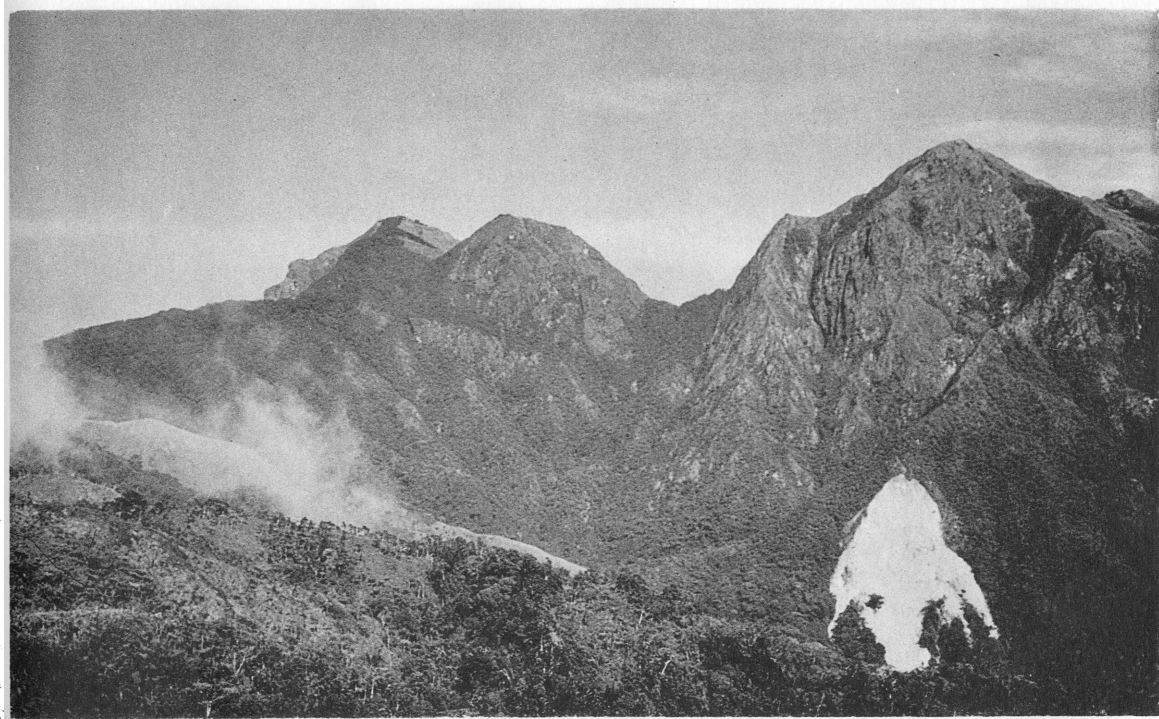
2

1. Goodenough Island: Wakonai village and the dry coastal plains viewed from the grassy lower mountain slopes

2. An expedition transport halt in Garuwata village, 640 meters, east slopes of Goodenough Island. Wynn in foreground



1



2

1. Deforested, 1500-meter crest of Grass Spur, below Top Camp, Goodenough Island. Tree-ferns (*Cyathea*) damaged by fire
2. Goodenough Island: three of the five central peaks, and head of the Garuwata Valley, viewed from a southeasterly direction and altitude of about 1400 meters. Mauna (left), Natuiola, and Vineuo (lower slopes scarred by a recent landslide)



1



2

1. Number 2 (900-meter) Camp locality, in virgin forest of the Utamodi Valley, Goodenough Island. Camp was in mid-distance on the extreme right of the picture
2. *Melaleuca leucadendron* savanna forest, near Mapamoiwa, Fergusson Island

sons. An immediate indication of this was the Ginum. In mid-May this big creek flowed strongly. The only water visible at our crossing late in July was in a pool under the now dribbling cascade beside the full flow of which we had climbed wet rocks at some risk on our ascent of the mountain.

AUGUST

Bat caves in limestone near Maneau village, close under the escarpment and about 5 miles east of our camp on the Gwariu, were visited by Wynn on August 6, on a detour while returning from a transport trip to the coast with collections and surplus stores. Wynn saw entrances to two caves, called Iamai and Gwebmantoi, both small holes near general ground level. Entering one of the caves, local natives captured many small leaf-nosed bats (*Hipposideros*) and an eel from an underground stream. From another cave, Maneau natives brought us the same day larger bats of a different species of *Hipposideros*. Wynn reported the local people as objecting to strangers entering the caves, from superstition or because the caves contained a potent "pig medicine" which is traded to hunters of the Maisina tribe of the coast. Extending west from Maneau village for about 3 miles to near Awani village, the limestone country was notable for good-looking brown soil and splendid rain forest in which a commercial timber tree known to Wynn as *helaga* (*Pometia pinnata*?) occurred in abundance.

On August 14 we evacuated the Gwariu River Camp (M 375, H 220, F 70, I 18,600, P 313) and set up another collecting base at the road crossing of Peria Creek, about two and a half hours of travel towards the coast and approximately 50 meters above sea level.

Leaving us on August 19 on another transport trip to Baiawa, Wynn continued along the coast to Tapio (see p. 106) for an examination of the caves in that neighborhood. He returned to Peria Creek six days later, having investigated four cave entrances, only one of which was enterable without ropes. In this, called Gwagwame, a high-ceilinged cave with no visible branches or other levels, he took specimens of two bats—a large *Hipposideros* and the dog-faced bat (*Rousettus*)—and reported many large *Dobsonia moluccensis* present.

At Opaigwari village on August 30, Tate, Wynn, and I photographed local people in dancing array, after which I botanized on the Rukua River near by. The dancing, which normally would have taken place at night, was begun by the Maiva people of Opaigwari, Budmag, and Awani villages. Later in the proceedings the Biniguni Daga made a formal entry, dancing down the track in double file, drums beating, and headdresses bobbing, in charge of their chief or *lohia*. Some good headdresses, featuring mainly white cockatoo feathers and greater bird of paradise plumes, were worn by the men. The men dressed in native breechclouts or *siri* of tapa cloth. The few women participating, in hind positions in the dance, showed less conservatism. Their dress was the traditional "grass" skirt of bast fiber, but for this special wear was dyed in purple, blue, and other non-native colors from a trade store on the coast.

SEPTEMBER

After cutting through the forest for several mornings, on a bearing of 315 degrees from Peria Creek Camp, Tate on September 1 completed the opening of a direct trail to the Rakua River. Extensive tangles of lawyer-cane (*Calamus* spp.), on low ground, made cutting difficult. As at Opaigwari, not more than about 3 miles upstream, the big river where Tate struck it had a broad, braided floodbed of sun-heated gravel and cane-grass islands, and a main channel of turbid water at that time running too fast and deep to be crossable.

Our work planned for the mainland was nearing completion. Surplus stores and accumulated collections having been sent out beforehand, we broke camp at Peria Creek (M 197, H 453, F 82, I 14,600, P 334) early on September 4 with 34 carriers, and by the middle of the afternoon we were safely across Moi Biri Bay and in the process of settling into the over-full resthouse at Baiawa. With no mud on the road and the streams considerably lower, travel to the canoe landing was much better than it had been when we walked inland four months earlier in the season.

The waiting canoes lay high and dry on the mud of the creek, and three hours passed before the tide rose high enough to float them, but the carriers insisted on delaying

their homeward journey to see us off. These were Biniguni, Budmag, Opaigwari, and Awani people. We had come to know many of them and had made gifts of such things as rice and canned beef to their villages. Now, women had brought us loads of native food and betel nut, and all the head men had accompanied us to the landing. There was general participation in handshakes and "goodbyes." The women, we noticed, had the horniest hands.

From Kwagira village, en route from the Peria to Moi Biri landing, we saw the brown smoke of grass fires rising from the summits of two of the peaks of the Goropu Mountains; the first proof our observations had brought of natives visiting these 12,000-foot heights. It would seem probable that the people concerned were hunters from some part of the Musa River valley.

Our large collections stored at Baiawa having been checked, outwardly at least, and found in good condition, time was found for some field work before a boat arrived to take us to Samarai. Most of the grassland in the neighborhood had been burned, but carried a fresh green shoot a few inches to a foot high. The air felt very noticeably drier here than on the rain-forested lowlands, not more than 10 miles distant, on which we had recently been working. A brown haze, characteristic of dry spells of weather in the southeast season, blotted out Mt. Dayman except very early in the morning, before the day was light enough for good distant views.

From Baiawa we traveled to Samarai on the small motor vessel "Cape Vogel," procured on expensive charter from the Cape Vogel Trading Company. Leaving Baiawa soon after sunrise on September 10 and keeping close in shore for shelter from a strong southeast wind and avoidance of reefs, in six and a half hours we tied up at the trading company's headquarters store in Tarakururu Inlet, a very good small harbor on the mainland in Ward Hunt Strait, with 7 fathoms of water, and 2 fathoms at a substantial small wharf. The hinterland, examined for about a mile, consisted of a somewhat undulating grassy plain of coral limestone carrying small patches of brushy forest and reaching back to grass-covered hills. The very rocky nature of the coral ground, and the sparse though seemingly fertile soil, were well seen in places

cleared by the natives for banana gardens.

From Tarakururu a run of 20 hours brought us to Samarai at noon on September 11. Here, after thorough examination and fresh insect-proofing with naphthalene and paradichlorobenzene, collections were stored, new collecting supplies organized, and stores purchased for a planned three months of field activity in the D'Entrecasteaux group of islands.

We were going out, however, without Tate. En route to Samarai on the "Cape Vogel," he had suffered a slight paralytic stroke which ruled out his further participation in field work and necessitated the making of arrangements for his return home. Three Gosiagos no longer needed were paid off at this time.

On September 16 Van Deusen, Wynn, and I were ready to leave Samarai, but by that time we were in the middle of a spell of strong, squally, southeast weather which drove small craft to shelter and delayed our departure until the twenty-first. That afternoon we sailed on the "Jessie" and with a suddenly calm sea and a bright moon in our favor, in 14 hours of running reached Esa'ala on Normanby Island, a distance of approximately 75 miles from Samarai. Beautifully situated in Dawson Strait, Esa'ala is administrative headquarters for the whole of the D'Entrecasteaux group.

Goodenough Island had from the beginning been one of our principal objectives. It was not until we reached Esa'ala, however, that any clear information on which a working plan could be based became available. The determining information came from an official interpreter named David, who in 1931 had accompanied Assistant Resident Magistrate Rich on an ascent of the easternmost high peak of the island, called Oiamadawa'a. David's recollections proved fuzzy or non-productive on various details of the Rich ascent important to us and were somewhat mixed with additions from superstition. But he had a useful knowledge of the island, and from his information and previous gleanings, it was possible to draw up an itinerary subject to alteration as might be indicated by subsequent developments.

Patrol Officer R. K. Greeney, then Acting District Officer at the post, decided to accompany us to Goodenough to do some

needed patrolling. We continued from Esa'ala on the "Jessie" at 9:00 A.M. on September 22, stopped briefly to put down our pay-off boys at Ailuluai on the south coast of Fergusson Island, delivered mails at Mapamoiwa medical post on the southwest corner of the island, and at 5:45 P.M. began to put our cargo ashore on Goodenough Island. Our landing was at Bolu Bolu, principal military port on the island in World War II and later the site of an administrative patrol post which was abandoned about 1951.

Dry-appearing hills on the Gomwa Bay side of the southeastern extremity of Fergusson Island carry a rather close savanna stand of grayish small trees which from a distance resemble *Eucalyptus alba* but may be *Melaleuca leucadendron* (see p. 147). From the south or Morima coast of this large island mountains 1000 to 1500 meters high rise from the sea in steep slopes formerly rain forested but now covered with second growths where not under actual cultivation. Few vestiges of the original forest remain at elevations up to 600 meters or more. Disturbance by a numerous native population, living mostly in shoreline villages at the present time, has not, however, resulted in the establishment of grassland. Climate and soil must be eminently suited for forest growth. But with a lowering of the mountains towards Cape Mourilyan and perhaps a decrease in orographic rainfall, patches of induced grassland appear, then on dryish-looking hills between the cape and the head of Seymour Bay areas of a savanna or savanna forest much like that observed on the opposite end of the island.

From Bolu Bolu, independent examinations of the central mountains were made by Wynn and Greeney between September 24 and 29. With one Gosiago, and several local natives as carriers and guides, Wynn investigated an old path reported to cross the island from Wakonai in the eastern foothills. On the first day from Wakonai he traversed formerly cultivated steep slopes of the Garuwata River valley, reached Garuwata village at about 640 meters, and camped at a waterfall at 800 meters. Following a faint trail on a very steep ascent through forest next morning he came out on a grassy spur at 1400 meters. This brought him to 1500 meters, where the grass ended, and for three

hours he cut trail through forest towards the crest of the range, when further progress was prevented by heavy rain. Having found a good place for a collecting base at about 1600 meters, Wynn spent the following day in as much clearing of a camp site as continued heavy rain would allow, then returned to Garuwata and Wakonai.

Greeney on his patrol had, besides carriers, two armed constables and an interpreter. He walked around the northern end of the island on administrative duties with the intention of finally crossing the central range, west to east, from Kuduia to Wakonai, by a path shown on the Australian 1-mile military map (Sheet 2064, Goodenough Island). This was the trail followed by Wynn from the east until he lost it and began to cut track, but the Kuduia people denied any knowledge of the route. Greeney therefore went farther south, turned into the mountains along Siala Creek (Wonataiweia Creek of the 1-mile map), and struck a trail which he was told crossed the mountains from Lauwela on the southwest coast to the eastern foothills village of Eweli. One night was spent at a small village at 450 to 600 meters on Siala Creek, another at or near the top of the range at about 1370 meters (4500 feet). This second camp was beyond a point where a trail leading to Garuwata and Wakonai forked from the Eweli trail. Greeney overtook Wynn at Garuwata village on September 28. He had been greatly hampered in travel and observation by wet weather in the mountains.

On September 26 Van Deusen visited a group of three small limestone caves about half a mile inland from Aituia village on Moresby Strait, about two hours' walk from Bolu Bolu. About 25 meters above sea level on a gentle, grassy slope, the caves were high enough to stand in, and the longest terminated in about 30 meters. One species of *Rhinolophus* was collected.

OCTOBER

Most of this month was spent at collecting camps in the mountains of Goodenough Island. Leaving the bulk of our supplies at Bolu Bolu (M 51, H 24, I 1000, P 130), on October 5 Van Deusen, Wynn, and I, with all Gosiagos and 53 carriers, traveled to Wakonai, a walk of about three hours. Our

route followed what had been the main military road from Bolu Bolu to Vivigani Airfield, then up a branch road to Wakonai at about 150 meters elevation. Except in places where it had been kept open as a government inter-village track, most of the dirt and gravel road was overgrown with rank grass about head high. All bridges had disappeared, but the road itself remained in good shape. Gallery strips of rain forest occurred along streams crossed by the road on the first half of the journey and gave welcome shade. Elsewhere on the flat coastal plain the sun beat down pitilessly, and in the tall stand of *Themeda* and other grasses of savannas and open grasslands not a breath of air stirred from the southeast breeze which we knew must be striking the coastline and the mountains.

Next morning we followed Wynn's route into the Garuwata Valley and to his Waterfall Camp, a journey of five and a half hours including a lunch stop of over an hour at Garuwata village. Avoiding the gorge-like mouth of the secluded, narrow valley, the path climbed steeply to the top of a grassy spur behind Wakonai, where the valley was entered at 500 meters and the path continued up over lateral spurs and down into rocky dry gullies in a gradual ascent along north-facing slopes. Garuwata village, 40 minutes travel from the Waterfall Camp, consisted of perhaps 15 small houses built on very rocky ground and shaded by tall coconut and betel-nut palms and big old mango trees. The strong-flowing Wauieo tributary of the Garuwata was crossed at 630 meters a few minutes after we left the village. From it we climbed a steep grassy spur to a hamlet called Iaawaka, then along a precipitous mountainside to the waterfall. This was on Walawala Creek, apparently the main stream of the Wauieo under another name, and barely enough ground could be found among great rocks to rig two flies and a tent. Tree ferns and pink balsams (*Impatiens*) were prominent in second-growth rain forest, and orchids on the rocks. We had passed through no primary forest that day. The south slopes of the valley were mostly grassy up to elevations of about 900 meters, with strips of brushy second-growth forest in the gullies. On the even more precipitous northern slopes, where 2160-meter Oiamadawa'a Peak rose

directly from the river, there had been less cultivation, and consequently extensive primary forests remained at elevations that on the opposite slopes had long gone to grass. The Garuwata natives state that they cross the river and hunt high on Oiamadawa'a. The valley carried a much larger population before, on government orders, evidently in the 1920's, many mountain communities of the island moved to positions nearer the coast and at lower altitude for the convenience of patrolling officers.

Continuing from the Waterfall Camp on October 7, the leading carriers reached the 1600-meter camp in less than three hours, the slowest in four hours. Up to 950 meters, and again from 1150 to 1300 meters, the often rocky slopes were very steep indeed and far more difficult than any on our Mt. Dayman transport trail. Slowly ascending, step by step, with loads balanced on heads, some Garuwata women who accompanied their men would tread on their knee-length grass skirts, and bits of the material in various colors marked the trail.

