RESULTS OF THE ARCHBOLD EXPEDITIONS. NO. 41

SUMMARY OF THE 1938–1939 NEW GUINEA EXPEDITION

BY RICHARD ARCHBOLD, A. L. RAND AND L. J. BRASS

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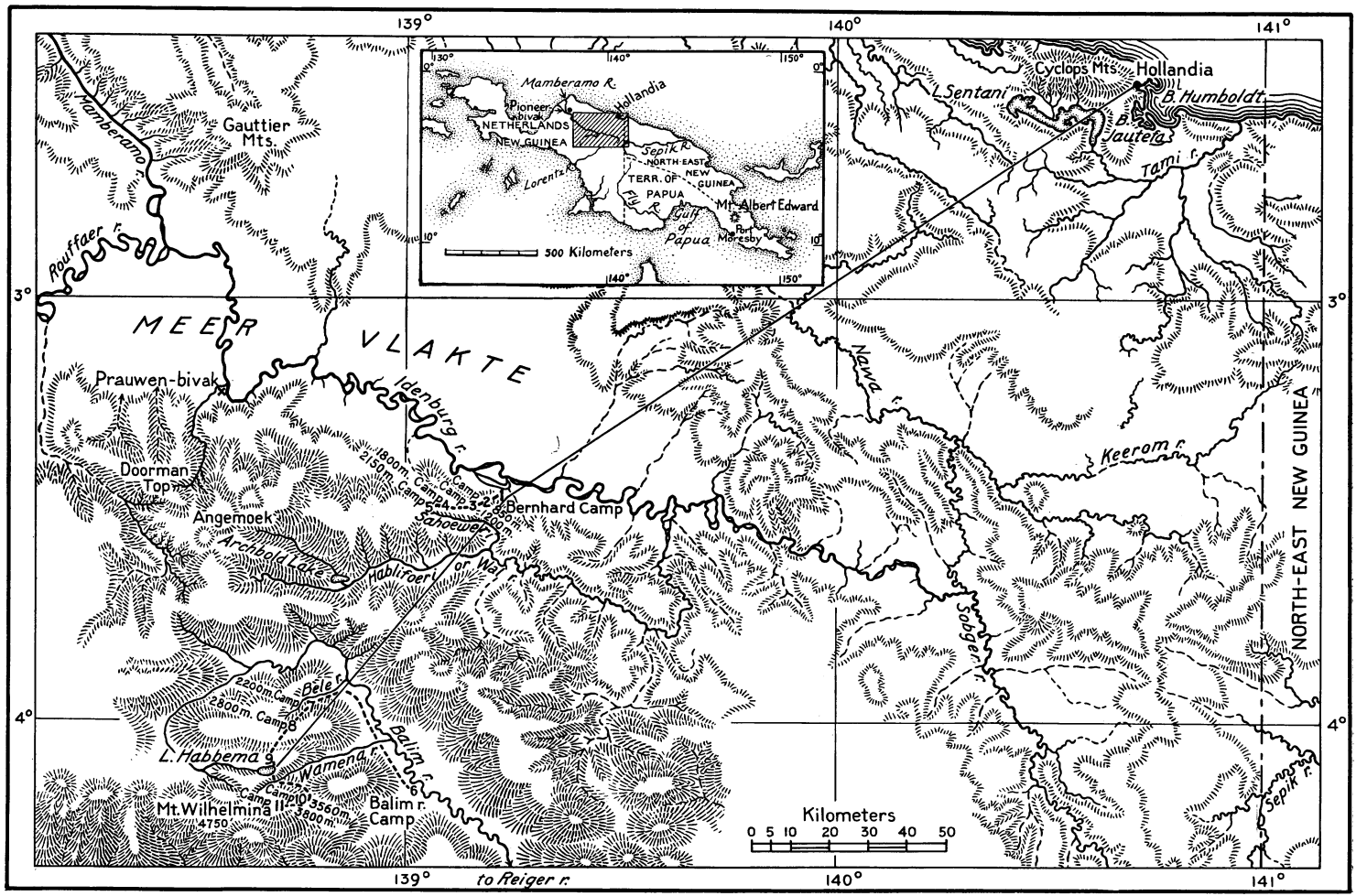
139°
140°
141°
3°
4°
MEER VLAKTE
Mamberamo r.
Gauttier Mts.
Rouffaer r.
Prauwen-bivak
Idenburg r.
Doorman Top
Angemoek
Archbold Lake
Habliroeri or Wal r.
Bernhard Camp
Camp 1
Camp 2
Camp 3
Camp 4
1800m. Camp
2150m. Camp
2200m. Camp
2800m. Camp 8
Camp 9
Camp 10
3550m.
3800m.
Bele r.
L. Habbema
Wamena r.
Balim r.
Balim r. Camp
Mt. Wilhelmina II
4750
to Reiger r.
Cyclops Mts.
Hollandia
B. Humboldt
Sentani
B. Jautefa
Tami r.
Nawa r.
Keerom r.
Sobger r.
Sepik r.
NORTH-EAST NEW GUINEA
Kilometers
0 5 10 20 30 40 50
Mamberamo R.
Pioneer bivak
NETHERLANDS NEW GUINEA
Lorentz
Sepik R.
NORTH-EAST NEW GUINEA
TERR. OF PAPUA
Fly R.
Mt. Albert Edward
Gulf of Papua
Port Moresby
500 Kilometers
130°
140°
150°
10°

MAP 1.—Area visited by the 1938–1939 expedition showing land routes, camps and the route followed on aerial transport flights. Various names of each collecting station follow:

1.—Bernhard Camp.
2.—850-meter Camp, four kilometers southwest of Bernhard Camp, Araucariakamp.
3.—1,200-meter Camp, six kilometers southwest of Bernhard Camp, Rotankamp or Tusschenkamp.
4.—1,800-meter Camp, fifteen kilometers southwest of Bernhard Camp, Mistkamp.
5.—2,150-meter Camp, eighteen kilometers southwest of Bernhard Camp, Topkamp.
6.—Balim River Camp.
7.—2,200-meter Camp, Bele River Camp, eighteen kilometers northeast of Lake Habbema, Ibèlèkamp.
8.—2,800-meter Camp, nine kilometers northeast of Lake Habbema, Mosboschkamp.
9.—Lake Habbema Camp.
10.—3,560-meter Camp, seven kilometers northeast of Wilhelmina-top, Brievenbuskamp.
11.—3,800-meter Camp, two kilometers east of Wilhelmina-top, Puindalkamp.

Article III.—RESULTS OF THE ARCHBOLD EXPEDITIONS. No. 41

SUMMARY OF THE 1938–1939 NEW GUINEA EXPEDITION

By Richard Archbold, A. L. Rand and L. J. Brass

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INTRODUCTION

This was the third expedition to New Guinea led and financed by Archbold in furtherance of a plan for a comprehensive biological survey of the island.[1]

In the course of making arrangements in Java for the expedition an agreement was reached with the Netherlands Indies authorities whereby they participated in the work, and the expedition became known as the Indisch-Amerikaansche Expeditie.

The area chosen for the work of the 1938–1939 expedition was the least known large area in New Guinea, the north slope of the Snow Mountains. Several large expeditions had reached high altitudes and brought back important collections from the southern slopes of the Snow Mountains, notably the Lorentz-van Nouhuys and Herderschee expeditions of 1909–1913 which reached the summit of Mt. Wilhelmina, and the Wollaston Expedition which reached the edge of the snow field on Mt. Carstensz in 1912. In 1921–1922 the Kremer Expedition made the sole important expedition on the north slopes of the Snow Mountains. They reached the summit of Mt. Wilhelmina, but the arduousness of the trip made it impossible to bring back collections from far inland. Between the fairly well-known Weyland Mountains to the west and the mountains about the headwaters of the Sepik to the east, the north slope of the central range was practically unknown biologically and very little in any way.[2]

It was the central part of this unknown area, between Mt. Wilhelmina and the Idenburg River, that the expedition studied. This included collections from camps from near sea level to near the upper

[1] For an account of the first expedition to southeast New Guinea, see Archbold and Rand, 1935, Bull. Amer. Mus. Nat. Hist., LXVIII, pp. 527–579, Pls. xxix–xlvi, 1 map; and for one of the second expedition to south New Guinea, see Rand and Brass, 1940, Bull. Amer. Mus. Nat. Hist., LXXVII, pp. 341–380, Pls. xxi–xlii, 2 maps.

[2] For a summary of exploration in New Guinea, see Nieuw Guinee, I and III, 1935 and 1938, de Bussy, Amsterdam.

limit of vegetation. Specialists in mammals, birds, insects and plants spent on the average about a month at each camp.

Some of this area was mapped for the first time, and valuable notes on the people were made.

The personnel of the expedition consisted of

MR. RICHARD ARCHBOLD, general leader and pilot

Netherlands Scientific Party:

DR. L. J. TOXOPEUS, leader of the Netherlands scientific party and entomologist
DR. E. MEYER-DREES, forester
MR. CH. VERSTEEGH, assistant to the forester
MR. J. OLTHOF, entomological preparator
Two Sundanese mantris (trained native collectors)
Twenty-five Dyaks
Two cookboys

Netherlands Military Party:

STAFF CAPT. C. G. J. TEERINK, commandant
LIEUT. V. J. E. M. VAN ARCKEN, subcommandant
LIEUT. C. W. SCHREUDER, supply officer
LIEUT. R. HULS, medical officer
Fifty-two non-commissioned officers and men
Thirty convict carriers

American Scientific Party:

DR. A. L. RAND, assistant general leader and ornithologist
MR. L. J. BRASS, botanist
Mr. W. B. RICHARDSON, mammalogist[1]
Two Ambonese collectors
One half-caste collector
Forty-two Dyaks
Two cookboys

Airplane and Base Camp Personnel:

MR. R. R. ROGERS, pilot
MR. G. D. BROWN, flight engineer
MR. S. J. BARRINKA, engineer
MR. R. E. BOOTH, radio operator
Mr. H. G. RAMM, radio operator
MR. L. A. YANCEY, navigator
MR. R. H. MIELCKE, overseer of native labor
Nine Malays
Three cookboys
Sundry local natives

Inland Radio Operators:

MR. C. BAZZONI
MR. F. J. EBELI (July to October)

ACKNOWLEDGMENTS

In making arrangements for and in prosecuting the work of this highly successful expedition a host of people gave unstintingly of their time and aid. To these we wish to express our thanks.

His Excellency, the Governor General, Jhr. Mr. A. W. L. Tjarda van Starkenborgh Stachouwer, graciously gave us permission to embark on our work. Dr. H. J. van Mook, Director of the Department of Economic Affairs, undertook the practical arrangements which were speedily and effectively made. Lt.-General M. Boerstra, Commander in Chief of the Army, and Maj.-General G. J. Berenschot, Chief of Staff of the War Department, gave us the benefit of their experience in large-scale transport and safety factors, and provided a military covering party that was not only effective but co-operated wholeheartedly in making the expedition a success. Dr. K. W. Dammerman, at that time Director of the 's Lands Plantentuin at Buitenzorg, assisted in arrangements affecting the scientific aspects of our organization.

Customs duties on our equipment were waived.

To many other government officials in Java we are especially indebted for favors, in particular to Dr. F. H. Visman, Member of the Raad van Nederlandsch Indië, Capt. E. A. Vreede, Chief of Staff of the Navy Department, and Mr. B. H. F. van Lent, Acting Head of the Afdeeling Luchtvaart van het Departement van Verkeer en Waterstaat.

The N. V. Koninklijke Paketvaart-Maatschappij granted us a reduced rate on

[1] In addition to his regular duties Richardson undertook the operation of the radio at the collecting camps.

their lines running to New Guinea, on both freight and passengers.

In Batavia Dr. J. A. Hoekstra of the Battafsche Petroleum Mij. and the Noord Nieuw Guinea Petroleum Mij. kindly arranged for emergency aerial assistance if it should be needed; Mr. H. Fechner of Erdmann en Sielcken, Firma, placed at our disposal information one of their expeditions had acquired in traveling in north New Guinea. Mr. M. P. Tielens, general manager at Batavia for the N. V. Internationale Crediet-en Handels-Vereeniging "Rotterdam," who acted as our agents, was of great assistance.

In particular we take pleasure in expressing our indebtedness to Dr. W. A. Foote, American Consul in Batavia, for the aid and advice with which he was always ready, and to Mr. A. H. Elliot and Mr. C. E. Hartford, of the N. V. Koloniale Petroleum Verkoop Mij., whose help was given in myriads of ways.

In Soerabaya we remember with pleasure the hospitality of Mr. Frederick van den Arend, American Consul, and Mrs. van den Arend, and of Mr. E. S. Newell, General Sales Representative of the N. V. Koloniale Petroleum Verkoop Mij., and Mrs. Newell.

In Makassar Mr. J. Boshuizen of N. V. Internationale Crediet-en Handels-Vereeniging "Rotterdam" acted as an efficient agent, through whom, after the initial purchases, most of our supplies were obtained.

Mr. H. J. Jansen, Resident at Ambon, gave us much useful information.

In Hollandia Mr. and Mrs. J. Hoogland extended us much-appreciated hospitality, and Mr. Hoogland, in his capacity as gesagheber or civil administrator of the district, aided us in innumerable ways in getting settled and in our contacts with the coastal natives.

To carry out a large expedition in a strange country is a great strain on the personnel involved. It is gratifying to us to compliment our personnel for their co-operation. It was this co-operation which brought the project to a successful conclusion.

Especially do we wish to thank the military party for their services. Not only did they provide effectively for our safety, but they undertook part of the routine work of the expedition, the care and feeding of carriers, the health work, the exploration of new areas and the overseeing of camp construction inland. It is to this aid that we were indebted for the speedy completion of our work.

EQUIPMENT AND ORGANIZATION

In previous reports we have pointed out the difficulties involved in traveling in New Guinea with carriers. To make our expedition practical, air transport was necessary. Archbold supplied a flying boat for this purpose. The "Guba" was a standard United States long-range patrol bomber, model PBY 2, built by Consolidated Aircraft Corporation, and considered by experts to be one of the most airworthy and seaworthy aircraft in existence at that time. It was identical in construction with 200 owned and operated by the United States Navy, and its parts were checked by the Navy inspectors. Changes made in the airplane, to adapt it for our work, included the installation of a monorail for moving cargo inside the ship, broad platforms on which cargo could be stored and which could be used as bunks, chairs and safety belts and a galley. A window was cut in the navigation compartment, the auxiliary motor for charging batteries was re-located, and special navigating and radio equipment was installed. The wing spread of the "Guba" was 104 feet (31.7 meters), the overall length 67 feet (20.4 meters). It was powered with two 1,000 horsepower Pratt and Whitney Twin Wasp engines. Completely fueled it carried 1,750 gallons of gasoline and 110 gallons of oil. When fueled to fly 800 kilometers over New Guinea, it had a payload of about 3,000 kilograms taking off at sea level; the payload when taking off from Lake Habbema, at 3,225 meters, was 1,000 kilograms. During the New Guinea work it customarily carried a crew of four, consisting

of pilot, co-pilot, flight engineer and radio operator.

We had no relief plane of our own. In the event of accident it would undoubtedly have been necessary seriously to curtail our plans. For possible rescue work we were fortunate in securing through Mr. Hoekstra of the N. N. G. P. Mij. the promise of one or both of the airplanes used in aerial survey work for the company in west New Guinea. Fortunately we never stood in need of this aid, but we are deeply indebted to the N. N. G. P. Mij. and Mr. Hoekstra for the service held in reserve.

For provisioning land parties away from bodies of water large enough for the plane to land, Archbold provided parachutes for dropping foodstuffs. In addition to a number of commercial twenty-four-foot cargo parachutes, Archbold also had made in Hollandia some of ordinary cotton cloth. These were twenty feet square, with a shroud on each corner and a square hole in the middle to reduce oscillation, and were quite serviceable. The usefulness of this means of re-provisioning is especially apparent in the account of the patrols of Capt. Teerink and Lieut. van Arcken in opening up the overland route.

Radio communication was provided for between the airplane, base camp and the two principal inland camps. The exploration patrols, referred to above, also carried transmitting and receiving sets.

The airplane radio equipment consisted of two transmitters and two receivers. The main transmitter, with 100-watts output on code, had four frequencies (500, 3,105, 6,210 and 12,420 kilocycles) with mechanical band switching; the other, with 40-watts output on code, was dial controlled for six frequencies (333.3, 375, 500, 3,105, 6,210 and 12,420 kilocycles). Both transmitters could be operated on either voice or code. The receivers were all-wave, band-switching superheterodynes similar to those used on United States naval aircraft. There was also a direction finder that could be used as a receiver. For want of suitable signal stations, this unit was practically never used in New Guinea.

The base station's transmitter was a four-stage crystal-controlled set with plug-in coils for changing frequencies, designed to operate on frequencies from 500 kilocycles to 15,000 kilocycles. It was built by Archbold and Ramm in the United States. The main feature was the large safety factor incorporated to guard against short circuits and momentary arcs caused by dampness and insects. From previous trips it was found impossible to keep insects out without using so fine a screen as to impair cooling of the tubes when using a power output of 400 watts and 1,500 volts on the plates. Because of this it was necessary to use two or three times the normal insulation and to use oversized power supplies. Two national H. R. O. receivers were used in conjunction with the base station transmitter.

The portable radio sets used inland were commercial A. W. A. (Amalgamated Wireless [Australasia] Limited) equipment purchased in Port Moresby and operated under special license from the Indies government. The transmitter, in a metal case, had a power output of ten watts on a frequency of 6,425 kilocycles. The receiver, in another metal case, was a superheterodyne. Both transmitter and receiver worked off storage batteries which were recharged by means of a one horsepower gasoline motor. The whole made five loads for carriers, the transmitter, receiver, two batteries and motor being each one load of almost twenty kilograms.

While the party was on Mt. Wilhelmina a small dry battery voice and code transmitter and receiver with one-watt output was tried and found satisfactory. Built of what materials were available at the base camp, and on that account not properly mounted and housed to withstand hard jolts, this set suffered somewhat in transportation. A daily half-hour schedule with the coast was maintained with it for three weeks without change of batteries. The transmitter and receiver weighed about ten kilograms; the dry cells, about twenty kilograms.

While contacts could not always be made, more than ninety per cent of the time both of the main inland camps were in daily radio communication with the

coast station. The importance of this service will be apparent when reading Captain Teerink's patrol account.

In venturing into an unknown area the kind of reception the natives will extend is unpredictable. Certain it is that natives in general tend to be more friendly toward a large, well-armed party than toward a small, weak one. Our parties inland were usually of the former category, and no unpleasant incidents of importance arose in our contacts with the people.

Carriers were necessary to move camps short distances. A man was therefore sent to Borneo, who, proceeding inland from Tandjoeng Selor, recruited fifty-one Dyaks for the American party and twenty-five for the Netherlands party. Two of these men died at Hollandia of pneumonia which developed on the voyage from Borneo, and seven more were repatriated as physically unfit before the expedition took the field. The Dyaks were excellent carriers, and several of them, trained as collecting boys, proved valuable as expert hunters and fair preparators. The military detachment had convict carriers, mostly natives of Java. The standard load for carriers was twenty kilograms, plus their personal belongings.

Supplies for the Dyaks, including food, clothing and blankets, were furnished from the stores of the War Department, partly, of course, on charge to the American party. Foodstuffs for the American staff and base personnel were purchased in Makassar or Soerabaya and arrived monthly by the K. P. M. steamer. Several months' supplies were kept on hand at Hollandia at all times, both for stocking reserve emergency rations at strategic camps, and in case there should be an accident to the monthly steamer shipment.

Camping and collecting equipment for the American party was brought from the United States; the Netherlands party brought theirs from Java, with the exception of tents, sleeping bags and some other articles for use at high altitudes, which were secured from Holland.

The organization of the expedition occupied considerable time. Plans for examining a cross section of the country between the Idenburg River and Mt. Wilhelmina were made in some detail in New York. Hollandia on Humboldt Bay was chosen for a coast base because of its harbor, which offered beaching opportunities for the plane, its proximity to the area to be worked and its monthly steamship connection with Makassar and Java. The Idenburg River, from numerous surveys, was plainly suitable for flying boat operation over much of its length; and the descriptions of Lake Habbema, near Mt. Wilhelmina, at 3,225 meters (10,577 feet) altitude, furnished by the Lorentz and Kremer expeditions, indicated that the plane should be able to land there and take off with a useful load.

The plan originally formulated was to establish a base at Hollandia, make a series of reconnaissance flights over the chosen area to see the best way of traveling it on foot, then establish a camp at a convenient place on the Idenburg. The river would provide an avenue of escape for the inland party if it were needed. Another base was to be laid down at Lake Habbema by plane. If possible the higher altitudes, more important and least accessible, were to be collected first. While the scientists were at work at high altitudes, an overland party would open a track between Lake Habbema and the Idenburg as an emergency retreat route. While the plane would transport personnel and supplies between these main camps, carriers would furnish transport between intermediate camps. The desired cross section would be completed with a series of collecting camps hinged on the Idenburg base.

In December, 1937, Rand went to Java to negotiate with the authorities for permission for the expedition to operate. The question was finally put in the hands of Dr. van Mook, Director of the Department of Economic Affairs, by the Governor General. There were two main points to be arranged. There must be adequate military protection, and it was advisable to combine with Netherlands scientists and make the expedition an international affair. In the following March these arrangements were completed. General Boerstra and General Berenschot arranged for an

escort consisting of fifty-six officers and men under command of Captain Teerink of the General Staff. Dr. Dammerman arranged for an entomologist and a forester to join the expedition. The activities of the expedition in the field were to be outlined by the scientific staff, but as the military party was to be responsible for the safety of all, they would decide whether or not this program could be safely carried out. For a safety measure it was decided that an inland party should not be flown to a place from which there was not already a line of retreat open to the coast in case of accident to the plane. This meant specifically that no one was to be flown to Lake Habbema until after the overland route between it and the Idenburg had been opened, and that the slopes above the Idenburg must be studied first. (The data gained from the reconnaissance flights [p. 211] made possible a revision of this and adherence to the original plan.)

It was agreed that the material collected by the American party would go to America; that by the Netherlands party, to Buitenzorg, and after study, a division of the materials was to be made so that both parties would share in all collections.

Brass, Ramm and Richardson arrived in Java in March. On March 30 Brass flew from Batavia to Soerabaya by K. N. I. L. M. airlines to purchase materials for the construction of the Hollandia base, obtain provisions and other supplies and engage the nucleus of a labor force for Hollandia. Special facilities were granted him by Mr. A. H. Zick, manager of "Internatio" at Soerabaya, and Messrs. Velders, Teerink, Grultemans and van der Linden of the "Internatio" staff were especially helpful in supplying what their warehouses could furnish and assisting in procuring other requirements from various European and Chinese firms in the city.

Orders for coolie foodstuffs were cabled to Makassar, where they received the careful attention of Mr. J. Boshuizen of "Internatio," and of the suppliers and packers, N. V. Molukken Veem. These supplies, consisting of unpolished rice, dried green peas, fried salted fish, brown sugar, dried chillies, coffee, tea, salt and coconut oil, were packed in soldered kerosene tins of four-gallon and two-gallon capacity, and each kind painted a different color.

Makassar, in southwest Celebes, is the terminal port for the K. P. M. steamers which ply the coasts of the Moluccas and Netherlands New Guinea on regular schedules. Through their specialization in regional requirements and their association with recent activities in exploration for oil and gold in New Guinea, the Makassar merchants were in a position to supply certain expeditionary needs, particularly provisions and trade goods, which were not in common use in Java and therefore not readily available in Soerabaya.

In Soerabaya the services of Mr. R. H. Mielcke were secured as overseer of coolie labor. Mielcke had had experience in construction work in Java and Borneo and had a good knowledge of Malay. A Javanese head cook for the base was also obtained there, through the kind offices of Mr. E. de Raadt, chief of the Gemeentelijk Bureau voor Arbeidsbemiddeling en Beroepskeuze. At Makassar nine Bugis Malays were engaged as handymen and boatboys, and two as cook's mates and houseboys, at wages ranging from twenty to thirty guilders a month.

Brass, Ramm, Richardson and Mielcke left for Hollandia on the April boat.

Rand remained in Java during April to arrange various business details such as the recruiting of Dyaks, arranging for the airplane fuel supply, which could not be sent on a regular boat but necessitated a special steamer, attending to the customs and arranging for entry of equipment. He took the May boat from Soerabaya for New Guinea, completed business arrangements at Makassar en route, and engaged there two cookboys for the inland party.

A GENERAL SURVEY OF THE AREA[1]

A brief account of the general aspects of the country with which we are dealing is in order.

The usual direction flown from Hollandia on the reconnaissance and subsequent transport flights was approximately 240° for 200 kilometers to the Idenburg, then 220° for 100 kilometers to Lake Habbema or Mt. Wilhelmina. On this course, after leaving the hilly shores of Humboldt Bay with their discontinuous fringe of secondary grassland, the Cyclops Mountains were passed on their inland side, and the plane flew over Lake Sentani.

Lake Sentani, beginning ten kilometers from the coast, has a length of about thirty-five kilometers, a width of one to six kilometers and lies at an elevation of eighty meters above sea level. From the air the lake is seen to be surrounded by hills partly covered with rain-forest but mostly by treeless grassland. Remarkably distinct lines of trees border the shores at the foot of the grassy hills and fill the gullies that score their sides. In some parts the shores are fringed with sago swamps. Off-lying valleys on the south and west sides look like dry arms of the lake. The lake carries a population of 7,000 people, most of whom live in villages built on piles over the water. The grasslands are undoubtedly a secondary condition following deforestation by the natives. Clearing for gardens, the process by which these grasslands are formed, can at any time be seen in operation on the forest edges. In the comparatively dry "winter" season of the southeast tradewinds, the fires which secure the invading grasses against the re-establishment of the original forest are almost a daily occurrence on some part of the area.

A somewhat scattered population continued westward on the line of flight for a distance of perhaps thirty kilometers from Lake Sentani. There and in a parallel flat valley to the south of the lake there were extensive grassy areas, some of them secondary, others apparently patches of marshy land not suited for the growth of trees.

Beyond the disturbed area of Lake Sentani was a broad tract of low mountain country, completely forested, and carrying a very sparse population living in small villages or scattered solitary houses. Apparently of limestone, the mountains attained a fairly even elevation of perhaps 800 to 1,000 meters and lay in closely parallel ridges trending east-southeast and west-northwest. When passing over them in early morning, there could be seen, when the weather was clear, two snow-capped peaks of the Central Range, far to the south. On one occasion, when flying at 3,500 meters after a period of storms, Mt. Wilhelmina with snow far down its sides and its top clear-cut and icy presented a magnificent sight, heightened in effect by a dark overcast and the blue-black of the lesser heights.

Between these still largely unexplored low mountains and the central mountain mass lies the valley of the Idenburg—the Meervlakte or Lake Plain. About 60 kilometers wide where it was crossed, the Meervlakte, as the name implies, is flat and swampy. Muddy tributaries loop over the plain to join the main river, which flows along the southern side near the base of the central mountains. The Idenburg is a broad stream, winding and silt-laden, with an amazing number of cut-off U-bends and, often, islands formed by the shifting of the channel. Out on the plain are big lagoons and areas of open grass marsh. Forests of swamp-inhabiting slender trees are conspicuous from the air, and the open canopy and abundance of sago palms in more mixed forest further testify to the swampy nature of the ground. Later it was learned that even the dense closed forests are inundated to a depth of one to two meters for months on end in the season of the northwest monsoons.

The Meervlakte extends up the Idenburg for a distance of about 170 kilometers from the Mamberamo. Similar conditions are reported to prevail for about an equal distance on the Rouffaer River, the west

[1] Taken largely from Brass, L. J., 1941, The 1938–1939 Expedition to the Snow Mountains, Netherlands New Guinea, Jour. Arnold Arboretum, XXII, pp. 272–342.

branch of the Mamberamo. Probably the larger part of these areas is under water from December to May, when the rivers, dammed back by rapids on the Mamberamo, overflow their banks.

The first line of the central mountains rises sharply from the Meervlakte in a complex system of bold ridges which proved to consist of dark-colored pultonic rocks. Except for one marshy valley draining into what is now known as Archbold Lake, areas deforested by natives and the tops of the higher outlying peaks, such as Angemoek and the Doorman-top, the ranges are forested up to high altitudes on the Snow Mountains. Practically every valley of consequence on the course from the Idenburg to the Balim carried some population. But not until Archbold Lake was passed did population have any considerable disturbing effect upon the forests. As far as could be seen from the air, the commencement of heavy population coincided with the change of the country rock to limestone. The heavy population occurred in an extensive valley system discovered by the expedition.

The northernmost of the new valleys drained to the Wal or Hablifoeri River, a tributary of the Idenburg. Most of them were, however, laterals of a great central valley, to which the name "Groote Vallei" was given by the Netherlands members of the party. About eighty kilometers long and up to twenty kilometers wide, this central valley had a bottom elevation of 1,500–1,700 meters and was found to be drained by the Balim (or Baliem) River, the headwaters of which were discovered by the Kremer Expedition in 1921. Flowing first west-northwest from the slopes of Mt. Wilhelmina and receiving the waters of Lake Habbema, the Balim described a wide loop to the east and southeast, then cut through the Snow Mountains in a deep gorge to join the Reiger, the main branch of the Lorentz River, which flows to the south coast.

The Grand Valley of the Balim, and many of its laterals, had been almost completely deforested up to elevations of 2,300–2,400 meters on the sides of the surrounding mountains. The utmost limit of cultivation was in the neighborhood of 2,500 meters. Whole mountain ridges had been stripped of their original vegetation and their contours laid bare under a pale coating of grass. On these bald ridges were many village groups of gardens walled with stones, and marking their surface, in pleasing native irregularity, were the old walls which had enclosed former cultivation plots. The pock-marked effect given by sink-holes indicated that most of the country rock was limestone. In the main valley the plane flew low over numerous walled or stockaded villages and beautifully patterned gardens laid out on rich alluvial flats. Broad ditches in these gardens were in many cases full of water, for much of the valley bottom was low lying and swampy. A first estimate of 60,000 people in these, for New Guinea, highly cultivated valleys, was probably too conservative.

Lake Habbema lies in the outermost and shorter of two broad, grassy valleys that run parallel to the axis of the range on a high, shelf-like plain. The Habbema valley is perhaps twice as long as the lake, which has a length of about four kilometers, a width of two kilometers and is 3,225 meters above sea level. The inner valley, in which a headwater stream of the Balim proper flows westward and the Wamena tributary eastward from an almost imperceptible divide, continues for an undetermined distance far to the west in the direction of Mt. Carstensz. The bottoms of these valleys of the high plain are flat and treeless. They contain many little pools and are drained by winding streams lined with the curious *Cycas*-like treeferns peculiar to high altitudes in New Guinea. There are also numerous pools on the tops of the smooth ridges that separate the two high valleys and form the rim of the Grand Valley. These ridges rise 75 to 125 meters above the plain and carry shrubberies and mossy scrubs in which numerous slender conifers (*Libocedrus*) rise above the lower vegetation. There is little closed forest. From the air, cushions of golden-brown moss are conspicuous on the trees, and patches of the same color appear in the shrubberies.

On the rugged main ridge of the Snow

Mountains, there was considerable low tree growth under bluffs and in other sheltered places up to an elevation of about 3,900 meters. The higher parts west of Mt. Wilhelmina consisted mainly of bare gray-white rock, frequently with a smooth, weathered surface exhibiting a criss-cross pattern of cracks. On the summit of the strongly stratified knife-edged limestone ridge of Mt. Wilhelmina peak was a small area of permanent snow. Several small lakes and shallow ponds occurred on both sides of Mt. Wilhelmina about 1,000 meters below the summit. A long, narrow lake lay between two sharp ridges that formed a double crest to the range about a dozen kilometers to the east of the peak.

ITINERARY

On a large expedition such as this, with several parties in several different places, it is impractical to weave the whole itinerary into a narrative so that the movements of all are readily referred to. In an attempt to remedy this the activities each month are listed in skeleton form under each person or group of persons. Special attention is then given to those activities which resulted in addition to our knowledge or collections.

The activities start with the landing in Hollandia in April, 1938, and end with the departure of the expedition from Hollandia in May, 1939.

April

The advance party, consisting of Brass, Mielcke, Ramm and Richardson, arrived at Hollandia by the monthly steamer "van Imhoff" on the night of April 23 with fifty-two tons (53,000 kilograms) of supplies. Having been advised by radio of their coming, Mr. Hoogland, the gesagheber, had arranged temporary accommodations and had a gang of natives on hand to take care of the cargo as it was put ashore. Landing facilities for cargo consisted of a small pier on which articles weighing up to about 400 kilograms could be delivered from the ship's boats.

Included in this first cargo were corrugated galvanized iron for two godowns or warehouses, each twelve by six meters, iron-monger's stores and tools, explosives, cement, flooring and shelving lumber purchased in Java, and some hardwood lumber secured enroute from the government sawmill at Manokwari. The sawyer at Manokwari had also undertaken to cut and supply by the next boat part of the hardwood decking for a ramp for the flying-boat. An order for the rest of the sawn lumber required for the ramp was placed with Mr. Ebeli, who operated a small water-driven sawmill in the hinterland and was in Hollandia to meet the boat. Mr. Ebeli's mill was on the lower southwestern slopes of the Cyclops Mountains. The 500-odd pieces of timber supplied by him had to be carried by natives ten kilometers to Lake Sentani, taken fifteen kilometers on canoes to the east end of the lake, carried another ten kilometers to the coast, then brought up the coast ten kilometers on canoes to Hollandia.

When informed of the needs of the expedition, Mr. Hoogland was most generous in his offers of assistance, granted entire liberty in the choice of a site for the base and at once sent word to the villages for labor. The town house of a planter, afterwards used as military headquarters for the expedition, was rented as a residence for the time being. Mr. Feninga, commander of the patrol boat "Bantam" then stationed at Hollandia, kindly made available a motor launch for a survey of the bay for a base site. The site chosen was on the town waterfront. Natives from villages along the coast and at Lake Sentani offered freely for work and by the 25th were cutting timber in the forests and bringing it in for the first godown. Two Ambonese former bird of paradise hunters (Cornelius Samala and Marcus) resident in the neighborhood, who later accompanied the expedition inland as collectors, were taken on as mandoers or headboys. After the work got properly under way, 100 to 120 natives were employed at wages of twenty-five cents with

food, or thirty cents[1] without food, for an eight-hour day. The labor was fed on sago twice a day, and rice for the evening meal. Fish fried in coconut oil and dried, and tea and sugar, were included in the rations, and there was a weekly issue of tobacco and matches. Locally made sago was bought for fifty cents per basket of about twenty kilograms. The local labor did all that was expected of it and proved satisfactory on the whole. In fact some of the better Papuans were quite as intelligent as the average Malay brought from Makassar and, though lacking in initiative and not particularly adept in the use of tools, were a good deal more willing and useful in their work.

Most of the buildings were erected over the raised concrete floors of previous structures, relics of the days when Hollandia flourished as a center for bird of paradise hunters. The location was low-lying, with a high water table, so that a considerable amount of filling had to be done with materials quarried from a neighboring hillside and brought to the site on portable tramlines borrowed from the government. To facilitate the handling of cargo, a tramline was also laid from the godowns to the head of the pier, a distance of about 300 meters. One of the galvanized iron godowns was for a mechanical workshop and storehouse, the other for the storage of provisions and general supplies. Other buildings included a shed for the aviation fuel, engine house, radio shack and houses for the coolies and the Dyaks, built, as were the godowns, of round timbers from the forests but roofed and walled with sago-palm thatch bought ready for use from the natives. An old, disused mission house was altered and renovated and an annex built beside it for the accommodation of the American staff. Staff quarters and godowns were supplied with electric light by a Kohler unit producing 5,000 watts, which also generated power for the radio. A tall forest tree at one end, and at the other end a bamboo lashed to the top of a coconut palm and stayed to the ground, supported the main radio aerial.

[1] The currency quoted is that of the Netherlands East Indies. At that time one United States dollar = 1.7 guilders.

Specifications for the flying-boat ramp—the major piece of construction work—called for a structure six meters wide with a slope to the water of not more than one in ten. As tides were small in Hollandia Bay and the beach a gently sloping one, the ramp had to be carried out fifty-eight meters from the lip of the beach to get a sufficient depth of water to bring the "Guba" ashore on one tide a day throughout the year. A further length of twenty meters on level ground above the beach was required for a parking place. The foundations consisted of four courses of heavy stringer logs, laid on the beach, bolted together, and anchored with stoneboats; the decking was of hardwood planks ten centimeters thick spiked to the logs. A permanent mooring buoy was installed in deep water outside a fronting reef which lay about 200 meters off shore. Some coral niggerheads were blasted away to clear and enlarge a natural passage through the reef.

The press of the work left little time for biological studies.

May

Rand and Schreuder arrived in Hollandia May 23 by the K. P. M. boat. Schreuder started work on warehouses and living quarters for the military and Netherlands scientific party. The preparations of the American party were continued.

There was little time for biological work.

June

The complete personnel of the expedition assembled at Hollandia this month, aerial reconnaissances over the interior were carried out, and some biological work was done about Hollandia. At the last of the month the base camp on the Idenburg, called Bernhard Camp, was established, and a start was made on provisioning it.

The airplane arrived at Hollandia June 10, having left San Diego, California, June 2 and flown to New Guinea by way of Honolulu and Wake Island.

Teerink was flown to Hollandia by a naval seaplane which arrived June 16. The following day the K. P. M. monthly steamer arrived with the rest of the military

party, the Netherlands scientific party and the Dyak carriers. The whole personnel of the expedition, about 200 individuals in all, were finally at Hollandia.

On the morning of June 28 a trial landing was made on the lagoon paralleling the Idenburg that had been chosen as the landing place for the plane. On the 29th and on the 30th two more flights were made with military personnel, Dyaks and stores.

BOTANY.—Brass selected three Dyaks to train for assistants and was able to do a little work about Hollandia.

ENTOMOLOGY.—Toxopeus, employing some Dyaks and local people as well as his assistants from Java, collected about Hollandia from June 17. Olthof was sent on a trip to Lake Sentani and the Cyclops Mountains on June 23, with which he occupied the rest of the month.

FORESTRY.—Meyer-Drees worked locally and left on June 23 for a trip to the Cyclops Mountains via Lake Sentani.

MAMMALOGY.—Richardson took one of the local Ambonese (Marcus) former bird of paradise hunters, and, with two Dyaks to train as assistants, conducted some work about Hollandia.

ORNITHOLOGY.—Rand, with the other Ambonese former bird of paradise hunter (Cornelius Samala) and two Dyaks as assistants, did a little local work.

RECONNAISSANCE FLIGHTS.—Our first inland work was to find exactly where to go. We had to judge of the suitability of Lake Habbema as a landing place, to select a camp site on the Idenburg River, and, for safety, to pick out an overland route between the two to be used if the necessity should arise. On our first reconnaissance flight, June 21, we surveyed the route used by the Kremer Expedition, the only party to have crossed this area. We took with us emergency rations for two months, guns, axes and mosquito nets for use in the event of a forced landing. From Hollandia we crossed Lake Sentani and went directly to the site of Kremer's Prauwen-bivak on the Idenburg, flew over Mt. Angemoek, then followed over what must have been Kremer's route southward to Mt. Wilhelmina. Clouds made continuous observation difficult, but we saw a rough, forbidding country, a succession of deep, dark valleys and forested ridges, each several thousand feet high, as described in Kremer's account. Population was not heavy, as indicated by the small areas of induced grassland. Lake Habbema looked suitable for a landing place and camp site. We could land anywhere on the Idenburg, and suitable lagoons were numerous near the river.

Upon our return from this flight we decided that farther east we might find a route between the Idenburg and Lake Habbema that would be somewhat shorter, with terrain more passable, than that followed by Kremer. It was worth investigating. On the 23d we again flew to near Mt. Angemoek and began a traverse to the east of our previous line of flight. We soon had a pleasant surprise. A wide, flat, heavily populated, grassy valley stretched away to the southeast. Kremer had apparently skirted around its upper, western edge without seeing it. This heavily populated valley, which we christened the Grand Valley, would be easy to travel through, and there was only one main ridge between it and Lake Habbema. Through the valley ran a broad, braided stream, deepening and changing in character in its course toward a gap in the main ridge of the Snow Mountains to the east of Mt. Wilhelmina. This proved to be the Balim River, the headwaters of which were discovered by the Kremer Expedition. Several big tributaries flowed into the Balim from branch valleys, all of which were heavily populated. The valley system, we estimated, carried at least 60,000, perhaps nearer 100,000 people. Between the Grand Valley and the Idenburg River there were only two main ridges, and between them, in the valley of the Wal or Hablifoeri River, we discovered a lake, later called Archbold Lake, on which the plane could land. North of this in the Meervlakte the Idenburg River ran close to the mountains, and a cut-off bend formed a lagoon of ample size for the "Guba." This was about sixty kilometers east of Kremer's Prauwen-bivak. The country seen on this flight offered a much easier overland route than Kremer's, and on the next two flights, on June 24 and 27, we went

back and forth over this area, photographing, making notes and sketches, deciding on places where overland parties could be provisioned by plane, and where parties starting from each end, that is, from the Idenburg and Lake Habbema, would meet. Captain Teerink and Lieutenant van Arcken, who would make the patrols we now envisioned, of course made all the final decisions on these matters.

The route finally chosen from the air and followed very closely on foot struck into the mountains from Bernhard Camp, touched on Archbold Lake, where it was planned to land the plane with provisions, then crossed to the upper end of the Grand Valley, where a meeting place was planned at the junction of the Balim and a big tributary river (later found to be called the Warok) coming in from the north. The patrol from Lake Habbema was to cross the ridge to the north of the lake, cut diagonally across the Grand Valley to the meeting place, and be re-provisioned once with foodstuffs dropped from the plane. Supplies for their return journey would be dropped to both parties at the meeting place.

This perhaps presents the patrol problems too simply, but it appeared so much simpler than our original plan of cutting a way through the rough country to the west that we wanted to adopt it. However, the agreement with the military authorities in Bandoeng was that the overland route would be opened up before we flew anyone to Habbema. It was necessary to present the proposed alteration of plans to them. Captain Teerink did this and obtained approval. The plan thus made and adopted had several advantages. By dividing the work between two parties, the preliminary land exploration could be completed and an overland route opened up in about half the time it would take one patrol to cover the whole distance. We could work the highest, most important, and from the viewpoint of our native personnel, most unpleasant camps first. The soldiers, carriers and collecting boys could be consoled with the thought of soon retiring to a warmer climate. Another advantage was that as camps closer to the lowland base were reached, the native personnel could be reduced. In this matter of choosing a route and formulating plans the airplane amply demonstrated its value in our exploration.

The Founding of Bernhard Camp.—The site of the landing place for the plane, on a big lagoon paralleling the Idenburg, had already been chosen on the reconnaissance flights. It was not until June 28 that the plane landed on the lagoon. Only the crew was on board. In addition to emergency rations and equipment they took in an anchor buoy and a load of gasoline. The landing demonstrated the suitability of the lagoon for a base, the buoy was dropped for a mooring for future landings and the gasoline put ashore. Later that day Teerink and van Arcken, with five soldiers, three convicts and food and medicines for three months, were landed there. By the next day, the birthday of H. R. H. Prince Bernhard, they had decided on the location of the base, and in honor of the day it was named Bernhard Camp. The water was low, and the camp was on a flat bank about nine meters above water level. Under the then existing water conditions the plane unloaded its supplies about a kilometer from the camp. Later, when the water rose, cargo could be discharged just opposite camp.

Five more flights followed. In all, the two officers, a brigade of soldiers (Sergeant Krutzen, two native non-commissioned officers and thirteen men), a medical orderly sergeant, twelve convicts, twenty-eight Dyaks and radio operator Bazzoni, that is, sixty persons with their equipment and provisions for three months, were flown to Bernhard Camp at this time. Captain Teerink shortly returned to Hollandia (on July 8), the remainder of the party being the permanent complement of this camp.

There was work, and plenty of it, to be done. Houses of palm thatch for everyone were to be built. Canoes had to be constructed, for, if the plane should be lost, the expedition would retire down the river to the Pioneer-bivak on the Mamberamo, where assistance could be expected at a permanent field police camp situated below the rapids and at the head of navigation for sea-going vessels. Land was to be

cleared and vegetable gardens established, and, as time was available, living and working accommodations constructed for the main party which would arrive there in six months' time.

July

The provisioning of Bernhard Camp was completed with flights on the 1st and 8th, and on the 18th a flight was made with Netherlands scientific personnel and food replenishments for August.

A last reconnaissance flight between Bernhard Camp and Lake Habbema was made on July 24, to give Teerink and van Arcken a final view of the country over which they were to walk, and to check their proposed routes and agreed meeting place in the Grand Valley. Van Arcken was returned to Bernhard Camp; Teerink, to Hollandia.

F. J. Ebeli, sawyer of Ifar on Lake Sentani and a retired warrant officer of the East Indies Army in which he had served as radio operator, was engaged to accompany Teerink on his patrol. Bazzoni was to accompany van Arcken.

On July 25 van Arcken with twelve soldiers, ten convict carriers and twenty-five Dyaks set off southward from Bernhard Camp with instructions to cut across in the direction of Lake Habbema and seek contact with Teerink's patrol.

Meanwhile the first landing had been made on Lake Habbema and the camp site chosen. The freighting of men and equipment to the lake was completed on the last day of the month.

Botany.—Brass did some collecting about Hollandia the first part of the month and went to Lake Habbema July 22 where work was continued.

Entomology.—Olthof returned from his Cyclops Mountains trip July 1 and collected about Hollandia until July 18, when he went in to Bernhard Camp on the flight of that day and continued his work there. Toxopeus collected about Hollandia until July 29, when, with his two Sundanese assistants, he was flown to Lake Habbema.

Forestry.—Meyer-Drees returned from the Cyclops Mountains July 1, reporting his highest camp at 900 meters on the slopes. On July 18 he, and his assistant Versteegh, were flown to Bernhard Camp from which they conducted work.

Mammalogy.—Richardson continued work at Hollandia as opportunity offered until July 19, when he was flown to Lake Habbema and started collections there.

Ornithology.—Rand worked about Hollandia until July 30, when he was flown to Lake Habbema.

The Founding of Lake Habbema Camp.—On July 15, with Archbold, Rogers, Booth, Brown and Yancey as crew, food supplies for two months, tents, arms, a radio set, a collapsible boat, a buoy and some spare gasoline on board, a trial landing was made on Lake Habbema. The lake looked shallow and it was first roughly sounded. For this a number of sinkers with bright-colored floats attached to them by five-foot cords were prepared beforehand. Circling low over the lake, the sounders were dropped in various places, all the floats disappeared and the ship was brought down. Experimental take-offs demonstrated that a payload of about 1,000 kilograms could be lifted from the lake. A full load of 3,000 kilograms could be landed.

A schedule of flights to the lake was soon laid out. On July 19 Teerink, Richardson, five soldiers and a cook were flown in with radio equipment and shelter, and food for two months. The "Guba" remained at anchor overnight while the crew built a little unloading dock with sawn planks included in this first cargo. Ten more flights, ending July 31, brought in the rest of the personnel and supplies.

The Lake Habbema party consisted of Brass, Rand, Richardson and Toxopeus, radio operator Ebeli, Captain Teerink, Lieutenant Huls, Quartermaster-Sergeant Schothorst, Sergeants Gottschalk and Wildeboer, thirty-three soldiers of other ranks, a hospital orderly, eighteen convict coolies, thirty-nine Dyaks, two Sundanese collectors, two Ambonese collectors and three cookboys—a total of 105 persons. It was provisioned with one month's full rations and two months' reserve rations; it had collecting equipment and supplies for three

months and of course tentage and full camp equipment.

