

THE KERAYAN-KALABIT HIGHLAND OF CENTRAL NORTHEAST BORNEO

WERNER F. SCHNEEBERGER

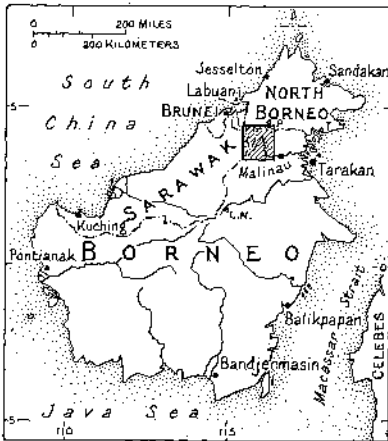


FIG. 1.—Location of the Kerayan-Kalabit highland of central northeast Borneo.

THE Kerayan-Kalabit highland in central northeast Borneo is so little known geographically¹ yet of such potential interest at this time as to warrant the publication of the following observations, fragmentary though they are. They were made on a visit to the region in 1939 in the course of a geological survey for the Batavian Oil Company (Bataafsche Petroleum Maatschappij).

In 1934-1935 the region was cursorily mapped by the Netherlands Indies Forest Department on a scale of 1:200,000. Although the map is

practically without astronomic control, with the survey net rather widely spaced and contouring largely sketched, it proved exceptionally useful. During our survey all major streams were resurveyed (compass and range finder, traverses over land by compass and chain) and adjusted to the Forest Department map, except for the Kalabit country in upper Sarawak and the upper Baram River, for which our own and some earlier observations by geologists of Sarawak Oilfields Ltd. were used.

RIVER HIGHWAYS

In undeveloped country such as this the rivers are the main lines of access to the interior. In the lower reaches traveling is usually adapted to the tides, unless one has an outboard motor or a motorboat to make one

¹ Very little has been published on the region, though there are numerous references to it in such publications as J. Mallinkrodt's "Het adatrecht van Borneo" (2 vols., Leiden, 1928), Charles Hose and William McDougall's "The Pagan Tribes of Borneo" (2 vols., London, 1912), and H. Ling Roth's "The Natives of Sarawak and British North Borneo" (2 vols., London, 1896). The most recent contributions are two articles in the *Sarawak Museum Journal* for July, 1937: "Teknonymy and Other Customs among the Kayans, Kenyahs, Kelamantans and Others," by F. H. Pollard and E. Banks (pp. 395-409); and "Some Megalithic Remains from the Kelabit Country in Sarawak, With Some Notes on the Kelabits Themselves," by E. Banks (pp. 411-437).

Of several unpublished memoranda by Dutch government officials, we had the opportunity of consulting the "Memoir on the Sub-Division Tjidoengsche Landen" by Sitsen, written possibly in the late 1920's.

independent of the tidal currents. But even then traveling time is influenced considerably, and gains or losses of 50 per cent are not unusual. The duration of a trip is expressed by the natives in "tides" (*pasang*); i.e. it takes so many tides to travel, for example, from Tarakan Island to Malinau. Naturally, only the flood tides are meant, the boat being anchored or moored during the ebb.

Above the tidal margin up to and beyond the rapids navigability depends on the weather or, rather, the water level. The section between the tidal margin and the first rapids is generally characterized by large gravel deposits, either on the slipoff side of the river or as islands in midstream. The current is swift, and during flood the gravel banks are difficult to navigate. Moreover, the water level is too high for the boatmen to snake along the riverbank, taking advantage of the backwash and pulling the boats with hooks fastened to the long poles; for the overhanging trees touch the water or are partly submerged. In the rapids themselves the situation is different; the most dangerous ones—with huge blocks strewn over the entire width of the river bed—in general are more readily navigated during flood than during normal water level. But others may be entirely impassable on account of whirlpools or sheer rock walls on both sides. Traveling in rapids country during floods is always hazardous. It may mean waiting in a confined spot for days, if not weeks. The natives usually have floodmarks above or below the rapids, such as a particular rock or gravel deposit, which must emerge before the rapids can be crossed. Under favorable conditions the proportion of travel time for ascending and descending the same river is about 3 : 1, but it may be as much as 6 : 1. Six weeks to two months is required for a round trip to the Kerayan-Kalabit highland.

LIMITS OF THE REGION









This highland, comprising the upper drainage basins of the Kerayan, Baram, Tuto, Limbang, and Trusan Rivers and their tributaries, is an upland of subdued relief separated by deeply dissected north-south ranges into several longitudinal valleys or basins. It measures about 57 miles long and 37 miles wide and is a remnant of a once wide peneplane, relics of which are still preserved in other parts of the island, especially in the interior of British North Borneo.