Rain-forest second growths indicating former cultivation extended to about 1100 meters on the lateral spur ridge we followed. A few relic oaks appeared at 1000 meters, and mid-mountain forest of oaks and *Castanopsis* clothed the slopes from about 1100 meters to where the track came out on Wynn's grassy spur at 1400 meters (see p. 117). Looking southeast from here we had a brief view through clouds of the Bolu Bolu coast, the Barrier Islands of Moresby Strait, and the massive, completely forested mountains of Fergusson Island. To the northwest, only 3 or 4 miles distant across the deeply entrenched and invisible Garuwata Valley, four of the five craggy summit peaks of Goodenough rose in imposing array. These peaks range in altitude from 7090 to 8350 feet (2161 to 2545 meters), according to the Australian 1-mile map, which gives their names, from east to west, as Oiamadawa'a, Nimadao, Oiautukekea, and Vineuo. Elders of Garuwata and Wakonai, who accompanied us, named the peaks Oiamadawa'a, Vineuo, Natuioli, and Mouna. When we saw the westernmost high peak, later on the expedition, no local native was at hand to give a name for it. The upper parts of the peaks, with the exception of Oiamadawa'a,

carried grasslands that appeared alpine, and on Mouna, and especially the Vineuo of our guides, these grasslands were quite extensive. Mouna, the highest peak, we christened "Old Timber-Top" from a broad strip of dark forest, apparently coniferous (such as *Podocarpus compacta*), which went to the apparent summit, flanked east and west by steep grassy slopes. The sharp summit of Oiamadawa'a appeared shrubby, and very little grass was visible on it.

With two boys on October 10, Wynn and I finished cutting through the forest to the crest of the range above camp, a trail that he previously had started. The slopes were moderate, but enormous quantities of scrambling bamboo and ferns, on which when trail was cut one often walked without putting foot to ground, made progress slow. From different positions on the divide, which the 1-mile map shows to be 5900 feet (1800 meters) in altitude at that point, we had a hazy view of high mountains on the New Guinea mainland, Vivigani Airfield, and what appeared to be Mud Bay on the south end of the island.

From the vantage point of the divide it became plain that the high peaks were beyond practical reach from our present camp. The distances involved (about $3\frac{1}{2}$ miles along the range crest to Natuioli summit and another mile to Mouna) were not great, and the idea had been entertained of establishing a subsidiary camp for work on the latter peak, but a week or more of heavy cutting would be necessary to open a path through the bamboo-encumbered forest visible from our position on the divide. This would mean a special project, which would use local natives and take more supervisory time than could be allotted to it. Reluctantly, it was decided to leave the peaks for the next biological party to visit the island.

Oiamadawa'a, we know, presents no special difficulty of ascent from the east coast, but it is sharp-topped and offers little scope at high altitudes. The other peaks, of which Mouna, as seen by us from the east and south east, exhibited greatest ecological diversity, could perhaps best be approached from the north coast. Our camp was within a mile of the top of the central range, on a spur ridge that formed the southern rim of the Garuwata River basin. Between this and the

peaks were at least two higher and shorter spurs rising from the Garuwata basin and partly grassy on top. Burnt patches on the nearest spur indicated a native path there, and probably another path went to the top of the divide on the more distant spur. But approach to Mouna by either of these spurs would probably be at least as difficult as by the more indirect route on which we found ourselves. We were not on an established native route to the peaks, nor could we learn of any such path.

Before our arrival on Goodenough we were informed that the natives hunted on the high peaks and burned the grass. However, in October, late in the dry season, we could see no sign of burning on any peak, although much had been done on grassy slopes of the Garuwata Valley and on the high spurs near our 1600-meter camp. The impact of fire upon forest may be deduced from the pattern of forest and grassland vegetation visible to us on the high peaks. Lightning might be a factor in starting the fires, but, fairly certainly, the peaks are visited, and fires started, by man.

Some natives of the island believe that the spirits of their dead go to the top of Oiamadawa'a before leaving for Koiateu on Ferguson Island and finally Bwebweso on Normanby Island.¹ At Wakonai we learned of a legendary salt-water lake high in the mountains, teeming with crabs, kingfish, and crocodiles. These beliefs may perhaps be taken as an indication that the uppermost parts of the island are seldom visited by the natives.

A site suitable for a collecting base intermediate in altitude between the lowlands and our 1600-meter camp had not been found on our journey into the mountains. But natives had since described a promising place on a route between Wakonai and our present camp said to be shorter and easier than the trail by which we came. This new information was confirmed by Wynn on a reconnaissance trip, after which, on October 16, he left for Bolu Bolu to bring up supplies for a second mountain camp to be established at about 900 meters.

On October 24, with 42 lightly laden carriers, we moved from Top Camp (M 54,

¹ Letter from Mr. Clement H. Rich, dated November 5, 1954.

H 133, I 2000, P 430) down to the second camp in about three hours, carrier time. Collecting on the way, I did it comfortably in four hours. Travel was by the Garuwata track to the lower end of the grass spur at 1400 meters. This same spur, the divide between the Garuwata and Utamodi valleys, was followed down to about 1200 meters, and after that a subsidiary spur to 960 meters, where the trail swung parallel with the noisy Utamodi and soon dropped into a small basin where Wynn awaited us in a camp deep in forest and well situated for our purposes. For the mountains of Goodenough Island, travel down had been reasonably easy except for parts of the main ridge below the grassland, where, instead of following the uneven crest, the path clung to the very steep south side of the ridge. Here footing was bad. Loosened rocks soon plunged out of hearing down the mountainside, but plenty of trees stood ready as handholds.

For a week we had known that, soon after our departure from Samarai in September, Tate had become very dangerously ill with a second seizure of cerebral apoplexy which brought completely incapacitating paralysis of the right side. When on October 27 another mail arrived with advice that he should soon be fit to travel and should be flown home as soon as possible, it was decided to close the expedition. Tate would not be fit to travel alone.

Wynn departed on October 28 for the coast and Mapamoiwa on Fergusson Island, where there was a radio station, to arrange for our return to Samarai. Van Deusen and I broke the 900-meter camp (M 19, H 40, F 2, I 1000, P 190) and moved down to Wakonai on the thirty-first. Botanizing on the way, I reached Wakonai in three and a half hours.

NOVEMBER

After some collecting at Wakonai (M 5, P 14), Van Deusen and I moved back to the coast at Bolu Bolu on November 2. To avoid as much as possible the heat of the grass plains, we started the journey at 6:00 A.M., but arrived at the beach not a little sunburned. One soon bleaches out in the mist

and forest shade of the mountains.

At Bolu Bolu we found the "Jessie" awaiting us. For the most part prearranged by Wynn, our evacuation of the 900-meter camp and transport to the coast had gone very smoothly and always with a surplus of carriers. For the last move, from Wakonai to Bolu Bolu, 31 carriers were needed and over twice that number offered. These men were from Wakonai and its outlying hamlets, Afufuia (another foothills village or group of villages), and Garuwata, three communities that stood by us staunchly in our mountains project. In the Bolu Bolu area we had been well helped by the Beli Beli people and especially by those of Kalauna. Eagerness for pay in tobacco no doubt had something to do with this. Most of all, I think, the reason was that, heavily recruited as they are for labor and have been for many years, the Goodenough people, and particularly those of the foothills and mountains, have remained rather unsophisticated, trusting, and very likable folk, and they preferred to help rather than hinder our project.

During the afternoon of November 2 we tied up at the small wharf at Mapamoiwa and were hospitably received by European Medical Assistant Charles Corbett, officer in charge of the medical post and native hospital. An examination of the savanna type of vegetation occurring close to Mapamoiwa showed the characterizing tree to be *Melaleuca leucadendron*.

A run of 15 hours from Mapamoiwa (M 1, H 1, P 21) on a flat calm sea brought us to Samarai on the evening of November 3. The next week was occupied in packing collections and gear for shipment to the United States. Doini Island, about 6 miles southeast of Samarai, was visited by Van Deusen on the eighth, primarily in search of bats in caves; none were found.

On November 12, Tate, Van Deusen, and I departed from Samarai by the weekly flying-boat, they to continue to New York via Australia and London, by BOAC, who did everything possible to facilitate their passage, I to close business in Port Moresby before flying home across the Pacific. Tate traveled as a cot case, attended by Van Deusen.

COLLECTING STATIONS

MENAPI, CAPE VOGEL PENINSULA

MARCH 21 TO MAY 4

AS THIS MAIN BASE in the Cape Vogel Peninsula dry area was our first camp on the expedition, much attention was given to the training of the native "boys" who had been recruited as zoological and botanical helpers, to treating with sulfanilimide powder and elastoplast the painful ulcerated sores which several of the boys had on their legs, and otherwise getting them into condition for the hard mountain work ahead.

Menapi, where we occupied the government resthouse, is a well-kept village of perhaps 40 or 50 houses on the western side of Menapi Bay, about 4 miles east of Baniara Government Station. A pleasant, healthy locality, though malarial, of course, and one of the two good all-weather anchorages for small craft on the south coast of the Peninsula (the other being at Baniara), Menapi Bay was the site of an Anglican Mission, then in charge of Father John Chisholm. The working area of the mission took in the southern part of the Peninsula and a great tract of rather thinly peopled lowland and mountain country reaching back to Mt. Simpson and the eastern slopes of Mt. Dayman on the main range. At the head of the small recess of Menapi Bay a coconut plantation of about 70 acres and a trade store, the property of Mr. Hobart Spiller, took the name Bakira from a creek which there entered the sea.

Behind low foreshores and a narrow coastal plain some 50 yards to half a mile wide on this part of the Peninsula, irregular hills rise rather steeply to a maximum height of about 150 meters in Menapi Hill, a bare half mile from the beach. The country is generally well drained, though semi-swampy in a few places along the coast, and small patches of sago swamp occur in the valleys of the larger streams. The Okawabero, $1\frac{1}{4}$ miles to the west and called a river on the 1-mile map, is about 30 yards wide at its mouth, apparently permanent in flow, and its muddy estuarine flats carry a fairly extensive stand of *Avicennia*

avicennia mangrove forest. The Arorara River, of approximately the same size but with less mangrove, is about $1\frac{1}{2}$ miles towards Cape Vogel. Many small intermittent streams, with steep gradient, lie in deep ravines in the hills. These by action of flash floods form gravel fans at their mouths in the wet season, and in the dry southeast season they are dammed across by sand washed in by the sea.

A shore-fringing coral reef, continuous except at the mouths of streams and within the influence of their fresh water, is covered about knee-deep at low tide. The bays and coves have open sandy beaches, and a narrow strip of beach follows nearly all the coast behind the fringing reef, though often screened by a thin line of mangroves. The coast seems to be subsiding. Large beach trees are being undermined, and coconut palms, scoured around to their ball of tough brown roots, are toppling into the sea.

Running into a point of land that forms the east side of Menapi Bay is a steep-sided, more or less flat-topped ridge of very rough, deeply creviced oolitic limestone, about 30 meters high, which is not shown on the 1-mile map. The same rock appears in ravines in the hills, where the basement rock is a greenish gray, stratified limestone dipping away from the coast.

Although the wet season was petering out when we arrived, and the gentle first movements of the southeast trades were already opposing fitful northeast to northwest breezes, some very heavy rains fell before the end of March. More heavy rain on April 12 and 13, and again on the twenty-ninth, came from the southwest. By the first week of April, however, a trade-wind pattern of weather had become fairly well established. Beginning usually before 10 A.M., a southeast wind, gradually becoming more constant and stronger as the month wore on, blew all day and often into and even through the night. The sea at first had always been flat calm in early morning and seldom became choppy through the day. Now whitecaps ran outside the protecting reef, and there was the noise of waves breaking a foot high on the beach

day and night. Short showery spells, and occasional onsets of boisterous wind and rain squalls, interrupted the usually fine weather. A rapid diminution in stream flow was observed early in April, and by the close of the month the water in most gullies in the hills was reduced to small pools at least in part fed by seepages.

Temperature records were not kept at Menapi Camp. It may be said that days were hot, and one seldom needed cover at night. There were gaps in the meteorological records at Baniara, and a long one during the war, when only native caretakers occupied the station. Average rainfall for 12 complete though not consecutive years between 1928 and 1952 was about 65 inches, the lowest for a year being 38.41 inches, the highest 97.87 inches. The rainiest months on complete figures for the three years 1950-1952 were January, February, and March; the driest, June, August, and October. Monthly extremes of rainfall for the same three-year period were 21.15 inches in January, 1952, and 0.44 inch in October, 1951.

The original or climax vegetation was a rather dry and not very rich mixed rain forest, now 50 per cent or more destroyed by native clearing for food gardens and gone to grass. Back in the hills, not much more than half an hour's walk from the village, extensive tracts of primary forest survive. But in the area much disturbed by cultivation the only apparently original forest remaining is on wet ground, or ground too rocky or steep to be well cultivable. Rain-forest second growths occupy most of the land formerly cultivated on the low coastal plain, where soils are relatively moist in the dry season, and in ravines and on the more sheltered slopes in the hills. The crests of ridges and the upper parts of the hills are mostly grassy. Trees of many species occur in the rain forests, and some attain large size on the better soils, but there is a poverty in species of woody and herbaceous undergrowth and in climbing plants and epiphytes. The principal species of the grasslands is the wind-dispersed *kurakura* or *kunai* grass (*Imperata*), growing 3 or 4 feet high and so densely as to exclude all but a few other grasses and herbs. *Heteropogon contortus*, a bunch spear-grass and not so tall, has possession of some of the drier

ridge crests. Savanna stands are formed by *Albizia procera*, a sparse-foliaged deciduous tree.

The natives of Menapi and vicinity, a healthy-looking, rather sophisticated Papuo-Melanesian people speaking the Paiwa language, have their villages on the beach. So far as could be seen, they make no attempt to cultivate the grasslands but cut down and burn patches of primary or, usually, secondary forest. The population is slowly increasing, and a progressive difficulty in finding land to cultivate in the shrinking forests, and increased labor in producing from the land that is brought under cultivation, might be expected. Presently, however, the natives have income from coconuts growing in the villages and in small community-owned plantations, which enables them to buy rice and ship's biscuits at the local trade store, and this no doubt eases pressure on the land and saves a lot of hard work in clearing and fencing gardens.

Our arrival was in an off-season for garden food, and sago was being made in the small swamps, but by the time we left the area garden produce had become fairly plentiful. The crops were mainly bananas and plantains, supplemented by taitu,¹ yams, sweet potatoes, taro, cassava, sugar cane, and various odds and ends. A special event of fresh-food interest was the arrival early in our stay of a bedraggled party of natives from Ikara village, on the slopes of Mt. Simpson, with about 100 pounds of English potatoes for sale. The party had been on the road six or seven days, and an asking price of sixpence a pound did not seem too much for their potatoes.

In a report on famine conditions which existed on parts of the Cape Vogel Peninsula 50 years ago as a result of drought, an experienced government officer expressed the view that the population of the area was steadily decreasing and on the way to dying out (Monckton, 1904). This raises interesting questions today, when a glance at the modern military maps, on which vegetation cover is indicated fairly accurately, shows a great preponderance of grassland and savanna on the Peninsula and for some distance west of

¹ A small yam of good quality, probably *Dioscorea esculenta* (Loureiro) Burkill.

it, especially inland from the coasts, but few villages inland and not much population on the north coast. From the top of Menapi Hill one looks over rain forest near at hand to a broad expanse of lower ridges and small valleys stretching at least halfway across the Peninsula. Not a village or a garden can be seen, and there is no village within 5 miles. Yet, instead of the rain forest which one might expect to see, the inland landscape is of grass, with only relics of the former rain forest cover surviving. It is not being stated that all the grasslands and savannas of the maps are man-induced. Large tracts of black-soil grasslands reported in the western interior of the Peninsula or still farther west in the same dry belt may perhaps be primary. Almost certainly secondary, however, are all the grasslands we saw from vantage points such as Menapi Hill, from boats off the coasts, and in our other working localities in the dry belt.

Could it be that the present concentration of nearly all population in coastal villages is recent? That before government control, which in this area dates back to at least the beginning of the century, most of the people lived inland, through hereditary choice or fear of raids from seafaring marauders, and with the growing exhaustion of forest land for gardens and traditional inability to cultivate the grasslands their fathers had brought into being, they moved to the coast after the government had made it safe to do so? The rather extraordinary inefficiency of the Menapi coast people in the arts of canoemanship and fishing would suggest such a historical background. And if most of the grasslands of this dry belt are indeed man-induced, the inland population that destroyed the forests, by clearing and burning, has either moved to the coast or practically died out, apparently in the not very distant past.

Field work at Menapi was facilitated by government foot tracks. A good track, which linked all coastal villages on the Peninsula, passed by our door. Another path, neglected and seldom used, crossed to the north coast at Mukawa. The larger streams on the coastal track were well bridged; the smaller ones were often spanned by single logs, uneven and springy and with no handrail.

One expects to find in tropical rain forest at any time of year many plant species without flowers or fruits. At Menapi the number was unusually high, at about 50 per cent, and of those in fertile condition about one-half bore only fruits. The natives said the main flowering came with the onset of the rainy season.

The locality was not rich in mammals, and the yield from traps especially, except in a common small *Rattus* of the native gardens and a white-bellied *Melomys* of the forests, was disappointing. Much attention was given to night hunting, by which was secured the arboreal marsupials *Petaurus breviceps*, common in coconut palms, *Phalanger maculatus*, and *P. orientalis*. The short-nosed bandicoot (*Thylacis macrourus*) was occasionally trapped in secondary grassland. Noisy at night, in forest strips and often in coconut palms, were two large fruit bats, a *Pteropus* and *Dobsonia moluccensis*. Three species of smaller bats were collected: a *Pipistrellus* on several occasions in holes in coconut palms and shot on the wing at dusk; a small *Miniopterus*, commonly shot over the garden clearings; and *Macroglossus*, shot and netted while feeding around wild fig trees.

This was a good locality for butterflies, and many of a large collection made by Tate were found frequenting flowering shrubs planted in sheltered but sunny situations about native houses, the red, orange, and yellow flowers of *Poinciana pulcherrima* seeming to be particularly attractive to some showy species. Also noteworthy was the great amount of light-trap material caught on dark, still nights, to say nothing of the numerous larger moths which came to the lights in camp. Mosquitoes and other biting insects were not very troublesome, if we except the ever-present, hard-biting "green ants" (*Oecophylla smaragdina*) which infested the forests and made conspicuous leaf-bag nests. The tiny red larval trombiculid mites or chiggers called "scrub itch" caused discomfort at times after a day in the field, but were not present in pest concentrations.