The party being complete at Lake Habbema, July 31 was declared a holiday. The airplane remained for the day so the crew could take part in the ceremonies. The Netherlands flag was raised over the camp, and Archbold and Teerink delivered addresses in honor of the occasion.

Though traces of natives and natives themselves had been seen, our first contact with them was made that day. Two men came to the edge of camp, exchanged smokes, and one showed us a very much worn steel axe he carried. He would not accept a new axe as a gift and refused to take it in exchange for his old one. Shortly the two natives shook hands all around and left. Despite this friendly encounter it was August 27 before we really established satisfactory relations with the natives, though many were seen and even met in the interim.

During the plane transport that brought from Hollandia everything except firewood, tent poles and timber for framing buildings, the camp was built and put in order.

Thus by August 1 the three main camps —Hollandia, Bernhard Camp and Lake Habbema Camp—were established and occupied, and the bulk of the expedition had only arrived in New Guinea about the middle of June.

August

During this month the military detachment conducted the very important patrols of exploration between Lake Habbema and Bernhard Camp. Van Arcken had already left Bernhard Camp July 25. Teerink left Habbema Camp on August 1, and on the 6th received food dropped by the plane in the Grand Valley. Van Arcken reached Archbold Lake on August 4 where the plane landed on its flight of the 6th and delivered him new supplies.

August 7 Teerink reached the Balim River; van Arcken, on August 10. They met on the 13th, when the plane came in and dropped supplies for both parties. Their meeting connected Bernhard Camp and Lake Habbema with an emergency overland route which could be covered in an estimated fourteen to sixteen days' walking time. This was one of the most important safety factors for the expedition and one of the most difficult to accomplish. Both Teerink and van Arcken deserve a great deal of credit for a prompt and efficient piece of exploration.

By means of his radio Teerink was informed that it was possible for the "Guba" to pick up his party farther down the Balim while van Arcken would be picked up at Archbold Lake.

Consequently, Teerink and party followed down the Balim August 16 to 18; on August 19 the plane landed on the river and carried them back to Lake Habbema in two flights. Van Arcken returned over his route to Archbold Lake, arriving there August 16, and on August 20 he and his party were taken back to the Idenburg in two flights.

During the rest of the month at Bernhard Camp the detachment was occupied with camp work, local patrols and canoe making. At Habbema Camp the military party made various local patrols, including one to the north, down into the Bele Valley to near the edge of population along a native path later used in establishing the 2,800-meter and Bele River Camps. August 22 to 24 Toxopeus made a trip down this path to the edge of population. August 15 to 17 Brass, Huls, Rand and Toxopeus made a reconnaissance trip toward the south and selected a camp site at 3,560 meters, about seven kilometers northeast of Wilhelmina-top.

August 26 Teerink and Rand left Lake Habbema for the slopes of Mt. Wilhelmina and set up, at 3,400 meters, an intermediate camp for porters (Tusschenbivak). The next day they went on to the spot selected for the 3,560-meter Camp and established this Camp.

The route from Lake Habbema to the 3,560-meter Camp circled the marshy eastern end of the lake and crossed directly south over a lightly forested ridge and then a broad, treeless plain to where a native track crossed the Wamena tributary of the Balim at 3,150 meters altitude. This was reached in three hours by carriers. From there the native track was followed. It

led southeasterly, past a rocky bluff and up through an area of scattered forest into a narrow, grassy valley running north and south in about one hour's travel. The Tusschen-bivak was located in this valley, about two hours' travel southward. The stream that flowed northward past this camp flowed in part underground, and a half-hour below camp was a large sink-hole. The stream rose to the southwest on Mt. Wilhelmina, but the native track led southeasterly over three ridges, more or less covered with low forest, and into another grassy valley, then turned south up the valley to a grassy floored amphitheater where the 3,560-meter Camp was located, about five and a half hours from the 3,400-meter Camp and about seven kilometers northeast of Mt. Wilhelmina.

On August 29 Teerink returned to Lake Habbema, and on the 30th Toxopeus went up to the 3,560-meter Camp with additional carriers bringing up equipment and supplies.

BOTANY.—Brass worked in the vicinity of Lake Habbema, with a three-day trip to the site of the 3,560-meter Camp to the south August 15 to 17.

FORESTRY.—Meyer-Drees and assistant worked on the Idenburg flood plains until August 20, when they were flown to Hollandia to prepare for the high altitude work near Mt. Wilhelmina.

ENTOMOLOGY.—Toxopeus worked from the Lake Habbema Camp, with one trip to the north into the Bele Valley August 22 to 24 and one to the south to near Mt. Wilhelmina August 16 to 17. Olthof continued to collect from Bernhard Camp.

MAMMALOGY.—Richardson continued his work at Lake Habbema.

ORNITHOLOGY.—Rand collected about Lake Habbema, with one three-day trip August 15 to 17 to near Mt. Wilhelmina, until August 27, when he moved to the 3,560-meter Camp to continue work there.

OPENING UP OF THE OVERLAND ROUTE.—A way of retreating on foot to Bernhard Camp where there was water transport was one of our important safety measures. The military party took over the whole of this work. Teerink went northward from Lake Habbema, van Arcken southward from Bernhard Camp. They planned to meet in the northwest corner of the Grand Valley, at the junction of a tributary of the Balim River, later found to be called the Warok. The plane was scheduled to bring in and drop ten days' provisions to them on August 6 and 13. Not only was this exploration of the overland route speedily and efficiently carried out, but Teerink also explored the lower Grand Valley, where it was found possible to land the airplane on the river, a circumstance which greatly affected our further plans. Now, instead of climbing back to Lake Habbema after collecting in the Grand Valley, we would be able to be flown from there to Bernhard Camp.

The following account of this splendid piece of exploration is based on the diaries of the two officers and a patrol map already published.[1]

CAPTAIN TEERINK'S PATROL.—On August 1 Teerink, with Sergeant Gottschalk, thirteen soldiers, radio operator Ebeli, twelve convict coolies and twenty Dyaks, a radio set and rations for ten days, set off from Lake Habbema. The way lay eastward at first, for about seven kilometers over the alpine grassland, then turned north, following a rude native path through forest down toward the Balim Valley. The first night camp was made in the forest. Some cutting to open the track had been necessary, travel was slow and the footing bad. One convict had a fall and apparently suffered internal injuries. He was carried back to Habbema by four Dyaks.

The next day Teerink continued down the Papuan track which led in the desired direction northward. At first difficult, the trail soon improved, and shortly native gardens were reached. Camp was established at 2,200 meters that night on the Bele River, a tributary of the Balim, in the midst of population. The contacts with the natives were friendly, though women and children kept at a distance. Men conducted the patrol to its camp site on the

[1] Uittreksel van het Algemeen Verslag van de Nederlandsch - Indische - Amerikaansche Expeditie naar Nieuw Guinea, 1938–1939, (Archbold-Expeditie), 1940, Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap, Amsterdam, (2) LVII, pp. 233–247.

river, and about 200 men gathered to watch. A fence, put around the camp to keep the natives from becoming annoyingly familiar, was respected. The word of greeting, oft repeated, with emphasis, was "Nap." Hand shaking was also a frequent greeting, either as we do it, though the left or right hand was used indiscriminately, or it was a grasping of the wrist or forearm. On August 3 the patrol continued down the valley in a northeasterly direction and camped about nine kilometers farther down the stream and about 400 meters lower. The party was approaching the Grand Valley and during the day had been able to look into it.

Though the route was easy, travel was slow due to the continued meetings with new, friendly people. They, adult men only, came flocking by fifties to the camp; they brought sugar cane, sweet potatoes and young pigs, which were accepted by the patrol. A pig was killed by the Papuans, and its flesh ceremoniously eaten by the patrol, and blood of the pig was daubed on wrists and feet. During the day bananas were noted about the native houses.

The next day, August 4, Teerink decided to reduce the size of his party and sent back to Lake Habbema Sergeant Gottschalk with three soldiers, two convicts and one Dyak. The patrol continued north and east, entered the Grand Valley and camped by a thinly wooded stream near a grassy hill. This was a very suitable site for the airplane to drop food, and Teerink decided to wait for it here. Travel during the day had been over easy terrain but had been slow and difficult due to the natives. They were very friendly but kept insisting that bad people lived in the country ahead and that the patrol should not go there. At the mid-day halt several hundred Papuans, mostly unarmed, surrounded the patrol. When it set off again the line of Papuans locked arms and, five deep, barred the path. Black looks, angry words and emphatic gestures cleared the way. Again and again the request was repeated, that the patrol go no farther. A few times the natives even barricaded the way with branches. Finally they were left behind, shouting and wailing, as the party moved farther into the Grand Valley, where it camped. Here only a few Papuans visited the patrol and were rather timid. However, they accepted a gift of a cowrie shell and brought the patrol a pig. Small cowrie shells, one-half to two inches in length, were excellent trade items for paying local carriers and purchasing specimens and food.

August 5 was spent in reconnaissance trips in the vicinity. The natives here were much the same as those on the Bele but were mostly armed with long wooden spears. No cowrie shells were accepted, though cigarettes were; the natives appeared less friendly.

On August 6, the airplane dropped the arranged-for provisions. Only one parachute load, that of gasoline for the radio, was lost. By noon the patrol set out again in a northwesterly direction along the south edge of the valley. One hundred kilograms of rice were left behind as there were no carriers for this, and no local natives could be induced to help. Again the Papuans tried to detain the patrol but ventured only to the limit of their territory. Shortly beyond this another group was met. As previously the natives brought much sugar cane, and many sweet potatoes, bananas and pigs.

On August 7 the patrol proceeded northwest and reached the Balim River. The population remained friendly and helpful, and even women brought sweet potatoes; native food was plentifully offered. By radio the patrol learned that the airplane contact with van Arcken on the 6th had been successful. The next day, August 8, local patrols showed that the camp was in the extreme northwest corner of the Grand Valley, near the confluence of the Tagee River with the Balim. Some six kilometers southeast another river, the Moenak, also joined the Balim from the north. From the air photographs it appeared that this latter was the meeting place agreed on, and Captain Teerink moved there on August 9. The population appeared more timid, but friendly. Here there was another change in the attitude of the natives, in that they readily took cowrie shells. Next day, August 10, a patrol was sent back

for the 100 kilograms of rice left behind, but the patrol, returning the same night, reported it had disappeared, taken by the natives. At this camp another pig ceremony was performed. The next two days were spent in local patrols. The country was all grassland, the only forest being on the mountains above the Grand Valley. There were many gardens, and the population quickly became friendly, only the women remaining somewhat shy.

On the 13th, as scheduled, the plane delivered food supplies. No trace of van Arcken had been found until the plane was seen dropping parachutes about ten kilometers south of Teerink's position. It was evident that van Arcken was there. The plane then dropped the foodstuffs for Teerink's party. The provisioning was carried out successfully, only one parachute failing to open, and only a few items thus being lost.

Teerink set off for the place where the plane had been seen to drop supplies, and by noon had joined van Arcken. The next day all of Teerink's patrol moved to the site of van Arcken's camp, and the opening up of the overland route was completed.

Plans for the return journey were now made. Van Arcken was to go back to Archbold Lake, where the "Guba" would pick him up and fly him to Bernhard Camp; Teerink was to proceed down the Balim to where recent airplane reconnaissance had shown that it was possible to land the plane. A number of Dyaks were exchanged between the two patrols, so that if it were ever necessary to use the overland route there would be men who had made the whole trip, not just half of it.

On August 15, Teerink set off down the Balim. Native guides could not be secured, as they would go but a short distance and would attempt to keep the party from proceeding farther. About the camp that night, which was apparently placed between the territories of two enemy groups of natives, the natives became very excited. As a demonstration a rifle shot was fired into a tree. The result was overwhelming. The hundreds of natives were suddenly gone and only returned with lagging steps.

Three days the patrol continued down the Balim, looking for a suitable stretch of river on which the plane could land. The river quickly lost the mountain torrent appearance it had where it entered the valley and became slow and meandering. The banks were lined with reeds or *Casuarina* trees. It was sometimes necessary to follow native tracks far from the river to cut off from the route many miles of meandering. The natives continued friendly, but sometimes violently protested against the patrol's leaving their area. The stretch of river on which the plane was later to land was reached on the evening of the third day. Here the natives were friendly, and one of the "dog-tired" Dyaks was even able to have his load carried by a Papuan, the first time this had occurred.

On the morning of the 19th a reconnaissance was made of the proposed landing place. It was seventy-five to 100 meters wide and seemed suitable. At 9:00 a.m. Teerink radioed all was ready; at 10:00 a.m. the plane arrived and landed. The patrol was moved to Lake Habbema in two flights.

Lieutenant van Arcken's Patrol.—On July 25, van Arcken with a force of twelve soldiers, radio operator Bazzoni, ten convict coolies and twenty-four Dyaks, with fourteen days' food and a radio, set off southward for the meeting place in the Grand Valley. The first two days the route climbed the Idenburg slopes over a trail that had been cut on preliminary reconnaissances. The radio could not be made to work and, with the operator, the four Dyaks who carried it and one Dyak who was sick, was sent back to Bernhard Camp. On June 27 the patrol entered new country. A Papuan path was soon found and followed. It led down a steep mountain slope, where shortly after mid-day natives were met. Perhaps 100 houses were seen by the time camp was made at 2:00 p.m. by a stream (Sigi). The natives here had a few knives, probably traded through from the Idenburg River.

On July 28, leaving at 6:30 a.m., the route lay past fenced-in gardens, where sweet potatoes, taro, sugar cane and bananas were grown. Visiting a village, pigs

were brought and a few purchased for a knife apiece. Then the patrol descended to a river, the Sahoeweri, which lies in a deep, narrow valley, climbed the other slope along a native path and pitched camp at about 1,100 meters near a village at 1:30 p.m. The natives were friendly, and at one time there were about eighty around the camp.

The next morning (July 29), two convicts and eleven Dyaks, who had been carrying food now consumed, started back for Bernhard Camp with an escort of three soldiers. At 6:30 a.m. the patrol went ahead with three Papuans as guides. They followed a much traveled path that led southward over a divide. By 9:30 the crest was reached, and the path descended into the valley of the Tjokkifoeri. The offer of a knife would not persuade the Papuans to go farther. In half an hour contact was made with other natives. The path became steep and rocky; by 2:30 the stream was reached, and camp was made at about 700 meters altitude. Many houses had been seen during the afternoon, and natives crowded about the camp in the evening.

July 30 camp was left at 6:30 a.m., and the climb of the south slope started. At 8:30 the wooded crest was reached, and the densely populated ravine of the Wagifoeri lay ahead. An hour later the stream was reached, where about 100 Papuans came to inspect the party. The climb up the nearly barren ridge ahead took until 1:30 p.m. About 2:30 a beautiful view was obtained of the Dinginfoeri Valley. It was populated only in its upper portion. The descent to the river, the Dinginfoeri, was gradual and through secondary forest, where camp was established at 4:30 p.m. at about 500 meters altitude. Guides had been obtained for short distances during the day, but none would go far beyond their village area.

Leaving camp at 6:30 on July 31 the patrol followed the river downstream, reaching the Hablifoeri, the main stream, at 7:30. The white rocky river bed was forty to sixty meters wide, bordered by casuarinas. It was fordable in only a few places. The water was blackish gray from the silt it carried. The patrol then turned up the Hablifoeri, cutting its way along the bank. At 11:00 a.m. they rested by a tributary, the Laroeri (or Larderi), about half the size of the Dinginfoeri. A short distance upstream a good path was found, and a rattan bridge across the Hablifoeri, though no gardens were visible. Camp was made at 2:30 p.m. near a waterfall, at an altitude of about 650 meters.

August 1 the party continued up the Hablifoeri, following a river-bank ledge. At 9:00 a.m. they reached a place where the river rushed through a chasm a few meters wide. The track crossed here on a rude bridge and turned southward, so the patrol left it and cut their way toward Archbold Lake. The terrain was very rough and mountainous, and the lake could be seen from one point where the cut trail crossed a ridge.

On August 2 the trail cutting commenced at 6:30 a.m., and the lake was reached at 8:00 a.m. It was about 800 by 1,000 meters in size and lay at an altitude of about 700 meters. It lay about one kilometer from the Hablifoeri, and at about the same level. The lake bottom quickly sloped to several meters' depth, and in the center was more than fifteen meters deep. To the south of the lake lay a small, to the north a large, herbaceous marsh. The east and west slopes were fairly steep and wooded. There were no gardens near the lake. Bird life was abundant; many herons, ducks and smaller birds were seen, as well as snakes and turtles. Fish similar to those caught in the Idenburg were taken.

The next two days were spent in the vicinity of the lake, one day in resting, one in local patrols to find the start of the trail south and in cutting trees on the southern lake shore to make the plane landing and take-off safer.

At 7:00 a.m. on August 6 the "Guba" was heard overhead above the low-hanging clouds. It went on to the Grand Valley, where it re-provisioned Teerink. By 9:00 a.m. the weather had cleared and the plane was back. At first it was doubtful whether it could land on this little body of water. But a survey showed that the Dyaks had sufficiently cleared trees from the south

end of the lake, and the plane landed. No collapsible boat was carried that trip, so unloading proceeded directly from ship to shore. The take-off presented no serious difficulties. The rest of the day was spent in camp.

August 7 the patrol set off southward at 6:30 a.m., retraced its steps down the Hablifoeri and crossed the river on the rude bridge across the chasm. They then followed a native track southward, the same path they had left on August 1. One old man was met, who at first wanted the patrol to turn back. Camp was made at 2:30 on the Baboei River.

August 8 at 6:30 a.m. the patrol again started, following the path toward limestone mountains showing ahead. The ascent was gradual at first, but after crossing a stream it became steep. It was always raining, and the trail was muddy. To the east perpendicular white walls (limestone) could be seen. About 11:00 a.m. the path entered a basin where thin bamboo grew. At 12:00 p.m. the divide (Modderpas) was reached at about 1,800 meters altitude. Here a native was met who offered to act as guide to the valley ahead, apparently the valley of the Hoeji (Hoej or Iloej) River, later found to be a tributary of the Balim. By 2:00 p.m. the patrol entered garden areas, and camp was pitched a half hour later on the Idaab River at about 1,700 meters altitude. The natives were friendly and offered many sweet potatoes to the patrol. Drainage ditches thirty to forty centimeters deep were common in the gardens. Here for the first time the natives knew of the Balim River, which they indicated was to the southwest.

Next morning, August 9, at 6:30, the patrol set off along a good path. It led over a mountain ridge covered with rhododendrons, ferns and raspberries—a New Guinea peat-moor scene met for the first time. Here were villages of four to six little houses, the houses grouped close together and surrounded by a high fence. Numbers of friendly natives joined and accompanied the patrol. At 8:30 a spur of the mountain ridge was crossed and the Hoeji Valley reached. Here for the first time the patrol found one of the large, densely populated valleys of central New Guinea. Everywhere were beautifully laid-out gardens. Many pigs were offered. The many natives were mostly armed with long spears. At 11:00 a.m. the patrol passed from this populous, friendly land to march through old, deserted garden areas. South of the Hoeji lay the Goemboel Ambera, a gray limestone mass with a barren crest more than 3,000 meters in altitude. Near the track conical limestone formations stuck out above the trees here and there. Here the Hoeji ran in part between perpendicular walls, sometimes even underground. Toward the south, gardens were seen again. Camp was pitched on a stream called the Dzjinggi at 3:00 p.m. Soon great numbers of natives appeared near camp, armed with bows and spears, their approach heralded with yapping cries, not the "wa, wa, wa" to which the patrol had become accustomed. These natives at first were somewhat aloof, but gifts of cowrie shells soon caused them to be friendly. An incident might be mentioned, showing the vigilance necessary in this area. A large knife was stolen, and the whole group of natives fled, though the knife was later brought back and friendly contact again established.

Again at 6:30 on August 10 the patrol followed the native track down the Hoeji, now apparently called the Warok or Warohop River. In an open place natives waited with presents of pigs, and large numbers of natives accompanied the patrol. The path now led among casuarinas bordering the Warok, now through gardens or grass fields, past many heavily fenced villages. The natives were all very friendly; men, women and children followed along with the patrol.

At 11:00 a.m., by a village, the natives wished to have the patrol make a detour over rough country, instead of following the open track which led straight ahead to the Balim. The track was barricaded with branches and spearmen posted there. Here occurred the one incident of the whole expedition where more than a show of force was necessary. The Balim was reached at 1:00 p.m. Here the river was about twenty meters wide, with a flood bed about sixty meters wide. It could be waded

in a few places. Van Arcken was of the opinion that this must be the designated meeting place with Teerink and made camp at the junction of the Warok and the Balim Rivers.

The next two days were spent in reconnoitering. This was a heavily populated area with vast sweet potato fields. Many natives came from near-by villages to visit the camp. At one time some 200 men armed with spears and bows demonstrated before the camp, then dispersed. Two natives who visited the camp intimated that Teerink's patrol was farther upstream, and van Arcken himself found day-old traces of one of Teerink's local patrols.

On the 13th the plane came in and dropped foodstuffs, as has been told. After delivering Teerink's supplies the "Guba" returned and dropped a note to van Arcken indicating Teerink's position. At 11:00 a.m. the captain arrived, and the next day the two patrols joined.

August 15 van Arcken started back on his route. At 4:00 p.m. he camped at 2,000 meters, the highest point on the Bernhard Camp-Balim Valley route, above the Hoeji valley. The natives were very friendly, and some even carried loads for the carriers. The next morning, August 16, the patrol set off at 6:30, being seen off by large numbers of the friendly natives. By 10:00 a.m. the patrol reached the Mud Pass. Descending the other side, Archbold Lake could be seen. Camp was made at 3:00 p.m. and here, above the Hablifoeri, two Papuans awaited them. These people were definitely of the population that lay to the north; their name for Archbold Lake appeared to be "Kadi." On August 17 two and one-half hours' marching put them at the lake. No trace of population was seen. At the old camping place peanuts had been planted, and these had now sprouted. The next two days were spent in cutting trees about the lake to make safer the plane take-off.

On August 20 the plane came in, and the patrol was flown to Bernhard Camp in two trips. The patrol was successfully completed. Not only must officers and men who made this patrol be highly complimented, but the airplane crew, and especially Rogers who handled the controls, gave a wonderful performance in finding the patrols and landing and taking-off from a narrow, untried river and from a small, untried lake, at considerable altitudes.

Perhaps here should be appended a translation of van Arcken's summary of his observations on the people he met.

"There is a distinct difference between the Papuans living north of the Hablifoeri or Kadie and those living south of there. Not only do they differ in build, clothes and adornment, but the ways of living and laying out gardens differ also.

"The purest specimens of both tribes are encountered in the Sahoeweri ravine, at about three days' distance from Camp Bernhard and on the Baliem plateau situated northeast of Lake Habbema. In the in-between-lying ravines and valleys intermingling of both types has taken place. So there are connecting roads between the Sahoeweri and the Baliem.

"No paths lead from the Sahoeweri to the Idenburg River, although contact must exist between the mountain Papuans and the inhabitants of the Lake Plain, considering the axes and parangs which were found among the first mentioned.

"Below follow a few principally ethnographic particulars concerning the population.

Sahoeweri Papuans	Baliem Papuans
Body Build, etc.	
Small and muscular or taller but slender.	Well-fed, well-developed.
10–20 per cent dwarfs.	A few remarkable, muscular types.
Semitic types.	Same.
Have beards.	Same.
Hair is worn short, to about 10 cm. length.	Same. Sometimes a sort of bob style of greased, twisted braids. Baldness occurs.

Dress, Ornaments, etc.	
Penis sheath, straight or curved, sometimes reaching above the shoulder. The sheath is tied on with a few strings.	Same.
Long hair hanging down the back with snood.	Head-dress of couscous fur, feathers or small hairnets.
One or more rattan stalks around the hips from which loose-hanging tail-ribbon or tree leaf.	Same.
Women wear, low around the hips, a two-part small apron of loose-hanging grass.	Small two-part apron of woven fibers. Girls wear grass aprons.
Septum of nose pierced for wearing boar's tooth.	Same.
A piece of shell is worn on a small cord around the neck.	The large pieces of shell are not worn, only cowrie shells.
Bracelets of rattan.	Same.
	Sometimes one or more finger phalanges are cut off.
Arms	
Wooden bow with rattan string.	Same.
Reed arrows with wooden, bone or plain head.	
Lances are little used.	The wooden lance is main weapon.
Cassowary bone as dagger.	
Housing, etc.	
Round houses, walls of split logs, grass roof.	Same.
Houses together in small groups or separate. Not fenced in.	Houses are built on both sides of a street at the end of which is a larger house. The whole is fenced in with a 'pagger' 2 to 3 m. high.
Small round pig sties, built in a line.	Inside the fence are also the rectangular pig kraals and small gardens.
	Drainage ditches from 30 to 100 cm. deep.
Fencing of split wood.	Same, but on fence are laid the tree roots, etc., of the cleared ladang ground."

September

The attention of the expedition this month was focused on activities above Lake Habbema. An unsuccessful attempt to scale Mt. Wilhelmina was made. Our highest collecting camp at 3,800 meters was reached in two and a half days from the lake, and as the climate was cold and wet, good fuel and building material scarce and living conditions poor here at timber line, native personnel was reduced to a minimum and changed as often as possible. There was almost continual transport up and down the track. As the two main camps above Lake Habbema were not far distant from each other, the white personnel frequently visited back and forth.

The route to the 3,800-meter Camp was along the native path that led up the wooded west side of the amphitheater in which the 3,560-meter Camp was set, into a grassy valley, where it turned southwest toward the peak, past a lake about 300 by 400 kilometers in size, at 3,650 meters, climbed a steep, partly wooded bluff and arrived at about 3,800 meters at a saddle. Here the native track turned downward on to the south slope of the central range. We left the native track and entered the mouth of Lorentz's Oranje Valley, passing over grass amid huge boulders and scattered patches of low timber, to the 3,800-meter Camp site.

On September 1 Rand returned to Lake Habbema from the 3,560-meter Camp. On the 2d and 4th the plane came in, each time with a half month's supply of food. Archbold, Meyer-Drees, Schreuder, van Arcken and Versteegh also arrived at Habbema on these flights. On the 4th, after discharging cargo, a reconnaissance flight was made around Mt. Wilhelmina to examine it for the easiest route to the summit. On the 5th and 6th Archbold, Brass, Rand and Richardson joined Toxopeus at the 3,560-meter Camp; on the 8th Archbold, Teerink and Toxopeus selected the site for the 3,800-meter Camp. September 10, Meyer-Drees, Huls, Schreuder and van Arcken arrived at the 3,560-meter Camp.

Van Arcken spent considerable time mapping this country. On September 13 the plane dropped mail, fresh food and radio masts at the 3,800-meter Camp. September 14 to 16 Archbold and Teerink explored south of the peak of Mt. Wilhelmina seeking a route to the summit, and Archbold, Rand, Schreuder and Teerink continued this unsuccessfully September 20 to 28.

From our aerial reconnaissances it had appeared that the sloping southern side of the mountain would be the most feasible way to make the ascent. Scouting trips were made along the north side of the main ridge, past the cliffs where Lorentz and Kremer had found a way up through narrow crevices, to a point apparently near the Ramp-bivak of Lorentz. This route seemed difficult and dangerous. An attempt was then made from the south. From the 3,800-meter Camp the main ridge was climbed, where it was all grass covered, and crossed at 4,250 meters, just east of the rock cliffs (see photograph, Pl. XXXIII); a descent was made on the southern side along the base of the steep limestone slopes buttressing Mt. Wilhelmina, and camp was set up in a little grassy basin, about half-way between and in a line between the peak (not visible from there) and a little, apparently shallow lake to the south. This camp was occupied September 20 until the morning of the 24th. It was at timber line, at 4,000 meters, and above it only a few scattered shrubs occurred in the grass.

Bad weather kept the party confined to camp for three days, then September 24 in a northwesterly direction they followed up a shallow valley to a saddle (marked on the photographs, Pls. XXXIII and XXXIV) to find themselves confronted with a small valley, widening and deepening westward, separating them from the main central ridge. A little lake lay just in front. The small snow cap was visible from here, apparently not much more than a kilometer away. It might have been possible to go down into this valley, go up eastward to its head, and scramble straight up the steeply sloping, rough limestone to the peak. However, it was decided to go westward, down the valley, camp, and climb the main ridge west of the peak and follow along its crest to the peak.

The saddle was near the upper edge of all vegetation. There were still many grasses and herbs under foot, but everything higher was bare rock. The valley bottom ahead was littered with huge boulders. The party followed this valley down westerly on its southern side until shrubs appeared, and they camped at 4,100 meters by a huge block of limestone, whose more commodious shelter was preferable to the cramped quarters of the tents. This camp was occupied September 24 to 28. It was probably nearly directly opposite, on the southern side, the place on the central ridge where Lorentz climbed the same ridge from the north.

Very bad weather kept the party in camp most of the time. At last came a clear day, September 27. Teerink and Schreuder explored to the eastward and found a way to the top of the ridge, from which they estimated six hours of marching would have taken them to the summit. Archbold and Rand followed eastward up the bottom of the valley, close to the steeply sloping bare rock wall of the main ridge, and perhaps a kilometer above camp and probably not much more than two kilometers from the peak, started to climb nearly straight up the rough limestone slope that here had an angle of sixty to eighty degrees. It was a rough, arduous climb, but not difficult nor dangerous as such climbs go. Only occasional loose rocks were encountered. They gradually worked eastward and topped the crest of the ridge after about two hours of climbing. Through a break in the clouds they could see the snow field, not much above them, and perhaps a half kilometer or more beyond. To the north the country dropped almost sheer to the Oranje Valley. Directly opposite was the little lake in the valley to the south (though it was not in sight at that moment). This was probably near the point which Lorentz and van Nouhuys reached in 1910. Archbold and Rand were at a very narrow point on the ridge. A misstep either side could have meant a fall of several thousand feet. Just ahead

the ridge broadened but became rugged. It presented some short but awkward-appearing climbs. Since clouds were gathering, it was decided to return to camp. The time allotted for the attempt on Mt. Wilhelmina being up, all further attempts were discontinued.

Judging both from the recently fallen, huge masses of rocks lying in the valleys to the north and the south of the central limestone ridge, and the precariously balanced masses of rock on parts of the crest, it seemed that the crest of the ridge must have been rapidly changing shape. The size of the snow cap, as may be seen from the photograph, was evidently much smaller than when Lorentz and van Nouhuys visited the mountain. Where Archbold and Rand turned back there were occasional accumulations of old snow in crevices but none on exposed surfaces.

September 28, evacuation of the 3,800-meter Camp was started, and it was abandoned September 30. The evacuation of the 3,560-meter Camp was started September 29.

BOTANY.—Brass moved up to the 3,560-meter Camp September 5 and 6, the 3,800-meter Camp September 17. He returned to the 3,560-meter Camp September 29, and Lake Habbema on the 30th.

ENTOMOLOGY.—Toxopeus spent the month at the 3,560-meter and 3,800-meter Camps, returning to Lake Habbema September 30. Olthof continued his work at Bernhard Camp.

FORESTRY.—Meyer-Drees spent the period from September 10 at the 3,400-meter and higher Camps, returning to Lake Habbema September 29. Versteegh worked about Lake Habbema during this period.

MAMMALOGY.—Richardson collected from the 3,560-meter and 3,800-meter Camps after September 6. Mammal-collecting boys worked from the camp not occupied by Richardson.

ORNITHOLOGY.—Rand worked from the 3,560-meter and 3,800-meter Camps and from higher camps to the south of Mt. Wilhelmina September 6 to September 30. Bird-collecting boys worked at the lower camps in Rand's absence.

OCTOBER

The first of October found the complete personnel of the high altitude party reassembled at Lake Habbema. The next day the plane came in with one-half month's food supply and returned to Hollandia via the Idenburg, returning van Arcken to Bernhard Camp and leaving Huls there for an inspection trip. Schreuder returned to Hollandia. On the 5th the plane brought in the second half of the month's stores; it had stopped at Bernhard Camp, and Huls returned to Lake Habbema. The plane then stayed on until the 8th so that the crew could aid Rand in collecting materials for a bird exhibition group for the American Museum.[1] On the 8th the plane returned to Hollandia, taking Meyer-Drees, who was returning to Java by the next boat, and Archbold.

On October 8 Brass and Toxopeus set out northward to select and establish a new camp at about 2,800 meters altitude. The local explorations of the military patrols, and of Toxopeus on August 22 to 24, had already indicated the route to the north and the probable site of the camp. The other members of the party moved down at intervals. As two months' reserve of food in addition to current stores were at Lake Habbema, for some time there was continued transport bringing this to the 2,800-meter Camp. In this transport we were much helped by the local natives carrying loads. The Lake Habbema Camp was kept open all this month.

Since transport and military protection were available, it was advisable to establish and provision the next camp, which was to be at an altitude of about 2,200 to 2,300 meters, as soon as possible. This would leave transport free in November to establish camp on the Balim, from which we were to be flown to Bernhard Camp at the completion of our work.

The period October 25 to 29 was spent by Brass and Teerink in a patrol of the Bele Valley and the smaller, rather recently settled Etlanti Valley, southeast of the Bele. They chose for the next collecting camp a site at 2,200 meters, near the upper

[1] For an account of collecting this group, see Rand, 1940, Natural History, XLVI, pp. 136–141.

edge of population in the Bele Valley. Teerink and Huls established this camp on October 31.

While collecting went on at the 2,800-meter Camp, stores and equipment that could be spared were taken down to the 2,200-meter Camp. Specimens were sent up to Lake Habbema to be taken out by the airplane on its final flights there in November. Richardson made a return trip to Lake Habbema to inspect the condition of specimens on October 30.

BOTANY.—Brass moved to the 2,800-meter Camp on October 8, and except for the period of October 25 to 29 taken up with the excursion into the Bele and Etlanti Valleys, continued collecting there. With the return of Meyer-Drees to Java and the continuance of his assistant, Versteegh, Brass undertook the direction of Versteegh's work, which materially increased his duties.

ENTOMOLOGY.—Toxopeus moved to the 2,800-meter Camp on October 8 and collected from there until the end of the month. Olthof was still at Bernhard Camp.

FORESTRY.—From now on Versteegh, while continuing to collect material for the Forest Research Institute, Buitenzorg, worked under Brass' direction, and in general from the same localities, so that henceforth his work will not be listed separately.

MAMMALOGY.—Richardson moved to the 2,800-meter Camp on October 9 and continued work there the rest of the month.

ORNITHOLOGY.—Rand collected material for an exhibition group to show the bird life of the highlands about Lake Habbema, October 5 to 10. This material was stored in a tent at the Lake Habbema Camp during the month. Rand moved down to the 2,800-meter Camp October 10. He continued work there the rest of the month.

NOVEMBER

This month found the expedition working at the 2,200-meter Camp. On the 11th Teerink, Huls and Toxopeus set out for the camp site on the Balim already selected by Teerink in August. They arrived there on the 14th, and the next day the plane landed there with provisions. Archbold also came in to stay a few days. On the 16th, 18th and 19th additional flights with provisions were made; Archbold returned to Hollandia with the last flight.

Twice after discharging cargo on the Balim, Rogers brought the "Guba" to Lake Habbema, taking out specimens and group material. Lake Habbema Camp was abandoned November 18, having been kept open since July 9.

November 23 to 25 Teerink and Toxopeus returned to the Bele River Camp, Huls being left in charge of the Balim Camp. On November 27 Teerink with Versteegh and a Sundanese entomological collector left for the Balim Camp with another transport, arriving there on the 29th.

BOTANY.—Brass moved to the 2,200-meter Camp on the 10th and collected in the vicinity the rest of the month. Versteegh moved to the Balim River Camp November 27 to 29.

ENTOMOLOGY.—Toxopeus made the round trip to the Balim and back November 11 to 25, collecting along the way and also having Olthof come in by plane on the 16th and remain at the Balim. One Sundanese collector was sent to the Balim Camp November 27 to 29.

MAMMALOGY.—Richardson moved from the 2,800-meter Camp November 8 and worked at the 2,200-meter Camp from then on.

ORNITHOLOGY.—Rand moved from the 2,800-meter Camp November 10 and spent the rest of the month at the 2,200-meter Camp, except for a trip to Lake Habbema November 14 to 19 to see to shipping the collections and group material.

DECEMBER

Teerink brought the carriers back from the Balim to the Bele River Camp December 1 to 3, and on the 5th Brass, Rand, Richardson, Teerink and Toxopeus set out for the Balim.

Camp was left about 7:00 a.m. The party consisted of eighty-seven men. To facilitate supervision the party was split into two units, traveling a half-hour apart. The route led along a much-used native track on the east side of the valley, well up above the Bele River. Soon the party was moving past and through well-tilled gar-

dens and past many villages on the steep slopes. The natives, by now having had considerable experience with our transport lines from previous porterage, were still interested in us. Contacts remained friendly when we left this valley for good. Camp was reached about 12:30 p.m., in an uninhabited area of shrubbery at 2,200 meters, within but near the mouth of the Bele Valley.

The next morning, December 6, camp was broken at 6:30. Some populated areas were passed, and a spur, carrying shrubbery of high altitude aspect, was crossed into the Grand Valley about 7:30. From here native paths were followed across broad, grassy slopes, evidently once tilled but now mostly fallow. Few natives were encountered. Slowly descending over somewhat ridgy country, between 1,860 and 1,680 meters, an area of open oak—*Castanopsis* forest studded with auracarias—was traversed. Crossing a small stream, a native track led over undulating to ridgy country clothed with grass but with many small forest patches. Several large villages were skirted. Camp was made about 2:00 p.m. by a stream in a grass and shrubby country where a few natives visited us late in the day. Mosquitoes were troublesome here.

Next morning, December 7, camp was left at 6:30. The Wamena, reached in about an hour, was a broad, shallow, but rapid stream that presented some difficulties, and the crossing took about forty minutes. Beyond, the party passed through an area of heavy population, many of whom regarded the patrol with indifference and continued to work in their gardens. Areas of intensive cultivation alternated with grassland and shrubbery. Nearing the Balim Camp, marked from afar by a huge, red erosion gulch on the slope to the southwest of it, the land became stony. Once tilled, most of it had been abandoned. Stone fences separated the fields, instead of trenches as had been the case near the Wamena. The camp on the Balim was reached about 1:00 p.m.

The whole party collected from this camp until December 18, when the first evacuation flight was made. On the 19th and 20th the rest of the party was transferred to Bernhard Camp, and on the 20th the scientific personnel and van Arcken went on to Hollandia for a vacation over the New Year. Teerink took over command of Bernhard Camp and spent December 24 to 30 patrolling in the neighborhood.

BOTANY.—Brass moved to the Balim Camp December 5 to 7 where Versteegh had already preceded him. Brass flew to Hollandia December 20, staying there the rest of the month, while Versteegh worked at Bernhard Camp after December 20.

ENTOMOLOGY.—Toxopeus collected from the Balim Camp December 7 to 18, where his assistant had been working since the middle of the preceding month. On the 20th Toxopeus flew to Hollandia, leaving his assistant in Bernhard Camp.

MAMMALOGY.—Richardson moved to the Balim Camp December 5 to 7 and flew to Hollandia December 20.

ORNITHOLOGY.—Rand moved to Balim Camp December 5 to 7 and to Hollandia December 20.

JANUARY

This marked the beginning of the collecting on the Idenburg slopes, and here the splendid exploration work of van Arcken proved of inestimable value to the scientific party. Van Arcken had thoroughly explored these slopes and had had a trail cut from Bernhard Camp to the highest practical summit within reach of that camp; it was at an altitude of 2,150 meters and could be reached in two and one-half days' march. Van Arcken had also chosen and made this trail with the object of selecting a number of collecting camps at about the altitudes required.

The result was that we worked at the highest altitudes first, and on our way up picked out a camp site at 850 meters and one at 1,200 meters. These the military party prepared for us so that when ready to move to them we were able to go right to work. Thus the aid of the military party saved us days of work and speeded up the expedition.

On these uninhabited Idenburg slopes we were rarely visited by natives, and it was

practical to establish small subsidiary collecting camps.

Throughout the stay on the Idenburg slopes, where the distance between camps was never more than a day's march and usually less, there was much visiting back and forth and almost continual transport.

On January 2 and 3 the plane brought Brass, Rand, Richardson, Toxopeus, van Arcken and supplies to Bernhard Camp. Teerink returned to Hollandia on the 2d for a few days' well-earned vacation.

January 6 and 7 Brass, Rand, Richardson, Toxopeus and van Arcken climbed to a camp already established at 1,800 meters, where they settled to work collecting. After January 20 a camp at 2,150 meters, already partly prepared by van Arcken, was operated more or less as a subsidiary camp, and after January 26 a subsidiary camp at 1,560 meters near the 1,800-meter Camp was operated.

BOTANY.—Brass arrived at Bernhard Camp January 3 and with Versteegh carried on collecting from the 1,800-meter Camp from January 7 until the end of the month. Versteegh went to the 2,150-meter Camp January 31. From January to the end of the expedition Brass had, in addition to his Dyak collecting boys, a half-caste assistant, Max Dexner, engaged at Hollandia.

ENTOMOLOGY.—Toxopeus also arrived at Bernhard Camp January 3 and at the 1,800-meter Camp January 7. He collected at the 1,800-meter Camp until January 20, when he went to the 2,150-meter Camp, returning and going down to the subsidiary 1,560-meter Camp January 26. His two Sundanese collectors were left at the 2,150-meter Camp for the rest of the month.

MAMMALOGY.—Richardson arrived at Bernhard Camp January 3 and at the 1,800-meter Camp January 7, working there until January 31, when he moved to the 2,150-meter Camp. His Ambonese collecting boy was sent with Toxopeus to the 1,560-meter subsidiary Camp.

ORNITHOLOGY.—As with Mammalogy.

FEBRUARY

The plane made one flight to Bernhard Camp on February 9 bringing in Schreuder and supplies, and one on February 21 with supplies. Teerink and Rand met the latter plane to discuss plans with Archbold.

The 2,150-meter Camp was evacuated February 10, the 1,800-meter Camp February 11. All the scientific staff, as well as Teerink, van Arcken, Schreuder and Huls, were assembled at the 1,200-meter Camp February 13. On February 15 Toxopeus and van Arcken established a subsidiary camp on the Sigi River; Teerink and Schreuder visited this camp February 28, and it was evacuated the next day.

BOTANY.—Brass collected from the 1st to the 10th at the 2,150-meter Camp; he took three days to make the trip to the 1,200-meter Camp, collecting along the way. From the 13th on he was in the 1,200-meter Camp.

ENTOMOLOGY.—Toxopeus vacated the subsidiary 1,560-meter Camp February 2 and descended to the 1,200-meter Camp February 3, where he collected until February 4, with a trip to Bernhard Camp February 5 to 7. He spent the period February 15 to 28 at the subsidiary Sigi Camp; his assistants remained at the 1,200-meter Camp.

MAMMALOGY.—Richardson worked at the 2,150-meter Camp February 1 to 10, descended to the 1,200-meter Camp February 11 and spent the rest of the month there. One of his collecting boys accompanied Toxopeus to the Sigi Camp February 15 to 28.

ORNITHOLOGY.—Rand collected at the 2,150-meter Camp February 1 to 10 and descended to the 1,200-meter Camp February 11 and 12, collecting along the way. He spent the rest of the month at the 1,200-meter Camp, with one trip to Bernhard Camp February 20 to 23.

MARCH

March 1 the Sigi Camp was vacated, and Toxopeus moved to the 850-meter Camp. March 7 the 1,200-meter Camp was evacuated, and the entire scientific staff was at the 850-meter Camp.

March 6 to 9 Huls, Schreuder and van Arcken made a patrol into the Sahoeweri Valley to gather information on the people.

March 24 a subsidiary camp at the foot

of the Idenburg slopes, about two kilometers from Bernhard Camp, was decided on, and construction started.

The plane brought provisions to Bernhard Camp March 15 and 29, on the return trips taking out to Hollandia Schreuder, one military man, seven convict coolies and twenty-two Dyaks.

BOTANY.—Brass collected at the 1,200-meter Camp until March 4, then moved the two hours' trip to the 850-meter Camp, where he spent the rest of the month.

ENTOMOLOGY.—Toxopeus moved from the Sigi Camp to the 850-meter Camp March 1, where he spent the rest of the month, with one trip to Bernhard Camp March 13 to 16.

MAMMALOGY.—Richardson collected at the 1,200-meter Camp until March 6, then spent the rest of the month at the 850-meter Camp.

ORNITHOLOGY.—Rand remained at the 1,200-meter Camp until March 7, when he descended to the 850-meter Camp and worked there, except for the period March 18 to 27 which he spent at Bernhard Camp to study the effects of high water on bird life.

APRIL

By April 8 the 850-meter Camp was abandoned, and all further work was carried on at Bernhard Camp and its subsidiary camp at the base of the mountains. Less military escort being necessary, Teerink and part of the military personnel returned to Java, and more Dyaks were sent to the coast.

BOTANY.—April 6 Brass moved to the subsidiary Bernhard Camp, and on April 18 to the main camp.

ENTOMOLOGY.—Toxopeus left the 850-meter Camp April 4 and collected from Bernhard Camp and its subsidiary April 4 to 14. He and his assistants were flown to Hollandia and left for Java, finishing the entomological work.

MAMMALOGY.—Richardson left the 850-meter Camp April 8, remained at the subsidiary Bernhard Camp until the 24th, then moved to the main camp.

ORNITHOLOGY.—Rand left the 850-meter Camp April 8 and moved directly to Bernhard Camp, from which all his subsequent work was done.

MAY

This month saw the end of the expedition. All inland work was restricted to the vicinity of Bernhard Camp, and it was evacuated May 8, 9 and 10, the whole party being flown to Hollandia.

The "Guba," with Rand aboard, left Hollandia for Port Moresby and Australia May 12, and the rest of the inland personnel left Hollandia by monthly K. P. M. steamer on May 21.

DESCRIPTION OF COLLECTING STATIONS

The stations are taken in geographical sequence, starting with Hollandia on the coast and proceeding southward to Bernhard Camp and the camps above it to 2,150 meters on the Idenburg slopes, then the Balim River Camp and those above it to the 3,800-meter Camp on Mt. Wilhelmina.

HOLLANDIA, HUMBOLDT BAY

Work on construction and organization of the base left the American staff little time for collecting in the interval between the arrival of the advance party at Hollandia in April and the arrival of the "Guba" toward the middle of June. Such time as was available between that and the departure of the party for Lake Habbema was devoted to a sampling rather than a systematic working of the various habitats about Hollandia, and there were opportunities for excursions to the bat caves at Tandjoong Skol on the southern shore of Humboldt Bay, the inner harbor known as Jautefa Bay, the near slopes of the Cyclops Mountains and Lake Sentani. After the

arrival of the Netherlands party on June 17, Toxopeus did chiefly intensive work in the immediate neighborhood of Hollandia, while Meyer-Drees divided his time between Hollandia and a nine-day trip to the south slopes of the Cyclops by way of Ifar on Lake Sentani. The most complete collections from the general locality were in butterflies, of which more than 230 species were taken. Other collections included a few birds, some mammals (mostly small bats) and about 400 numbers of plants. These collections were later augmented by purchase from local residents: some 175 bird and 30 mammal skins from Mr. F. J. Ebeli, and a collection of insects from Mr. W. Stuber.

