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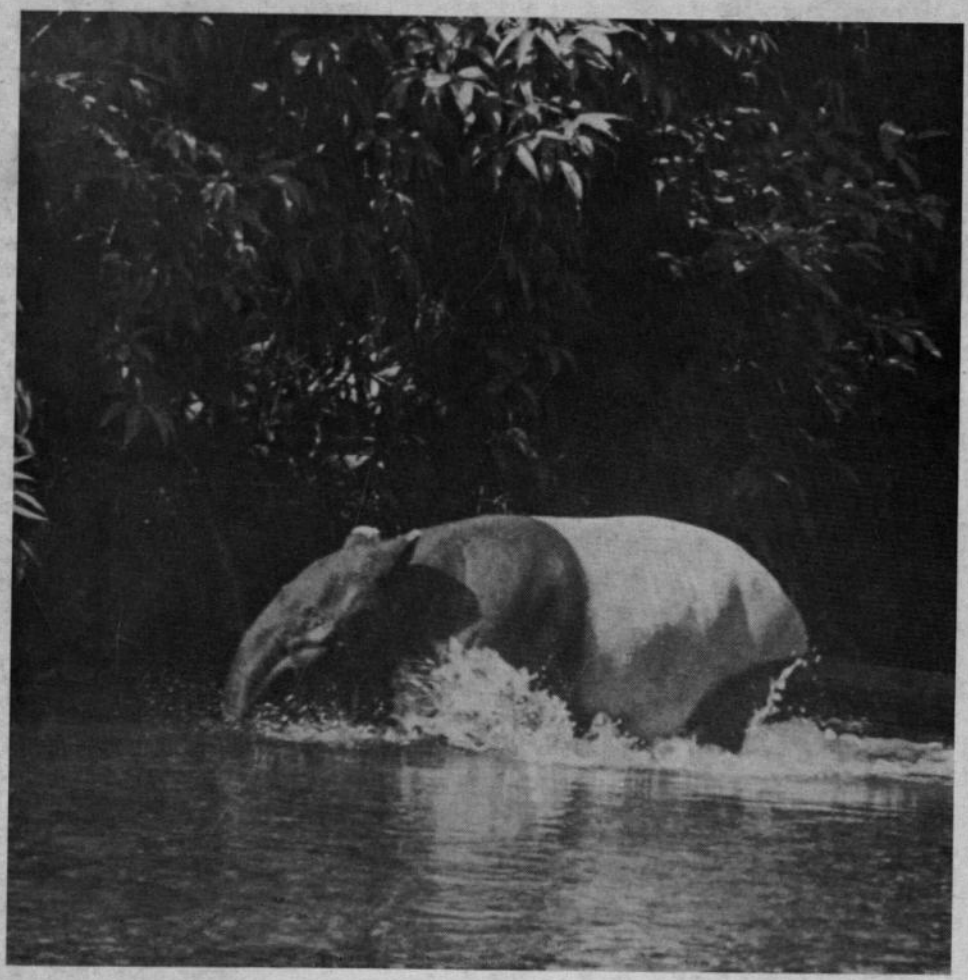

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Cover photograph: Tapir in the Sg. Sat, Taman Negara, Pahang (photo — T.C. Whitmore).

THE
MALAYAN NATURE JOURNAL

Vol. 24 (1970-71) August 1971 Part 3 & 4

a special double issue on

National Parks of Malaysia

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National Parks of Malaysia

Preface

edited by

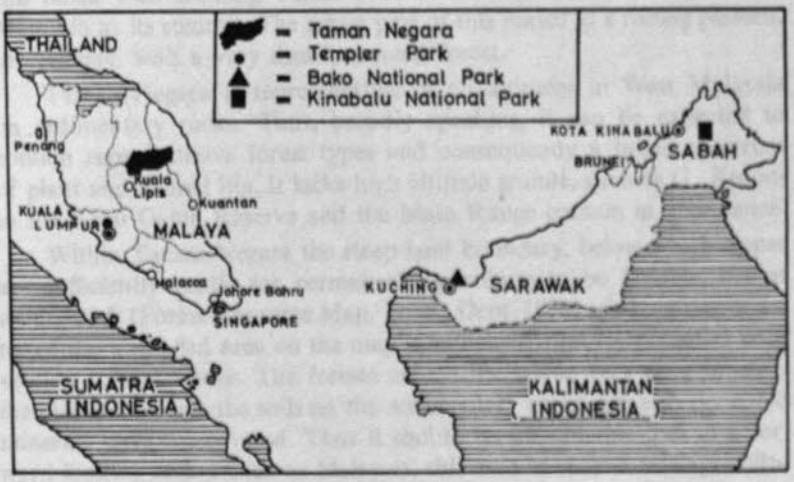
HO THIAN HUA, E. SOEPADMO & T.C. WHITMORE

This special issue of the Malayan Nature Journal seeks to provide the would be visitor with brief illustrated guides to aspects of the natural history of the parks, together with information on how to reach them.

There is increasing pressure on the virgin jungles which still clothe part of Malaysia and threats to extract the timber from the parks are already beginning. Timber extraction would cause catastrophic and irremediable loss to the wild life in a way not widely appreciated.

The Malayan Nature Society believes it has a role to play in awakening public awareness of, and interest in, the unique and important natural heritage of the nation which the parks represent. The case for their conservation intact is developed in a series of papers following the descriptions of the individual parks.

There are at present four National Parks in Malaysia, two in the West and two in the East parts of the country (see map below).



Malay. Nat. J. **24**: 113–114 (1971)

Taman Negara

Introduction

Taman Negara lies in the centre of West Malaysia athwart the boundaries of Kelantan, Trengganu and Pahang and includes the headwaters of three major river systems, the Relai-Aring-Lebir, Terenggan and Tembeling, one in each state respectively. The area is 1677 square miles. Fifty seven percent of the land area is in Pahang (958 sq mi), 24 percent in Kelantan (410 sq mi), 19 percent in Trengganu (310 sq mi). About 17 percent of Taman Negara lies on granite, the rest on sedimentary rocks, mostly shales; there are a few scattered limestone hills, including Gua Peningat 2370 ft the highest in the country. The distribution of land between different altitudes above sea level is as follows:

below 250 ft	0.6 percent,	10 sq mi
250–1000 ft	57 percent,	959 sq mi
1000–2500 ft	28 percent,	477 sq mi
2500–4000 ft	11 percent,	183 sq mi
4000–5000 ft	2 percent,	32 sq mi
over 5000 ft	1 percent,	15 sq mi

These altitude classes are shown by shading on the map (p. 114). The land over 5000 ft is entirely on the Tahan massif, a sandstone and quartzite block with Gunong Tahan 7186 ft the highest mountain in West Malaysia as its summit. The upper part of this massif is a rolling plateau, the *padang*, with a very dwarf, stunted forest.

Taman Negara is representative of all altitudes in West Malaysia on sedimentary rocks. Thus, broadly speaking, it can be expected to contain representative forest types and consequently a broad spectrum of plant and animal life. It lacks high altitude granite, such as G. Benom in the Krau Game Reserve and the Main Range contain in abundance.

Within Taman Negara the steep land boundary, below which slopes are sufficiently gentle for permanent agriculture to be feasible, lies at about 400 ft (Forest Resource Map, Forest Dept. 1970) so about one quarter of the unshaded area on the map is sufficiently flat for potential conversion to agriculture. The forests are on the whole very poor in commercial timber and the soils on the sedimentary rocks are also poor. No minerals have been found. Thus it should be unthinkable that in a forward looking nation such as Malaysia, this area of second-rate agricultural and forestry potential can be considered for any other use than conservation of a large representative sample of the wild plant and animal life of the Sunda shelf, to be kept in trust for all mankind, with controlled access for scientific research, education and tourism.

TAMAN NEGARA
● – Salt Lick
▲ – Gunong = Mountain
△ – Camping Place
G. Rabong
G. Gagah
S. Perting
S. Kenyam
S. Terengan
K. Tahan
H.Q. Nat. Park
S. Tahan
S. Tenas
S. Atok
Gua Peningat
Boundary
N
5000 ft.
4000 ft.
2500 ft.
1000 ft.
250 ft.

Malay. Nat. J. **24**: 115–117 (1971)

What to do and where to go in Taman Negara

E. PELINCK[1]

The main attractions of Taman Negara are boat trips, game watching, hiking, fishing and swimming. For each of these activities excellent opportunities are provided by the Game Department. At the Park Headquarters at Kuala Tahan accommodation is available in a rest house, chalets, hostel and on a campsite. There are visitors' lodges at Kuala Atok, Kuala Terenggan and Kuala Kenyam and fishing lodges at Lata Berkoh and Kuala Perkai. Visitors can make their own arrangements on what to do with the Park Superintendent. A number of worthwhile trips are suggested below: —

RIVER TRIPS

Although boats have to be used also if other activities are undertaken, two river trips as such can give the visitor an exciting time. Boats with a crew can be hired in Kuala Tahan.

Sg. Tahan

This trip is most fascinating, neram trees on the river banks bend over from both sides to meet overhead making the river cathedral-like. Dependent on the water level one can go as far as *Lata Berkoh*, a formidable cataract, two hours above Kuala Tahan. Part of the return trip should be made without the use of the outboard engine, enabling the passenger to see and hear many birds.

Sg. Tembeling

Between Kuala Tahan and Kuala Terenggan the river flows through a fine gorge with a series of seven rapids, which if there is sufficient water may be negotiated non-stop by outboard. Kuala Terenggan is one hour above Kuala Tahan and Kuala Kenyam about two hours.

GAME WATCHING

The best place to see wildlife is at one of the salt licks where the Game Department has built observation hides to provide the visitor with optimal opportunity to see forest animals. Although never abundant, chances of seeing deer are good, while seladang, tapir and elephant may also be seen during certain periods. Early morning and late afternoon are the best times for game watching, while during full moon the best chance of seeing tapir and elephant is at night.

1 c/o Forest Department, Kuala Lumpur.

Kuala Tahan

Five minutes walk behind the rest house a large padang has been cleared, mainly to attract seladang and deer.

Jenut Belau

This salt lick can be reached by boat in 15 minutes and another 10 minutes walking down the Sg. Tembeling from Kuala Tahan.

Jenut Tabing

About half an hour by boat or one hour walking up the Sg. Tahan is needed to reach this natural salt lick.

Jenut Kumbang

In the observation hide overlooking this salt lick visitors may stay overnight, and this is recommended especially during full moon. It is situated one hour by boat up the Sg. Tembeling from Kuala Tahan to Kuala Terenggan, followed by about one hour's walk.

HIKING

Well kept trails through the jungle enable the hikers to reach mountain tops and other places of interest.

Bukit Tersik

This 1130 ft high hill near the rest house can be climbed in 40 minutes. From the top vast areas of virgin forests can be overlooked, including the Ulu Tahan and on a clear morning the bulky Tahan massif in the far distance.

Bukit Guling Gendang

A return trip from Kuala Tahan to the solitary 1867 ft peak of this mountain can be made in a full day. From its summit Gunong Tahan can be seen.

Gua Kenyam

This is a limestone hill with a shallow cave, $1\frac{1}{2}$ hours walking from Kuala Kenyam, which is itself 2 hours above Kuala Tahan by boat.

Gunong Tahan

To reach the top of the highest mountain of West Malaysia takes about five days of travelling time. The return journey takes roughly one day less. Special arrangements have to be made for guides and camping equipment.

FISHING AND SWIMMING

The most suitable time of the year for fishing are the months of February, March, July and August. Fishing is excellent near several of the lodges.

Kuala Kenyam

Two hours by boat along the Sg. Tembeling.

Sg. Kenyam

One hour upstream the Sg. Kenyam from Kuala Kenyam. Kuala Perkai lodge is up the Sg. Kenyam.

Lata Berkoh

This cataract in the Sg. Tahan can be reached in two hours from Kuala Tahan. Below and above Lata Berkoh, there are many pools. which contain plenty of fish and are good as well for swimming.

Kuala Tahan

Ten minutes from the rest house there is a pool, Lubok Sempon, in the Sg. Tahan, which is a favourite spot for swimming.

Malay. Nat. J. **24**: 118–124 (1971)

Plants and vegetation along the paths from Kuala Tahan to Gunong Tahan

E. SOEPADMO[1]

INTRODUCTION

Gunong Tahan (7186 ft) is the highest peak in West Malaysia, and it has some of the most interesting types of vegetation in the country. However, though it is frequently visited by biologists, there are very few published records on the fauna and flora. The only known comprehensive account on the types of vegetation and their floristic composition occurring on G. Tahan and in its vicinity is that by Ridley published in 1915 which deals with general aspects of the flora and vegetation, especially at Wray's camp and above. In addition to this paper there is a handful of others dealing with plants, vegetation or animals of what is now Taman Negara, and for the sake of completeness these are listed at the end of the present account.

The present contribution is based on the result of a botanical expedition financed by the University of Malaya, carried out from August 26 to September 8, 1970. The party consisted of myself (botanist), Mr. Tho Yow-Pong (entomologist), Mr. David Labang and Enche Baharuddin b. Nasir (field investigators), and eight aborigines as guides, porters and tree-climbers.[2] We left Kuala Tahan on the August 28 and due to the rain, heavy loads we were carrying and the botanical activities carried out, we reached the summit of G. Tahan at noon on September 5. We followed the usual route to the summit but did not camp at places where the ordinary tourists or hikers usually do. We spent one night each at Sg. Kentul, the ridge between Sg. Melantai and Sg. Puteh[3], Kuala Sg. Puteh, Wray's camp[4], and two nights each at Kuala Teku and the Padang.

BRIEF DESCRIPTIONS ON THE VEGETATION ALONG THE ROUTE FROM KUALA TAHAN TO THE SUMMIT OF G. TAHAN

The most readily recognisable types of vegetation or plant-community along the path to the summit are:

(a) Undulating lowland dipterocarp forest between Kuala Tahan and Sg. Melantai (Plates 33a & b).

---

1 School of Biological Sciences, University of Malaya, Kuala Lumpur.

2 Our sincere thanks are due to Chief Research Officer, Forest Research Institute, Kepong, and Dr. T.C. Whitmore for the opportunity given to us to make use of two tree-climbers during the expedition

3 Note that on the latest 1 inch Survey Map the wrong stream is labelled Sg. Puteh, about 2 miles south of the true position.

4 Called *Pondok nombor dua* on the latest 1 inch Survey Map.

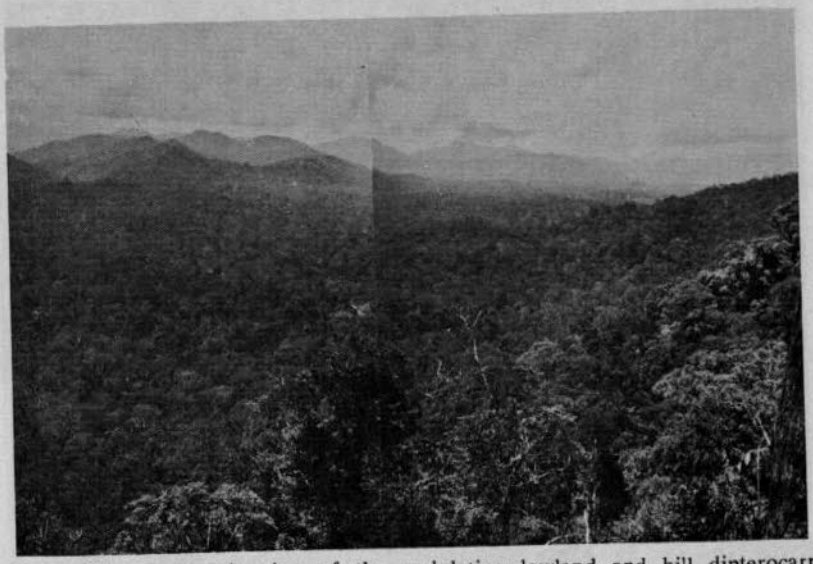


PLATE 33a. Panoramic view of the undulating lowland and hill dipterocarp forest between K. Tahan (Bt. Tersik) and G. Tahan.

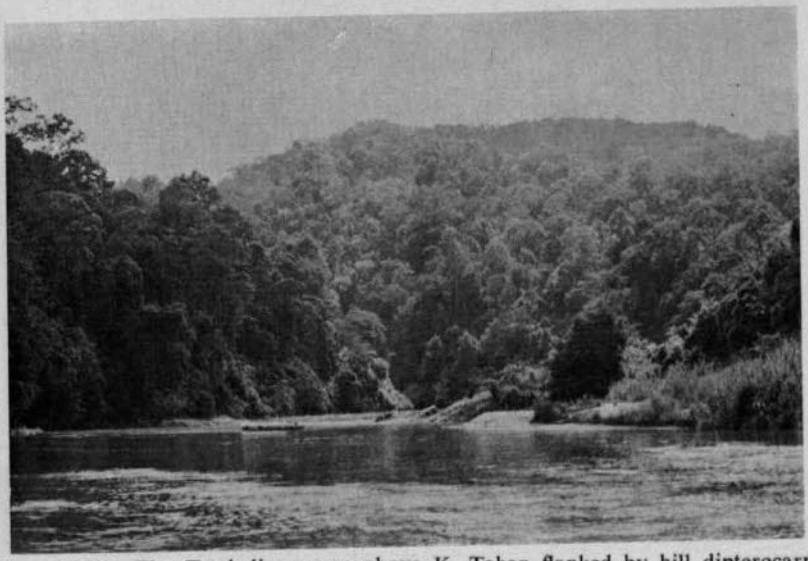


PLATE 33b. The Tembeling gorge above K. Tahan flanked by hill dipterocarp forest (*photo*—T.C. Whitmore).

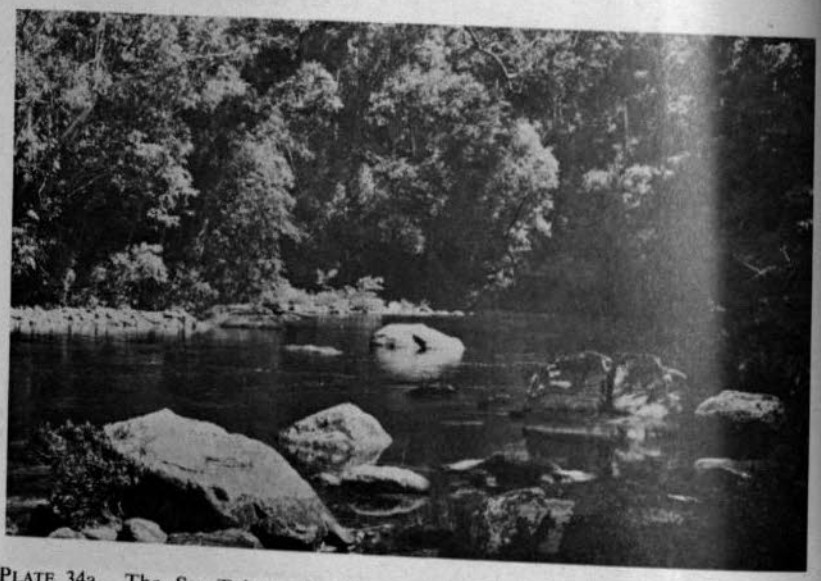


PLATE 34a. The Sg. Tahan, showing a deep stony pool with luxuriant forest along the banks.

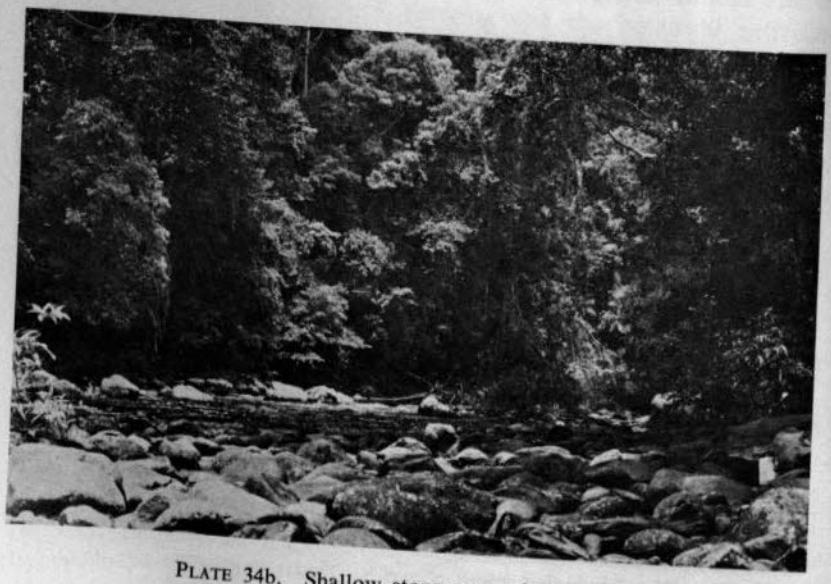


PLATE 34b. Shallow stony part of Sg. Teku.