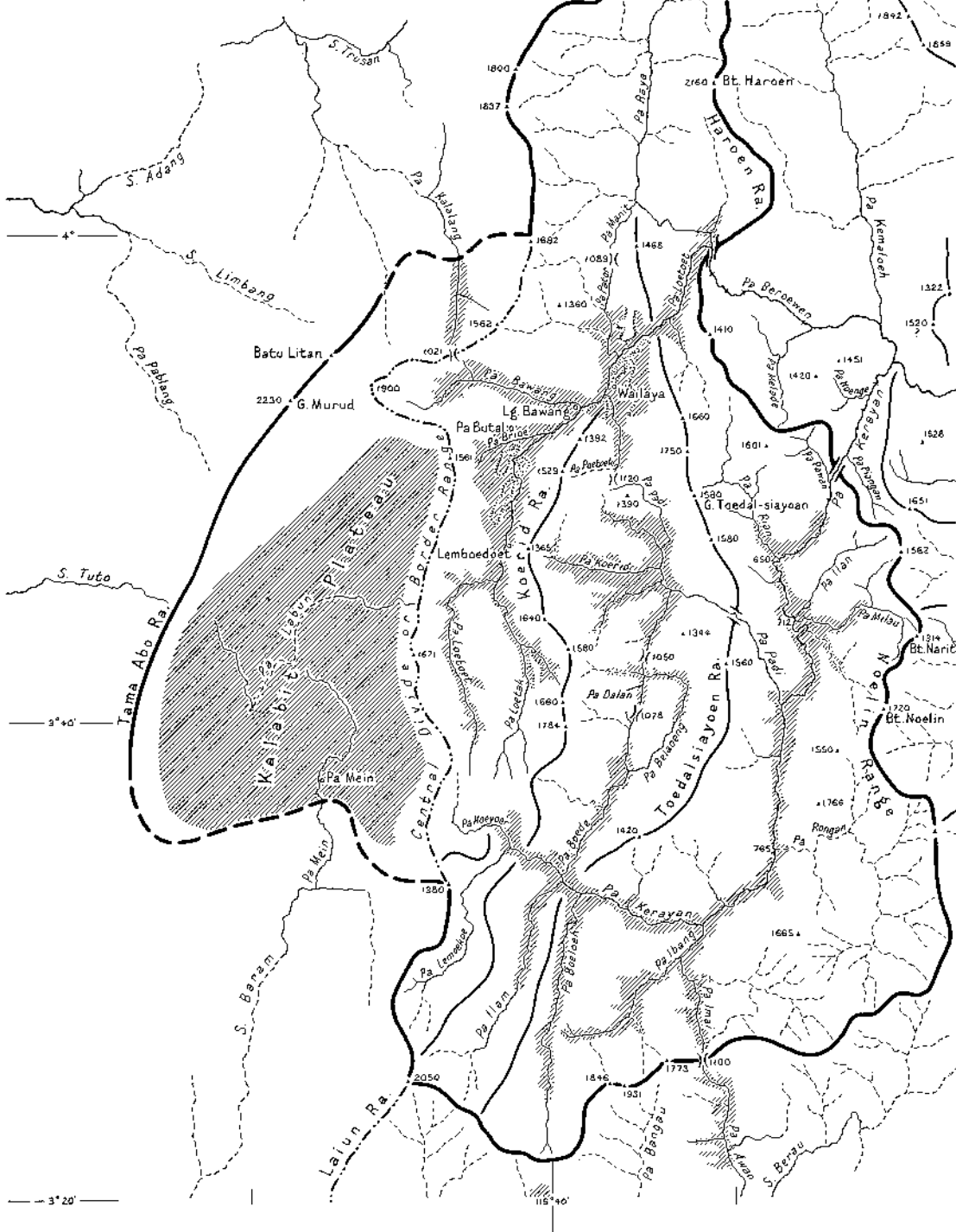
Most of the ranges that border the highland on all sides and divide it into basins do not have a geographical name. Individual peaks or prominent mountains, however, are generally known to the natives under local names, and in Sarawak most of the more prominent ranges bear recognized

MORPHOLOGICAL MAP OF THE KERAYAN-KALABIT HIGHLAND, BORNEO, AND ADJACENT AREAS.

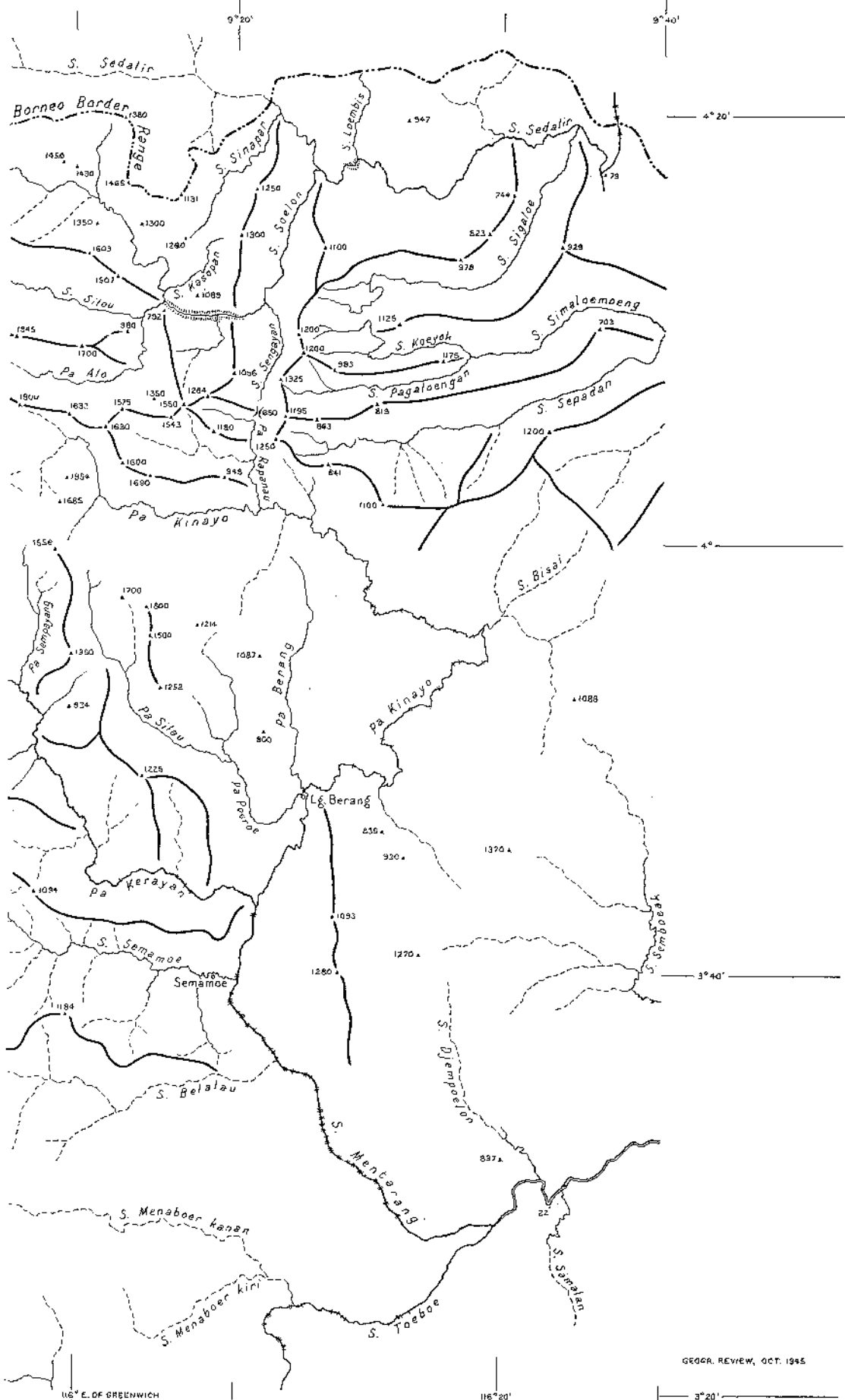
4° 20'