Humboldt Bay lies in an attractive setting of grassed and forested hills and dark mountain ranges broken by the alluvial plains of the Tami River to the south. Not far from its eastern shore, Mt. Bougainville, across the border in the Mandated Territory, rises abruptly to 1,206 meters. The western shores, which concern us most, are alternately rugged and reed-fringed and edged with sandy beaches on which a considerable surf breaks in the southeast monsoon. A narrow passage on this side of the bay gives entrance to the landlocked inner harbor of Jautefa, from which a good road, passable by motor cars, leads inland nine and a half kilometers to Lake Sentani. On the northeast corner of the bay, where the Cyclops Mountains (2,160 meters high) rise steeply from the water's edge, two small islands protect the entrance of another inner harbor, at the head of which is the township of Hollandia. Hollandia is built in a little glen, so low-lying that the fresh ground water rises with the tides to within a foot or two of the surface, and so hemmed in by mountains that much of it lies in shadow after mid-afternoon. An L-shaped dyke protects the township from the flood waters of a little gravelly, reed-fringed river that flows through the glen, and from sea water backed up by occasional southeast blows. A graded path, over which one may take a horse or a bicycle, connects Hollandia with the Jautefa-Sentani road.

Hollandia is the administrative center of a vast district of mostly little-known or quite unexplored territory extending west to the Mamberamo River and south to the Snow Mountains. Over this, nominal control is exercised by a gesagheber, with the assistance of a few outpost officers and a detachment of about fifty field police. Formerly Hollandia was a center of the bird of paradise trade; the now commercially unimportant town has a population of about 200 consisting of government employees and their families, Papuan servants, Malay artisans and Chinese engaged in trade. There is a small export in copra, kapok, cacao, marine products and also orchids. A scheme to settle Eurasians from Java in the general area, and particularly about Lake Sentani, met with failure, and the majority of the colonists have returned to their home country. The plantation products exported represent chiefly the scarcely profitable output of small government plantings and the properties of two German expatriates from what is now the Mandated Territory of New Guinea.

The low world markets and the high freight rates responsible for this gloomy economic picture do not, however, much concern the native Papuans, who live as of old by agriculture, the product of their sago swamps, fishing and a certain amount of hunting, and get along with a minimum of manufactured goods. Their cultivated food plants include sweet potatoes, taro, yams, bananas, sugar cane and coconuts, papaw, pineapples, maize and a variety of small crops of recent European introduction.

At least geographically, population is divided into coast dwellers and lake dwellers. The coast people live in villages built over the water on piles and have stubby outrigger canoes. The much more numerous lake people, numbering about 7,000, occupy both dry land and pile villages and have long, rakish canoes which they manage to keep afloat without a stabilizing outrigger. It is due to the efforts of the native population, the destruction of the original heavy forest, repeated cultivation and disturbance by fire over a long period of time, that strips of the coastal hills and

an extensive area of several hundred square kilometers around Lake Sentani have become and are maintained as grassland.

Average annual rainfall at Hollandia is 2,336 millimeters, of which sixty-four per cent falls in the northwest monsoon season, November to April, and thirty-six per cent in the southeast trade wind season, May to October. February, with an average of 310 millimeters over eleven years of recorded rainfall, is the wettest month; September, with 86 millimeters, the driest.[1] Although the days are humid and enervating in the northwest monsoon season, night temperatures throughout the year are modified by a downdraft of cool air from the mountains. As judged by coastal New Guinea standards, the climate is neither unhealthy nor unpleasant.

Both non-calcareous rocks and limestone, the latter exhibiting perpendicular faces and containing caves, occur at low elevations about Hollandia. Streams disappear underground, and parts of the Cyclops Mountains, the upper levels of which are of limestone, are practically devoid of surface water. On an excursion up the slopes of this range, Brass and his Dyak collecting boys traveled twelve hours with no water other than the usually acrid and not very potable fluid obtained from the stems of lianes.

The mangrove formation is poorly developed on the western shores of Humboldt Bay. Stands of *Casuarina equisetifolia* and the sand-binding vine (*Ipomoea Pes-caprae*) characterize the strand vegetation. In the fairly luxuriant rain-forests which clothe the limestone ridges about Hollandia, *Pometia pinnata*, with large shining leaves, is a common and conspicuous tree, and mesophytic ferns such as *Dryopteris phaeostigma* and *Tectaria ferruginea*, and especially tall-growing *Selaginella caudata*, characterize a plentiful herbaceous undergrowth. The non-calcareous ridges carry a drier type of heavy rain-forest in which common canopy trees include rough-barked *Syzygium* spp., *Gordonia papuana* and two or three Dipterocarpaceae; woody undergrowth is plentiful, and the harsh fern (*Syngramma pinnata*) the characteristic floor plant. Dense swamp forest of sago palms, favorite haunts of wild pigs, occur here and there in hollows between the ridges about Hollandia and cover considerable areas around the edges of Lake Sentani. Oaks (*Quercus* sens. lat.) appear in the forests at about 350 meters on the slopes of the Cyclops. At about 550 meters mosses and hepatics are abundant on both the trees and the ground of tall, moist forests in which the treeferns (*Cyathea melanoclada* and *C. pulcherrima*), a climbing pitcher-plant (*Nepenthes*) and masses of subscandent *Cyathea biformis* are striking features of the undergrowth. Conspicuous from an airplane and against the skyline as the range is viewed from the bay are tall trees of the coniferous genus *Araucaria*, common at the upper levels.

A distinctive dry primary brush occupies some low coastal hills on Jautefa Bay. The hills are of raw coral limestone with a rough, pitted surface in which are numerous pockets of rich-looking though very dry red soil. In these soil pockets root such small trees and shrubs as *Mallotus* sp., *Pittosporum ferrugineum*, *Myoporum papuanum* and the striking, Yucca-like tree (*Pleomele multiflora*) which attains a height of five to six meters and raises its stout branches above the general level of its associates.

Some patches of grass-covered ground to the south of Lake Sentani appear from the air to be marshland. With the possible exception of these areas and marshy edges of streams and of the lake, which can scarcely be termed grassland, all grass cover in the general area is clearly a secondary condition, following deforestation by man. On the seaboard, where population is not so dense as to preclude selection of garden lands, this condition appears to obtain chiefly on the non-calcareous ridges, which have suffered more disturbance than the more fertile but generally more rugged limestone ridges, and on which the second growths that spring up after the destruction of primary forest are less vigorous than on limestone and dominated, moreover, by different species of trees. About Hollandia, some recently deforested limestone soils are occupied by lalang grass

[1] Braak, C., 1935, Nieuw Guinee, I, p. 186.

(*Imperata arundinacea*), the usual grassland pioneer on clearings in the rain-forest zone of New Guinea. Elsewhere in the locality the place of lalang may be taken completely or in part by *Ischaemum pubescens* or the scrambling fern (*Dicranopteris linearis*) or a mixture of both. The old-established grasslands of Jautefa Bay and Lake Sentani are dominated by *Themeda triandra* and other grasses characteristic of the dry *Eucalyptus* savannas of southern parts of the island.

Some unique successional communities, associated with peculiar soil conditions and containing plants seen nowhere else in the area, occur on seemingly long-deforested slopes on the northeast of Hollandia Bay. Evidently far from fertile, the red, lateritic soil of these slopes has a powdery texture and sets hard when exposed to the sun. From a few sedge clumps and scattered tufts of the grass (*Eriachne pubescens*) on the most sterile soil, succession appears to pass to a tangled cover of *Dicranopteris*, followed by *Ischaemum*, shrubs such as *Nepenthes mirabilis* and *Myrtella Beccarii*, and such forest second-growth trees as *Deplanchea* sp., *Xanthostemon papuanus* and *Commersonia Bartramia*. *Acacia Simsii*, whose seeds germinate in great numbers after a fire in the fern and grass, forms pure scrubs which, with a species of *Casuarina* occurring as a small tree, give a distinctly Australian appearance to the landscape.

There were few birds restricted to or commonest in the secondary grassland and shrubbery at Hollandia. The open grassland held the warblers (*Cisticola* and *Malurus*); the willie-wagtail (*Rhipidura leucophrys*) frequented all the open habitats about the beaches and through the town; the kite (*Haliastur indus*) was common; crows (*Corvus*) were found by the expedition only along the coast about Hollandia; and the nightjar (*Caprimulgus*) was common about the second-growth forest and grassland, as was the sunbird (*Cinnyris jugularis*). The honeyeater (*Meliphaga analoga*) was one of the commonest birds in the secondary brush, and the leatherhead (*Philemon novaeguineae*) and the butcher-bird (*Cracticus cassicus*) were the commonest forest species that invaded the trees in the town. Occasionally flocks of swifts (*Collocalia esculenta*, *C. vanikorensis*, *C. whiteheadi* and *M. novaeguineae*) appeared over the town or its surrounding second growth.

No ornithological field work was done about Sentani Lake, but from the collection, chiefly of grassland and marsh birds, made by Mr. Ebeli it appears that the grassland there is much richer in bird species than that about Hollandia; there occur such species as *Chlamydera cerviniventris*, *Synoicus ypsilophorus*, *Saxicola* (in some places only a mid-mountain bird), *Megalurus* and species of *Lonchura*. The collection of marshbirds: ducks, herons, egrets, gallinules, cormorants and anhingas, indicates the richness of that habitat.

The forests about Hollandia were rich in birds. The magnificent bird of paradise (*Diphyllodes*) occurred here near sea level, the lesser bird of paradise (*P. minor*) was common near the town, as were *Megapodius* and *Talegallus*. From local information the bird of paradise (*Drepanornis*) and the goura pigeon did not occur in the hill country about Hollandia but were common in the flat, forested country south of Humboldt Bay. Certainly we found none about Hollandia. Here is a case where an uncritical person might conclude that overshooting had exterminated those birds near the settlement.

The residents of Hollandia kept many lories in small cages, especially *Lorius* and *Chalcopsitta*, and some of the Papuans brought in numbers of swifts (*Collocalia esculenta*) taken from the caves where they were nesting.

Mammal trapping yielded very poor results, as in so many places in the lowlands of New Guinea. The best night's catch was four small rodents from 440 traps. The natives brought in some interesting mammals, including bats from neighboring caves, and a number of tree kangaroos (*Dendrolagus*) said to come from the flat forest south of the bay where *Drepanornis* and *Goura* were said to occur. These tree kangaroos made interesting pets, and several were brought back to America.

Two bat caves of considerable interest

were visited. One we found in the forest near Hollandia. At dusk a steady stream of little bats issued from a cleft in a small rocky ravine and moved away through the forest in a line that could be followed as such for nearly a hundred meters.

The cave at Tandjoong Skol was a slit in a wall of rock facing the sea. The cave was forty meters high and about as wide; the floor was deep water. Several species, from big fruit bats (*Dobsonia*) to little insectivorous bats, clung to its walls. From natives who guided us we learned that they sometimes came here to shoot the fruit bats, an item of food also prized by the local Chinamen. The actions of a sea eagle, flushed from the mouth of the cave, suggested that it might have been trying to catch bats. During our stay natives brought us dugongs taken near-by in the bay.

Bernhard Camp, Idenburg River

Established as an exploration base, reserve supply depot and radio station on June 29, 1938, Bernhard Camp was in continuous occupation by the military party until the termination of the field work of the expedition on May 10, 1939. Van Arcken, who commanded the detachment stationed there, spared no thought and effort to make it a comfortable camp. Tentage was discarded in favor of roomy buildings with roofs and walls of sago-leaf thatch. The staff dining room, the radio shack and a building used for the preparation of collections were mosquito-proofed with wire gauze carried in on the "Guba." As a measure of mosquito control, the forest, except for some trees left for shade, was cut down to a distance of 100 meters or more from the buildings. Other health precautions included the establishment in the clearing of about three acres of gardens in which sweet potatoes, and beds of beans (katjang pandjang), cucumbers, peanuts, shallots, capsicums and purslane were grown successfully for the personnel. Maize, tomatoes and lettuce did not do so well in the humid heat of this lowland climate. Much to the satisfaction of those keen fishermen, the Dyaks, the lagoon and the streams flowing into it furnished an abundance of fish, although to European tastes the catfish (*Siluroidea*) which comprised most of the catch could not be considered choice eating. The camp regime allowed opportunities for fishing and foraging for the palm cabbage, edible leaves and odds and ends of game to be had in the forests. Such dispositions and circumstances had much to do with the very good standard of health and morale maintained over almost a year of occupation, under sometimes trying conditions from which there was no escape. The chief ailments were mild malaria and septic sores on arms and legs. There was no case of beriberi, dysentery or other serious illness.

Among the varied camp activites may be mentioned the construction of a fleet of about ten canoes for general camp uses such as hunting and cargo-carrying, and, if the emergency should arise, for transport down the river. As an experiment by which the entomological collections were expected to be enriched, flowering shrubs of kinds known to be attractive to insects were brought from Java by Toxopeus and set out in an open place on the edge of the lagoon, where they promptly took root.

Between July 18 and August 20, in the low water season of 1938, Meyer-Drees, assisted by Versteegh, examined the flood plain forests and made comprehensive collections of plants at a time when most of the trees came into flower. Olthof collected insects from July 18 to the middle of November, 1938, and almost continuous work was carried out in this field from December 20, 1938, to April 14, 1939. The flood plains, and the mountain slopes up to an altitude of about 400 meters, were examined by the American scientific group under wet season conditions between April 6 and May 10, 1939. Collections from the locality included about 260 mammals, 1,000 birds and a total of about 900 numbers of plants.

Only fifty meters above sea level, Bernhard Camp was on an old cut-off bend of

the river, about sixty kilometers upstream from the Prauwen-bivak of the Kremer Expedition and about one kilometer from the foot of the mountains which rise from the southern edge of the Meervlakte. From the steep front of this unnamed mountain range the flat plains of the Meervlakte stretched unbroken for about sixty kilometers to the north, about eighty kilometers to the east, and about 250 kilometers in a direction approximately west. At its lower end, an hour's canoe journey from the camp, the ox-bow lake or lagoon formed by the cut-off was connected with the Idenburg by a narrow channel so that its waters fluctuated, slowly, with the rise and fall of the river. The old river bed beyond the upper end of the lagoon had become silted up and choked with marsh vegetation and forests of swamp-inhabiting trees. Instead of an upflow created by water entering its lower end, at times of high flood when the river overflowed its banks, there was a movement in the direction of the river's course, but even then only a slight current flowed through the lagoon. Having over most of its length a width of 400–500 meters and containing at all times an ample depth of water, the lagoon afforded an excellent landing place for the "Guba" and an anchorage in which the ship could lie in reasonable safety from damage by driftwood.

A high bank on the side of the lagoon nearest the mountains was chosen as the camp site. Situated about a kilometer below the anchorage, this bank formed a little promontory at the junction point of a stream of clear water and stood about nine meters above the June level of the lagoon. It appeared to combine the highly necessary feature of security from floods with advantages such as proximity to the anchorage and facility of approach to the mountains. Landings and take-offs could be watched from this position and cloud conditions on the mountains observed for the radio reports which the pilots of the "Guba" would require at frequent intervals when on inland flights. A small amount of clearing would allow free play to any breeze that stirred and also open up pleasing views. A camp shut in by forest can be very depressing.

The water of the lagoon fell another meter to reach its lowest level in August. A brief flood in the opening days of October, following a wet spell locally and in the mountains, inundated parts of the camp and aroused misgivings as to what might happen in the approaching wet season. This flood also rose over the "butterfly bushes" and killed them, just at the time when the most forward ones were beginning to flower. November marked the beginning of the rainy season at Bernhard Camp. As the monsoon gained force the average monthly level of the lagoon became higher and higher. A flood that destroyed the vegetable gardens in January caused the first serious inconvenience in camp. The receding waters left a sour, disagreeable smell, while swarms of mosquitoes, mostly *Anopheles*, which bred in the forest, infested the camp day and night. A higher flood came in February. The peak flood occurred in March when the waters, sluggish and silt-laden, covered the highest ground in camp to a depth of thirty centimeters. As the flood rose, the log corduroy paths between the buildings were replaced by trestled foot walks fitted with hand rails. High platforms were built in the godown to accommodate the stores, and the personnel slept on the tables or moved their beds to the crossbeams under the roofs of the barracks. Finally, in view of the possibility that the river might break back into its old channel, a flood refuge camp was set up at the base of the mountains, to which, should the necessity arise, men and supplies could be moved by canoe in a minimum of time. The water began to subside as these preparations were in progress, but Bernhard Camp "B" subsequently served a useful purpose as a subsidiary collecting station.

In April, when the collecting party returned to the river from the mountains, conditions were on the mend with the turn of the season. Bernhard Camp had altered greatly in appearance. The fine big trees which had shaded it from the sun had been cut down after one dragged its roots from the soggy ground and crashed over a

building, and the threatened fall of others constituted a grave danger to the camp. A deposit of gray silt on the ground was beginning to take a powdery form upon drying, while a silt band left on the vegetation of the surrounding plain marked the level attained by the floods. Most of the low trees lining the banks of the lagoon and side creeks had shed their leaves to the height of this silt band, although above it their crowns were green and flourishing and covered with vines in full flower.

When, at the end of April and the beginning of May, the water rose to within a few centimeters of the previous record high level, we were able fully to appreciate the trials the river garrison had been through. By cutting a passage through the underbrush in places, most of the forest of the flood plains could be traversed by canoe. Conditions such as these were more of an advantage than a handicap in hunting birds. One could pass at will from the heat of the marshes and open waterways to the comparative cool of the forests, then out again to cross some other waterway or examine some attractive swamp. On the other hand, all manner of creeping and biting creatures found their way into one's canoe and were soon in one's clothing and hair. Ants, spiders, everything that got shaken down when the vegetation was disturbed, were able to swim and immediately made for the nearest object upon which they could crawl. Sedges and other plants which one would normally find growing about the edges of marshes and on river beaches formed floating gardens on drift logs imprisoned in quiet backwaters. There was even a lizard that skittered from tree to tree along the top of the water. Early in the flood, the plant-drying ovens were placed on a raft, which despite the suffocating smoke from eight wood fires, became a popular gathering place where loiterers could at least escape the mosquito pest. Trapping and snaring operations on the flood plains were, of course, gradually restricted to the few small patches of ground that remained dry, and there little was caught. Insect collecting by canoe, as it concerned such things as butterflies and dragonflies, was more productive of thrills than specimens. In the botanical field, attention had for the most part to be confined to the smaller forest trees, the underbrush and a plentiful flora of epiphytes which could be reached from a canoe or dragged down with hooked sticks. Big trees could not be felled from a canoe because of the dangers involved, nor could they be climbed because of the ants which infested them.

The Meervlakte hereabouts was inhabited by a scattered nomadic people who kept out of the way of the expedition for two months, then, when friendly contacts were finally made, gathered in the vicinity of the camp, apparently in the hope of obtaining protection from their enemies. According to van Arcken, from whom we have most of our information concerning these people, they called themselves the Tabbertoea. In times of high flood they took to their canoes with their dogs and few household belongings and disappeared from the neighborhood, to return when the waters had somewhat receded. Van Arcken's description of the men as "big, heavily built, wild-looking fellows, covered thickly with itch" (i.e., ringworm) fitted well. Apparently they planted nothing, unless they can be credited with establishing some of the numerous breadfruit trees which occurred on the banks of the waterways. They built only temporary houses, subsisted on sago and by hunting and fishing, and perhaps seldom ventured far from their clumsy dugouts. Their arms consisted of black palm (*Caryota*) bows and long arrows tipped with wood, and many of them possessed Malay parangs (big knives), obtained no doubt from earlier white travelers on the river. The men wore an apron of bark cloth and a larger piece of the same material behind; the women, a skirt of bark cloth reaching about the knees. Earrings of cassowary wing quills, and boar's tusks passed through the septum of the nose, were common ornaments. The Tabbertoea were at enmity, it seemed, with the Fau people downstream and maintained trade relations with a mountain people in or about the Sahoeweri Valley. Occasionally a canoe load or two

would land at the camp, rather timidly, to exchange a wild pig or a cassowary for a knife or an axe, or just to see what was going on. Relations with the expedition left nothing to be desired.

As already stated, the mountains rose abruptly from the plains. There were no prominent spurs. About 200 meters of altitude were gained in each half-hour of steady climb to the crest of the fronting ridge where van Arcken's track to the inland camps surmounted it at 900 meters, scarcely more than two kilometers in an air line to the southwest of Bernhard Camp. Between the flood plains and the lift of the mountains was a strip of rising ground, a few meters to about 0.5 kilometer in width, consisting of stony ridges and gently sloping flats, the latter more or less swampy in the wet season. Several small streams, their beds gravelly on the plains, dropped down through rocky ravines to join deep, sluggish creeks or empty directly into the lagoon. The ox-bow lagoon on which the camp was situated had a length of about twelve kilometers. A few hundred meters to the east of it, in an older bed of the river, was another lagoon, roughly crescent-shaped, about three kilometers in length.

The prevailing vegetation cover consisted of rain-forests, which changed in character and composition as mountain slopes merged into flood plains and gave place to swamp-forests and open marshes on the lower parts of the plains. (It should be emphasized that most of the observations of the American party were made in the wet season.) A good view of the flood plain vegetation was to be had on a canoe trip from the camp down the lagoon to its outlet on the river. For a third of the distance, mixed rain-forests, in which large-leaved *Wormia macrophylla* was plentiful and occasional very large fig trees occurred, came out to both banks and ended in low fringing growths at the water's edge. *Mucuna* sp. and *Gnetum latifolium* were abundant as screening lianes, the former bearing few flowers in April and May, though presenting a fine display of flame red blossoms in December. With the silting-in and narrowing of the old river channel to a width of about 100 meters at this point, the closed forests began to give way to open stands of swamp trees and bodies of floating grass in quiet bays too deep for trees. The principal swamp-forest trees were a slender clear-boled *Adina* with pale, poplar-like leaves, and bushy, red-flowered *Barringtonia spicata*. Below the narrows the channel meandered through extensive grass marshes, dotted with low trees in places and containing forested islands. Beyond the marshes was a silt levee, covered with a fine stand of purple-plumed wild sugar cane, through which the channel cut to join the river.

The flood plain plant communities fell into two inundation categories, namely, permanent marshes and semi-permanent swamp-forests, and communities inundated only in the flood season. Degrees of inundation were determined from a series of soundings, made from a canoe during the high flood of April and May, and water-level tables compiled from records kept by the military party. Several of the communities occurred on the Fly River, where they came under the observation of the second Archbold Expedition in the dry season of 1936.

In the first category, in order of depth of inundation, were:

PERMANENT GRASS-MARSH.—Present in sluggish creeks and covering extensive areas of old river bed as dominant of the open marshes was the grass *Echinochloa stagnina*, whose long, buoyant culms rooted on the bottom. With it were associated a blue-flowered *Commelina*, *Polygonum* sp. and *Jussiaea repens*, of similar habit. *Pistia stratiotes* was present as a floating aquatic. Similar marshes occurred on the Fly River.

ADINA SWAMP-FOREST.—The slender *Adina*, averaging twenty-five meters in height, formed pure, open forests of limited extent on ground covered to an average depth of about four meters by the highest flood, and continuously under water for thirty-eight days in November and December and for the whole of the 128-day period, January 1 to May 8. The smooth gray trunks of the trees carried quantities of fleshy sun-epiphytes such as

Dischidia, Hydnophytum, Hoya and *Cyclophorus lanceolatus*. Forests of this kind covered large areas on the Fly River.

BARRINGTONIA SWAMP-FOREST.—Bushy, briefly deciduous *Barringtonia spicata* formed extensive pure stands five to six meters high, difficult to penetrate by a canoe at high water. The highest flood inundated this forest to an average depth of about three meters so that in general the habitat was flooded continuously for thirteen days in November, and for all but two days between January 1 and May 8. The closely related *B. tetraptera* forms swamp-forests in south New Guinea.

SAGO-SWAMP.—Although very extensive on other parts of the Meervlakte, forests of sago-palms (*Metroxylon*) occupied but a few small areas within tall rain-forest at Bernhard Camp. The river flooded this habitat to a maximum depth of about one meter. In the southeast monsoon local rains no doubt suffice to maintain the more or less swampy conditions essential for this palm. Sago-swamps occur in rain-forest throughout the lowlands and lower mountains of the island.

SWAMPY RAIN-FOREST.—On the edge of the flood plain were patches of a rather open type of mixed rain-forest inundated by the river to depths of under one meter to about one meter and a half (flooded about fifty to ninety-eight days between January 1 and May 8). From the uneven ground surface and the presence as characteristic ground cover of a swamp sedge (*Hypolytrum* sp.), the amphibious fern (*Microsorium pteropus*) and the rice grass (*Oryza Ridleyi*), more or less swampy conditions would appear to be maintained after the fall of the river waters. The principal trees (*Campnosperma auriculata* and species of *Couthovia, Parkia* and *Serianthes*) attained a height of thirty to thirty-five meters and developed in some cases heavy, prominently buttressed trunks. *Styrax* sp. and *Ardisia* sp. were characteristic of a rather open woody undergrowth, while *Pandanus penicillus* and a fan palm (*Borassus*) figured conspicuously in the substage.

The second category included:

CANE-BRAKES.—*Saccharum spontaneum*? formed extensive brakes eight to ten meters high on the silt levees of the river and also grew on open beaches of sand and gravel in creeks draining from the mountains. As peak floods inundated the levees to depths of two and a half to three and a half meters, on the average they would be under water on all but two days between January 1 and May 8. Any plants that occurred on lower banks of silt and mud were under water and out of sight during the period of observation, but species growing on old drift logs afloat in backwaters and in the marshes, such as the sedges *Torulinium ferax* and *Fimbristylis miliacea, Pouzolzia zeylanica, Jussiaea* sp. and *Abelmoschus* sp., probably belonged to such a community. The banks of the middle Fly River carry similar cane-brakes.

TIMONIUS-FOREST.—Pure forests of *Timonius* sp., about twenty-five meters high, occupied at the lower end of the lagoon extensive silt-beds submerged to a depth of one and a half to two meters by the highest flood (flooded on an average of seventy-three days, and dry forty-five days between January 1 and May 8). Breadfruit trees (*Artocarpus communis*), no doubt man-distributed in the first place, were frequent marginal associates. Masses of a climbing aroid (*Pothos*) were a characteristic feature. The *Timonius*-forests appeared to represent the one successional stage between cane-brakes and mixed rain-forest on the silt levees of the river.

NAUCLEA-FORESTS.—Pure stands of a six to seven-meter high small *Nauclea* sp., remarkably like a low *Sonneratia alba* mangrove community in appearance, covered flat islands in the upper end of the lagoon and sometimes fringed its banks. They grew on ground submerged to a depth of about 2.7 to 3.7 meters by the highest flood. Complete flooding was therefore the average condition from January 1 to May 8.

WORMIA-FOREST.—Plains generally inundated to a depth of two and one-quarter to two and one-half meters at highest flood level, and therefore under water 117 and 120 days in the period January 1 to May 8, carried distinctive mixed rain-forests in

which *Wormia macrophylla* took a prominent part and formed nearly pure stands of considerable extent. Readily distinguished by its reddish, flaky bark and large ribbed leaves, the characteristic tree attained a height of about thirty meters and a diameter of one meter. The trees were well spaced and, there being little woody undergrowth, the forests were open underneath. Any herbaceous undergrowth they may have contained was under water in April and May. The high-climbing fern (*Stenochlaena palustris*) and the aroid of the *Timonius*-forests were prominent root-climbers. But the most impressive feature, as one traveled through the forest by canoe, was the wealth of large shade-epiphytes, e.g., the ferns, *Asplenium ellipticum*, *A. pseudophyllitidis*, *Goniophlebium subcordatum*, *Microsorium punctatum* and *Humata, heterophylla*, *Selaginella Hieronymiana* and bright-flowering Zingiberaceae, that crowded the tree trunks down to about two meters from the high-water mark. There was a considerable interchange of species between these and the swampy rain-forests described above, and possibly the *Wormia*-forests also remained somewhat swampy after the floods.

Fringe Communities.—The *Nauclea*, *Adina* and sometimes the *Barringtonia* forests present open faces to the waterways, and the trees straggle out into the open marshes. These trees also occur with an entirely different set of species in a dense fringing vegetation that hides from sight the interior of other types of flood-plain forest. It is in these fringe communities, their aerial parts rising from anything up to three meters of water in the wet season, that the richest assortment of woody plants is found on the river plains, and also the showiest flowers. Bordering the *Wormia* type of forest and leaning low over the water, is a continuous line of *Syzygium* sp., reported by Olthof to be attractive to parrots in its flowering season before the rains. Elsewhere much of the fringe vegetation is made up of *Kleinhovia hospita*, *Pongamia pinnata*, *Hibiscus tiliaceus* and *Crataeva* sp. as trees, and such scrambling shrubs as *Combretum* sp., *Faradaya* sp., with large white flowers, *Loeseneriella sogerensis*, *Caesalpinia nuga* with fragrant yellow flowers, and *Flagellaria indica*. On the lowest banks, a species of *Ficus* with large scabrous leaves forms level thickets that stand not more than one meter to one and one-half meters above water at high flood and support an abundance of *Cayratia trifolia*, a pink *Ipomoea*, a spinose Acacia with fluffy balls of white flowers, and other climbing plants.

There were pronounced changes in the character of the forest on the strip of rising ground between the flood plains and the mountains. Many species found as high as 600 to 800 meters on the slopes came down to the edge of the flooded ground, while certain flood-plain trees, such as *Couthovia* and *Parkia*, occurred in abundance on the lower ridges as well as the somewhat swampy flats. Among other common trees of an irregular canopy layer may be mentioned species of *Terminalia*, *Sloanea*, *Elaeocarpus* and *Intsia*, the latter a very big tree, up to about forty meters high, on the ridges, and also present on the flood plains. Palms, most of them showing preference for soft, muddy ground, were numerous on the flats, where climbing *Calamus* and *Korthalsia* made their first appearance. Tall *Cyrtostachys* sp., *Rhopaloblaste* sp. and the shorter *Borassus* were abundant in the substage, and young plants of them all, together with small species of palms, formed a good part of a rather plentiful woody undergrowth. The palms, a dense herbaceous layer of *Elatostema* and *Ophiorrhiza* on the drier flats, the local abundance of *Freycinetia Klossii* and a *Piper* as small root-climbers, together with mosses on the undergrowth and an abundance of ferns, such as *Asplenium acrobryum*, *Polypodium damuense*, *Campium heteroclitum* and *Vandenboschia aphlebioides* as mesophytic low epiphytes, gave an appearance of lowland luxuriance to a forest actually poor in species.

At Bernhard Camp "B," only twenty-five meters above the flood plains, the forests had already lost most of their luxuriance. Floristic changes occurred with increasing altitude, but much the same general appearance was maintained up to the zone of daily cloud accumulation

on the fronting ridge of the mountains, where, in an abrupt change within fifty meters of the summit, the very mixed rain-forest gave place to mossy beech (*Nothofagus*) forest. An oak (*Quercus* sens. lat.) appeared as low as 120 meters and became plentiful at 550 meters but was nowhere abundant enough to characterize the forest. The vegetation of the slopes may be described as a poor type of tall, dry-appearing rain-forest with a thin canopy, poorly developed lower tree layers, a sparse, predominantly woody undergrowth, and few lianes and epiphytes. Only on flat places on the spur ridges, where *Selaginella suffruticosa* and a few coarse ferns, such as *Craspedodictyum Schlechteri*, *Tectaria Cesatiana* and *Taenitis blechnoides*, occurred in quantity, was there any massing of undergrowth plants, except in the ravines. Even the ravines, crowded as they were with other large ferns, presented an appearance in keeping with the dryish conditions which with reasonable certainty can be said to prevail on the slopes in the season of the southeast trades.

Rainfall at Bernhard Camp, July 11 to May 8, inclusive:[1] July (21 days), 100 mm.; August, 259 mm.; September, 718 mm.; October, 304 mm.; November, 547 mm.; December, 454 mm.; January, 561 mm.; February, 511 mm.; March, 539 mm.; April, 802 mm.; May (8 days), 139 mm.; total, 4,934 mm.

In birds this camp stands out as being the place where a new species of lowland bird (*Philemon brassi*) was collected. About 150 species of birds, all species of the Meervlakte plains, were taken at this camp in about six weeks of collecting.

After our long stay in the comparatively uniform habitat of the forest it was especially interesting to work in the diversity of habitat present along the river and its lagoons. The water level varying with the season undoubtedly has a considerable effect on the local distribution of bird life. With all sand bars and mud banks covered, some species, such as *Casmerodius* and *Egretta*, moved into the areas of floating grass, but some, such as stilts, sacred ibis and the little heron (*Notophoyx picata*), evidently went elsewhere. During the latter part of our stay, when a few sand bars were exposed by the falling water, a few of these birds appeared.

Many of the birds of the grass marshes were naturally restricted in the extent of their habitat and were forced into the tops of clumps of grass still left exposed by the rising water. This made them easier to secure from a canoe, and thus the collection is richer in marsh-birds, and they are represented by more adequate series than would be possible at low water conditions. Unfortunately there were no high "islands" in the flooded areas to judge whether or not the flood concentrated ground and underbrush inhabiting birds in dry areas, but what work was done along the edge of the flooded areas indicated no such concentrations. In traveling through barely flooded forest from which the water was just receding, with much mud showing, such ground birds as megapodius, cassowaries and goura pigeons were found to be common. Indeed, the goura was commonest in such places.

The hunting in the forest did not suffer from flooded conditions, for it was possible to send a canoe through the forest in many places, to follow little waterways and to watch forest edges and tree tops better from a canoe than on foot.

Few birds frequented the open lagoon. They were chiefly cormorants, anhinga and the tern (*Sterna albifrons*). The permanent grass marsh was the important marsh habitat. Here the egrets fed; *Ixobrychus*, *Poliolimnas*, *Porphyrio*, *Malurus* and *Lonchura grandis* were restricted to this habitat. The warbler (*Acrocephalus*) was commonest in the grass marsh but also frequented open stands of cane grass; the weaver finch (*L. tristissima*) also frequented this habitat but only in the vicinity of forest; in a few places where the vegetation was open and floating at about water level, there were a few jacanas; the tree duck (*Dendrocygna guttata*) with downy young was occasionally seen on the grass marsh or perched on floating logs.

The height to which the various woody plant communities had attained and the density of the stands seemed of more im-

[1] From copies of records kept by the military party.

portance than the species composing the stands, insofar as it concerned the avifauna. There were a few birds found almost exclusively in the seral communities, such as *Ducula mülleri, Ptilinopus aurantiifrons, Halcyon sancta, Merops ornatus, Coracina papuensis, Cinnyris jugularis* and *Philemon brassi.* The only two specimens of *Amaurornis* found were in low, dense, deeply flooded shrubbery.

There were a number of other birds that frequented the wooded or forested edges of waterways: cormorants, anhingas, herons, egrets, sea eagles and kites (*Haliastur*) rested in the tops of trees; the little kingfishers (*Alcyone pusilla*) sat in low shrubbery over the water; *Butorides, Dupetor* and *Gerygone magnirostris* were found only along the wooded waterways. The willie-wagtail (*Rhipidura leucophrys*) occurred wherever there were low open places to feed and perch, along waterways or in marshes.

Of course many forest species occurred, at least occasionally, in the seral growths, while some were as common there as in the forest, such as *Geoffroyus geoffroyi, Philemon novaeguineae* and *Oriolus szalayi.*

Low in the forest fringing the waterways, the flycatcher (*Monarcha alecto*) was more common than it was elsewhere in the forest.

Hunting over all the open habitats and on occasions even over the forest were the kites (*Haliastur*) and the swifts (*Collocalia lowei, C. vanikorensis* and *Mearnsia novaeguineae*).

In the tall dense cane-brakes were few or no birds except for *Centropus bernsteinii* along the edges, but in one open stand of cane grass in a grass swamp *Lichmera alboauricularis* was concentrated, nesting, as well as being found sparingly in the trees along the lagoon edge, and *Acrocephalus,* usually in the grass swamp, was occasionally found there.

Birds were only fairly common in the forest. There were few small species of the ground, such as *Pitta* and *Eupetes caerulescens;* larger ground birds were more common, such as *Goura, Chalcophaps, Gallicolumba helviventris, Megapodius* and *Talegalla.* Cassowaries were not uncommon in the flat country, judging by their tracks, though only three were secured. The abundance of the goura pigeon on the muddy, half-inundated flats was surprising. Again there were few species of birds restricted to the undergrowths; *Crateroscelis murina* and *Rhipidura leucothorax* were examples of this. But there were many species found most commonly in the low, slender, substage trees, such as *Poecilodryas hypoleuca, Rhipidura rufiventris, Arses insularis, Monarcha manadensis, M. chrysomela, M. guttala, Meliphaga analoga, Pycnopygius ixoides, Toxorhamphus novaeguineae, Glycichaera fallax, Melanocharis bicolor, Gerygone chrysogaster, Pomatorhinus isidori, Tanysiptera galatea* and *Centropus menbeki.*

Higher up in the substage were found such birds as *Cicinnurus regius, Sauromarptis gaudichaud, Xanthotis chrysotis* and *Pycnopygius ixoides.* A number of species that were frequently found together in the leafy substage layer, moving through the forest in loose flocks, included *Pitohui ferrugineus, P. kirhocephalus, Dicrurus carbonarius, Paradiseae minor* and *Edolisoma melan.*

A few birds, such as *Peltops blainvillii,* species of *Edolisoma, Hemiprocne, Cracticus, Cacatua, Probosciger, Ducula pinon, D. zoeae, Chalcopsitta* and *Mino dumonti,* commonly fed in the tops of the tallest trees.

Some fruiting fig trees attracted most of the fruit-eating birds of the forest, and it was common to find thirty or forty birds feeding in such a tree, including such as *Mino, Pitohui kirhocephalus, Megaloprepia,* and species of *Ducula, Ptilinopus* and *Edolisoma.*

The starling (*Aplonis metallica*) was one of the few species flying and feeding in large flocks and often perching conspicuously on some tall, dead tree.

At Bernhard Camp most evenings, between 3:00 and 5:00 p.m., long broad lines of lories (probably *Trichoglossus* and *Chalcopsitta*) were seen passing over, 100 to 200 meters up, going in to the hills. No similar reverse movement was noticed in the mornings. This is interesting in connection with the observations at the 1,800-meter Camp of flocks of lories arriving from

the Meervlakte and passing on over that camp.

Mammal trapping, as is usual in the lowlands of New Guinea, yielded poor results. The best night's trapping yielded seven mammals of at least four species. Besides about 300 traps, a number of Dyaks were engaged in making snares, and by the time the camp was vacated over a thousand of these were set.

Hunting yielded more mammals than at the higher camps. A number of small bats were shot at dusk, and daytime roosts of the big fruit bats were discovered. Along the edge of the lagoon cuscus (*Phalanger maculatus*) were found sleeping during the day or moving about at dusk. The natives brought in a few wild pigs they had killed.

850-Meter Camp (Araucariakamp)

Four Kilometers Southwest of Bernhard Camp

March–April, 1939

Situated in a shut-in valley behind the fronting ridge of the mountains that rise from the Meervlakte, this camp was reached in four hours with laden carriers from Bernhard Camp. The distance from the river base was probably nearer five than four kilometers.[1]

The valley was drained by a tributary creek of the Sahoeweri River, which van Arcken named Araucaria-rivier for stands of these trees seen by him on the mountain sides some distance downstream from the camp. Only one *Araucaria* tree (like *A. Cunninghamii*) was discovered, at an altitude of 1,100 meters, on the collecting grounds. For about an hour's travel below camp, and a greater distance above it, the valley floor had a gentle gradient and widened into flat alluvial basins with a breadth of up to about one-half a kilometer. Most of the basins were partly swampy and some, such as the one in which the camp was built, were intersected by small flood channels and subject to occasional violent flooding over most of their area. In this part of the valley the stream, fifteen meters wide at camp, presented a series of deep rock pools separated by bouldery stretches and long, gravelly reaches. Farther down, the valley narrowed, and the creek became a succession of rapids, pools and small waterfalls. Runoff was very rapid. The boulders in the bed of the stream ground and cracked together under the force of the spates which followed the afternoon rains, and occasionally during our stay the water swept over the lower flood plains. However, none of the torrential downpours experienced produced a flood of consequence, and in the mornings the stream was always fordable.

Here at last, after making the best of narrow mountain ridges, the military planners and builders of our camps were able to rejoice in a roomy piece of level ground, unlimited supplies of straight poles, palm-trunk slabs and rattan for construction work, and gravel for paths. The results in comfort and convenience were worth the effort expended. Tracks cut through the forest, and a rattan suspension bridge over the creek, gave easy access to the collecting grounds.

The valley of Araucaria Creek was uninhabited and undisturbed by man, although faint trails in the forest indicated that sometimes natives came that way. Small parties of men from the Sigi tributary of the Sahoeweri, who followed tracks cut by the expedition and seemed unfamiliar with the country, visited the camp on four occasions to trade dogs for knives and shells.

[1] The cartographic work of the military party subsequent to the establishment of this series of collecting camps showed that in all cases the distances from Bernhard Camp were underestimated in the beginning. The approximate distances, according to the military map, were: 850-meter Camp, five kilometers; 1,200-meter Camp, nine kilometers; 1,800-meter Camp, twenty-one kilometers; 2,150-meter Camp, twenty-three kilometers. The distances first estimated were, however, used on the collection labels, and to save confusion they are retained in this paper.

The names adopted for the camps by the Netherlands party are given in parentheses.

Over most of its course examined above camp, the creek flowed through mature tall forest growing on stable banks. Often its bed was almost roofed over by outthrust, epiphyte-laden branches of the forest canopy trees and of smaller trees leaning out to the light. Most of the ferns and herbaceous plants massed on its banks were of species common to the forest floor. The few narrow beaches carried little vegetation apart from small ferns growing on moss-covered, slimy boulders imbedded in the gravel. Just above the camp, the stream assumed an open character, and with the changed conditions due to active lateral erosion and the deposition of beds of sand and gravel, old forest alternated with seral forest, and plants with special habitat requirements or adaptations appeared along the banks. Scattered or clumped on otherwise practically bare low gravel beds was a salmon-pink *Impatiens*, the only occurrence of the genus noted on the expedition. Tall brakes of *Saccharum spontaneum* occupied higher, marginal beds of sand and gravel. Flood-resistant low *Ficus* trees of two species, and a *Syzygium*, alike in their wide-spreading, horizontal branches, appeared on gravel bars and low banks as representatives of a stream community found everywhere in the lower mountains of New Guinea. Masses of slender clump palms (*Actinophloeus*) leaning over the water, and a gregarious *Boerlagiodendron*, with striking purplish inflorescences and narrow-palmate leaves, occurred with these small trees. Associated with them on flood-washed ledges and points of rock, and also growing on the clayey bases of stream cliffs, was an equally widespread and characteristic herbaceous community, chiefly of the small ferns (*Dryopteris Casatiana, D. mutabilis* and *D. riparia, Selaginella Kerstingii*) and the grasses (*Pogonatherum paniceum* and *Isachne micrantha*). The fern (*Dipteris conjugata*) and a large *Curculigo* figured conspicuously in the mixed woody and herbaceous growths which followed the pioneer moss (*Pogonatum Klossii*) on the moist red clay of landslips. In sunny edges of old forest on eroding banks a reddish *Rhododendron* (also common as a high epiphyte) and a *Poikilogyne* with large panicles of purple-pink flowers grew together as shrubs, while on low alluvial banks occurred a scrambling *Mussaenda* with white and yellow inflorescences attractive to insects, and one of the brilliant red-flowering mucunas known in British New Guinea as D'Albertis Creeper.

Rain-forests occupied the valley bottom and the lower slopes. The character of the forests denoted a rainfall far greater and of more regular distribution than at Bernhard Camp and on the slopes facing the Meervlakte. Also, from the unusual amount of moss on trees and ground, it was apparent that the frequent fogs and mist experienced by the expedition were more than a seasonal occurrence. Generally, the rain-forests were poor in species. In swampy parts of the valley bottom, where the ground surface was broken by muddy pools, the trees were seldom more than body-thick and grew in open formation. In such places a scrambling bamboo combined with *Calamus* spp. and young *Pandanus* to form a dense, prickly undergrowth difficult to penetrate, and tall palms (*Actinorhytis*? and *Orania*[1]) were very abundant in association with large, stilt-rooted *Pandanus atropurpureus*. In other parts where forest development was retarded by wet soil conditions, the ground was heavily mossed under a broken, irregular canopy, and herbaceous plants and low epiphytes were abundant. Characters were scarcely more uniform on the slopes, where a predominantly woody undergrowth varied from open to dense, but the crests of prominent spurs were always thick with moss. A species of *Casuarina* (*C. sumatrana*?) figured conspicuously on the sandy creek banks and the sides of the steeper ridges; big *Agathis* trees (*A. Labillardieri*) showed smooth stems above the forests of the slopes, and a liberal sprinkling of several species of oaks and a *Castanopsis* occurred throughout.

The rain-forests were best developed on the deep sandy loam of creek flats raised above the level of normal floods, where

[1] Several members of the party became violently ill with stomach pains and vomiting after eating boiled *Orania* "cabbage."

species of *Schizomeria, Sloanea, Hibiscus, Syzygium* and *Santirea, Cryptocarya palmerensia, Dysoxylum Randianum, Calophyllum Brassii* and *Evodia Forbesii*, about thirty meters high, were important trees of the canopy layer. Most of the trees and the undergrowth were conspicuously, though not heavily, mossed. Mosses also covered exposed surface roots, and the ground was thinly spread with leaf litter. A rich undergrowth contained *Psychotria, Codiaeum* and *Kibara elongata* as small trees, several small palms, *Cyathea geluensis* and very slender *C. gracillima* as treeferns; it was chiefly characterized by herbaceous plants and ferns, such as *Procris* spp., *Elatostema* spp., *Tectaria Cesatiana, Dryopteris micans, D. multiauriculata, Selaginella velutina* and several showy species of *Begonia.* Canopy lianes were well represented, and the scrambling bamboo (*Schizostachyum*) and root-climbing *Freycinetia angustissima* massed themselves upon the tree trunks. A rich and very abundant complement of herbaceous and woody epiphytes on the tree trunks and underbrush included species of Elatostematoides, *Ophiorrhiza* and *Medinilla* as fleshy herbs and shrubs, and, among creeping and tufted ferns, *Arthropteris dolichopoda, Meringium gorgoneum, Polypodium accedens, P. albidosquamatum, Asplenium* spp., *Leucostagia pallida, Nephrolepis Lauterbachii, Hymenolepis revoluta, Lindsaya marginata* and *Loxogramme subselliguea.* In the treetops, small orchids and especially ferns grew half buried in moss, and a pitcher-plant (*Nepenthes*) occurred commonly as a subscandent shrub.

Good examples of seral rain-forest or rain-forest "second growths" occurred on the lower and newer sandy flood plains, where all stages of development, from the first invasion of the cane-brakes by woody plants to twenty-five-meter stands of *Homalanthus* and *Albizzia*, could be seen. The quick-growing small trees *Parasponia simulans, Breynia* sp., *Schuurmansia Henningsii* with big panicles of rose-colored flowers, prickly *Saurauia* spp. and big-leaved *Dammaropsis Kingiana*, also *Casuarina* and the noble treefern (*Cyathea contaminans*) played a prominent part in this succession. Open parts of the young forest contained a dense undergrowth of upright ferns (*Nephrolepis hirsutula* and *Dryopteris unita*), *Elatostema* spp. and a white-flowered *Spathoglottis.*

Between 870 and 950 meters on the south slope of the valley, some broad ridges, at best poorly drained and in parts swampy, carried a distinctive type of forest dominated by *Agathis Labillardieri.* Attaining a height of about forty-five meters and a diameter of one and one-half meters, the trees rooted shallowly in a compacted gray sand covered with a thin layer of peaty plant remains and living moss. They grew, as a rule, in very open order and had beneath them a thin subsidiary layer of slender *Metrosideros paralellinervis, Quintinia* sp., *Campnosperma montana* and *Daphniphyllum* sp., fifteen to twenty meters high. Species of *Astronia, Drimys* and *Pandanus stenocarpus*? supplied a rather plentiful woody undergrowth. The ferns (*Taenitis blechnoides, Dryopteris viscosa* and *Macroglena meifolia*) typified a somewhat meager ground flora, and a *Hanguana* was conspicuous in the swampier parts.