Tate acquired a considerable number of reptiles by trade: a stick of tobacco for a medium-sized lizard, for example, and smaller pieces of tobacco for smaller specimens. Young children were paid with candy and

ship's biscuit, and one diligent little girl seldom failed to appear in the afternoon and to earn the reward of a whole square of the hard-tack for her catch.

DABORA, CAPE VOGEL PENINSULA

APRIL 7 TO 10

Only Van Deusen and I used this subsidiary camp on the south coast of the Peninsula some 6 miles east of Menapi and 4 miles west of the southern tip of Cape Vogel in Sibiribiri Point. Van Deusen's chief interest was in examining for bats the Tapitapi Caves, about an hour's walk in a northerly direction, while I wished particularly to see extensive grasslands reported to occur towards the end of the Peninsula. Actually, we camped in Kirikirikona government resthouse, about half a mile westward along the beach from Dabora village. Van Deusen, accompanied by Tate and Wynn, visited the caves again on April 15.

Dabora is in a small, sandy bay exposed to the southeast and fringed with the usual coral shore reef of this coast. A dinghy passage opposite the resthouse gave a moderately good landing while we were there. Two creeks, the smaller named Okobobarina, the other Didi, and both carrying good flows of clear, sweet water in April, emptied into the bay. The western horn of the bay, Neara Point, rose in vertical sea-washed cliffs of honeycombed limestone, 8 to 10 meters high, fronting a rough limestone ridge covered with a low, scrubby growth of rain-forest species.

East of Dabora, four or five lines of cliffs similar to those of Neara abut on the sea. After an hour's continuous walk at low tide, when alone the government track is passable under some of the cliffs, one strikes inland from a pretty little cove in the cliffs and by a short defile through rain forest comes suddenly to wide savannas and open grasslands on an undulating low plateau there about 30 meters above sea level and sloping gently to the east. Goodenough Island rises high and blue across the sun-bleached open country, and beyond Ward Hunt Strait, which lies below the line of view. The nearer landscape is dotted with sharply defined small patches and mere clumps of low timber of dry rain-

forest type. Scattered trees, where they form a savanna, are of the same species but principally *Timonius timon* and an *Alstonia*. *Albizia procera* also occurs. A dense cover of erect bunch grasses, generally about a meter high, is dominated by *Heteropogon contortus*, *Themeda ?triandra*, and an *Andropogon*. Very little *Imperata* is present. The grassland flora is poor. Only six species of grasses were seen, few associated herbs, and no true grassland shrubs or trees. The grasses were beginning to ripen seed, and patches had already been burned along the trail.

Signs of wallaby, said by the natives to be brown in color (probably *Protemnodon agilis*), were plentiful, as were bandicoot rootings in the grass. A rough, pitted ground surface was hard to walk over, especially where unburned, and sharp jags of rock left by differential solution of the hard gray limestone were hidden in the grass. The solution pits held a chocolatey red or brown, rich-looking soil. The savannas and grasslands seemed undoubtedly a secondary condition following cultivation, not recent. There was no sign of former cultivation, such as planting hills or stones piled into walls or heaps, and no loose stone, for that matter. Population in 1953 was confined to the coast.

The Tapitapi Caves were in primary rain forest on a gently ridgy limestone plateau, about 60 meters in elevation, steeply scarped to the south, where it rose from flat lands carrying gardens of the Dabora people. Our party was given sugar cane to chew at a large garden recently carved out of the forest between the top of the escarpment and the entrance to the caves. What appeared to be the main entrance was under an overhanging cliff, perhaps 25 or 30 meters high, facing approximately west. There were two openings, one above the other at the base of the cliff, the lowermost of which received a stream (dry when we saw it) fed by a sink-hole catchment basin extensive enough to shed a large volume of water from heavy rains. The entrance of the disappearing stream was 2 meters or more high and as wide; the upper entrance was more in the nature of a crevice, spanned by some rotten poles which someone had used as a bridge by which to enter the level. A third entrance,

used by us, went in from the bottom of a small sinkhole back about 50 meters eastward from the rim of the cliff.

My one view of the cave was with two natives for company. Crouching low to enter, we soon found plenty of room and a good floor. In about 50 meters the cave forked. We took the right-hand branch and in a short distance came to a large chamber which fairly swirled with small bats. Using switches, and in places floundering in soft, wet guano several inches deep, we brought down 15 bats of four species. Van Deusen, exploring the cave farther, brought the bat catch up to eight species, including *Rousettus* and the large fruit-eater *Dobsonia moluccensis*. The local natives valued these two species for meat. About 300 were claimed to have been killed in a foray into the caves a week or so before our visit. Another hunt, with electric flashlights and coconut-leaf torches, took place while we were there. I did not see the bag. It must have been ample, for my boys came into possession of six big dobsonias, neatly bundled up in wrappings of fresh fan-palm leaves.

Discovered in 1925 or 1926 by Assistant Resident Magistrate O. J. Atkinson (1927, 1928, 1929) of Baniara, and partly explored by him between then and 1928, according to the Annual Reports, Tapitapipi is evidently a well-developed system of caves. Recently Father Cruttwell of Menapi Mission and a companion penetrated a distance he believes to have been about 2 miles, where they were forced back by bad air.¹ It would appear that no white man has gone far enough into the caves to reach a land underground where, the natives of Dabora believe, the choicest of all bananas, mangoes, and breadfruit grow.

BAIAWA, MOI BIRI BAY

MAY 6 TO 11; SEPTEMBER 7 TO 9

The entrance to this small bight on the southern side of Collingwood Bay is obstructed by coral reefs and patches and the low Jarrad Islands, but good passages exist for small vessels. The muddy shores are bordered to some depth with mangroves, and close in to the eastern side of the bay,

where Baiawa is situated, lie several tiny coral islets also covered with mangroves. A break in wide shore reefs affords a good anchorage at Baiawa, off the shallow mouth of a very small creek, where we had 6 fathoms about 100 yards from the mangroves. Inside the creek was the head of a long, rickety catwalk which led straight to the village through a lane cut in the mangroves. At least 200 meters long, the catwalk was raised a meter or more above the mud on very thin mangrove forks and roughly and insecurely decked with sticks, bits of old dugout canoes, and driftwood. The village, an unattractive place of about a dozen houses and a native station of the Anglican Mission, straddled a narrow strip of dry ground between the inner edge of the mangroves and the very steep lift of a ridge, on top of which, perhaps 30 meters above the village, stood the government resthouse. The village had enough coconuts between the mangroves and the ridge to produce a little copra, dried in the sun on raised racks. A few unthrifty old *Hevea* rubber trees survived as reminders of one of the government planting programs in cash crops for natives. Government tracks went east and west along the coast and inland to the Gwoira mountain country.

Any inconvenience that occupants of the resthouse may have from village noises too close at hand, and thieving dogs constantly on the prowl, is compensated by a magnificent view of the mountains, from Mt. Dayman, seeming very close in the clear morning air of May, to the higher and more rugged Goropu Peaks, and the Mt. Victory group of the Cape Nelson Peninsula, the last two cloudier than Dayman and appearing wetter at that time of year. Days were hot and nights pleasantly cool to chilly in May, when, on this lee coast from the southeast trades, a little wind came from easterly directions in the afternoon, and local showers could be expected after about 3 P.M. In September, when conditions were very dry locally, we had no sight of Mt. Victory, and the other mountains were obscured or completely hidden by haze or cloud after early morning.

Baiawa is at the western end of the Cape Vogel dry belt and on the edge of a broad tract of low ridges, for the most part grassy,

¹ Letter from the Rev. N. E. G. Cruttwell, dated January 2, 1952.

which stretches from the foot of the mountains, about 6 miles inland, clear to the coast. Average elevation near Baiawa is about 30 meters; the highest point, Dark-Top Hill, within half a mile of the village and a prominent landmark, is about 60 meters. The soft, grayish and gritty, volcanic country rock has been described as a tuffaceous greywacke (see p. 89). It weathers into a soil dark gray when moist, and, as seen in eroded paths on the grasslands, a yellowish clayey subsoil. Low, scarped outcrops of the rock are frequent.

Again, in this low rainfall area, the processes of deforestation described for the Cape Vogel Peninsula have been at work. The surviving rain forest is mostly in gullies and the valleys of small streams, although Dark-Top Hill is capped with it. In seasonal aspects in September it became evident that two types of forest were present: one fairly tall and evergreen; the other low, brushy, and composed in considerable part of deciduous trees, characteristic of the smaller gullies, and more like a dry monsoon forest than rain forest.

Richer in species than those examined on the Cape Vogel Peninsula, the grasslands occupied most ridges and some hollows and gullies. A savanna effect was produced by scattered, crooked small trees, chiefly *Timonius timon*, *Sarcocephalus cordatus*, *Albizia procera*, and another tree of monsoon forest or rain forest affinities that could not be identified or found in flower or fruit. In general the grass cover consisted of a soft, leafy stand of *Themeda triandra*, about knee-high, with *Heteropogon contortus* plentiful on some ridges, and tall, coarse species often dominant in gullies. In May most grasses had shed their seeds, but 10 species could be collected. Most of the grassland was burned about the middle of the year, and in September, though the country appeared very dry and only a few pools remained in streams which had been flowing in May, a good fresh shoot of grass gave a green tinge to the ridges.

Although primarily a supply and transportation base, where first attention had to be given to such matters, Baiawa nevertheless yielded good results in insects and plants during our short sojourn in May. Some

deciduous elements of the dry brushy gullies, which had been sterile in May, were collected in flower in September. Van Deusen found mammals very hard to come by on both visits. Only a single specimen was taken in numerous traps. Wallabies (*Protemnodon agilis*) were plentiful enough on the grasslands to keep patches of grass and herbage cropped short on some ridge tops, but so wary that few fell to the guns. It was interesting to find here, as on the Cape Vogel Peninsula, *Thylacis macrourus*, a bandicoot characteristic of the natural savannas of southern New Guinea and northern Australia.

The day before our final departure the small force of Baiawa men and youths put on a hunt, with long black-palm (*Caryota*) spears, heavy nets, and dogs. They returned late in the afternoon carrying a wild pig, cut in pieces, and several wallabies and bandicoots hanging on shoulder poles between two pairs of bearers. With this meat and garden produce our Gosiagos were entertained at a dance and feast. Betel nut brought by our retainers from Biniguni helped to enliven the proceedings. The drums beat and the people sang far into the night.

TOP CAMP, NORTH SLOPES OF MT. DAYMAN

MAY 17 TO JUNE 19

The camp locality and the upper parts of the mountain are described in some detail in the part of this report that deals with itinerary and routes. Situated at an altitude of 2230 meters (7316 feet) by aneroid, camp was on the western bank of the Atairo in a secluded grassy hollow within quarter of a mile of the head of that stream, and $1\frac{1}{2}$ to 2 miles northwest of the summit of Maneau Peak. From it plant collections were made up to the 2790-meter summit of Maneau, and mammals trapped to within about 50 meters of the top. General collecting was extended down the Biniguni trail to about 1950 meters on the northern slopes of the mountain. In the bottom of the gorge of the upper Gwariu River, plants were collected at 1840 and 2030 meters. Messengers traveling light and fast could reach camp in less than a day from Biniguni. On one occasion a policeman carrying mails made the journey from Baniara

Government Station in the remarkably short time of three and a half days.

The Atairo flowed through a strip of forest, narrow at camp where steep grassy slopes rose close on both sides, broadening and ascending lateral ravines upstream and down. A low divide, in forest, separated its head from a small feeder of the Gwariu. Climbing out of the deep little grassy hollow where camp was placed, in a few minutes' walk back along the Biniguni trail we could get a view of the picturesque upper valley of the Gwariu to the south, look down into the imposing, dark-forested gorge of the Gwariu to the west, and beyond it over Mt. Tantama to the majestic high Suckling and Goropu Peaks. The position of camp gave it protection from wind, but the morning sun did not appear over the heights until about seven thirty, and sundown came at about four o'clock. Water temperature in the camp stream was 56° F.

Our two tents, a bark cookhouse and a work fly closed in with bark, were set up in the grassy hollow, for we needed light for our work. In the dim, relatively warm shelter of the forest the boys had a roomy bark shelter covered with a fly to make it completely rain-proof. They laid their sleeping mats on beds of grass on a bark floor on the ground and with four blankets each, and fires burning in the shelter, were comfortable in any weather. We had to see to it that, after getting wet in the field, the boys changed clothing. Otherwise the second flannel shirt with which each was provided would have been kept in shop-new condition for later display on the coast.

Great diversities in weather were experienced during our 33 days at this camp. Few days, however, were without mist, which drifted up from lower levels very often by mid-morning and tended to clear off before nightfall. No clear morning after a rainless night was without frost on the grass, and on the colder mornings water vessels froze over in camp and the tents had a rime of ice inside and out before sunrise. We had only slight drizzles on three of the first 12 days, then two days and nights of intermittent heavy rain which thoroughly soaked the ground and necessitated the hasty deepening of drains in camp. Again, beginning with the

new moon on June 11, were four days of driving drizzle and heavier rain broken by rare bursts of sunshine. Nights in general were clear and bright or with scuds of cloud or mist, and only five were actually rainy. Thermometers set a meter above the ground under a bark shed in the camp hollow gave the following data: mean maximum for 29 days, May 22 to June 19, 21.3° C. (70° F.), extremes, 18.5° and 24.5° C. (65° and 76° F.); mean minimum for 30 days, May 21 to June 19, 5.1° C. (41° F.), extremes, 0° and 11° C. (32° and 52° F.). Selective readings by whirling hygrometer on seven days in the thermometer house, for the purpose of determining relative humidity minima, gave extreme lows of 40 per cent at noon, 49 per cent at 5.30 P.M., and 51 per cent at 6.30 A.M. These lows all occurred on May 24 to 27, before the first heavy rains, which began three days later. Conditions were never so dry again while we were on the mountain. When camp and higher levels on the mountain were clear, clouds driving in and upward from the north often filled the Gwariu Gorge. And, so far as comparisons could be made, mist and drizzle began an hour or two earlier in the day in the beech-forest zone, beginning at about 2100 meters, than in the camp locality.

Intense sunshine and the virtual absence of clouds and mist, for several days towards the end of May, dried out the upper parts of the mountain. Abundant bracken on the grasslands had been whitened and withered by frosts. A result was fires, lit by our personnel despite warnings, which burned over some hundreds of acres of grasslands and here and there made slight entry into the forests. Another fire, affecting the forest, has already been mentioned (see p. 113). Native hunters lit many more, distant from our camp (see p. 113). Such fires have demolished more than one-half of the original forest over an area of 15 to 20 square miles above about 2150 meters on the extensive northern and eastern slopes of the mountain.

On burnt forest land a dense growth of fern (mostly bracken, *Pteridium aquilinum*) springs up. Quick-growing, second-growth trees such as *Dodonaea viscosa*, and species of *Weinmannia*, *Olearia*, and *Alphitonia*, establish themselves among the ferns. Much

scrambling fern (*Gleichenia* and *Sticherus*), almost as inflammable as the bracken, grows on fire-damaged forest margins and constitutes a hazard in dry spells. Fire is carried within the forest by an abundant coating of mosses and hepatics on the trees, which dries very quickly in the absence of frequent mist and rain. While man roams the mountain, as do native hunters with firesticks in the dry season of every year, the forests will continue to recede.

On page 110 the primary vegetation cover of the mountain above the beech forest is called mossy forest. A discussion of vegetational zonation is given below. In forests anything but uniform in composition, height, and mossiness, first among canopy trees were several species of *Decaspermum* and *Xanthomyrtus*, very twiggy and with small leaves, and a *Phyllocladus* and a *Papuacedrus* as conifers, the latter often a super-canopy tree. Other important dominants included species of *Elaeocarpus*, *Schizomeria*, *Quintinia*, *Ilex*, *Rhodamnia*, and *Pygeum*. Common especially in stunted, scrubby, heavily mossed forest on exposed high ridges were several *Vaccinium* species which, with two or three small-tree species of *Rhododendron*, may be regarded as subalpine elements. Tropical rain-forest elements, ascending sheltered ravines up to about camp level, included as large canopy trees at least three species of figs (*Ficus*) and a big stinging tree (*Laportea*) up to 25 meters tall and over a meter in trunk diameter. Always thrusting its stem and tiered narrow crown well above the general forest level and attaining under most favorable conditions a height of fully 60 meters, a splendid *Araucaria* (*A. cunninghamii*?) grew abundantly on both slopes and ridge crests up to elevations of 2450 meters or more and lent a conspicuous coniferous aspect to the forests.

Some fine stands of *Araucaria* of heavy timber volume occurred on the slopes of the upper Gwariu Valley. In one area of dryish, moderate slope I botanized in a virtual forest of these great trees 1 to 1½ meters through at breast height. *Papuacedrus*¹ up to 60 cm. in diameter was also abundant. At its upper edge, at about 2000 meters, the forest of this

slope contained many small *Araucaria* and *Papuacedrus* trees, and mossy old rotten logs on the ground, indicating a regenerated forest. A *Weinmannia*, already noted as a second-growth element, was the principal tree of this young forest and attained a height of about 16 meters. Elsewhere on the mountain a fairly abundant regeneration of the two conifers was observed, following fire. It was noted, too, that unless protected by bracken or other cover the *Araucaria*, while less than about 2 meters tall, may be severely damaged by frost. Comparable young *Papuacedrus* appeared to be frost-resistant.