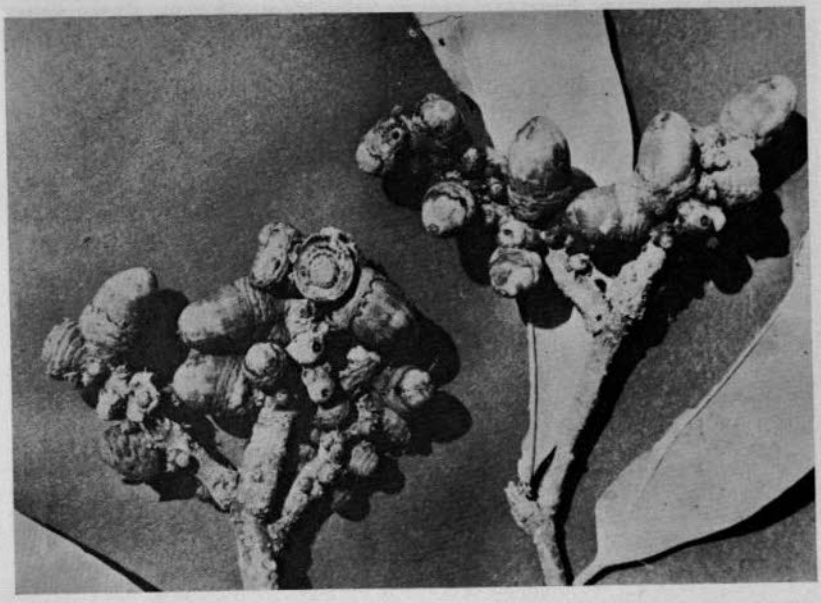


PLATE 35a. *Lithocarpus erythrocarpus*, one of the commonest oaks along the path from K. Teku to Wray's camp.

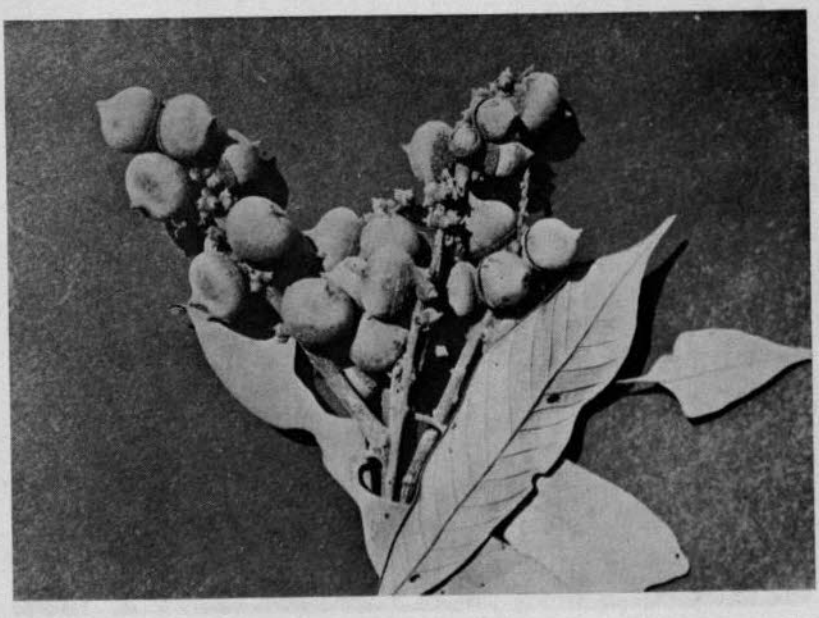


PLATE 35b. *Lithocarpus wallichianus*, the commonest oak between K. Tahan and K. Teku.

PLATE 36a. Thicket of *Dipteris conjugata*, at Wray's camp.

PLATE 36b. *Matonia pectinata*, at Wray's camp.

PLATE 37a. Three aborigine porters overshadowed by *Leptospermum flavescens* at G. Tuan Sket.

PLATE 37b. Dwarf Upper Montane ericaceous forest growing on bare rocks at south-east shoulder of G. Gedong.

PLATE 38a. *Podocarpus deflexus* on bare rocks between the Padang campsite and the summit of G. Tahan.

PLATE 38b. *Pentaphragma aurantiaca* growing profusely between damp rocks of the gully vegetation.

PLATE 39a. *Nepenthes*, an abundant species of the Padang vegetation.

PLATE 39b. *Dendrobium* sp., an orchid plentiful along streams in the Padang.

PLATE 40a. *Eugenia stapfeana*, abundant on bare rocks in the summit region of G. Tahan.

PLATE 40b. The pipewort *Eriocaulon silicolum* growing well especially on wet [illegible] Padang.

(b) Undulating hill or ridge dipterocarp forest between Sg. Melantai and Sg. Teku.
(c) Riparian vegetation along Sg. Tahan and Sg. Teku (Plates 34a & b), which includes:
  i. Forest of medium sized trees (up to 70 ft).
  ii. Shrubs community, up to 10 ft tall known as rheophytic vegetation.
(d) Lower Montane forest: upper dipterocarp forest merging to fago-lauraceous forest between Kuala Teku and Wray's camp.
(e) Upper Montane ericaceous forest between Wray's camp and Tangga Dua Belas.
(f) Gully vegetation between Tangga Dua Belas and the south-east shoulder of G. Gedong.
(g) Padang and summit vegetation (Plates 36–38), which includes:
  i. Dwarf shrubby vegetation on bare rocks.
  ii. Shrubby vegetation on elevated hillocks or ridges.
  iii. Vegetation along the streams.

a. Undulating lowland dipterocarp forest between K. Tahan & Sg. Melantai

The tallest trees in this type of forest reach up to about 100–150 ft and most of them belong to the family Dipterocarpaceae (*Anisoptera* spp., *Dipterocarpus* spp., *Shorea* spp.). Other noticeable large and tall trees are *Parinari* ? *corymbosum* (Rosaceae), *Diospyros* sp. (Ebenaceae) and *Lithocarpus wallichianus*, *L. cantleyanus*, *L. encleisacarpus*, *Castanopsis inermis* and *C. lucida* of the Fagaceae, *Paranephelium* sp. (Sapindaceae), *Canarium littorale* (Burseraceae), *Payena* sp. (Sapotaceae), *Ochanostachys amentacea* (Olacaceae), *Knema* spp. and *Myristica* spp. (Myristicaceae) and several species of *Eugenia*. Among the fruit trees seen are: *Durio oxleyanus*, *Baccaurea* spp., *Artocarpus* spp. and *Xerospermum* sp. The small sized tree and shrub community consists of many species of Euphorbiaceae, among which is *Erismanthus obliquus* which possesses winged fruits; Annonaceae, Rubiaceae, *Memecylon* spp., *Helicia* spp., *Eugenia* spp., *Garcinia* spp., and *Gironniera parvifolia*, etc. The undergrowth is mainly composed of members of the Araceae, Zingiberaceae (*Costus*, *Zingiber*), Maranthaceae (*Donax*), Gesneriaceae (*Didymocarpus malayanus* with bright yellow flowers and another with deep red flowers) and saplings of large trees. *Cycas rumphii* is fairly common in this forest in the neighbourhood of the Park Headquarters.

b. Undulating hill or ridge dipterocarp forest between Sg. Melantai and Sg. Teku

Dominant trees in this type of forest are: *Anisoptera laevis*, *Dipterocarpus grandiflorus* (recognised by its large leaves and strongly

ridged large fruits), *D. baudii* (with hairy leaves and fruit-wings), *Shorea leprosula* of the Dipterocarpaceae, *Garcinia* spp. and *Calophyllum* spp. of the Guttiferae, and several species of *Eugenia*. Among the Fagaceae are: *Castanopsis inermis, C. lucida, Lithocarpus wallichianus* and *L. cantleyanus*. Leguminous trees such as *Koompassia malaccensis* and *Parkia* are found here and there especially within the valleys and near the streams between the ridges. On a few ridges, trees of the conifer *Agathis dammara* (damar minyak, kauri) are seen mixed with species of *Eugenia* and *Calophyllum*. The most noticeable shrubs or treelets are *Agrostistachys longifolia, Gironniera parvifolia*, several species of Annonaceae, and palms such as *Licuala* spp., *Johannesteijsmannia altifrons* and *Pinanga*.

c. *Riparian vegetation along Sg. Tahan and Sg. Teku*

i. Medium-sized tree community:

The commonest trees in this community are: *Tristania whiteana, Dipterocarpus oblongifolius, Lithocarpus wallichianus, Castanopsis inermis, Nauclea* sp., and many others. Among the woody climbers are: *Bauhinia, Entada* and *Mucuna*. Epiphytes such as orchids and ferns are numerous.

ii. Rheophytic vegetation:

This plant community develops well on rocky banks of the rivers, and the plants are characterized by their shrubby appearance, narrow and pointed leaves, tough stems and branches, and strong anchorage. The plants constituting this community include: *Antidesma salicinum, Eugenia* sp., *Ixora stenophylla, Aglaia salicifolia, Dysoxylum angustifolium, Calophyllum rupicolum, Dipteris lobbiana, Gomphandra* cf. *lanceolata*.

d. *Lower Montane forest: upper dipterocarp forest merging to fagolauraceous forest between Kuala Teku and Wrays camp.*

The forests lying between Kuala Teku and Wray's camp grow on steep ridges between 1000 to 3000 ft elevation. They are extremely rich in Fagaceae, Myrtaceae and Guttiferae species. Members of the Dipterocarpaceae still constitute the dominant trees, prominent amongst them the hill species *Shorea curtisii* (seraya) and *S. ovata*, but the number of individuals is markedly decreasing. Among the Fagaceae found in this forest are: *Castanopsis javanica, C. lucida, Lithocarpus erythrocarpus* (which can be recognised by its large leaves and densely rufous tomentose acorns), *L. kunstleri, L. cantleyanus, L. wallichianus, L. cyclophorus* (which is recognizable by its large leaves and acorns and cups), *Quercus gemelliflora, Q. nivea* (a new record for Malaya), *Quercus subsericea* (common along the path), and many others. Other non-dipterocarp trees common in this forest are: *Swintonia* sp., *Agathis*

dammara, Canarium pentanervium, Santiria griffithii, Atuna excelsa, Walsura neuroides, and several species of *Eugenia* and *Garcinia.* Ground flora is composed mainly of gingers, aroids, ferns, and Selaginellas. The palm-flora of this forest is extremely rich among the commonest species are: the Tahan bertam, *Eugeissona brachystachys* growing gregariously along the path, several species of *Pinanga* and *Licuala,* and approaching Wray's camp one may see plenty of the giant diamond-leafed daun payong, *Johannesteijesmannia altifrons.* Around Wray's camp the forest changes suddenly to Upper Montane rain forest in which are found many medium-sized trees of: *Dacrydium elatum, Eugenia* spp., *Garcinia* spp., *Lithocarpus rassa, Baccaurea bracteata, Elaeocarpus* sp., and many others. Common shrubs are: *Schima wallichii, Vaccinium* spp., *Rhododendron* spp., *Tenstroemia, Gordonia,* etc. Among the herbaceous undergrowth seen plentifully are: *Pentaphragma aurantiaca, Begonia* sp., *Sonerila, Nepenthes, Lycopodium* spp., *Selaginella* spp., *Dipteris conjugata* and *Matonia pectinata.* Mosses, such as *Sphagnum* are common everywhere, especially on the wetter grounds.

e. Upper Montane ericaceous forest between Wray's camp and Tangga Dua Belas

This type of forest occurs on undulating steep ridges ranging from 3500 to 5000 ft elevation. Though this vegetation occurs at a much lower altitude than at G. Ulu Kali (5600 ft) or G. Brinchang, Cameron Highlands (*c.* 6000 ft) its appearance or physiognomy is more or less the same. The forest is typical of Upper Montane ericaceous forest in which the dominants consist of rather shrubby looking trees of *Leptospermum flavescens* and *Dacrydium beccarii* with horizontal branches and flat-topped crown and thick, deeply fissured bark. Other common shrubs or treelets are: *Podocarpus falciforme, Rhododendron* spp., *Vaccinium* spp., *Pentaphylax euryoides, Styphelia malayana, Symplocos pulcherrima, Weinmannia blumei, Austrobuxus nitidus, Ilex* sp., *Gordonia* sp., *Ternstroemia* sp., and many others. An endemic species of fan palm, *Livistona tahanensis* is very common, especially on the slopes of these ridges. Common herbaceous plants seen along the path are: orchids, ferns (*Matonia, Dipteris*), *Lycopodium* spp., *Selaginella* spp., *Nepenthes* spp., and on the wetter ground are *Pentaphragma, Burmannia,* and several sedges.

f. Gully vegetation between Tangga Dua Belas and south-east shoulder of G. Gedong

A completely different type of vegetation from those already described occurs in the undulating valleys or gullies between the rocky ridges of Tangga Dua Belas and G. Gedong. The vegetation here is of medium height and its appearance is reminiscent of a slightly dwarfed

Upper Montane forest in which the trees do not exceed 50–60 ft in height and possess spreading branches and a dense canopy. There is a relatively thick layer of peaty soil on the ground and in some places it is very damp. As a result of this the basal parts of the main trees or shrubs are densely covered with various species of mosses, ferns and orchids. Among the readily recognised trees are: the endemic Tahan kauri, *Agathis flavescens*, *Eugenia* spp., *Garcinia* spp., *Schima wallichii*, *Polyosma*. Rhododendrons and Vacciniums are abundant along the path. The herbaceous undergrowth is mainly composed of *Pentaphragma aurantiaca*, *Didymocarpus* spp., *Burmannia* spp., *Nepenthes* spp., *Hedyotis* and *Phyllagathis*.

g. Padang and summit vegetation

This vegetation extends from the south-east shoulder of G. Gedong westwards and northwestwards to the Teku Gorge and northwards and northeastwards to the summit of G. Gedong and G. Tahan itself. The plants here grow mainly on bare rocks, ranging from 5000 to 7186 ft in elevation. The greater parts of the area consist of sandstone rocks traversed here and there by veins of white milky quartz. Fragments of milky and clear quartz are plentiful on the ground. Apart from the areas along small streams and in the valleys between ridges or hillocks the ground is devoid of soil. Based on their specific composition and physiognomy, the Padang vegetation may be divided into three distinct communities, namely the 1–2 ft tall, dwarf and shrubby plant community growing on bare rocks, the 10–15 ft tall, dense and shrubby community on elevated ridges or hillocks, and the 30–50 ft tall, thick community growing along the small streams traversing the area, or in the depressions or valleys between the ridges.

i. Dwarf shrubby vegetation on bare rocks

Though in specific composition the vegetation of this habitat is more or less the same with that of the Upper Montane ericaceous forest between Wray's camp and Tangga Dua Belas and other similar habitats in Malaya, its appearance is quite different. Here all the woody plants are dwarfed to 1–2 ft and posses a strong xerophytic habit, such as thick, leathery leaves either densely covered with yellowish-brown tomentum or with waxy substances; a thick, deeply fissured bark; and tough branches and stems, etc. From their general appearance it can be assumed that the plants growing in this habitat are subjected to very strong wind, high fluctuations of temperature and humidity, and above all they are subjected to an adverse condition of the substrate, i.e. soil-less rocks. The commonest woody plants here are: *Dacrydium beccarii*, the endemic *Podocarpus deflexus* mixed with *Leptospermum flavescens*, *Baeckia frutescens*, *Styphelia malayana*, *Pentaphylax euryoides*,

Rhodoleia ovalifolia, Olea capitellata, Terminthodia viridifolia, Euodia simplicifolia, Tristania merguensis, Eugenia stapfeana, E. tahanensis, E. pahangensis, Ilex spp., and several others. Among the herbaceous plants are: Orchids (*Eria* spp., *Arundina gramminiifolia, Spathoglottis aurea, Bromhedia rupestris*); pitcher plants (*Nepenthes gracillima, N. singalala*); sedges (*Xyris ridleyi, Schoenus distichus, Gahnia javanica;* ferns (*Gleichenia montana, Dipteris conjugata, Matonia pectinata*); lycopods (*Lycopodium cernuum, L. carolinianum*); *Eriocaulon silicicolum* and *E. hookerianum.*

ii. Shrubby vegetation on elevated hillocks or ridges

This particular plant community occurs, for example, in the Padang area between the southeast shoulder of G. Gedong and the camping site, and the northeast slopes of G. Gedong and the summit area of G. Tahan. The shrubs and treelets grow close to one another, and possess wavy branches and flat-topped canopy. Unlike the bare rock habitat mentioned above the ground here is covered with a thin layer of peaty soil. Plants common here are: Rhododendrons (at least three different species), Vacciniums, *Rhodoleia ovalifolia, Elaeocarpus* spp., *Eriobotrya bengalensis, Polyosma* sp., *Weinmannia blumei, Dacrydium beccarii, Carallia montana, Litsea* sp., *Schima wallichii, Pandanus klossii,* etc. Mosses, ferns and orchids are plentiful on the grounds as well as on the tree trunks and branches.

iii. Vegetation along the streams

This plant community is much taller and more luxurious than the surrounding vegetation. This is due to the fact that it grows on sheltered parts of the Padang in which relatively thick peaty soils occurs, and water is readily available to the plants. The ground is always damp and cover with mosses, ferns, orchids and other herbaceous plants. The stand is dense, makes it difficult to penetrate. *Agathis flavescens, Podocarpus deflexus, Dacrydium falciformae, Schima wallichii,* and *Ilex patens* are the commonest medium-sized trees in this community.

CONCLUSION

From the brief descriptions given above it is clear that G. Tahan in particular and Taman Negara in general, are very interesting botanically, since nowhere in W. Malaysia at present one can find such diversity of habitats and plant communities ranging from the lowland dipterocarp forest near Kuala Tahan to the dwarf Upper Montane ericaceous vegetation of the summit region of G. Tahan where several endemic plants are found. It is also well known that within these diverse types of vegetation, there are many rare and protected animals such as the elephant, tapir, tiger and Sumatran rhinoceros. Apart from these, as pointed out by

Lowry, Whitmore and Ho Coy-Choke elsewhere in this issue, these forests may contain plants which have economic potential, but not yet fully studied or exploited, such as the wild fruit-trees, or those which may contain a valuable chemical substance. Therefore, it is important for us to preserve these unique habitats, to ensure that future generations will be able to enjoy and make use of their potentialities.

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The Distribution of Large Animals in Taman Negara

MOHD. KHAN BIN MOMIN KHAN[1]

Taman Negara is situated in the States of Pahang, Trengganu and Kelantan covering a total area of 1677 square miles of typical Malayan mountain, forest, river and stream and contains most species of indigenous wild life and vegetative growth excluding that typified by estuarine and coastal areas.

In the National Park the wild life is managed not for direct economic purposes, but primarily for recreational, aesthetic and scientific purposes, with some economic benefits as by-products. The ivory is not taken for revenue and the game is not hunted, either for meat or for sport. In this reserved area no kind or category of wild life is given precedent to the detriment of any other. This is a difference that is not always understood or taken into account by critics of wild life management policies. It makes a trenchant distinction between wild life management in a National Park and wild life management elsewhere. In our National Park we try to maintain *all* the native species of wild life—game, predators, and small mammals—in their natural proportions and relations. Instead of concentrating on some preferred kind of animal or group of animals, we try to maintain in the park a well-balanced system of wild life that will serve the purposes that are outstanding there—recreational, aesthetic and scientific.

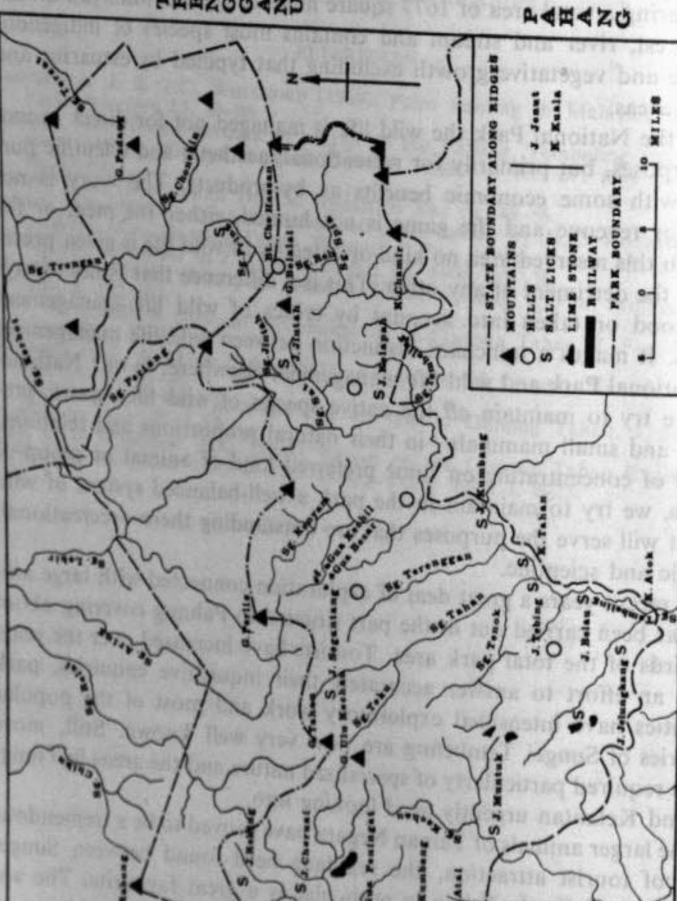
In recent years a great deal of exploration connected with large animals has been carried out in the part situated in Pahang covering about two-thirds of the total park area. Tourists have increased over the years and in an effort to answer accurately their inquisitive enquiries, park authorities have intensified exploratory work and most of the popular tributaries of Sungei Tembeling are now very well known. Still, more work is required particularly of specialized nature and the areas in Trengganu and Kelantan urgently need looking into.