Although elevated only 50–100 meters above Araucaria Creek, the crest of the ridge fronting the Meervlakte, as already noted, bore a very different kind of forest in which a species of *Nothofagus* was the principal tree and attained a high degree of dominance. The distribution of the beech forest was in close agreement with that of the mist clouds which regularly between 9:00 and 10:00 a.m. settled on the ridge and enveloped its summit until evening. The mist drifted through the forest to be absorbed by the thick coating of green and brownish bryophytes that covered the ground and the trunks and branches of the trees. The soil was a yellow clay, overlain with about twenty to fifty centimeters of moss, matted roots and peat. On the crest, where wind-stunting was apparent, stilt roots tented with moss were developed, and the average height of the forest was about fifteen meters. Chief among the few species associated with the beech in the canopy layer were the conifers (*Phyllocladus* sp. and *Podocarpus imbricatus*) and yellow-

flowered *Metrosideros paralellinervis*. Scattered *Agathis* trees and a palm (*Gulubia* sp.) protruded above the canopy. Small subsidiary trees, such as *Astronia* sp. and *Tetractonia Lauterbachiana*, thrust their tops into the branches of the canopy trees and did much to exclude light from these gloomy forests. Breaks in the canopy permitted the development of an abundant woody and herbaceous undergrowth characterized by dwarf *Pandanus leptocaulis*, the subscandent ferns (*Oleandra cuspidata* and *Cyathea biformis*) and small *Freycinetia* spp. Under conditions of dense shade, scattered small ferns and an *Argostemma*, with crisp leaves and starry white flowers, occurred as floor plants. Present as common canopy climbers were a *Nepenthes* with large green pitchers, *Freycinetia pleurantha* and especially the scrambling *Schizostachyum* already mentioned as occurring in the rain-forests of the valley bottom. Poor for this type of forest, the epiphytic flora consisted mainly of filmy ferns and small orchids.

Dull, showery weather relieved by only six fine days made conditions unpleasant for work in the forests. Short spells of dazzling sunshine between morning showers and steady rain in the afternoon and evening made up the weather for an average day. Early morning fogs and more or less misty days were frequent. Thunderstorms moving down the valley from the north-northwest after about 4:00 p.m. brought torrential rains and were accompanied by strong, gusty wind, sometimes of sufficient force to wrench off branches and uproot big trees in the forests.

Temperature (C.) March 6–April 5: maximum (27 days) 22.5–28.0, mean 25.0; minimum (27 days) 16.5–19.0, mean 18.0.

Collections of 176 mammals, 425 birds, 130 wood specimens and 623 numbers of plants were made between altitudes of about 800 and 1,100 meters in the valley of Araucaria Creek and down to 600 meters on the Idenburg slopes. Richardson had disappointing results from his traps and Dyak snares.

The avifauna here was, of course, poorer than that of Bernhard Camp, though many of the species that did occur were the same as those of the lower camp. There were in addition a number of lower mountain species, such as *Aepypodius, Charmosyna, Pachycare, Diphyllodes, Erythrura, Sericornis beccarii, Pachycephala hyperethra* and *Meliphaga montana*. About ninety-five species were collected, somewhat fewer than might be expected, and individually they were not particularly common.

The stream and its open habitats were responsible for a few non-forest birds: *Motacilla cinerea* was fairly common in March; a few ducks (*Salvadorina*) were found in the pools; the sandpiper (*Actitis hypoleucos*) was occasionally found; *Monachella* and *Pomareopsis* were rare. The moustached swift (*Hemiprocne*) perched in high exposed branches along the stream and hawked for insects over the open areas there.

The second-growth forest along the streams was not responsible for the presence of a single species of bird, though the dove (*Macropygia*) was more common there than in the forest, and most of the forest species roamed into this habitat.

The scarcity of large forest birds at this camp was rather striking. In the three weeks here only four or five hornbills were seen and only rarely were black or white cockatoos observed. Except for the dove (*Macropygia*) pigeons were very scarce.

On the other hand, there were striking concentrations of flower-feeding birds about certain trees. About some large-crowned, flowering trees there were sometimes 100 to 200 birds at a time, feeding, hopping about and darting back and forth. At some trees they included the lories (*Charmosyna josefinae*—rarely), *C. pulchella* (the most common), *C. rubronotata* (rarely) and *C. wilhelminae* (rarely), and the honeyeaters (*Myzomela cruentata, M. eques, M. nigrita*) and occasionally *Meliphaga analoga, Toxorhamphus iliolophus, T. novae-guineae, Melilestes* and *Oedistoma*. In some trees there were mostly lories and *M. eques;* in other trees, mostly honeyeaters.

It was very difficult to identify these species from the ground and almost impossible to collect desired specimens. Finally the practice was adopted of sending collecting boys (Dyaks) up into trees

neighboring the flowering trees, stationing them there for the morning with instructions at first to shoot one of each kind of bird, then with instructions to take series of certain things. This worked very well, though it was a bit of a shock one day when a Dyak, who had been collecting for months, apologetically brought in an *Oedistoma pygmaeum*, the smallest New Guinea bird, and asked if it was wanted. When he understood it was a new species for the collection and very desirable, the Dyak appeared much relieved that he had not wasted his shot on such a small bird. He said there had been lots of them about the flowering tree where he was stationed, but he had hesitated to shoot any of them because of their small size.

Richardson's snares and traps yielded many ground-frequenting birds, such as *Pitta macklotii*, *Drymodes*, *Aepypodius* and *Talegalla*.

Study on the mating behavior of the magnificent bird of paradise (*Diphyllodes*) at its bower was one of the most important ornithological results of the camp.

About half the birds collected here showed some indication of breeding activity.

Trapping was poor but better than in the lowlands. The catches were more varied and averaged larger than at Bernhard Camp. The best night yielded nine mammals of at least seven species in about 350 traps and about 980 Dyak-made snares. Hunting yielded small bats at dusk, and at night marsupials and occasionally small rodents were shot with the aid of a headlight. Natives from the Sigi River visited the camp and sold dogs to the expedition.

Considering the altitude and the range of habitats represented, the locality was also rather disappointing botanically. A poverty in canopy trees in the rain-forests, and of epiphytes in the beech-forests, was especially noticeable. Of the 130 trees from which Versteegh took wood specimens twenty-one per cent were in flower or about to flower, sixteen per cent in flower and fruit, fifty-one per cent in fruit and twelve per cent sterile.

The unfavorable weather conditions were reflected in the collections of day-flying insects such as butterflies and dragonflies. There were clear, still nights when almost no insects appeared on the illuminated white screens, and others, stormy and rainy, which furnished magnificent catches.

1,200-Meter Camp (Rotankamp or Tusschenkamp)

Six Kilometers Southwest of Bernhard Camp

February–March, 1939

This was on a steep mountain slope, near the head of a small feeder of Araucaria Creek, about two carrier hours from the 850-meter Camp. From the camp clearing, on the crest of a minor spur ridge, one looked into and over the valley of Araucaria Creek, and on clear mornings snow-capped Juliana Peak, over 200 kilometers to the southeast, could be seen across the flanking ranges of the Snow Mountains. A climb of fifty meters from the camp brought one to the crest of a bold leading spur having its axis on a 1,600-meter peak one and one-half kilometers to the southwest. This spur and peak were the dominant topographic features of the locality. Numerous narrow subsidiary spurs, dropping sharply and separated by deep, rocky ravines, supplied the minor features. Small landslips were common. No recent traces of natives were seen, but little-used trails ran along the tops of some of the spurs, and the remains of a palm-leaf shelter were found near camp.

Notwithstanding the increased altitude, the rain-forests which constituted the bulk of the vegetation cover were far richer in species than those of the 850-meter Camp locality, attained generally a better structural development, and were at least as tropical in appearance. The explanation for this undoubtedly lies in the very different topography of the two localities and its influence on local climate and soil conditions. Fogs were rare and occurred only at night on this high slope; mists, though

frequent, showed a definite tendency to cling to the more prominent spurs and leave clear the spaces between; and probably there was less rain than in the valley below. *Agathis Labillardieri*, and the *Casuarina* of the Araucaria Creek valley, followed the misty ridges up to an altitude of 1,200 meters, while *Nothofagus* and associate trees of the beech-forest followed them down to at least 1,100 meters and were common on narrow prominences where soft beds of moss and roots covered the ground. With increasing cloud frequency, mixed rain-forest finally gave way to beech-forest at about 1,500 meters on the main spur. Above this altitude the heights were daily blanketed in clouds, and chill mists floated through the forests, from about nine o'clock in the morning until nightfall.

The rain-forests attained their best development on the tops and stable upper slopes of ridges, where a rich assortment of trees, thirty to thirty-five meters high, formed a forest open in character under the canopy and often rather deficient in undergrowth. Masses of bryophytes, mostly brown in color, cluttered the tree-tops, and the trees, especially those with buttressed trunks, carried a considerable amount of moss near the ground. The camp got its name "Rotankamp" from the impenetrable tangles of *Calamus*, which, with a species of *Schizostachyum*, filled frequent openings in the forest caused by soil movement, and scrambled up the surrounding trees.

These forests were interesting for the prominence assumed by Lauraceae (e.g., *Beilchmiedia bullata*?, *Endiandra flava*, *Litsea fulvosericea*) and species of *Syzygium* in the canopy layer. Other important trees included *Calophyllum papuanum*, *Gordonia papuana*, *Ilex Versteeghii*?, *Myristica Brassii* and *M. Buchneriana*, *Halforida papuana*, and species of *Schizomeria*, *Elaeocarpus*, *Terminalia*, *Hibiscus*, *Platea* and *Santiria*. Among characteristic elements of the ridge forest undergrowth were a very striking fan-palm of uncertain identity, *Pandanus limbatus*, gregarious in open places; species of *Ixora*, *Garcinia*, *Anomopanax* and *Ardisia* as small trees and shrubs; and the treeferns *Cyathea melanoclada*, *C. pulcherrima* and *C. gracillima*. The moist bottoms of the ravines, although they contained an abundant and often dense undergrowth of small trees covered with mosses and epiphytic ferns, were chiefly remarkable for their luxuriant herbaceous communities characterized by *Dryopteris novaguineensis*, *D. multiauriculata*, *Tectaria decurrens* and other large ferns, species of *Alocasia* and *Homalomena* (Araceae) and tall Zingiberaceae. A *Balanophora*, growing in dense shade and giving off a strong "mousey" odor, was common as a root parasite.

Two species of bananas (*Musa*) grew in the ravines, one of them a plant three to four meters high, with unusually large orange-yellow bracts, locally common on the banks of streams. The other was a giant species of very rare occurrence, a measured young sterile specimen of which had a stem 6.7 meters long and 0.67 meter thick at the base and a total height of about twelve meters. The banks of the streams carried a great many small rock-inhabiting ferns, such as *Selenodesmium obscurum*, *Athyrium Ramosii*, *Campium Taylori* and *Polypodium diaphanum*, associated with mosses in moist shade, and in more open places fleshy *Cyrtandra* spp., bright-flowering begonias and medinillas, and massed growths of *Elatostema* spp.

Among the many large lianes were one of the red-flowered mucunas, a *Mussaenda* which made a conspicuous show of white on the forest roof, species of *Ficus* and *Morinda*, and a *Dimorphanthera* (Ericaceae) producing a profusion of white flowers attractive to birds. Ascending to the middle spaces in the ridge forests with *Schizostachyum*, *Calamus* spp. and large epiphytic Araceae, were two fine species of *Freycinetia—F. percostata* with white and *F. Archboldiana* with showy pink bracts.

A rich flora of low epiphytes, present in most parts of the forest and especially well developed in the ravines, included, besides mosses and hepatics, many insignificant orchids, and was characterized by such ferns as *Asplenium scandens*, *A. Cromwellianum*, *A. Nidus*, *Polypodium accedens*, *P. diaphanum*, *Nephrolepis Schlechteri*, *Grammitis subrepanda* and *Humata kina-*

baluensis. An equally rich and abundant and more diversified flora of tree-top epiphytes included several small trees, e.g., *Mearnsia cordata* and species of *Sericolea*, *Fagraea* and *Ficus*, the ferns (*Oleandropsis ferrea*, *Holcocorus bisulcatus*, *Ctenopteris eximia*, *Humata Werneri*, *Davallia trichomanoides*, *Macroglaena Schlechteri* and *Meringium rubellum*), several brilliant little Dendrobiums and other small orchids. Most of the tree-top epiphytes were derived from the mossy beech-forests of higher altitudes.

The broader ridge crests carried, at altitudes of about 1,200–1,300 meters, a few isolated small patches of mid-mountain forest. The best example occurred at the edge of the camp clearing, where, over an area about 100 meters long and 50 meters wide, two or three species of oaks and one of *Castanopsis* formed a practically pure, dry-appearing forest about twenty-five meters high. In marked contrast with the surrounding mixed rain-forest, the trees were virtually free of moss. They had grayish, slightly spurred trunks sometimes surrounded by coppice shoots, were widely spaced and formed a thin canopy of brownish leafage which admitted abundant light. Despite the thin canopy, the lower tree strata were poorly developed; there was little woody undergrowth and only a sparse herbaceous undergrowth characterized by the stiff fern (*Syngramma Hookeri*). The tuft ferns (*Vittaria ensiformis* and *V. elongata*) and shrubby *Oleandra Werneri* and *O. cuspidata*, growing near the ground, were common epiphytes.

A great deal of rain fell at this camp, but most of it came in heavy, intermittent showers during the afternoon and therefore did not interfere much with field work. The heaviest rains occurred late in the afternoon and during the early hours of the night and generally followed a pleasant, sunny day. There were two distinct movements of mist clouds. The first rose in the morning as the fogs lifted from the valley of Araucaria Creek and generally affected the camp level for brief spells between 9:00 and 11:00 o'clock. The second was a solid, progressive downward drift of cloud from the 1,600-meter peak, which reached the camp late in the afternoon.

Temperature (C.) February 11–March 3: maximum (12 days) 20.5–23.0, mean 22; minimum (12 days) 15.0–16.5, mean 16.0.

1,600-Meter Subsidiary Camp.—The beech-forests of the 1,600-meter peak were examined by Rand, Brass and Versteegh on February 11 and 12. Although oaks and *Castanopsis* were present, the forests presented much the same appearance and were dominated by the same species (*Nothofagus-Weinmannia*) as those of the 1,800-meter Camp situated on the same mountain ridge, seven hours' journey farther to the southwest. A fine palm of the genus *Gulubia*, with stem twenty-five to thirty meters long and swollen toward the top, occurred singly or in small groups on the crest.

Sigi Subsidiary Camp.—Established primarily for insect collecting, this camp on the Sigi tributary of the Sahoeweri River was at an altitude of 1,500 meters where open stream conditions offered better opportunities for collecting some groups of insects than the 1,200-meter Camp. The collections of Toxopeus and Olthof, made here over the two-week period February 15 to 28, included fifty-three species of butterflies. Satisfactory collections of mammals were also made by Richardson's Ambonese assistant, working under the direction of Toxopeus. The camp was visited by a few natives from lower down the valley, eager to trade for steel.

The 1,200-meter Camp and its subsidiaries yielded collections of 152 mammals, 424 birds, 100 wood specimens and a total of 423 numbers of plants.

About eighty-five species of birds were taken at this camp, slightly less than at the 850-meter Camp.

This was a forest camp, but the presence of little streams in the forest was responsible for the occurrence of one non-forest bird, the stream-haunting *Pomareopsis* of the mountains.

In the tree tops were found such conspicuous lowland birds as *Probosciger*, *Cacatua*, *Gymnocorvus* and *Rhyticeros*, which reached their upper limit here, as well as *Zosterops*, *Lalage*, *Peltops montanus*, *Di-*

phyllodes and *Eos; Psittrichas fulgidus* was common, usually in the tree tops. Some of the fruiting high trees brought together such species as *Diphyllodes, Edolisoma, Pitohui* and *Ptilinopus.*

A concentration of flowerpeckers (*Melanocharis bicolor* and *M. longicauda*) was found feeding in the tops of a group of tall, small-fruited trees; otherwise these birds were found most often in the substage.

Mixed flocks of birds were a more conspicuous feature of the camp here than at the lower altitudes. For long periods one would wander through the forest seeing few or no birds, then suddenly be surrounded by numbers actively feeding. These were typically species of the substage, but some of them also fed in the tree tops; often found in these flocks were *Pachycare, Pachycephala griseiceps, Zosterops, Rhipidura rufiventris, R. hyperythra, Erythrura trichroa, Toxorhamphus iliolophus* and *Sericornis spilodera,* with occasionally other species such as *Microeca griseoceps.*

The attraction of a white-flowered liana (*Dimorphanthera*) brought together numbers of flower-feeding species, the most persistent of them being *Charmosyna josefinae. Philemon meyeri, Myzomela eques, Melanocharis bicolor* and occasionally *Lorius* came to feed at these flowers, but they were more common elsewhere in the forest.

Some species were more common low in the forest, about the sapling-like substage and shrubbery, such as *Pachycephala hyperethra, Meliphaga analoga, Toxorhamphus, Microeca leucops;* and in the shrubbery and on the ground, *Crateroscelis.*

Ground-inhabiting birds were represented by a few good species, but they were shy, such as *Eupetes, Drymodes, Pachycephalopsis, Ailuroedus* (both the lowland and the mountain species), *Gallicolumba, Talegalla* and *Megapodius.*

In the capturing of these birds Richardson's mammal traps and snares were a tremendous help; some of the records of ground-frequenting birds were made only through the specimens taken in mammal sets.

As at the 850-meter Camp the display grounds of the bird of paradise (*Diphyllodes*) were found, and the study of its behavior was started here.

Slightly more than one-third of the birds collected at this camp showed some indications of breeding.

This was the first camp in which snares assumed importance in the mammal work. These snares were made by the Dyaks after a fashion used in their own country. They consisted of a loop, tightened by a spring when the animal touched a release. They were set chiefly on the ground, were made entirely of local materials and proved effective in securing ground-inhabiting mammals and also birds.

The mammal catches were varied and fairly good, though the best night's catch was ten mammals in 438 traps. A few phascogales were shot during the day and a few small bats in the evenings, but the terrain made night hunting very difficult and unsatisfactory.

The rain-forests were exceptionally rich in plants, but the steepness of the slopes made them difficult to explore, and probably a greater number of species were sterile than would be the case in the less rainy southeast monsoon. Eighteen per cent of the trees represented in the collections were in flower or bud, twenty-three per cent in flower and fruit, forty-nine per cent in fruit and ten per cent sterile.

1,800-Meter Camp (Mistkamp)

Fifteen Kilometers Southwest of Bernhard Camp

January–February, 1939

The first of the mountain stations south of the Idenburg to be established and worked, this camp was reached in nine hours' march from the site of the 1,200-meter Camp. After ascending the 1,600-meter peak, the route kept to the narrow crest of the range of which this peak was the eastern termination, passed over a 1,750-meter peak,

dropped down to 1,460 meters in a saddle, then surmounted a 1,900-meter peak before reaching the saddle in which the camp was built. It was a long, hard day with much climbing and descending through mist-saturated beech-forest, by a path slushy with trampled peat, obstructed by roots trodden bare from the thick ground moss, and in places very steep. The forking-point of the outer ridge which formed the north side of the valley of Araucaria Creek was passed at the 1,750-meter peak, so that from there on the range we followed fronted directly on the Meervlakte. The range dropped very steeply, almost precipitously, and was only shallowly dissected by ravines on its Idenburg face. On its south side it sloped less abruptly but still steeply to the narrow valley of the Sahoeweri River; there were prominent spurs and deep ravines, but by skirting small waterfalls the rocky beds of some of the streams could be followed without much difficulty. Landslips were common on the Idenburg side of the range and in the ravines on the Sahoeweri side.

While we had reason to believe we were under close observation by natives of the Sahoeweri Valley, who could not have missed seeing the smoke from our camp fires, no contact took place with these people. Probably the sound of the hunter's gunfire made them wary of open approach. Trails, old but seemingly in only occasional use, followed the crest of the range and the tops of some of the spur ridges. It was not uncommon to find the stilt-roots of a large-seeded *Pandanus* (*P. brosimos*) frequent in the forests here and at higher altitudes on the range, scarred with old axe-cuts or tied with bits of vine as marks of native ownership. The indications were that, in season, the seeds of the *Pandanus* were gathered for food.

The beech-forests of the crest of the range were heavily mossed, from about fifteen meters high on the narrower and more exposed parts to twenty-five meters or over in saddles and on flat summits. A dense layer of subsidiary trees made it difficult to see the tops of the canopy trees. Becoming generally taller, less mossy and more open as regards undergrowth, the beech-forests followed the misty major spurs of the Sahoeweri slope down to at least 1,500 meters. On the Idenburg slope, where the clouds, under the influence of air currents rising from the plains, maintained a higher and more uniform level, beech-forest gave place to mixed rain-forest not far below the crest.

Occurring in quantity with the dominant *Nothofagus* in parts of the beech-forest was the *Weinmannia* sp. which first appeared on the 1,600-meter peak, and a *Phyllocladus* and *Calophyllum congestifolium* were also common canopy trees. Two species of Cunnoniaceae, yellow-flowered *Metrosideros Pullei* var. *parvifolia*, and *Tetractomia Lauterbachiana* predominated in the subcanopy or subsidiary tree layer. Characteristic features of the undergrowth included climbing *Cyathea biformis* and narrow-leaved *Freycinetia laterifolia* and *F. erythrospatha*, massed in quantity on the lower tree trunks; the little treeferns (*Cyathea perpelvigera* and *C. melanoclada*); a pale pink *Medinilla* subprostrate in the ground moss, and a sprinkling of such small herbs and ferns as *Argostemma* sp., *Burmannia longifolia*, *Lindsaya marginata* and *Grammitis Knutsfordiana*. Only a sparse woody undergrowth developed under conditions of dense shade, but thick growth of three to four-meter slender trees, chiefly *Rapanea* sp., *Drimys* spp. and *Medinilla* spp., accompanied by *Palmeria Fengeriana*, *Nepenthes* sp., the fern (*Sticherus venosus*) and other scrambling plants, grew in windfall openings, in small rest clearings made by natives and about the heads of landslips. Two very large species of *Pandanus* (*P. brosimos* and *P. brachyphyllus*) occurred in the heads of ravines where beech-forest met rain-forest. For beech-forest the flora was rich. It was particularly rich in epiphytes which included, besides many small polypods, filmy ferns and orchids, several Zingiberaceae with red and yellow and pink flowers, numerous shrubs, such as species of *Vaccinium*, *Drimys*, *Rapanea*, *Sericoles*, *Hydnophytum*, Araliaceae and Melastomataceae, some attractive red and pink rhododendrons, and scandent *Lucinaea*, *Psychotria*, *Alyxia* and *Nepenthes*. Among characteristic epiphytic ferns were

Plagiogyria tuberculata, Oleandra Werneri, O. crassipes, Polypodium plebiscopum, Calymmodon mnioides, Dryopteris Lauterbachii and *Macroglena meifolia,* growing from ground level to the middle spaces, and *Humata kinabaluensis, Grammitis interrupta, Polypodium plebiscopum, Amphipterum humatoides* and *Pleuromanes pallidum* in the tree tops.

A descent of fifty meters in the ravines below the camp saddle brought one to rain-forest on both sides of the range and almost to the lower limit of the beech-forest on the Idenburg slope. The two types of forest merged gradually one into the other on the slopes between spur crests and ravine bottoms on the Sahoeweri slope. The rain-forests showed a marked decrease in tree species as compared with those of the 1,200-meter Camp and, despite a most luxuriant and varied undergrowth in the ravines, they were no longer tropical in physiognomy and contained few lowland species. Canopy-forming elements included numerous *Syzygium* spp., several Lauraceae, species of *Elaeocarpus, Astronia* and *Platea, Garcinia Schraderi, Vavaea Archboldiana, Acronychia goniocarpa,* and, below the 1,600-meter level, oaks and *Castanopsis.* Characteristic undergrowth plants, crowding the banks of streams in the ravines, included *Saurauia* and *Cyrtandra* spp. as fleshy small trees and shrubs, species of *Begonia, Elatostema,* and some very striking tall Zingiberaceae as herbs. There were treeferns (*Cyathea*) of several species, and an extraordinary wealth of other ferns, ranging from *Marattia coronata,* with broad fleshy fronds two and one-half meters long, to finely dissected little Hymenophyllaceae, and including several *Athyrium* and *Dryopteris* species and the beautiful dwarf treefern *Leptopteris alpina* var. *major.*

Every day, from as early as dawn and rarely later than noon, the crest of the ridge was enveloped in mist from clouds which rose from the Meervlakte, and every day brought rain. The general daily sequence of weather consisted of mist, with occasional breaks from 8:00 or 9:00 a.m. to about noon, followed by continuous mist and cold, driving rain which increased in intensity toward evening. This was varied with days entirely misty and rainy, thunderstorms in the afternoon and evening, and strong squalls of rain and wind between early evening and midnight. Clear, starry nights were not unusual, and sometimes warm night fogs rose from the Meervlakte.

Temperature (C.) January 11–31: maximum (20 days) 17.0–20.5, mean 18.5; minimum (21 days) 10.0–13.5, mean 13.0.

The collections comprised 164 mammals, 363 birds, 92 wood specimens and 578 numbers of plants. Hunting, trapping and the collection of day-flying insects were hampered by the weather. At all times butterflies were scarce and birds scarce and shy except for a few common species. With the onset of the mists a hush fell in the forests, and visibility was limited to a few meters. The birds moved quietly in the thick foliage and on the ground, and there was not much activity in the animal world until, shortly before dark, small bats began their feeding flight in open places. Rich catches of insects, containing as many as eighty species of Lepidoptera, were secured on warm, foggy nights. Noctuidae were especially abundant in species and individuals, and occasionally a great atlas moth would appear from the forest and thump around the lamps and onto the tents before being captured.

Thirty-two per cent of the trees collected bore flowers or flower buds, twenty-two per cent were in flower and fruit, thirty-one per cent in fruit and fifteen per cent sterile. Most plants, as if hard put to exist let alone reproduce themselves under the prevailing weather conditions, produced few flowers, and these soon rotted in the rain.

Beneden-Mistkamp.—Situated at an altitude of 1,560 meters in a ravine on the Sahoeweri slope of the range immediately below the main camp, this subsidiary camp was occupied by Toxopeus and by collecting boys of Rand and Richardson from January 26 to February 2. The climate was less misty and, of course, warmer at that altitude, and lowland elements began to appear in both fauna and flora. A series of three small waterfalls provided good catching spots for butterflies, but the ravine was so deep and narrow that the sun

did not reach the stream until after eight o'clock in the morning.

About 55 species of birds were taken at this camp, a marked decrease compared with the 1,200-meter Camp. Also the avifauna was much poorer than that of the comparable 2,200-meter Camp on the central range. A correlation that at once comes to mind is that the land mass at this altitude here is much smaller than that at the 2,200-meter Camp.

The bird life at the 1,800-meter Camp was quite different from that at the 1,200-meter Camp. Of the fifty-five species collected here, only about half a dozen also occurred at the 1,200-meter Camp.

This was strictly a forest camp, but along one of the little streams in the forest was found the weaver-finch (*Lonchura tristissima*). This is a non-forest bird, and like most of its genus usually thought of in connection with grasslands, but here it occurred in the natural openings along the small streams.

The pigeon (*Gymnophaps*) seems erratic in its vertical distribution. Variously recorded from near sea level to timber line, in southeast New Guinea in 1933 we found it common only from 2,400 to 2,800 meters; here we found it common only from 1,800 to 2,150 meters. It was a conspicuous bird, flocks up to a dozen or two being seen circling over the forest; sometimes we could hear their wing strokes as they flew by in the mist, when we were unable to see the birds. The swift (*Collocalia esculenta*) was fairly common, and one night two *Collocalia lowei* came to the illuminated cloth used to attract moths and were taken in butterfly nets. A single specimen of *Chalcites meyerii* also came to this light one night, the only one taken. Perhaps this indicates a nocturnal habit, which would help explain why we have so rarely found *Chalcites* in the field, even in localities where they were common, judging by the number of their eggs found in the nests of host species, as on the middle Fly River in 1936. Frequently in the evenings flocks of lories (probably *Eos* or *Trichoglossus*) appeared, often flying high and in from the direction of the Idenburg, as though they had come from a considerable distance. This perhaps indicated that these birds fed out on the plains of the Meervlakte during the day and returned to the hills to sleep.

In the tree tops were such species as the pigeons (*Gymnophaps* and *Columba*, the latter found here only), the parrot (*Eclectus*), flocks of the lories (*Eos* and *Neopsittacus musschenbroekii*), the cuckoo shrike (*Coracina longicauda*), the warbler (*Phylloscopus*), the honeyeaters (*Myzomela rosenbergii*, *Oreornis subfrenatus* and *Melidectes belfordi*) and the bird of paradise (*Astrapia*). Congregations of birds about flowering and fruiting trees were not pronounced, but sometimes a tall flowering tree was found where the honeyeaters (*Myzomela rosenbergii* and *Oreornis subfrenatus*) and the lory (*Charmosyna pulchella*) gathered to feed. Usually lower in the forest, in the substage, were such species as the flycatchers (*Rhipidura albolimbata*, *Microeca papuana*, *Machaerirhynchus nigripectus* and *Poecilodryas albonotata*), the warblers (*Sericornis perspicillatus* and *S. papuensis*), and usually lower in the substage, *Eugerygone*, the birds of paradise (*Paradigalla* and *Loria*), the babbler (*Ifrita*), the honeyeaters (*Melipotes* and *Ptiloprora guisei*), the thickheads (*Pachycephala schlegelii* and *P. lorentzi*), the flowerpecker (*Pristorhamphus*), the pigeons (*Macropygia nigrirostris* and *Ptilinopus bellus*) and the parrots (*Geoffroyus simplex* and *Micropsitta bruijnii*), the last creeping about on tree trunks. Mixed flocks of birds were not a conspicuous feature at this camp.

In the undergrowth were such species as *Sericornis nouhuysi*, *Poecilodryas cyana*, *Crateroscelis robusta* and *Pachycephala tenebrosa*. The only specimens of *Crateroscelis nigrorufa* secured by the expedition were taken at the 1,560-meter subsidiary camp. The birds of the ground were not many: *Eupetes leucostictus*, *Amalocichla incerta*, *Scolopax* and *Rallicula*. Again Richardson's mammal traps added considerably to the collection of ground-frequenting species.

The bowers (basin-shaped with a central column) of *Amblyornis* were commonly found on the crests of ridges, but the birds themselves were rarely seen or heard.

Nearly half of the specimens collected at this camp showed some indications of breeding.

Trapping was fairly good, a catch of nineteen specimens of at least five species in 453 traps being the best for one night. Occasionally phascogales were shot in the daytime; small bats were shot over camp at night, and a few cuscus were shot in night hunting, despite the very difficult terrain.

2,150-Meter Camp (Topkamp)

Eighteen Kilometers Southwest of Bernhard Camp

January–February, 1939

Situated on the westward continuation of the same mountain ridge, this camp was provisioned from 1,800-meter Camp and occupied by Toxopeus January 20 to 25 and by the American party February 1 to 10. It was on the exposed point of a very narrow triangular bluff which rose almost sheer for 100 meters on the crest of the ridge. Most of that 100 meters was a foot-and-hand scramble through tunnels cut between and under the raised roots of stunted, heavily mossed forest which became more stunted and mossy and eventually gave place to shrubberies and mounded *Sphagnum* (*S. sericeum*) beds near the top. In one place one dragged oneself up by a length of rattan tied to a tree. A little below the camp the path skirted the head of a steep rockslide, carrying growths of *Lycopodium* and ferns (*Sticherus hirtus, Gleichenia peltophora, Dipteris conjugata,* etc.) but supporting over quite half of its area only a partial cover of white lichens and the dark green mosses (*Campylopus umbellatus*) and *Dawsonia limbata.* An extremely slender tree *Rhododendron* with small bell-shaped flowers and a *Eurya* of similar habit were scattered over the slip, and on the talus at its foot *Parasponia rigida* was establishing forest conditions. About a kilometer beyond the camp was a 2,250-meter peak, from which the ridge sent down spurs to the Idenburg on one side and the Sahoeweri on the other.

From the bluff in clear weather one had a grand view of the Meervlakte stretching like a map north to the Gauttier Mountains, and of the upper valley of the Idenburg, extending far to the east toward the border of the Mandated Territory. The Cyclops Mountains, about 220 kilometers to the northeast, stood out plainly against the horizon. To the southeast, rising behind lesser ranges of probably igneous rocks, was a massive limestone range, exhibiting perpendicular bare walls. Mt. Wilhelmina and adjacent parts of the Snow Mountains showed through a gap to the south. At closer range, down on the Meervlakte, the entrance to the Bernhard Camp lagoon could be made out, and cutting east from under the bluff was the valley of the Sahoeweri, with secondary grasslands and a few villages and gardens on its lower slopes.

The beech-forests, where not stunted by exposure and slope, were much like those of the previous collecting locality in general appearance. They differed, however, in the identity of their major dominants and in the relative abundance of forms and to some extent in the floristic composition of their lower layers and epiphyte flora. *Weinmannia* persisted as a minor dominant, but the *Nothofagus* with which it was associated at lower levels, a species sterile during our visit, was replaced by two species of the genus, both in full flower and bearing fruit in early February. Two species of *Xanthomyrtus* (*X. exigua* and *X. scolopacina*) figured prominently in the subcanopy tree layer. On the upper parts of the 2,250-meter peak a slender, subscandent bamboo formed a dense high undergrowth which effectually shaded out or otherwise precluded the growth of most of the undergrowth plants, including bryophytes, found in other parts of the forest. Conspicuous about the edges of the bluff was a member of the subalpine coniferous genus *Libocedrus.*

Other subalpine elements, notably an ericoid *Rhododendron* abundant at Lake

Habbema and on Mt. Wilhelmina and also occurring as low as 2,100 meters in natural open habitats in the Balim Valley, found an isolated, abnormally low station in the shrubberies on the bluff.

Rain-forests occupied the bottoms and lower slopes of the ravines up to about 2,000 meters, and rain-forest trees, such as *Syzygium*, *Sloanea* and *Evodia*, occurred as high as 2,200 meters in the beech-forests of the peak. The rich undergrowth societies which distinguished the rain-forests of the 1,800-meter Camp locality were not developed at these altitudes. An *Elatostema* supplied the bulk of the undergrowth along the streams. There were few ferns.

Squally nights, and days of mist, rain and little sun were the rule. The wind blew with such force that one night the more exposed tents had to be taken down to save them from being torn to pieces. These strong winds, as at the 1,800-meter Camp, came from the northeast. Higher shade temperatures were recorded than at the 1,800-meter and 1,200-meter Camps. The thermometer shed was placed on the shrubby point of the bluff, where intense radiation in clear weather induced rapid evaporation, and the air, when the sun shone, possessed to some extent the dry, crackling qualities it had at high altitudes on the Snow Mountains during spells of fine weather.

Temperature (C.) February 4–10: maximum (7 days) 20.5–26.5, mean 23.0; minimum (7 days) 11.5–12.5, mean 12.0.

Collected here were 47 mammals, 130 birds, 24 wood specimens and 204 numbers of plants. Botanically, this was regarded as a subsidiary of the 1,800-meter Camp, and attention was chiefly directed to a search for plants not present in that locality. Such plants comprised more than fifty per cent of the collections. Twenty-five per cent of collected trees were in flower or bud, thirty-eight per cent in flower and fruit, thirty-three per cent in fruit, and four per cent sterile.

Of course in the short stay here not all the birds found at the 1,800-meter Camp were recorded. But it is interesting to record that a number of higher altitude birds were taken at their lowest altitudinal station on this small, exposed peak, such as *Accipiter melanochlamys*, *Orthonyx temminckii*, *Heteromyias albispecularis*, *Epimachus meyeri*, *Daphoenositta miranda* and *Paramythia montium*.

Here the best night's mammal trapping yielded ten specimens of at least four species in 438 traps. A few Dyak-made snares were employed. Neither the terrain nor the climate was suitable for night hunting; a few small phascogales were shot in the daytime.

Balim River Camp (Baliem-rivier)

December, 1938

This supply base and collecting camp was on the south bank of the river, 1,600 meters above sea level. It was here that, in August, Teerink and his party were picked up by the "Guba" and flown back to Lake Habbema after having followed the river down from the meeting place of the Habbema-Idenburg overland patrols. The camp was established by Teerink and Huls in November, the requirements of the airplane being given first consideration in the choice of the site. The river at this point had a width of about 100 meters and flowed strongly between steep tree-lined banks. Above the camp was a straight stretch long enough for landings and take-offs. Below it, at a distance of about one kilometer, the river began to drop away in rapids, and the valley narrowed rapidly and curved southward to the great gorge by which the Balim cut through the backbone of the Snow Mountains to empty its waters into the Reiger River.[1] Upon landing, the "Guba" was secured to an anchor buoy in

[1] The "Guba" was flown through the gorge and out over the southern plains on August 13, 1938. A numerous population was observed to extend through the gorge and down the southern slopes of the range. In January of 1939, aviators of the N. V. Mijnbouw Maatschappij Nieuw-Guinea, on a flight from their base at Tanah Merah, established that the Balim and the Koekoek tributary of the Reiger were one and the same river.

the middle of the stream and warped in to the bank with ropes. As the river flowed to the southeast and the prevailing wind blew from that direction, downstream take-offs frequently were necessary. Only a high-powered airplane, in the hands of a skillful pilot, could be operated in such a place.

The demands of a numerous agricultural population had long since led to almost total destruction of primary forest in this part of the Grand Valley and its replacement by grass. Apart from a very few, carefully preserved relics, the nearest primary forests were about a day's march from the camp and therefore out of collecting range. These forests were on the southern slopes of the valley, where cultivation and deforestation ended at an altitude of about 2,400 meters on what appeared to be the main ridge of the Snow Mountains. The country rock of the lower slopes of that side of the valley consisted of both sandstones and limestones; the forested upper slopes terminated in a line of sterile limestone cliffs, standing out boldly against the skyline. Deforested, almost treeless, conditions obtained over the entire northern side of the valley, where a limestone range with somewhat rocky slopes and hillocked summits rose in bluffs from the river to an altitude of about 2,400 meters.

This deforestation, effected with stone tools and fire, was the work of a people who had reached a high level of development in agriculture.[1] Theirs was a one-crop, grassland agriculture, based on the sweet potato. The crop was grown in permanent fields, walled with stones or mud, or where timber was available, substantially fenced. The alluvial flats were drained and swampy land reclaimed by deep ditches and erosion-controlled by stone walls built across the slopes to serve as contour terraces. By a system of rotation, under which the land received a long rest between periods of cropping, soil fertility was to some extent maintained. Impoverished alluvial and swamp lands were top dressed with materials from trenches or ditches dug, in many cases, especially for this purpose. Cultivated in addition to the staple sweet potato were small quantities of taro, sugar cane, cucumbers, gourds, spinach and beans. Bananas and tobacco were grown solely in the village enclosures. Many of the bananas grown in New Guinea are cooking kinds, which are cut for roasting or boiling while still unripe. In the Balim they were all good table sorts which were allowed to ripen on the plant, and none had the pronounced "native" flavor, relished by the people of the country but not appreciated by white men, which distinguishes so many of the bananas in cultivation in other parts of the country. One small thin-skinned kind was eaten skin and all.

There being no forest to hunt in within easy reach and not much in the way of game on the grasslands, in all probability the people of this part of the valley spent most of their time in their gardens, varied with visits to friendly villages in the neighborhood. Having no new land to bring under crop, they had to work hard to produce from the old. They were a settled, conservative people who never ceased to regard the expedition with, as far as we were concerned, fitting feelings of awe. Their invariably peaceable attitude could not always have been inspired by consideration of the expedition's fighting strength, for most of the time the camp was held by only a small body of men. At first they mistook the Dyaks for women, and there was apprehension that the expedition might wish to settle down permanently and plant crops for its sustenance. But after doubts on this score were allayed, and it became clear that their land rights and customs were being strictly observed, that we could live without drawing upon them for food, and that, anyhow, soon we would fly away and they would be rid of us, they accepted our presence in a kindly, philosophical way and appeared to wish nothing more than to be left alone. Their conservatism, or perhaps an inner mistrust of the expedition and all its doings, was evinced in their refusal, until almost the end of our stay, to accept English potatoes

[1] For an account of agricultural methods in this area see Brass, 1941, Stone Age Agriculture in New Guinea, Geog. Review, XXXI, pp. 555–569.

and peanuts for planting. They would greatly admire the steel tools carried by the expedition, and by sometimes asking to have a tree felled, or borrowing an axe or a chopping knife to do some cutting for themselves, showed their recognition of the superiority of these tools over their own, yet seldom would such objects be accepted in trade or even as a gift. There was a moderate demand for salt and matches. But coveted most of all our possessions were the cowrie shells which had been brought along for trade purposes.

The premier position of cowrie shells as a medium of trade with these mountain people was evident from the beginning. Shells possessed such advantages in the matter of bulk and weight to be transported that most of the more costly articles with which the expedition was provided, such as steel, cloth and trinkets, were gladly written off as not worth carrying and buried at the upper camps. It was soon found that large cowries, both white and colored, had no value at all. Only small ones, white or with a pearly gloss,[1] preferably with the back or convex part removed, were acceptable. Values within these limits varied in accordance with shape, size, ribbing, shade and luster. About ten kilograms of sweet potatoes could be bought for a shell of average quality. Six to ten good ones would purchase a small pig. For obvious reasons, the possession of shells was forbidden the native personnel of the expedition.

The people were dark-skinned, sturdily built and generally of short stature. The height of several men measured by Huls at the Balim Camp averaged 1.65 meters. They could not by any stretch of imagination be called pygmies. The men wore a gourd (*Lagenaria*) penis sheath and sometimes a hairnet as ordinary dress. Some had a good growth of curly beard, but as a rule the facial hair or at least the moustache and hair under the mouth was removed with an implement made of a small stick of wood broken half across and used as tweezers. The women dressed in very short thin string skirts, worn several one above another, or, instead of skirts, an arrangement of cords passed around the thighs, and always, as their chief covering, one or more large carrying nets hung over the back from the forehead. Ornaments, worn chiefly by the men, consisted mainly of braided armbands, boar's tusks passed through the septum of the nose, and cowries, plates of some large marine shell, boar's tusks and bits of fur and string as neck pendants. The cocoon of a case-moth, also worn at the neck, was used as a receptacle for valuables such as cowries. Lengths of rattan for fire making, tobacco and odds and ends of personal property were carried by the men in armpit bags of string net, or in larger bags hung half-way down the back and ornamented with feathers or designs worked in yellow with materials obtained from the pseudo-bulbs of orchids. Bushy-like fur headdresses and headbands of *Pandanus* leaf were donned for battle and on other special occasions. Arms and implements consisted of bows and arrows, very long spears, axes and adzes of polished stone, and, for digging, sticks trimmed more or less flat at one end and pointed at the other. These people had Jew's harps made of bamboo, but, strangely for New Guinea, no drums were seen or heard in the valley. Social organization was primitive, the highest authority, and that not very secure, seeming to rest in village headmen or heads of clans. Excision of thumb and finger joints was practiced in mourning. There was some evidence that cannibalism, involving parts of the body at least, was practiced. Huls, who made anthropological and ethnological studies and had opportunities to pick up some of the language, was able to establish that the dead were disposed of by cremation.

In some other, probably more turbulent, parts of the valley, the villages were well spaced, surrounded by high stockades and contained as many as fifty or sixty houses. Here the villages were not far apart, of at most twenty houses, and sometimes only two or three. There were no solitary houses, for men and women occupied separate quarters. The men's houses were circular in ground plan, with the roof in the shape of a dome. The women's houses,

[1] Chiefly *Cypraea moneta* and *C. annulus*.

which seemed generally to be shared in part by the pigs, were long and narrow, with a rounded hip roof. Construction was of upright split stakes laced together with vines and forming double walls, with a thick roof of grass thatch. The houses were without floors, the occupants sleeping on grass beds on the ground or, at least in the case of the men, on a stage above the central fire. The smoke escaped wherever it could. In every village were pens into which the pigs were brought for safety at night.

The heavy work of ditching the land and digging fallow was performed by the men. Men and women often worked together in weeding the crop, but for the most part the carrying fell to the women. The day's labor ended at two or three o'clock in the afternoon when the men, dusty or mud-caked from their digging, would repair to the nearest stream to bathe, and the women return to the villages carrying food. For the rest of the afternoon the expedition camp was the gathering place for the neighborhood, where the men brought things for sale and sat in groups under the trees by the river, discussing events, while the children played. As the air turned chilly toward nightfall and the smoke of the cooking fires hung low over the villages, the visitors would depart in small parties, men and children together, in the direction of their respectives homes.

Only once, when the evacuation to the Idenburg was in progress, was the camp visited by natives at night. Then a party of about a dozen leading men asked and received permission to enter. With much whispering around a fire, they cooked and ate a small pig, of which pieces were given to the white men. Following this was a ceremony in which water was sprinkled through the camp—a proceeding for which no explanation is offered, unless some notion of cleansing was involved.

Cordial relations existed between the people on both sides of the valley; in fact, some cultivated gardens on one side and lived on the other. Men frequently swam the river with the aid of a log or crossed it on crude rafts propelled with sticks used as paddles.

A very fine suspension bridge, not at all like the crazy rattan affairs one usually finds in the country, spanned the river at the head of the rapids. Made of forest lianas, it carried a decking of split timber fully a meter in width. Its lines were perfect, and remarkable skill had been displayed in building the pole trestle work of the land abutments. As many as twenty people were seen crossing the bridge at one time. At least during the day, a guard of about ten men kept watch over this important link of communication, for a desultory war was in progress with people whose territory began half an hour farther down the river. The war appeared more vocal than violent. In the early morning, when sounds carried far, the people among whom we camped would sit comfortably on sunny rocks about their border and exchange howls of defiance with the enemy. Occasionally a war party, bodies greased and blackened, and decked out in full regalia, would stage a demonstration or conduct a bloodless foray into hostile territory. When Teerink and Huls visited one of the "hostile" villages in an effort to establish peace, they were given a friendly reception, but as no envoy of either side would trust himself to their protection, their mission failed to better relations between the belligerents.

Here and elsewhere in the valley the expedition received proposals for an active military alliance, for friendship's sake, and a share in the spoils. Needless to say there was never any departure from a policy of strict neutrality. Care was also taken to prevent too free mixing and undue familiarity between the expedition personnel and the native population. All camps in inhabited territory were surrounded by a fence. No native was allowed to enter without permission, and no man allowed to leave the camp at night. Dyaks and convicts working away from camp always did so under supervision and under guard. Thus, by maintaining a proper reserve, respecting rights, customs and taboos, regulating trade relations, and by taking a firm but tolerant stand with the natives when necessary, no situation developed during our lengthy stay in the

valley of the Balim and its branches which left cause for regret.

Enough relics of the original forests remained in the vicinity of the Balim Camp, and between there and the Bele River, to show that mid-mountain forests of great extent formerly occupied the lower slopes of the valley between elevations of about 1,500 to 2,200 meters. There were indications that rain-forests had covered the alluvial plains. Beech-forests clothed the southern slopes at the upper limit of cultivation. Not a single remnant patch of primary rain-forest survived. Of the mid-mountain forest there remained one group of hoary old araucarias, here and there a clump of *Castanopsis* trees and oaks, and one narrow strip of pure *Castanopsis* forest on the banks of a minor stream near the camp. The latter relic contained an abundance of ferns such as *Humata mecodioides*, massed on the ground and characterizing the undergrowth, and *Nephrolepis cordifolia*, *Davallia trichomanoides* and *Vittaria zosterifolia* as epiphytes.