The mossy forest contained a wealth of terrestrial and epiphytic ferns, especially in the gullies, although even in these sheltered situations, where filmy ferns (Hymenophyllaceae) abounded, most epiphytic species wilted and shriveled in the driest weather. Tree ferns (*Cyathea* and *Dicksonia*) figured prominently; one large *Cyathea*, common in forest edges, occasionally growing as well on grassy slopes, resistant to the frequent frosts. Several *Elatostema* species provided a great abundance of fleshy herbaceous undergrowth, characteristic of the broader bottoms of gullies and ravines, where a scrambling shrub of the Urticaceae, *Medimilla*, *Saurauia*, a beautiful, horizontally branched *Amara-carpus*, and other shrubs and treelets formed an often plentiful woody undergrowth, and large ferns also contributed to conditions that made trail cutting necessary. The most obstructive element, however, was a graceful, small-leaved, scrambling bamboo, tangled in openings made by fallen trees and ascending to 10 meters or more where an unusual amount of light came through the canopy at the lower altitudinal levels.

The small-leaved bamboo was more characteristic of the beech forests farther down the slopes. But for it these forests would have been pleasantly open underneath, as indeed they were where the canopy cast a shade too dense for the bamboo. To the description of the beech forests already given (p. 110), it may be added that only one species of *Nothofagus* was recognized. Visibility was poor in these forests (and frequently in the mossy forest). Found often on the ground were the fallen flowers of two species of *Rhododendron*, one pink and dainty, the

¹ The Biniguni Daga call the *Papuacedrus*, *beneb*, and the *Araucaria*, *moi-otwi*.

other white and carnation-scented, but in the misty high crowns of the beeches, where they grew as epiphytes, only one *Rhododendron* plant was seen on five excursions into these forests. Mossy forest elements such as *Phyllocladus*, *Papuacedrus*, and *Xanthomyrtus* went well down into the beech forests on narrow, heavily mossed ridge crests.

Perhaps stimulated by the rains which began on May 30, and two weeks of relatively warm weather that followed, many trees and other plants of the forest, previously sterile, began to come into flower. Among them were numerous epiphytic orchids, mostly small or with inconspicuous blooms, but some, especially of a mountain group of *Dendrobium* species, quite showy, a common one having brilliant orange and yellow flowers, another flaunting blackish purple with red and magenta.

Even though large in extent, the grasslands were poor in species. There cannot be much doubt that, apart from narrow areas in cold streamways in the upper Gwariu Valley and perhaps a very occasional high, dry, rocky slope and more frequent landslide surfaces, the upper parts of Mt. Dayman, before hunters came there and applied their firesticks to what would burn, were clothed in continuous forest. The true grassland flora is alpine, with some at present indeterminate elements. Some floristics are given above (see p. 112). The 3420- to 3670-meter heights of Mt. Suckling and the Goropu Mountains, where extensive grasslands, most probably in large part a primary condition, occur at a distance of only 20 miles, offer a convenient hypothetical source for alpine elements coming in after the burnings of man on Mt. Dayman. The bracken, prevalent to the summit of Maneau Peak, was perhaps as good an indicator as any of the secondary or induced nature of the grasslands of this mountain. It is not alpine in New Guinea. It grew more rapidly than the grasses and burned more fiercely. Most of our boys (who wore no shoes) were lamed with feet punctured by bracken stubble on burnt grasslands.

By diligent trapping and much night hunting in the forests by himself and his leading boy, David, Van Deusen secured a very satisfactory collection of 18 species of mam-

mals at this camp. The only terrestrial species found in the grasslands were the small, dark brown wallaby *Dorcopsulus vanheurni*, which came out onto the grass and had pads there but actually lived in the forests, and a white-bellied *Rattus*, often trapped along the edges of the mossy forest. A beautiful little *Pogonomelomys* was also found in this shrubby forest fringe. Two species of bats (*Miniopterus* and *Tadarida*) were shot in the camp hollow; a *Macroglossus* was caught after flying against Van Deusen's lighted tent. Trapped on the ground in the forest were a gray-bellied *Rattus*, a *Melomys*, a marsupial mouse (*Phascosorex*), and, though normally arboreal, the pygmy possum, *Eudromicia caudata*. Cut out from hollows in trees, as much as 15 meters above the ground, were a fine *Pogonomys* (several always found together) and a giant rat (*Uromys anak*). The giant rats *Hyomys goliath* and *Anisomys imitator* were shot in trees at night. Among the larger arboreal marsupials were very dark brown *Phalanger vestitus*, beautiful *Pseudocheirus corinnae*, greenish gold on the back, and small *P. forbesi* with striking black and brown face markings. Lured by rat bodies, the marsupial "cat" *Satanellus albopunctatus* was trapped in camp. Native hunters told us of the large monotreme *Zaglossus*, a tree-climbing kangaroo (*Dendrolagus*), and a bandicoot occurring in the uppermost forests of the mountain (see p. 113), but we did not collect them in this camp locality. Our boys ate well on the flesh of the larger marsupials, though with unpleasant after-effects in body odors.

The only birds collected here, or anywhere else on the mainland, were caught accidentally in mammal traps and preserved in formalin. Most birds in the locality showed little fear of man. In the forest, especially when thick with mist, one could almost touch small species in the undergrowth. Flocks of a tiny green parrot fed in the tops of flowering forest trees. In good weather, a bird of paradise (*Astrapia*) called every morning from trees beside camp and displayed its very long, ribbon-like, black tail feathers which in flight streamed out in a remarkable flowing, undulating motion. The first fresh meat on our table for a month was from a megapode caught in a trap and a big pigeon shot

by one of the boys. With rice and onions, they made an excellent stew. Scratchings of the megapodes were seen in the forests, but not their nesting mounds, and I did not hear the unmistakable megapode calls. Droppings of cassowary indicated the not rare presence of these great flightless birds in the forests. Our hunting boys were instructed to go after them for meat if opportunity offered, but to my knowledge only once was a cassowary seen, walking over open grassland from one forested gully to another.

Tate's 132 herpetological specimens from this camp included no snakes or tortoises, and but few species of small lizards and skinks. For the most part they were small frogs. One of the common sounds of the wild was a frog call which, when coming from several of the creatures, sounded for all the world like concerted cackling in a distant fowl-yard. Between showers one wet morning Van Deusen applied himself to the discovery of the animal concerned. The sounds were difficult to pinpoint, but with the keen help of the cooks several specimens were uncovered from under about 10 cm. of loose, somewhat peaty humus in raspberry tangles bordering the forest. Reddish brown and about an inch long, the frog proved to be a new species, *Sphenophryne crassa* (Zweifel, 1956, p. 11).

Results were small as regards numbers (about 5000) in insects and spiders. The first of a very few butterflies was not caught until June 1, when a small "white" was found wet in the grass after heavy rain. When adulthood came for white-haired, brown-and-black larvae that infested the camp in June, crawling on tents and into everything, some medium-sized butterfly or moth should have been plentiful. Odonata likewise were scarce and even less often seen. Until the rains came at the end of May, best results were from the beating sheet, and in ectoparasites (mostly lice, fleas, and ticks) collected by Van Deusen from mammals shot and trapped. After conditions too dry, cold, and moonlit for all but a few nocturnal insects, a splendid lot of moths and beetles was caught in light traps during the first wet evening and by being picked from the walls and roofs of the tents, and for several following nights the catches continued fair to good.

NUMBER 2 CAMP, NORTH SLOPES OF MT. DAYMAN

JUNE 20 TO JULY 12

Here at 1550 meters (5085 feet) on the crest of the leading spur ridge we had followed up from lower levels, we were on an old camping place of traveling or hunting natives, as indicated by ashes and charcoal, small patches of ground baked red by camp fires, and a great abundance of scrambling bamboo invading a small clearing that had been made in the forest. A local flattening and slight widening of the spur crest gave room for two tents and three flies on uneven, mossy, and peaty ground. At the time of our ascent of the mountain in May, a good water supply existed in a very steep gully near camp, but in June, with the advance of the "dry season," it was necessary to follow the gully some distance farther down for water. New Guinea people think nothing of carrying water up a steep slope of 100 meters or so, and the climate was such that, it must be admitted, we did not consider a daily bath essential. Water temperature in the stream was 59° F. on July 11.

But for three of the five days following the establishment of our collecting base here and three rainless days in July, the weather can be summarized as generally dull, misty, rainy, and downright disagreeable. The climate evidently was much wetter at this altitude than at our upper camp on the mountain, at least at this time of year. Many tall trees were felled to let light and wind into the camp, but for days together only rare brief bursts of sunshine would break through the clinging murk of cloud and mist and enter the clearing. On better days, by 10 A.M. often and by noon nearly always, the usual uphill air movement brought mist that turned into drizzle or was accompanied by showers. Substantial amounts of rain fell on nine days and during five nights, but as a rule the sky cleared soon after nightfall. Some of the rain was from general disturbances, for heavy falls were experienced on the lowlands at times during this period. Thermometer-house temperatures in the camp clearing were: mean maximum for the 16 days June 25 to 27 and June 30 to July 12, 20.7° C. (69° F.), extremes, 18.5° and 23.5° C. (65°

and 74° F.); mean minimum for the 17 days June 24 to 27 and June 30 to July 12, 14.1° C. (57° F.), extremes, 11.5° and 15.0° C. (53° and 59° F.). It will be noted that, owing no doubt to effects on solar radiation of the all too constant diurnal blanket of cloud and mist, maximum temperatures were slightly lower here than at the Top Camp, 680 meters higher on the mountain.

The main transport route provided ready access to collecting grounds up and down the slopes and a good trail for night hunting. Tate and his boys opened up another trail in an easterly direction by which the bottom of the deep Atairo ravine, at an elevation of about 1370 meters, could be reached in an hour from camp. Most of our field operations, probably including those of a native who was employed for a few days as a hunter of mammals (see p. 114), were carried out within elevations of roughly 200 meters above and below camp. Botanical forays extended up to 1800 meters and down to 1150 meters on the main trail; collecting of insects and "herps" up as far, and down to about 900 meters.

Except to the west where the slopes were much cut by deep ravines, the terrain about camp held some steep little gullies but for the most part consisted of fairly easy ridges. Many large trees over 30 meters tall occurred in a generally well-spaced forest dominated by a *Castanopsis* and two or three species of oaks. *Engelhardtia*, a frequent associate of these trees in New Guinea, was present, with representatives of *Gordonia*, *Sloanea*, and other genera. A big, red-flowered *Metrosideros* made occasional blazes of color in ravines. Many dead trees, standing, or fallen and covered with mosses and ferns, gave parts of the forest an over-age appearance. Especially on ridge crests, the bases of the trees were mounded with a network of surface roots and covered deep with bryophytes. An abundance of leaf and twig litter lay on the ground over a carpet of mosses and hepatics. Tree trunks and branches, and a predominantly woody undergrowth, were lightly to heavily mossed. Especially abundant on ridge crests and climbing to 20 meters or more, the scrambling bamboo of this altitude had larger leaves than that of the Top Camp, and as its lower stems were erect, seldom close to-

gether, and easily cut, it was not so bad an obstruction in the forest. An *Evodia*, common as a substage small tree, probably the *mamata* reported by Guise on the mountain, had very strongly aromatic leaves prized by our native personnel for wear in their hair and armbands.

These mid-mountain forests of the ridges differed almost entirely in floristics from the mossy forests and the beech forests of our Top Camp, only a few ferns and other minor elements occurring in common. But in gullies and ravines, where mixed rain forest replaced the mid-mountain forest, a lush undergrowth contained rather numerous ferns, including *Leptopteris*, *Vandenboschia*, *Nephrolepis*, and large *Asplenium* species, and fleshy-leaved shrubs and large herbs, such as *Medinilla*, *Saurauia*, and *Begonia*, already familiar in similar habitat niches in the beech and mossy forests. The altitude was still too high or the climate too misty for palms to figure prominently, even in moist gullies in which one species ascended as high as Top Camp, and only a *Calyptrocalyx*, a small *Linosyadix*, and one other were present in addition to one or two climbing *Calamus* species. *Pandanus*, likewise, was not prominent.

The deep Atairo ravine, which an injured shoulder prevented me from visiting, was said by Tate and Van Deusen to be a beautiful place, very mossy, and crowded with ferns. My boys collected many rain-forest elements there which we did not find elsewhere on the mountain, one conspicuous plant being an *Impatiens* with large white flowers, another the fig-like *Dammaropsis kingiana*, the great leaves of which served well as bath mats in our open-air "shower room." Of special interest as high mountain herbs descending low in this streamway were a buttercup (*Ranunculus*), *Nertera granadensis*, and *Gunnera macrophylla*. *Ranunculus*, an alpine genus in New Guinea, was not met with elsewhere on Mt. Dayman.

The beech forests, which replaced the mid-mountain oaks and *Castanopsis* at 1800 meters (see p. 110), could not be thoroughly examined. The one species of *Nothofagus* found was not readily separable on field characters from the species observed at the upper limits of this forest, 300 meters higher on the mountain.

Traffic on the trails soon wore through a surface layer of 5 to 10 cm. of peaty brown humus and exposed slippery yellow clay. In camp, we corduroyed the most trampled ground with sticks, between which the mire squelched and spurted as we walked in the mist. It became necessary to burn lamps in the tents all day and much of the night to dry specimens and clothing, and to have extra kerosene carried up the mountain for this purpose. Until we did this, mammal specimens pinned to drying boards remained limp, and mosses flourished on drying trays hung under the peak of my tent to take advantage of the almost non-existent heat of the sun.

Leeches, standing on end on the ground humus and waving back and forth in readiness to attach themselves to a blood supply, were active, particularly in hollows and gullies. The boys scraped them off their bare feet with their big knives every day, but they were not the nerve-racking pest that this type of leech can be in New Guinea. Scrub itch was present, but it had been much more bothersome under the generally drier conditions at Top Camp, where leeches were few.

Collecting proved very satisfactory for species of plants, less so for series, mainly because of my inability to negotiate the more difficult slopes. Many of the numerous epiphytic ferns and orchids were sporadic in the forest. In general, more trees bore fruits than flowers; perhaps one-third were sterile. A number of trees, shrubs, and the fewer vines were in various stages of developing flower buds. Herbaceous plants other than ferns and orchids were few in species and usually in individuals. A rich bryophytic flora differed substantially from that of the upper levels.

Conditions which could scarcely have been less favorable restricted most trapping and shooting to within easy range of camp, where, for a small area, a remarkably rich and abundant mammal fauna of 20 species was revealed. Traps set on the Atairo stream yielded only a gray-bellied *Rattus* common at camp level and in the forests at Top Camp. Other rodents of a total of eight species of seven genera included a second species of

Rattus; *Melomys*; the monotypic *Anisomys* and *Hyomys*, encountered by us first at Top Camp; *Pogonomys*, one specimen of which was grabbed by hand from a vine at night; and, genera hitherto unencountered, *Leptomys* and *Lorentzimys*. Only one species of small bat (*Pipistrellus*) was shot. In addition to the *Phalanger* and two *Pseudocheirus* of Top Camp, dark brown *Pseudocheirus cupreus* was collected. Entirely new to the collection in arboreal marsupials were big brown *Dendrolagus dorianus* and the pretty but odoriferous pale gray and black striped *Dactylonax palpator*, with enormously elongated fourth fingers. *Antechinus* was a genus of marsupial "mice" not taken before. The top mammal prize for the camp was *Zaglossus*, New Guinea's most peculiar mammal.

Frogs were very vocal on wet nights and kept Van Deusen busy when jacking for mammals was slow; they turned up fairly well in species for the collection. Lizards were few, and our first snake for the mountain, small *Natrix picturatus*,¹ was caught by me in oak-*Castanopsis* forest at 1250 meters.

Night-flying insects occurred in greater numbers and much more variety than at Top Camp. The almost constantly dull and rainy weather and the almost unbroken forest canopy were not favorable for diurnal insects such as butterflies and dragonflies.

At this camp the mystery of the "six o'clock cricket" was solved. Every evening and morning within about 10 minutes of six o'clock, regardless of weather conditions, strident chirrings fill the forests of the mountains of New Guinea. They are most noticeable in the evening when the birds are still. At over 2800 meters in Murray Pass on the First Archbold Expedition, we failed in a special effort to locate the makers of the noise. There are similar sounds, equally regular, in the mountains of northeastern Australia. The noise had intrigued us at Top Camp on Mt. Dayman. Here at 1550 meters the insect responsible was first picked from the trunk of a tree by Van Deusen one evening in camp, and afterwards several specimens were taken. The "cricket" was a very

¹ Determination by Dr. Richard G. Zweifel, the American Museum of Natural History.

big, green, brown, and mahogany-red cicada about 7 cm. long, *Sawda sharpi* Distant,¹ previously known only from the teneral type specimen collected in southeast New Guinea. Different cicadas might make the six o'clock sounds at other altitudes and in other areas.

NUMBER 3 CAMP, NORTH SLOPES OF MT. DAYMAN

JULY 13 TO 26

This camp at 700 meters (about 2300 feet), being our lowest on the mountain, was also called "Bottom Camp." It was situated close below the junction of the mixed rain forests of the lower slopes and the oak and *Castanopsis* forest of the middle slopes. As evidenced by second-growth rain forest beginning immediately below the camp, we were at the exact upper limit of former cultivation on this part of the mountain by the Daga people who now live in the Biniguni group of villages on the lowlands. Here and there, down to an altitude of about 500 meters on the slopes, the sites of former hamlets were marked by old house posts or by planted betel-nut palms, colorful cordylines, clumps of big-stemmed bamboo, or fruiting lime trees growing in the forest where clearings had been made by the villagers. The felling of a few trees on the down slope at camp opened up a view of many miles of coastline and of lowlands lying between the mountains and the sea, about 12 miles away. With little cutting, Tate and his boys opened and marked a trail which descended by very steep, rubbly, formerly cultivated slopes to the bed of the Atairo at 400 meters, less than a mile to the northeast from camp. An excellent water supply for our use was provided by a smaller stream which plunged down the mountainside about five minutes' walk to the west of camp: a succession of small rock pools in a bed 15 to 25 feet wide, falling to the Ginum.