The larger animals of Taman Negara have proved to be a tremendous source of tourist attraction, the seladang herd found between Sungei Terenggan and Kuala Tahan in particular is a great favourite. The appearance of tapirs, Sambhur deer, elephants, wild pigs and evidence of tigers and bears at the many salt licks of the park have often been reported in the visitors' book at the Park Rest House.

ELEPHANT (*Elephas maximus*)

From the west side of the Park in the vicinity of Sungei Tanum and its tributaries, and around the limestone massif of Gua Peningat and north

[1] Pejabat Pelindong Mergastua Kanan, Batu Gajah, Perak.



Taman Negara (King George V National Park)
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to the Park boundary in Kelantan there exists no less than two distinct herds of elephants. Tracks of these elephants were recorded as far east as the upper reaches of Sungei Kechau. Two salt licks, Jenut Cheruai and Jenut Kumbang (Tanum) are regularly visited by the larger of the two herds numbering about ten animals. Recently the Pahang Game Department had killed two animals from this herd which wandered outside the Park boundary. The smaller herd of three to five animals may be found in the vicinity of Jenut Reking. The valley of the Tahan beyond Kuala Tenok is seldom frequented by elephants except for wandering lone bulls.

Proceeding further east, in the vicinity of Kuala Teku on the east side of the Tahan, tracks of a small herd of about 6 to 8 animals were recorded on a few occasions. These animals evidently came from the upper reaches of Sungei Kenyam Kechil, a pleasant valley with many large limestone outcrops, evidently a valley most intensively used by this herd. Tracks of this herd were recorded a short way up the main Gunong Tahan ridge, eventually heading down into the Tahan some distance above Kuala Teku. They were also noted one and one half miles below Kuala Perkai going down to Kuala Kenyam crossing the Tembeling River and down for about one and one half miles. Somewhere along this stretch of the Tembeling the herd crosses the river again and makes its way to the upper reaches of Sungei Kenyam Kechil.

A herd of from 12 to 15 animals frequents the lowland southern part of the Park from Kuala Atok to Kuala Tahan moving on both sides of the Tembeling as far upstream as the Terenggan. Frequent visits are made to the Tahan salt licks particularly Jenut Belau.

Proceeding further east is the Sungei Sat in the vicinity of which are found two salt licks, Jenut Kelapoh and the more important Jenut Jintoh located well away in the upper reaches of the river. This salt lick is well patronised by a herd of elephants numbering between five to seven animals which are believed to wander northwards across the low divide via the Pertang into Kelantan. The country between the Sat and the Sg. Spia particularly the upper reaches is rough and elephants are few. A small herd of about six animals visits the vicinity of Kuala Chamir occasionally.

The few trips that were made to the upper reaches of the Reh and Kenering in Pahang, Bukit Che' Hassan in Trengganu and the valleys of the Kenering, Pring, Ulu Terenggan, and Sungei Chonchin and on the plateau of Gunong Padang produced little or no evidence of elephant apart from lone bulls which were few and far apart.

Elephants are fairly common in that part of the park which lies in Kelantan and which contains the rivers Aring, Relai and part of the upper reaches of the Lebir. Given the time it would be relatively simple to estimate the number of herds and their sizes in these areas.

It is estimated the elephant population in the park is between 40–49 animals from the herds already described, 46–55 animals including the

wandering lone bulls and a rough 58–67 animals including the animals in the Aring, Relai and Lebir areas. In the opinion of the writer this is a good estimate but work on the population should be continued so that an accurate figure may be arrived with adult sex ratios and the percentage of young.

SELADANG (*Bibos gaurus*)

In the southern part of the park between Kuala Atok and Kuala Terengganu there exist an estimated population of thirty animals. The well-known herd which visits Kuala Tahan and remains in the vicinity for periods up to a month and more is accurately estimated to contain twenty-four head although usually fewer animals appear. Mr Bernard Thong has recorded six animals in the upper reaches of Sungei Atok and the tributaries of Sungei Tenok and Sungei Kechau. This herd is believed to be distinct from the Kuala Tahan herd already described.

The valleys of the Kenyam do not hold any resident seladang herd although tracks of lone bulls were observed from time to time. Hislop (1961) once recorded the fresh tracks of a fairly large herd along the Perkai River in the lower reaches of the Kenyam and several other records of probably the same herd were made by the late Chief Game Warden, Mr. Aw, at Perkai lodge. Along the Sungei Sat a fairly large herd of about ten animals is found in the vicinity of Jenut Jintoh. The Spia appears not to hold any seladang and the only other seladang herd to be found in the eastern part of the park is over the divide inhabiting the valley of the Pring and upper Terenggan in Trengganu. A few miles downstream from Kuala Pring there is a salt lick and a well used route which leads to the upper reaches of the Terenggan and across a low divide into the Pring. Further east on the banks of Sungei Chonchin and at the foot of Gunong Padang, tracks of about six seladangs may be found but since the Chonchin and Terenggan is only a short distance apart and separated by relatively low country, it is probable that the same herd from Terenggan visits the Chonchin valleys.

On the west side of the Park tracks of two more herds of seladang may be found in the valleys of Sungei Tanum. In the vicinity of Jenut Kumbang and Jenut Atai tracks of about six animals were recorded and this herd is known to feed outside the park boundary. Further north still along Sungei Tanum in the vicinity of Jenut Reking a herd of about ten animals is known to exist. This herd is being harrassed by poaching.

Including lone bulls the National Park holds between 62–68 head of seladang.

RHINOCEROS (*Didermoceros sumatrensis*)

The Sumatran Rhinoceros is a very rare species of animal now existing in the States of Malaya and three individuals are known to exist within

the boundaries of the park. Visual record of one animal crossing a river was reported by a senior game ranger in the vicinity of the Spia. It is probable that at least one other animal may exist in the valleys and in the upper reaches of the Spia. C.S. Ogilvie has recorded tracks of the species from the valley of the Spia and G.R. Leonard in a survey to the east of the Spia up to the border of Trengganu came across many wallows but very few of anything fresh, but the evidence, nevertheless, was conclusive that one or two animals still wander around the upper reaches of the Spia.

Hislop (1961) personally covered a great deal of the country from Gunong Tahan eastwards to Ulu Trengganu and found no evidence of existing rhinoceros although old wallows were common and he reported aborigines having told him there were one or two individuals in the steep country at the source of the Kenyam, but those reports have never been verified. It is very interesting to note that the same senior game ranger recorded visually a rhino at Kuala Tahan in 1964 and Thong who followed the animal to the upper reaches of the Tahan river found fresh tracks at Jenut Segantang. The animal was reported to have stayed there for at least three days before going over the divide into Kelantan. It is safe to say a minimum of three animals still exist within the boundaries of the park and there may be a maximum of five.

TAPIR (*Tapirus indicus*)

Tracks of tapir are often met along most tributaries of the Tembeling indicating that the species is numerous in the National Park. They are also found from lowland swamps to the steepest slopes and high ridges up to an elevation of at least 4000 ft. Tapirs are often seen by visitors to the park during the hours of darkness and photographs too were taken of the animals. An excellent photograph of one pair at a salt lick, taken by Dr. Vincent Wager appeared in Animal, Volume 11, No. 4 page 152.

SAMBHUR DEER (*Cervus unicolor equinus*)

Sambhur Deer is common within the boundaries of the National Park. An average of between seven to ten animals appear nightly at Padang Seladang and the visitor is assured the opportunity to see a few animals. Tracks of Sambhur Deer are common in all salt licks and all tributaries of the Tembeling.

SEROW (*Capricornis sumatrensis*)

Serow are rare within the boundaries of the National Park and their existance is little known. From reliable sources it is reported to exist in the vicinity of Gua Besar and Gua Peningat may contain a few individuals.

It should be noted that little or no effort was made to investigate the existence of Serow within the boundaries of the National Park. The many limestone outcrops are suitable habitats for the species and may probably contain a number of individuals.

TIGER (*Felis tigris*)

Tracks of tigers are not as numerous as those of Sambhur Deer or Tapirs and they are certainly very seldom met. Wild Pig (*Sus scrofa*) is mainly preyed upon as food and to a much lesser extent the Sambhur Deer. Young seladang and month old baby elephants were recorded as being followed by tigers but mortality of young seladang and elephant caused by tigers is believed to be uncommon. Usually tracks of one tiger are found in the vicinity where wild pigs are plentiful. It is certain tigers do a good job keeping down the population of animals which otherwise may present serious problems. Although not as numerous, nevertheless the tiger is well distributed in the National Park and may be found along all tributaries of the Tembeling River.

It is important to remember that in the National Park the wild life is managed not for direct economic purposes, but primarily for recreational, aesthetic and scientific purposes, with some economic benefits as by-products. Economic benefits of wild life include the maintenance of industries connected with fishing, such as the manufacture of angling tackle, and sporting equipments and accessories, support of lodges, hotels and other accomodation where anglers and tourists are catered for, industries that play a part in transporting tourists and anglers, and guiding, patronage of photographic industries and publication of sportsmen's magazines.

Recreational benefits of wild life include the pleasure, satisfaction and good health that accrue directly to those who participate in sports such as angling, wild life photography and wild life observation. The practice of wild life management itself, the work of park wardens, game wardens and wild life scientists, will, if undertaken in the right spirit, yield as a by-product a rich recreational reward.

The aesthetic benefits of wild life are closely related to the recreational benefits, but do not in all cases include the element of activity that is associated with recreation. Aesthetic benefits are not restricted to artists but may be experienced by all who appreciate the beauty of wild creatures.

The scientific benefits of wild life are numerous and widespread. Scientists naturally desire to know as much about life as possible. The scientific research necessary to obtain the desired information can in many cases be carried on most readily and conveniently with wild creatures as the immediate objects of study.

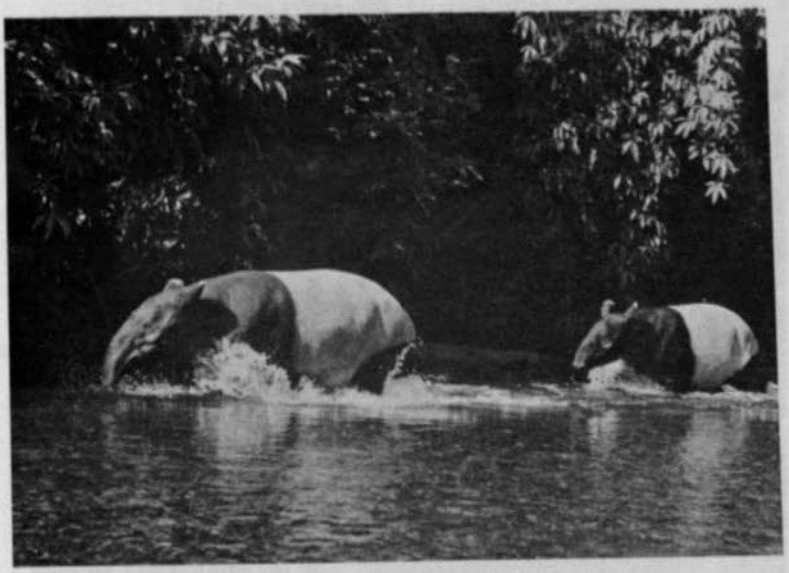

PLATE 41a. Tapirs in the Sg. Sat (*photo—T.C. Whitmore*).

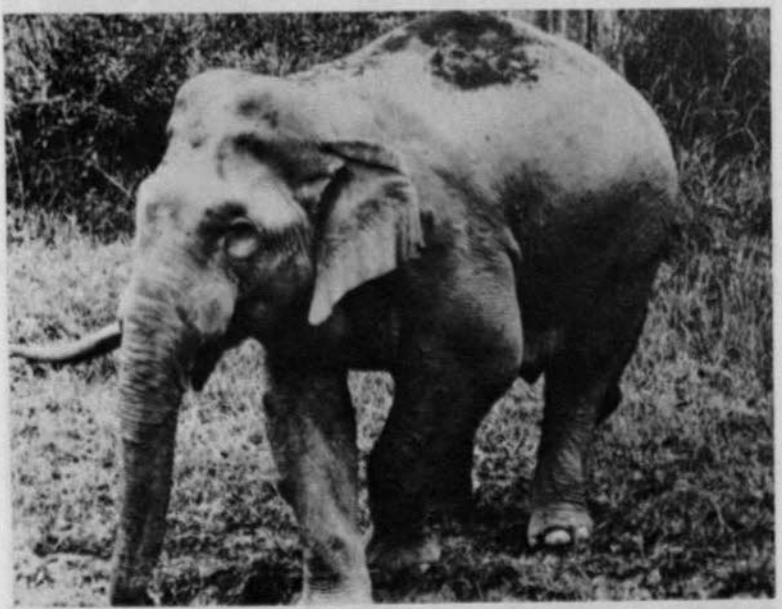

PLATE 41b. Elephant (*photo—Game Dept.*)

PLATE 42. Sumatran rhinoceros (*photo—Game Dept*).

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Grateful thanks are tended hereby to the Chief Game Warden, Mr. Bernard Thong Kwong Sin who gave valuable information and advice and provided transport and guides to the writer for a short visit to the Park and the assistance of Enche Rafiah Muda, Mohd. Rani, Jamidin and Jamalludin of the National Park are highly appreciated.

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The Last Refuge

LES WEIGUM[1]

As I stood unprotected amidst those slender banana stalks and stared at death only a scant 22 feet away, fear froze me to the spot. Just two hours earlier an old Malay man in a warning had told me 'that you can frequently fool them by pretending to speak to someone'. It did not seem so funny now as I helplessly waited. Suddenly, without warning he gave me another look, turned and crashed away. I sat down trembling and with closed eyes saw again that huge black ox. I had stumbled upon a sleeping bull seladang (*Bos gaurus hubbacki*) and lived to tell about it. Only after more experience was I to conclude that far from being aggressive, seladang are shy and retiring, and like this bull want only to be left alone.

I had come to the Taman Negara in 1967 at the request of the West Malaysian Game Department to study the biology of the seladang. From July 1967 to July 1968 my work was supported by the Peace Corps, and from September 1968 until December 1969 by the New York Zoological Society and the Canadian Wildlife Service.

Although I ranged over much of the 1677 square miles of virgin jungle, mountains and rivers of the beautiful National Park, I concentrated mainly on the seladang of one herd. This herd was accessible as it frequented an area around Kuala Tahan.

Seladang or gaur is a near relative of domestic cattle. It is found in India, Nepal, Burma, Indo-China, and here in the Malay Peninsula. Though very similar, the Indian gaur, Burmese gaur, and the Malaysian gaur have been designated separate subspecies. The seladang is usually found in herds of about eleven animals, though solitary bulls are not uncommon. Adults are dark brown and often appear black. They have a conspicuous raised dorsal ridge which runs from the neck to the middle of the back, characteristic white 'stockings' on the legs, and two dewlaps —pendulous folds of skin. The larger of the two dewlaps hangs beneath the neck and a smaller dewlap can sometimes be seen under the chin of old animals. Seladang are deep-bodied with short legs. Their hooves are small and slender, more like a deer than an ox.

The bull is larger than the cow, and one male has been recorded as 6 ft 3 in. to the top of his shoulder, though this must be a record. A young black bull which I immobilized with the drug M-99 measured 4 ft 10 in. to the top of his dorsal ridge. Besides size, bulls can readily be distinguished from cows by their thicker and wider horns. Neither, however, have very large horns, perhaps because this would prove disadvantageous in moving through thick undergrowth.

[1] Formerly American Peace Corps attached to Game Dept.

Many people consider the seladang a jungle animal and though they will travel and often rest in deep jungle, their food is in clearings and disturbed areas. This habitat is either man-made or riverine (subject to constant flooding). The grasses and sedges, forbs[1] and shrubs that begin invading a new field provide the bulk of the seladang's diet. They however, do not always distinguish between planted varieties and those growing wild. They will eat rice (padi), banana, pineapple, tapioca, and enjoy the shoots and leaves of sapling rubber trees. Nine times out of ten however, cultivated fields have been left unattended and one cannot blame the poor animal for taking what appears to have been abandoned.

With this in mind, the park personnel cut and cleared a 21 acre area allowing only grasses and small forbs to persist. Near the centre of this field I buried a bag of rock salt and made a pond (piping in water from a spring). Overlooking this new meadow and its artificial salt lick was an observation blind which I had constructed in the crotch of a large tree (106 ft above ground). The herd liked this clearing and would sometimes stay in the vicinity for several weeks.

The people living in this area have an unreasonable fear of the seladang. He is big, roars like a lion, is not afraid of the tiger, and appears very aggressive. They told me that there is an aurora surrounding the seladang and that this eerie glow can sometimes be seen above the herd at night. I watched them many times at night but never did see this 'kilat' (glow).

Seladang are extremely wary. They have an incredible sense of smell and one is often aware of them only when they dash away. If the breeze is right one may come upon them unsuspected. A herd thus approached may do two things, uneasily drift away or 'scout' the intruder. Once I came upon the herd in a cool clearing in the jungle. The herd saw me but could not catch my scent. Barely seventy feet separated us as I squatted down to watch their reaction. Blowing and snorting the herd 'eyed' me. An old female walked forward stopping to blow several times. When she was very close (25 ft), she stood several minutes then gave a loud snort, wheeled and crashed through the underbrush (along with the panicked herd). In such an environment they rely mainly on their noses.

Tigers prey upon the young seladang, but do so at their own risk. From a safe perch up a tree, I once witnessed such a confrontation. Grazing in the study field at six in the evening the herd paid no attention to the distant rumbling of a tiger. In fact only a yearling bothered to raise his head. The tiger was perhaps a mile up-river and was no cause for alarm. Every five minutes though, the call was heard closer. Suddenly the quiet was broken as he loudly announced himself at the clearing. The herd was grazing about 400 ft away. No panic or even retreat was seen as the whole

[1] An American term for herbs other than grasses (Eds.).

herd rushed towards him. Snuffling and blowing, the old cows led the charge. In the rear, the master bull remained at the side of a female and her young calf. They were all near the tiger's position, and as the bull guarded five calves and a cow, nine others left the short grass searching for the big cat. Blowing loudly with noses near the ground, they resembled hunting dogs following a scent. Closing in on their adversary, two young females leaped back as the tiger countered with a vicious snarl. Bellowing and snorting, the big bull lowered his horns and rushed in. This was too much for the tiger and he unceremoniously fled. Later he was heard farther down river. The seladang remained in the brush snorting and blowing until dark. All sixteen animals were placidly grazing the next evening. Tigers most certainly take calves, but I cannot confirm any such losses.

There is a definite 'peck order' or dominance within the herd. Size seems to be the criterion and since the master bull is the largest, he is given room by all. At the salt lick, when he moves in, all but several old females move away. In general, old cows, young cows, two-year olds, yearlings, and calves follow in descending order. Black bulls moving into the herd fit in at various levels. One large new-comer joined the herd and was subordinate to only the master bull. Smaller bulls sometimes rank even below young cows.

Reinforcing this peck order is a sport sometimes engaged in which I called head wrestling. Though I have witnessed this sparring on only three occasions, it followed the dominance pattern seen at the salt lick. Head to head the seladang twist and turn as the larger pushes his opponent. I have seen all size groups participate. Calves and yearlings particularly seem to enjoy it as they run and jump playfully. Serious bouts between bulls are probably uncommon. I have seen rump gashes on an adult and an immature brown bull. In 1954, however, there was a fatal encounter in this herd. The chief game ranger related that upon investigating a noisy thrashing in a nearby clearing, he saw two large bulls engaged in violent head wrestling. The herd grazed as the two sparred. One bull finally withdrew to a hillock. The dominant bull turned, presenting his side to his subordinate. The subordinate charged and hit his rival in the side. The large bull fell and was impaled by a sharp tree stump. With a pierced hip he struggled up and limped off. Two weeks later he was found dead six miles from the skirmish.