Scattered occurrences of open, low, seral growths, three to five meters high, consisting chiefly of *Vaccinium adenanthum*, *Alphitonia ferruginea* and *Grevillea subargentea*, and more in the nature of woodland than forest, developed on the predominantly sandy soils of the southern slopes. On rocky limestone knolls no longer considered worth cultivating and on rocky declivities rising from the river on the opposite side of the valley were sclerophyllous scrubs in which the *Grevillea* figured with *Rhamnus javanicus*, *Leucosyke* sp. and other small trees and shrubs. *Vaccinium adenanthum*, growing to a height of three to four meters, formed a distinctive dense scrub on poor sand at 2,100 meters. Glades in this scrub were filled with bracken (*Pteridium*) in which, and about the edges of the scrub, an ericoid subalpine *Rhododendron*, also found at the 2,150-meter Camp, was abundant.

The largest individual area of secondary forest in the neighborhood occurred on a stony alluvial fan which reached out to the south bank of the river from a great erosion gully cut in soft sandstone about one kilometer above the camp. On newly deposited, seepage-moistened materials on the lower periphery of the fan were tall thickets of reeds (*Phragmites Karka*). Some older parts supported low woody growths in which a *Ficus* and an arborescent *Piper* played a prominent role. But covering most of the debris were young forests of *Casuarina* sp., a quick growing, wind-dispersed tree which, in parts of this mountain country undisturbed by man, grew on gravel beds and along the banks of rivers.

Most of the secondary forests in the valley bottom consisted of pure stands of this adaptable tree, which established itself freely on soils—particularly alluvial soils—disturbed by cultivation, and attained a height of twenty-five to thirty meters in maturity. In heavily peopled sections like the Balim Camp locality, the demand for garden land was such that usually only strips and small patches of *Casuarina* forest were preserved or allowed to develop, for the most part on the banks of streams. The expedition camp was in one of these strips. In them many of the villages were built for shelter from the trade winds. The hard, fissile wood of the tree provided the villagers with most of their fuel and practically all of their building and fencing timber. It was planted for timber supply by the inhabitants of the old grass slopes. At first the natives were not disposed to allow the removal of some to facilitate the take-offs of the "Guba," but later this was arranged, and a shell was asked and paid for each tree cut by the expedition.

Undergrowth in the *Casuarina* forests varied from none at all in very dense stands to tall growths of the grass (*Pennisetum macrostachyum*) on stony soils, and, on moist alluvial soils, dense thickets of mixed grass and brush consisting of *Ischaemum digitatum*, *Saccharum spontaneum*, *Miscanthus japonicus* and *Phragmites Karka* as grasses, and *Rhamnus javanicus*, *Cudrania* sp. and *Rubus rosaefolius* as shrubs.

With the exception of *Ischaemum digitatum* (a swamp species) the grasses mentioned above, and also *Imperata cylindrica* (alang-alang), common everywhere in the valley, are wind-dispersed species with a

wide distribution in open habitats in the forested regions of New Guinea. The grasses and grass associates of the open slopes, on the other hand, were mostly of species characteristic of the natural savannas of the semi-arid lowlands and lower mountains of south and southeastern parts of the island. Their seeds in most cases could not very well have been transported to this valley by wind. Chief among open grassland dominants were *Germainia capitata*, *Ischaemum pubescens*, *Andropogon intermedius*, *Sorghum niditum* and *Pollinia leptostachys*, growing to a height of sixty to eighty centimeters. Among herbs and small woody associates were *Euphorbia serrulata*, *Wahlenbergia gracilis*, *Crepis japonicus*, *Cassia mimosoides* and *Osbeckia chinensis*. A *Melastoma* and a yellow-flowered *Rhododendron*, the latter a common species in forest openings within the range of the oaks in the Bele Valley, occurred as shrubs.

Although most of the expedition camps were in country free from malaria by reason of altitude or remoteness from human habitation and otherwise healthy enough, only at the Balim could the climate be called pleasant. Day temperatures going as high as 29°C. standard were modified in their effects by the tradewinds which blew most of the time, and even to people who had just spent months at high altitudes were not oppressive. The nights were crisp, and the morning air just cold enough to make one reluctant to discard one's coat upon going into the field after breakfast at sunrise. Ground fogs about dawn were rather common, and nearly every day, toward the middle of the morning, clouds gathered on the southern slopes at about the altitude of the upper gardens. In December, when rain fell from thunderstorms almost every afternoon and evening and changes of wind to the northwest heralded the approach of the monsoons, the natives were active in digging and planting, and on one occasion the river rose to near the top of its alluvial banks.

Temperature (C.) November 25–December 17:[1] maximum (20 days) 21.0–29.0, mean 25.0; minimum (20 days) 13.5–17.0, mean 15.0.

The collections included 141 mammals, 300 birds and 276 numbers of plants. Collecting in this locality, where one could range widely in any direction and cover a lot of territory in a day, was satisfactorily concluded for birds and mammals within the two weeks allotted for it. As Olthof began operations on November 15, the entomological field could be considered well covered for the season. Worthwhile additions to the plant collections could have been expected from a longer stay. The natives kept close watch over Versteegh in his search for trees, and would allow wood specimens to be taken from only about two-thirds of a total of twenty-nine species discovered by scouring the country up and down the river and up to 2,200 meters on the southern slopes. Seventeen per cent of the trees were flowering, forty-five per cent in flower and fruit, thirty-five per cent in fruit and three per cent sterile.

The river was unsuccessfully examined for fish, and from the way in which the natives regarded fresh-caught supplies brought in from Hollandia on the "Guba," it was concluded that they had no previous knowledge of the existence of such creatures. A large crayfish was common in the Balim and its branches.

For birds this was primarily an open-ground camp, with interest centered about the grasslands, gardens and the river. The little patches of forest and the *Casuarina* stands were also hunted, and, though their avifauna was scanty, it presented some interesting aspects. The forests, continuous with those higher, were too distant to collect systematically. Only about forty-five species of birds were secured here.

In the river itself cormorants (*Phalacrocorax melanoleucos*) fed and were also commonly seen perching on dead trees along its banks, sometimes in considerable numbers. Ducks (*Anas superciliosa*) were present in small numbers, feeding from the surface of backwaters and roosting on gravel bars. Golden plover (*Pluvialis*) fed on the large gravel bars; the sandpiper (*Actitis*) fed along the river margin more

[1] Records November 25 to December 6 made by Olthof.

generally and in the gardens. *Monachella* was found along the river rarely. A heron (*Notophoyx novaehollandiae*) was occasionally seen solitary along the river but more often about swampy ponds in the gardens and grasslands. A snipe (*Gallinago*) was occasionally flushed from marshy places, and mammal traps set in the grass about such places yielded some specimens of the little black rail (*Porzana tabuensis*). The wagtail (*Motacilla cinerea*) was uncommon about gardens and waterways where the ground was clear enough for it to walk about.

In the open grassland the warbler (*Cisticola exilis*) was fairly common, the weaver-finch (*Lonchura teerinki*) and the quail (*Excalfactoria*) were common, especially on old cultivated land where many weed plants had grown up to provide abundant food. About the shrubby edges of fields and along hedge-rows were the warblers (*Megalurus timoriensis* and *Malurus*) and the stone-chat (*Saxicola*). The swift (*Collocalia hirundinacea*) and the swallow (*Hirundo*) fed over the open country; the wood-swallow (*Artamus maximus*) hawked out over it from conspicuous perches. The hawks (*Haliastur indus* and *Ieracidea*) hunted commonly over open country. One rather surprising find was a nightjar (*Caprimulgus*) sleeping in the edge of a grass field. This last is usually a non-forest bird of the lowlands and to find it at this altitude was surprising.

The marsh-hawk (*Circus*) was scarce but occasionally seen beating over the extensive grass and marsh lands.

The *Casuarina* groves were particularly attractive to two species, a cuckoo (*Cacomantis variolosus*) and a warbler (*Pseudogerygone*), though, of course, other forest species occurred in them. In the small remnants of oak forest there were few bird species: *Phylloscopus, Sericornis perspicillatus, Sericornis nouhuysi, Rhipidura brachyrhyncha, Dicaeum, Myzomela rosenbergii,* and particularly *Zosterops,* were most frequently found. In the larger stands of *Casuarina* forest along the river there was more diversion in the bird life. In addition to the above we found *Macropygia amboinensis, Lophorina, Melidectes torquatus, Coracina caeruleogrisea, Pachycephalopsis* and *Pachycephala pectoralis.*

The natives here brought in a few birds, chiefly those of the grasslands, but their help was of little real importance to the bird collections.

Nearly half of the specimens collected at this camp showed some indications of breeding.

The Grand Valley was probably insufficiently explored by us. Our camp, placed in accordance with the needs of air transport, was in the most sterile part of the valley. The more extensive areas of marsh and forest seen farther up the valley would undoubtedly have yielded considerably richer collections. There were two species of birds recently found in the northeast part of New Guinea, for which the grasslands and sterile hills seemed very suitable, that we did not find: the lark (*Mirafra*) and the quail (*Turnix*). It is also worth mentioning that despite extensive hunting in suitable habitat, we found no sign of the shrike (*Lanius*) or of the quail (*Synoicus*).

The mammal collection of this camp consisted chiefly of small rodents, mostly *Melomys* and *Stenomys*. The natives were much less troublesome in trapping operations than at the Bele River Camp from which we had just come, but also they brought in no mammals of importance. The best night's trapping yielded twenty-one mammals in 384 traps. Pigs and a dog were bought from the natives. The dog, one of the very few seen in the locality, was highly prized and was secured only with difficulty at the exorbitant price of forty shells. A number of species of small bats were shot about the camp in the evening.

Bele River or 2,200-Meter Camp (Ibèlèkamp)[1]

Eighteen Kilometers Northeast of Lake Habbema

November–December, 1938

The Bele or Ibèlè ("I" meaning water) tributary of the Balim took its source about two kilometers to the north of Lake Habbema. Its narrow valley, cut deep in limestones and sandstones and populated to within a long day's journey of the lake, offered the most direct and also the most desirable route from the highlands to the Grand Valley. Easier traveling might conceivably have been had by following the crest of either one of the high spurs which flanked the valley, but such a route would have the disadvantage of carrying us above the villages of the natives, from whom fresh food and some assistance in carrying could be expected, and, more importantly, it would give a less representative biogeographical cross section of the slopes. The 2,800-meter Camp was on a headwater stream of the Bele, the Bele River Camp at an altitude of 2,200 meters on the right-hand bank of the river, about ten kilometers from the mouth of the valley. A small tributary called the Gugui joined the river at the camp.

The camp was in a kind of pocket where the valley widened a little between two limestone gorges spaced less than a kilometer apart. The downstream gorge, through which the river dropped about 200 meters to what we called the lower valley, had a length of rather more than one kilometer. The lower valley, in which sandstones predominated, carried a heavy population and, but for a few brownish patches of oaks and *Castanopsis* on its steep slopes, had been denuded of primary forest up to altitudes of 2,200 to 2,400 meters on both sides. Although settlement was doubtless more recent than in the Grand Valley, in many parts deforestation appeared already to have been pushed up the slopes to levels at which, owing to the prevalence of mists, the soil of the beech-forests became too peaty for the profitable cultivation of the staple sweet potato. The villages here were as neat and prosperous-looking as those of the Balim; the gardens, as carefully tilled. Of special interest were the contour terraces of wood and stones designed to control rain water run-off and to prevent erosion. From a stockaded village perched on the top of a cliff at the lower end of the gorge, one had, from an elevation of 2,350 meters, a splendid view of this lower valley with its villages, gardens, contour terraces, grassy fallow slopes and low secondary forests, and beyond, in the Grand Valley, large areas of flat, yellowish grass plain and green swamp.

The upstream gorge did not exceed 200 to 300 meters in length. Above it was a second pocket, several times larger than the first, reaching up to the confluence of the two main tributaries of the Bele—the Bena and the Mon. In parts of this pocket primary forest came down to the river banks. Other parts were deforested and grassy. In it were several small villages and a number of scattered dwellings, comprising in all about fifty houses. To all intents and purposes this was the upper limit of permanent habitation in the valley, although one isolated garden was seen some distance up the Bena, and there may have been others. The highest garden in the pocket, and the highest observed on the expedition, was at an altitude of 2,480 meters.

The pocket between the gorges contained three more small villages and several deserted houses from which the people had moved to cultivate new land. Brushy second-growth forest and grass extended up to about 2,400 meters on the camp side of the river, where the villages and producing gardens were, and up to about 2,350 meters on the steeper opposite slopes. Filling the gorges and completely surrounding this disturbed area were magnificent tall beech-forests. Little beaches of sand and gravel and narrow alluvial banks on which a mauve orchid (*Spathoglottis*)

[1] Arrived at by estimate, this distance exceeds by about four kilometers that indicated on the military patrol maps of the expedition.

flowered plentifully in the grass, and *Astilbe* sp. with pink and *Hypericum habbemense* with large yellow flowers grew as shrubs, occurred in both pockets. A grassy terrace in the fork of the river and the Gugui provided an ideal site for the camp, within easy reach of all types of habitats. The river, a racing stream of cold, clear water, with a rocky and bouldery bed twenty to thirty meters wide, was bridged in two places by felling heavy trees which reached from bank to bank. Between the almost daily spates, the shallower parts could be crossed by wading over one's knees.

Here we were among people who had visited us at Lake Habbema and made frequent trips up to the 2,800-meter Camp with garden produce and birds and mammals to sell for shells. They made the arrival of the party the occasion for a mass gathering on the outskirts of the camp, dancing by both men and women, proceedings in the nature of an initiation ceremony, and a feast. The ceremonies, which Archbold and Rand have described elsewhere,[1] included the eating of pig's livers by the elder natives and the white men, speeches, blood-sprinkling rites and the earmarking of gift pigs. As the tents were being dismantled on the morning of our departure, some of the men dug a small piece of ground in camp, and, producing sweet potato cuttings, invited us to plant them. This appeared to symbolize a grant of privilege to cultivate the land. Previously, we were given to understand that when the pigs we had earmarked during the initiation ceremonies had matured and grown tusks, we were expected back to kill and eat them at a great feast which would be given in our honor.

Other actions of these people were not so pleasant. Greed for shells and excessive eagerness to acquire them, chiefly on the part of a few young men and the associates of a rapacious one-eyed headman of the upper pocket who pestered us in the field, hissed incessantly around the fence to attract attention and even went so far as to attempt to enter the camp by force, led to some tense situations during the first week or so. As a measure to abate this nuisance a shed was erected outside the camp where visiting natives could shelter from the rain, and where, by strict rule, all barter transactions were carried out. Four men chosen as having some influence over their fellows were given the freedom of the camp and appointed to serve as trade intermediaries and to keep some sort of order. One of these go-betweens, Gira, a headman of the lower valley who had guided Teerink and Brass on their patrol in October, was of real use; but even he, upon occasion, succumbed to the temptation to take unethical advantages of his position.

The insatiate desire for shells was, after all, greatly to the advantage of the expedition. A large-scale trade was done in mammals and birds. Supplies of sweet potatoes, bananas, spinach and other foodstuffs on offer exceeded the requirements of our large party. In the interests of the natives, especially those of the small communities living close at hand who, in their cupidity, sold more than they could spare, the purchase of food was curtailed after a while, with the result that the activities of the men were directed more and more toward hunting. Excitement ran high when, the day before we left for the Balim, parting gifts were given our more useful friends and helpers, and it became known that quantities of reserve stores and materials no longer needed would be left behind. That night the singing of many visitors was heard in the near-by villages. In the morning, the older men gathered to weep at our going, while, as soon as the guard was withdrawn, the younger ones looted the camp. An hour or two on our journey we were overtaken by men laden with spoils carried in copra bags on their heads. Gira, who held himself aloof from these undignified proceedings, had evidently sent representatives to attend the sack, for, as he bade us an affectionate farewell by the wayside, we saw loads of our former property pass into his village.

The somewhat aggressive people of the Bele Valley were in all essentials similar to those of the Balim. They were alike in physical characteristics, dress and ornaments, lived (in the lower valley) in the

[1] 1941, Natural History, XLVII, pp. 193–199.

same types of houses, had, so far as we could see, the same customs and spoke at least a dialect of the same language. As at the Balim, a few, who could not otherwise be distinguished, called themselves Morip, while the rest referred to themselves as Pesigam. The Morip and Pesigam had each their separate villages and sections of territory and lived on good terms with each other. Body armor in the form of a cuirass, finely worked in split rattan, was found in the Bele Valley but not in the Balim Camp area. Housing differed inasmuch as all the dwellings in the outpost pockets of the upper valley were of the circular, dome-roofed kind.

The inhabitants of this valley had one important food crop, doubtless a valuable source of proteins, which was not observed below altitudes of about 2,000 meters and which, though known to the people, did not occur in the Balim Camp area. This was a large species of *Pandanus*,[1] a native of the forests up to altitudes of about 3,000 meters, commonly planted about villages and on old garden lands in the root-crop zone and in openings in the forests at higher elevations. Called *weramo* by the natives, its large oily seeds were eaten fresh from the tree or smoke-cured and stored in the houses. The leaves of the tree were sewn together and made into long hoods, which the natives used to cover head and body when traveling in rain.

The forests were composed of three species of *Nothofagus*, all forming great straight-stemmed rough-barked trees over forty meters high and up to a meter and one-half in diameter. One species, with young leaves of a pale reddish color, dominated from the river banks up to about 2,400 meters—that is, up to about the level of daily cloud accumulation and the upper limit of cultivation on the slopes Another species, darker red in young foliage and with rougher bark, provided most of the stocking above that level. The third, yellowish in young leaf, was common about 2,300 meters. Associated with these, as large subsidiary trees twenty-five meters to over thirty meters high, were oaks of four species, *Castanopsis*, *Engelhardtia*, several species of Cunoniaceae, Lauraceae, *Elaeocarpus* and *Syzygium*, *Flindersia chrysantha*, *Turpinia papuana*, and representatives of the genera *Fagraea*, *Platea*, *Sloanea*, etc. Significantly, the oaks and *Castanopsis*, which can usually be taken as indicators of good agricultural land, were confined to the lower slopes, where, up to altitudes of about 2,350 meters, they actually attained dominance and formed isolated small patches of typical dry-appearing, mid-mountain forest on the crests of some of the broader spur ridges. Rain-forest elements, including many large trees but for the most part small trees and undergrowth plants, were conspicuous on the river banks and, in diminishing numbers, reached far up the slopes, beyond the limit of the oaks, in ravines and hollows between the spurs.

The forests of the lower and upper slopes were alike in that, under optimum conditions, the dominants and the subsidiary trees combined to form a fairly close deep canopy. Usually, however, owing to the steep pitch of the slopes, the canopy was somewhat broken. In their best development, the lower forests contained a rather thin substage layer of saplings and slender small trees, such as *Pygeum melanocarpum*, *Xanthomyrtus lanceolata*, *Aristotelia* sp., *Phyllanthus* sp. and *Melicope heterophylla;* a sparse woody undergrowth on the spurs, and in the hollows a plentiful mixed woody and herbaceous undergrowth in which species of *Saurauia*, *Cyrtandra*, *Amaracarpus* and *Chloranthus* and *Melicope marcophylla* occurred as shrubs and small trees with the slender treefern (*Cyathea everta*) gigantic *Marattia coronata*, species of *Pilea*, *Elatostema* and *Begonia*, *Selaginella opaca* and *Dryopteris protecta*. A scrambling *Calamus* was locally plentiful in hollows, and, as in the upper forests, *Freycinetia sterrophylla*, a common large root climber. Except on the river banks where the ground was heavily bedded with bryo-

[1] Probably *P. brosimos*, described as new by Merrill and Perry, 1940 (Jour. Arnold Arboretum, XXI, pp. 163–200) from material collected at the 2,150-meter Camp. Seeds of the Bele Valley tree were sent to the Coconut Grove Palmetum, Florida, and Buitenzorg. The seeds sent to Florida died soon after germination. Those sent to Buitenzorg were planted at the mountain experimental station at Tjibodas, where good germination was obtained and about thirty fine young plants were growing under glass in June, 1939.

phytes, the ground cover consisted of leaf and twig litter, with at most a thin sprinkling of soft hepaticas. Fuzzy hepatica coated the undergrowths and with mosses covered exposed surface roots and the trunks of the trees to a height of one to three meters.

Orchid species probably exceeded fern species in number, but only ferns were prominent in a not very rich flora of epiphytes associated with the bryophytes and therefore growing chiefly near the ground. Occurring as epiphytes on the river banks and in hollows were nest-forming *Asplenium nidus*, fleshy *A. amboinense*, *A. Foersteri*, *Elaphoglossum novoguineense* and *Polypodium albidosquamatum;* more generally distributed and extending into the upper forests were such species as *Ctenopteris pendens*, *Grammitis subrepanda*, *G. frigida*, *Mecodium Reinwardtii* with small crinkled fronds, and *Loxogramme subselliguea*.

In the upper forests, especially on the spurs, there was a considerable development of "mossy" ground cover; rhododendrons of several species were prominent in a plentiful, predominantly woody undergrowth dominated by a small-leaved *Rapanea*. A scrambling bamboo often formed dense thickets under open canopy conditions and on landslips, which occurred here and there on the steeper slopes.

More clearly perhaps than in their dominants, the lower and upper beech-forests were distinguished by the presence or absence of oaks and *Castanopsis* and in what may logically, by reason of their position on the slopes, be considered their respective seral growths. In the seral growths of the lower slopes, the secondary forests which sprang up after deforestation and cultivation, seral rain-forest species, e.g., *Macaranga* spp., *Homalanthus* sp. and *Saurauia occulta*, and *Dodonaea viscosa* and *Buddleia* sp., were the chief dominants. At least on the peaty soil of the upper slopes, the small-leaved *Rapanea* was chief dominant, and *Kania* sp., *Rhododendron* spp., *Ilex Versteeghii* and the scrambling bamboo, all derived from the primary forest, prominent.

A number of the rain-forest seral trees of cleared land, prominent among them the *Piper* noted as occurring on the Balim, found an "original" habitat on the faces of the limestone cliffs, where they grew in association with stunted, often shrubby *Nothofagus*. A talus slope, the only original station for grassland plants apart from the river beaches, carried the grasses *Pogonanthrum paniceum* and *Imperata cylindrica* and growths of bracken (*Pteridium aquillinum*).

Floristically, the old-established grasslands of the deforested slopes were a depauperate counterpart of those of the Balim, with *Imperata cylindrica* in general control, *Pollinia leptostachys* and *Setaria geniculata* dominant on some dry slopes and *Ischaemum digitatum* in possession in moist hollows. Tall stands of *Saccharum spontaneum* constituted an early stage in forest succession on newly abandoned garden lands.

When Teerink and Brass passed through the valley in the last week of October, the streams of the limestone slopes were dry and the crops in need of rain. When we camped there in November and early December, rain fell on all but four of twenty-six days, most of it coming in the afternoon and the heavier falls being accompanied by thunder and continuing into the night. The mornings as a rule were clear; in fact, it was necessary to build thatched sun roofs over the tents to make them habitable. Mist clouds, affecting the upper slopes about 10:00 a.m., sometimes drifted in from the Grand Valley, but the general movement was downward along the confining spurs of the valley. Rarely, after heavy rains, the mists descended to the river.

Temperature (C.) November 13–December 4: maximum (22 days) 19.0–26.0, mean 23.0; minimum (22 days) 9.0–12.5, mean 10.5.

Collections: 1,108 mammals, 581 birds, 61 wood specimens and 512 numbers of plants. The botanical collecting possibilities of the locality, with its virgin forests, second growth forests, grasslands and river banks, were by no means exhausted when the time came to move to the Balim. Of Versteegh's trees, twenty per cent were

flowering and eighteen per cent in bud, twenty-eight per cent in flower and fruit, twenty-four per cent in fruit only, and ten per cent sterile.

This camp yielded about ninety-five species of birds, as large an avifauna as that recorded from the 850-meter Camp. The natives here brought in a great many specimens, some of species not seen otherwise, and series of some shy, secretive forest birds that would have been represented by few specimens but for their help. The natives were paid in cowrie shells, which presented some difficulty in paying for small items not worth a shell apiece. However, this was overcome in part by buying a number of birds for one shell, and sometimes several natives would put their birds together for the sake of a single shell. This was only the second camp, of the forty or so we had established in New Guinea in more than three years collecting on three expeditions, where the natives were a real help in general collecting. They brought in many more birds than could be prepared and birds of many species.

The natives hunted with bow and arrow; they apparently caught some ground-frequenting species in their mammal deadfall traps, and they set up blinds or hides by little hollows containing water, where birds came to drink. The arrangements of one shooting stand were rather interesting. The water was in a cavity in a prostrate tree trunk, the hide of branches a few feet away. A tube pointed from the blind to just above the water, where a small perch had been arranged; just beyond that had been placed a wad of moss apparently as a backstop for the arrows. There was no aiming. The hunter shot his multiple-pointed arrow down the tube at the bird on the perch; the arrow hit the moss and stopped, and the hunter could reach down the tube and pull back the arrow.

The numbers of the natives in the area about the camp and their persistence in following us about in the field made collecting somewhat trying.

Since many of the specimens were brought in by natives, sometimes by parties who had evidently come from a distance, records of altitudes at which some of the specimens were taken are lacking. Certainly at this 2,200-meter Camp we received some bunches of birds that had been taken on the top of the range above 3,000 meters.

The river was responsible for the presence of few birds, chiefly the duck (*Salvadorina*) and the wagtail (*Motacilla cinerea*). The grasslands had much the same avifauna as the Balim River Camp, though not all the grassland birds of that area occurred here. There was but a single grassland species, *Rallus albertisi*, taken here that was not found elsewhere.

There appeared to be no birds restricted to the second growth in this area, the non-forest birds which haunted its edges being found also out into the grasslands, such as *Saxicola* and *Malurus*.

In the forest tree tops were such species as the lories (*Charmosyna papou, Neopsittacus pullicauda* and *N. musschenbroekii*), the honeyeaters (*Myzomela rosenbergii, Oreornis subfrenatus* and *Melidestes leucostepheni*), the warblers (*Pseudogerygone* and *Phylloscopus*), the cuckoo (*Chalcites ruficollis*) and the cuckoo shrikes (*Coracina longicauda* and *C. caeruleogrisea*). More characteristic of the higher substage were the pigeons (*Reinwardtoena, Macropygia nigrirostris* and *Ptilinopus bellus*), the parrot (*Psittacella brehmii*), the kingfisher (*Syma megarhyncha*), the creeper (*Climacteris*), the nuthatch (*Neositta*), the honeyeaters (*Ptiloprora guisei, P. meeki* and *Melipotes*), the birds of paradise (*Astrapia, Epimachus, Loria* and *Paradigalla*) and the warbler (*Gerygone cinerea*). Usually found lower in the substage were such birds as the parrot (*Psittacella madaraszi*), the bird of paradise (*Pteridophora*), the flycatchers (*Machaerirhynchus nigripectus* and *Microeca papuensis*), the warblers (*Sericornis papuensis* and *Eugerygone*) and the thickhead (*Pachycephala pectoralis*).

In the undergrowth were such birds as *Poecilodryas cyana, Sericornis nouhuysi* and *Crateroscelis robusta*, while frequenting the forest floor were such species as *Orthonyx, Amalocichla incerta, Melampitta lugubris, Eupetes leucostictus, Heteromyias* (that feeds on the ground and when

alarmed flies up into the lower part of the forest), *Pachycephalopsis*, *Amblyornis* (that also fed high in the forest), *Rallicula*, and *Gallicolumba jobiensis* and *G. beccarii*.

The swift (*Collocalia esculenta* and *C. hirundinacea*) fed commonly over the open ground and forest, and a colony of *C. hirundinacea* was found nesting in a cave in the forest. The cave descended vertically in the forest floor, and the bulky nests were placed on crevices on its steep sides.

About half of the specimens collected at this camp showed some indications of breeding.

Especially in the mammal work was the influence of the natives felt. They followed the trappers, examined the traps and even tended the traps and brought in (expecting pay) mammals removed from them. But they were effective trappers on their own and from their deadfalls brought large numbers of specimens. One day more than 100 specimens, representing at least nine species, were purchased from them. In all nearly a thousand mammal specimens of at least eighteen species were bought from the natives. Of course not all could be saved, but it was necessary to buy the common species to be sure of continuing the supply of rare ones. Richardson, however, was able to discontinue purchasing one abundant species of rat that the natives evidently caught about their homes, without ill effects on the general supply. Very few mammals were secured by hunting.

2,800-Meter Camp (Mosboschkamp)

Nine Kilometers Northeast of Lake Habbema

October–November, 1938

Situated high in the upper drainage basin of the Bele River beside a well-used path which led from the inhabited regions up to Lake Habbema, this camp was on a small stream, a feeder of the Mon, called the Simo. It was in heavily forested country consisting of parallel spur ridges and very narrow valleys or ravines, rising rapidly toward the highlands but not particularly difficult to get about in. Rock exposures in the stream beds and on occasional landslips showed the country rock to be chiefly of limestone. A clearing about fifty meters long and twenty meters wide was hewn out of the forest on the edge of a planted *Pandanus* grove in which Toxopeus had camped a night on his excursion down the slopes from Lake Habbema in August. There being very little level ground, most of the tents were set up on platforms of saplings. The establishment of the camp was carried out under the surveillance of a crowd of excited natives, who hastened up from their villages to guard the *Pandanus* trees and support the owners in their demand for immediate compensation for the few that sustained damage in clearing operations.

In this locality *Pandanus* trees grew scattered all through the forest. Each wild tree, old and young, had an owner. A few forest trees around some of them had been ringbarked and killed to admit the light. Between altitudes of about 2,600 and 2,900 meters they were planted in little brushy clearings and in natural openings resulting from the fall of great beech trees affected by dry rot. In several of these primitive plantations, including the one beside which we camped, were solitary houses built of split timber and treefern stems and roofed with sheets of bark. The natives used these houses when visiting their *Pandanus* trees and traveling in the mountains. Faint trails ran in all directions through the forest, and a tolerably good path followed the top of every spur ridge.

The natives, although disturbed at first by our trespass on their home territory, fearful of our every action and therefore quick to demonstrate with bow and arrow or spear, for the most part were friendly and helpful. They carried eighty loads of supplies down from the lake for payment of one shell per load, brought much-appreciated foodstuffs and did some hunting for mammals and birds.

Beech-forests continuous with those of

the Bele Camp area and equally tall in the valleys clothed the slopes up to about 3,100 meters, where they met in a narrow ecotone subalpine coniferous forests dominated by *Podocarpus papuanus*. Conspicuous at the junction of the two forests and so plentiful that the position of the ecotone could be traced on the slopes by its gray-green foliage was a species of *Quintinia* which occurred only rarely at lower levels.

The 3,100-meter level was far from being the lower limit of the subalpine flora. At 3,000 meters the continuity of the beech-forests was broken on a swampy shelf, on parts of which *Podocarpus papuanus* predominated in low, very mossy forest, and *Libocedrus* also occurred. Interrupting these low forests were open, marshy glades filled with tussocks of an alpine sedge (*Gahnia*) and containing shallow peat-stained pools. In the drier parts of the glades and in small open places from which the stunted forest appeared to have been burned by the natives were shrubberies of subalpine *Vaccinium cryptodon*, *Diplycosia edulis*, *Rhododendron* spp., etc., and a typical alpine peat moor turf of *Oreobolus ambiguus*? and *Lycopodium* spp. covered the ground. Somewhat similar peaty openings, which traveling natives used as resting places and all of which contained subalpine shrubs, occurred on the crests of spurs down to 2,600 meters. Alpine grassland plants, such as *Deschampsia Klossii*, species of *Ranunculus*, *Potentilla*, *Trigonotis*, *Epilobium* and *Tetramolopium*, were found on landslips, about native houses (where their seeds may have been carried accidentally by natives), and in greater abundance in the bed of Simo Creek down to camp level and lower. Two alpine grasses, a buttercup and a *Hydrocotyle*, grew on wet rocks in the bed of the Bele at 2,200 meters.

Above about 2,800 meters in these beech-forests, the *Nothofagus* of the upper Bele slopes was almost sole dominant. Another species, apparently identical with that of the lower Bele slopes, appeared below 2,800 meters and was in control on some spurs at 2,700 meters. Generally, the lower trunks and the crowns of the trees, the undergrowth and the ground were abundantly, often heavily, mossed down to about 2,600 meters on the spurs and 2,700 meters in the valleys. A deep, springy ground cover of matted roots and brownish hepatics developed on the narrow crests of the more prominent spurs above camp level, where the forest was stunted to a height of fifteen meters or less, and open in character, and the trunks and main branches of the distorted, thick-stemmed trees were heavily blanketed and cushioned with both mosses and hepatics. These stunted forests carried, in association with tangled wiry-stemmed orchids and a few ferns, a distinctive shrubbery undergrowth of chiefly small-leaved *Xanthomyrtus Klossii*, *Rapanea* sp. and *Vaccinium debilescens*.

The principal subsidiary trees of the tall upper forests were *Phyllocladus* sp. and a glaucous form of *Podocarpus papuanus* on the ridges and *Elaeocarpus* spp. in the valleys. In the stunted forest of the crests, the conifers assumed the role of co-dominants. The subsidiary tree layer, as a rule, was not well developed, and the canopy therefore was rather open above a plentiful high substage characterized chiefly by *Xanthomyrtus papuana*. A rather abundant undergrowth included *Pygeum rigidum*, *Rapanea*, *Symplocos* and *Drimys* as small trees, several small treeferns, and in wet valley bottoms *Dryopteris Engleriana* var. *hirta*, *Asplenium Foersteri*, *Elatostema* spp. and small, clumped Zingiberaceae. A very rich flora of moss-inhabiting epiphytes, conspicuous nearly everywhere and especially so in the stunted forests of the ridge crests, included *Polypodium Werneri*, *P. albidosquamatum*, *Selliguea crassisora*, numerous Hymenophyllaceae (*Mecodium novoguineensis*, *Meringium rubellum*, *M. gorgoneum*), *Calymmodon clavifer*, *C. cucullatus*, *Prosaptia* spp. and *Humata kinabaluensis* among the commoner ferns; *Ceratostylis*, *Glomera* and some very brilliant little Dendrobiums among the orchids; and among shrubs *Vaccinium oreomyrtus*, with urceolate red flowers. Scandent *Dimorphanthera* spp. occurred throughout, as did *Ilex scabridula* (a large liana), and *Freycinetia sterrophylla* went as high as 2,850 meters in the valleys.

The forests of the lower slopes were generally taller, the canopy denser and the lower layers in consequence poorly developed. A more plentiful and more varied subsidiary tree layer was characterized by Cunoniaceae and *Elaeocarpus* spp.

Outpost plant species of the tropical rain-forests, following the sheltered bottoms and lower slopes of the valleys, ascended in some force to altitudes of 2,700 to 2,750 meters where, with singular abruptness, most of them reached the upper limit of their range. This sharp falling off of rain-forest elements was most apparent in the successional communities of clearings and other openings in the valley of Simo Creek, in which, up to 2,750 meters in a series of flattish little basins containing houses and *Pandanus* groves, species of *Saurauia*, *Macaranga* and *Homalanthus* held first place in seral growths of tropical appearance, and such genera as *Ficus*, *Cypholophus*, *Solanum* and *Strongylodon* found their uppermost limits.

The upper basin, and indeed the whole valley of the Bele, was protected from the trade winds by high spurs. There was therefore little air movement, and although mists frequently enveloped the more prominent local ridges and sometimes filled the little valleys, there was no very regular massing of clouds in the immediate camp locality. The occupation of the camp from October 8 to November 9 was during a period of variable weather, with pleasant sunny mornings and showery afternoons, successions of overcast rainy days, and one dry spell in which no rain fell for four days and nights. A total of nine days was without rain. A standard shade temperature of 21.5°C. was registered during the four-day dry spell; 1:00 p.m. relative humidity readings of forty-four to forty-six per cent were recorded in the thermometer shed in the camp clearing, and readings of fifty-four to fifty-five per cent recorded in the adjacent forest. At sunrise, however, relative humidity was never lower than eighty-seven per cent in clearing and forest, and even in the stunted forests of the ridges conditions were never so dry as to suggest the possibility of the mosses carrying a destructive fire.

Temperature (C.) October 15–November 9: maximum (18 days) 13.5–21.5, mean 17.5; minimum (19 days) 4.5–10.0, mean 7.0.

The collections included 220 mammals, 664 birds, 61 wood specimens and a total of 667 numbers of plants. Twenty-five per cent of the trees collected by Versteegh were in flower and four per cent in bud, twenty-five per cent in flower and fruit, twenty-eight per cent in fruit only and eighteen per cent sterile. Only stray flowers of many trees and other plants were obtainable. Few of the mosses were in fertile condition.

Good catches of insects were taken at this camp. Diurnal butterflies, among them some particularly beautiful delias, were prominent. Toxopeus noted that among the night moths the Lithosiidae, the larvae of which live on lichens and mosses, predominated, and the number of species of Tortricidae was also remarkable. Among other insects the appearance of Locustidae and Gryllidae was noteworthy, also a leaf-insect (*Phyllium*) and true wasps (Vespidae), all of which were lacking at Lake Habbema and higher altitudes. A small black leech extended up to this altitude but was not plentiful enough to be troublesome.

We recorded about seventy species of birds from this camp, but a few of these were brought in by the natives and certainly came from the lower altitudes. Probably about sixty-five of the species recorded came from the few hundred meters' range of altitude covered personally during the collecting from this camp.

This was essentially a forest camp, but the little stream flowing through the forest near camp was responsible for the presence of *Pomareopsis* and *Motacilla* (the latter seen but not collected).

The change in the avifauna between this and the lower camp consisted in the dropping out of a considerable number of species and the appearance or increased abundance of a lesser number.

Some birds, such as *Oreopsittacus*, *Daphoenositta*, *Amalocichla sclateriana*, *Gerygone murina*, *Oreostruthus* and *Paramythia*, were found only rarely below this camp.

Some rare species were also found (only rarely) lower, as *Clytomyias*, *Ptiloprora erythropleura* and *Archboldia*.

Slightly less than one-third of the specimens collected at this camp showed any indications of breeding.

The mammal trapping was fair, eighteen specimens in nearly 450 traps being the best night catch. The catches here were more varied than at higher altitudes, where they were predominantly of two species of *Stenomys*. Toward the end of our stay the natives began to bring mammals to us from lower altitudes, ten specimens of seven species being the most in one day. Hunting yielded little, though phascogales were not infrequently shot in the daytime. No echidna were taken by the expedition, but a native brought us part of an old skull at this camp.

Lake Habbema Camp

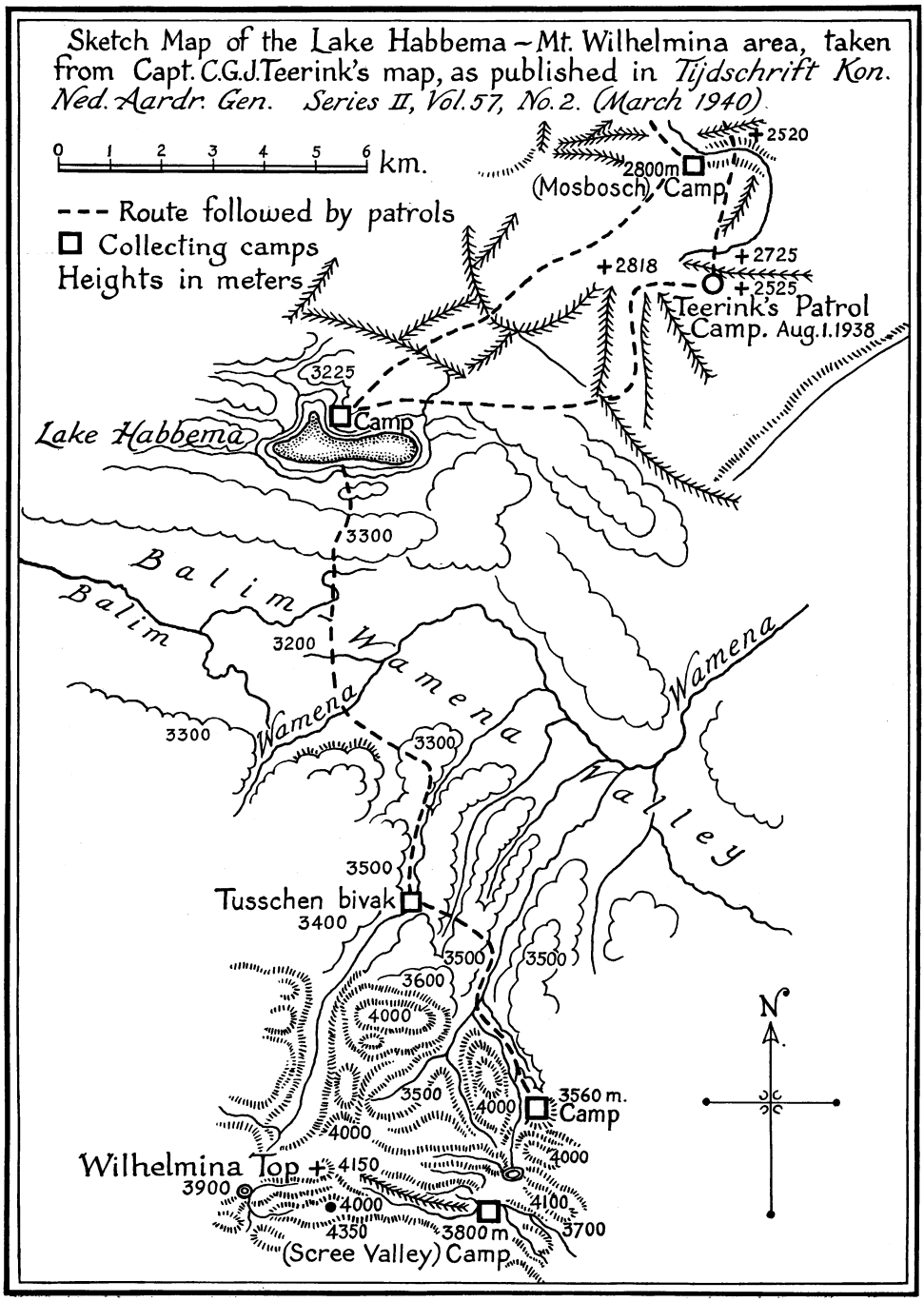
July–September, 1938

Lake Habbema, 3,225 meters[1] above sea level, lies on a shelf-like upland, trending east and west, and about nine kilometers in width at the lake. The northern edge of this upland forms the rim of the Grand Valley of the Balim. From its southern edge rise the barren, rocky heights of the Nassau Range, and snow-capped Mt. Wilhelmina. The upland continues in an easterly direction for a distance of about ten kilometers from the lake. The limit of its western extension was not observed. On the second reconnaissance flight, when in cloudy weather we flew south from the Doorman-top to the Nassau Range, we crossed it about thirty kilometers west of the lake, and from glimpses of the country obtained at that time from an altitude of 4,500 meters it seemed probable that it extended as far west as Mt. Carstensz.

The major topographic features of the upland in the vicinity of Lake Habbema, consisting of two long timbered ridges with rounded profiles and two nearly flat broad grass valleys, lie in parallel alignment with the Nassau Range and the Grand Valley. The northernmost of the two ridges forms a raised rim to the upland and has a fairly even elevation of about 3,350 meters. The other ridge separates the two grass valleys and rises to about 3,300 to 3,350 meters. The outer or northern valley, in which the lake lies, has a length of roughly eight to ten kilometers and a width of up to about three kilometers. The inner valley, which extends for an undetermined distance to the west, is three to four kilometers wide and has a bottom elevation of about 3,200 meters. Little meandering streams, their banks lined with treeferns, wind through the valleys, and in the valleys and on the flat parts of the ridge crests are innumerable small pools with bottoms of sand or peaty mud. The outlet of the lake, which carries a considerable volume of water and appears to be the principal headwater stream of the Balim proper, flows westward, and at a distance of several kilometers gorges through the intervening ridge to unite with another stream flowing west in the long inner valley. This westward-flowing stream of the inner valley heads at about 3,200 meters on an almost imperceptible transverse water-parting on the valley floor at a point opposite the upper end of the lake, east of which drainage goes to the Wamena tributary of the Balim. The Wamena, flowing northward down the slopes of Mt. Wilhelmina and already a stream some ten meters wide, swings sharply east from the water-parting and cuts a great gulch thirty meters deep and 200 meters wide in deposited materials in the valley bottom.

A good view of Mt. Carstensz, 160 kilometers to the west, is had from the rim ridge in favorable weather. Mt. Wilhelmina, about fourteen kilometers to the south, and the smoothly weathered white rock crests of the Nassau Range to the west of the peak cast their reflections on the lake. The lake is about four kilometers long and about two kilometers in greatest width. The upper end and much of the

[1] Mean of three boiling-point observations made by Archbold.


Sketch Map of the Lake Habbema – Mt. Wilhelmina area, taken from Capt. C.G.J. Teerink's map, as published in *Tijdschrift Kon. Ned. Aardr. Gen. Series II, Vol. 57, No. 2. (March 1940)*
0 1 2 3 4 5 6 km.
--- Route followed by patrols
Collecting camps
Heights in meters
+2520
2800m
(Mosbosch) Camp
+2818
+2725
+2525
Teerink's Patrol Camp. Aug. 1. 1938
3225
Camp
Lake Habbema
3300
Balim
Balim
3200
Wamena
Wamena
Wamena Valley
3300
3300
3500
Tusschen bivak
3400
3500
3500
3600
4000
3500
4000
3560 m.
Camp
4000
Wilhelmina Top +4150
3900
4000
4000
4100
4350
3800 m
3700
(Scree Valley) Camp
N

MAP 2.

south shore and lower end are bordered with open marshes of grass (*Deschampsia Klossii*) and sedge (*Scirpus*), and there are some marshy edges on the north shore. Several lateral ridges, timbered to the water's edge and with grassy hollows between them, come down to the shore on the north side of the lake. The outlet stream, at first deep, sluggish and sedge-fringed, soon drops away in rapids. Beds of *Potamogeton* grow in the outlet stream, and quantities of tufted *Isoetes* root in sand and thin mud in the marginal shallows of the lake itself.

Under the influence of spells of dry and wet weather, the lake fluctuated over a range of about twenty centimeters in level during our stay. The water was stained slightly brown by peat.[1] Tiny mollusks were collected in the lake by Toxopeus. No crustacean was actually taken from the lake, but a dead crayfish about twenty centimeters long was picked up on the adjacent grasslands. A search of the lake shallows and the streams for fishes, carried out by various methods, including treatment of the water by powdered *Derris* root, gave negative results.

A good anchorage and camp site, sheltered from the southeast winds by a ridge wooded with a thin stand of stunted *Libocedrus* trees and scrubby thickets, was found in a bay on the north side of the lake. An anchor buoy for the "Guba" was placed in the bay and, to facilitate the discharge of cargo, a short pier was built of planks flown in from the coast. A cargo of 2,500 kilograms could be unloaded in half an hour.

Included in the equipment were two collapsible boats of plywood and canvas, and among the supplies were several thousand two-meter "sticks" of sago-palm thatch. Palm thatch, or any kind of thatch for that matter, is excellent material for the construction of warm temporary quarters. It was taken to the lake primarily for the Dyaks, who do not at any time feel at home under tents and flies and who were thus able to build a house in the style that suited them best. Thatch was also used for closing the ends of flies and for the walls of a large tarpaulin storehouse which held our supplies. A considerable amount of material, including drums of airplane fuel and cases of oil, the anchor and buoy, the boats, a large military tent and some provisions, were left behind when the camp was abandoned.