Although much overcast weather was experienced, rain of some sort fell on 10 of the 14 days we were in this camp, and four days could be called wet from late morning to late afternoon, we were in a drier and much

more pleasant climatic zone than at the Number 2 Camp, 850 meters higher on the mountain. With great regularity in late morning or early afternoon a pall of heavy dark cloud enveloped the slopes above us, its lower edge often resting in the treetops of the oak-*Castanopsis* forest only 50 meters higher on the slopes, but we were below the zone of regular mists and seldom had any in camp. A brown haze obscured the lowlands and the coast nearly always, and at no time were the mountains of the Cape Nelson Peninsula visible, though distant less than 40 miles to the north. Mean maximum temperature for eight days, July 19 to 26, was 25.1° C. (77° F.), extremes, 23.5° and 27.0° C. (74° and 81° F.); mean minimum, 17.2° C. (63° F.), extremes, 15.0° and 18.5° C. (59° and 65° F.).

The second-growth forests already mentioned occupied much of the mountainside below camp level and for the most part had reached stages of development beyond jungly tangles and therefore were fairly easy to travel through, on the less steep ground. Some areas of slopes in the rain-forest zone were too precipitous for the proper development of forest. The best of the primary rain forest occurred in the heads of gullies, where ferns (a group which seems to be in New Guinea in endless variety) were numerous in a rather open undergrowth and low on the trees with a moderate abundance of epiphytic bryophytes. A dipterocarp (?*Hopea*), called *ruru* by our boys, occurred commonly as a canopy tree at about camp level. Contributing to a general facies decidedly more tropical than at the Number 2 Camp were herbaceous Zingiberaceae and Araceae and, abundant in gullies, *Pandanus danckelmanianus* with large subglobose red fruitheads, widespread in eastern New Guinea and the Solomons. Conspicuous, too, though hardly tropical, was a high-climbing large *Vaccinium* bearing masses of showy red flowers, associated with the very tropical "blue D'Albertis creeper" (*Dioclea*), which sprinkled the ground with big, pea-like flowers produced in the forest canopy. A remarkable shrubby orchid climbed to 15 or 20 meters and bore thousands of small, purple-spotted brown blooms.

¹ Determined by Dr. W. E. China, British Museum (Natural History).

Down on the Atairo, where Tate's track reached it, the stream dropped about 30 meters in a two-stepped waterfall with a big, clear pool below it, then continued a rapid drop in cascades and more pools. Shady rock walls in the waterfall spray area were partly covered with small ferns, *Selaginella*, begonias, balsams (*Impatiens*), *Peperomia*, *Boea*, *Medinilla*, and a very large, fleshy *Elatostema*. The altitude at this camp was too low for an abundance of tree ferns, but at least three species of *Cyathea* were present, a very large one being conspicuous in secondary forest.

The mid-mountain forest, at once distinguished from the more mixed rain forest by its generally more open character under the canopy and the distinctive appearance of its dominant oaks and *Castanopsis*, is described briefly on page 109. A certain interchange of species occurred. Rain-forest canopy trees entered the mid-mountain forest and extended sporadically far up the mountainside. Scattered large trees of one of the oaks, with small acorns, grew in the upper parts of the rain forest at camp level. Many minor floristic elements such as woody and herbaceous undergrowth species, epiphytic orchids and ferns, and some large lianas occurred in both types of forest, but others did not. The lower limits of the zone of regular cloud formation on the mountainside marked, here as apparently everywhere in New Guinea where such cloud conditions prevail, the contact line of two readily distinguishable forest types.

The time spent in this camp was too short for a thorough botanical examination of slopes often too steep for easy working, and a large proportion of the trees, even of the more ever-blooming undergrowth, bore neither flowers nor fruits. The open rocky beds of the streams provided good catching places for a few species of butterflies, dragonflies, and damselflies. Light trapping for insects was only moderately productive. Frogs in good variety, including the very large brown *Rana arfaki*,¹ were taken by jacklight at night. Hunting for reptiles yielded only one snake and a few skinks. Our observant boys,

with their special interest in animals as food, were not long in discovering eels in rock holes of the water-place stream at camp level. Several of these eels (*Anguilla*) were preserved as specimens. The only fishes found on the mountain, they were not seen at higher elevations.

The remarkably good results in mammal collecting at the camps higher on the mountain could not be sustained here. Traplines of well over 200 sets sometimes yielded only one or two specimens in a night. Small bats darted erratically in the forest in the evening but rarely over the camp clearing, and regularly about dusk the very large, slow-flying fruit bats *Pteropus neohibernicus*, with a wing span of over 1.5 meters, would flap by along the escarpment, tantalizingly out of gunshot range. Extraordinarily rich in variety, however, was the small take of 50 specimens, with 16 species of 15 genera represented, many of the species being new to the collection. The first bandicoot of the mountain, a *Peroryctes*, was collected here. *Phalanger vestitus* of the upper slopes was replaced by *P. orientalis*. *Pseudocheirus*, the other genus of larger, possum-like arboreal marsupials, was not seen here or, for that matter, in any locality at a lower altitude than the Mt. Dayman Number 2 Camp. A special prize was the giant rat *Xenuromys barbatus*, known before from only two specimens. Among other rodents were a rain-forest *Rattus*, *Melomys*, *Pogonomys*, *Leptomys*, *Uromys caudimaculatus*, and *Lorentzimys*. Five genera of bats, including the giant *Pteropus neohibernicus*, were collected.

BINIGUNI CAMP, GWARIU RIVER

JULY 27 TO AUGUST 13

This lowland or lower foothills collecting camp stood in a small new clearing on the low, sandy, and bouldery north bank of the Gwariu, an estimated three-quarters of a mile south of Biniguni village and about 200 meters above sea level.² The identity of the Gwariu and the Biniguni villages is discussed on page 109. It might be added, for clarity, that the principal Biniguni village of 1953, and the site of our transport base, was lo-

¹ Determination by Dr. Richard G. Zweifel, the American Museum of Natural History.

² Our aneroid readings here now appear to have been as much as 50 meters too high.

cated at an elevation of about 170 meters on the southern rise of the isolated 741-foot hill which the 1-mile map shows in the angle between the Rakua River and the "Gwadi."

Where it issued from its gorge, about 1000 yards above camp, the Gwariu was turned westward by a small lateral ridge of basement rock and flowed under the very foot of the steep escarpment of the mountains for $1\frac{1}{2}$ miles, where it turned sharply north to join the Rakua River. Half a mile west of the northward bend of the Gwariu, Biniguni Creek dropped from the escarpment in a picturesque five-step waterfall of considerable volume and perhaps 60 meters in height, below which the three decrepit houses that remained of old Biniguni village were beautifully situated in plantings of coconuts, betel-nut, and breadfruit trees on a small alluvial flat. The 1-mile map is wrong in having Biniguni Creek flow north to the Mai-u (Ma-u of this map). It turns east under the escarpment and flows into the Gwariu.

At its lower end the gorge of the Gwariu is a north-south cleft in the mountain only about 20 meters wide. Its walls of rock rise sheer and even overhang, and being generally dry they carry little vegetation. The river is a continuous rapid in the gorge but with moderate fall, and at the low stage of water we could cross from rock to rock and by wading and penetrate a distance of about 300 yards. At camp, where we looked across the river to native gardens on steep slopes, the stream flowed very strongly in a normal bouldery bed 20 meters or so in width and a dry flood channel several times that width. The natives, to reach their gardens, bridged the river crudely with whippy *Casuarina* trunks placed on rocks barely above the current. Below this, to its northward bend, the stream divided into channels separated by bare bars or elongated low islands covered with cane grass (*Saccharum*) or young secondary rain forest in a wide, sun-beaten bouldery bed that showed abundant evidence of violent flooding in the wet season.

An aggregate of several square miles of uneven surface sloping generally north from the Gwariu, including the immediate camp locality but lying mostly to the east and towards Biniguni, was covered in a remarkable manner by stones and boulders of what

appeared to be waterworn hard igneous rock. The surface boulders, often piled in low ridges, were so loose in some parts of the area, especially near the river, that they moved noisily when walked upon, and one had to watch every step. The depth of the boulder layer no doubt varied considerably. Occasionally one came across vertical round holes, up to about 2 meters deep, which could have been left by large trees that had had boulders deposited around them, then rotted away. Another feature was well-defined hollows which had the appearance of water channels. So sparse was the soil over much of the area that it held no attraction for native cultivators. The boulder bed carried, however, tall forest, but a poor development largely of a *Casuarina* which also figured prominently on low, gravelly flood banks of the river.

An explanation for the boulder bed or slope must lie in the recent geological history of the neighborhood. It would seem reasonable to speculate that within the last 100 years and probably a much shorter span of time the Gwariu Gorge was blocked by a landslide and that upon the breaking of the dam a large tract of country was devastated by flood and the nearer parts were covered with detritus. Observations by Sir Francis Winter (1900) on another river, heading only a few miles away on the Goropu Mountains (see p. 88), lend support to this theory. Winter postulated damming by a landslide which he appears to have connected with rains of the great hurricane of 1898 (see p. 91). The Maiva people of territory to the east of the Gwariu have a legend about a great flood, time and place unascertained, caused by the escape of waters from a dammed-up gorge.¹ It cannot be said whether the Biniguni Daga also have such a legend, but it should be repeated (see p. 109) that apparently these people did not arrive in the general area until the year 1913. The Maiva tale may concern not our supposed happening on the Gwariu but a similar event affecting a smaller area, of which there is evidence on Ginum Creek, close to the east along the escarpment.

Primary or secondary rain forest covered

¹ K. M. Wynn, oral communication.

all the working area of this camp with the exception of the open beds of the larger streams, native gardens and village clearings, and a few small patches that had gone to grass, at least temporarily, after cultivation. Where examined, up to an altitude of 400 meters, the forests of the mountain slopes near camp were chiefly second growths, although most of the range, east and west, carried primary forests. The plain below the mountains, away from the boulder-bed area, supported some very tall primary forest, but often the large trees grew far apart and the resulting incomplete canopy favored a greater development of subsidiary tree layers and of undergrowth than is usual in tall virgin forest of gently sloping ground. The red of the shedding leaves of a common large *Planchonia* made it conspicuous in July, when the lowland forests, as seen from our lower camp on the mountain, were ablaze with its color. Big lianas figured conspicuously in these primary forests, among them a deciduous *Combretum* dropping countless small red blossoms, a *Piper* with sausage-like red fruiting spikes, and one of the brilliant red-flowered species of *Mucuna* called "D'Albertis creeper" for the early Italian explorer Count Luigi Maria d'Albertis. Such lianas usually spread over the tops of the canopy trees and there flower unseen from the ground. But here, where the larger trees were often spaced in an open stand, the lianas, unable to reach from tree to tree, formed dense columns of foliage enveloping the trunks of the forest giants. An especially striking effect was produced by vines on *Casuarina* trees in the boulder-bed area, the trees being 50 to 60 meters tall and straight and columnar in form.

Seral forest of two types took part in rain-forest succession. One, a pure or almost pure community of *Casuarina*, formed very dense stands on gravelly and bouldery low flood banks of the river, the young trees frequently pioneering on bare ground without the protection of other vegetation. Of greater extent on flooded ground, where it may be preceded by cane brakes or by mats of *Passiflora foetida* (a naturalized native of the South American tropics) trailing on the ground, was a mixed community of soft-wooded small

trees, chiefly of *Commersonia*, *Trema*, a *Ficus*, and several species of *Macaranga*, which also filled the regrowth role on old garden land.

Our 18 days in this camp were hot and for the most part dry, with good showers (and on one occasion two hours of steady rain) on only four days in the afternoon or evening. Upon arrival our skins were bleached by five weeks of wet weather and forest shade at the second and third mountain camps, and in consequence we had some sunburn. Smoke hung in the air from new garden clearings being burned by the natives. Although reflected heat from the bare stones of the river floodbed carried through camp by a fitful breeze either up or down the stream made temperatures uncomfortably high in the heat of the day, in the evening the air became so soft that one was not conscious of contact with it, and two blankets were necessary for comfort towards morning. Relative humidity in camp dropped to 54 or 55 per cent at 1 P.M. on the average clear day, and stood at 84 to 91 per cent just before sunrise. Sultry, overcast days were not infrequent. Towards the end of our stay, however, the softer plants of the forest were wilting from heat and want of rain, and the few mosses on the trees had become crumbly-dry. The river, with a water temperature of 68° F., fell about 23 cm. during our stay, and rose briefly in only one small freshet, indicating no rain of consequence on Mt. Dayman during this time. Mean maximum temperature for 10 days between August 3 and 13 was 33.6° C. (92.5° F.), extremes, 32° and 36.5° C. (90° and 98° F.); mean minimum for the 11 days, 17.9° C. (64° F.), extremes, 16° and 20.5° C. (61° and 69° F.).

Botanical results could be called only fairly good. The forests were actually poor in species, and collecting in the middle of the dry season could not be expected to yield the best possible results. Bats (*Hipposideros*, two species) from the caves near Maneau village (see p. 115), a broad-nosed bat (*Philetor*), and *Pogonomys*, captured in hollow trees by enterprising local urchins, boosted mammal numbers, but results from trapping and shooting were disappointing. Among a good total of 20 mammal species taken here,

however, were the first specimens of the marsupial *Dactylopsila trivirgata* collected on the expedition.

Van Deusen's desire not to catch roaming village dogs attracted by the scent of the sets, if not by the bait, somewhat hampered trapping operations. Results from night hunting by native personnel fell off after Losima, the Number 2 cook, saw a ghost one evening while frogging in the river, and in flight over the boulders towards camp fell and smashed his collecting bottle against his chest. The great big luminous eye that stared Losima in the face was no doubt the reflection of his own headlight on the water. But the boys would not believe that, and thenceforth they hunted in pairs, away from the river.

Tate, after some lean results on the mountain, came into his own at this camp, with good catching for butterflies and Odonata along the river and abundant proceeds from the lights. In amphibians and reptiles, too, results were very pleasing, especially in skinks and frogs. Rather numerous snakes included amethystine pythons (*Liasis amethystinus*), of which the largest measured 4.41 meters. Geckos brought in at night by the mammal hunters included the beautifully banded *Gymnodactylus lousiadensis*,¹ fully 25 cm. in length. The river yielded at least six species of small fishes. A big blue pool at the foot of the Biniguni waterfall contained very good mullet (*Cestraeus goldiei*), which came to our table from the spear of a non-expeditionary native.

Apart from the heat of the day, to which we soon became conditioned, this was a pleasant camp. At least we could always look down the river to the cool height of the Goropu to the west. We were on amicable terms with the natives, but removed by the best part of a mile from their too-close attentions. A Saturday market brought to camp an abundance of native garden produce, purchased with salt and valuable sheets of "The New York Times" and the "Herald Tribune" from the botanical paper supplies. From Wynn's .22-caliber rifle we had pigeons for

the pot, the pressure cooker necessary to make enjoyable fresh meat of them being on hand in the cookhouse.

PERIA CREEK, KWAGIRA RIVER

AUGUST 14 TO SEPTEMBER 6

This camp at an elevation of 50 meters (or less) on the coastal plain was on the point of land at the confluence of two creeks of considerable size which we took to be the Ginum and the Ailok of the military 1-mile map. The creek names we had from the natives were not on the map. The actual streams did not much resemble those of the map makers, and we did not follow any of them far enough to make sure of their identity. If the right-hand branch at camp was indeed the Ginum, and the left-hand branch the Ailok, the stream below the junction, which we knew as the Peria, was the Kwagira Creek (not Kwagira River) of the 1-mile map, and we were about 8 miles from the coast of Collingwood Bay.

The camp was in tall, uninhabited, primary rain forest, where the land began to rise in gravelly low ridges from the low-lying and in parts semi-swampy broad coastal strip. We came upon outlying gardens of Awani village less than 1½ miles to the southeast, close to the rise of the mountains. Approximately 2 miles in a westerly direction was Opaigwari village, on the east bank of the Rakua River. In a still partly grassy clearing about a mile to the northwest lay an abandoned garden village of the Opaigwari people called Dududu, on an almost dry stream of the same name. About 4 miles to the northeast was Kwagira village.

The Peria at camp had a gravelly bed about 50 meters wide. In May it flowed about knee-deep, but in August and early September there remained only pools of clear water. The banks there were stable and raised above ordinary floods. Below camp about a quarter of a mile the character of the stream changed. The banks were low and actively eroding, the channel was narrower, and the pools were connected by running water. Many big trees, undermined by floods, had toppled into and across the creek. The vegetation of the banks became largely tall brakes of wild

¹ Determination by Dr. Richard G. Zweifel, the American Museum of Natural History.

sugar cane and low stands of secondary forest. Obviously the stream spilled over its banks in flood time. Upstream from camp the right-hand branch carried a small flow for perhaps a quarter of a mile, then small pools, and at about a mile widened into a gravelly bed 100 meters across and quite dry. The left-hand branch also contained small pools at intervals, and at a mile, which was as far as I followed it, had high banks and a dry bed arched over by the tall forest. Close to the northeast of camp a large spring gave rise to a lively, shaded stream ("Spring Creek") which flowed to the Iungi, a creek that seemed to be the Itoi of the 1-mile map. Towards the mountains the streams carried very little water, but below us, an abundance and running. We appeared to be on a spring line emerging parallel with the mountains. No rock outcropped anywhere in the locality. A pale reddish, compacted, clayey loam, exposed under the alluvium in creek banks, provided the nearest approach to what is generally called rock.