Calves are born distinctly rufous in colour. They do not have white stockings yet nor the pronounced dorsal ridge. Some authors have wondered at the conspicuousness of this colour. I found, though, that far from being conspicuous, they were extremely hard to see unless standing beside their dark parent. A new calf can be seen near its mother at any time of the year contrary to seasonal breeding in India. The new calf stays close to its mother and often appears to be standing beneath her. They suckle in the same manner as domesticated cattle—from either side or

PLATE 43a. The artificial salt lick. The many tongues have exposed the bag of rock salt.

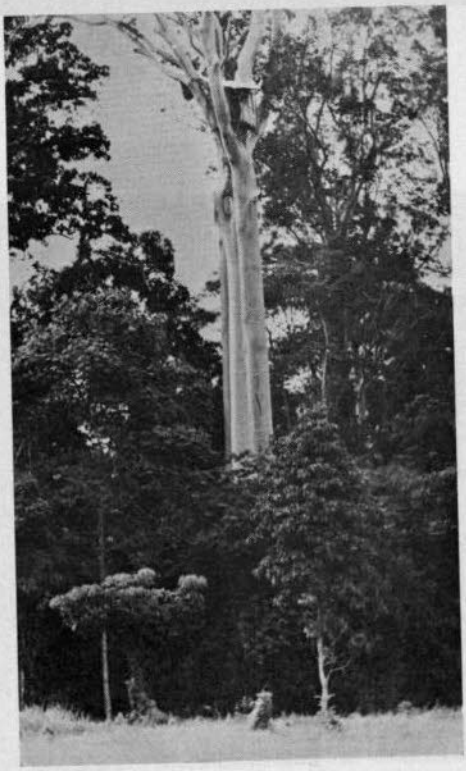

PLATE 43b. The observation blind at the artificial clearing near Kuala Tahan, 106 ft up a tualang tree.

PLATE 46. Seladang head-wrestling (photo. Game Dept.).

from between the hind legs. As they become older, their colour darkens and by six months they are brown with light stockings. As yearlings with six inch horns they must be on the watchout for grouchy adults. They have lost their privileged status and if they come too close or in some way offend an adult they may be chased. The yearlings are not as wary as adults and probably accounts for most losses to tigers.

Seladang have definite periods of activity. Dawn will find the herd grazing, but as the sun rises the herd moves into brush and may continue browsing until nine or ten o'clock. They will then seek a shady place either in heavy brush or the nearby jungle. They will all lie down at some time during the morning and afternoon though some can usually be seen standing. They do not begin active feeding until half past four or five o'clock in the afternoon. I usually managed to climb a tree to observe these movements and many are the times when I have had to relinquish the tree to the nasty tempers of the nesting red ant. Night finds the herd in a clearing and there they remain feeding and resting until dawn. The coarse lalang grass (*Imperata cylindrica*) is the most preferred night bedding.

This particular herd ranges over an area of approximately 5½ square miles. This area is mostly out of the Park. A 240 acre area of young rubber just across from headquarters provides enough grasses and shrubs so that the herd remains there during much of the year. Farther down river and still outside the Park are many abandoned rice fields. These fields are left idle from between two and six years, and thus provide a renewable food source for the herd. The herd moves between these areas just before dawn, travelling on a maze of well-defined trails, both in secondary growth and primary jungle. They cross the two major rivers at only three places shallow enough for the herd to cross without swimming. The herd moves in single file. The lead cow is followed by the master bull, cows and young calves, yearlings and older calves, and lastly an adult female. They habitually rest in particular places—sometimes in brush, sometimes in jungle, and sometimes in grass, depending upon the time and area.

Within this herd's home territory are two salt licks. One is natural and the other man-made. The natural lick is in the Park and like most such places is situated near a small stream. This lick being rich in calcium and sodium is used mostly by deer and tapir. The seladang preferred the rock salt at the artificial lick, yet there still remains the question as to why they want the salts at all.

The orang asli often refer to seladang as 'our cattle'. In fact the seladang will oftentimes be found near these gentle people. Like cattle, seladang can voice their feelings, but one must be lucky to hear them. The first time I heard their challenging bellow I had a hard time convincing myself that there were no lions in Malaysia. It could best be described as a roar and would intimidate the bravest intruder. Sometimes at dusk how-

ever, can be heard the rather musical 'bugle' call of the seladang. This call could sometimes be heard miles away and seemed to be used in a variety of situations. This mournful call lasts as long as 3½ seconds.

Rather surprisingly the herd is not led by the master bull. An old female whom I called 'Golden-Tail' (because of the unique colour at the tip) tells the herd when to feed, rest, and move. Her authority is unquestioned and any yearling that does not move quickly enough may be 'bumped' as a reminder. She is constantly alert, testing the wind and investigating suspicious clearings. She must worry about man as well as tigers. Fortunately for this herd the people they encounter are mostly friendly. A great majority of the villages nearby are in some way benefited by the Park, so poaching is no problem.

In the large Park I travelled by boat, raft and foot to collect information on the total gaur population. Searching for signs, I discovered that not only is the jungle difficult at times but also puzzling. What is it that makes one leaf on a bush quiver while all around are quiet? What are the origins of the many perfumes that sometimes overwhelm you? Once coming down the Relau River on a bamboo raft I was so impressed by the natural beauty that I described it in my notes as 'a river with a continuous living archway.....orchids and other flowering epiphytes droop to the water...'. I had previously estimated perhaps 100 seladang in the Taman Negara. Further expeditions caused me to revise that figure. I know of only three herds, and an average of 11 seladang per herd would mean a population of about 33. Two other known herds having been in proximity to civilization have been broken up. From the tracks of single animals and pairs I would put the total population as under 65. This is a very small population base and should be increased. Habitat improvement has been shown to work and the Game Department has begun this in a few places in the Park. It will have to be continued if the herds are to be kept within the Park.

I left the National Park and Malaysia in December 1969. I went to India to compare their gaur with the seladang. Schaller in his book *The Deer and Tiger* gave the location of the few known gaur herds. I decided to visit the Bandipur Sanctuary where not only was the gaur population sizeable, but accessible.

I flew first to Hyderabaad to see four of the few living gaurs in captivity. The two oldest, a male and female, both a healthy 2½ years looked so similar to Malaysian seladang that superficially I could not distinguish them. At Mysore City I spoke to the sanctuary personnel about seeing their gaur. With a laugh they told me 'there aren't anymore,—they all died this past year of the (cattle) disease rinderpest'. In fact, all over India disease has practically wiped out the remaining population of gaur. I was taken to the sanctuary and spent two days enjoying the scenery, the wild deer and birds. Of the vast gaur herds that inhabited this and the nearby

Mudumalai Sanctuary there was no trace. One tracker said he had seen hundreds lying dead in the sanctuary. Now only a few herds of scrawny cattle (which undoubtedly brought in the disease) can be seen where the gaur used to be.

Could Malaysia be the last sanctuary for the gaur? Perhaps some old-timers will recall when shooting a seladang was the finest of sports; in Johore, Negri Sembilan, Kedah and other states. Now a person is just plain lucky to find a fresh track. What happened to the seladang? Where has he gone? I can name only one place where man and seladang still live together (Taman Negara). When man comes, he cuts the trees, plants his crops and destroys any animal that would threaten it. The latest victims were in Kedah.

Fearing that the flooding waters of the new Muda dam would not only inundate seladang range, but would pose a threat to the animals, Dr. W. Stevens (Colombo Plan Game Adviser) and Bruce Weber (Peace Corps) did a quick survey. The only signs of any seladang were at a well-known salt lick. The freshest tracks were so old as to be barely discernible. Overlooking the lick was a rotting shooting platform. I do not think we have to worry about drowning any seladang here.

As the seladang has completely disappeared from Selangor and Negri Sembilan, what of the few remaining in Johore and Trengganu? Isolated seladang populations have never been able to compete with man so little optimism is warranted. In Perak and Pahang there are still areas suitable for the seladang. Land development schemes mean that these areas are no longer safe. I am fearful that only the National Park will one day harbour the wild seladang, and only then through habitat improvement and complete protection.

An avenue that should be explored is the economic value that the seladang might offer (excluding tourism). Instead of importing sick and poorly adapted beef animals (especially from India and Pakistan) would it not make more sense to try crossing Malaysia's own wild beef with domestic cattle? It has been done before (in northern India and Burma) producing a fine animal. With an economic value the seladang would be given the protection it must have.

Malay. Nat. J. **24**: 139–147 (1971)

Templer Park

A Brief Account of the Natural History of Taman Rimba Templer (Templer Park)

M. NADCHATRAM[1]

HISTORICAL BACKGROUND

Kanching, where Templer Park is situated, figures prominently in "The Story of early Kuala Lumpur" by Gullick (1956). It is perhaps by chance rather than design that Kuala Lumpur is situated where it is. The seeds for the growth of Kuala Lumpur were sown at the embankment at the junction of Sungai Gombak and Sungai Klang when Yap Ah Loy began a thriving trade in tin.

Although the tin deposits were richer in Kuala Lumpur than those discovered around Kanching, the miners in Kanching had arrived there before the mines around Kuala Lumpur were opened. There were bitter quarrels between the miners of Kuala Lumpur and the miners of Kanching in the late 1860s not only because of economic jealousy but also because these mining groups belonged to different clans. There were numerous battles both in Kanching and Kuala Lumpur between the rival factions with losses in lives running into hundreds. It is reasonable to presume that due to the able leadership provided by Yap Ah Loy, the Captain China of Kuala Lumpur, and the fact that Kanching mines were wrecked by quarrels among the miners themselves that Kanching was reduced to obscurity in comparison to the early growth and prosperity of Kuala Lumpur.

The remains of the historic "kongsis" are scattered and covered with secondary vegetation. The remains of a fairly large historic village along the old Kuala Lumpur/Ipoh Road within the boundary of the Park is unfortunately under active mining lease, and is likely to disappear.

This rich historical heritage coupled with the excellent geographical situation made this area an eminently obvious choice as a nature reserve for the preservation and conservation forever of nature's rare handiwork for the unlimited enjoyment of all people. The rapid expansion of the city of Kuala Lumpur and the rapid growth of her population is real. Presently a large acreage of land around the suburbs of Kuala Lumpur is speedily being utilized for construction of houses and for industrial development. With the intensive as well as extensive commercial development radiating from the federal capital there is a fear of extinction of historical land marks and the destruction of natural habitats of our wild life. Therefore the need to preserve stretches of virgin territory becomes ever greater.

[1] Hon. Secretary Friends of Templer Park Society, c/o Institute for Medical Research, Kuala Lumpur.

TEMPLER PARK
LEGEND
Park Boundary
Section Boundary
Virgin Jungle Bdy.
Main Road
Jeep Track
Footpath
Rough Track
Mining Pool
Limestone cliffs
ms. milestone from K. Lumpur
Mile
ULU GOMBAK FOREST RESERVE
SERENDAH FOREST RESERVE
WESTERN SECTION
CENTRAL SECTION
EASTERN SECTION
Sg. Gadjah
Sg. Kanan
Sg. Udang
Sg. Kanching
Sg. Chui Tinggi
Anak Takun Caves
Bukit Takun Caves
Tin Mine
Jungle
Falls
Rubber
Canteen
To Rawang
To Kanching
From K. Lumpur
Kanching Pass
1324 ft.
1189 ft.
13 ms
14 ms
15 ms

Only in this way will future generations inherit an area with scenic treasures that are forever safeguarded from commercial intrusion. Any natural park is the property of the people. There is peace and quiet, pleasant sounds of waterfalls and streams, the sweet notes of birds and all the opportunity for relaxation in tranquility. We are very fortunate, therefore, that a small area of mixed forest only eleven miles from the heart of the capital and very easily accessible, is permanently preserved as a nature reserve and a public park. This gift to us is due largely to the foresight and wisdom of the former Sultan of Selangor, His Highness the late Hishamuddin Alam Shah and the former High Commissioner of the Federation of Malaya, Tun Sir Gerald Templer, both of whom were keen naturalists. The Park was named after Tun Sir Gerald Templer by the Sultan of Selangor himself.

A general account of Templer Park is presented by Hilton (1961). A brief summary is, however, given here to make this paper comprehensive for the benefit of those who have no ready access to other published information. For the convenience of the more serious reader a bibliographic list pertaining to Templer Park is given at the end.

Taman Rimba Templer (Templer Park) was officially opened by Tun Sir Gerald Templer on 19th May 1954. The Park covers approximately 3000 acres. Excepting a narrow strip of hilly land on the left of the road near the 14th mile, the Park is situated on the right side of the Kuala Lumpur/Ipoh trunk road between the 11th and 14th milestones (see map).

The Selangor State Government, in Gazette Notification No. 104 of 11th February 1955 (signed by Raja Sir Uda, Menteri Besar, Selangor) put Templer Park under the control of the Member for Natural Resources. An ad-hoc Committee composed of dedicated officers of the Department of Agriculture and the Department of Forestry under the Chairmanship of Dr. Ismail bin Dato Abdul Rahman (now Tun Dr. Ismail, Deputy Prime Minister) carried out the initial work in the Park. The Friends of Templer Park Society was inaugurated on 5th October 1955 at a public meeting. The meeting was opened by the Honourable Dr. Ismail who paid tribute to the driving force of Tun Sir Gerald Templer who initiated the project and to the keen Government officials who carried out the early development. Dr. Ismail in concluding his opening address said "Templer Park will be an asset to Malaya ..... it is rich in natural beauty and has considerable scientific interest. It is a cross section of Malayan nature. It is right and appropriate that the people of Malaya should learn and understand their natural heritage. I commend this project ..... to all of you who are here and to all who look upon Malaya as their home ..... as a project worthy of support". The President of the Malayan Nature Society, Dr. Molesworth supported the project and said that the Malayan Nature Society planned to become a founder member of the "Friends of Templer Park" and provide experts in various fields

and assist the Friends and the public to the best of their ability. The formation of the Friends of Templer Park Society was formally moved by Dato Sir Clough Thuraisingam and was unanimously carried. With the formation of the Society, the Honourable Raja Sir Uda was elected the first chairman of the council of the Society. Many distinguished personalities, including the Honourable Tun Abdul Razak (present Prime Minister) and the Honourable Enche Othman bin Mohamed (formerly Mentri Besar, Selangor) had lent their active support before and after Templer Park was established.

ADMINISTRATION

At present the Park is administered by the Friends of Templer Park Society on behalf of the Ministry of Agriculture and Mines by an elected Council comprising a President, Hon. Secretary, Hon. Treasurer, Hon. Warden and 19 Council members. In its 16th year since Templer Park was established the Park Society is privileged in having as its President the Honourable Dato Hamzah bin Dato Abu Samah, a keen naturalist and bird-lover. He has been President of the Society since 1965 when he was a senior government official. The Park is serviced by eight full-time park-keepers. The Society receives an annual subvention of $10,000 from the Ministry of Agriculture and Mines for the day-to-day running of the Park.

There is an active move to establish a "Taman Negara Act" which will bring all parks in the country under a single Government body, a move which is in the right direction. In the case of Templer Park, it is envisaged that the governing board will also include naturalists, biologists, zoologists and representatives of voluntary organisations who would be interested in the development of the Park as a public park and a wildlife sanctuary, as well as a field study area for long term botanical and zoological research. It is noteworthy that this is, perhaps, the only natural park in the country that has been administered by a purely voluntary organisation on behalf of the Government since its inception. Natural parks run by voluntary organisation in other developed countries have been highly successful. It has also become abundantly clear that the Park is a sound social investment and that the protection of outstanding natural features, resources, and items of historical interest are worthy of preservation, as the services provided to local visitors and foreign tourists will equal or surpass whatever money may be gained by exploiting the resources of the Park.

GEOGRAPHY AND NATURAL FEATURES

The Park's Eastern, Northern and Western boundaries are the Forest Reserves of Ulu Gombak, Serendah and Kanching. Abutting the left of the

road on the way to Ipoh, towards the Kuala Lumpur end, at the Kanching Pass, is the Bukit Lagong Forest Reserve. These combine with the popular land mark, Bukit Takun, a pinnacle of limestone approximately 1100 ft high, to form a unique setting in the foothills of the Main Range. For convenience the Park is considered in three sections—Western, Central and Eastern.

The Western Section bordered on the south by the 13th to 14th mile of the Kuala Lumpur/Ipoh Road is approximately 250 acres in extent. It has a system of well kept footpaths (Adam 1956)[1] giving fine views of Sg. Kanching, Tasek Barat (a small lake) and the distant undulating forested hills. A spectacular view of Bukit Takun is obtained from Tasek Barat. This Section adjoins a series of waterfalls and rock pools on the northeast border. The waterfalls are reached by a footpath that winds in a series of steps through jungle and are very popular with visitors. Some eight acres of land have been cleared of undergrowth and planted as lawns, on either side of the winding Sg. Kanching. Indigenous and introduced trees in this area provide ample shade. An internal motorable circuit road, Jalan Chawi-chawi also serves this and part of the Central Section of the park. (This was formerly a stretch of the main Kuala Lumpur/Ipoh Road).

The Central Section, some 610 acres running approximately from 12th to 13th mile of the Kuala Lumpur/Ipoh Road, contains the flat expanses of tintailings, the ruins of the old Kanching village, Bukit Tahun[2] and Anak Bukit Takun. The latter is the less conspicuous of the two, but is of greater scientific and touristic value as it contains a network of dark caves with primitive spiders, insects, bats, as well as a variety of other harmless small animals (Dunn 1965). This is, indeed, a world within a world. The Central Section is under active mining at present. However, when all the rich tin ore is extracted the numerous mining holes could be used for boating, fishing and other forms of water sport. The flat tintailings will be ideally suited for maximum development for recreational purposes without loss to flora and fauna. Children's playground, golf driving range, horse riding, motel, restaurant, miniature railway and orchid garden are some of the items considered for introduction.

The Eastern Section is approximately 2100 acres of forest bordered to the south by the 11th to 12th mile Kuala Lumpur/Ipoh Road. It is a low range of hills and the source of the Sungai Kanching, Gadoh and Udang. The highest point is 1500 ft. The upper reaches of the Sg. Gadoh is primary forest and the remaining forested area is either disturbed or secondary. Old logging tracks and orang asli (aborigine) pathways with addi-

[1] Due to mining activities and also further development in the Park, this useful guide is partly out of date.

[2] This limestone outcrop is just within the Forest Reserve and it is hoped that it will be included in the Park.

tional paths made by Park workmen make this Section quite accessible to the visitor. These paths which lead through attractive jungle, along streams, waterfalls and rocky gorges are infrequently used by the public though the paths are kept in good order by park workers. Off the 12th mile, a 15-minute walk along a well beaten track leads to a swimming pool situated in a valley in a natural jungle setting. The pool, 140 × 60 ft, attracts 200–300 people each week-end. It will soon be renovated with toilet and changing facilities provided.

The attractive features surrounding the Park, though not within the Park itself are the Kapur[1] forest, the only place in West Malaysia, west of the Main Range where these characteristic trees grow naturally, and a quartz ridge seen behind Bukit Takun. This ridge is a continuation of the well-known Klang Gates ridge.

FACILITIES

Though the object is to provide a recreation centre for people of all ages with varied interests as well as to foster the appreciation of Malaysian botany and zoology, for two main reasons no significant development was undertaken to provide large scale recreational facilities. Firstly, tin deposits continue to attract miners. This affects almost the entire Central Section and part of the Western Section. Secondly, the Society has no funds for capital expenditure, and private developers have not found it worthwhile to expend large sums of money in the Park up till now. However, through the generosity of a few charitable organisations it was possible to build new motorable bridges so that the internal circuit road (Jalan Chawi-chawi) is accessible to light traffic. Foot bridges across the Sg. Kanching and its tributaries were also built. Twelve halting sheds or pondoks and approximately fifty benches at various vantage positions have been installed. Several miles of foot paths are kept open and serviced regularly. In addition approximately fifteen acres of land along the Sg. Kanching are lawned. The Society hopes to spend approximately $20,000 in the next year or two to provide further amenities to make the Park a more welcome retreat away from the hurry and scurry of city life.

WILDLIFE

Mammals

The Park is bordered on all sides by Forest Reserves. These and the 2100 acres of forest within the Park serve as a sanctuary for small and big animals alike, as well as pathways for wide-ranging animals such as leopards and tigers. Another unique feature of the Park is that there are various ecological habitats—primary forest, disturbed forest, secondary forest, belukar, lalang grassland, reed swamp, etc.—each habitat being

[1] Borneo Camphorwood, *Dryobalanops aromatica*.

more attractive to certain species of wildlife than others. Wild animals are instinctively afraid of man, because of his destructive nature. For this reason rather than for lack of animal life one rarely sees big animals in the wild during rambles in the forest. There is no documented record of wildlife seen in the Park, except for few scattered observations recorded now and then in the Malayan Nature Journal or the newspapers. By way of big game I, in ten years of experience, have seen one serow or kambing gurun, a wounded tapir, and a few wild pigs in the Park. A list of mammals seen, identified by foot prints or recognised by calls by various observers is given in Table I. In addition to these mammals several species of squirrels (*Callosciurus* spp.) were seen. The commoner squirrels seen in the clearings and the edge of the forest near the waterfall are the Golden-backed Squirrel (*C. caniceps*), the red-bellied Plantain Squirrel (*C. notatus*), and the Black-banded Squirrel (*C. nigrovittatus*). The Park land also offers ideal environmental conditions for other small mammals, such as forest rats and shrews which have been caught in traps and released by me and my associates. Elephants, Rhinoceros, Seladang and Banteng are absent in the Park. About six Silver Leaf Monkeys were released near Anak Bukit Takun in 1962, but these have not been seen since. With the help of the Game Department a survey will be carried out to locate natural salt-licks and choose suitable spots to introduce artificial salt-licks with the intention to build hides from where animals visiting the licks may be observed.