0 5 10 MILES
0 5 10 KILOMETERS

-  Limits of Kerayan-Kalabit Highland
-  Divide; mountain range
-  Mountain top with spotheight in meters
-  River with rapids and waterfall
-  Alluvial plains
-  River capture (break through)
-  Wind gap with height
-  Village
- Soengei (S)* River
- Long (Lg.)* Rivermouth
- Pa* River, creek
- Bookit (Bt.)* Mountain
- Gnoeng (G.)* Mountain



3° 20'



GDGA. REVIEW, OCT. 1945

116° E. OF GREENWICH

116°20'

3°20'



FIG. 3—The Loetoe basin at the junction (left) of the Loetoe and Brice Rivers looking south. Mature landscape; rivers meandering, not deeply incised. Mountain slopes, largely deforested, are covered with shrubs and bracken; extensive rice fields with island of quartz sand terraces. (Photograph by Dr. R. Baechlin.)



FIG. 4 (left)—Poetock valley near junction with Loetoe. Abandoned rice fields in valley bottom, now largely occupied by grass swamps.



FIG. 5 (right)—Loetoe basin. Extensive rice fields on alluvial flats surrounded by low, deeply-eroded mountains.

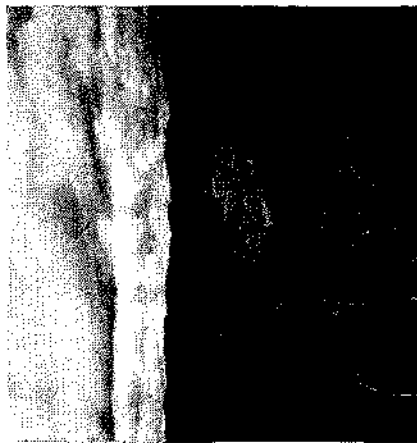


FIG. 6 (left)—Poetock valley looking north from the pass leading to the Pa Pad basin, Loetoe valley in background.



FIG. 7 (right)—Loetoe valley looking west from pass over Koerid Range. Rice fields and village of Lemboetoe. Central Divide in the background with Mt. Murrud beyond at right.

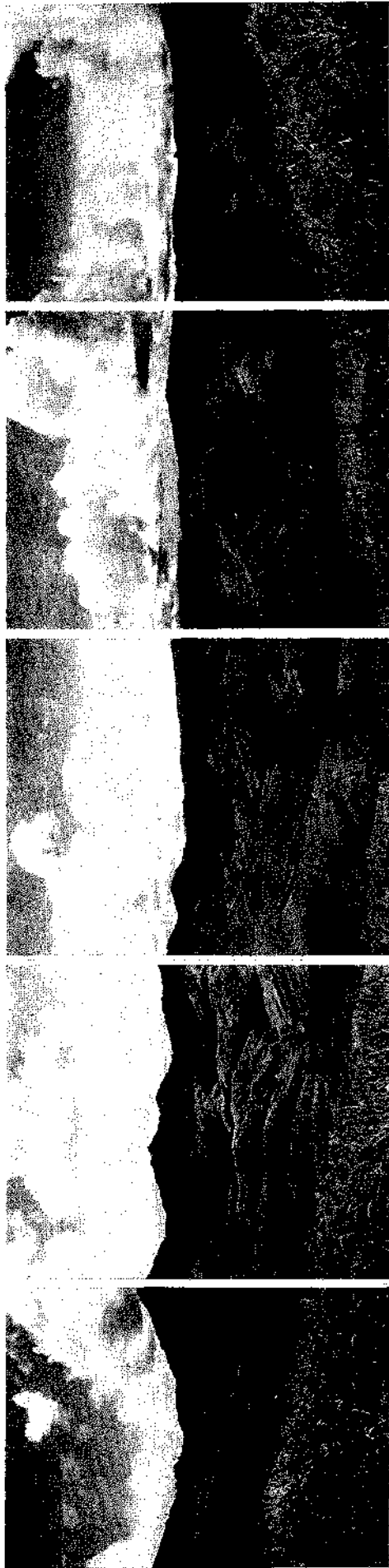


FIG. 8—Upper Bahau country to the south of the Kerayan-Kalabit plateau. Largely deforested through clearing and burning by once numerous population; now largely uninhabited, covered by lalang grass, excepting on the highest slopes and along watercourses; active soil erosion.



FIG. 9 (left)—Semamoe valley, looking east from Noelin range. Area of rejuvenated erosion.
 FIG. 10 (right)—Youthful landscape in the upper Toeboe, tributary of the Mentarang. Steep, V-shaped valleys; remnants of earlier erosion cycle are preserved as shoulders.

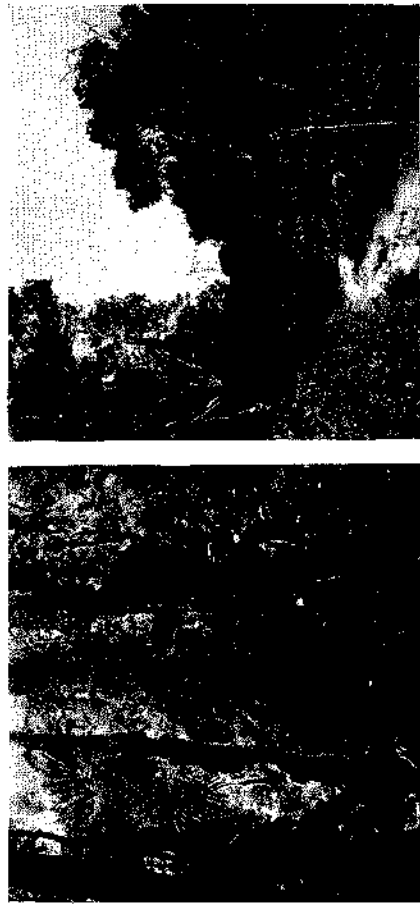


FIG. 11 (left)—Moss forest at an elevation of 5500 feet on the Central Divide between the Barau and Baram Rivers.
 FIG. 12 (right)—Vegetation of stunted trees and shrubs on terrace within the Loetotet basin.

geographical names. To facilitate reference, we have tentatively introduced names derived from the highest or most conspicuous mountain within a range.