Camp was built on reasonably dry ground—the best available—sloping up from the lake. The peaty soil which covered the entire countryside was in a saturated condition much of the time, and it soon got slushy under the trampling of our numerous personnel. However, log-corduroy walks laid through the camp enabled one to get about dry-shod in canvas shoes. The various living accommodations and working quarters were provided with floors of logs laid on the ground or raised above it, and the sleeping quarters were fitted with platforms of poles covered with a thick layer of springy *Libocedrus* twigs on which to lay bedrolls and sleeping bags. The trees about camp were spared for the shelter they afforded, the timbers for camp construction and wood for the many cooking and heating fires being carried in from the near-by slopes. Straight sticks long enough for ridgepoles were not easy to find. The green *Libocedrus* wood burned poorly, giving off little heat, and it smoked abominably. Eventually the fuel problem was solved by making charcoal, which was used in stone hearths and braziers made from kerosene tins. The completed camp was an imposing if somewhat heterogeneous assemblage of military oil-cloth shelters, thatched buildings and tents of various shapes and sizes, and it was as comfortable as it could be made under the circumstances.

The remains of an old military bivouac, consisting of a line of shelters, several fireplaces and a stack of firewood, were found on a small wooded peninsula on the south central shore of the lake. The Kremer Expedition had camped there on December 8 and 9, 1921.

The camp was visited from time to time by natives, and many more traveling regular paths passed the lake. For some time

[1] Water temperature, July 27: thirty centimeters below the surface at the lake edge, 57°F.; one meter below the surface, 58°F.

these traveling natives ignored all friendly advances and maintained a strangely nonchalant attitude toward the expedition. They showed no hostility or alarm, and, apparently considering themselves safe if they kept out of arrow range, they would watch us from a path which passed close to camp. If surprised on the trail they walked on at a steady pace, holding their bows and arrows horizontally over their heads in a peace gesture, or behaved as though, with some effort of will, they pretended not to see us. After a number of unsuccessful attempts, contact with the natives was established on July 31, thirteen days after the arrival of the first of our party, but nearly another month elapsed before their reserve broke down, and they could be induced to enter camp. After that they brought us garden produce and pigs. They even sold their weapons—a bow and a bunch of arrows for a cowrie shell.

Some of these people lived in the Bele Valley. Others appeared to come from branch valleys east and west of the Bele and perhaps from the Grand Valley itself. It is probable that some were from the south side of the range. They traveled, as a rule, in small groups of from four or five to twenty people, although on one occasion a party of over a hundred passed our 3,560-meter Camp on the slopes of Mt. Wilhelmina. Women, and even quite small children, took part in these journeys. Sweet potatoes were taken along for food, and fire was carried in smouldering, torch-like bundles of bark. Besides these two essentials and their arms and *Pandanus*-leaf hoods, the travelers sometimes carried long cylindrical bundles wrapped in *Pandanus* leaves, and led or were followed by pigs. They moved over the highlands in all kinds of weather.

Big paths, conspicuous from the air, passed east and west through the two upland valleys. One of the largest and most traveled (the path which the expedition followed to high altitudes) ascended the range from the inner grass valley and crossed the range in a 3,800-meter pass under the east shoulder of Mt. Wilhelmina. The east-west and west-east traffic may perhaps have been between populations of laterals of the Grand Valley who took a short-cut over the highlands or traveled that way to avoid hostile territory. Certainly the inhabitants of the Balim system of valleys had communications with people living on the southern slopes of the range. The Pěsěgěm people found by Lorentz[1] on the Orah tributary of the Lorentz River, about twenty-five kilometers south of Mt. Wilhelmina, were in all probability an outpost population of the Pesigam of the Grand Valley.

It seemed probable that the natives journeyed over the highlands primarily on social and trading visits. They also did some hunting, most of it apparently incidental to the main purpose of their travels. Deadfall traps were made for mammals. We found, cast-up on the shores of the lake, numerous arrows which doubtless had been shot at ducks and coot. An arrow which missed its mark on a long shot would not be considered valuable enough to retrieve from such cold water.

The natives had recognized stopping places, usually in situations commanding a good view, where they rested and made fires to keep themselves warm. They also built crude sleeping shelters of various types. The most primitive of the shelters were no more than a few leafy branches arranged to serve immediate needs. The better ones were lean-to or hip-roofed structures, two to four meters long and one and one-half meters high, made of small logs slanted against a ridgepole, stuffed between with moss, and covered with *Libocedrus* bark, grass, treefern fronds and brushwood. In the center was a fire pit burned in the peaty ground, around which the occupants huddled on a bed of grass. The best of the shelters were surprisingly poor affairs, considering the frequency with which they were used and the abundance of bark available from the *Libocedrus* trees, and they must have afforded barely adequate protection in bad weather.

The country rock of the Lake Habbema area is chiefly a pale gray sandstone, weathered into smooth slopes, on which an

[1] Lorentz, H. A., Zwarte Mensche...witte Bergen, Leiden, 1913.

accumulation of peaty organic matter overlays a sandy mineral soil. Extensive exposures of sandstone occur on the central ridge of the upland. It shows in residual hillocks on the ridges and in the lake valley, and loose boulders occur in places on the basal slopes. Sinkholes indicate the presence of limestone on the rim ridge and its laterals, and forested limestone cliffs rise from the southern edge of the inner grass valley. The limestone is also covered with peat.

The woody growths of the ridges consist of open and closed communities of subalpine forest. Such closed forest as there is occurs in patches, from a few meters to a hundred meters or more across. These forest patches nearly always occur in association with limestone, and in at least some of them a yellow clay is present under the peat. The closed forest is peculiar in having two tree layers, either of which may form a canopy and thus dominate the habitat. The upper layer of trees, which is in control on the comparatively warm Grand Valley slopes of the rim ridge, on the limestone on the south side of the inner upland valley and also in a few places about the lake, consists of a twelve to fifteen-meter stand of the conifers (*Podocarpus papuanus* and *Libocedrus* sp.), with which *Phyllocladus* sp. and also a *Schefflera* (Araliaceae) occur in quantity. The crowns of the trees are laden with bryophytes, in which grow small ferns and orchids, the latter including fiery red *Dendrobium* spp. As typically developed on the upland, however, the closed forest is a five to seven-meter high elfin wood of broad-leaved trees dominated by *Vaccinium dominans* and containing other *Vaccinium* spp., *Rapanea*, *Symplocos*, *Olearia* (Compositae), *Decaspermum Lorentzii* and *Saurauia alpicola*, overtopped by an open stand of conifers. The broad-leaved forest develops a very dense stiff canopy, thinly draped with brown and purplish hepatics with which are associated small black and white lichens. The crooked, leaning tree trunks are shaggy with hepatics, and a rather thin carpet of hepatics covers the ground. Shading is so heavy that normally there are few epiphytes and undergrowth plants. The commoner epiphytes include *Meringium rubellum* and *Microtrichomanes digitatum* (Hymenophyllaceae), *Grammitis subrepanda*, *Selliguea Feei*, *Polystichum alpinum*, *Ctenopteris pendens*, *C. Brassii* and *Asplenium setisectum* as ferns, and the weak little shrub *Vaccinium debilescens*. The few ground ferns include *Dryopteris habbemensis*, *Ctenopteris allocata* and *Grammitis integra*; *Dicksonia Hieronymi* is a common small treefern, and a red *Rhododendron* flowers profusely under breaks in the canopy.

Where closed forest meets grassland on the edges of glades and open hollows, it is bordered with a compact wall of erect shrubs growing to a height of one and one-half to two meters from deep moss. Associated with an ericoid *Rhododendron* and *Styphelia Vandewateri* in these living firebreaks are other shrubs and two very striking xerophytic treeferns (*Cyathea tomentosissima* and *C. cheilandthoides*).

The prevailing open forests of the ridges vary greatly in character. Quite well-grown thin forests of *Podocarpus* and *Libocedrus*, up to about fifteen meters high and half a meter in diameter, develop on sheltered upper slopes, while under the most unfavorable conditions in which trees are found *Libocedrus* grows in scattered order in stands only six to eight meters high. The undergrowth, which appears actually to control the habitat in most of the open forest, consists variously of very heavily mossed low-tree thickets or dense *Rhododendron* shrubberies, or the ground may be occupied by grass tussocks or dwarf grasses and sedges.

Very dense and rigid and about two to five meters high, the low-tree thickets are chiefly composed of *Xanthomyrtus Dielsiana*, stunted *Phyllocladus* and *Vaccinium dominans*, *V. oreites* and *Pygeum retusum*; *Schefflera* occurs abundantly as a tree of four to six meters, red and pink rhododendrons supply splashes of color, and there are many small ferns and orchids in the deeply mounded ground moss and among the mosses and hepatics which coat the trees. The erect ericoid *Rhododendron* of the closed forest borders, which has a grayish appearance, dominates the shrubberies.

Spiny myrmecodias, whose immensely swollen stems are inhabitated by ants, occur in quantity as epiphytes in the open forests and also descend to the ground.

The grasslands are alpine and for the most part doubtless a primary condition. As mentioned above, they contribute the ground cover to some of the open forest of the ridges. In the valleys and lateral hollows and in the numerous glades which penetrate the forests, they are treeless. The treefern (*Cyathea tomentosissima* and, to a less extent, *C. cheilanthoides*), lining the banks of streams and occurring in large numbers near forest edges, forms a characteristic feature of the grassland landscape.

"There were two types of grassland, readily separable on gross appearances, but in all but a few situations especially superior or inferior as regards soil conditions, comprised of approximately the same species—one a community of tall grasses, the other of dwarf grasses and sedges. Not often did one find the tall grasses unaccompanied by dwarf species and vice versa" (Brass, 1941). Dominated by tussock-forming *Deschampsia Klossii* and containing a few minor grasses and brownish clumps of *Gahnia* (Cyperaceae), the long-grass community is best developed on well-drained soils about the forest edges and on the often somewhat elevated sandy banks of streams; it also forms thick stands, up to a meter or more high, in the marshes and on quaking, hummocked bogs. Comprised chiefly of the grasses (*Monostachya oreoboloides* and *Aulacolepis* sp.) and the sedge (*Oreobolus ambiguus*?) about two to five centimeters high, the short-grass community develops as a rigid close sward over most of the area. Mosses, hepatics and lichens, growing on the grasses and among them on the ground, are a constant feature, and a *Sphagnum* is found in marshy places. A rich assortment of herbs—mostly rosette-forming perennials—includes *Ranunculus* spp., *Potentilla* spp. (*papuana, habbemana* and others), *Acaena anserinifolia, Myosotis saruwagedica*, and species of *Eriocaulon, Plantago, Gentiana, Euphrasia, Ischnea, Gnaphalium, Keysseria* and *Epilobium*. Species of *Astalia, Sagina* and *Centrolepis*, and also a *Rhododendron* with showy red flowers, form alpine cushions. Common shrubs include *Vaccinium ciliatipetalum* and *Styphelia Dekockii* growing prostrate with the dwarf grasses (*Hypericum Macgregorii, Kelleria papuana, Eurya Brassii*) and species of *Tetramolopium* and *Drimys*.

The equilibrium between forests and grasslands had to some extent been disturbed by fire. Parts of the ridges in firm occupation by the long-grass community appeared ecologically suitable for closed tree communities and perhaps formerly were forested. In relic trees and abundant charcoal on the ground, other long-grass communities bore definite traces of former forest. These areas, on some of which treeferns grew in great numbers, were, however, small. On the other hand, there were some very good examples of forest regeneration after destructive fires. The burn succession was initiated by shrubs of the primary forest borders, such as *Styphelia, Drimys, Rhododendron* and *Coprosma*, and was marked by the early appearance of *Libocedrus*. It appeared that in spite of heavy native traffic over the highlands fires destructive to forest did not often occur, that only small areas were affected by such fires and that disturbance by fires had not resulted in any great territorial gain by the grasses.

Some members of the personnel suffered from altitude sickness upon arrival at the lake, and for a day or so all were inconvenienced by the rarity of the air. One Dyak arrived in a state of collapse. The low night temperatures caused some discomfort before proper arrangements could be made for housing the party. Both white and colored personnel experienced sunburn and cracked lips in the beginning and many developed hacking coughs which were attributed to the unaccustomed dry air.

Rain fell on only six of the thirteen days July 19 to 31, and the weather was generally drier then than at any other time up to November 18, when the camp was abandoned. On July 27, a clear, bright day, relative humidity fell to thirty-three per cent at noon. During this period of scanty rains and at times during August, the grasslands and open forest communi-

ties dried out to a stage at which, although the soil remained moist or even wet, they would carry fire. A fire lit in low-tree thicket by wood-cutting Dyaks burned until it was extinguished by our men. Another fire on grassland burned to the edge of a patch of closed forest, where it was stopped by the border shrubberies. Rain fell on eighteen days in August, but the lake fell twenty centimeters by the end of that month, when it was filled by an afternoon and night of heavy rains. In September, 284 millimeters of rain fell on twenty-one days. Falls of four to twenty millimeters on twenty-one days gave a total of 258 millimeters for October.[1]

Weather conditions were extremely variable, but there was a tendency for sequences of warm, dry, intensely bright days to alternate with spells of unrelieved bleak, drizzling and showery weather during which it was a hardship to be afield. Most of the clear days began with a heavy frost on the grass and a blanket of fog covering the lake and its surroundings from before dawn to about 7:30 a.m. Not many days were clear throughout. Low overcast conditions, mist and a cold drizzle from clouds which descended from the heights of the range or rose from the direction of the Grand Valley were usual in the afternoon. The heaviest rains came in late afternoon and evening. Hail fell on three occasions, and there were two thunderstorms with severe lightning in August. Only moderate winds were experienced, the strongest and most prevalent coming from the southeast.

Temperature (C.) July 26–September 3: maximum (37 days) 11.0–21.0, mean 18.0; minimum (38 days) minus 3–plus 4.5, mean 1.1. Fourteen minimum readings of zero Centigrade or lower were recorded. Isolated relative humidity readings made to determine extreme rather than average conditions gave the following results: 6:30 a.m., 92 to 100 per cent; noon (clear, dry weather), 33 to 59 per cent; 1:00 p.m. (clear, dry weather), 46 to 58 per cent; 6:00 p.m. (overcast after dry days), 76 to 82 per cent.

[1] Rainfall was recorded by the military party through August, September and October. The records for August are not available.

Collections: 340 mammals, 700 birds and 594 numbers of plants. No better time could have been chosen for botanical collecting at this altitude, for all but one of the flowering plants encountered bore flowers or fruits or both, and all the ferns and most of the bryophytes were fertile. Toxopeus found the area rich in insects, considering the high altitude. Many beetles, bugs and small Cicadae were obtained by beating flowering shrubs. Moths of numerous species were attracted by the lamps, but butterflies were limited to eight species, of which three were considered strays from lower levels.

The interesting diversity of habitats present was reflected in the comparatively long list of birds found here, about fifty species being recorded. There is a great change in the forest avifauna at about 3,000 meters, many species being left behind, while a few new forest species appear at the higher altitudes. More than a third of the birds collected about Lake Habbema were birds of the grassland, marsh and water.

On the open lake, the duck (*Nyroca australis*) was the most common bird, usually in flocks containing up to fifty or so individuals. The ducks (*Anas superciliosa* and *Salvadorina*) and the coot (*Fulica*) were also common on the lake, though more frequent along the shores. A cormorant (*Phalacrocorax melanoleucos*) was found once on the lake. The grebe (*Podiceps novaehollandiae*) was occasionally seen in the lower end of the lake, and in the outlet stream, where two specimens of the duck (*Anas gibberifrons*) were also taken. Judging by the numbers of arrows found drifted up along the lake shore the natives must hunt waterfowl with considerable intensity.

Two interesting finds were a specimen of the glossy starling (*Aplonis metallica*), strictly a lowland bird, and a specimen of *Ptilinopus bellus*, that we found otherwise only at much lower altitudes, floating dead on the lake. Both had been dead some time. It is probable that they were flying across the lake when it was still and, not seeing the water, had dashed into it and been drowned. However, the fact that

these birds should be crossing the range at this altitude is surprising.

Along the lake shore were found solitary examples of *Tringa hypoleucos* and *Halcyon sancta*, one a migrant from the Arctic, the other from Australia.

Along the marshy lake shore the little black rail (*Porzana tabuensis*) was common, and one example of the rail (*Hypotaenidia philippensis*) was taken. In October the snipe (*Gallinago*) was very common in the marshes of the open ground where there was none in August.

Out in the grassland the warbler (*Megalurus timoriensis*) occurred where the grass was tall, the pipit (*Anthus*) where it was short and sparse. Other birds almost exclusively grassland in habitat were the quail (*Anurophasis*), the weaver-finch (*Lonchura montana*), the harrier (*Circus*) and the falcon (*Falco cenchroides*). Some birds, such as the swifts (*Collocalia esculenta* and *C. hirundinacea*), fed commonly over the open ground, and one of the solitary nests of *C. esculenta* was found on a sheltered rock ledge in hilly grasslands.

Some birds of the shrubbery fed commonly out into the grasslands or were characteristic of shrubbery and forest edges, such as the honeyeaters (*Melidectes nouhuysi* and *Oreornis chrysogenys*), the thrush (*Turdus*), the weaver-finch (*Oreostruthus*) and the parrot (*Psittacella lorentzi*).

The open stands of *Libocedrus* and its accompanying shrubbery were most frequented by a few birds, such as the warbler (*Pseudogerygone*) and the honeyeaters (*Melidectes nouhuysi* and *Oreornis chrysogenys*), and, of course, some of the forest species occasionally ranged through it, as *Pachycephala lorentzi* and *Acanthiza murina*.

The small areas of closed forest held a number of species that were closely associated with them and rarely found elsewhere, such as the honeyeater (*Melidectes belfordi*), the birds of paradise (*Macgregoria* and *Astrapia*), the flycatcher (*Petroica bivittata*), the flowerpecker (*Paramythia*) as well as other species that were less closely restricted to the forest areas, such as the lories (*Neopsittacus pullicauda* and *Oreopsittacus*), the parrots (*Psittacella brehmii* and *P. lorentzi*), the babbler (*Craterocelis robusta*), the warblers (*Sericornis nouhuysi* and *Acanthiza murina*), the flycatchers (*Rhipidura albolimbata* and *Poecilodryas*), the honeyeaters (*Myzomela rosenbergii, Ptiloprora guisei, Melipotes* and *Oreornis subfrenatus*) and the woodcock (*Scolopax*).

One of the most interesting ornithological results of this camp was the data obtained on the breeding behavior of the bird of paradise (*Macgregoria*), a commonly breeding species in August.

About one-third of the specimens collected showed some indications of breeding.

Mammal collecting was good compared with that in the lowlands. Mammal signs were easily found, and about 400 traps often yielded ten to twenty specimens a night. The variety was comparatively small, and in the catches two species of small rats (*Stenomys*) predominated. Most of the mammals were small, and even the cuscus were pygmy species, but also one of the largest New Guinea rodents, the giant rat (*Mallomys*), was found. It was of special interest to us to find no pigs in these apparently suitable highlands. In the southeast New Guinea highlands they were fairly common.

3,560-Meter Camp (Brievenbuskamp)

Seven Kilometers[1] Northeast of Wilhelmina-top

August–September, 1938

The upper subalpine forest was examined chiefly from this camp. It was also the supply base for operations at higher levels. The 3,800-meter Camp was reached in about three hours from here by laden carriers. The Tusschen-bivak at 3,400 meters, where the transport trains coming up

[1] About five kilometers northeast of Wilhelmina-top, according to surveys made by the military party after most of the collecting was done. The bird collections were labeled "3,600 meters."

from Lake Habbema stayed overnight, was five and a half carrier hours distant. The paths were soon cut up and mired by heavy traffic in the wet weather which prevailed during our stay at the higher altitudes, but even before this happened the carriers traveled slowly and stopped often to rest. It was found that a load of fifteen kilograms, plus food for the journey, a blanket and a change of clothing, was as much as the average man could well carry on the two-day trip from the lake. A rest for recuperation was given the carriers after each trip. Frequent changes of military covering detachments and other replaceable personnel were made with Lake Habbema in order that no one should be exposed unnecessarily to the wet and miserably cold conditions of the mountain camps.

The 3,560-meter Camp was in the trough-shaped valley of one of the headwater streams of the Wamena which formed a natural, though from Lake Habbema a somewhat circuitous, approach to the mountain to the east of the route taken by the Kremer party in 1921. The sides of the valley were occupied by low, broken forest, and its bottom was grassy. Where the path we followed dropped into it four to five kilometers below the camp, the valley had a bottom elevation of 3,440 meters, at the camp its floor was 3,500 meters above sea level. Between these points it was crossed by two low ridges of limestone through which the stream tunnelled underground.

The camp was in an amphitheater, about a kilometer long and half as wide at the bottom, which lay between the uppermost of the transverse ridges and a cliffed step of limestone, some fifty meters high, at the base of which the stream gushed out from a cave connected with an upper pocket. The upper pocket, in which the valley ended about one kilometer from the 3,800-meter Camp, had a length of about three kilometers and in it at an elevation of 3,650 meters was a rock-basin lake. The lake, about 400 meters long and about 300 meters wide, emptied over the notched lip of a smooth U-shaped rock step, and at its upper end was a marshy flat. The ridges enclosing the valley piled up toward the summit of the range and were topped by bald sandstone peaks of 3,900 to 4,000 meters.

A short distance below the amphitheater the native path forked, one branch going over the eastern ridge at an altitude of 3,700 meters and down into a parallel valley which drained south to a tributary of the Lorentz River, the other branch continuing up the valley, past the foot of a moss-fringed waterfall on the west side of the amphitheater, around the limestone cliffs by a side hill climb, and on past the lake to cross the Lorentz-Wamena divide at 3,800 meters. In some places long traffic and erosion by rain waters had worn the path more than a meter deep in the ground.

Up to near camp level the natives built sleeping shelters in the forest. The shelters were of brushwood and treefern fronds and grass, for there were no *Libocedrus* trees at these altitudes, and apparently no other subalpine tree had free-stripping bark which could be taken off in sheets big enough to be useful for roofing material. Rock shelters, which had become increasingly common as the forest thinned out and the terrain got more rugged with altitude, were used exclusively at elevations above about 3,500 meters. Some of the best examples of these were on dry ledges under the cliffs of the amphitheater where charred fragments of human bones were found in the ashes of one of the fires, and in a roll of bark cached in a hole in the rock were partly burned pieces of a human skull and femur. Evidently some traveler had died and been cremated there, although the bark which contained the bones was from a *Libocedrus* tree and must have been brought from a distance.

The significance of some actions of the natives could only be guessed. For example, in the pass by which the path crossed the range at 3,800 meters they had placed stones in line along the top of a rock with the idea, perhaps, of propitiating the elements or the spirits of the mountains. Knotted wisps of grass tied to trees or to sticks set in the ground beside the paths, and bunches of grass and twigs placed in

the forks of bushes and added to from time to time until they formed conspicuous masses like the nests of some large birds, may have had a similar meaning.

Most of our collecting in the locality was done between altitudes of about 3,500 and 3,900 meters in and around the amphitheater in which we camped. The steep slopes of this part of the valley and the wet climatic conditions favored landslip development, and a multitude of small slips and soil creeps occurred in the area. But apart from the cliffs, some of which were wooded and others practically bare of vegetation, there were no extensive rock exposures except on the high ridge crests. There were few streams on the slopes. The streams of the valley bottom cut a meandering course and were very narrowly entrenched between perpendicular banks to depths of two meters or more. The grassy bottom of the amphitheater was flat and somewhat swampy and contained a number of shallow pools with sharp-cut edges of peat. The soils of the slopes, whether on sandstone or limestone, also were peaty. The camp was placed on the grassy debris cone of a big landslip in the forest on the east side of the amphitheater near the cliffs.

As developed in the amphitheater, the forests consisted of patches and clumps separated by grassy glades and other, apparently natural, grassy spaces too broad to be called glades. By far the largest body occurred on the sheltered, steep, and, by reason of their steepness, relatively dry slopes about the cliffs. The forests were heavily mossed, very dense and rigid and often dwarfed and sheared by wind. They differed from those of Lake Habbema chiefly in the absence of conifers. *Podocarpus* and *Libocedrus* were abundant on the slopes up to an elevation of about 3,500 meters in the vicinity of Tusschen-bivak, but only one tree—a *Libocedrus*—was observed in the 3,560-meter Camp valley and that grew at about 3,500 meters on an east-facing slope about four kilometers below the camp. One also missed the epiphytic myrmecodias, which appeared to reach the upper limit of their range at 3,450 meters in this valley.

Replacing the conifers as characteristic overtopping trees was the araliaceous "umbrella-tree" (*Schefflera*) which has been mentioned as occurring at Lake Habbema, the bunched rayed leaves and spreading pink influorescences of which protruded conspicuously above the forest roof up to elevations of about 3,700 meters. Another tree of the same family appeared at about 3,560 meters and continued up to about 3,800 meters. *Vaccinium dominans*, attaining a maximum height of five to six meters, formed the bulk of the forest. Present as minor dominants of varying importance were a species each of *Rapanea*, *Symplocos* and *Olearia*, *Xanthomyrtus Dielsiana*, *Eurya Brassii* var. *erecta* and *Vaccinium quinquefidum* var. *orangense*. The trees, especially those of the forest edges, were heavily cushioned with bryophytes—chiefly mosses—and wherever light entered a thick cover of mosses grew on the ground. Most important of the few floor plants were a slender sedge (*Uncinia*) and the ferns (*Selliguea Feei*, *Hypolepis Archboldii* and *Polystichum Archboldii*). Some few orchids lingered as epiphytes, but the epiphytes were chiefly ferns, e.g., *Selliguea Feei*, massed *Meringium Forsteri*, *M. melanosorum* and *Asplenium Brassii*, and tufted *Ctenopteris bipinnatifida*, *C. Whartoniana*, *Calymmodon fragilis* and several *Grammitis* spp., including *G. mollipoda* and *G. plurisetulosa*. Narrow border shrubberies of the same character as those described for Lake Habbema were composed mainly of a *Rhododendron* with showy red or yellow flowers, the ericoid species of Lake Habbema, *Styphelia obtusifolia* var. *hypoleuca*, *S. nubicola*, and a robust brownish *Coprosma* which was not seen below 3,400 meters. Also characteristic of the borders were the gregarious ferns (*Blechnum Hieronymi* and *Hypolepis revoluta*) growing stiffly erect.

Some of the forest on the western slopes of the amphitheater had been considerably disturbed by fire, but for the most part the burned areas carried good regenerative growths of climax species of trees or younger burn communities of *Coprosma* and treeferns associated with a rank stand of grass tussocks. The tussock grass doubt-

less became very inflammable in dry weather, and a fire in it could not be expected to have any beneficial effect on the forest regenerative communities; but if fires were very common or very destructive when they occurred, the present extent of the forests on these much-traveled highlands would be difficult to explain. In only one place in this locality or on any part of the mountain slopes examined could the firm establishment of grasses at the expense of forest have taken place on a fairly large scale. That was about the lake in the upper pocket, where, between about 3,670 and 3,800 meters, altitudes which were becoming increasingly critical for trees, old grassland exceeded forest in area on slopes where conditions of soil and topography appeared suitable for forest, and some forest relics could still be seen.

Two species of open ground treeferns (*Cyathea tomentosissima* and *C. Muelleri*) occurred in large numbers in the burn communities of this area, in the forest border shrubberies, on the banks of streams and on grassy basal slopes below the forest. The former, with young fronds of a striking golden brown, was abundant in like situations everywhere between here and Lake Habbema. The latter, an almost glabrous species, was extremely rare at Lake Habbema and infrequent below 3,500 meters. Both reached the limit of their vertical range at about 3,700 meters in the upper pocket.

The grasslands, like the forests, were essentially similar to those of the Lake Habbema area. But unlike the forests, which became progressively poorer in species of all ranks with altitude, the grasslands showed a gain in minor dominants and in herbs associated with the dominants.

Our stay on the mountain slopes was during a spell of very wet weather which began on August 31 and lasted until October 7, a week after our return to Lake Habbema. Raw, misty, rainy conditions continuing week after week greatly hampered field work. The saturated peaty soil of the grassland squelched underfoot; the turgid moss blanket of the forests dripped icy water which numbed the hands; the drying of wet clothing became a major problem; boots were never dry. This trying sequence of weather was broken now and then and the flagging spirits of the native personnel somewhat revived by sparkling frosty mornings, when the slush of the paths froze solid, and by occasional fine days sunny until late afternoon.

Temperature (C.) September 10–22: maximum (8 readings) 10.5–17.0, mean 13.5; minimum (8 readings) minus 2.0–plus 2.5, mean 0.

The combined plant collections from this camp, the Tusschen-bivak, and the 3,800-meter Camp totalled 783 numbers,[1] of mammals about 252 specimens and birds about 300 specimens.

TUSSCHEN-BIVAK.—The sheltered, pleasant little valley in which this transport camp was situated at 3,400 meters ran approximately north and south, parallel with the 3,560-meter Camp valley. It had a grassy bottom through which flowed a stony stream, and on its steep, unstable sides were the last of the unbroken forests. The west slope carried mainly primary forest with many dark old *Libocedrus* and lighter-colored *Podocarpus* trees. The opposite slope was largely burnt-over land regenerated to tall shrubberies and low forest in which sturdy young conifers were plentiful. Treeferns (*Cyathea tomentosissima*) were unusually abundant on some basal slopes seemingly deforested by fire. The stream went underground in the lower part of the valley, and about half an hour's walk below the camp was a large sink-hole about twenty meters deep, under the overhanging walls of which the natives had camping places. A thick bed of rounded pebbles and boulders exposed in the upper walls of the sink-hole had the appearance of a glacial deposit.

Overnight stops at this camp provided opportunities for a little general collecting, and Meyer-Drees spent two days here gathering plants.

Hunting at this camp was carried on amid the scattered clumps of forest, on the extensive areas of grasslands and about the marshes and the little ponds. About thirty species of birds were taken.

[1] Meyer-Drees took part in general botanical collecting at the Mt. Wilhelmina camps.

The avifauna differed little from that about Lake Habbema, the chief difference being the dropping out of some of the forest species and the absence of some species whose occurrence depended on the presence of the lake. This was above the conifers, and we were interested to find that the bird of paradise (*Macgregoria*) was not confined to the conifer zone as we had thought from our experience in the mountains of southeast New Guinea in 1933.

Mammal trapping was fairly good, though the rat (*Stenomys*) predominated in numbers; twenty-three specimens of five species in 378 traps was the best night's catch, but eighteen of these were *Stenomys*.

3,800-Meter Camp (Puindalkamp)

Two Kilometers East of Wilhelmina-top

September, 1938

This, the climbing base and the alpine collecting camp of the expedition, was in the head of a grassy amphitheater into which a waterfall about twenty meters high dropped over a sandstone rock-step from a deep V-shaped valley trending approximately east and west between the summit ridge of the mountain and a 4,300-meter false peak. The position of the camp was actually a little south of east from the snow top and a little east of north from the truncated prominence on the comb of the summit ridge which Lorentz named "de Stier." Unaware at the time that Lorentz had given the valley the name of the royal house of Oranje, we called it Puindal or Scree Valley, for extensive screes of gray-white limestone which slid down its slopes from the summit ridge about a kilometer above the camp. The valley drained to the Noordost tributary of the Lorentz River and in its continuation below the camp was separated from the head of the north-south valley of our 3,560-meter Camp by a rocky low divide. The native path by which we approached from the north topped this divide at 3,800 meters, then dropped down the southern slopes of the range. It would appear that the Lorentz Expedition, on its approach to the mountain from the south in 1909, entered Oranje Valley or Scree Valley near this divide.

At an elevation of 3,880 meters in the valley, between the waterfall and the screes, we found some not very rusty tin cans and the remains of a fire at what was probably the site of Lorentz's Vallei-bivak. At 4,040 meters, on a ledge with a scattering of dwarfed trees on the north slope of the valley, two empty petroleum tins and the stopper and broken bits of a medicine bottle of purplish glass marked the probable site of Lorentz's Matigheids-bivak. The location of these supposed camps of the Lorentz Expedition agreed fairly well with the positions indicated for them on van Nouhuys' map,[1] but, as determined by the Lorentz Expedition, the altitude of the Vallei-bivak was 3,570 meters and the altitude of the Matigheids-bivak 3,856 meters. The approximate location of these is shown on the photograph reproduced as Plate XXXIII.

About a kilometer below our camp, at an altitude of 3,700 meters under the eastern termination of the summit ridge, the natives had a large shelter under an overhanging rock wall, protected from the weather by a strip of forest. This was the only native camp found in the locality, and the north-south track which passed over the range near-by was the only path. In crossing the range the native travelers probably kept close to the path, for none visited our camp, about half a kilometer to the west of it, and natives passing through Scree Valley would have found and almost surely carried away the articles left by the Lorentz Expedition.

We were hard put to find in the stunted tree growths of these altitudes poles long

[1] Van Nouhuys, J. W., 1913, Nova Guinea, VII, Pl. VI. (Note: Published at the end of an ethnology paper by Lorentz, "Der Bergstamm Pęsęgęm im Innern von Niederlandisch-Neu-Guinea." pp. 1–33.)

enough to rig a tent, and even when spliced several together, such sticks as were available made a rickety and unsatisfactory support for the radio aerial. Bamboos for a radio mast were therefore brought from the coast on the "Guba" and delivered by parachute. At the same time Rogers dropped a much-appreciated package containing the mail, fresh beef, apples, oranges and eggs. Not an egg was broken in the descent. To save the carriers, we abandoned at this camp such surplus food as we had and gear no longer needed and took back to Lake Habbema only the collections and equipment necessary for the continuation of the expedition.

Mt. Wilhelmina proper and the false peak were formed of alternating thicknesses of sandstone and limestone dipping very sharply to the south and scarped in cliffs to the north. The eastern end of the summit ridge, including de Stier, was of sandstone; the western end, within the confines of Scree Valley, of limestone. The false peak was of sandstone, largely sterile, and exhibiting at the upper end of Scree Valley some large, remarkably smooth-sloping faces of bare rock. Beds of marly limestone (?) rich in fossil shells,[1] underlay the sandstone of the false peak and outcropped to the north.

The sandstone step of the waterfall by our camp continued as a bluff-line to the top of the false peak, and there were other bluffs and rock walls in this part of the valley. Great blocks of erosion-pitted white limestone lay about on the slopes below the amphitheater. The floor of the amphitheater and of the valley for some distance below it was rough with innumerable little dips and rises, which appeared to represent the slump lines of a large earth flow and through which the drainage stream of the valley took mainly an underground course. Above the waterfall, the stream soon disappeared under a rocky jumble of mixed limestone and sandstone talus debris which filled the valley bottom. Besides the active limestone screes of the summit ridge, there were old ones grown over with tussock grass and dotted with dark *Coprosma* bushes. Impounded by debris under the screes, at an altitude of 3,920 meters, was a small lake or pond, half filled with *Sphagnum*. In a bleak rock basin on a saddle at the head of the valley, from which the summit ridge rose in a tremendous bare wall, was another lake, or rather a collection of shallow ponds, at an altitude of 4,150 meters. Two more small lakes, one of them only seen from the air, lay on the false peak.

Westward, beyond this saddle, the valley continued with little fall for about two kilometers. By skirting its northern side, travel amongst the huge blocks of fallen limestone was fairly easy. The south side of this valley was formed by the steep, bare walls of the summit ridge. Presumably Lorentz and Kremer had found their way up one of the many crevices in its face. Much talus along its base and many big boulders littering the bottom of the valley indicated rapid weathering. To the north the valley wall was a more gradual slope of the ridge leading westward from the false peak. About two kilometers west of the peak, the valley suddenly ended, and a wide gap opened through the ridge bordering it on the north. This was apparently near the site of Lorentz's Ramp-bivak. From here a good view of the country to the north was obtainable.

Gradually, after the continuous bodies of the lower slopes of the range were left behind at about 3,400 meters in the vicinity of the Tusschen-bivak, the forests became more interrupted by grass; trees became increasingly selective as regards habitat conditions; the grasses were in the ascendant. There was still a good deal of forest at 3,700 meters, particularly on the south slopes of the range where *Podocarpus papuanus* reached to about 3,500 meters. At 3,800 meters, the forest was reduced to compact little clumps on the slopes, open scrubby growths scattered among rocks and a very narrow strip under the waterfall rock-step. Scattered bushy tree clumps of *Rapanea* and *Drimys* were abundant up to 3,900 meters and straggled up to 4,000 meters in Scree Valley. Absolute tree

[1] The geological collections of the expedition, which included material taken from these beds at altitudes of 4,100 to 4,130 meters, went to the Geological Museum, Bandoeng.

limit was at 4,050 meters under a north-facing bluff on the false peak.

The forest strip under the waterfall rock-step consisted mainly of *Vaccinium dominans* and *Rapanea* sp., growing to a height of three to five meters. Other trees were *Drimys* sp., *Olearia* sp. and *Pittosporum pullifolium*. The trees were crowded with brown and green moss cushions and rooted in deep, mounded moss. Present as epiphytes in the moss were the massed filmy ferns (*Meringium Forsteri, Calymmodon fragilis, Grammitis plurisetulosa, G. debilifolia* and *Selliguea Feei*). The latter also grew in the ground moss. Forming a narrow but very dense marginal shrubbery under the outthrust branches of the trees were the red or yellow *Rhododendron* of the 3,560-meter Camp, two *Coprosma* spp., *Styphelia nubicola, S. obtusifolia* var. *hypoleuca* and a *Symplocos*.

One of the coprosmas, a shrub of one meter to a meter and a half, generally bearded with a brown hepatic, was also common on the grasslands below tree limit and grew scattered over tussock grass slopes up to an altitude of about 4,150 meters. Up to 4,300 meters on the summit ridge, the highest elevation at which botanical observations were made, *Hebe* spp., *Tetramolopium* sp. and an ascending or prostrate heather-like form of *Styphelia obtusifolia* were plentiful among the grass as shrubs of ten to thirty centimeters.

Especially characteristic of the limestone, the tussock grass (*Deschampsia Klossii*) covered, besides the old screes, large areas of slope above and below tree limit and still flourished among limestone rocks at 4,300 meters on the summit ridge. Associated with it were *Festuca nubigena, Calamagrostis Brassii, Hierochloë redolens* and species of *Agrostis* and *Poa*. Best developed on shallow soils over sandstone, the short-grass community was dominated chiefly by *Monostachya oreoboloides* and *Aulacolepis* sp. Among common herbs, most of them present on both types of grassland, were cushion-forming *Potentilla Forsteriana* var. *Keysseri, Astelia* and *Centrolepis, Potentilla Archboldiana, P. Brassii, Plantago, Eriocaulon, Ranunculus, Trigonotis, Gentiana, Veronica, Euphrasia, Epilobium* and numerous Compositae, including *Gnaphalium, Keysseria* and *Lactuca*. Archbold and Rand, on their attempted ascent of the peak, found two grassland plants, an *Agrostis* and an *Oreomyrrhis*?, growing under rocks at 4,500 meters.

On the upper parts of the sandstone false peak there were desolate wastes of rock and very shallow soil on which practically the only flowering plants were a tiny rosette-forming *Plantago* and a bushy *Tetramolopium* dwarfed to ten to fifteen centimeters, and on which mats and cushions of brown, yellow and green mosses and hepatics growing on the rocks provided the most conspicuous feature of the vegetation. Bryophytes, particularly mosses, were much in evidence on the mountain slopes. Their prominence in the forests has been mentioned. They were everywhere on the grasslands. Some of the mosses were indifferent as to substratum and occurred in a wide variety of habitats. *Holomitrium cirrosum* and *Schlotheimia pilicalyx*, for example, were characteristic terrestrial and epiphytic species in the forests, abundant on the grasslands and among the principal species found on otherwise bare rocks.

Weather conditions at this camp were as described for the 3,560-meter Camp. Here, however, there was an earlier blanketing by clouds which, on most days not entirely misty and rainy, enveloped the higher parts of the summit ridge as early as seven or eight o'clock and by mid-morning or noon came swirling into the valley bottom. One morning we awoke to find snow down to 4,250 meters on the slopes. It was only a light fall, soon melted by rain. The Lorentz Expedition apparently found snow in the upper part of Oranje Valley (Scree Valley) in November. From Lake Habbema on August 22 and again during the first ten days of October we saw snow blankets covering Mt. Wilhelmina much lower than at any time when we were on the mountain, and there was also snow on the false peak on those occasions.

The misty nights brought out great numbers of Lepidoptera, nearly all of them very sensitive to light, and many of them

species which were not found at lower altitudes. A mosquito (Culicidae) occurred at camp level. At 4,250 meters, which was as high as insects could be sought under the adverse weather conditions, the catch consisted mainly of flies, taken in the mist.

This was near the upper edge of timber, and from here we worked up to the upper edge of the grass, giving an opportunity to see which birds reach the highest altitudes here. The duck (*Salvadorina*) and the coot (*Fulica*) were common in the little lake at 3,650 meters, but tracks of a duck, almost surely *Salvadorina*, were seen about the lake at 4,150 meters. The duck (*Nyroca*) had been left behind at Lake Habbema, and *Anas superciliosa* was last seen at the little ponds at 3,600 meters. The rail (*Hypotaenidia*) was most common along the track between Lake Habbema and the 3,560-meter Camp but was not found higher.

Of the birds of the grasslands the pipit (*Anthus*) probably ranges commonly the highest, being found up to 4,500 meters, above where areas of grass exist. The thrush (*Turdus*) also goes up to 4,200 meters or more. We had come to know it as a bird of the forest edges, feeding in the grassland and flying to trees for shelter when alarmed; here it flew to the shelter of the cliffs when alarmed. The warbler (*Megalurus*) ranged as far upward as did dense tussocks of grass, which was about as far as did the weaver-finch (*Lonchura montana*). The quail (*Anurophasis*) ranged up onto the edge of the bare rocks.

The swift (*Collocalia hirundinacea*) ranged up to 4,000 meters, while *C. esculenta* ranged only to 3,600 meters. *Falco cenchroides* was occasionally found to 3,800 meters altitude.

There was one bird peculiar to the edges of the areas of bare rocks, the flycatcher (*Petroica archboldi*), that probably has the highest altitudinal range of any bird in New Guinea. It was not found below about 4,000 meters. If this bird is restricted to such altitudes over the rest of New Guinea, its range must be very small as there are only a few peaks on which it could live.

There was an owl that evidently was fairly common above timber line, judging by the pellets and feathers found in caves under boulders and in crevices amongst the larger fragments of talus. No specimen was secured, and but one was seen, a medium size, dark bird, probably *Tyto tenebricosa*. Comparison of feathers gathered supported this identification.

The honeyeaters (*Melidectes nouhuysi* and *Oreornis chrysogenys*) extended up as far as the shrub (*Coprosma*), which grows isolated here and there in the grass to above 4,100 meters.

The list of forest birds that reach to about 3,800 meters is short: the woodcock (*Scolopax*), the parrot (*Psittacella lorentzi*), the cuckoo (*Cacomantis*), the babbler (*Crateroscelis robusta*), the thickhead (*Pachycephala lorentzi*), the honeyeater (*Myzomela rosenbergii*) and the bird of paradise (*Macgregoria*).

Mammal traps were productive here, the best night's catch being eight mammals of five species in 104 traps. Many signs of the giant rat (*Mallomys*) were seen about the timber patches, out in grass areas and under rocks, and many of their remains were found in owl pellets, but few were taken. The natives that visit the alpine grassland set many dead falls in the patches of timber for mammals, perhaps chiefly for this species. They would furnish food, and the lower jaws with their sharp incisors would furnish cutting instruments. No wallabies nor pigs were found.

PLANT FORMATIONS AND SUMMARY OF HABITATS

The following classification of New Guinea plant formations or vegetation zones has been proposed by Brass.[1] Except as they concern the savanna and savanna-forest, the 1,700-meter upper limit for which is from an observation by Lane-Poole,[2] the altitudes in the table represent the levels between which the communities were observed to occur by the Archbold expeditions of 1933–1934 and 1938–1939. The Archbold Expedition of 1936–1937 did not work in the high mountains.

Savanna and savanna-forest	0–1,700 m.
Monsoon-forest	0– 450 m.
Rain-forest	0–2,400 m.
Mid-mountain forest	480–2,350 m.
Beech-forest	850–3,100 m.
Mossy-forest	1,500–3,200 m.
Subalpine forest	3,000–4,050 m.
Alpine grassland	2,900 m. up to permanent snow line

Savanna and savanna-forest, monsoon-forest and mossy-forest are not represented in the area examined by the 1938–1939 expedition. The secondary grasslands of Humboldt Bay, Lake Sentani and the Balim River valley are, however, stocked with savanna grasses, and they are inhabited by savanna birds.

The plant formations, as represented in the collecting localities of our present area, are described under camp headings; their distribution in the area may be summarized as follows:

RAIN-FOREST.—The whole of the lowlands and hilly hinterland of Humboldt Bay, including the Lake Sentani area, and the south slopes of the Cyclops up to 575 meters—the highest altitude on this coastal range reached by members of the American party—lie in the rain-forest zone. At Bernhard Camp on the Idenburg River it takes in the alluvial plains of the Meervlakte, fifty meters above sea level, and all the mountain slopes up to an elevation of about 850 meters. Following the valleys and ravines of the southwesterly continuation of this unnamed range fronting the south side of the Meervlakte and reaching progressively higher as the mountains increase in altitude, rain-forests extend up to observed elevations of about 1,500 meters in the drainage basin of Araucaria Creek (850-meter and 1,200-meter Camps), 2,000 meters in the valley of the Sahoeweri River (1,800-meter and 2,150-meter Camps), and about 2,000 meters on that part of the range which faces the Meervlakte in the 1,800-meter and 2,150-meter Camp localities. In the deforested valley of the Balim River (Balim River Camp) on the north slopes of the Snow Mountains, relic indicators suggest that rain-forests, connected through the river gorge with the great forests of the southern lowlands, occupied extensive alluvial bottom lands at 1,600 to 1,700 meters and probably reached several hundred meters higher in branch valleys and ravines. In the valley of the Bele tributary of the Balim River, rain-forest elements, following the streams in the beech-forest, persist in some force up to an elevation of about 2,750 meters (2,800-meter Camp).

The following habitats are included in the rain-forest zone:

Strand communities (Humboldt Bay)
Mangrove communities (Humboldt Bay)
Xerophytic brush (Jautefa Bay, in Humboldt Bay)
Wormia-forest (Bernhard Camp)
Swampy rain-forest (Bernhard Camp, 850-meter Camp)
Timonius-forest (Bernhard Camp)
Adina swamp-forest (Bernhard Camp)
Nauclea-forest (Bernhard Camp)
Barringtonia swamp-forest (Bernhard Camp)
Sago swamp-forest (Humboldt Bay, Lake Sentani, Bernhard Camp)
Fringe communities (Bernhard Camp)
Streamside communities (850-meter Camp)
Mixed second-growth forest (well developed at Humboldt Bay, 850-meter Camp, Balim River Camp—in part; represented at Bernhard Camp, 1,200-meter Camp, 1,800-meter Camp; intruding into the beech-forest zone at Bele River Camp and 2,800-meter Camp)
Acacia scrub (Hollandia)
Casuarina-forest (Balim River Camp—in part)
Landslips (850-meter Camp, 1,200-meter Camp, 1,800-meter Camp)
Sand and gravel beds (Hollandia, Bernhard Camp, 850-meter Camp, Balim River Camp)
Cane-brakes (Bernhard Camp, 850-meter Camp,

[1] Brass, L. J., 1941, The 1938–1939 Expedition to the Snow Mountains, Netherlands New Guinea, Jour. Arnold Arboretum, XXII, pp. 271–342.
[2] Lane-Poole, C. E., 1925, The Forest Resources of the Territories of Papua and New Guinea, Government Printer for the State of Victoria, Australia.