Reptiles

Though there are in Malaya 110 species of snakes that live on land, one hardly sees these shy animals in the forest. Even then only sixteen species are considered poisonous and none of these are abundant. The snakes that have been seen in the Park are Rock Python, Reticulated Python and less than a dozen other species of harmless snakes. Two kinds of monitor lizards were seen, both unidentified species of *Varanus*. One, a five-footer, was basking in the sun in the Eastern Section of the Park, and a smaller one crossed a footpath in the Central Section. In the Eastern Section flying lizards (*Draco* spp.) were seen on a number of occasions and a Tokay or Giant Gecko.

Birds

The Park abounds with numerous species of birds: ground-loving birds, birds of the underbrush and the tree-top birds. There are approximately 600 species of birds in West Malaysia, and one may safely assume that the more observant and sensitive bird-lover would find at least one-fifth of the bird fauna in the Park itself. With my very limited experience as a bird-watcher, I have recognised over sixty species over a number of years of casual observation. In the Western Section of the Park alone, where there is much clearing, in one morning between 8.00 a.m. and 10.00

a.m. I recognised twenty-three common species which included Bulbuls, Babblers, Kingfishers, Sunbirds, and one Flowerpecker, Drongo, Barbet, Woodpecker, Bee-eater, Oriole, Broadbill, Swift, Waterfowl, and Quail.

Insects

The Park is also a paradise for insect collectors and a weekend does not pass by without one seeing a collector running after a butterfly with outstretched net in his hand. We are fortunate that one of the world's most attractive butterflies, the Rajah Brooke's Birdwing, is native to Malaysia. This large, very colourful insect, though evasive, is common along the streams in the Park. The ground-loving Amathusiids with rich metallic blues and blacks are also sought after by collectors. Of the insects Malaysia boasts of approximately 900 species are butterflies alone. The splendour and variety of forest insects seen in the Park is the proud heritage of our country.

These and the other wildlife must at all cost be protected for the enjoyment of the future generations of mankind without fear of these becoming extinct as a result of the destruction of their natural habitats. In this regard also it is most gratifying to learn that the Forest Department is planning to bring more forest land under forest reserves.

ACKNOWLEDGEMENTS

I wish to thank the President and the Friends of Templer Park Society for access to the Society's records and permission to use four of the Society's photographs to illustrate this paper.

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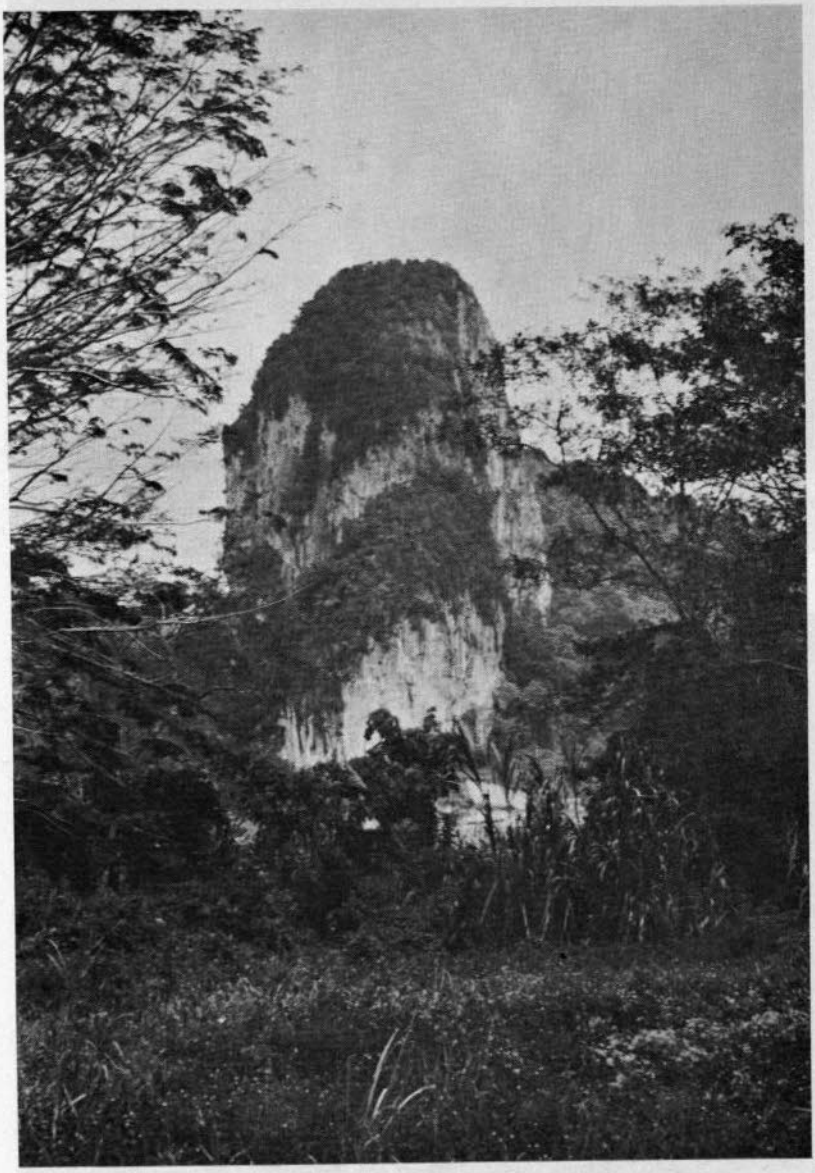

PLATE 47. Bukit Takun, Templer Park.

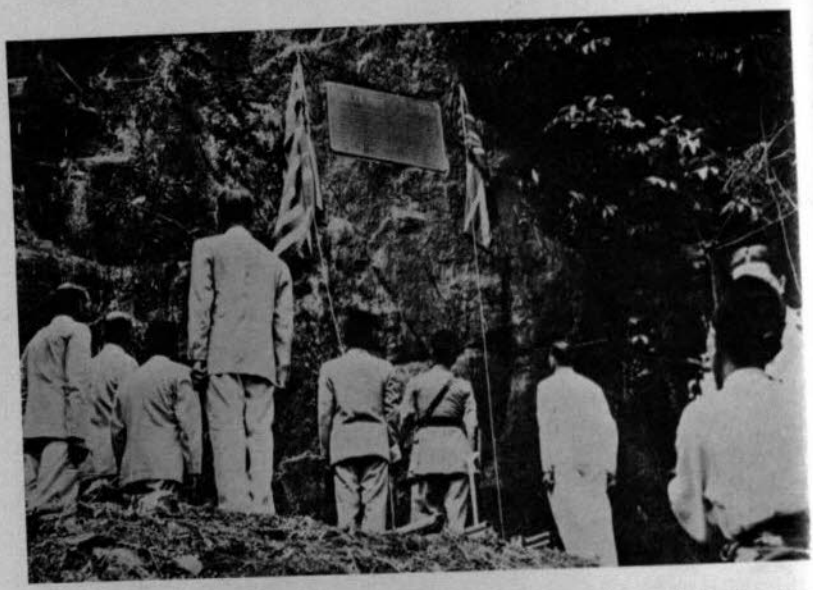

PLATE 48a. The plague unveiled, during the opening ceremony of the Templer Park on May 19, 1954.

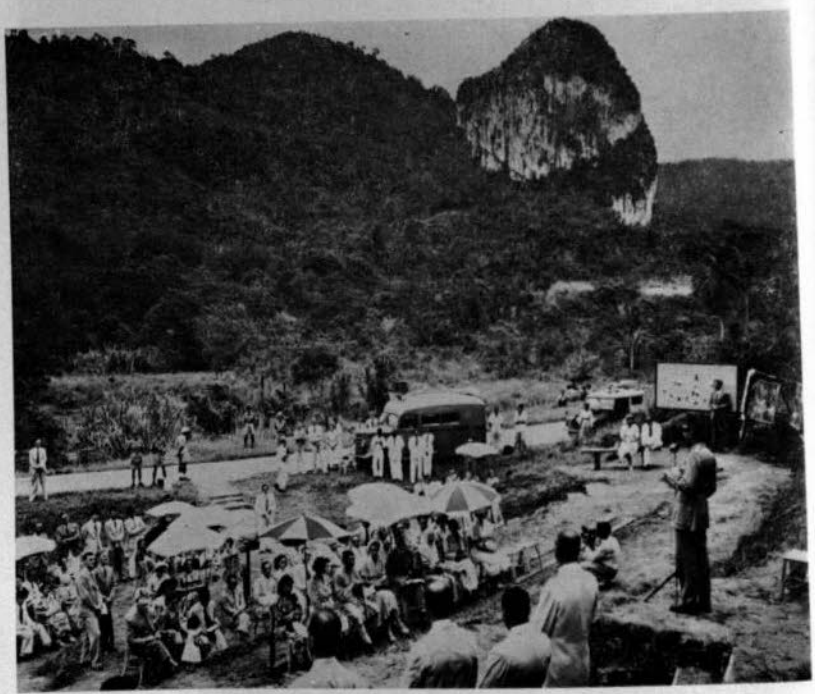

PLATE 48b. Tun Sir Gerald Templer delivering his address during the ceremony.

PLATE 49a. Jalan Raja Udang in the Western Section of Templer Park.

PLATE 49b. The former Sultan of Selangor, the late Hishamuddin Alam Shah planting a commemorative chengal tree at the opening ceremony.

PLATE 50a. Tasek Barat, Templer Park.

PLATE 50b. Picnic spot in the Western Section of the Park.

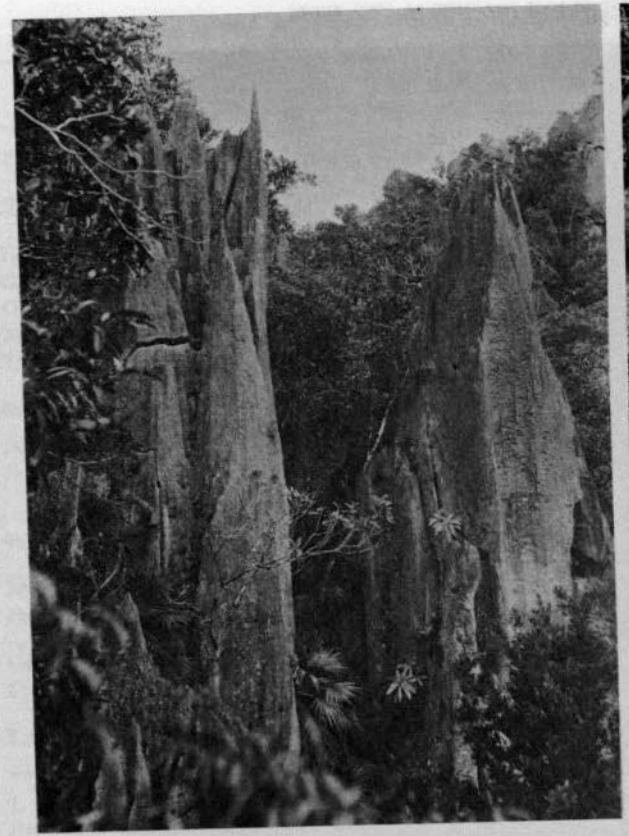

PLATE 51a. Limestone pinnacles on the summit of Bt. Takun.

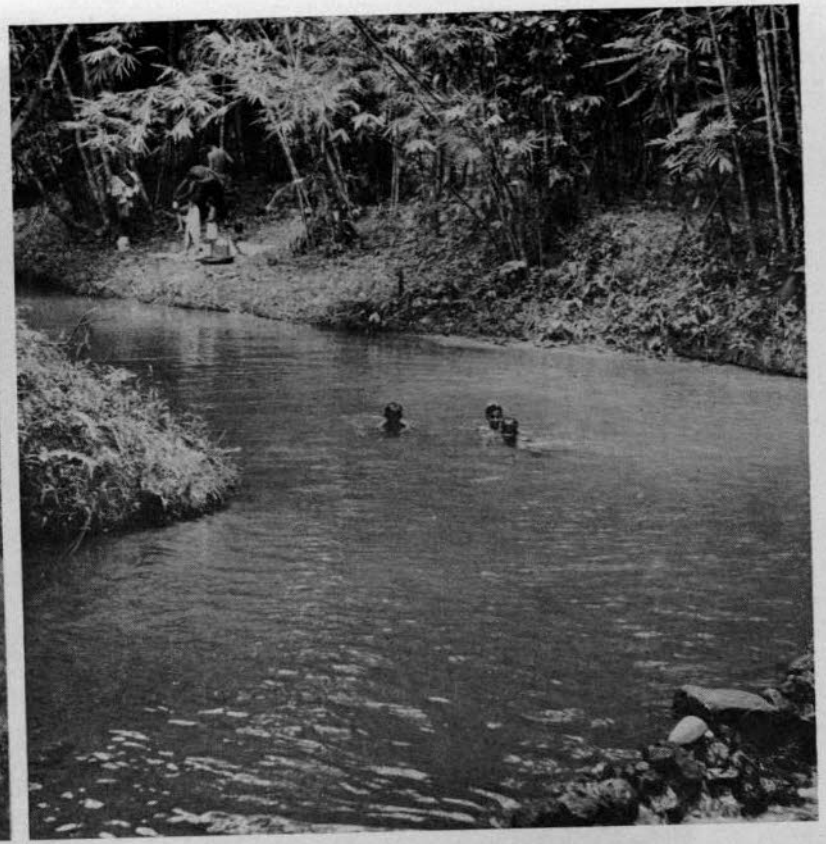

PLATE 51b. The Sg. Kanching in Templer Park.

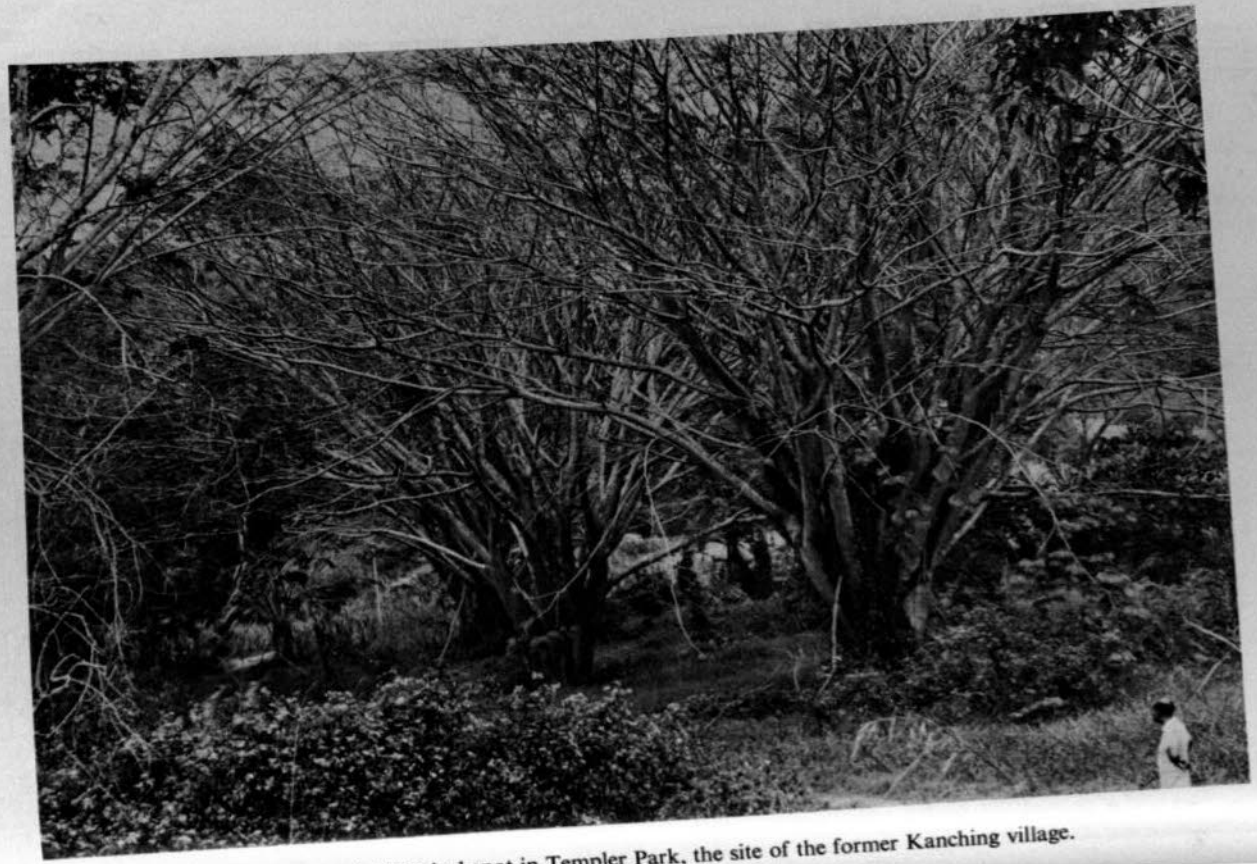

PLATE 52. A historical spot in Templer Park, the site of the former Kanching village.

Table 1. Wild mammals either seen, identified by foot prints, or recognised by call in Templer Park.

Species	*Seen*	*Footprint*	*Call*	*Location by Section*	*Observer*
Tiger (Harimau belang)	+	+	–	E. & C.	Park workers, Game Warden, motorist.
Black Panther (Harimau kumbang)	+	+	+	W.	Park worker (Rahman), motorist.
Leopard (Harimau bintang)	+	–	–	E./C. border	Park worker (Jamil).
Civet (Musang)	+	–	–	W. & C.	Park workers, the author.
Otter (Berang-berang)	+	–	–	W.[1]	Park worker, the author.
Malayan Bear (Beruang)	+	–	–	E. (on tree)	Park workers (Jamil, Rahman)
Tapir (Chipan)	+	+	–	E. & W.	Park workers, the author, visitors.
Sambhur Deer (Rusa)	+	–	–	E. nr. Sg. Kasan	Park worker (Jamil).
Barking-deer (Kijang)	+	–	+	E./C. border	Park worker (Jamil).
Serow (Kambing Gurun)	+	+[6]	–	W. & C.[2]	Park worker (Rahman), the author, D. Eyles, other visitors.
Wild Pig (Babi hutan)	+	+	–	W.C. & E.	Park workers, the author, visitors.
Mousedeer (Kanchil)	+	+	–	W.C. & E.	Park workers.
Pangolin or Scaly Anteater (Tenggiling)	+	–	–	W.[3]	Park worker (Rahman), the author.
Gibbon (Wa-wa)	–	–	+	E.	Visitors, the author.
Dusky Leaf Monkey (Lotong berchelak)	+	–	–	E.[4]	Park worker (Rahman) the author.
Long-tailed Macaque (Kera)	+	–	–	W.[5]	Park workers, the author.

1. Swimming in Sg. Kanching. 2. Waterfall and limestone hills. 3. Near waterfall. 4. In forest near clearing. 5. Near waterfall in Terap fruiting season. 6. Droppings.