On the east the highland is bordered by the rather irregular Noelin-Haroen Range, with average heights of 1500 meters (4900 feet) in the southern part but increasing toward the north (Boekit Haroen, 2160 meters). At some time it must have formed the watershed between the Mentarang and the rivers of the highland, but it is breached now by the Kerayan River and, farther north, by its tributary the Beroewen. The breaches seem to be of comparatively recent date. On the south the highland is bounded by a rugged mountain range (average height, 1800 meters) that forms the divide between the Kerayan and the Bahau. The western and northwestern margin is formed by the central divide, the Laiun Range according to Banks, a steep and deeply dissected range on the western slope of which the Baram River originates, and by the imposing Tama Abo or Pamabo Range, culminating in the Murud peak, 2195 meters (7200 feet) high.²

Three main ranges divide the highland into four valleys: the Toedalsiayoen Range, which separates the middle Kerayan Valley from the Koerid-Pa Padi basin; the Koerid Range, which separates this basin from the Loetoet or Meloetoet basin; and the Border Range, the central divide, which separates the Loetoet basin from the Kalabit plateau. It is interesting to note that the central divide does not coincide with either of the higher ranges, Tama Abo and Toedalsiayoen, but is formed by a rather low range, which in the headwaters of the Kerayan is a complex of somewhat irregular hills. Outside the highland the central divide is a high and rugged range.

A MATURE LANDSCAPE

The mature aspect of the landscape is obvious: the mountain ranges have been worn down to sharp ridges with undulating crest lines. This is especially the case with the secondary divides within the basins, which are built up of somewhat softer material and consequently have been more affected by erosion. Knife-edged crests and sharp spurs, separating steep, deeply incised gullies, are the most conspicuous features. In some places the steep mountain slopes meet the alluvial flats in a sharp line, but elsewhere a zone of foothills may intervene. The valleys are wide and flat or gently rolling, with extensive complexes of irrigated rice fields. The rivers meander sluggishly over the whole width of the valley flat, frequently changing

² See Eric Mjöberg: An Expedition to the Kalabit Country and Mt. Murud, Sarawak, *Geogr. Rev.*, Vol. 15, 1925, pp. 411-427.

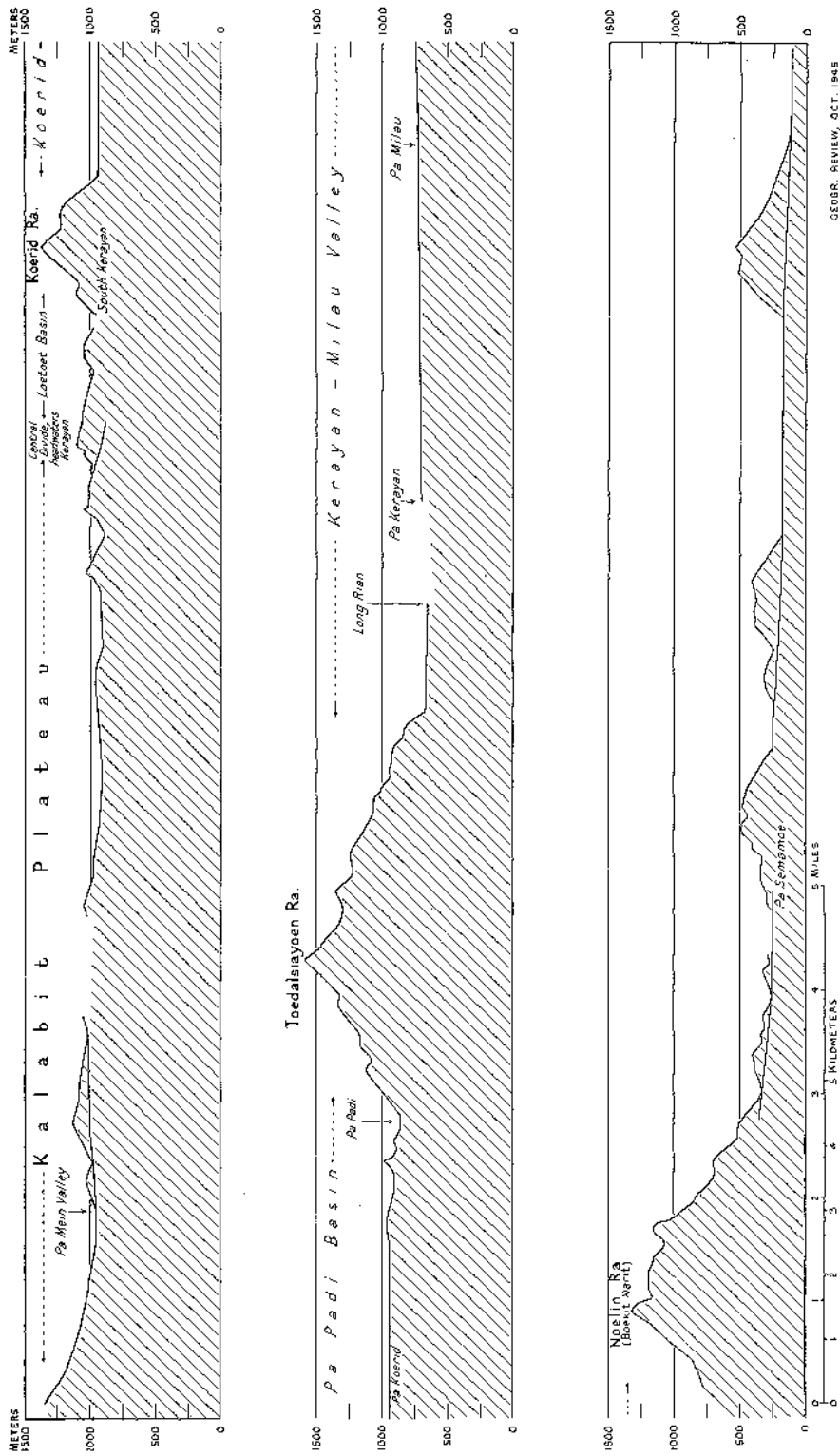
course; in fact, during heavy rains the whole valley bottom may be inundated, except for some low rises of white quartz sand. This is especially the case in westernmost Kerayan and the Kalabit plateau, where shallow dug-outs without sideboards are used by the native population.