Balim River Camp)
Reed thickets (Hollandia, Balim River Camp)
Secondary grassland (Humboldt Bay, Lake Sentani, Balim River Camp—in part)
Native gardens (Hollandia, Lake Sentani, Balim River Camp—in part)
Grass marsh (Lake Sentani, Bernhard Camp, Balim Valley)
Agathis-forest (?) (850-meter Camp)

MID-MOUNTAIN FOREST.—At its lower edge the mid-mountain forest lies in contact with the rain-forest, while above it is the beech-forest. This forest appears to require well-insolated, smooth slopes for its proper development. In topographically unfavorable localities it may be reduced to scattered small patches surrounded by rain-forest or beech-forest, or it may be altogether absent as a forest entity. The chief generic dominants (*Quercus* sens. lat. and *Castanopsis*) occur, one or both, in rain-forest down to 120 meters on the mountain slopes near Bernhard Camp and are very abundant in rain-forest at the 850-meter Camp and below 1,600 meters in the Sahoeweri Valley (1,800-meter Camp), but only at 1,200 to 1,300 meters in the Araucaria Creek basin (1,200-meter Camp) do they attain dominance and form patches of typical mid-mountain forest on the explored parts of this range of mountains. In the Balim Valley, only relic patches are left of a massive development between elevations of about 1,500 and 2,200 meters. In the Bele River branch of the Balim Valley there are small patches, isolated on broad ridge crests in the beech-forest at elevations of 2,300 to 2,350 meters.

This zone contains, in the Balim Camp locality:

Mixed secondary forest—in part
Vaccinium scrub
Casuarina-forest—in part
Secondary grassland—in part
Native gardens—in part

BEECH-FOREST.—The beech-forest occurs over a broad vertical range, and next to the rain-forest is the most extensive in our area. Under maximum conditions the dominant *Nothofagus* spp. reach a height of forty meters or more, and it is the tallest of all the forests; on exposed crests it is low and heavily mossed and even reduced to scrubs. In the mountains southwest of Bernhard Camp, where it occupies the upper parts of the ridges and its lower contact is with the rain-forest, an outlier body is encountered at the very low altitude of 850 to 900 meters (850-meter Camp). The main body, entered at 1,500 meters (1,600-meter subsidiary camp) on our route, continues uninterrupted along the top of the range (1,800-meter Camp) for some thirteen kilometers to the 2,250-meter peak (2,150-meter Camp), the highest point reached and the limit of the territory examined. On the Snow Mountains, where it forms a broad belt below the subalpine forest, the beech-forest now extends from altitudes of about 2,400 meters (Balim River Camp) and 2,000 meters (Bele River Camp) up to 3,100 meters (2,800-meter Camp) on the slopes below Lake Habbema. The lower parts of this forest in the Balim and Bele Valleys, which apparently touched on rain-forest in the valley bottoms and mid-mountain forest on the slopes between streams, have suffered total destruction at the hands of the native population.

The beech-forest zone includes:

Mixed secondary forest (Bele River Camp, 2,800-meter Camp)
Pandanus groves (2,800-meter Camp)
Native rest clearings (2,800-meter Camp)
Landslips (Bele River Camp, 2,800-meter Camp)
Stream beds (Bele River Camp, 2,800-meter Camp)
Grassy river beaches (Bele River Camp)
Grassy talus slopes (Bele River Camp)
Secondary grassland (Bele River Camp)
Native gardens (Bele River Camp)

SUBALPINE FOREST.—Confined to the Snow Mountains in our present area, this forest reaches from the beech-forest at 3,100 meters on the slopes of the range up to tree limit at 4,050 meters on Mt. Wilhelmina (Lake Habbema Camp, 3,560-meter Camp, 3,800-meter Camp). Over most of this large area, however, it is much interrupted and fragmented by the alpine grassland. It has been somewhat disturbed by fire. A reduced outpost occurs on swampy ground in the beech-forest at 3,000 meters (2,800-meter Camp), and subalpine plants are found as low as 2,100 meters in open habitats in the Balim Valley (Balim River Camp). Subalpine elements

also appear in open habitats at 2,150 meters (2,150-meter Camp) in the mountains southwest of Bernhard Camp.

At the lower levels this is a coniferous forest dominated chiefly by *Podocarpus papuanus* and *Libocedrus* sp. *Vaccinium dominans*, which characterizes a subsidiary layer of broad-leaved trees at the lower elevations, attains dominance as the conifers thin out and finally disappear with altitude.

The following habitats are integral parts of the subalpine forest:

Coniferous open forest (Lake Habbema)
Low-tree thickets (Lake Habbema)
Rhododendron shrubberies (Lake Habbema)
Forest border shrubberies (Lake Habbema, 3,560-meter Camp, 3,800-meter Camp)
Mixed secondary forest (Lake Habbema, 3,560-meter Camp)
Treefern stands (Lake Habbema, 3,560-meter Camp)
Lake shores (Lake Habbema)

ALPINE GRASSLAND.—In our section of the Snow Mountains the alpine grassland alternates with the subalpine forest far below tree limit and lies in contact with this forest along its lower border. Its lower limit may be placed at about 3,100 meters in the upland valleys in the vicinity of Lake Habbema. On Mt. Wilhelmina, which is largely bare limestone above about 4,300 meters, grassland plants still occur in soil pockets under rocks at 4,500 meters, about 200 meters below permanent snow line. Elements of the alpine grassland flora appear in open glades in the beech-forest at an elevation of 3,000 meters (2,800-meter Camp), and in other open habitats in this forest down to 2,200 meters (Bele River Camp).

The following alpine grassland habitats are recognized:

Forest glades (Lake Habbema, 3,560-meter Camp, 3,800-meter Camp)
Stream sides (Lake Habbema, 3,560-meter Camp, 3,800-meter Camp)
Lake shores (Lake Habbema, 3,560-meter Camp, 3,800-meter Camp)
Marshes (Lake Habbema, 3,560-meter Camp)
Pools (Lake Habbema, 3,560-meter Camp, 3,800-meter Camp)
Shrubberies (Lake Habbema, 3,560-meter Camp, 3,800-meter Camp)
Treefern stands (Lake Habbema, 3,560-meter Camp)
Talus slopes (3,800-meter Camp)
Rocky barrens (3,560-meter Camp, 3,800-meter Camp)

NOTES ON THE DISTRIBUTION OF BIRDS

The following points are of general interest in connection with the work of the expedition.

Our collection of marsh birds was rather rich in numbers of individuals and species. Some of them have been infrequently recorded for New Guinea, and it might seem either that earlier collectors rarely secured them because their abundance has changed in recent years or because their distribution is very local.

There are also other factors involved. Our aim was to secure series of all species of birds, not only series of rare things; our equipment for hunting marsh birds—small Dyak-built canoes and Dyak paddlers—was probably better than that usually available for New Guinea bird collectors, and while on the Idenburg River high water conditions were especially favorable for securing certain types of marsh birds. Of course the same high water made it difficult to secure river-beach birds.

Some of our New Guinea collecting experience on this and earlier expeditions indicates that actually some marsh birds have either very local distribution or restricted habitat requirements that we do not properly understand. Examples of this are *Porphyrio*, that we have found only near Bernhard Camp, and the absence of *Anas superciliosa*, *Gallinula* and *Dendrocygna arcuata* from apparently suitable marshes near Bernhard Camp.

The absence of *Nyroca*, *Anas superciliosa*, *Fulica* and *Porzana tabuensis* from the lakes and marshes on top of the Wharton Range (1933) and *Ardea sumatrana* and *Anas superciliosa* from the marshes we hunted in south New Guinea (1936) was real.

Though this cross section of the north

slope of the Snow Mountains has been untouched by white men's activities, there are many non-forest birds that occur in places. There are the marsh birds, ducks, herons, rails and terns; there are a few species, a duck (*Salvadorina*), a babbler (*Pomareopsis*) and a flycatcher (*Monachella*), that frequent forested streams; and then there are grassland birds.

The alpine zone birds are, of course, grassland species, restricted to this habitat and altitude. That it is not always a question of simply grassland versus forest habitat is shown by the big gaps in the distribution of alpine grassland in New Guinea; there are large gaps between the alpine grasslands of southeast New Guinea and those of the Snow Mountains, and yet some of the same species, as *Turdus poliocephalus* and *Anthus gutturalis*, occur on both, while they are absent from the grasslands that occur only a few miles lower on the same mountain slopes.

Some birds, however, do occupy both alpine grassland and mid-mountain grassland, as *Megalurus timoriensis*. And here there is an interesting point in that the birds of this species from Mt. Wilhelmina are more like the birds from Mt. Albert Edward than they are like the birds of the same species from the Balim Valley; there is a closer relationship between isolated populations several hundred miles apart but at the same altitude than between isolated populations only a few miles apart but at different altitudes.

We have already discussed the occurrence of non-forest birds in virgin forested areas, and the enlargement of their range by man's activities in other areas,[1,2,3] and here will mention some additional examples.

Birds of the forest edge of the alpine zone of the Snow Mountains, as *Melidectes nouhuysi*, were rather closely restricted to it, but another species, *Oreostruthus fuliginosus*, that also appeared at first restricted to the forest edge at timber line also occurred down to about 2,700 meters, where small clearings have been made in the forest by the falling of trees. With artificial extension of the alpine grassland these species would increase and spread.

Below the 1,800-meter Camp on the Idenburg slopes we found *Lonchura tristissima* along a small stream flowing through forest, some miles from any grassland. At Bernhard Camp we also found this species not uncommon in the floating beds of marsh grass, in close proximity to the forest; another weaver-finch (*L. grandis*) and a warbler (*Malurus alboscapulatus*) were common; both of these are considered typical grassland birds in some places, and here we found them common in an area where there was no grassland. These three birds are a striking example of the original habitat of some grassland birds. At Bernhard Camp there were also some second-growth birds—birds that were commonest in tree growth but shunned the forest. The disturbed areas along the waterways were their optimum habitat. Some of these species were *Philemon brassi*, *Coracina papuensis*, *Cinnyris jugularis* (that also ranged out into the marsh grass), *Stigmatops alboauricularis* and *Haliastur indus*.

These examples are sufficient to show specific cases where birds, that under certain conditions occur only in grassland or second growth areas that are the result of human agencies, can and do find a niche in a largely forested country untouched by man's activities.

Our collection was poor in species and numbers of hawks and owls.

Forest-inhabiting owls are of course difficult to secure, and it is impossible to estimate their abundance. However, above 2,800 meters *Tyto tenebricosa* was evidently fairly common, though none was secured.

Hawks for the most part are scarce in New Guinea. They are simply not seen. There are some exceptions. *Haliastur indus* is usually common, as is *H. sphenurus* in some localities; *Halicetus leucogaster* was common along the Idenburg and Fly Rivers; at Lake Habbema *Circus* was not uncommon but very shy and difficult to secure, while in the Grand Valley *Ieracidea* was fairly common but difficult to secure.

[1] Archbold and Rand, 1935, Bull. Amer. Mus. Nat. Hist., LXVIII, pp. 534, 556, 557.
[2] Rand and Brass, 1940, Bull. Amer. Mus. Nat Hist., LXXVII, p. 377.
[3] Rand, 1941, Amer. Mus. Novitates, No. 1122, pp. 1, 3.

Otherwise the collections give a fair key to the abundance of hawks.

The difference in bird life at different altitudes was, of course, one of the most striking phenomena of bird distributions in the area worked.

The greatest altitudinal range of any species was that of the swiftlet (*Collocalia esculenta*) from sea level to 3,600 meters and that of a strictly forest bird (*Reinwardtoena*) from sea level to 2,800 meters; most species had a considerably smaller altitudinal range.

While the exact altitudinal ranges of few species coincide, groups of some species tend to have about the same altitudinal range, giving altitudinal belts or zones of distribution. The altitudinal levels between which birds live may vary in different parts of New Guinea, and within a short distance local conditions may affect altitudinal distribution. However, for convenience it is advisable to separate and name these bands or zones.

Going from the lowlands to the mountain tops on the north slope of the Snow Mountains, many species are left behind in the lowlands, and there is another change at 950 meters, but the single biggest change in the bird life is found at about 1,200 meters altitude. Many species from the lowlands reach that high, but above that are few species that also occur in the lowlands. At 1,800 meters one encounters an avifauna of which some components go to timber line, a larger group to about 2,800 meters, near the upper limits of the beech-forest, and a still larger group that extends only from about 1,600 to 2,200 meters. Near 2,200 meters one encounters another group of species that seems restricted to the 2,200 to 2,800-meter belt, and another group about as large, that ranges between 2,200 meters and timber line. There is a considerable drop in the number of species at 2,800 to 3,000 meters, and the additional species of strictly high altitude birds appearing here are few. The alpine grassland has a small, but distinct, group of species.

From a consideration of the data from this area, it seems advisable to retain the system of classification set up in southeast New Guinea based on our 1933 work.[1]

Tropical	0–1,200 m.
Subtropical	1,200–2,200 m.
Temperate	2,200 m. to timber line
Alpine	3,200 m. up

The lack of mossy forest in this area and the correlated upward pushing of the beech-forests apparently result in an upward extension of a number of birds resulting in a less clear distinction between the Temperate and Subtropical Zones.

The question of increase in size with increase in altitude has been discussed for southeast New Guinea in an earlier paper by Rand.[2] The same phenomenon was common on the Snow Mountains, and even more conspicuous.

One good example is *Collocalia esculenta:*

Altitude	Snow Mountains, ♂ and ♀	Southeast New Guinea, ♂ and ♀
3,600 m.	112 mm., 120	108, 109, 110, 110, 110
3,225 m.	110, 113, 115, 118	
2,800 m.	114, 114, 119	104, 106
2,400 m.		103–107
2,200 m.	110, 113, 114, 118	
2,150 m.	107, 108	
2,000 m.		102–103
1,250 m.		102–106
1,200 m.	108, 110, 112	
900 m.		109
450 m.		101–103
00 m.	97–105	

While this is a pronounced increase in size with increase in altitude, it does not seem practical to separate altitudinal races by name in many such cases.

In some other species, such as *Pachycephalopsis poliosoma* and *Dicaeum geelvinkianum*, series from different altitudes represent differences in size and color that warrant recognizing them by different names.

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[1] Archbold and Rand, 1935, Bull. Amer. Mus. Nat. Hist., LXVIII, pp. 542, 543.

[2] 1936, Amer. Mus. Novitates, No. 890, pp. 1–14.

RESULTS OF THE EXPEDITION

The specialists naturally attempted to make complete collections in their own fields, mammals, birds, insects and vascular plants, but Richardson also collected cold-blooded vertebrates, Toxopeus collected invertebrates generally and Brass collected non-vascular plants.

The following is an approximate list of the collections:

Mammals	3,486	specimens
Birds	4,846	"
Reptiles and Amphibians	849	"
Fishes	about 500	"
Invertebrates	about 100,000	"
Plants	5,331	numbers
Plants collected independently by Meyer-Drees	about 600	"
Wood	602	specimens

The vertebrate animal collections are deposited in The American Museum of Natural History, and the persons responsible for the working out of the collections are as follows:

Mammalogy	G. H. H. Tate
Ornithology	A. L. Rand
Herpetology	C. M. Bogert
Ichthyology	J. T. Nichols

When this material is worked out, duplicates are to be sent to the 's Lands Plantentuin, Buitenzorg, Java.

The invertebrate collections are deposited in the Zoölogisch Museum of 's Lands Plantentuin, Buitenzorg, and the Director there is responsible for their distribution to specialists for study. When the study of the invertebrate material is complete, duplicates are to be sent to The American Museum of Natural History.

The general botanical collections are deposited in the Arnold Arboretum. Dr. E. D. Merrill and Dr. L. M. Perry are working on certain groups, and various specialists have undertaken the determination of other groups. Four new genera and 358 new species of plants have been described from the collections to date (August 27, 1941).

Duplicate sets of the botanical material have been sent to the Herbarium of the 's Lands Plantentuin, Buitenzorg.

The forestry material and the independent Meyer-Drees plant collection are deposited in Buitenzorg.

Some results based on the study of this material have been published; others are in press and in preparation.

Many data on the biology in the area were secured in addition to the collections.

Topographical data on the area were gathered by Lieutenant van Arcken, and this material is to be incorporated into a map by the Topografischer Dienst at Batavia.

Data on the natives were gathered by Lieutenant Huls and will be published by him.

Publications on the Archbold New Guinea Expeditions that have appeared since January 1, 1940, and papers in press or completely prepared as of February, 1942, are as follows:

GENERAL

1940. RAND, A. L., AND BRASS, L. J.
Results of the Archbold Expeditions, No. 29. Summary of the 1936–1937 New Guinea Expedition. Bull. Amer. Mus. Nat. Hist., LXXVII, pp. 341–380.

1940. TOXOPEUS, L. J.
Nederlandsch - Indisch - Amerikaansche Expeditie naar Nederlandsch Nieuw Guinea (3e Archbold-Expeditie naar Nieuw Guinea 1938–1939): Lijst van versamelstations. Treubia, XVII, pp. 271–279 (in both Nederlandsch and English).

1940. [EDITOR]
Uittreksel van het Algemeen Verslag van de Nederlandsch - Indische - Amerikaansche Expeditie naar Nieuw-Guinea, 1938–1939 (Archbold-Expeditie). Tijdschrift Kon. Ned. Aardr. Gen., (2) LVII, pp. 233–247.

1941. ARCHBOLD, RICHARD, AND RAND, A. L.
Latchkey to a Savage Tribe. Natural History, XLVII, pp. 193–199.

1941. ARCHBOLD, RICHARD
Unknown New Guinea. Nat. Geog. Mag., LXXIX, pp. 315–344.

1941. BRASS, L. J.
Stone Age Agriculture in New Guinea. Geog. Review, XXXI, pp. 555–569.

ECOLOGY

1941. BRASS, L. J.
The 1938–1939 Expedition to the Snow Mountains, Netherlands New Guinea. Jour. Arnold Arboretum, XXII, pp. 271–342.

MAMMALOGY

1941. TATE, G. H. H.
Results of the Archbold Expeditions, No.

31. New Rodents and Marsupials from New Guinea. Amer. Mus. Novitates, No. 1101, 9 pp.

1941. TATE, G. H. H.
Results of the Archbold Expeditions, No. 35. A Review of the Genus *Hipposideros* with Special Reference to Indo-Australian Species. Bull. Amer. Mus. Nat. Hist., LXXVIII, pp. 353–393.

1941. TATE, G. H. H.
Results of the Archbold Expeditions, No. 36. Remarks on Some Old World Leaf-nosed Bats. Amer. Mus. Novitates, No. 1140, 11 pp.

1941. TATE, G. H. H.
Results of the Archbold Expeditions, No. 37. Notes on Oriental *Taphozous* and Allies. Amer. Mus. Novitates, No. 1141, 5 pp.

1941. TATE, G. H. H.
Results of the Archbold Expeditions, No. 38. Molossid Bats of the Archbold Collections. Amer. Mus. Novitates, No. 1142, 4 pp.

1941. TATE, G. H. H.
Results of the Archbold Expeditions, No. 39. A Review of the Genus *Myotis* (Chiroptera) of Eurasia, with Special Reference to Species Occurring in the East Indies. Bull. Amer. Mus. Nat. Hist., LXXVIII, pp. 537–565.

1941. TATE, G. H. H.
Results of the Archbold Expeditions, No. 40. Notes on Vespertilionid Bats of the Subfamilies Miniopterinae, Murininae, Kerivoulinae and Nyctophilinae. Bull. Amer. Mus. Nat. Hist., LXXVIII, pp. 567–597.

ORNITHOLOGY

1940. RAND, A. L.
Courtship of the Magnificient Bird of Paradise. Natural History, XLV, pp. 172–175.

1940. RAND, A. L.
Flying Birdmen (an account of collecting a habitat group for exhibiting birds). Natural History, XLVI, pp. 138–144.

1940. RAND, A. L.
Results of the Archbold Expeditions, No. 25. New Birds from the 1938–1939 Expedition. Amer. Mus. Novitates, No. 1072, 14 pp.

1940. RAND, A. L.
Results of the Archbold Expeditions, No. 26. Breeding Habits of the Birds of Paradise: *Macgregoria* and *Diphyllodes*. Amer. Mus. Novitates, No. 1073, 14 pp.

1940. RAND, A. L.
Results of the Archbold Expeditions, No. 27. Ten New Birds from New Guinea. Amer. Mus. Novitates, No. 1074, 5 pp.

1940. RAND, A. L.
Results of the Archbold Expeditions, No. 32. New and Interesting Birds from New Guinea. Amer. Mus. Novitates, No. 1102, 15 pp.

1941. RAND, A. L.
Results of the Archbold Expeditions, No. 33. A New Race of Quail from New Guinea; with Notes on the Origin of the Grassland Avifauna. Amer. Mus. Novitates, No. 1122, 2 pp.

1941. RAND, A. L.
Results of the Archbold Expeditions, No. 42. Birds of the 1936–1937 New Guinea Expedition. Bull. Amer. Mus. Nat. Hist. (in press).

1941. RAND, A. L.
Results of the Archbold Expeditions, No. 43. Birds of the 1938–1939 New Guinea Expedition. Bull. Amer. Mus. Nat. Hist. (in press).

ICHTHYOLOGY

1940. NICHOLS, J. T.
Results of the Archbold Expeditions, No. 30. New Catfishes from Northern New Guinea. Amer. Mus. Novitates, No. 1093, 3 pp.

BOTANY

1940. JOHNSTON, IVAN M.
Studies in the Boraginaceae XIV: Miscellaneous Species from Asia, Malaysia and America (Boraginaceae in part). Jour. Arnold Arboretum, XXI, pp. 48–66.

1940. KOBUSKI, CLARENCE C.
Studies in Theaceae V: The Theaceae of New Guinea. (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXI, pp. 134–162.

1940. COPELAND, EDWIN BINGHAM
Oleandrid Ferns (Davalliaceae) of New Guinea. Philippine Jour. Sci., LXXIII, pp. 345–347.

1940. COPELAND, EDWIN BINGHAM
Notes on Hymenophyllaceae. Philippine Jour. Sci., LXXIII, pp. 457–469.

1940. MERRILL, E. D., AND PERRY, L. M.
Plantae Papuanae Archboldianae II (Pandanaceae, Pittosporaceae, Rosaceae, Melastomataceae, Apocynaceae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXI, pp. 163–200.

1940. MERRILL, E. D., AND PERRY, L. M.
Plantae Papuanae Archboldianae III (Barringtoniaceae, Meliaceae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXI, pp. 292–327.

1940. KOBUSKI, CLARENCE E.
The Oleaceae of New Guinea Collected by L. J. Brass. (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Aboretum, XXI, pp. 328–335.

1940. MERRILL, E. D., AND PERRY, L. M.
Plantae Papuanae Archboldianae IV

(Zygophyllaceae, Sapindaceae, Cornaceae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXI, pp. 511–527.

1941. COPELAND, EDWIN BINGHAM
Gleicheniaceae of New Guinea. Philippine Jour. Sci., LXXV, pp. 347–361.

1941. COPELAND, EDWIN BINGHAM
Miscellaneous Ferns of New Guinea (Marattiaceae, Schizaeaceae). Philippine Jour. Sci., LXXVI, pp. 23–25.

1941. MERRILL, E. D., AND PERRY, L. M.
Plantae Papuanae Archboldianae V (Rutaceae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXII, pp. 32–59.

1941. SMITH, A. C.
Studies of Papuasian Plants I (Myristicaceae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXII, pp. 60–80.

1941. SUMMERHAYES, V. S.
Additions to Our Knowledge of the Figs of New Guinea. (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXII, pp. 81–109.

1941. SMITH, A. C.
Studies of Papuasian Plants II (Monimiaceae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXII, pp. 231–252.

1941. MERRILL, E. D., AND PERRY, L. M.
Plantae Papuanae Archboldianae VI (Ulmaceae, Rosaceae, Meliaceae, Callitrichaceae, Aquifoliaceae, Celastraceae, Sabiaceae, Rhamnaceae, Thymeleaceae, Elaeagnaceae, Lythraceae, Sonneratiaceae, Crypteroniaceae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXII, pp. 253–270.

1941. SMITH, A. C.
Studies of Papuasian Plants III (Guttiferae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXII, pp. 343–374.

1941. MERRILL, E. D., AND PERRY, L. M.
Plantae Papuanae Archboldianae VII (Vitaceae, Campanulaceae, Goodeniaceae). (Botanical Results of the Richard Archbold Expeditions.) Jour. Arnold Arboretum, XXII, pp. 375–388.

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Plantae Papuanae Archboldianae IX (Myrtaceae in part). Jour. Arnold Arboretum, XXIII. (Part in press for March Journal, to be completed in July number.)

1942. CROIZAT, LEON
New Species of Croton L. from New Guinea. Jour. Arnold Arboretum, XXIII. (MS completed. Possibly to be published in July number.)

1942. BARTRAM, EDWIN B.
Mosses of Papua, New Guinea. (MS completed.)
Third Archbold Expedition Mosses from the Snow Mountains, Netherlands New Guinea. (MS completed.)

In April, 1941, the following completed manuscripts were on the list of papers to be published by the Philippine Journal of Science. At the time our paper goes to press it is uncertain when and where these will appear.

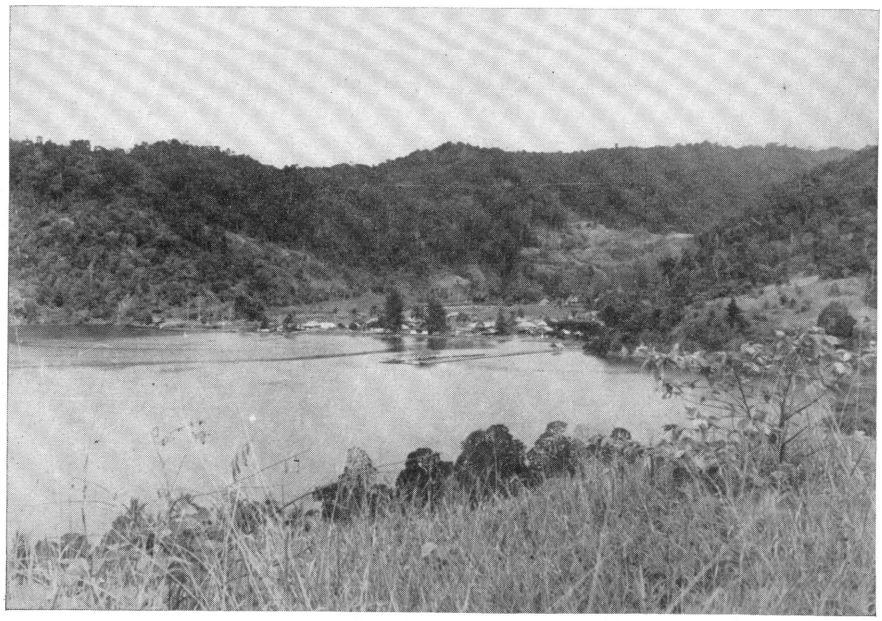
COPELAND, EDWIN BINGHAM
Cyathea in New Guinea
Polypodioid Ferns of New Guinea
Dicksonid Ferns of New Guinea
Athyrioid Ferns of New Guinea

PLATES I–XXXV

PLATE I

Fig. 1. Hollandia viewed from secondary grasslands on northern side of Hollandia Bay.

Fig. 2. Spare engines and other heavy equipment being rafted ashore at Hollandia.



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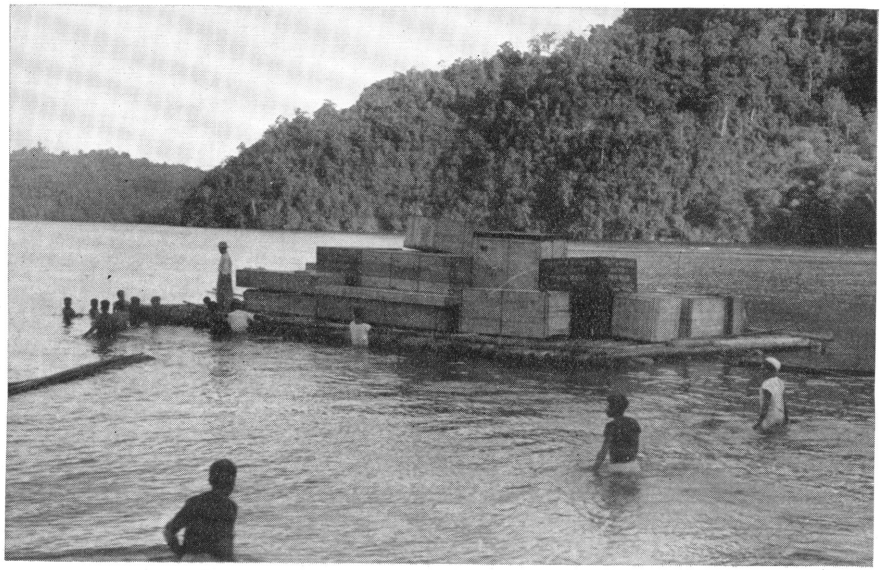

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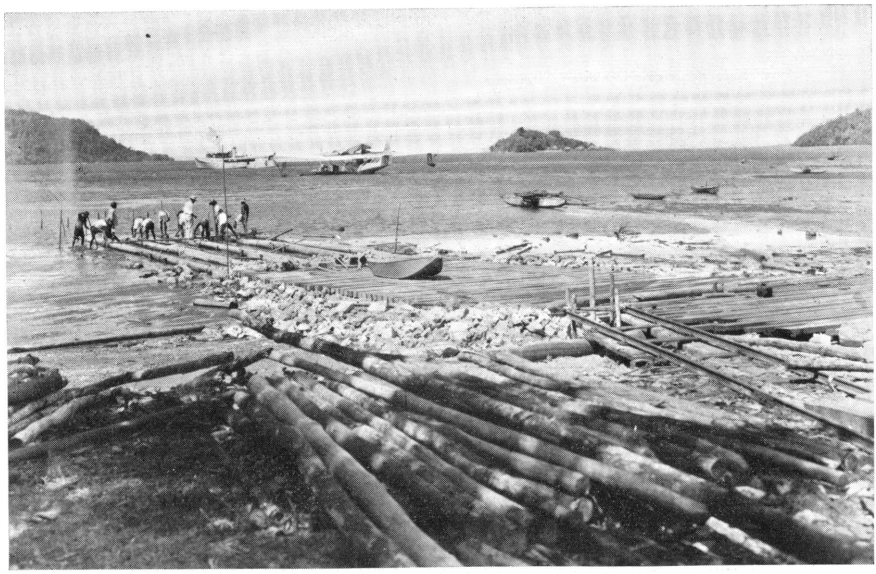
PLATE II

Fig. 1. Flying boat ramp under construction at Hollandia. The "Guba" and a government patrol boat at anchor in the bay. On the ramp is one of the collapsible boats carried on the "Guba" and used by the inland party on Lake Habbema.

Fig. 2. Government offices, police barracks and the gesagheber's residence, Hollandia. Primary rain-forest and a few small clearings surround the town, with its plantings of coconuts, kapok and *Casuarina equisetifolia*.



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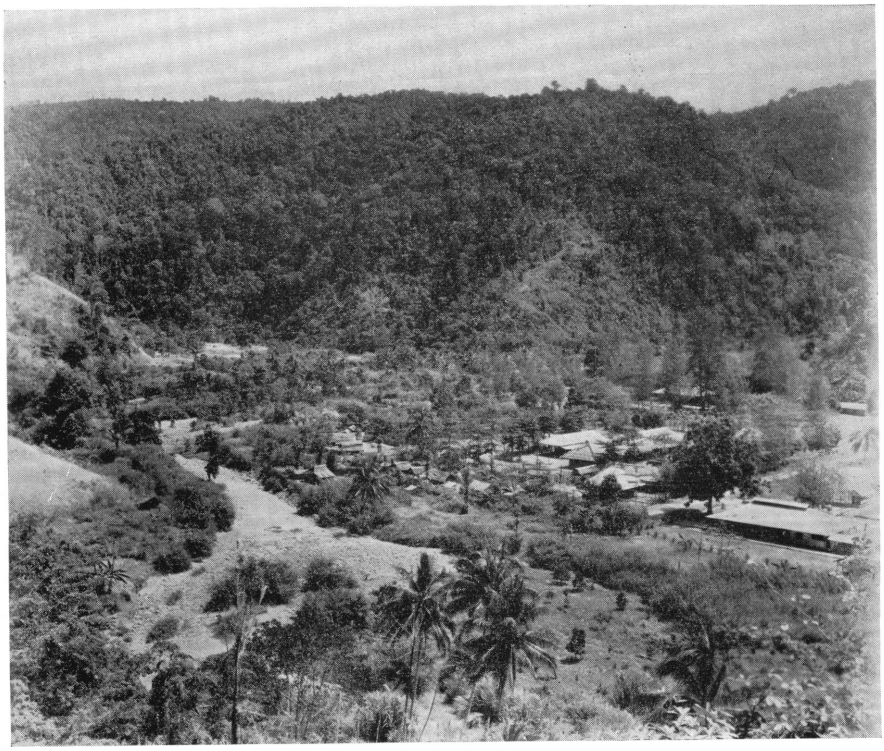

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PLATE III

Fig. 1. Tabati Village, Jautefa Bay. The high ridge in the background carries a pattern of primary rain-forest and secondary grassland characteristic of the disturbed coastal fringe and the area around Lake Sentani.

Fig. 2. Rain-forest of the limestone ridges, Hollandia. *Selaginella caudata* (right) characterizes the ground cover, and climbing aroids are prominent in this type of moist forest.

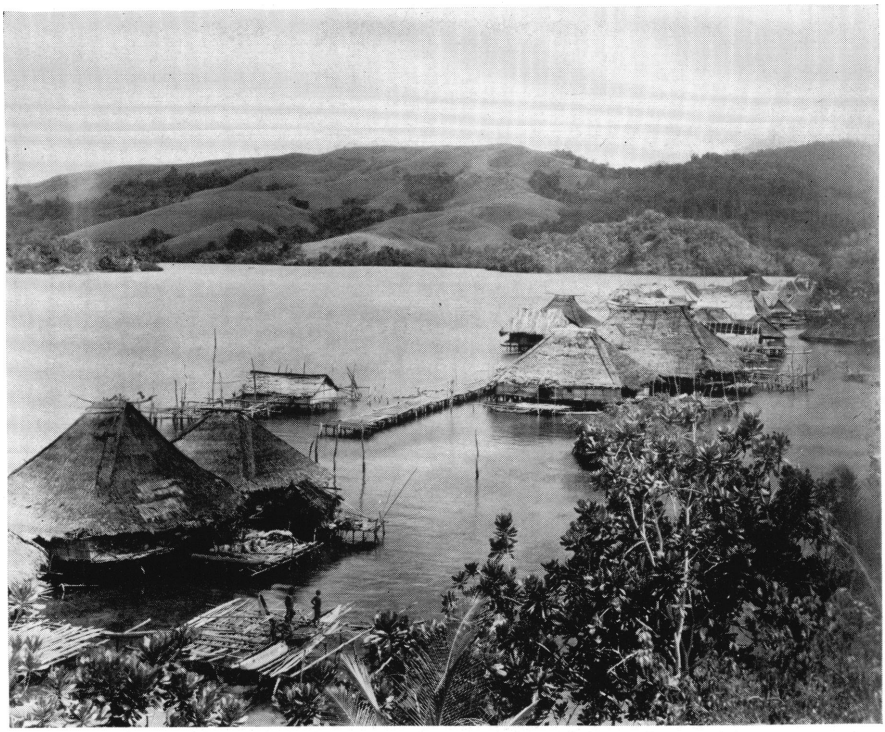

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PLATE IV

Fig. 1. Soldiers and supplies going aboard the "Guba" for transportation to Bernhard Camp.

Fig. 2. Aerial view of Bernhard Camp, at a time when the river was in half flood.

1

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PLATE V

Fig. 1. The "Guba" being unloaded into Dyak-built canoes at Bernhard Camp anchorage. Early morning clouds rising from the plains of the Meervlakte blot out the mountains on which the expedition had its second chain of collecting camps.

Fig. 2. Flood waters rise on Bernhard Camp. Epiphytes and climbing aroids are conspicuous on the trees.

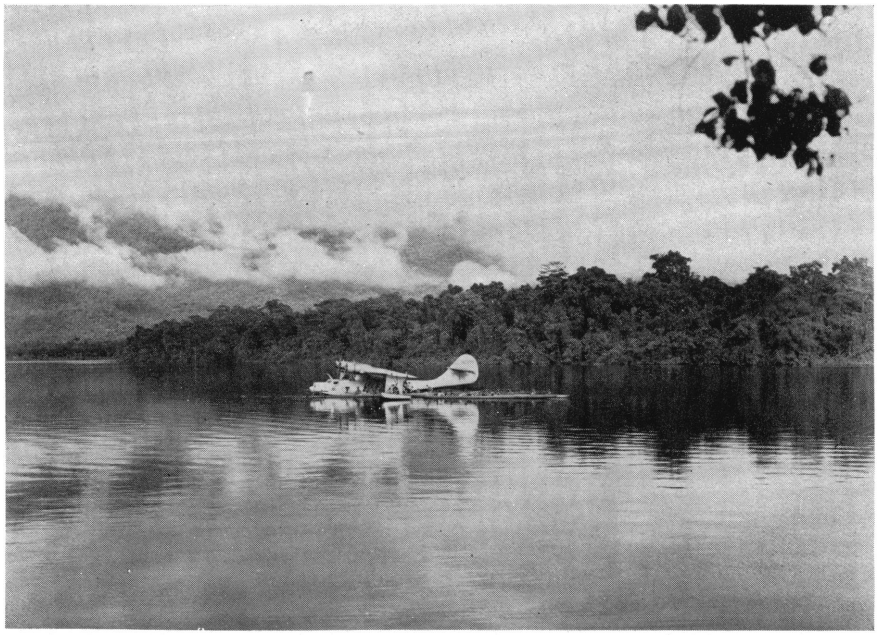

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PLATE VI

Fig. 1. Beds of floating grass (*Echinochloa stagnina*) in the side creek at Bernhard Camp. This was the habitat of *Lonchura tristissima*. The forest in the background was flooded to a depth of two meters when this photograph was made.

Fig. 2. Somewhat swampy forest of the flood plain, Bernhard Camp (inundated to a depth of about one meter by highest flood). The larger trees are *Intsia* sp. (center) and *Couthovia* sp. (right); ground cover of *Oryza Ridleyi* and *Hypolytrum* sp.

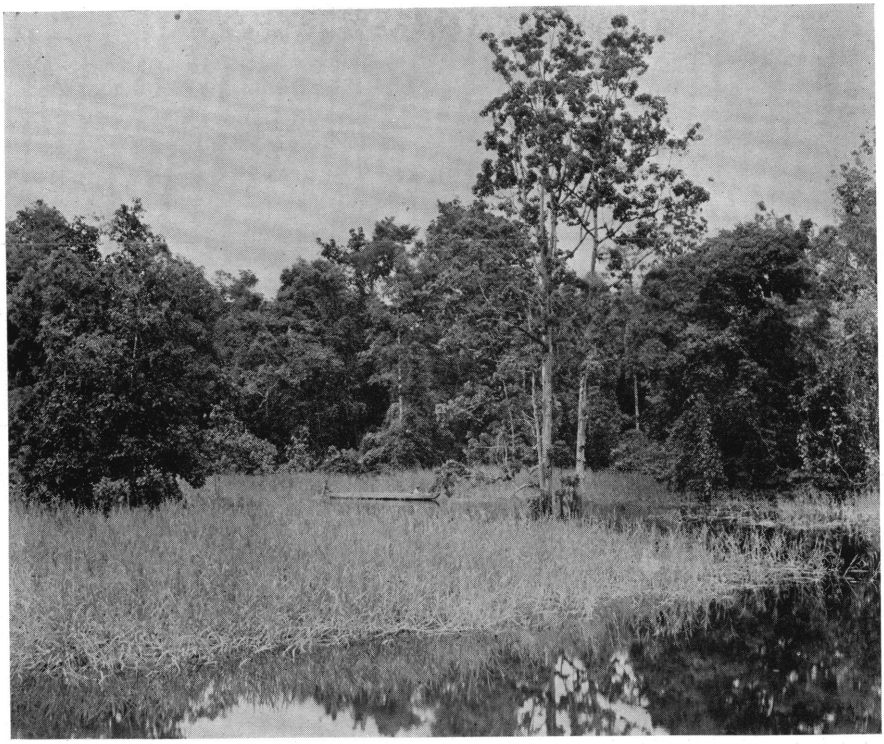

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PLATE VII

Fig. 1. *Adina* swamp-forest, Bernhard Camp, inundated to a depth of three and one-half meters when this photograph was made. The small deciduous tree in left center is *Barringtonia spicata*.

Fig. 2. Botanical collecting canoe, on the north bank of the flooded Idenburg River a little above the entrance to the lagoon. A brake of *Saccharum spontaneum* (seen in foreground) lines the opposite bank.

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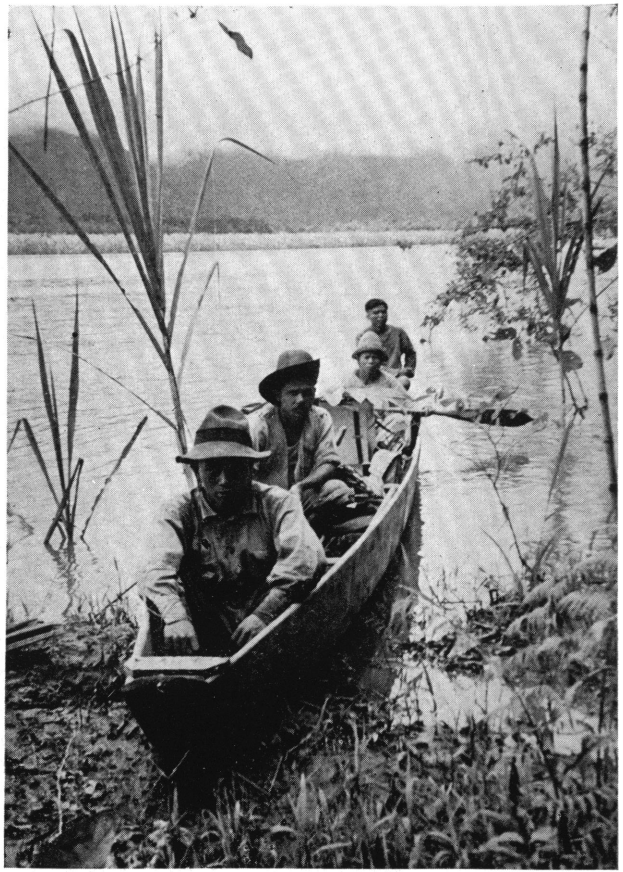

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PLATE VIII

Fig. 1. Staff dining room, Bernhard Camp, at the height of the March flood. Water is more than a foot deep over the floor. Wire screening gives protection from insects.

Fig. 2. The plant-drying raft, Bernhard Camp.

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PLATE IX

Fig. 1. A deserted camp of the flood plain nomads, near Bernhard Camp.

Fig. 2. Nomads of the flood plain, Bernhard Camp.

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PLATE X

Bernhard Camp "B," flood refuge and subsidiary collecting camp at seventy-five meters altitude at the foot of the mountains. The big stumps and logs are of *Intsia* sp., a valuable hardwood tree common on the lower mountain slopes and also found on the flood plains.

PLATE XI

Fig. 1. 850-meter Camp in rich flood-plain rain-forest on Araucaria Creek four kilometers southwest of Bernhard Camp.

Fig. 2. Seral rain-forest on a sandy flood bank of Araucaria Creek (altitude 850 meters), containing *Schuurmansia Henningsii*, with long narrow leaves, and the treefern *Cyathea contaminans*. A small *Ficus* spreads its horizontal branches over the water.

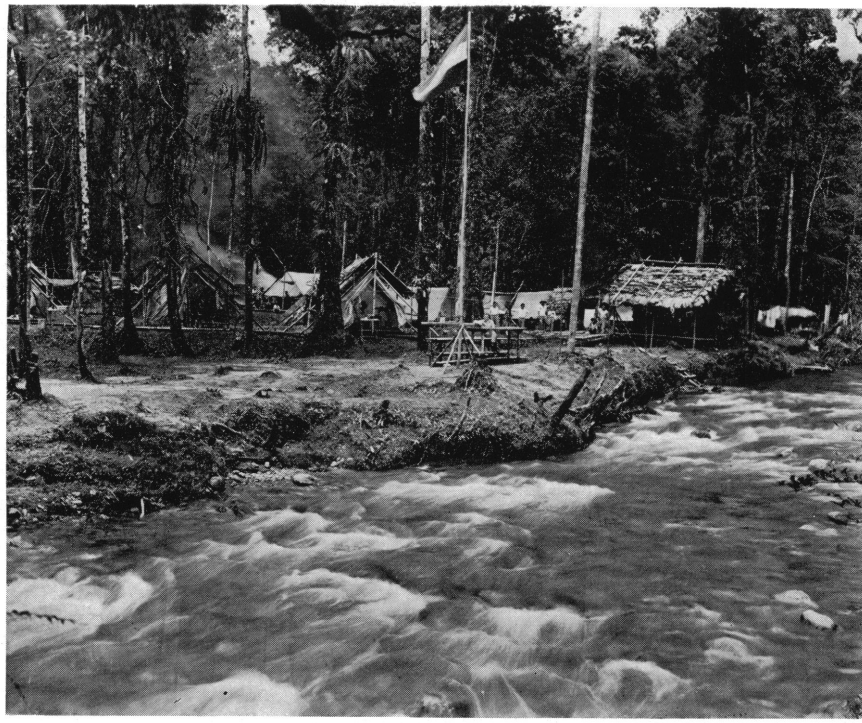

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Plate XII

Fig. 1. *Agathis* forest at 900 meters altitude in the valley of Araucaria Creek. *Pandanus* sp. and young palms (*Gulubia* sp.) abundant in the undergrowth.

Fig. 2. Heavily mossed *Nothofagus* forest at 900 meters on the exposed crest of a ridge near the 850-meter Camp.

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PLATE XIII

Fig. 1. 1,800-meter Camp in the tall, heavily mossed *Nothofagus* forest of a ridge crest fifteen kilometers southwest of Bernhard Camp.

Fig. 2. The dining fly at the 1,800-meter Camp. Left to right: Richardson, Teerink, Rand.

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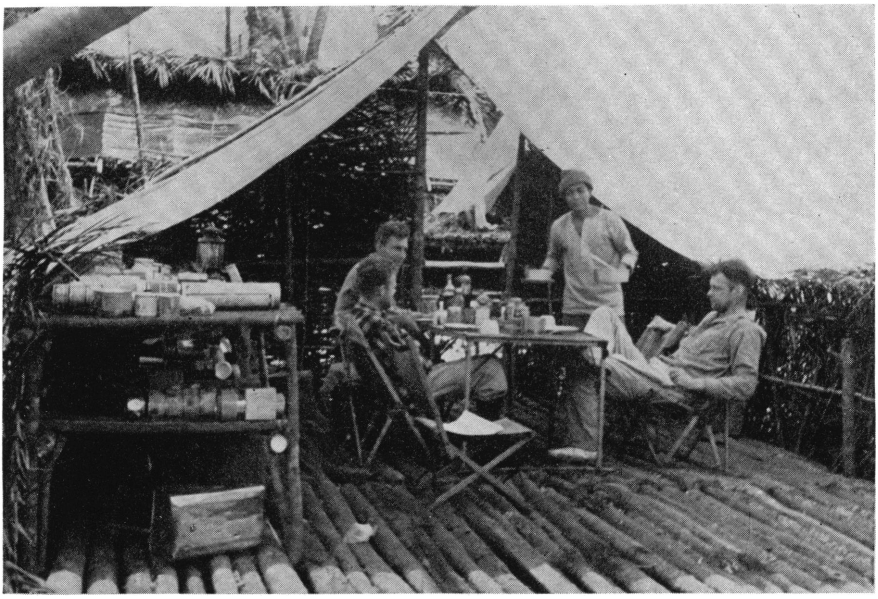

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PLATE XIV

Fig. 1. View northeast over the Meervlakte and the Idenburg River from the 2,150-meter Camp eighteen kilometers southwest of Bernhard Camp.