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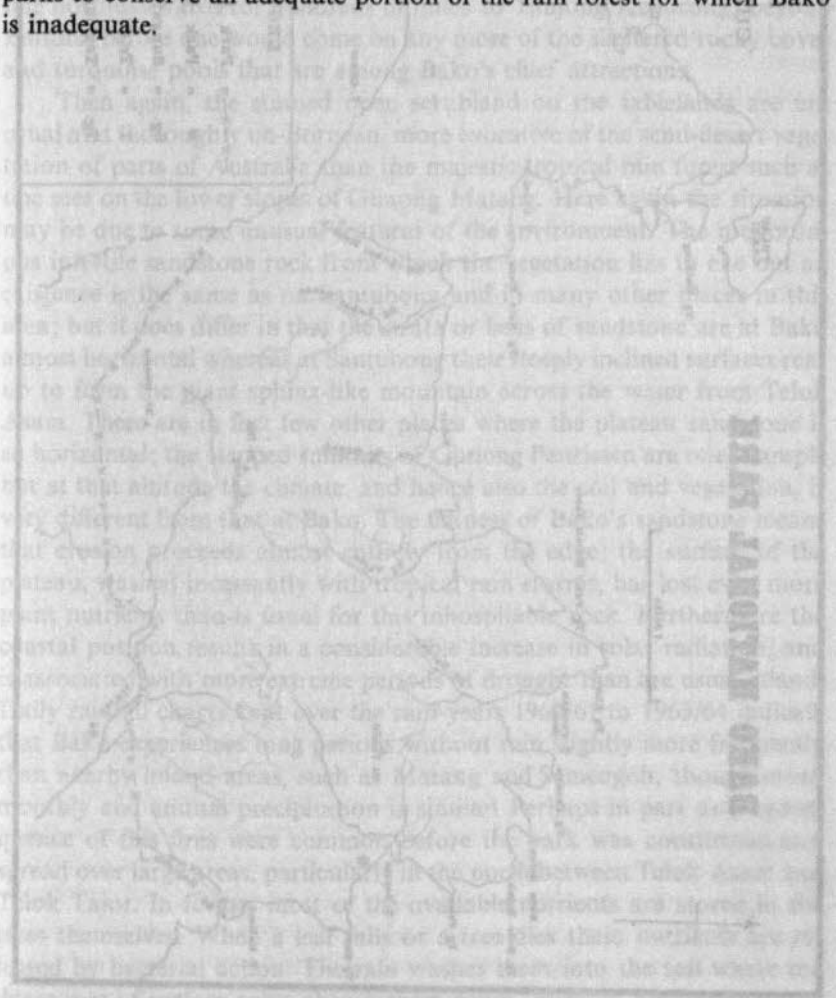
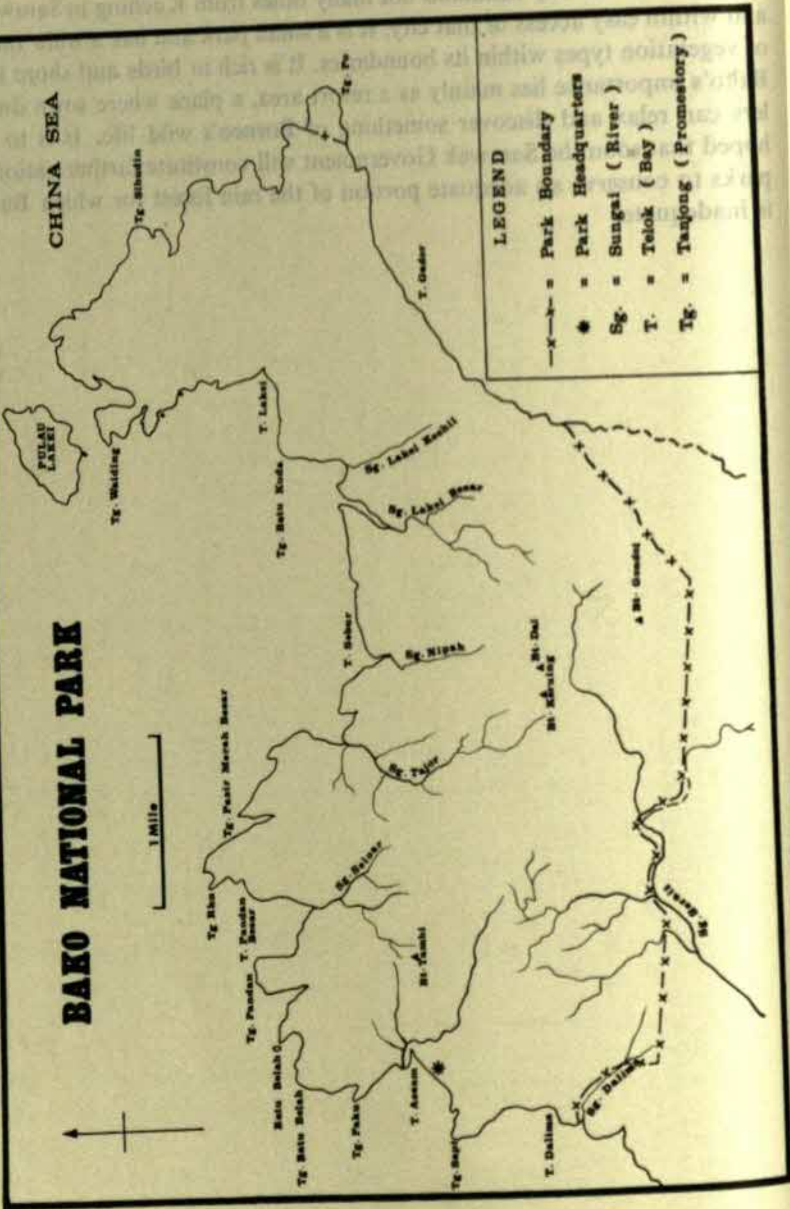
Bako National Park

Bako lies on a rocky headland not many miles from Kuching in Sarawak, and within easy access of that city. It is a small park and has a wide range of vegetation types within its boundaries. It is rich in birds and shore life. Bako's importance lies mainly as a resort area, a place where town dwellers can relax and discover something of Borneo's wild life. It is to be hoped that soon the Sarawak Government will constitute further national parks to conserve an adequate portion of the rain forest for which Bako is inadequate.




BAKO NATIONAL PARK
1 Mile
CHINA SEA
PULAU LAKEI
Tg. Wailding
Tg. Sibudin
Tg. Po
T. Lakei
Tg. Batu Kuda
T. Sebur
T. Gador
Tg. Rhu
Tg. Pasir Merah Besar
Tg. Pandan
T. Pandan Besar
Batu Belah
Tg. Batu Belah
Tg. Paku
T. Assam
Tg. Sapi
T. Dalima
Sg. Delima
Sg. Serait
Sg. Rejuan
Sg. Tajor
Sg. Nipah
Sg. Lakei Besar
Sg. Lakei Kechil
Bt. Tambi
Bt. Keruing
Bt. Dai
Bt. Gondol
LEGEND
= Park Boundary
= Park Headquarters
Sg. = Sungai (River)
T. = Telok (Bay)
Tg. = Tanjong (Promestory)

Malay. Nat. J. **24**: 151–162 (1971)

The Plants and Vegetation of Bako National Park

P. S. ASHTON[1]

Visitors to Bako will at once notice the unusual appearance of the vegetation around them. The woods, hanging on steep hillsides over the picturesque rocky coastline, are unusual; this is because rocky coastlines are in fact rare in Sarawak. They are found here, and also at Santubong and Tanjong Datu, but from Tanjong Po one could walk right along the coastline northeastwards for hundreds of miles to Tanjong Kedurong, beyond Bintulu, before one would come on any more of the sheltered rocky coves and turquoise pools that are among Bako's chief attractions.

Then again, the stunted open scrubland on the tablelands are unusual and thoroughly un-Bornean, more evocative of the semi-desert vegetation of parts of Australia than the majestic tropical rain forest such as one sees on the lower slopes of Gunong Matang. Here again the situation may be due to some unusual features of the environment. The monotonous infertile sandstone rock from which the vegetation has to eke out an existence is the same as on Santubong and in many other places in this area; but it does differ in that the strata or beds of sandstone are at Bako almost horizontal whereas at Santubong their steeply inclined surfaces rear up to form the giant sphinx-like mountain across the water from Telok Asam. There are in fact few other places where the plateau sandstone is so horizontal; the stepped summits of Gunong Penrissen are one example but at that altitude the climate, and hence also the soil and vegetation, is very different from that at Bako. The flatness of Bako's sandstone means that erosion proceeds almost entirely from the edge; the surface of the plateau, washed incessantly with tropical rain storms, has lost even more plant nutrients than is usual for this inhospitable rock. Furthermore the coastal position results in a considerable increase in solar radiation, and is associated with more extreme periods of drought than are usual inland. Daily rainfall charts kept over the rain-years 1960/61 to 1963/64 indicate that Bako experiences long periods without rain slightly more frequently than nearby inland areas, such as Matang and Semengoh, though mean monthly and annual precipitation is similar. Perhaps in part as a consequence of this fires were common before the park was constituted and spread over large areas, particularly in the north between Telok Asam and Telok Tajor. In forests most of the available nutrients are stored in the trees themselves. When a leaf falls or a tree dies these nutrients are released by bacterial action. The rain washes them into the soil where the dense mat of surface roots absorb them again. Burning breaks the cycle, destroys the main food source, and in the space of time before vegetation

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littoral vegetation there is usually a band of another but equally characteristic type, but in Bako this has long since been cut down.

Mangrove forest is limited in area in the park, being found mainly at Telok Asam and nearby Telok Delima, at Telok Sebur and Telok Lakei, and small areas elsewhere. Here again nearly all the species are widespread and therefore not of much botanical interest, though visitors who do not know this kind of forest should visit the overhead walk through the mangrove at Telok Asam at low tide, when the lines of curious aerial roots radiating from the *Sonneratia* trees are exposed and the oozing cat-clay is sonorous with the popping of 'Locan', an edible bivalve; the pop-eyed amphibious fish and many brightly coloured crabs manoeuvre about, each leaving its characteristic trail, as the intruder passes by.

Three types of mangrove forest can be distinguished in Bako: on sheltered parts of the coast on saline sands and clays, is one in which Pedada (*Sonneratia alba*) is the commonest tree. This is the type at Telok Asam and Telok Delima; small patches are also found at Telok Sebur, Telok Gadur and along the east coast. On the heavier clays near the channels the occasional Bakau Kurap (*Rhizophora mucronata*), recognised by its long stilt roots and large leaves, is found, while on the sandier areas around the margin Api-api (*Avicennia officinalis*) replaces the Pedada. At Telok Tajor in particular Putut (*Bruguiera parviflora*) is common. On more consolidated muds richer in clay, as along margins of the larger rivers near their mouths, is another type consisting almost entirely of Bakau Kurap. This is found for instance behind the last-mentioned type at Telok Asam and also at Telok Gador, Telok Pandan Besar and Kechil, and in a big area at Sg. Lakei. Other mangroves such as Tumu Merah (*Bruguiera gymnorrhiza*), Tumu Puteh (*Bruguiera sexangula*), Berus (*Bruguiera cylindrica*) and Tengar (*Ceriops tagal*) are occasional in this type.

The third type occurs on land flooded at high tide only, and is found behind the beach at Telok Asam and between Telok Sebur and Telok Lakei; small patches are also found elsewhere. This consists of dense stands of Nipah palm (*Nipa fruticans*), a common but very interesting plant. It is used for innumerable things, but is particularly unusual in providing both sugar (from the inflorescences) and salt (from the leaves) from the one plant; it is also peculiar in that it is capable of producing heat—the young inflorescences are *warm*! A few other plants occur scattered among the Nipah, including Nibong palm and the large crowned Dungun (*Heritiera globosa*), easily distinguished by its prominent, spreading and branching, narrow, plank buttresses.

THE INLAND VEGETATION

It has already been stated that the availability of plant nutrients and water in the soil strongly influences the luxuriance of the vegetation. The availability of plant nutrients depends on two independent factors: the actual

concentration per unit volume of soil, and the depth of soil available for the roots to exploit. Drainage is important in two different ways: the constancy of the water supply is important, but on the other hand excess of water, as in waterlogged swampy areas, excludes oxygen, essential to the roots, from the soil and thus reduces the depth of soil available for the plant to exploit.

The ideal soil conditions for the development of a high tropical rain forest rich in tree species is therefore where the soil is deep, rich in nutrients, well drained but with constantly available water, either retained between rain storms or supplied by lateral water movement through the soil. The opposite of these three conditions is the worst, and leads to poverty in size and number of species; it is this one which is prevalent at Bako. Nevertheless, the soil factors just discussed do vary in the park, and it is mainly on this account that several different types of vegetation can be recognised. In the driest areas and the most fertile areas, however, the influence of man is sometimes paramount.

The most fertile soils are the alluvia in the valleys of the larger rivers, occurring at Telok Asam between Telok Sebur and Sungei Lakei. Here the alluvium is sandy clay, and though wet, is rarely stagnant owing to strong lateral water movements; peat only occurs therefore in a few small patches, and roots penetrate relatively deep. Though the forest here has in parts been completely felled, and selectively creamed for timber elsewhere, the remnants still existing proclaim it to be the tallest in Bako. It is also very rich in species, typical examples being *Campnosperma coriaceum*, the swamp durian *Durio carinatus* and the Durian isa (*Coelostegia borneensis*), a stately tree with prominent buttresses whose woody fruits, resembling durians, lie unrotting at the base of the trees for months and can often be seen near the plank walk through the valley at Telok Asam. The illipe nut tree Engkabang jantong (*Shorea macrophylla*) is also here, and a variety of fruit trees in the genus *Artocarpus*, such as Bintawak (*A. anisophyllus*), Chempedak (*A. integer*), Pudau (*A. kemando*) and Terap (*A. odoratissimus*). The ground is often covered with dense stands of the thorny stemless palm Asam paya (*Salacca conferta*). In the Ulu Serait there is another area of alluvium called the Paya Jelutong. Here the soil is more swampy, and though lateral movement is still strong, water at the soil surface and peat accumulation up to two feet deep is a common sight. This, added to the fact that the aluvium is grey silty coarse sand, means that conditions are not as favourable as at Telok Asam. The forest, though still rich in species, is less so than the previous type, and the canopy is somewhat lower. Of the *Artocarpi* only *A. odoratissimus* remains. Engkabang jantong is replaced by Engkabang rusa (*S. stenoptera*), characteristic of poorly drained sandy soils; similarly Durian isa is replaced by Bengang (*Neesia malayana*), a short-boled broad-crowned tree, also of the durian family, often associated with Engkabang rusa and pos-

sessing a curious large fruit resembling in shape a Chinese lantern—beware of it for inside it is coated with irritant hairs! Bengang does occur, but is far less common, at Telok Asam. Indicating the more swampy conditions existing here is the presence of two true swamp trees, Bintangor jangkar (*Calophyllum sclerophyllum*) and Jelutong paya (*Dyera lowii*). Past tapping of the latter for latex is the only human influence discernible in this forest. At the margins of the Paya Jelutong, where drainage conditions are better, several dipterocarp species are found and the transition to this type of forest, which occurs on the nearby slopes of Bukit Gondol and Bukit Dai, is gradual. On slightly sloping depressions of the sandstone plateau and on gentle slopes of the escarpment by the larger streams a forest transitional between that in the Paya Jelutong and Heath forest (Kerangas) occurs. This is found in the Ulu Pandan and Ulu Delima, while a more extreme version is found in the Ulu Tajor. Water is near the surface but drainage is good, and the soils, though variable, are frequently yellow near the surface. Boulders abound however, and on the plateau the sandstone is never far below the surface. The canopy is yet lower than in Paya Jelutong; Lun paya (*Shorea longiflora*) occurs, as well as Simpor paya (*Dillenia pulchella*), Entuyut (*Tetramerista glabra*), and Kawi (*Whiteodendron moultonianum*) all of which are tolerant of acid peaty soils with poor drainage; Bintangor jangkar and Bengang are still prominent components. The larger streams that pass through these forests have sandstone beds and are fringed by sandstone rocks and banks of white sand. The fringing vegetation, which is seen at its best by the pools in the Ulu Tajor, is characteristic and very beautiful. The dark brown clear water reflects the bright green canopy of *Dipteris lobbiana*, a slender fern which covers the bordering sandstone rocks, while the brilliant coppery bark of the gregarious *Tristania clementis* trees contrasts with the darkness of the water. In the shallow margins the pale leaves of an aquatic *Utricularia* with pale blue flowers shine in the pools.

The deepest and most fertile residual soils are found on the slopes of the scarp, and on the southern slopes of Bukit Dai and Bukit Gondol. Here alone the soil is yellow with iron oxide, an indication of comparatively high fertility compared with the white soils of the plateau. Texturally they would be classified as loamy sands or sandy loams. The forest, which is almost as tall and rich in species as on the alluvium at Telok Asam, differs from the forests there both in its species composition and structure. The appearance of the forest differs markedly owing to the dominance of the family Dipterocarpaceae; the hemispherical crowns of the many large dipterocarps, resembling so many cauliflower heads, can be picked out on the slopes above Telok Delima when coming into Telok Asam by sea. This forest is hence called Mixed Dipterocarp forest. There are few ground herbs except on boulders, and the ground vegetation is mainly composed of tree seedlings and saplings.

The most favourable conditions occur over small areas on the north-eastern and north-western slopes of Bukit Gondol, and on the lower slopes of the western and eastern escarpment north of the cut boundary as far as Telok Gador and Telok Asam. Here, on the gentle lower slopes, drainage is good but moist conditions prevail, and the soil has a relatively high clay content. Here there are many emergent dipterocarp species, noticeably species of Keruing (*D. geniculatus, D. costulatus, D. nudus, D. confertus* and others), Mersawa kunyit (*Anisoptera grossivenia*) with its golden crown and leaves clothed below with turmeric-coloured scales, Kapur bukit (*Dryobalanops beccarii*) and several merantis (*Shorea bracteolata, S. pauciflora, S. beccariana, S. scabrida, S. scaberrima*). Among other larger trees are several species in the oak family, such as the deciduous Bornean chestnut *Castanopsis motleyana*, and the oaks *Lithocarpus cooopertus* and *L. dasystachyus*, whose acorns are often seen on the paths. There are so many different species in all, none of which are noticeably more common than others, that it is not possible to single out names.

On somewhat steeper slopes, where rocks are more abundant and the soil somewhat more sandy there is a shift in the species composition. Dipterocarps still dominate the canopy though and in many places appear more prominent. Among the merantis, for instance, *Shorea bracteolata, S. pauciflora, S. beccariana* and *S. scaberrima* drop out and are replaced by *S. ovata, S. slooteni, S. elliptica* and others, while the Selangan batu, *Shorea crassa*, is particularly evident. This type is found where the Ulu Serait passes the slopes of the escarpment at the cut boundary, on the slopes south and partly to the north of Paya Jelutong, in some places between Batu Puteh and Sg. Delima, on the lower slopes behind Telok Delima, on the slopes of the escarpment south of Telok Tajor and Telok Lakei, and at Telok Lakei, itself.

In the drier areas on the middle and upper slopes of the coastal escarpments, such as at Telok Asam and Delima, at a small area at Telok Sebur, and along the east coast, the soil becomes more sandy and podsolisation becomes more severe; this is also noticeable in transition areas to Heath forest in other places, such as at Bukit Gondol and Batu Puteh. Frequently there is an upper layer of white or grey sand separated from the yellow sandy loam below by a dark coloured humic B horizon of variable depth. Water availability is more variable than in other Mixed Dipterocarp forest soils, but is nowhere acute. Here the forest structure becomes simpler, the canopy more even and somewhat lower, and the species fewer. There is a further shift in species composition; two species, *Shorea flava* (Selangan batu) and *Dryobalanops beccarii* become very abundant and almost semi-gregarious, while *Shorea multiflora, Dipterocarpus sarawakensis*, and in some places *Dipterocarpus borneensis* which is a Heath forest species, make their appearance. Many species have dropped out, though *S. ovata, S. crassa* and *S. scabrida* remain frequent. Heath

forest elements appear in the lower storeys as well, such as Jenjulong(*Agrostistachys borneensis*) and a species of Kayu malam (*Diospyros hermaphroditica*).

The remaining area of the park, which is more than half the total area, bears podsolised white sands, and sometimes clays. The vegetation on these soils is called collectively Heath vegetation or Kerangas. The primary vegetation varies from low forest to open scrubland according to the soil conditions. Where the physiological depth of the soil is relatively great a closed canopy Heath forest is found; Brunig has described it well: 'Even the botanically less experienced, casual wanderer will notice the change when he enters the Kerangas forest from the Lowland Dipterocarp forest, not only because of the change in species, with which he may not be familiar, but also because of the striking difference in the structure and texture and in the whole colour of the forest. The Lowland Dipterocarp forest is a rather loose tangle of integrated storeys of which none is clearly separated or dominating the others. The whole growing space is loosely and evenly filled with green foliage and the general impression is of a sombre but fresh green. In the Kerangas forest the storey formed by large saplings and small poles dominates. The lower storeys are dense and composed of straight stems of saplings and poles forming a tidy and orderly but forbidding phalanx, which is often difficult to penetrate. The main canopy is low, uniform, and usually densely closed. Single emergents may occur and usually indicate extreme site conditions. Brown and reddish colours prevail in the foliage of the upper storeys and the sun fills the forest with a rather bright light of reddish-brown hue, which, in spite of the dense main canopy, appears to be considerably brighter than the light in the Lowland Dipterocarp forest with its higher and more irregular vegetation'.

A comparison has been made earlier between the scrubland and the arid vegetation of Australia. In fact this scrubland possesses many plant genera that appear to have originated in the remote past from the Australian area, genera that are more particularly found on mountain tops in tropical S.E. Asia, such as *Tristania* (closely related to *Eucalyptus*), *Gymnostoma* (a form of *Casuarina* or She-Oak frequently planted in gardens), *Baeckia*, *Austrobuxus*, *Styphelia*, *Podocarpus*, and *Dacrydium*. These two last mentioned are among the very few conifers found in Borneo, *Dacrydium* being the only lowland species with needle-like leaves and resembling in many ways a fir tree of the temperate tundra. Conifers are considered by botanists more primitive and ancient than the flowering plants, and in Borneo have only been able to compete against them where conditions are relatively unfavourable for flowering plants.