In the valleys of the Pa Bawang, the Loetoet, the Labun, and the Kalalang, and especially in the wide plains around Wailaya, there are extensive accumulation terraces supporting only a thin layer of soil, which rests on white, leached quartz sand. Exposures in gullies show a horizon of concretionary ironstone at 8-10 feet below the surface, the concentrated ferrisolutions, leached out from the quartz sand and precipitated near the groundwater level. These terraces support a poor vegetation of hardwood shrubs with leathery leaves, bracken, and lalang grass. In shallow, poorly drained depressions grows a lush vegetation of reeds and sphagnum moss, interspersed with abundant nepenthes, either ground forms with large, mug-shaped pitchers or climbing forms with long and slender ones. The stagnant water in these swamps has a characteristic tea color, due to humic acids. It is, however, quite tasteless and potable.

The silting up of the valleys is obviously proceeding rapidly, largely on account of the extensive deforestation by the native population. The lower mountain slopes are stripped of much of their topsoil, and the subsoil, a heavy sandy loam, supports only a vegetation of stunted shrubs and bracken.

EROSION

Without accurate height control a correlation of the various, clearly recognizable erosion levels is not feasible and has not been attempted. Three such levels, however, are clearly distinguishable in a cross section (Fig. 12), one at about 1250 meters in the form of shoulders in the Koerid, Toedalsiayoen, and Noelin Ranges, another at 900-950 meters, represented by the alluvial flats, in the Kalabit plateau and the Loetoet and Koerid basins, and a level of about 700 meters in the middle Kerayan Valley. Most of the valleys of the highland—for instance, the Labun, Mein, Loetoet, and Koerid Valleys—are coincident with the second level, which is recognizable also in the southern Kerayan country, in the Pa Imai and Ibang Valleys and, south of the divide, in the upper Pa Awan, a tributary of the Bahau. The Kerayan Valley is lower; only in its upper reaches does it approach 900 meters (Pa Koeyoer, 883 meters). At Long (=mouth) Rongan it is 765 meters above sea level, at Long Milau 712 meters, and at Long Rian 650 meters. Downstream from the mouth of the Rian, the Kerayan shows several small rapids, which gradually become more numerous where the river breaks through



GEOGR. REVIEW, OCT. 1945

FIG. 13—Composite cross section through the Kerayan-Kalabit Highland and the adjacent area to the east.

the Noelin Range. From there on it has all the appearance of a young or rejuvenated river; the gradient is comparatively steep and the valley narrow and V-shaped through most of its length.

Above the break-through the Kerayan and its tributaries show a distinct anomaly in the drainage pattern. All the tributaries—for instance, the Pawan, the Rian, the Ilau, the Milau, and the Padi—join the main river at an angle that suggests a southward course; this may actually have been the case during an earlier cycle of erosion. The Imai and Awan Valleys with the wind gap at 1100 meters between them may be remnants of an ancient Kerayan valley through which the eastern part of the highland was drained into the Bahau River.

RIVER CAPTURES

Vertical uplift affecting the whole Kerayan-Kalabit highland seems to be the cause of the rejuvenation of the streams. Reactivated erosion by the Mentarang, the collecting river east of the highland, caused one of its tributaries gradually to cut through the Noelin Range and to capture the Pawan, the highest tributary of the southward-flowing Kerayan. Further differential vertical movement may have resulted in a gentle northward tilting of the highland; this in its turn caused an interruption of the southward course and finally a reversal of the whole river system, which then found an outlet through the gap in the Noelin Range formed by the capture of the Pawan. Retrogressive erosion gradually lowered the level of the upper Kerayan Valley, but the waterfall line has not progressed far beyond the old divide of the Noelin Range. The lowering of this level may have been sufficient to induce the tributary Pa Padi to cut retrogressively through the Toedalsiyoen Range and to capture the headwaters of a river which before flowed southward through the wide longitudinal valley between the Koerid-Pa Padi basin and the upper reaches of the Kerayan, now occupied by the misfits Pa Dalan and Pa Boede.

The acquisition of so large a volume of water through the capture of the middle Kerayan naturally increased the erosional capacity of the captor downstream from the point of capture and resulted in a lowering of the erosion level here. Reactivation of the tributaries followed, especially of the largest, the Beroewen, and a new capture was effected, that of the Pa Loetoet-Pa Raya system. The Pa Raya originates on the eastern slopes of the central divide and flows southward in a deeply incised strike valley until, after being joined by the Manit, it suddenly breaks through a sandstone range in a narrow canyon and joins with the Pa Loetoet. Beyond the

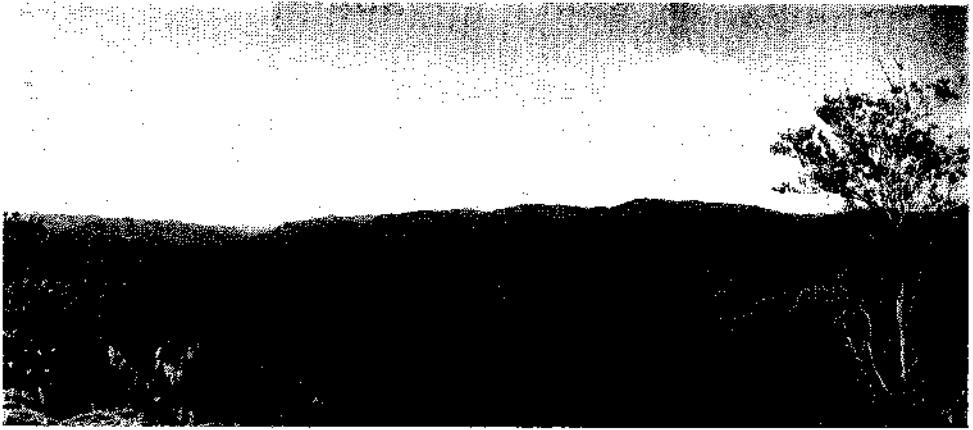


FIG. 14—Koerid-Pa Padi basin seen from the western slope of the Toedalsianyoen Range. In left background abandoned valley with wind gap. The Padi now breaks through the Toedalsianyoen Range (in left middle distance). Mature landscape.