In variable weather experienced here, from pleasantly sunny to hot and sultry and spells completely overcast and even squally, rain that would have been measurable fell on no fewer than 14 of the 24 days. Modified by the tall and almost always moist forest cover, day temperatures at their hottest were lower than any recorded at Biniguni Camp, while night readings averaged nearly 3° C. higher. At different times much rain fell during two days and one night, and other downpours lasted up to an hour or two. The dry creeks did not run with the most copious rains, and the water in a big pool at camp fell about 30 cm. during our stay. Occasional localized gusts of southeast wind were strong enough to sway the big forest trees and, after one heavy rain, to bring at least half a dozen crashing down within hearing of camp. Mean maximum temperature, August 20 to September 6, was 28.8° C. (84° F.), extremes, 26.5° and 31.0° C. (80° and 88° F.); mean minimum, 20.7° C. (69° F.), extremes, 18.0° and 22.5° C. (65° and 72° F.).

The forests of the general area appeared to have timber volume sufficient to give them commercial value. They contained many species of big trees, the largest, *ilimo* (*Ocoteles sumatrana*), occurring in some quan-

tity and reaching a height of 50 meters and diameter of 1½ meters above the buttresses. Prominent buttressing was a feature of the forests. The big-tree flora included a substantial number of briefly deciduous species which shed their leaves and broke into flower and new foliage during our visit.

On the prevailing deep sandy loam and on gentle gravelly ridges the forest had usually a well-spaced stand of the largest trees and numerous big trees of second magnitude which, between them, formed a canopy too complete and shady for any great development of undergrowth layers. Easy to travel through, undergrowth was predominantly woody, of slender small trees, except near streams and on some patches of moist ground where large ferns, aroids, an *Ophiorrhiza*, and big-leaved Zingiberaceae and Marantaceae characterized a luxuriant herbaceous undergrowth, and abundant root-climbing ferns (*Stenochlaena*), clamped to tree trunks and undergrowth treelets, presented a striking aspect of New Guinea's enormously rich and varied fern flora. Palms, among them a big, thick-stemmed *Orania*, a fine *Gulubia* over 30 meters tall, and several attractive species of the substage and undergrowth, were prominent. Epiphytes, mostly ferns and orchids, grew chiefly on creek-bank trees, where lighting was good, and high on the big trees, especially the deciduous trees. One tall, temporarily leafless tree at camp supported on its upper branches no fewer than 12 great staghorn ferns (*Platycerium*) of a species common in all the lowland forests. A red *Mucuna*, screening the forest face, made photogenic masses of color on creek banks. There, too, prickly lawyer-canes (*Calamus*) of several kinds, which would have been spectacular in a botanical garden, climbed high and made impenetrable, tearing tangles hard to cut through. *Calamus* was seen at its best, or worst, on low-lying tracts half swampy in the wet season, where the trees grew very tall, but the canopy was discontinuous, and the aggressive scrambling palms took possession of the forest.

Conditions for botanizing were much better here than at Biniguni Camp. The collections, rich in big trees and canopy lianas, will give a good view of the flora of that part of the coastal plain. The flowering

trees attracted many birds. Noisy, clumsy hornbills (*Rhyticeros plicatus*) littered the ground beneath their feeding trees with broken fruiting branchlets. Loud in camp from about two o'clock on through the afternoon were the raucous calls of greater birds of paradise (*Paradisaea apoda*) which, ignoring our presence, congregated out of sight in the top of a great tree that stood almost over the tents.

This proved a very rich camp for Tate in insects (especially beetles), reptiles and amphibians, and fishes. The larger fishes, among them a tasty bream-like species, were obtained with a minnow seine, others with gun and .303 rifle. The most interesting came from small, drying pools that local natives had poisoned with "New Guinea dynamite." One morning I watched an Awani man and his wife fish by this method. A brownish root 0.5 to 3 cm. thick, called *duba*, was used. This the man cut into about 40-cm. lengths, pounded on a log, dipped in the water, then wrung out, making a milky cloud in the pool. Wads of the pounded root were stuck on a wire-pronged spear and poked under submerged drift timber. In a matter of minutes the stupefied fish floated bottom up and were collected by hand and by the man with his spear. Crayfish, unaffected by the material, soon began nipping the tails from the very small fishes which were not taken by the poisoners. From specimens gathered from the poisoned pools by Van Deusen, the new species *Pseudomugil furcatus* and the new genus and species *Tateurndina ocellicauda* have been described by Nichols (1955). The *duba* plant is a big scrambling shrub, planted in the villages. It appears to be a species of *Derris*, and *duba* is a variation of a name widespread for plants of this genus used for stupefying fish.

Mammals came to the collection slowly but, with 24 species, in greater variety than at any other camp. The Opaigwari people helped by bringing in *Pogonomys* and small bats. Of special interest among bats was a specimen of *Kerivoula*, found caught in a prickly tangle of *Calamus* near camp.

As is so often the case, one of the most prized accessions turned up in the last evening of hunting. This eleventh-hour treasure was the little feather-tailed marsupial *Dis-*

toechurus pennatus, shot by Van Deusen in an undergrowth tree in the forest. Of great interest to the boys, to whom, with due consideration of the zoological interests they had developed by this time, it meant "big meat," was the giant bandicoot, one specimen of which measured 79 cm. from tip to tip and weighed 10½ pounds. The pidgin Motu name meaning "pig's younger brother" applied to bandicoots well describes these somewhat swine-like marsupials but does not prepare one for the light-footed speed they display when started from cover in the forest. The gray *Phalanger gymnotis*, seen only on or near the ground at night, was first collected here on the expedition; also the water rat *Hydromys chrysogaster*, hunting for crayfish in the shallows of the creek. A scrub wallaby (*Dorcopsis*) was present in this lowland rain forest but extremely wary. One day I discovered a cluster of tiny sheath-tailed bats (*Emballonura*) hanging under the fronds of a tallish fan-palm.

BOLU BOLU, GOODENOUGH ISLAND

SEPTEMBER 22 TO OCTOBER 4

At Bolu Bolu, on the southeastern coast of the island, nothing remained of the military port of the Second World War (see p. 117) but a few wharf piles, a system of gravelled roadways overgrown with grass, and sundry relics of road-making machinery, motor vehicles, and airplanes. The sole human activity was at a medical aid post in charge of a native orderly, situated behind a narrow sandy beach where a shady old tree marked an indentation of the shore which for many years had been an anchorage for small vessels passing along the coast. Through courtesy of the Government, we had for our base an abandoned patrol post on an open grassy slope about a quarter of a mile inland, approached from the beach by a planted avenue of young kapok trees. Established sometime after the war, when war-damage payments were being made to the natives,¹ the post was closed and put in charge of a native caretaker two years before our visit.

¹ All natives from the area of military installations and operations on Goodenough Island were removed to encampments on neighboring Fergusson Island.

It comprised a well-built main structure with galvanized iron roof and walls and concrete floor, which we used for quarters (an included jail serving for storeroom), and a row of galvanized iron cottages for native police and clerks, in one of which our boys lived. Water was formerly piped from a spring at 150 to 200 meters in the near-by hills. Our water was caught in part from the roofs and in part was carried from a fine big spring which, about a half a mile inland, flowed across the old road that led to Vivigani Airfield.

The almost inevitable termites had started to eat away the American softwood timbers of the main building. Gatherers of scrap metal who camped at the post before us had left a number of 50-gallon drums of small shell cases which, becoming filled with rain water, formed ideal breeding places for mosquitoes. Our not very hopeful kerosening of the drums did nothing to abate a swarm of *Anopheles* which invaded the establishment in the evening and probably were responsible for heavy attacks of malaria which Van Deusen and I went down with several months after the end of the expedition and our discontinuance of suppressive dosages of aralen. Goodenough Island had a bad reputation for malaria during the war, and on the northeastern part of the island the dangerous, mite-borne, rickettsial disease scrub typhus gave trouble.

No rainfall records are available for the island. In the mountains, at middle levels and higher, the nature of the forest cover indicates an ample precipitation throughout the year, and the western side of the island in general would appear well favored with rains. Owing perhaps to a rain shadow effect from the 1200–2070-meter heights of Fergusson Island, rising close to windward, the lower mountain slopes and the lowlands of the eastern part of the island may become very dry in the trade-wind season. Bolu Bolu is in this dry area, at the southern end of an extensive, flat to undulating plain, 3 to 4 miles wide, which lies between the coast and the steep uplift of the mountains. Through clearing for cultivation by the natives, apparently, and the inability of second growths of the original rain forests to maintain themselves well under repeated disturbance and a sparse rainfall during several months of the year,

the lowlands and the mountain slopes up to an elevation of about 750 to 1000 meters on this dry side of the island have largely gone to grass. Most of the surviving forest is in gullies on the slopes, and on swampy ground and along streams on the coastal plain.

Although the dry season was well advanced, conditions had become only moderately dry up to the end of our term at Bolu Bolu, and not much grass had been burned. Growing crops in the few gardens in the neighborhood seemed to be thriving. Other gardens, on the grassy hillsides, were being dug and planted with yams in anticipation of the approaching rains. Small amounts of rain, from mere scuds to sharp showers, fell on six of the 12 days of our stay, the greatest amount being from intermittent showers from dawn into the night of September 27, coincident with heavy rains in the mountains, where Wynn at that time was camped. Frequent, very violent gusts of approximately southeast wind were a feature of this immediate neighborhood, but not of adjacent areas, where the wind usually blew steadily. The wind from the southeast kept up day and night at first, but about the end of September it tended to moderate and at times change to the southwest and bring calms and hotter, more sultry weather.

Forming the southern boundary to the broad coastal plain and having a height of about 300 meters immediately to the rear of Bolu Bolu patrol post was a lateral spur of the central mountain mass which fell quickly to the sea through a small coconut plantation on Nuatutu Point, the easternmost projection of the island, 2 miles southeast from our base. Predominantly grassy, this spur also carried in recesses and gullies a considerable aggregate of surviving rain forest. Likewise in relic bodies, other forest occurred near by to the north, where mangroves of tidal Waidala Creek gave place to sago swamp and, on well-drained ground, fringing rain forest. The largest body of forest came down from the mountains in a broad wedge which pinched in to almost nothing where we got our water from the spring-fed Wufa branch of Waidala Creek, and there junctioned with the forest of this stream. Relics of a strand forest of large *Hibiscus tiliaceus* and *Terminalia catappa* trees oc-

curred on the coast towards Nuatutu, where there were scattered gardens, two or three garden houses, and many coconut palms. Inland about 2 miles, in grassy surroundings near the foot of the mountains, was the big village of Beli Beli with a population of around 400 people.

It is doubtful if any old primary forest survived in the area. The forest contained large trees, 25 to 30 meters tall, but was poor in species, and wherever examined it had the appearance of a secondary forest. Common as big trees in the old secondary forest, if such it can be called, were yellow-flowered *Pterocarpus indicus*, *Inocarpus edulis* (on lowlands), a *Ficus*, a *Planchonia*, and especially a mango (*Mangifera*), the unripe small fruits of which the natives ate with relish. A plentiful woody undergrowth of few species offered little obstacle to progress through the forest. A thin covering of dry leaves lay on the ground. Very poorly represented were herbaceous plants, except along paths, and epiphytes and lianas. A regional peculiarity noticed in the rain forests was that many plants had broad, very smooth, and somewhat bluish leaves.

The grasslands mostly took the form of an open savanna on which the principal and often the only tree (small on the hillsides and up to about 12 meters high on the plains) was sparsely branched deciduous *Albizia procera* with pale gray bark, leafless or partly so when we saw it. There is no reason to consider any of the grassland or savanna a primary condition. No true savanna tree, such as a form of *Melaleuca leucadendron* which occurred on Fergusson Island, could be found, and a grassland wallaby present could have been introduced from the mainland by voyaging natives. The principal grasses were an erect, bunched *Themeda*, dominant on well-drained soils in a dense stand about waist high, and coarse *Manisuris rottboellioides* on low ground, forming a very tall thick cover hard to walk through. Only a few herbaceous associates, chiefly small perennial Leguminosae, were in evidence in the dry season. Mostly somewhat rubbly or pebbly and dark in color, the grassland soils appeared fertile, and extensive areas of black, friable soil on gentle ridges appeared to be especially good. The natives

cultivated grasslands as well as forest lands. In preparing a garden there, groups of several men and sometimes a woman or two worked in unison, using two-handed digging sticks to loosen and turn over, downhill, long sods held together by the grass roots. The Good-enough grasslands should be suitable for cattle grazing.

Food seemed scarce at the time of our stay. The people had very little to sell, but they brought us a few sweet potatoes, an occasional yam of an inferior kind, pumpkins, papayas, tomatoes, limes, and the best oranges we had on the whole trip.

Very pleasing mammal collections were obtained at Bolu Bolu, though poor results from traps kept numbers low. By collecting 14 species, Van Deusen in 12 days doubled the known mammal fauna of the island. Included were *Petaurus breviceps*, *Phalanger orientalis*, and a forest bandicoot. Only skulls of the grassland wallaby (*Protemnodon agilis*) were obtained at this time, from natives who had kept them as trophies, the animals being difficult to hunt until later in the year when the grass can be burned. Five species of bats included the extraordinary tube-nosed *Nyctimene major*, peculiarly marked with green, white, and yellow.

Attention to general expedition matters somewhat curtailed botanical work at Bolu Bolu. Insects were collected when opportunity offered, mostly at the lamps at night.

TOP CAMP, EAST SLOPES OF GOODENOUGH ISLAND

OCTOBER 7 TO 23

Also called the 1600-meter camp, this was located in the only area seen in the generally very steep mountains of the island where slopes at the upper forested altitudes were moderate enough to permit reasonably free getting about on daily and nightly field work. The small clearing made for our tents and flies was on easy ground on the crest of the leading spur we followed on the last part of our ascent from the Garuwata Valley (see p. 117). About 10 minutes, or roughly one-third of a mile, of walking down the trail to the east brought us to the upper end of the grassy part of the spur at about 1550 meters. In an easy ascent (but for the hindrance of

scrambling bamboo) of about 200 meters along the spur we could reach the crest of the central range in probably less than 30 minutes, and much less than a mile. Immediately below camp to the north the Wetowetobwoiabwoilala stream, southernmost tributary of the Garuwata River, flowed noisily in the rocky bottom of a very steep-sided ravine about 100 meters deep, into which it plunged from towards the comb of the range in a two-stepped narrow waterfall fully 30 meters high. In the forest on the opposite edge of camp, convenient for dipping water, was a cold little mossy-banked head-water stream of the Utamodi, a big creek which at Wakonai village, 1450 meters below, was called the Uiofea. A frequent overabundance of climbing or scrambling bamboo and a very wet and misty climate were the only real inconveniences to working in the area.

Here the weather was not quite so unpleasant, and it also lacked the regularity it displayed at our very misty and rainy 1550-meter camp on Mt. Dayman. Mist often drifted through the forest and down to the ground at dawn, and by about seven o'clock cleared until late morning or sometime in the afternoon. Three of our 17 days here were without either mist or rain. Clear, starry night skies were usual, but two of five heavy and prolonged rains extended far into the night. Rain fell during some part of nine days and five nights. Strong gusts of wind, lashing the top of the forest, most frequent and pronounced at night and coming usually from the southeast but also the southwest and even the northeast, constituted one of the more unpleasant features of the weather and brought thoughts of falling trees and branches. Maximum temperatures in the camp thermometer house for seven days between October 16 and 23 were: mean, 19.5° C. (67° F.), extremes, 18.0° and 20.5° C. (64° and 71° F.); minima for this eight-day period, mean, 14.5° C. (58° F.), extremes, 13.0° and 15.5° C. (55° and 60° F.). An isolated minimum of 10.0° C. (50° F.) was recorded on October 11. Although the cool season of the southern tropics had passed by this time, mean maximum was 2° C. lower here than at our comparable 1550-meter camp on Mt. Dayman, and mean minimum but 1° C. higher.

Camp was in a rather low, fairly abundantly mossed forest dominated by *Castanopsis* and probably also oaks (the trees were just coming into flower and thus not readily distinguishable) about 25 meters high. An incomplete canopy of brownish leafage allowed the entry of much scrambling bamboo and numerous large *Pandanus* trees. Also present was a striking tall palm with purple inflorescence and red fruits, the only palm in the locality apart from a climbing *Calamus*. Away from this broad ridge crest the forest of both ravines and ridges was more mixed, the *Castanopsis* and probable oaks disappeared, and there were no trees that could be called characterizing dominants. In these mixed forests occasional very big old *Nothofagus*, up to 2 meters in diameter but not more than 25 meters tall, occurred at about camp level on shelves in the Wetowetobwoiabwoilala ravine, and smaller trees of the species, as little as 10 meters high, were found in the stunted forest of the range crest. Other canopy trees of the mixed forest included, commonly, species of *Timonius*, *Rapanea*, *Myristica* (in ravines), *Calophyllum*, *Pullea*, *Fagraea*, and *Nouhuysia*, which in usually small or stiff leaves and upright branchlets bore the imprint of the somewhat severe climate. Towards the top of the range the continuous forest of camp level soon gave way to an impassable tangle of scrambling, small-leaved bamboo, with tree ferns and flowering trees protruding above it, and patches and strips of low forest, overrun with the bamboo, on the ridge crests. Quantities of scrambling *Gleichenia*, *Pteridium*, and *Lycopodium* added a local ferny element to the bamboo entanglement.

Made attractive by an unusual abundance and richness in tree ferns (*Cyathea*, seven species; *Dicksonia*, one) and a great plenty in gullies of three stately, stilt-rooted *Pandanus* species, the forests of about camp level were not in general thick enough with the prevalent bamboo to prevent our free movement through them in daylight. In its ravine, the Wetowetobwoiabwoilala flowed 3 or 4 meters wide between pools in a bed almost entirely rocky and with moderate gradient. Conditions were very moist and mossy, and the vegetation of the banks was lush with ferns, a striking long-leaved *Schuurmansia*

and at least two or three species each of *Selaginella*, *Elatostema*, big-leaved *Saurauia*, and *Medinilla*, but noticeably poorer in species than such a stream would have been on Mt. Dayman.