Brunig (1965) in his report on the Kerangas vegetation of Bako National Park, recognises 6 subtypes in a series related to decreasing physiological depth of the soil and increasing variability of water supply.

Under the most favourable conditions dipterocarp species are still prominent among the larger trees, but Rhu ronang (*Gymnostoma nobile*) and the conifer Sempilor (*Dacrydium beccarii* var. *subelatum*) are present also. Here the canopy is at about 90–105 ft high. On the best sites, as around Bukit Tambi, the enormous leaves of the stemless palm *Johannesteysmannia altifrons*, resembling the feathers in a shuttlecock, are a typical sight, whereas in damp places the large fan-palm *Pholidocarpus majadum* is frequent. On rock outcrops the wild sago *Eugeissona insignis* is very common, and, where shady conditions prevail, the tree fern *Cyathea latebrosa*. Where the rocks are exposed they are richly covered in beautiful ground herbs, including Aroid lilies and several species of *Didymocarpus* and other Gesneriaceae with cream and lilac tubular flowers. Small palms of the genera *Pinanga*, *Areca*, *Iguanura* and *Licuala* everywhere abound. Forests of this type occur around Bukit Tambi, on the plateau east of Telok Delima, along the Serait path, in the Ulu Lakei, around Bukit Gondol and Bukit Dai, and in a disturbed state near Batu Puteh.

As conditions become more adverse, the soil shallower and more liable to drought, dipterocarps become fewer, *Cotylelobium burckii*, with its leathery oblong leaves with ochreous undersurface, being an exception. Other emergents include *Dacrydium*, *Gymnostoma*, some *Shorea ovata* and *Dipterocarpus borneensis*, *Whiteodendron moultonianum* and the Renghas tree *Melanorrhoea beccarii* whose black sap is well known owing to its toxicity. There is a notable increase at all heights in trees in the genera *Eugenia*, *Calophyllum*, *Kayea*, *Garcinia* and *Stemonurus*. The understorey is now more dense and the canopy lowered to 75–95 ft. This is the most widespread type all over the plateau on gently sloping land, usually in continuous and large areas.

As drainage becomes yet more variable, the soils yet shallower and drought of longer duration, the forest becomes shorter and denser and is best described as a pole forest. The canopy is here only about 27–36 ft high, and is dominated by a few species only, in particular *Dacrydium*, *Stemonurus umbellatus*, *S. lanceolatus*, *Dillenia excelsa*, *Melanorrhoea beccarii*, *Cotylelobium burckii*, and some Sapotaceae and Theaceae. *Eugeissona* is still common on rocky places, but most other palms are fewer or have disappeared. This type is found in a broad belt along the northern coast from Tanjong Pandan to Sg. Lakei and on the whole north and south sides of the Paya Jelutong range, where it is fringed on the coastal side by better forest of the preceding types, and gives way in places to forests yet to be described. It occurs in large compact areas dotted with rocky outcrops bearing different vegetation, or as belts between other types.

Around the margins of open canopy vegetation or scrubland an extreme type of forest is found with a canopy at about 15–30 ft high. Though

the species are much as in the last type single species frequently become dominant; the dominant species varies from place to place. Palms are yet rarer, but there is a noticeable increase in the density of mosses both on the ground and on the lower parts of the trees.

A closed canopy vegetation of similar height also occurs round the tops of cliffs, as, for instance, in some places at the top of the scarp above Telok Delima, and the tops of cliffs at Tanjong Sapi, Tanjong Asam, Tanjong Paku and Tanjong Pandan. This is similar to the last but the small leaved *Eugenia bankense* is particularly abundant and scrubland plants such as *Styphelia malayana* and *Baeckia frutescens* make their appearance.

On flat rock surfaces near the headlands in the north around Tanjong Rhu there is a curious open forest in which *Dacrydium* is the only common species. Owing to the open crown of this species the ground vegetation is dense, though poor in species, and epiphytes are common on the *Dacrydium* trees, whose shaggy bark both provides good purchase and accumulates plant remains which provide nutrients.

The open vegetation in Bako, known where probably primary as scrubland and where probably secondary as fire padang, is very widespread on the sandstone plateaux, and is variable in species dominance and composition as well as in structure. It is very likely that man has been associated with the Bako headland for a very long time owing to its commanding position on the coast. Records of burning or cultivation even in the last 50 years are very scanty however, though gambier is known to have been much cultivated in the Ulu Serait in the 19th century. Brunig (1965) has discussed at length the possibility of a secondary origin for most or all the Bako scrubland, and concludes that much may in fact be natural. This is presumably true of the small islands of scrubland that occur on almost soil-less sandstone knolls and plateau in the closed forests north of Bukit Dai, but elsewhere evidence is at present insufficient to support either argument.

Most areas of obvious secondary origin occur either around the Lintang path, or along the northern part of the plateau from Telok Asam across to Telok Tajor; frequently, particularly on the Telok Tajor path, a small valley will have open scrubland on one side and closed canopy Heath forest on the other, suggesting that the damp watercourse had prevented the fire from spreading further. Certain plant species indicate relatively recent burning, in particular the ground orchid *Bromheadia finlaysoniana* with its pink and magenta flowers, the shrubby trees *Cratoxylon glaucum*, *Dillenia suffruticosa*, and *Fagraea racemosa*, the Resam fern (*Dicranopteris linearis*) and Rumput naga (*Lycopodium cernuum*). Recently burnt areas are usually poorer in epiphytes than other scrubland.

The stable scrub vegetation however is rich in epiphytic plants, in particular *Nummularia* ferns, *Hydnophytum* and *Myrmecodia tuberosa*—remarkable plants whose roots form swollen tubers full of passages which

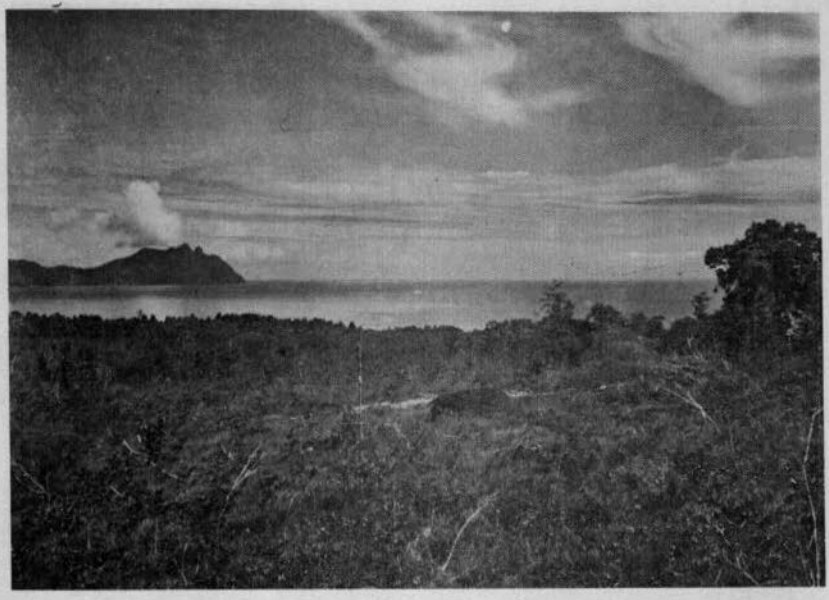

PLATE 53a. Fire climax vegetation over flat sandstone beds at Bako with G. Santubong in distance where the beds are steeply inclined.

PLATE 53b. Paku Laut, the primitive *Cycas rumphii*, on the shore at Bako.

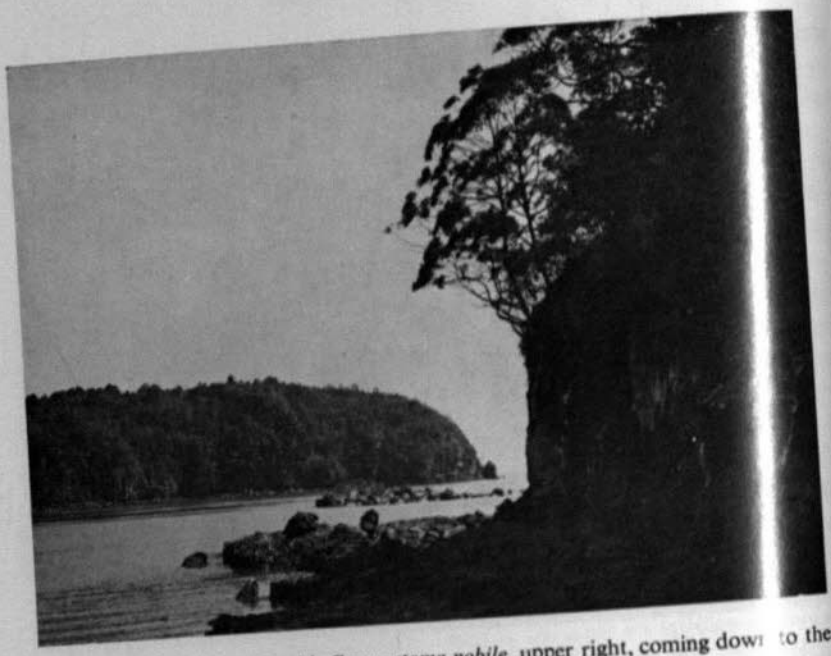

PLATE 54a. Heath forest with *Gymnostoma nobile*, upper right, coming down to the water's edge at Telok Waiding. P. Lakei in background.

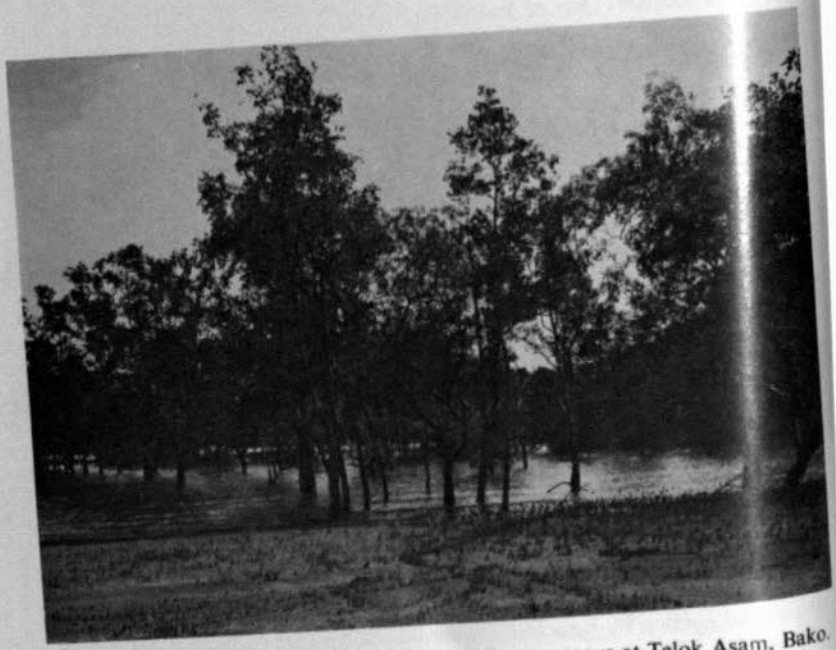

PLATE 54b. Incoming tide in the *Sonneratia alba* mangrove at Telok Asam, Bako.

PLATE 55. Durian Isa (*Coelostegia borneensis*), a stately tree with prominent buttresses. Asam Paya, *Salacca conferta*, palm in background.

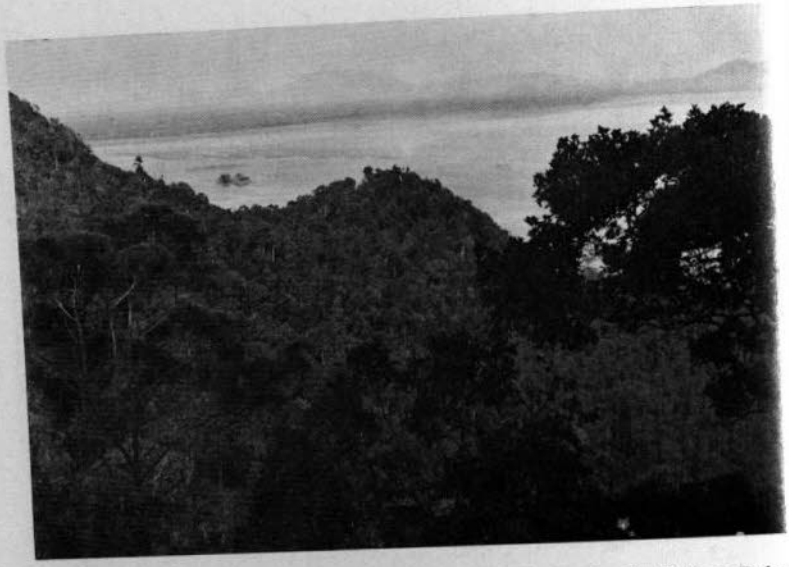

PLATE 56a. Mixed dipterocarp forest cloaking the hillsides in the Ulu Delima, Bako Buntal Bay and G. Matang in distance.

PLATE 56b. The enormous leaves of the stemless palm *Johannesteysmannia altifrons* resemble the feathers of a shuttlecock.

PLATE 57a. *Dacrydium* dominated forest on flat rock near the headlands.

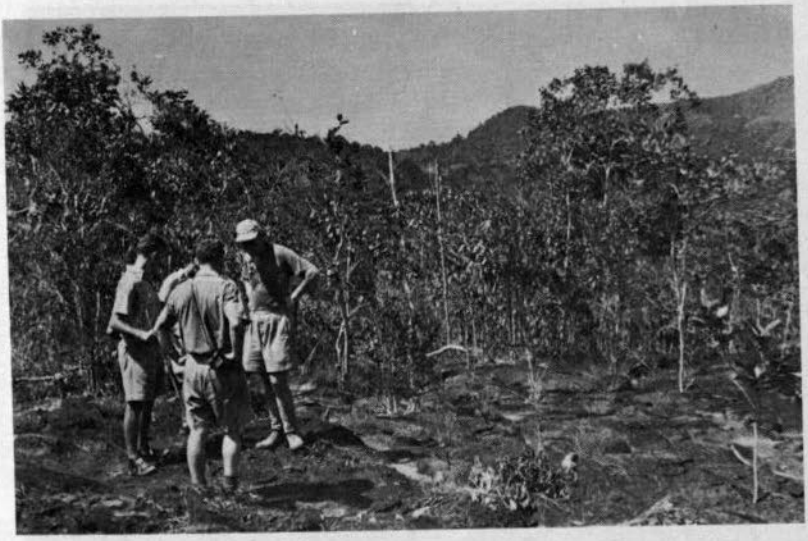

PLATE 57b. Small islands of scrub occur within closed forest on almost soil-less sandstone knolls and plateau.

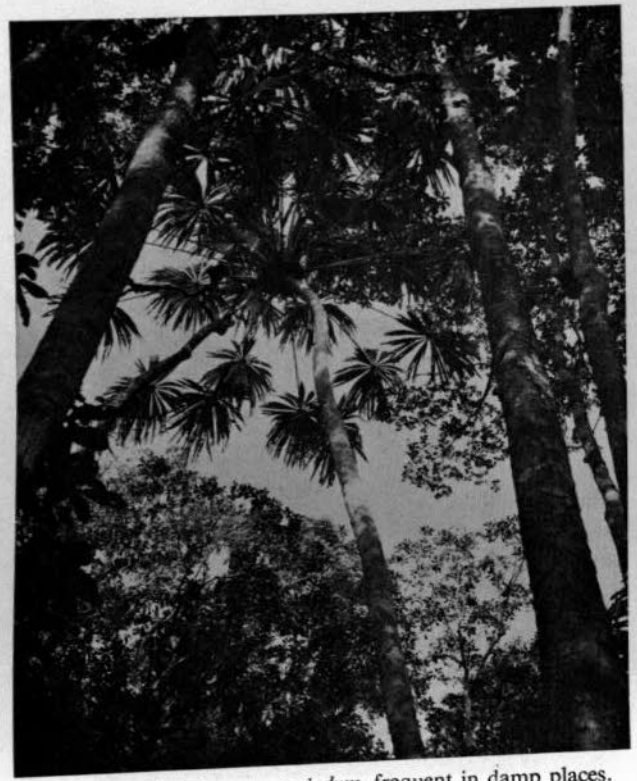

PLATE 58a. *Pholidocarpus majadum*, frequent in damp places.

PLATE 58b. The pitcher plant *Nepenthes ampullaria* with *Lycopodium cernuum*—rumput naga.

are inhabited by ants, and *Henslowia*; parasitic mistletoes (family Loranthaceae) are also common. Under these impoverished conditions plants occur which have evolved cunning methods of supplementing their meagre diet. Just as the ants in the tubers of the epiphytes mentioned above play an important part in providing nutrients for them, some trees and shrubs at Bako, such as *Clerodendron fistulosum* with its beautiful pink and white flowers, possess hollow swollen stems which also harbour ants, apparently for the same reason. Five pitcher plant species are also found—*Nepenthes ampullaria* which forms rosettes on the ground with small bulbous pitchers, *N. gracilis* which is a small climber with slender pale green pitchers furnished with two fringes of long hairs, *N. albomarginata* with somewhat bigger purple striped pitchers, *N. mirabilis* which resembles *N. gracilis* but lacks the hairs, and *N. rafflesiana* with a broad pitcher striped with purple and with two fang-like processes at the base of the lip. Another insectivorous plant which is rare in the lowlands outside Bako is the Bornean sundew *Drosera spathulata*, a small rosette plant found growing commonly along paths by streams and water seepages in open places; its small red leaves bear on their upper face a pad of hairs which secrete a sticky exudation with which insects are caught and digested. Another frequent genus is *Burmannia*, whose members are hemi-saprophytes; at Bako *B. coelestis*, with blue flowers, is common in damp places, whereas the cream flowered *B. disticha* is more widespread.

Many beautiful trees are found in the scrubland, some of which merit introduction into our gardens. Notable among these are *Tristania stellata* with smooth purplish and olive striped bark and rufous hairy leaves, *Ormosia microsperma* with ochreous hairy leaves and pods splitting open to expose hard little brilliant vermillion seeds, the dense hemispherical shrub or low tree *Calophyllum nodosum* with small fragrant cream flowers and the needle-leaved Chuchor atap (*Baeckia frutescens*). In rocky areas *Dacrydium*, *Cratoxylon glaucum*, *Calophyllum nodosum* and *C. incrassatum* are the commonest trees. On damper, flatter areas, Chuchor atap becomes dominant, with Somah (*Ploiarium alternifolium*) and *Dacrydium* associated. In a small area at the beginning of the Ulu Serait path a *Dacrydium* dominated scrub occurs on an excessively drained hillslope bearing shallow red clay soil; elsewhere in many places small almost pure stands of *Dacrydium* occur in scrubland on wet to moderately wet shallow sandy soils. Near streams and other areas where surface water is more or less constantly present, and shallow humus stained sands overlie sandstone rock or clay pockets, Somah forms a dense low scrub in association with *Tristania stellata*, *Rhodamnia cinerea* and a few other species.

Along the beaches many curious and beautiful fruits are washed up, and a favourite pastime is to see how many different kinds can be collected. These fruit originate from mangrove and sea-shore trees, and frequently even from riverside trees far away in the ulu, which spread by

dropping their floating fruit in the fast flowing water. Striking among them are the fruit of *Nipa*, the spear shaped mangrove fruits which develop a big root before they fall to anchor them in their shifting muddy habitat, the large four sided fruit of Putat Laut (*Barringtonia asiatica*) and the finned fruit of Dungun (*Heritiera globosa*) mentioned earlier, and the beautiful fruit of *Barringtonia conoidea*, shaped like an old-fashioned lantern, whose soft tissue is eaten away by the sea to leave a delicate tracery of vascular elements.

Bako is a nature lover's paradise. If you are thinking of taking up an interest in the wild plants of Sarawak, Bako with its well cut paths, its easy accessibility and its great variety is ideal. Along the Lintang path many of the trees have been labelled, with Malay and scientific names, specially for your interest. But please treat them with respect, these plants are silently building up a beautiful woodland from an inhospitable impoverished soil. The damage your match can cause may be irreparable. If you see a beautiful flower, do not pick it, for others will not then be able to share its beauty.