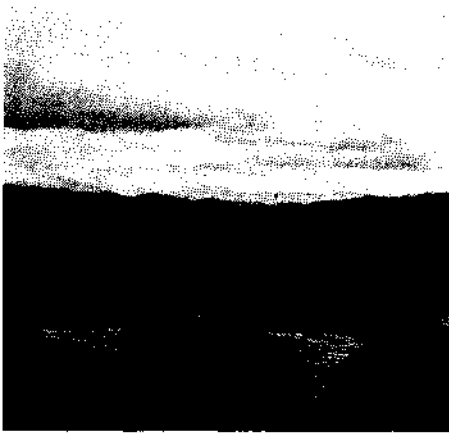


FIG. 15 (left)—Upper Pa Padi; valley. Steep, dissected and deforested slopes; alluvial flats with rice fields.



FIG. 16 (right)—Koerid valley. Steep, deforested ridge; village on spur; bamboo grove; rice fields.



FIG. 17 (left)—Paddy fields in the Pa Bawang valley. (Photograph by Lt. J. Eekhof, R. N. N.)



FIG. 18 (right)—Koerid valley and range looking west. Swampy, meandering creek in valley bottom.



FIG. 19 (left)—Irrigated rice fields in the Pa Dalan valley.



FIG. 20 (right)—Looking up the Pa Ibang to the divide between the Kerayan and Bahau basins. Swamp and meadow on the alluvial flats. (Photograph by Lt. J. Eekhof.)



FIG. 21 (left)—Middle Kerayan River in flood; crude dugout.



FIG. 22 (right)—Middle Kerayan valley. Rice fields on the farther bank; dugouts in foreground.

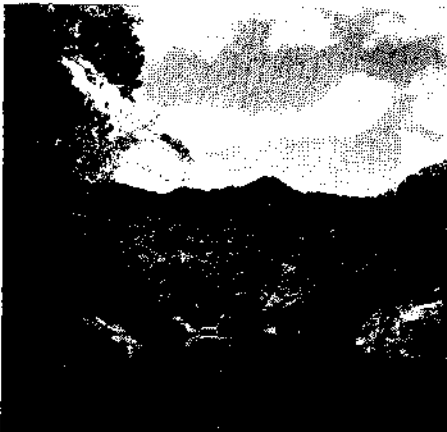


FIG. 23 (left)—Middle Kerayan near junction with the Pa Milau. Toedalsianyoen Range in background.



FIG. 24 (right)—Toedalsianyoen Range seen from the northwest.

junction the river, known as the Beroewen, enters a narrow gorge, called Lobang Kwor Asai by the natives. Downstream of this spectacular gorge the Beroewen Valley is narrow and deeply incised in steep sandstone ridges, with numerous waterfalls and rapids. The river has all the characteristics of a young or rejuvenated stream, and its break-through at Lobang Kwor Asai must be of comparatively recent date. It is probable that through this gap a lake that had occupied the Loetoet Valley and the basins of Wailaya and Poetoeck was emptied. During heavy rains the drainage capacity of the gorge is insufficient, and the Loetoet Valley is extensively inundated. This apparently is the reason for a native legend regarding the origin of the Beroewen gorge. It relates briefly that the mighty chief Kwor Asai, for the benefit of his people, who were short of ground for rice fields because of the great lake occupying the valleys, cleft the rock with one blow of his sword. The lake emptied itself through the gap, and the people began to make paddy fields in the wide flats that emerged from the water.

River capture is apparently not an uncommon feature in Borneo, though little attention has been paid to this phenomenon so far. Professor Max Reinhard³ has described well an instance from British North Borneo, where the Tambalunan River has been captured by a tributary of the Sarudong and breaks through a high range in a canyon, the Giram Besar, with numerous waterfalls and rapids. Large-scale captures apparently have also occurred in the Segama river system in the Dent Peninsula of British North Borneo.⁴

The same mature stage of the landscape observed in the Kerayan country also prevails on the Kalabit plateau, west of the central divide, where some parts suggest an even more advanced stage. The alluvial plains are broader, and the valleys have rather the appearance of wide basins. This is striking when seen from the Tama Abo Range to the west. The hills bordering the plains, which are largely broken up into irrigated rice fields, rise abruptly from the flat surface "almost as if it were water, which it doubtless once was and as much of it occasionally now is in very wet weather."⁵

To the south the plateau gradually loses its characteristics as it becomes more and more affected by the new erosional cycle. The rivers, which meander over wide alluvial plains in their upper reaches, gradually become more deeply incised until they reach the Baram, which as a young stream rushes from the central divide in a gorgelike, rather inaccessible valley. The footpath leading southward into the middle Baram Valley does not follow

³ Contributions to the Physiography and Geology of the South-East Coast of British North Borneo, *Geogr. Journ.*, Vol. 63, 1924, pp. 121-134.

⁴ Communication from Dr. E. Wenk, Basel.

⁵ Banks, *op. cit.*, p. 425.

the river itself but ascends into the high ranges to the east until it rejoins the river at its junction with the tributary Malong. Just below this junction the Baram crosses a rugged sandstone range in a series of deep gorges 10 miles long to Lioh Mato, where the valley gradually begins to widen. The Tuto, Limbang, and Trusan Rivers, radiating to the west and northwest, are young, their valleys narrow and steep, though some of their tributaries are still unaffected by the rejuvenated erosion in their upper reaches.

The same juvenile stage of erosion is apparent to the northeast and east of the highland; i.e. in the Sembakong, Mentarang, and Toeboe river systems. The first two rivers show a well marked asymmetry in drainage pattern, most of the larger tributaries originating in the mountainous areas west of the main river. Moreover, all of them—for instance, the Sepadan, the Simaloemoeng, the Sigaloe, and the Sedalir (affluents of the Sembakong) and the Kinayo, the Silau, the Kerayan, the Semamoe, and the Belalau (affluents of the Mentarang)—are incised in deep, V-shaped valleys with innumerable waterfalls that cut at right angles across the prevailing north-south strike. The watersheds between these tributaries are high (as much as 760 meters), rugged, and steep ridges, which, however, have preserved on their slopes remains of earlier erosion levels in the form of terrace remnants. Spurs between secondary creeks are short and end in steep triangular facets toward the main valley. The persistence of these rivers in cutting across the strike of resistant and practically vertical strata suggests that they are superimposed on the present surface from an eastward-tilted plane in connection with the vertical uplift of the Kerayan-Kalabit highland.