Where the grass spur below camp had escaped being burned by hunters or travelers it carried a dense tangled cover of a weak-stemmed *Themeda* or "kangaroo-grass" up to a meter high. Small annual sedges (*Fimbristylis*) and small herbs (*Brachycome*, *Lactuca*, and *Mitrasacme*) formed a sparse fire community among sprouting stubble on ground recently burned. On the upper end of the spur and about the forest edges the grass was replaced by tangles of *Gleichenia* and bracken in which grew a tall *Cladium*-like sedge and, as woody plants, a shrubby *Haloragis*, a scrambling *Scaevola*, and a purple-flowered *Melastoma* growing as tall as a man. Tall tree ferns of a forest species grew in places sheltered from strong winds but not from fire.

The treeless open grass and fern communities of the spur ridge were undoubtedly a secondary condition. Ascertainable cultivation had never reached above about 1100 meters on the slopes or 300 meters below the lower end of the grassy part of the spur. Hunters' or travelers' fires, lit in mossy forest on a path long in use for crossing the island, inferentially were responsible for the bald condition of the narrow ridge crest. Small rest clearings, in places that command a good view, are a common feature of native paths in the New Guinea mountains. We came to three, all grassy, at elevations of 950 to 1300 meters on our ascent from the Garuwata Valley. In the non-inflammable forests of the lower mountains, such clearings remain small. But at the higher elevations, where the forest becomes mossy, fires escaping from rest places on ridge crests in dry, windy weather can be very destructive. We saw recent fire damage to the low, moss-grown forests flanking our grass spur.

Just as plainly owing to disturbance of the original forest but more difficult to account for were the very extensive entanglements of scrambling bamboo which encumbered, and made impassable to man except by laborious cutting, a great part of the upper slopes hereabouts. One gained the impression that most of the large-scale replacement of

forest by bamboo was rather recent and owing to the spread of fire from native paths. A low forest heavily mossed on trees and ground would be very vulnerable to fire in an abnormally dry time such as the drought year of 1900 and a lesser drought in 1912 (see p. 90). It appeared that climatic conditions in this zone favored the bamboo rather than grasses on deforested slopes. An abundance of scrambling ferns locally in the bamboo in our camp locality gave probable evidence of a recent succession from fern to bamboo, and competition between rampant ferns and bamboo could be seen through the glasses on neighboring spur ridges. To a minor known extent, the bamboo entanglements masked landslide scars. Landslides were frequent in these mountains; factors involved were steep slopes, heavy rainfall, occasional torrential downpours from cyclonic disturbances, a rotten granite rock which gave instability to some slopes, and the possible dislodgement of soil and rock by earth tremors.

Goodenough Island carries an attenuated but in many respects still rich representation of the flora and fauna of mainland New Guinea. There were more similarities than differences between this camp area and Mt. Dayman at the same altitude, the differences being largely in things lacking on the island. One missing feature was the "six o'clock cricket." A noisy cicada sounded off at about 5:20 A.M., but no cicada noise attracted attention in the evening.

Many plants of the locality seemed identical with species found on Mt. Dayman, but the majority were specifically distinct, and genera occurred here that were not observed on Mt. Dayman. The season was favorable for collecting, most of the plants being found in flower or fruit. A number of other species, especially trees, were in young leaf or with flower buds that could be expected to open in another month.

Wynn, when in camp, took over the collection of insects and reptiles and amphibians. At other times, no special attention could be paid to these groups. Collections, therefore small, consisted chiefly of light-trap and other night-flying material; the day-flyers came mostly from the bed of Wetowetobwoiabwoilala stream. Many frogs were obtained. The only reptiles were two small

skinks found in the botanical investigation of mossy treetops.

An early very lean period in mammal collecting enabled Van Deusen to devote some time to mountain birds. Specimens were obtained of several endemic species previously little known. A report by Mayr and Van Deusen (1956) records three species for the first time for Goodenough Island and describes a new subspecies of *Pachycephala*.

In the forest one morning I saw a black bird the size of a small crow which seemed to be a bird of paradise but not *Manucodia comrii* or *Phonygammus keraudrenii*, the only members of the family reported from the island. Our native hunter confirmed the absence of *Paradisaea decora*, endemic on neighboring Fergusson Island, and on Normanby Island, as far as is known. He described, however, a small black bird with a long tail, which dances in treetops in the mountain forests of Goodenough, a description that suggests an *Astrapia*, or ribbon-tailed bird of paradise.

Expectations of the usual good trapping for mammals in heavily mossed forest were not fulfilled at this camp. From 150 to 200 traps set every night, the total catch amounted to six specimens of *Rattus* and one of *Hydromys*. A colony of blackish brown *Pogonomys* was cut from a hollow tree, well above the ground. A small black *Pipistrellus* was shot in the camp clearing. Results in mammals would have been very poor but for the success of a Garuwata man named Vilaubala, who, with a small boy as helper some of the time, spent 11 days with us and hunted in the forest with dogs. Secured only in this way were a small black wallaby with white under pelage (*Dorcopsis*), a black-headed bandicoot (*Echymipera*), and *Dobsonia*, which always is blackish. Found by the dogs under the heavily mossed roots of trees and also shot by Van Deusen at night was a blackish form of *Phalanger orientalis*, which Vilaubala said fed largely on *Pandanus* fruits at that time of year. The big *Dobsonia* bats also lived in holes under trees and in hollow tree trunks. Seven of the nine species of mammals obtained here were new to the island. The melanism in mammals in this mountain locality was a remarkable phenomenon, the more so in that it did not

appear in any of our other working localities on the island or to any unusual extent on the mainland.

Trophy skulls were brought to us by Garuwata people who on three occasions climbed nearly 1000 meters from their village to trade garden produce (yams, taro, sweet potatoes, pumpkins, sugar cane, and bananas) for salt. They also brought betel nut to exchange for as much as they could get of our boys' weekly issue of tobacco. In contrast to those of Bolu Bolu, the Garuwata gardens were well forward, and food from them was in ample supply.

NUMBER 2 CAMP, EAST SLOPES OF GOODENOUGH ISLAND

OCTOBER 24 TO 30

Situated at about 900 meters (2950 feet) by aneroid, this also had the name of 900-meter camp. It stood on good ground in tall virgin forest in a basin several acres in extent in which an excellent spring gave rise to a small, western, closely parallel-flowing tributary of the Utamodi. Steeply above the camp rose the heights of the main spur ridge which separated the Utamodi from the Garuwata Valley to the north and west. On the opposite side, a narrow ridge formed a low rim to the camp basin, and from it the ground dropped precipitously to the Utamodi, 100 to 120 meters below. Accentuating the generally abrupt slopes of the deep and almost gorge-like valley of the Utamodi were bare rocky bluffs which capped in part the ridge, estimated at 1200 meters in height, that formed the opposite or eastern side of the valley. Associated with the bluffs were some small grassy declivities too steep or too unstable for trees. Although at least an hour's journey from the nearest contemporary gardens of the Wakonai people, we were close to the upper limits of former cultivation. About five minutes towards the coast and at camp level on the ridge which separated the spring-fed stream from the main Utamodi Valley, the primary forest was replaced by second-growth polewood forest on old garden land. In another five minutes, still at about 900 meters altitude, one came to an isolated spur-crest strip of recently burned grassland dominated by the *Themeda* of the lowlands. From

this grassy spur one had a fine view of Vivigani Airfield, the lower Garuwata River, and the coast beyond.

Weather conditions could not have been better for field work. Clouds hung on the heights not far above us. We had overcast conditions as often as not. But we were below the regular mist belt and in six days had only a few drops of rain. Thermometer readings on October 29 and 20 were: maximum, 24.0° and 26° C. (75° and 79° F.), minimum, 17.0° and 18.0° C. (63° and 64° F.).

The camp was in transition mid-mountain forest and rain forest. A scattering of two species of oaks and one of *Castanopsis* occurred with species of *Terminalia*, *Sloanea*, *Gordonia*, *Podocarpus* near *neriifolius*, and other trees, including a striking purple- and white-flowered member of the Proteaceae, in a mixed forest in which the larger trees were fully 35 meters tall and of good, big diameter. A mixed woody and herbaceous undergrowth contained a number of large ferns, especially on rocky ground. A thin coating of bryophytes on the tree trunks was dry during our visit; the rich, friable brown soil was quite moist in the forest. Tree ferns and *Pandanus* were not much in evidence. The scrambling bamboo of the upper slopes had disappeared.

Rain forest, without the oaks and *Castanopsis*, occupied the ravine of the Utamodi. So precipitous were the slopes that in places a plentiful undergrowth of *Elatostema* was not sufficient to stabilize the soil and rubbly rock, and there were numerous small slides. The stream was very rocky and rapid and wide enough to be difficult to cross. An extraordinary moss hung from trees by the creek in tresses up to a meter long. Other bryophytes, epiphytic, saxicolous, and terrestrial ferns, herbaceous *Elatostemas*, a few Zingiberaceae and Marantaceae, and a shrub by *Laportea* with rather mild stinging properties made a show of luxuriance in a flora actually rather poor for a moist ravine at an altitude of 800 meters.

Because of Tate's illness and the consequent necessity of our returning to Samarai, we could spend at this camp only half of the time planned for it, and we far from exhausted the possibilities of the area. A fairly

general flowering season for plants was in progress, but as at the upper camp a number of fern species could not be found with sporophylls. The Wakonai natives informed us that when their newly planted yams began to grow the oaks and *Castanopsis* would break into flower. Snakes of three species and several small lizards and frogs were added to the collection. An eel occurred in the small camp stream. Insects, as usual, were collected, including a pleasing small lot of Odonata and Lepidoptera.

A meager take in mammals comprised only 19 specimens of seven species. Trapping ran true to form for the island, with only one rat for over 900 trap nights, but this happened to be a soft-furred *Melomys*, a genus new for the D'Entrecasteaux group. New to the collection also were a second species of *Pogonomys*, jacklighted at night, and a small *Hipposideros*.

WAKONAI, GOODENOUGH ISLAND

OCTOBER 31 TO NOVEMBER 1

Our transient stay at Wakonai, the last of our camps on Goodenough, was concerned partly with the psychological and local political intricacies of the arrangement of transport for our collections and gear back to the coast at Bolu Bolu. Some time could be spent on mammals and botany and a little leisure found for talk with the villagers on subjects other than carrying. Following the example of the mission teacher, numbers of parents brought their small children to Van Deusen to have their sores doctored with sulfanilamide and elastoplast.

The Australian 1-mile map (Sheet 2064, Goodenough Island) has Wakonai village on the 600-foot form line. Our aneroid readings gave an average of about 150 meters, or about 500 feet. It is an old village of 25 to 30 houses built on very rocky ground on the high north bank of the Utamodi, which here issues from the mountains and has the name Uiofea. The village site, on an open foothill slope at the very base of the mountains, is marked from a distance by many tall coconut palms, conspicuous in a landscape chiefly of grass and scattered small *Albizia* trees. From the government resthouse on the outskirts of the village we could see the coast

and the distant Amphlett Islands and nearer at hand the former Vivigani Airfield, now a desolate stretch of grass traversed by the bitumen-surfaced main runway and flanked by earthwork revetments on the coast side. The Uiofea flowed strongly in a very rocky bed at Wakonai. But it soon dwindled, and a mile or so towards the coast, where the road to Bolu Bolu crossed it, the gravelly and bouldery channel carried no surface water at this time of year.

Conditions were dry at Wakonai, and the weather was hot and hazy. Rain was needed for the new yam gardens on the lower mountain slopes and for small patches of bananas beside the creek. All gardens seen were in regrowth rain forest. Apparently there was no digging and cultivating of grassland as in the Bolu Bolu and Beli Beli area.

The grasslands, stocked principally with the kangaroo-grass (*Themeda*), here called *dakadaka*, were essentially similar to those of Bolu Bolu. Late as it was in the dry season, most of the grass remained too green to carry fire, and only local burning had taken place. Rain forest, most of it brushy second growths, was confined to narrow strips along watercourses of the foothills and adjacent lowlands, and on the lower mountainsides to small bodies in gullies and on concave slopes. The banks of the Uiofea carried the only forest that appeared to be primary. Prominent there were xeric ferns, associated with a rampant scrambling *Piper* on partially shaded rocks, and other ferns growing with large sedges on moist edges of the stream.

In all, the collections contain seven species of mammals from near Wakonai, five of them obtained by natives and brought to our camp for reward. The only species not collected elsewhere was the big brownish wallaby of the lowland grasslands and savannas, shot by Wynn while Van Deusen and I were in the mountains. This would appear indistinguishable from the grassland wallaby of the Cape Vogel Peninsula and the natural savanna areas of southern Papua, *Protemnodon agilis*.

From leading elders we learned some of the history of Wakonai. Originally these people lived in the mountains, the site of their former main village being at an elevation of 500 meters on our route to Garuwata. They

moved down to the foothills by government order, executed by a "Mr. Beeby." In the old days, before the coming of the white man, the people from about Wakonai north to Wataluma on the east side of the island were allied with the Moratau people of the west coast against the south end of the island. There was constant warfare, cannibalism, and killing by sorcery. The stone adzes then used (apparently they did not have stone axes) came from Isaiasi on Cape Vogel Peninsula, in trade for pigs and garden food to Moratau, thence over the top of the island to Wakonai. Our Top Camp was on this old mountain trail. It might be mentioned, incidentally, that one of several stone adze heads we bought at Wakonai was said to have been made locally.

In the peace of the present time, inter-marriage takes place between the old warring factions. When the Wakonai people are short of garden produce, as is not infrequently the case in this low-rainfall area, they trade wallaby meat to the southern people for root foods.

In all the villages we saw on the island and at old village sites in the mountains, we were intrigued by rough stone platforms on the edges of which were set, at an outward slant, one or more flat stone monoliths. The platforms were of loose rock or stone slabs, the monoliths being without carving or other devised marks. Today, we were informed, and observed at Wakonai, the platforms are used as meeting places for talk and singing, while the monoliths serve as back rests. In the past, according to Jenness and Ballantyne (1920, p. 46), who mention them briefly, it was on the platforms, called *tuwaka*, that the bodies of captured enemies were disemboweled and dismembered in preparation for the cannibal feasts.

MAPAMOIWA, FERGUSON ISLAND

NOVEMBER 2

An overnight stay at the medical post at Mapamoiwa on the southwestern coast of Ferguson Island gave opportunity for a brief examination of savannas which we had seen from the sea on our way to Good-enough Island in September (see p. 117). Jenness and Ballantyne (1920, p. 25) reported

a "bastard eucalyptus" in the hot springs area of Daidai on the southern end of Fergusson Island. We had in September a distant view of savannas in that neighborhood on which the trees had the appearance of *Eucalyptus alba*, a characteristic species of the savannas of the Port Moresby dry area, which at their nearest point lie about 180 miles to the west. The savannas examined at Mapamoiwa on the opposite end of the island were timbered with a form of *Melaleuca leucadendron* with whitish, papery bark, here called *kigegela*. This *Eucalyptus* relative formed a typically Australian "tea-tree" savanna forest 15 to 20 meters high. A dense to rather thin ground cover, dominated by a *Themeda*, included five other grasses among the 21 plants that could be collected in the short time available, *Rhynchospora rubra* and other Cyperaceae, a *Pimelea* and other herbs.

Undoubtedly a primary community, the

Mapamoiwa savanna forest began a half to three-quarters of a mile inland. Where examined it occupied a low ridge of well-drained sandy gray soil bounded by rain-forested gullies and beyond the gullies ridges on which the original rain forest had to a considerable extent been cleared for cultivation and gone to grass. From the low sandy ridge the savanna forest widened and extended up to the crest of a mountain spur, some 500 meters high, behind Cape Mourilyan. The rain forest at Mapamoiwa indicated a climate a good deal wetter than that of the eastern lowlands and foothills of Goodenough Island. *Melaleuca leucadendron* would appear not to have been reported before from any locality closer to Mapamoiwa than the Port Moresby dry belt.

Van Deusen shot a small *Pipistrellus* and heard a few flying foxes over coconut groves of the coast. A tree frog was also collected.

MAJOR PLANT COMMUNITIES

VAN STEENIS, somewhat emending an earlier proposal of his (1935), has recently (1950a) put forward the following classification of altitudinal zones for Malaysia:

METERS	
4600-5000	Nival zone (eternal snow)
4100-5000	Alpine zone (treeless)
2400-4100	Subalpine zone (forested, with open spots especially above 3600 meters, from 3000 meters up often shrubby or mossy forest)
1000-2400	Montane zone
1000-1500	Submontane subzone
500-1000	Colline subzone
0-1000	Tropical zone

These, with the exception of the nival, are floristic zones, based on "the outcome of statistics of contours of c. 800 mountain plants, in which both lower and upper contours are used." For the New Guinean part of Malaysia, however, an altitudinal sequence of major plant communities is recognizable and has been described and classified, at least in a preliminary way. Schemes of floristic and vegetational zonation are arrived at by different methods and have different purposes and uses. For the field worker, the latter should have most value, and this I believe to be the case with a system of classification of major plant communities proposed in part by Lane-Poole (1925) and emended and expanded by me (1941a) on the basis of observations made on the Archbold Expeditions up to 1939:

	METERS
Savanna and savanna forest	0-1700
Monsoon forest	0- 450
Rain forest	0-2400
Mid-mountain forest	480-2350
Beech forest	850-3100
Mossy forest	1500-3200
Subalpine forest	3000-4050
Alpine grassland	2900 up to permanent snow line

This system has few points of correspondence with van Steenis' zones. Nevertheless, it held for the major communities encountered by us in 1953, in both zonation and the altitudes between which the communities occurred.

Savannas or savanna forests considered

primary were found only on Fergusson Island, at elevations from near sea level up to about 500 meters. Extensive savannas and open grasslands on ridgy lowlands of the Cape Vogel to Baiawa dry belt on the mainland and on the eastern lowlands and lower mountain slopes of Goodenough Island are considered to be a result of human activity, although the presence of primary savannas in the Cape Vogel-Baiawa area, not seen by us, seems probable (see p. 122).