Fig. 2. View from the 2,150-meter Camp looking east along the mountain ridge on which this camp, the 1,800-meter Camp and the 1,600-meter subsidiary camp were situated.

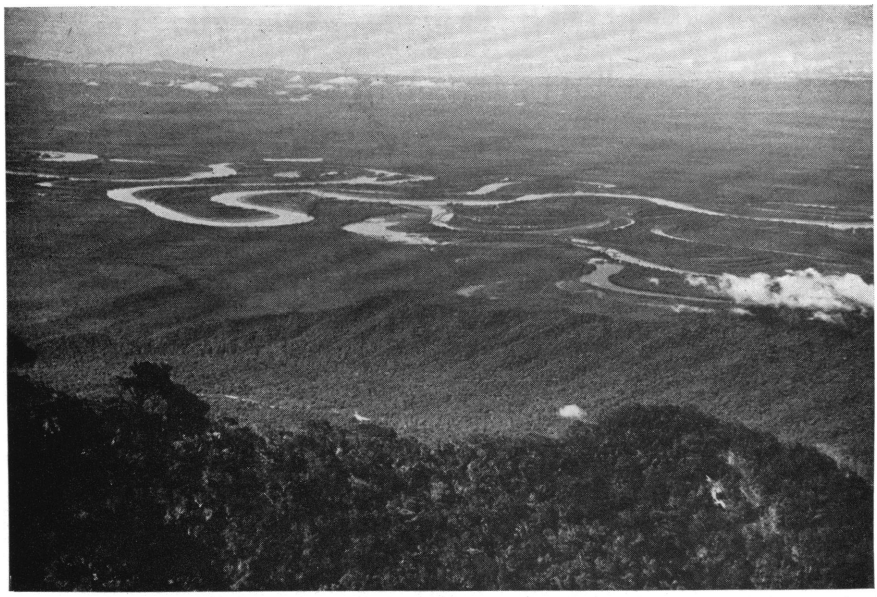

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PLATE XV

Archbold Lake, fed by a marshy stream and separated from the Wal or Hablifoeri River by a limestone ridge about one kilometer in width.

PLATE XVI

Aerial view of the Grand Valley of the Balim, looking southeast from a position near the meeting place of the Teerink and van Arcken patrols. "X" marks the approximate position of the Balim River 1,600-meter Camp, beyond which is the gorge through which the river cuts through the Snow Mountains to join the Reiger.

PLATE XVII

Fig. 1. A river-bank village in the Grand Valley, surrounded by cultivated and fallow fields.

Fig. 2. View over the lower end of the Grand Valley from the southern slopes opposite the Balim River 1,600-meter Camp. The old-established grass slope in foreground, showing ruins of stone walls, slopes down to cultivated bottom lands carrying strips and patches of *Casuarina* trees. Old stone walls give a terraced appearance to the deforested limestone range which rises to 2,400 meters on the far side of the river.

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PLATE XVIII

Fig. 1. A village near the Balim River 1,600-meter Camp. In the foreground are sweet potato gardens. Bananas and sugar cane grow within the village walls. The *Casuarina* trees surrounding the village have been stripped of most of their branches for fuel.

Fig. 2. Suspension bridge over the Balim, about two kilometers below the expedition camp.

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PLATE XIX

Fig. 1. A chain of Dyaks, bracing themselves against the current with sticks, helps the rest of the party across the Wamena River in the Grand Valley.

Fig. 2. Expedition party on the march in the Grand Valley.

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PLATE XX

Fig. 1. Natives gather to watch the party at a rest halt in the Grand Valley.

Fig. 2. Bele River 2,200-meter Camp eighteen kilometers northeast of Lake Habbema. The formerly cultivated slope behind the camp carries growths of secondary forest and grass and a few planted *Pandanus* trees.

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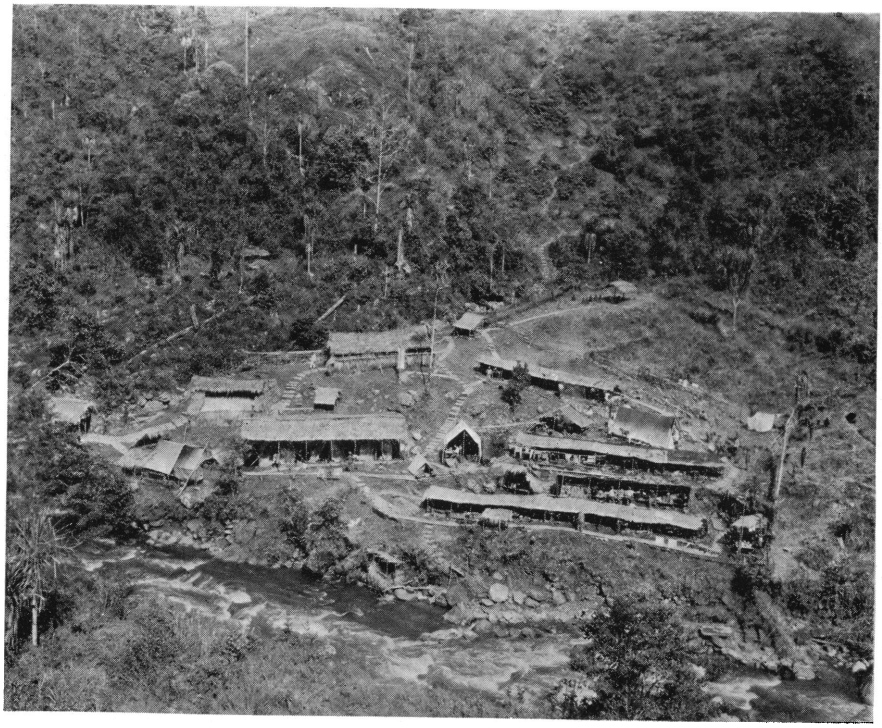

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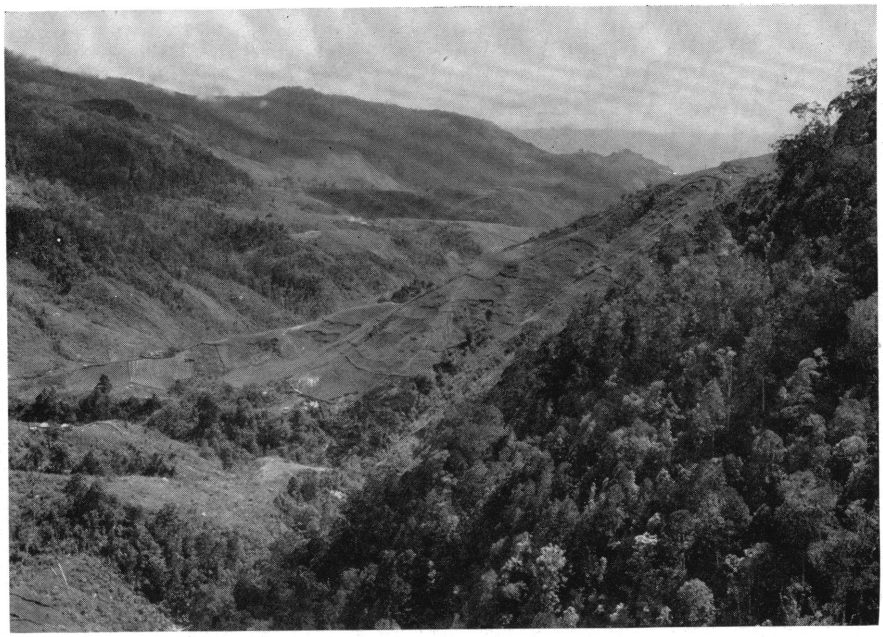
Plate XXI

Fig. 1. View down the Bele Valley from a position above the mouth of the limestone gorge, about two kilometers downstream from the 2,200-meter Camp, showing contour-terraced slopes and secondary forest and secondary grassland on slopes formerly cultivated. *Nothofagus* forest covers the steep slope on right and the upper parts of the spur across the valley.

Fig. 2. A new garden in *Nothofagus* forest at 2,480 meters in the Bele Valley.



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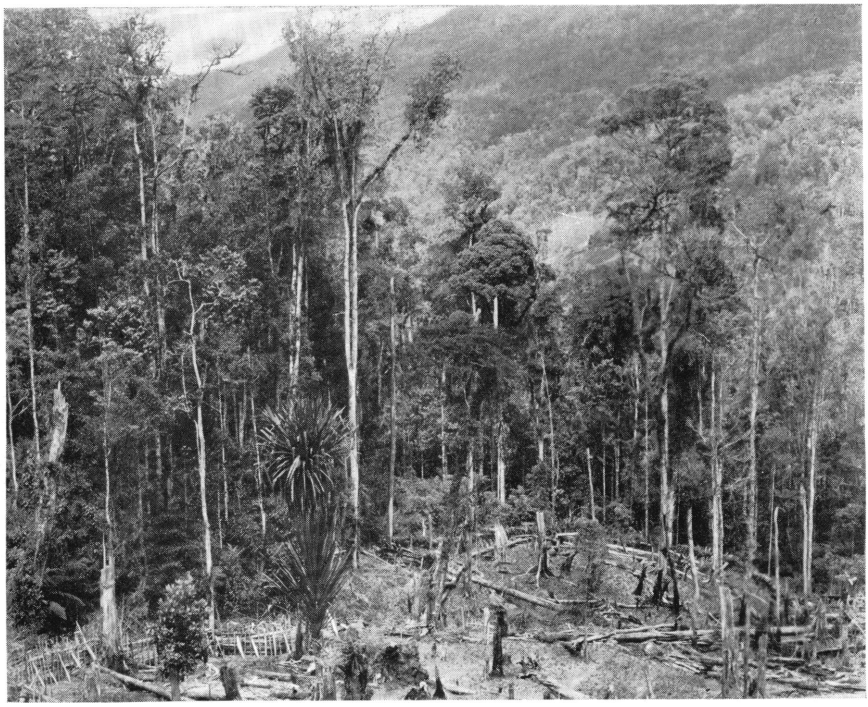

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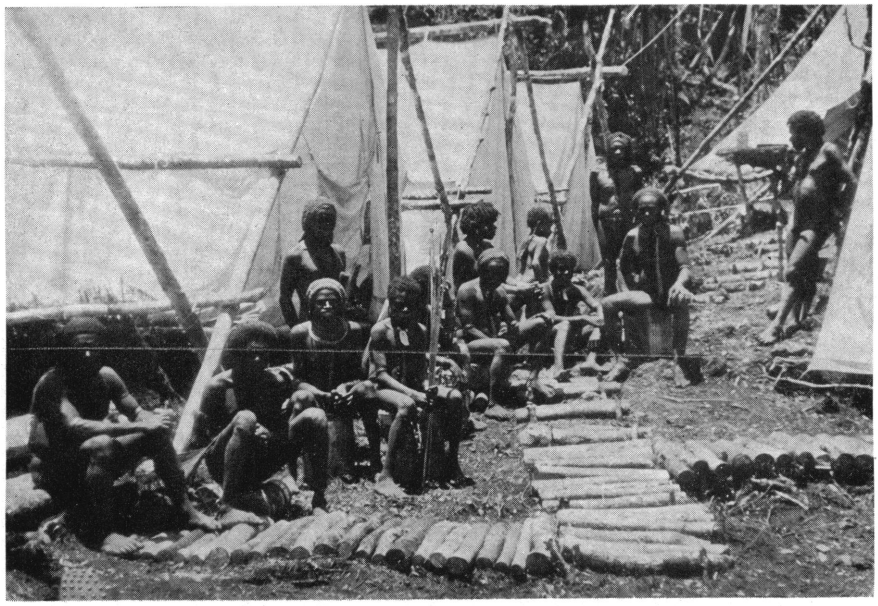
PLATE XXII

Fig. 1. Natives, who have carried from Lake Habbema to the 2,800-meter Camp, sit on their loads while awaiting payment in shells.

Fig. 2. 2,800-meter Camp nine kilometers northeast of Lake Habbema. Dyak carriers arrive under military escort from Lake Habbema. The camp was in a planted *Pandanus* grove surrounded by tall *Nothofagus* forest.



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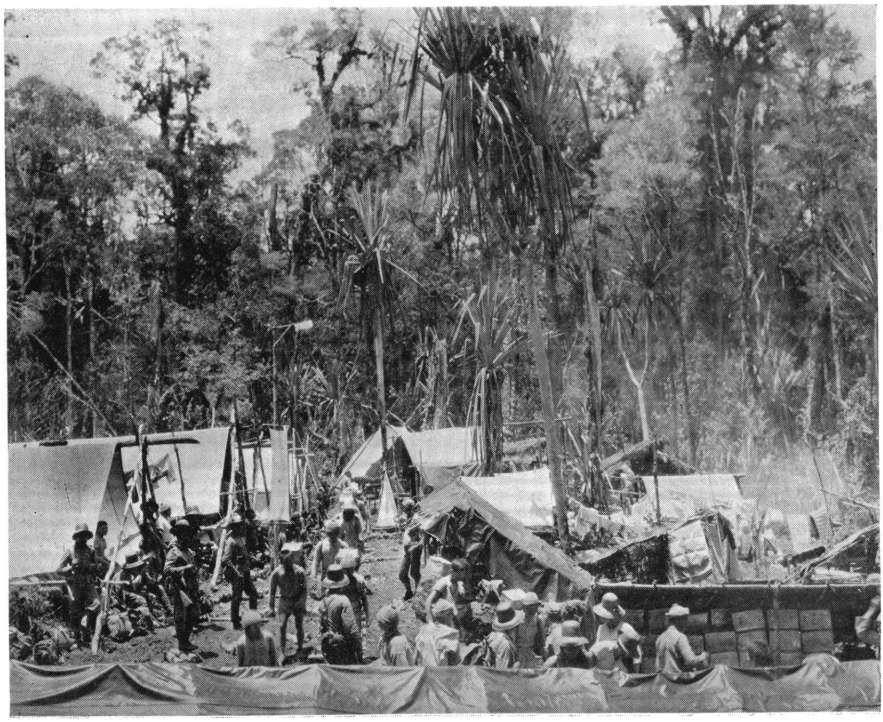

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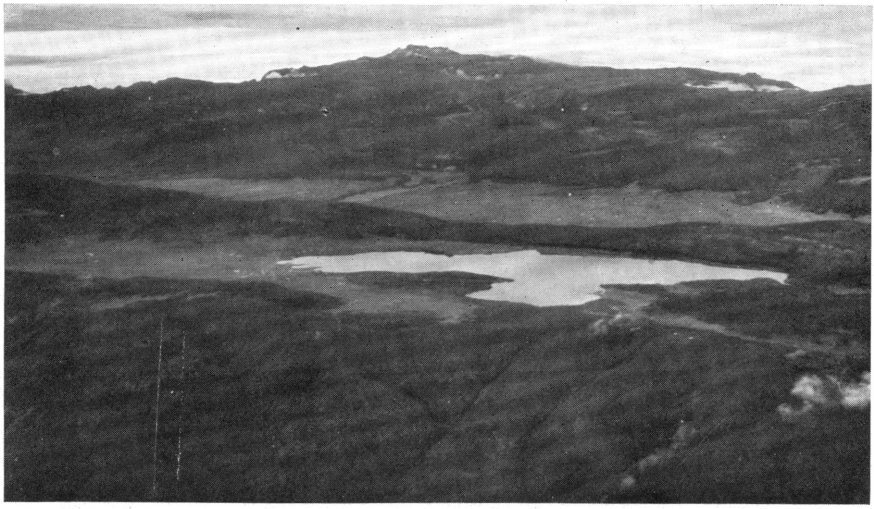
PLATE XXIII

Fig. 1. Aerial view of Lake Habbema showing the rim ridge of the Grand Valley in foreground, the broad grass plain in the Balim-Wamena Valley beyond the lake and the eastern end of the Nassau Range culminating in Mt. Wilhelmina.

Fig. 2. The "Guba" being unloaded at Lake Habbema. An open stand of *Libocedrus* is seen to the left. Tufts of *Isoetes* grow on the beach in foreground.



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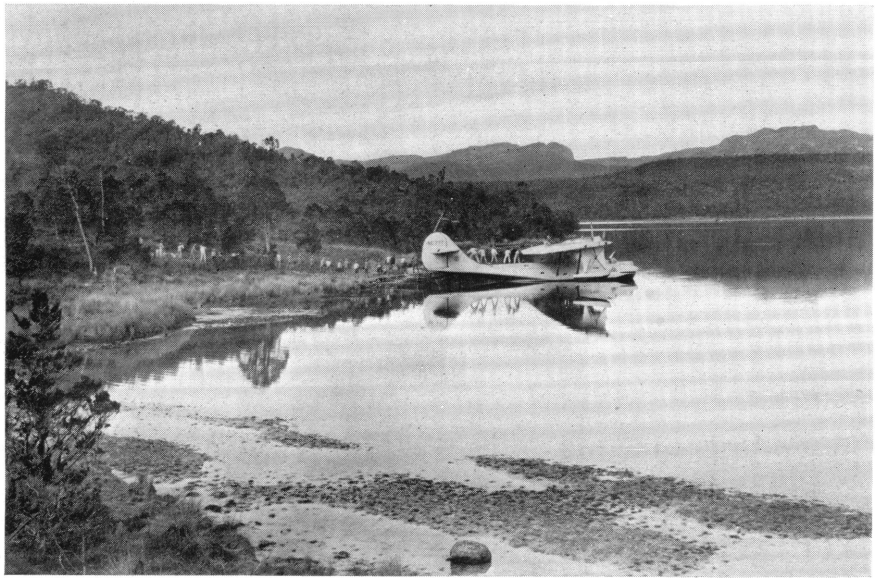

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PLATE XXIV

Fig. 1. Toxopeus arrives at Lake Habbema with equipment and supplies. Note the strips of sago thatch being passed hand to hand from the "Guba" to camp.

Fig. 2. Lake Habbema Camp, with heights of the Nassau Range in the distance. The vegetation in foregound consists of an open stand of *Libocedrus*, a low ericoid *Rhododendron*, clumps of *Gahnia* sp. and a ground cover of dwarf grasses and herbs.

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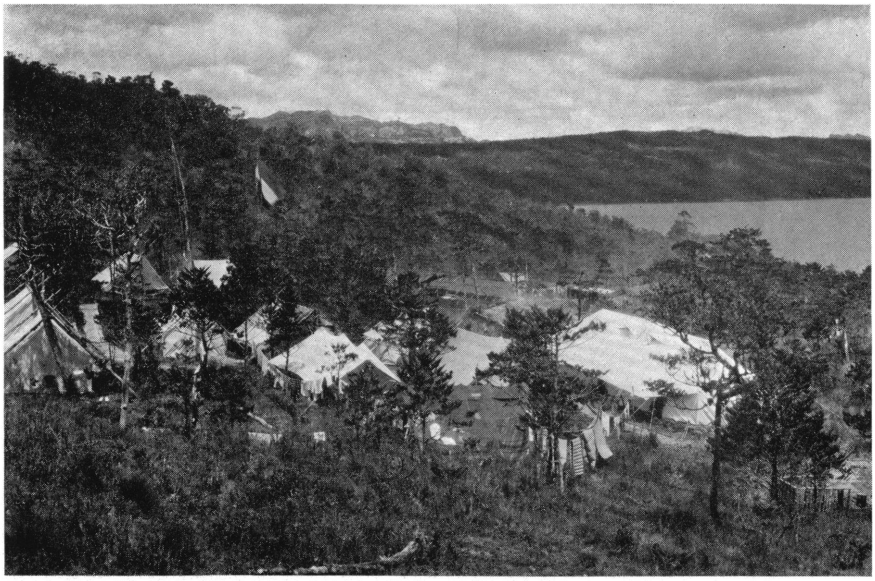

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PLATE XXV

Fig. 1. Richardson examining trays of bird and mammal skins drying in the sun at Lake Habbema Camp.

Fig. 2. Teerink (center) and Huls trading with native visitors at Lake Habbema Camp.

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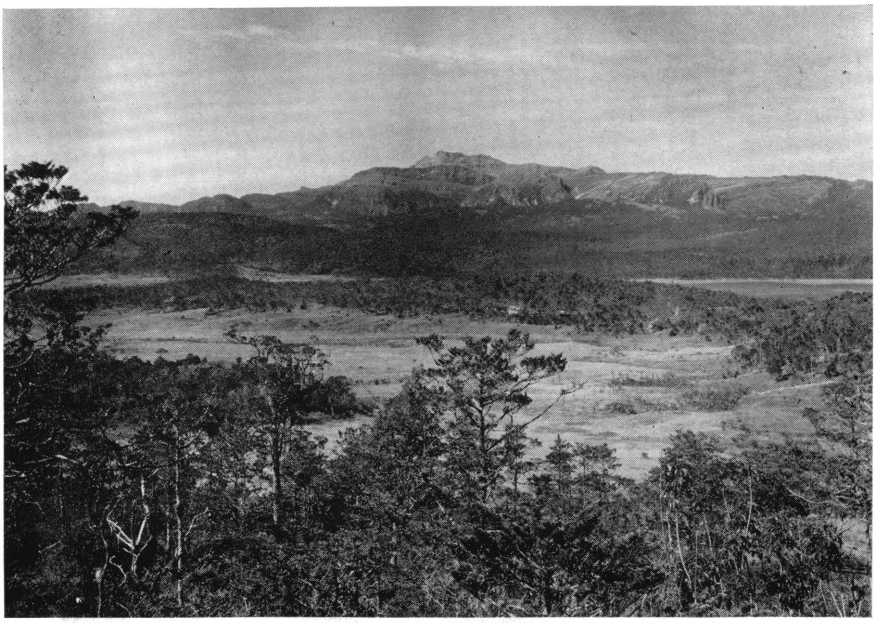
Plate XXVI

Fig. 1. Mt. Wilhelmina viewed over the expedition camp on Lake Habbema from an altitude of 3,265 meters on the rim ridge of the Grand Valley. *Podocarpus papuanus* and *Libocedrus* sp. rise above a patch of closed *Vaccinium* forest in the foreground. Treeferns mark the course of a stream in the grassy hollow.

Fig. 2. Grassland treeferns (*Cyathea tomentosissima*) growing on the banks of an entrenched stream, Lake Habbema.



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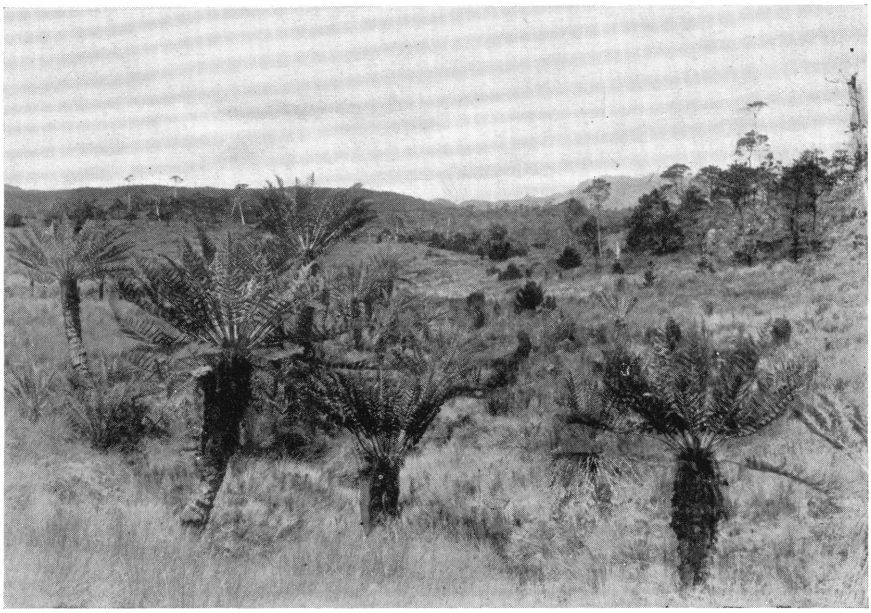

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PLATE XXVII

Fig. 1. Interior of closed subalpine (*Vaccinium*) forest, at 3,235 meters altitude, Lake Habbema. Hepatics constitute most of the bryophyte flora on trees and ground.

Fig. 2. Anthouse plants (*Myrmecodia*) epiphytic on *Podocarpus papuanus*, Lake Habbema. The shrubbery in lower foreground consists of *Rhododendron*, *Vaccinium* and *Coprosma* species, and *Pygeum retusum*.

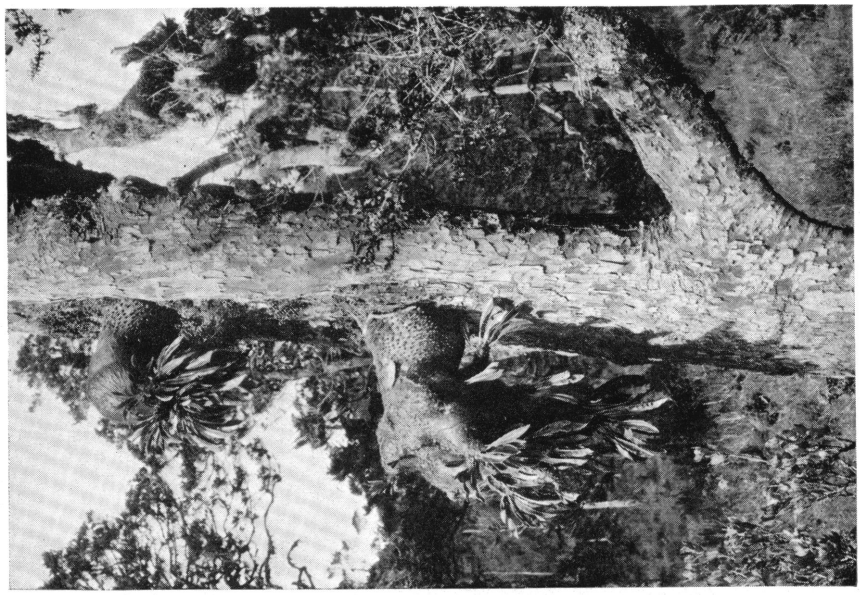

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PLATE XXVIII

Fig. 1. Open subalpine forest of *Podocarpus papuanus* and *Libocedrus* sp., developed on a south-facing slope at 3,265 meters, Lake Habbema. An ericoid *Rhododendron* supplies most of the dense undergrowth, while *Rapanea* sp. and *Pygeum retusum* form a low-tree thicket on left.

Fig. 2. The outlet stream of Lake Habbema, edged with tall *Scirpus* and *Carex* and containing quantities of *Potamogeton* sp.

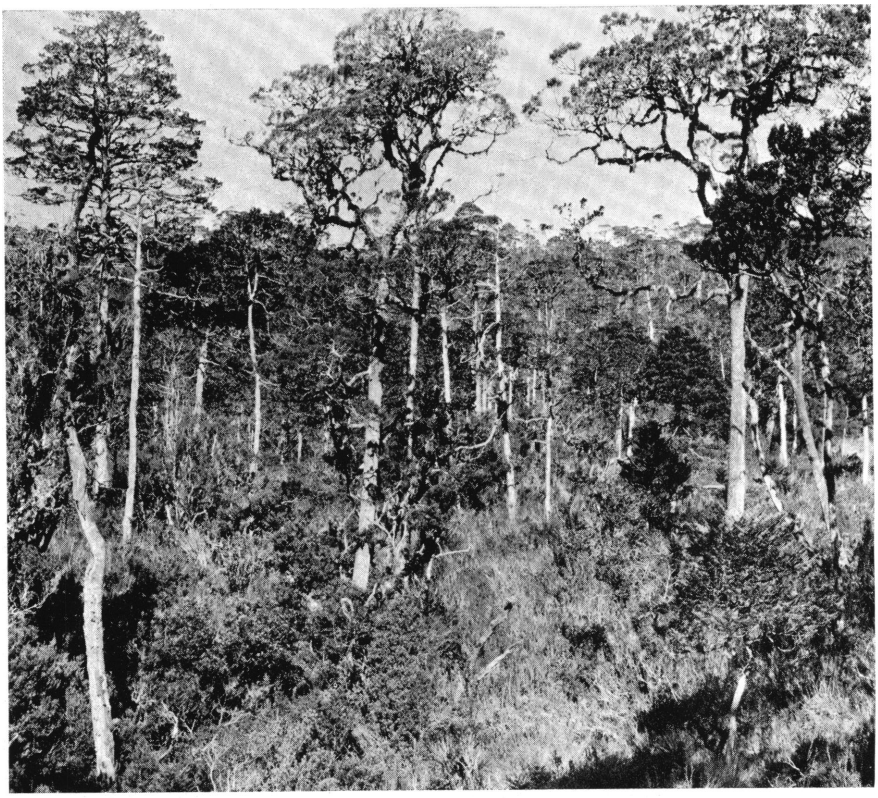

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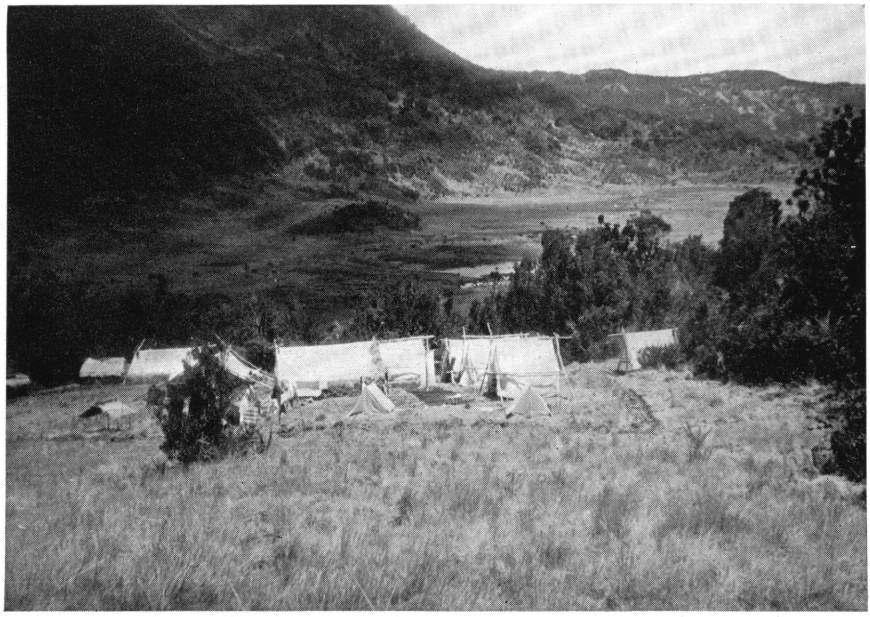
PLATE XXIX

Fig. 1. 3,560-meter Camp seven kilometers northeast of Wilhelmina-top. Umbrella trees (*Schefflera* sp.) conspicuous in closed subalpine forest on right.

Fig. 2. Richardson's Ambonese assistant, Marcus, at work in the preparations fly, 3,560-meter Camp.



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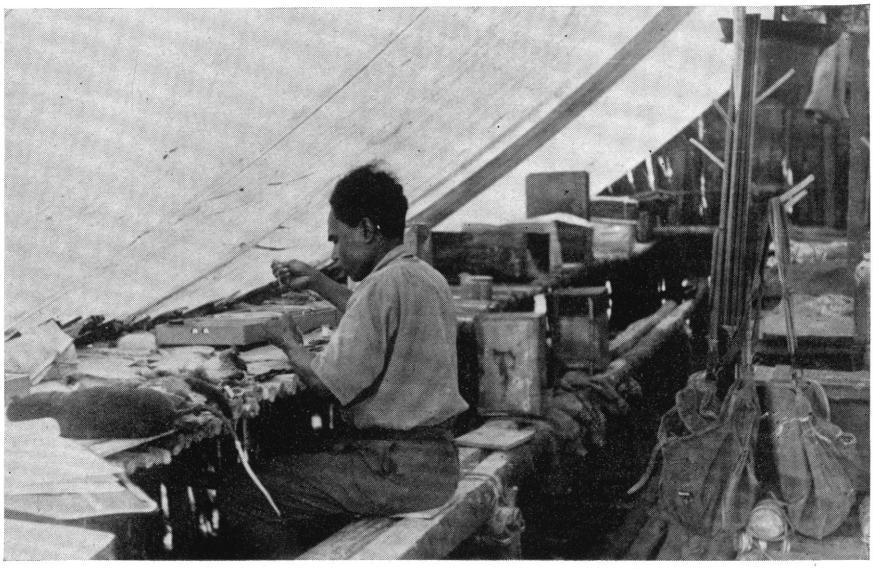

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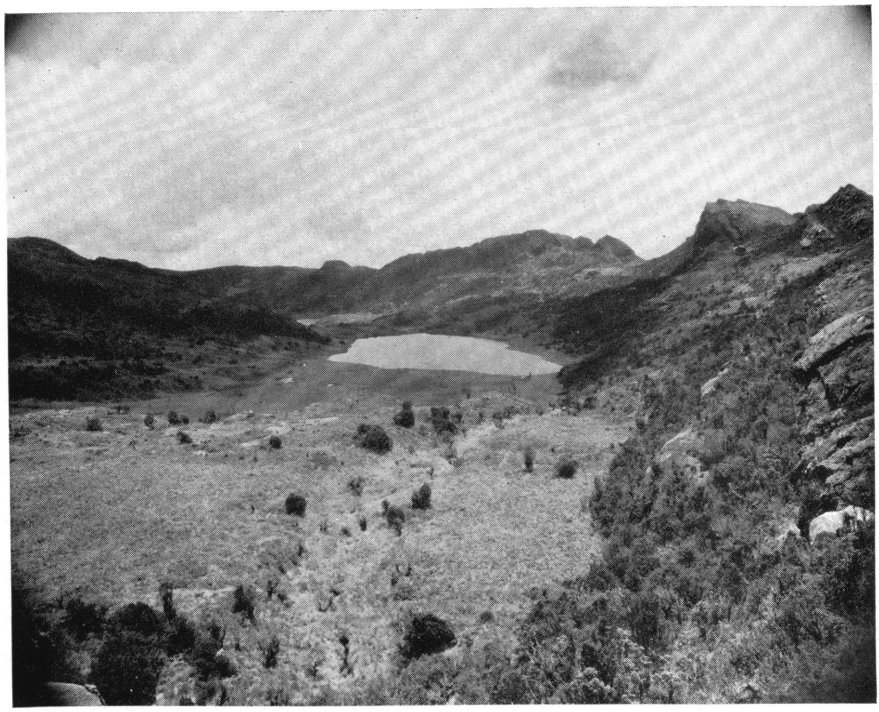
PLATE XXX

Fig. 1. The 3,650-meter lake viewed from an altitude of 3,800 meters about one kilometer east of Scree Valley Camp. The forest around the lake shows effects of disturbance by fire.

Fig. 2. 3,800-meter (Scree Valley) Camp two kilometers east of Mt. Wilhelmina summit.



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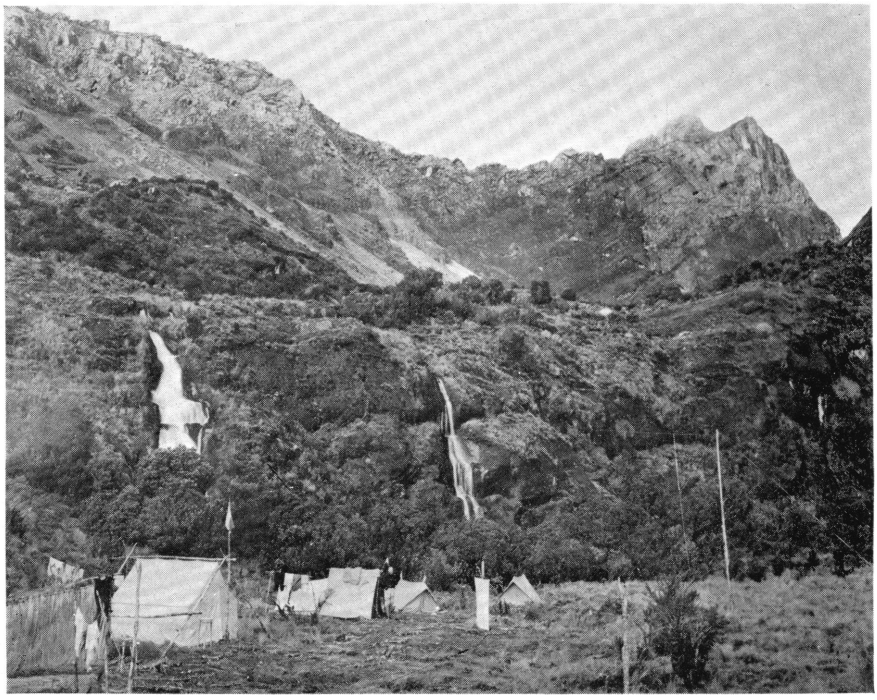

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PLATE XXXI

Fig. 1. Clumps of subalpine forest on a north-facing tussock-grass slope, at 3,900 meters altitude, in lower end of Scree Valley. *Coprosma* sp. (large shrub) and cushions of *Astelia* and mosses associated with the tussock-grass (*Deschampsia Klossii*). Trees chiefly *Vaccinium* sp.

Fig. 2. Interior of a strip of *Vaccinium-Rapanea* subalpine forest at 3,800 meters on the north slope of Mt. Wilhelmina. The massed filmy fern is *Meringium Forsteri; Styphelia nubicola* forms the inner part of the border shrubbery on left.

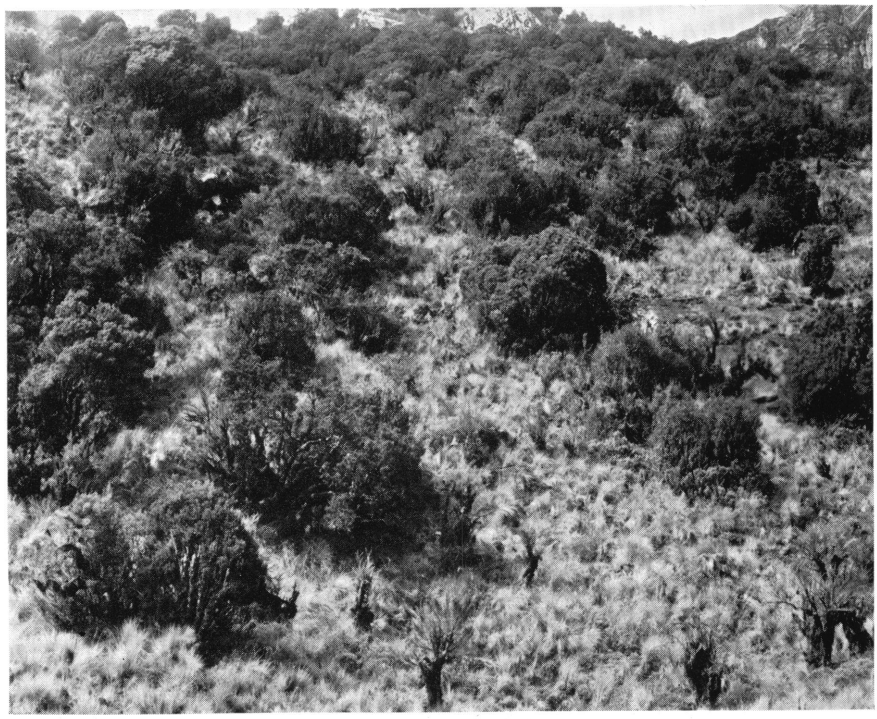

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PLATE XXXII

Tree limit in Scree Valley. Stunted examples of the highest-ranging trees, *Rapanea* and *Drimys*, form thickets with *Coprosma* and *Rhododendron* amongst the rocks in foreground. *Coprosma* extends up the tussock-grass slopes (left and center) to about 4,100 meters. Limestone summit ridge of Mt. Wilhelmina on left, sandstone false peak on right. Photographed from altitude of 3,880 meters.

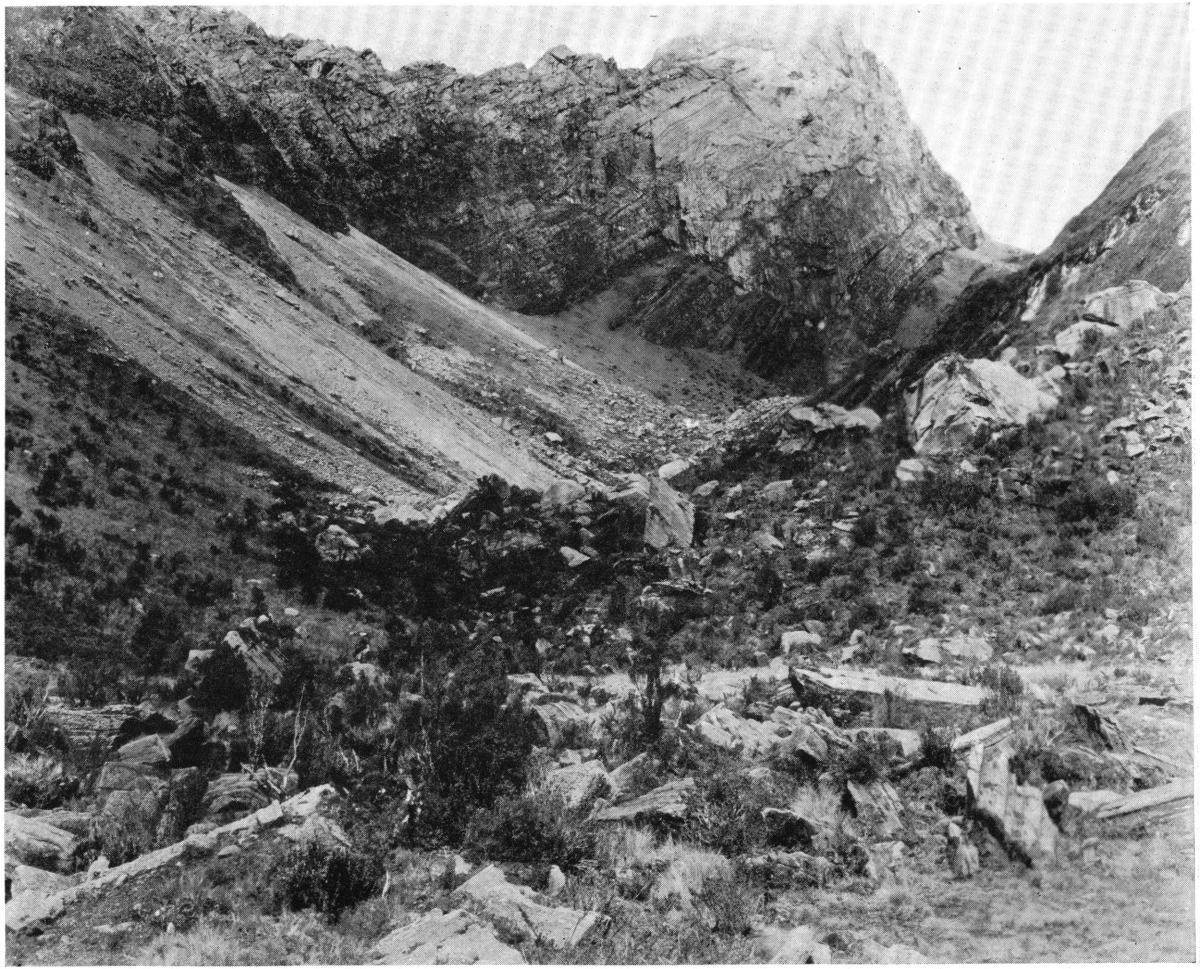

Plate XXXIII

A. —3,800-meter Camp.
B. —Route followed north of the peak.
C. —Probable site of Lorentz-van Nouhuys Vallei-bivak.
D. —Lake at 3,920 meters.
E. —Probable site of Lorentz-van Nouhuys Matigheids-bviak.
F. —Lakes at 4,150 meters.
G. —Route to 4,000-meter climbing camp, south of peak.
H. —Arrow points to site of 4,000-meter climbing camp, hidden in pocket.
I. —Route to 4,100-meter climbing camp.
J. —Saddle through which valley containing 4,100-meter climbing camp was reached.
K. —Snow cap on Mt. Wilhelmina.
L. —False peak.
M. —Lake (not visited).

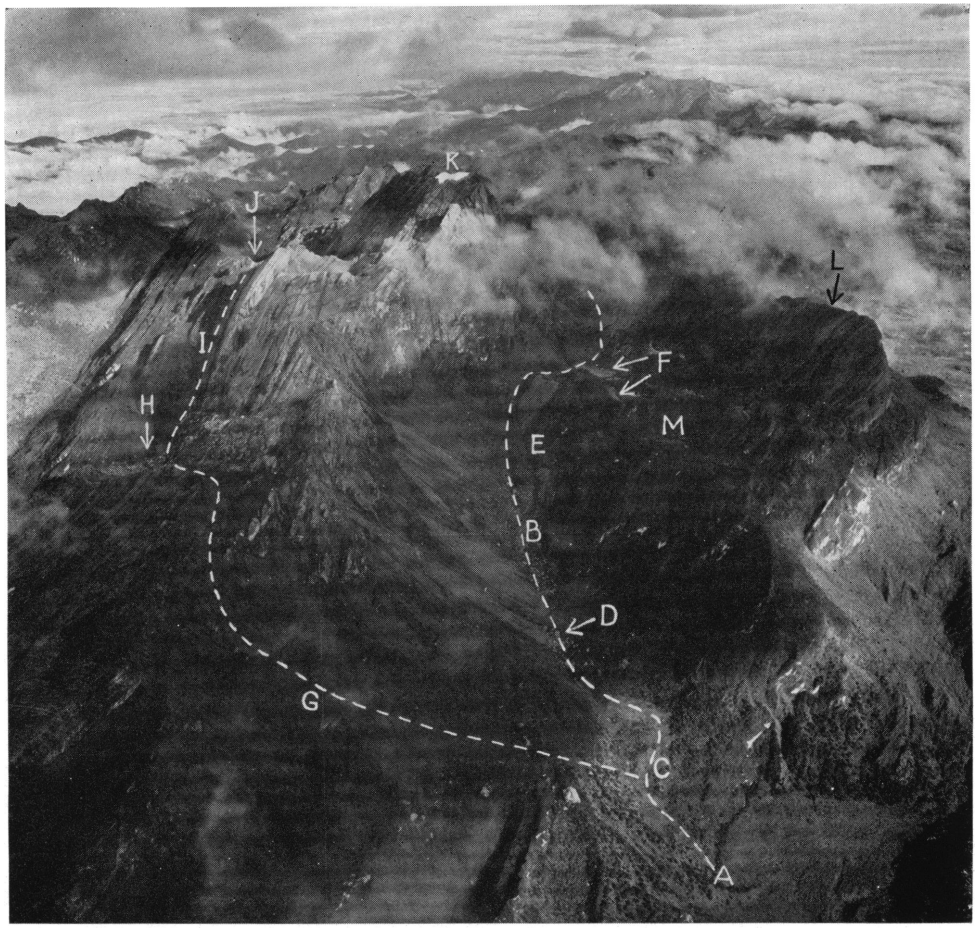
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PLATE XXXIV

A.—Route followed by climbing party September 24.
B.—Snow cap on Mt. Wilhelmina.


B
A

PLATE XXXV

A.—Arrow points in direction of 4,000-meter climbing camp.
B.—Route followed to valley in which was 4,100-meter climbing camp.
C.—Arrow points to site of 4,100-meter climbing camp hidden in valley.
D.—Route by which highest point, 4,500 meters, was reached.
E.—"X" marks highest point reached by expedition members, September 27.
F.—Arrow points to lake in valley, mentioned September 24 and 27.
G.—Snow cap on Mt. Wilhelmina.


G
E
D
C
F
B
A

Sketch Map of the patrols between Bernhard Camp and Lake Habbema. Taken from the Sketch Map of Capt. C.G.J. Teerink and Lieut. V.J.E.M van Arcken, as published in *Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap. Amsterdam. Series II, Vol. 56, No. 3. (May 1939)*