Differential vertical uplift apparently is the cause of the young aspect of the part of the highland north of the Beroewen River. Here the two chief rivers, the Raya and the Kemaloech, originating on the central divide, follow a longitudinal course in remarkably straight valleys deeply incised in comparatively weak rocks. The intervening country is one of the most rugged mountain complexes in this part of Borneo.

ANCIENT DRAINAGE PATTERNS

Reconstruction of the ancient drainage pattern is almost impossible because of the many vertical movements that seem to have affected the highland, not always as a whole but differentially. However, anomalous arrangements of the drainage patterns and a series of wind gaps at 1000–1100 meters give some clues. There is little doubt, for instance, that before its capture the Kerayan River had a southerly course west of the Noelin Range and was a tributary of the Bahau. The uppermost parts of the Pa

Padi and the Pa Koerid very likely at one time formed the headwaters of a river flowing southward in the now abandoned Pa Dalan-Pa Boede Valley. The capture of the Dalan by the Belaoeng is an interesting but minor feature. The upper Labun may once have formed part of the Loetoet river system: there is a conspicuous gap in the central divide just where the Loetoet turns to the east to join the Loetak, and it is likely that the Labun was captured and diverted to the south by another stream on the Kalabit plateau. The Loetoet itself, before its capture by the Beroewen, may have had a northerly course along the valley now occupied by the Pator, the Mani, and the Raya and may have been a tributary of the Padas River until the area around the Padas peak was uplifted to its present height by a movement that not only reversed but also rejuvenated this part of the river.

Repeated uplift of the peneplaned surface was obviously the cause of its final obliteration by the retrogressive erosion of the rejuvenated streams along its margins.

A HUMID CLIMATE

The abundant rainfall and the dense forest that covers practically the whole area are the causes of the high humidity of the atmosphere. The Malaysian type of rainfall regime⁶—two monsoons (northeast and southwest) and changes between them, making four seasons—seems to prevail in northeast Borneo. Although there are periods of heavier rain, there is no dry season; rain falls throughout the year. Unfortunately, no records are available for the highland area. Tarakan, off the eastern seaboard, has a mean annual rainfall of about 150 inches; Malinau, up the Sesasjap, has rather less.⁷ Despite the altitude of the highland, its rainfall may not greatly exceed, if it does exceed, these figures, because of the screen of high bordering ranges. Evidence of the screening effect is seen in the distribution of the moss forest that clothes the mountains above 1460 meters (4800 feet): it extends farther down and is better developed on the outer side of the bordering ranges than on their inner slopes. The nearest interior stations

⁶ Compare the section on climate in E. H. G. Dobby: Singapore: Town and Country, *Geogr. Rev.*, Vol. 30, 1940, pp. 84-109. The general situation of Borneo as regards the wind regime may be seen on the maps in Mr. Dobby's "Winds and Fronts over Southeast Asia," *ibid.*, Vol. 35, 1945, pp. 204-218. A study of the wind and rainfall regime of the island would be most rewarding.—EDIT. NOTE.

⁷ Data on stations in Dutch Borneo are given in the annual *Regenwaarnemingen in Nederlandsch-Indië* issued by the Koninklijk Magnetisch en Meteorologisch Observatorium, Batavia; also in J. Boerema: *Regenval in Nederlandsch-Indië [1879-1928]*, *Kon. Magnet. en Meteorol. Observatorium te Batavia Verhandelingen*, No. 24, Vol. 1, 1931; the atlas of diagrammatic rainfall maps of Borneo accompanying Professor Boerema's work (Vol. 3, 1932) shows the Kerayan-Kalabit highland area within the rainfall range 3000-4000 millimeters (120-160 inches). See also C. Braak: *Klimakunde von Hinterindien und Insulinde (Handbuch der Klimatologie, Vol. 4, Part R)*, Berlin, 1931, pp. 75-76.—EDIT. NOTE.

for which there are records are Long Nawang, to the southwest (2° N., $114^{\circ} 45'$ E.), which has about 160 inches of rain, and Pensiangan, to the northeast in British North Borneo, which has about 110 inches. Most of the rain falls as showers in the late afternoon or during the night, especially after very hot days; in the "rainy seasons," however, there may be continuous rain for 24 hours or more.

In the mountains of the upper Sembakong and the Mentarang the temperature is fairly steady, ranging from 70° to 80° F. at night and from 86° to 92° F. during the day. In the highland the temperatures are considerably lower and are not unlike those of some hill stations in Java and Sumatra. Clear nights are sometimes very cool, and indoor early-morning temperatures of 60° F. have been observed. Frost does not occur. The natives report occasional hailstorms. Temperatures on the higher ranges are low, and the winds cold and penetrating. Banks reports a minimum temperature of 58° F. on the Tama Abo Range, but on November 1, 1939, we observed a 6 a. m. temperature of 42.9° F. on the central divide (1676 meters) during heavy rain.

In general, the climate in the Kerayan-Kalabit highland is invigorating; solar radiation is noticeably higher than in the low land, and the country seems to have definite prospects for health and vacation resorts in the future.

A JUNGLE VEGETATION

Practically the whole area from the coast to the mountains is covered with heavy jungle. Characteristic of this part of Borneo is the dense undergrowth, which tends to become lighter only at the higher altitudes (1000–1280 meters). Above 1460 meters moss forest is typically developed. It reaches, as was mentioned before, farther down on the weather side of the ranges than on the lee side. It is very well developed on the western slopes of the central divide between the Bahau and Baram Rivers (off the map) and on the eastern slopes of the Noelin Range about the Semamoe River. The flat parts of the ranges are covered with white, leached quartz sand and shallow swamps. Thick sphagnum cushions grow on the ground and on the stems and branches of the trees. Cold winds, mist, the continuous dripping from the water-soaked trees, and frequent rains make the stay in these altitudes extremely unpleasant.