At Baiawa were remnants of a partly deciduous, somewhat sclerophyllous community which may have been a form of monsoon forest. As seen from the sea, certain dry forests on hills of the Collingwood Bay side of the Cape Vogel-Baiawa dry belt had the appearance of monsoon forest. Some deciduous trees of the drier rain forests can probably be regarded as derived from this community, as can *Albizia procera*, the most characteristic tree of the induced savannas of Cape Vogel-Baiawa area and of Goodenough Island.

Widely differing developments of the great mixed rain forest community (the most extensive in area in New Guinea and having seemingly the greatest altitudinal range) extended in a more or less solid front on our route from the coast of Collingwood Bay to an altitude of 750 meters on the slopes of Mt. Dayman. From there it ascended the narrow valleys and persisted, at least in the contribution of conspicuous elements to the forests, as high as 2230 meters in the moist, sheltered bottoms of ravines. Where rain forest survived on the eastern side of Goodenough Island, it occupied all slopes up to about 900 meters and the bottoms of ravines up to about 1550 meters. Reduced in area as they are by human disturbance, rain forests still occupy, in the aggregate, a large part of the Cape Vogel-Baiawa dry belt. The mangrove and sago-palm swamp forests, present on all coasts and lowlands in our area but always of small extent, are communities in the rain-forest hydrosere.

The distinctive mid-mountain forest of oaks and *Castanopsis* sometimes blends with the upper rain forest in a narrow ecotone. But as a rule the transition from one type of

forest to the other is remarkably abrupt, the demarcation line corresponding with the lower edge of the cloud bank which, with a high degree of regularity in both time and local altitude, settles on the mountain slopes early in the afternoon. Occupying the spur ridges of the mountains, the mid-mountain forests interdigitate downward, with rain forests thrusting up in the valleys. In our area on Mt. Dayman the lower edge of the mid-mountain forest was at 750 meters and its upper limit at about 1800 meters; on Goodenough Island the limits were about 900–1100 meters and 1600 meters. The oaks and *Castanopsis* are Asiatic in origin.

Though evergreen, or only briefly partially deciduous, the beech forests of subantarctic *Nothofagus* have a distinctly temperate appearance. Where well developed, as was often the case on the slopes of Mt. Dayman between altitudinal limits of 1800 and 2100 meters for the community, there was no mistaking this fine forest of massive, heavy-crowned, rough-barked trees. On Goodenough Island a few beeches occurred in the forest zone next above the mid-mountain, from an elevation of 1600 meters to the upper limit of our explorations at 1800 meters. In this zone on the island much forest had been destroyed, and replaced by scrambling bamboo, but from the evidence available it would appear that the beeches were elements of a mixed forest, rather than preponderant dominants, as is typically their role on the mainland. Varying amounts of scrambling bamboo cluttered the beech forests of the mainland, a feature shared by the upper parts of the mid-mountain forest there and on Goodenough Island.

The name "mossy forest" presents problems. Mossiness in New Guinea is a manifestation of a misty climate. It does not necessarily have anything to do with high altitude or low temperatures. Heavy mossing on trees and ground occurs under appropriate conditions in rain forests of the lowlands. The upper parts of the mid-mountain forest on Mt. Dayman and Goodenough Island were conspicuously mossy. So were the beech forests where they covered narrow, steep, and exposed ridge crests. The community named "mossy forest" by Lane-Poole is one in which some of the most characteristic domi-

nants are small-leaved *Xanthomyrtus* and *Decaspermum* of the Myrtaceae, and *Phyllocladus* of the Coniferae. These were important genera on Mt. Dayman where the community, varying from a heavily padded scrub on exposed crests to not very mossy, rather tall forest in sheltered situations, began at about 2000 to 2100 meters. The mossy forest is the uppermost forest zone on the mountain. Formerly it must have reached to the top of the highest peak at a reputed 3000 meters. But at the higher elevations it had been greatly reduced by fire and survived mostly in strips in the shelter of gullies. Imposing stands of a "hoop-pine" (*Araucaria*), towering high above the canopy-forming trees, were a feature of this forest up to altitudes of about 2450 meters or more. The araucarias usually are overtopping trees of the mid-mountain forest, but on Mt. Dayman they were absent from this zone and the beech forest, and on Goodenough Island absent entirely. A scrambling bamboo, different from the mid-mountain species and appearing first in the beech forest, occurred in quantity sufficient to be a nuisance in the lower parts of the mossy forest on Mt. Dayman.

Although not represented as a community on Mt. Dayman, the subalpine forest is considered to have contributed some species to the mossy forest in, for example, the genera *Vaccinium*, *Agapetes*, *Rhododendron*, and possibly *Papuacedrus* (formerly in *Libocedrus*). Observed from a distance on the highest peak of Goodenough Island (2545 meters) was a dark low forest dominated by a conifer which recalled subalpine *Podocarpus papuana* or *P. compacta*. That would be a low altitude for subalpine forest.

At elevations above about 2200 meters in the mossy forest zone of Mt. Dayman, large-scale invasion by the alpine grassland community has taken place after deforestation by fire, whether from original grassy strips in streamways and in patches on rocky high slopes, or largely dispersal from loftier mountains at no great distance, can only be conjectured. Where well developed it is a tussock-grass community. The grasslands of the high peaks of Goodenough Island, as yet unknown biologically, are almost certainly alpine.

RESULTS OF THE EXPEDITION

FOLLOWING IS A LIST of the collections of the expedition. Included in the figure for mammals are 234 skulls and mandibles without skins, procured from natives. All but 16 of the birds were preserved in formalin, as accidental proceeds from mammal traps. The number of insects and spiders, naturally, was estimated.

Mammals	1954 specimens
Birds	91 specimens
Reptiles and amphibians	1645 specimens
Fresh-water fishes	145 specimens
Insects and spiders	80,000 specimens
Ectoparasites of mammals	750 specimens
Fungi for antibiotics research	126 samples
Plants	3445 numbers
Anthropological items	34

Van Deusen collected the ectoparasites; Brass, the antibiotics material. The mainland collections of reptiles and amphibians, fishes, and insects and spiders were the work of Tate; on Goodenough Island the bulk of the collections in these groups were made by Wynn, some by Van Deusen and Brass.

The zoological collections are deposited at the American Museum of Natural History, where Van Deusen is studying the mammals, John T. Nichols (1955) has reported on the fishes, and the frogs are being examined by Richard G. Zweifel. Various groups of insects have been allotted to specialists for determination. The ectoparasites, after study by the Army Medical Service in Washington, will revert to the Museum.

All botanical collections, with the exception of antibiotics research materials, are deposited at the Arnold Arboretum of Harvard University. The recent reorganization of this institution has led to unavoidable delay in the initiation of work on the collections by specialists in the United States and abroad. The antibiotics materials were collected for Chas. Pfizer and Company of New York. In addition to the botanical collections listed above, viable materials of several palms and other ornamental plants were sent by air to the Fairchild Tropical Garden in Florida.

A photographic record of the expedition in still pictures consists of approximately 2800 35-millimeter Kodachromes and 150 35-millimeter black and whites. No moving pictures were made.

It has been customary in previous general reports on our field work in New Guinea to give progressive bibliographies of the results of the expeditions. Since the appearance of the last list (*in* Archbold, Rand, and Brass, 1942), however, the formidable number of over 100 titles has accrued. A mimeographed list of publications based on the collections and activities of the Archbold Expeditions in New Guinea and Australia, presently comprising 209 titles, is available upon request to Archbold Expeditions, the American Museum of Natural History, Central Park West at 79th Street, New York 24, New York.

REFERENCES

- ANON.
1952. Louisiades battered by cyclone. *Pacific Islands Monthly*, vol. 22, pt. 10, p. 17.
- ARCHBOLD, RICHARD, AND A. L. RAND
1935. Results of the Archbold Expeditions. No. 7. Summary of the 1933-1934 Papuan Expedition. *Bull. Amer. Mus. Nat. Hist.*, vol. 68, pp. 527-579, pls. 28-46.
- ARCHBOLD, RICHARD, A. L. RAND, AND L. J. BRASS
1942. Results of the Archbold Expeditions. No. 41. Summary of the 1938-1939 New Guinea Expedition. *Bull. Amer. Mus. Nat. Hist.*, vol. 79, pp. 199-288, pls. 1-35, 3 maps.
- ATKINSON, O. J.
1927. Baniara. *Ann. Rept. Territory of Papua, 1925-1926*, pp. 53-54.
1928. Baniara. *Ibid.*, 1926-1927, pp. 50-52.
1929. Baniara District. *Ibid.*, 1927-1928, pp. 33-34.
- BAKER, GEORGE
1946. Preliminary note on volcanic eruptions in the Goropu Mountains, southeastern Papua, during the period December,

- 1943, to August, 1944. *Jour. Geol.*, vol. 54, pp. 19-31, figs. 1-5.
- BRASS, L. J.
 1941a. The 1938-39 expedition to the Snow Mountains, Netherlands New Guinea. *Jour. Arnold Arboretum*, vol. 22, p. 338.
 1941b. Stone age agriculture in New Guinea. *Geogr. Rev.*, vol. 31, pp. 555-569, figs. 1-15.
 1953. Results of the Archbold Expeditions. No. 68. Summary of the 1948 Cape York (Australia) Expedition. *Bull. Amer. Mus. Nat. Hist.*, vol. 102, pp. 137-205, pls. 41-47, map.
- CHALMERS, JAMES, AND W. WYATT GILL
 1885. Work and adventure in New Guinea. [London], the Religious Tract Society, 342 pp., 21 illus., 2 maps.
- DE VIS, C. W.
 1894. Report on ornithological specimens collected in British New Guinea. *Ann. Rept. British New Guinea, 1893-1894*, pp. 99-104.
- DUBUY, FATHER JULES
 1954. The giant Pandanus of New Guinea. *Jour. Fairchild Trop. Gard.*, vol. 10, pp. 3-8, 5 figs.
- FORTUNE, R. F.
 1932. Sorcerers of Dobu. The social anthropology of the Dobu Islanders of the Western Pacific. London, George Routledge and Sons, Ltd., xxviii+318 pp., 5 figs., 8 pls., map.
- GEOLOGICAL MAP OF AUSTRALIA AND NEW GUINEA
 1952. [Canberra], Map Compilation Group, Geological Section, Bureau of Mineral Resources, Geology and Geophysics.
- GUISE, REGINALD E.
 1894. Report . . . on expedition . . . from Collingwood Bay to the Main Range. *Ann. Rept. British New Guinea, 1893-1894*, pp. 78-87.
- HIGGINSON, C. B.
 1912. [No title.] *Ann. Rept. Papua, 1911-1912*, p. 112.
 1922. Eastern Division. Detailed account of south coast. *Ibid.*, 1920-1921, p. 53.
- JENNESS, D[IAMOND], AND A. BALLANTYNE
 1920. The northern D'Entrecasteaux. Oxford, Clarendon Press, 219 pp., 17 pl., 2 maps.
- LANE-POOLE, C. E.
 1925. The forest resources of the Territories of Papua and New Guinea. [Melbourne], Government Printer, State of Victoria, iv+209 pp.
- LAURIE, ELEANOR M. O.
 1952. Mammals collected by Mr. Shaw Mayer, in New Guinea 1932-1949. *Bull. Brit. Mus. (Nat. Hist.) Zool.*, vol. 1, no. 10, pp. 269-318.
- LE HUNTE, G. RUTHVEN
 1900. Despatch from the Lieutenant-Governor reporting visit of inspection to the islands in the eastern portion of the Possession. *Ann. Rept. British New Guinea, 1898-1899*, p. 31.
- LE ROUX, C. C. F. M.
 1935. De exploratie. In Klein, W. C. (ed.), *Nieuw Guinee*. Amsterdam, J. H. de Bussy, vol. 1, p. 40.
- LYONS, A. P.
 1927. Eastern Division: Wamira aqueduct. *Ann. Rept. Territory of Papua, 1925-1926*, pp. 43-44, pl. on p. 99.
- MACGILLIVRAY, JOHN
 1852. Narrative of the voyage of H. M. S. Rattlesnake, commanded by the late Captain Owen Stanley . . . during the years 1846-1850. Including discoveries and surveys in New Guinea, the Louisiade Archipelago. . . . London, T. and W. Boone, 2 vols.
- MACGREGOR, WM.
 1893. Despatch enclosing Mr. Moreton's report on expedition conducted by him from Phillips Harbour, in Collingwood Bay, towards Mount Suckling. *Ann. Rept. British New Guinea, 1891-1892*, p. 11.
 1894. [No title.] *Ibid.*, 1893-1894, p. xxx.
- MAIR, L. P.
 1948. Australia in New Guinea. London, Christophers, xviii+238 pp., 8 pls., end map.
- MAITLAND, A. GIBB
 1893. Geological observations on British New Guinea in 1891. *Ann. Rept. British New Guinea, 1891-1892*, pp. 53-85. (Bibliography appended.)
- MALINOWSKI, B[RONISLAW]
 1915. The natives of Mailu: Preliminary results of the Robert Mond research work in British New Guinea. *Trans. Proc. Roy. Soc. South Australia*, vol. 39, pp. 494-706, pls. 27-43, map.
- MAYR, ERNST, AND HOBART MERRITT VAN DEUSEN
 1956. Results of the Archbold Expeditions. No. 74. The birds of Goodenough Island, Papua. *Amer. Mus. Novitates*, no. 1792, pp. 1-8.
- MEEK, A[LBERT] S.
 1913. A naturalist in cannibal land. London and Leipzig, T. Fisher Unwin, xviii+238 pp., 31 pls.

- MONCKTON, C. A. W.
1904. Report on affairs of North-Eastern Division. Ann. Rept. British New Guinea, 1902-1903, p. 33.
1922. Some experiences of a New Guinea resident magistrate. London, John Lane, p. 38.
- MORESBY, JOHN
1876. Discoveries and surveys in New Guinea and the D'Entrecasteaux Islands . . . of H.M.S. Basilisk. London, John Murray, xi+327 pp., 7 illus., map.
- MORETON, M. H.
1893. [No title.] Ann. Rept. British New Guinea, 1891-1892, pp. 11-14.
- MURRAY, J. H. P.
1912. Papua or British New Guinea. London and Leipzig, T. Fisher Unwin, 388 pp., 38 illus.
- NEWTON, HENRY
1914. In far New Guinea. London, Seeley Service and Co., Ltd., pp. 124-125, fig.
- NICHOLS, JOHN T.
1955. Results of the Archbold Expeditions. No. 71. Two new fresh-water fishes from New Guinea. Amer. Mus. Novitates, no. 1735, pp. 1-6, figs. 1-2.
- PÖCH, RUDOLF
1907. Travels in German, British, and Dutch New Guinea. Geogr. Jour., vol. 30, pp. 609-616, 7 figs.
- RAND, A. L., AND L. J. BRASS
1940. Results of the Archbold Expeditions, No. 29. Summary of the 1936-1937 New Guinea Expedition. Bull. Amer. Mus. Nat. Hist., vol. 77, pp. 341-380, pls. 21-42, 2 maps.
- RANDS, WILLIAM H.
1894. Report on a collection of rock specimens from British New Guinea. Ann. Rept. British New Guinea, 1893-1894, p. 96.
- RIESENFELD, ALPHONSE
1951. Tobacco in New Guinea and the other areas of Melanesia. Jour. Roy. Anthropol. Inst., London, vol. 81, pp. 69-102, map. (Bibliography of 354 titles.)
- ROTHSCHILD, WALTER, AND ERNEST HARTERT
1896. Contributions to the ornithology of the Papuan Islands. Novitates Zool., vol. 3, pp. 8-20.
- SELIGMANN, C. G.
1910. The Melanesians of British New Guinea. Cambridge, University Press, xxiv+766 pp., figs. 1-50, pls. 1-79, map.
- SMITH, STANFORTH
1927. Handbook of the Territory of Papua. Fourth edition. Canberra, H. J. Green, Government Printer, p. 77.
- STANLEY, EVAN R.
1923. The geology of Papua. Melbourne, Albert J. Mullett, Government Printer, 56 pp., 50 figs., map.
- STEENIS, C. G. G. J. VAN
1935. On the origin of the Malaysian mountain flora. Part 2. Altitudinal zones, general considerations and renewed statement of the problem. Bull. Jard. Bot. Buitenzorg, ser. 3, vol. 13, pp. 289-417.
1950a. Nomenclature of altitudinal zones. In Steenis, C. G. G. J. van (gen. ed.), Flora Malesiana. Djakarta, ser. 1, vol. 1, pp. xli-xlii.
1950b. Survey of botanical collecting density in Malaysia. In Steenis, C. G. G. J. van (gen. ed.), *op. cit.* Djakarta, ser. 1, vol. 1, pp. cviii-cxii.
- STEENIS-KRUSEMAN, M. J. VAN
1950. Malaysian plant collectors and collections. Being a cyclopaedia of botanical exploration in Malaysia and a guide to the concerned literature up to the year 1950. In Steenis, C. G. G. J. van (gen. ed.), Flora Malesiana. Djakarta, ser. 1, vol. 1, pp. cxvii-clii, 1-639.
- STRONG, W. M.
1916. Notes on the North-Eastern Division of Papua (British New Guinea). Geogr. Jour., vol. 48, pp. 407-411, map.
- WINTER, FRANCIS P.
1900. Despatch from the Acting Administrator reporting visit of inspection to the Eastern and North-Eastern Districts of the Possession. Ann. Rept. British New Guinea, 1898-1899, p. 4.
- ZWEIFEL, RICHARD G.
1956. Results of the Archbold Expeditions. No. 72. Microhylid frogs from New Guinea, with descriptions of new species. Amer. Mus. Novitates, no. 1766, pp. 1-49, figs. 1-9.