In the hill region the high camphor tree and the tall and straight *bengaris* (or *mangaris*, *mengeris*) are conspicuous. The latter is spared by the natives when making clearings for rice fields, since it is the home of wild bees, which suspend their honeycombs from the under side of the large branches; honey and wax are collected at night. Open grass country is

rare. The only occurrences worth noting are in the Kerayan-Kalabit highland and the adjacent upper Bahau country. Continuous clearing and burning of the original jungle prevented it from reoccupying the lost ground, which consequently was invaded byalang grass. Soil erosion is active in some parts of the open grass country. Mention has been made of a vegetation of stunted trees and shrubs with thick, leathery leaves on the wide alluvial flats, the quartz-sand terraces, and the lower mountain slopes in the Kerayan-Kalabit plateau.⁸ Some of the shrubs closely resemble the *perapat* tree of the coastal brackish-water zone. In the highland they are indicators of brine springs, sources of salt for the native population. The shrub vegetation, which near the villages is cropped short by the numerous water buffaloes, cattle, and goats, is interspersed with open meadows of short grass, which give the landscape a parklike appearance. These open areas are of considerable extent; for the natives move their houses every few years and some of the domestic cattle left behind keep down the return of the jungle. Various fruit trees grow in the parks, especially several kinds of citrus, but they seem not to have been planted intentionally, for these fruits are not an article of diet among the natives. Except for rice, which is grown in abundance in the irrigated fields and never seems to fail, little is planted; a small kind of banana, *keladi*, sweet potatoes, chili, and cucumbers are on the meager list.

Although practically the whole country is covered with jungle, it is not all the true virgin jungle (*rimbah* in Malay) it may appear to the newcomer. Over large tracts there occur numerous fruit trees such as the durian, the rambutan, and the *langsep*, which undoubtedly prove that these areas have been occupied and were under cultivation in a not too distant past. Such jungle interspersed with fruit trees occurs especially along the Mentarang, in the northern and middle Kerayan country, the Kinayo and Berang area, and practically throughout the Sembakong-Sedalir country, especially in the upper Simaloemoeng.

Many of the jungle trees yield first-class timber; for instance, the several different varieties of ironwood (*ulin*, *tebulin*), the ipil, the kapur, and the *meranti*. The camphor tree is fairly common and occurs in two varieties, one on high and dry ground, the other in the lower regions. Sandalwood (*gaharu*) and several varieties of caoutchouc-producing trees grow throughout the area. The latter, however, have been practically exterminated

⁸ This would seem to be similar to the "heath forest" of Mt. Dulit described by P. W. Richards in "Ecological Observations on the Rain Forest of Mount Dulit, Sarawak," Part 1, *Journ. of Ecology*, Vol. 24, 1936, pp. 1-37; reference on pp. 23-36.—EDIT. NOTE.

through the destructive methods of the collectors; i.e. felling and subsequent ringing of the trees.

A palm tree yielding a reddish sago grows abundantly on the lower ranges. The sago is used by rattan and rubber collectors to eke out their rice diet while staying in the jungle. In the upper Kerayan region and on the Kalabit plateau this palm seems to be planted near the villages, occasionally in rather thick groves. The leaves are used for thatching. There is also a variety of palm the heart of which makes an excellent vegetable dish.

Bamboo occurs in many varieties but is only locally abundant; for instance, along the upper reaches of the Kerayan and on the Buluh (bamboo) River, where it is mostly the *bambu betong*, the giant in the bamboo family. It is very likely that the groves were planted. In the parts of the highland that have been extensively deforested, bamboo takes the place of timber in construction and is also frequently used as pipes and aqueducts in the rice fields. A kind of bamboo is used upcountry instead of flint for making fire; the hard, silica-containing surface is struck with a piece of earthenware and the sparks caught on tinder.

Rattan in many varieties occurs practically everywhere. On the lower ranges there is the *semambu* (cane), the *segah*, and the *kenkorang*; higher up the rattan *merah*; and on the swampy patches on the high ranges the rattan *sutra*.

AN ELDORADO FOR ANIMAL LIFE

The extensive and uninhabited jungle is an Eldorado for mammals, birds, and reptiles. Although most of the native tribes are enthusiastic hunters, the more distant and inaccessible mountain regions are a safe refuge for many species, and there is, with a few exceptions, no danger of extinction for any. The most numerous forms are deer, pig, and a large variety of monkeys. Deer are abundant in areas with wide valley bottoms, such as the upper Kerayan Valley and the Kalabit plateau. Pigs occur always in great numbers. They are likely to do serious damage to rice fields and other plantations and disappear from the inhabited areas only during the short periods when the jungle fruits are ripe. Usually once a year, especially when the oily seeds of the *tangkawang* tree are plentiful, the pigs migrate in numbers. On such occasions they are ambushed and killed by the natives while crossing the rivers.

The carnivores are represented by the smaller forms, such as the spotted panther (leopard), the tree leopard, the civet cat, and the Malay bear (the tiger did not reach Borneo on its migration from the Asiatic mainland). There are a large variety of monkeys—for example, the proboscis, the

lampong monkey and several varieties of rhesus, and different species of lemurids—but not the orangutan. Porcupines and anteaters are numerous, and squirrels of many kinds inhabit the jungle and especially the marginal areas of cultivation.

The pachyderms are represented by the rhinoceros and the elephant, which, according to native tradition, was imported by the sultans of Brunei and Sulu from Achin. Elephants occasionally visit the eastern tributaries of the upper Sembakong River from British North Borneo, where they still occur in small herds. The rhinoceros, although apparently widespread, is not very numerous. It occurs in fairly large numbers in the mountain ranges between the middle Kerayan and the Mentarang and in the border area of British North Borneo; for instance, in the upper Soelon Valley. Although the tribes inhabiting these areas are not keen rhino hunters, the animal is frequently hunted by Iban Dyaks coming over from Sarawak or British North Borneo. Horns, hide, and intestines find a ready market in Chinese shops, where medicine is made from them, though the animal is officially protected.

According to Hose and McDougall, more than 450 species of birds are represented in Borneo, a great many of which occur in the Kerayan-Kalabit highland. The most conspicuous is the hornbill, represented by several species.

Snakes are rather numerous; the largest and most spectacular is the python, which has its habitat by preference along the rivers; cobras seem to occur in the highland, but none were seen by us.

THE NATIVE POPULATION

The native tribes inhabiting the highland and the adjacent areas are anthropologically and linguistically interesting. A large number of megalithic remains are to be found, and many customs in connection with them. This, however, must be the subject of another article.