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Animals in Bako National Park

G. ROTHSCHILD[1]

The Bako National Park is a wonderful mixture of forest and open heathland, cliffs and mangroves, sandy beaches and rocky headlands—all within a remarkably small area. The accessibility of all this rich diversity of habitats along extensive and well laid paths makes Bako an exciting area for the naturalist to explore. The botany and the geology of Bako are fairly well known already for they have been the subject of relatively detailed and intensive study but, unfortunately, no such comparable zoological study has yet been made. Bako's animals remain largely unknown. This article, therefore, is in no way a summary; rather it is a collection of zoological impressions, a sample of some of the more generally interesting and conspicuous, the specialities, of the vast assemblage of animals that makes up Bako's fauna. Possibly the life of the seashore takes up a rather disproportionate amount of space, but it is a fact that the vast majority of visitors, mainly families with children, spend the greater part of their time on the shore, and it is here that nature is probably at its most conspicuous and bizarre to the non-zoologist.

Of all the endlessly varied and prolific life of the seashore shells are probably the most familiar, certainly the easiest to study, and equally certainly amongst the most beautiful of all animals. Lying amongst the bric-a-brac of debris washed up and renewed afresh by each successive tide beautiful or grotesquely shaped and coloured, they clamour for attention and are almost irresistibly collected. A shell is the creation and habitation of a very soft backboneless animal called a mollusc; it is part of a living animal that grows and undergoes repair so long as the animal is alive; it is the 'bones' that remain after the animal has died. The empty shells on any shore can be divided even superficially into two fundamental types: a usually spirally coiled, one piece type, and another consisting of two fan-like parts, or valves, joined together by a hinge which is, however, often broken in empty shells. The former type is called a univalve, or gastropod, and is represented by such well known gastronomic titbits as winkles and 'French snails', the latter being among the many landliving, air-breathing forms. The type with two valves is called a bivalve, or lamellibranch, and is also best exemplified with reference to the stomach by cockles, mussels, oysters and giant clams which Captain Cook referred to as 'cockles of so enormous a size that one of them was more than two men could eat'.

Gastropods and lamellibranchs are the two most important and widespread of the several groups of molluscs. It may come as a surprise to

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many to hear that a third, the cephalopods, comprise the octopi, squids and cuttlefish, for in appearance there is little in common between sessile oysters and mussels, only slightly more agile snails and winkles, and the extremely active and alert octopi and squids. But, in fact, they all share basic similarities in their anatomy and the cephalopods are simply molluscs that have become adapted to an active, swift moving, predatory life. Small octopi can sometimes be seen at Bako, and the chalky, white, internal skeleton of the cuttlefish is a familiar object along the tideline.

The form and colour of a shell is largely determined by its environment. Those shells that live between the tidelines amid pounding seas and surf beaten rocks are solid and frequently ornamented with knobs and ridges for added protection. The limpets, periwinkles and rock whelks that can be found on the rocky headlands at Bako have this sort of protection. Others such as the familiar mussels anchor themselves firmly and permanently to the rock surface. Calmer, deeper waters on the whole produce thinner less ornamented shells, while those species that live buried in mud or sand, such as many lamellibranchs, are much more subdued in both form and colour. However, the significance of the extravagant and flamboyant extremes of colouration and ornamentation shown by many gastropod shells is by no means clear and remains to be explained.

The names of gastropod shells are often as flamboyant as the shells themselves. Pimpled Purpura, Blood-red Volute, Puce-mouthed Castor Bean, Ponderous Frog Shell, Gouty Spider Shell and Giant Noddiwink are all names of common Indo-Australian shells that can be found at Bako, at least in closely related form. The commonest gastropod forms at Bako are small, globular, delicately marked sandshells (family Naticidae) and long spiral, extremely graceful and aptly named auger shells (family Terebridae). But countless others are present—large but delicate tun shells (family Tonnidae), named after their supposed resemblance to wine barrels, elaborately spiny murex shells (family Muricidae), strombs (family Strombidae) with peculiar ear or wing-like processes and, perhaps most beautiful of all, exquisitely polished and brilliant cowries (family Cypraeidae). A word of warning is necessary concerning the handling of cone shells (family Conidae), which are sometimes found alive at Bako. These large shells, though handsome, have a sinister reputation and are equipped with a virulent poison system which has been known to cause death to human beings. Like many other gastropods the cone shells are also carnivorous, preying on other molluscs, boring into their shells and sucking out the juices. Such was the fate of the many shells lying empty on the beach with a neat round hole bored through their side.

Lamellibranchs or bivalves are probably even more numerous than gastropods at Bako. Many lamellibranchs live by burrowing in mud or sand, others bore into wood or rock while some, such as mussels (family Mytilidae) and oysters (family Ostreidae), fasten themselves permanently

to some firm support. Among the more conspicuous and numerous species at Bako is one which is shining white, fragile, and shaped rather like a wing. It is appropriately called an Angel's Wings Borer or, less attractively, a piddock. The various forms of this group all have an amazing capacity for boring into rock, clay or submerged wood and some forms do considerable damage to wooden piering and boats. Scallops or fan shells (family Pectinidae) are also present. Possibly they are the most familiar of all shells if only because one form is the trade mark of a well known petroleum company. They are also good eating and have the distinction of being able to fly through the sea by flapping their shell valves. Other common forms at Bako are the beautiful pink and purple sunset shells (family Garridae), the familiar sturdily built heart cockles (family Cardiidae), the more delicately ridged and finely sculptured tellens (family Tellinidae), and many others.

Crabs in various shapes and sizes are essential members of the fauna of any shore. They are largely scavengers feeding on any organic matter that comes their way, and without them tropical beaches would be far less pleasant and unpolluted than they are. Some species feed on the more obvious refuse and are also predators to some extent, others chew sand thereby extracting even the most minute particles of organic matter, while many mangrove species feed on the slimy mud surface, picking daintily with their claws. Many shrimps and prawns, closely related to crabs, are also scavengers and will readily demonstrate their efficiency on someone's hand if it is dangled into a suitable rock pool, for example around the headlands at Telok Asam. Shrimps will quickly come and crawl around one's fingers removing anything movable—dead skin, dirt from one's fingernails—and they make an excellent job of cleaning any open wound. Some species specialise in performing this sort of service for fish in the sea. They may have a definite cleaning station where fish come and queue to have their skin, gills and mouth picked over for parasites, fungal growths and to have sores cleaned. These cleaning shrimps play an important part in maintaining the health of many fish.

The most conspicuous crabs at Bako, both on the sandy beaches and on the mangrove mud, are various forms that spend much of their time out of water. At low tide they feed and scavenge on the sand and mud and then, as the tide advances, disappear into a hole blocking it after them with a neatly made trapdoor, a snugly fitting plug of sand or mud.

The small, shy *Scopimera* lives this sort of life, making its hole on sandy beaches between the tidelines. It is the animal that is responsible for all the small holes in the beach at Bako which are surrounded by a characteristic radiating pattern of small sand pellets. These small crabs scoop up sand with their claws and stuff it into their vertical slit-like mouths. Organic matter is extracted and after being "processed" the residue of sand is ejected through the top of the slit mouth in the form of

tiny sand pellets. *Scopimera* feeds only close to its hole and hence the radiating pattern of grooves and pellets.

Two other very common crabs of the sandy beaches of Bako lead a rather different life. The Sand Crabs *Ocypoda* make their burrows in soft sand above high water level and feed partly by extracting food from sand in the same way as *Scopimera*, but they are also more general scavengers and predators. These are the fairly large spidery looking crabs extremely active and agile, that scurry about "crabwise" over the sand with amazing speed and twinkling legs. Far more peculiar are the hermit crabs, not true crabs but rather intermediate between crabs and lobsters. They have taken to living in the empty shells of gastropod mollucs and are cunningly adapted to this way of life. Their soft, vulnerable abdomen finds protection inside the shell and is spirally twisted in the same way as the shell. If danger threatens the crab retreats inside and the entrance to the shell is blocked by its heavily armoured and perfectly fitting larger claw. But they are very vulnerable and defenceless when, at intervals, they outgrow their shell and have to fit themselves into a new one. The majority of hermit crabs live in the sea and never leave water, but on tropical beaches various land hermits, *Coenobita*, lead an almost entirely terrestrial life, only returning to the sea to breed. At Bako these land hermits wander far inland and can often be met on some jungle path wandering ponderously along dragging their home behind them. Like many crabs they are most active at night and often clamber up into the bungalows to feed on crumbs and other debris.

The inhabitants of the mud and mangroves are perhaps even more interesting, particularly as at Bako one is able to watch them from the comfort of the long bridge over the mud at Telok Asam. At low tide the mud is covered with hordes of solemnly beckoning, brightly coloured crabs sitting close to their holes or making a short foray to repel an intruder onto their territory. These have one of their claws, right or left, enormously enlarged and brightly coloured blue, pink or yellowish, spotted with black. As they sit beside their hole they periodically jerk and wave their enlarged claw grotesquely in the air and look like nothing more than a crowd of flamboyant competing vendors beckoning for one's custom. These crabs are males of various species of *Uca* whose two English names, Caller Crab and Fiddler Crab, refer to the beckoning or fiddling motion of the claw. This display has the dual function of stimulating and attracting the females (which are much less conspicuous, lacking the enlarged claw), and intimidating rivals for the favours of the females. The males parade around the area surrounding their holes waving at and threatening other nearby males, but are noticeably less aggressive as they stray to the edge of or off their territory. A wandering, big, brightly coloured male is easily repulsed by one much smaller and dowdier, on its home ground. Mostly the males fight only battles of bluff which the biggest, handsomest

individuals win, but occasionally two come to grips more drastically. With claws interlocked they strain, until usually the weaker breaks away unharmed; but sometimes the weaker is jerked off its feet, flailed back and forth, and thrown headlong, a foot or more, often leaving behind its claw in the grasp of the victor. But such tragedies are rare and the antics of the males are mostly confined to blustering and showmanship.

Another amusing member of the mangrove fauna is the mudfish or mudskipper. With bulging eyes and bulbous outsize head they hop and slither over the mud and, when startled, skitter over the surface of the water on their beating tails. But they lay claim to distinction in being the most truly amphibious of all fish and in living a life which must be similar to that led by the first ancestral colonisers of the land.

Before leaving the sea and shore mention must be made of the wonderful phosphorescence which can sometimes be seen in the sea at night at Bako. At times it is particularly abundant, at other times it may be absent altogether. But on a good night each wave breaks with a shower of greenish, dancing sparks and, paddling in the shallows, one leaves a trail of swirling lights. Most of this phosphorescence is caused by huge numbers of tiny planktonic protozoons called Dinoflagellates and the light is produced by an oxidation process which causes the little flagellates to glow as they are agitated in the water.

Bako, situated as it is on a northward facing peninsula, is particularly interesting bird-wise as a place for seeing migrants. From September to November many species retreat southwards from the icy winter waster of Siberia and pass through Bako to winter in Borneo or even further south. Plovers, wagtails, pipits, shrikes, warblers and flycatchers all appear, many of them familiar European species. They often arrive in the greatest numbers during or after a period of bad weather with strong winds and rain when, tired and storm driven, they alight and rest at the first sight of land, instead of flying on into the interior. Undoubtedly the best places for seeing these newly arrived migrants is in the *Casuarinas* and scrub fringing the sandy beaches, and at such times rare migrants blown far off course are often included. One late October day in 1963 there was just such a fall of migrants and over 30 Arctic Warblers *Phylloscopus borealis* were counted in the *Casuarinas* at Telok Asam, where there had been only one or two the previous day. Other species included Brown and Sooty Flycatchers *Muscicapa latirostris* and *sibirica*, Brown and Thick-billed Shrikes *Lanius cristatus* and *tigrinus*, a Pallas's Grasshopper Warbler *Locustella certhiola* and a very rare and beautiful female Ashy Minivet *Pericrocotus divaricatus*. Next day there were five White-throated Spinetail Swifts *Chaetura caudacuta* over the main padang, only the second time this species has been seen in Borneo.

The graceful *Casuarinas* which fringe all the sandy beaches are a favourite haunt of many birds other than migrants. At flowering time they

are full of darting, flitting, brilliantly coloured flowerpeckers and sunbirds, and beautiful yellow, black and white Common Ioras *Aegithina tiphia*. Raucous White-collared Kingfishers *Halcyon chloris* scream from their branches, and they and Olive Bulbuls *Pycnototus plumosus* and *brunneus* flip down to the sand to catch small crabs. The little, blue, coral-legged Velvet-fronted Nuthatches *Sitta frontalis* creeping up and down and around, head-down and upside-down, are probably nowhere else so common as in *Casuarinas*, while on the very topmost, drooping branches Swallow Shrikes *Artamus leucorhynchus* sit snugly together in line or swoop gracefully to snap up a passing dragonfly or cicada—their friendly cuddling up together contrasts with their disagreeable bickering and mobbing of other species.

Most of the forest areas of Bako appear to have a rather impoverished bird fauna, particularly so the *kerangas* areas. But all the main forest-living groups are represented and the best place to see them is from the plank walk through the forest behind Telok Asam. Trogons, woodpeckers, barbets, bulbuls, babblers and flycatchers are all common and particularly conspicuous are the gorgeous Fairy Bluebirds *Irena puella*. Flocks of the velvety black and irridescent blue males often gather in the early morning in the trees just behind the bungalow. One of Bako's most spectacular birds, the Pied Hornbill *Anthracoceros coronatus*, can be seen in some of the forested areas and sometimes visits the *Casuarinas* at Telok Asam.

Bako is the haunt of several White-bellied Sea Eagles *Haliaeetus leucogaster* in plumages ranging from the pastel grey and white of the adults to the mottled brown of immature birds. One or two invariably soar over Telok Asam every evening between five and seven o'clock and are often joined in aerial battle by two or three Brahminy Kites *Haliastur indus*. The kites dive upon the larger eagles which roll effortlessly at the crucial moment, present beak and talons to the swooping kites, which must turn away in a flurry of wings. The sea eagles have feeding rocks on the cliffs at both Telok Pandan Besar and Kechil, littered with the remains of their fish and sea snake prey. The kites feed on smaller fry and can be seen quartering over the sand and mud, and dropping vertically to snatch some crab or mudfish in one sure yellow talon.

Apart from the Common Sandpipers, *Tringa hypoleucos*, which bob and fuss around the lawns and beach at Telok Asam, and an occasional egret, shore birds are strangely scarce at Bako, even though they swarm on the similar looking mud at Buntal across the bay. Also sea birds are notoriously scarce in Sarawak waters—no gulls at all in contrast to the vast numbers on temperate region coasts—and only an occasional tern is likely to be seen at Bako. In fact possibly the most conspicuous birds around the beach are the familiar urban House Swifts *Apus affinis* which nest in a rural and probably ancestral setting on the cliffs at the southern end of Telok Asam.

Mammals on the whole are difficult to see and observe in Sarawak and Bako is no exception. As a result little is known of Bako's mammals and only a few species have been recorded. Bearded Pig, *Sus barbatus*, and Sambhur Deer, *Cervus unicolor*, although little seen, are common and their tracks can often be found on the beaches. Various species of squirrels, bats and a small shrew are also common but inconspicuous and only monkeys and otters are at all regularly seen. The otter concerned is the Hairy-nosed Otter, *Lutra sumatrana*, which lives both on the coast and far up the rivers in the interior. They breed regularly at Bako and it is a not uncommon sight to see a family party gambolling over the mud near the boatshed, hunting for crabs and other small fry. They can also be seen from the plank walk behind Telok Asam where they often attract attention by their shrill, human-like whistling.

Pride of place of Bako's mammals must undoubtedly go to the grotesque, though prettily coloured, Proboscis Monkeys, *Nasalis larvatus*. This is an animal endemic to the mangroves and adjoining forest of coastal Borneo, and southwest Sarawak is one of their centres of population. They can often be seen in the forest behind Telok Asam and along the plank walk it is possible to get quietly in amongst a feeding party.

They are easily distinguished from Bako's other very common monkey, the Kera, *Macacus irus*, by their lovely reddish-brown fur and long white tail and lower back. The females and young have little snub noses, and it is only the much larger male which has the huge, fleshy red, bulbous nose that gives the animal its name. They are very specialised monkeys able to run well on mud and are remarkable in being able to swim and dive and remain below water for considerable periods. They live very largely on the young leaves and growing tips of the mangrove *Sonneratia*.

Perhaps one other animal ought to be mentioned. Visitors to Bako often return with tales of strange lizards and iguanas of enormous dimension, with crested back, confronting them in the bungalows. These lizards are monitors, *Varanus*, and being scavengers have become accustomed to prowling around the dustbins and, becoming tame and bold, sometimes even enter the kitchen by the backdoor. They are not iguanas and, no matter how many people say so, they do not have crested backs. They are quite harmless even though of impressive size, so please do not be scared if confronted suddenly one evening with an apparent five foot dragon in the kitchen.

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Geology of Bako National Park

G. E. WILFORD[1]

Bako National Park consists of a dissected plateau formed by almost horizontal, thick layers of cross-bedded sandstone (Plateau Sandstone Formation), which is cut in a few places by dykes and sills of diorite and gold-bearing dacite intrusions. Marine and river erosion has formed spectacular cliffs, many of which are parallel to major northwesterly trending joints in the sandstone formation. Sandstone outcrops are abundant and are characterized by a large variety of weathering features such as: solution pans on nearly horizontal surfaces, honeycomb weathering on some steep and overhanging surfaces, and ubiquitous hemispherical concavities. Secondary iron oxides occur as veins along joints and, within the sandstone, as thin concentric films and impregnations which are seen as colour banding on freshly exposed surfaces.

PLATEAU SANDSTONE FORMATION

Sandstone and thin beds of conglomerate and mudstone underlie the whole Park and belong to the Plateau Sandstone Formation; similar rocks build the Santubong Peninsula and the Matang Range. With the exception of a piece of fossil wood found at Telok Limau no fossils have been found in the formation in the Park but, by analogy with other areas, the sandstone is thought to be of Upper Cretaceous age i.e. about 75 million years old. The sand, pebbles, and clay which now form sandstone beds and thin layers of conglomerate and mudstone were originally deposited in a delta which covered the Park area; the source of the sediment is thought to have been in central Borneo. Bedding in the sandstone, typical of rapid deltaic deposition, can be seen in almost all the cliffs around the Park. The most common, are various types of cross bedding and slump bedding.

The sandstone beds dip north at about 5 degrees except near Pulau Lakei where southerly dips are common. Thus in marked contrast, for instance, with the Santubong area where similar sandstone has been quite steeply folded to form rugged mountains, folding has hardly affected the sandstone at Bako.

INTRUSIVE ROCKS

Diorite

Diorite, a hard, fresh, well-jointed rock which weathers to a dark red clayey soil, forms small headlands on the western shore of Telok Limau, opposite Pulau Lakei, and also crops out in the Sg. Serait where it marks

[1] Formerly Geological Survey, Sarawak.

the southern boundary of the Park. At Telok Limau the diorite forms a 20-foot dyke trending northwest, and a second intrusion forms a small headland where its easterly margin is in contact with baked sandstone and trends north-northwest. The intrusions in the Sg. Serait are probably sills injected along bedding planes in the sandstone.

The age of the diorite is probably mid-Miocene as similar diorite which also cuts Plateau Sandstone Formation on Satang Island has been dated by the potassium-argon radioactive decay method as 19 ± 3 million years old.

Dacite intrusions and gold mineralisation

Dacite intrusions consist mainly of rather deeply weathered dykes 4 to 12 feet thick, some sills, and a few irregular intrusions. They are mainly restricted to the Serait Valley in the southern part of the Park area, and two intrusions occur on the eastern side of Telok Limau. They are typically white to pale grey hydrothermally altered rocks in which white feldspar, and less commonly glassy quartz crystals, can be seen in hand specimen. They are similar to the igneous rocks in the Bau mining area and many of them appear to be slightly gold-bearing. Coarse gold was originally panned in the Serait Valley, and a gold mine once operated for several years prior to 1943, but the production is unknown. The ore was mined from a hill of weathered pyritic dacite and pyritic sandstone which forms the southern bank of the Serait immediately south of the Park boundary. A dyke of similar pyritic dacite in the north bank tributary of the Serait, immediately east of the junction of the Lintang and Gondol paths, contains a trace of gold, and pyritic-impregnated sandstone adjacent to it, contains more than 1 dwt of gold per ton.

GEOMORPHOLOGY

Erosion in the Bako National Park area has removed a soft-sediment cover from the underlying thick resistant sandstone beds which now form the present plateau-like surface and which dips gently northwards from about 1000 ft above sea level in parts of the Serait Valley to 200 to 400 ft above sea level on the north coast. The Serait, draining the southern part of the Park, has a wide, U-shaped valley and probably its catchment area, particularly in the east, has become progressively reduced by erosion of the sea. Streams with shallow valleys drain the plateau surface and usually follow joint-determined courses before plunging over waterfalls or rapids at the plateau edge into the sea or the Serait Valley.

Major northwesterly trending joints in the sandstone have controlled the outlines of most headlands, and the courses of many streams. Less well defined west northwesterly and north northwesterly trending joints have determined a few stream courses such as some tributaries of the

Delima and Serait Rivers. Marine erosion has formed small islands and sea stacks, particularly in the Tanjong Pandan area. Linear sea caves are common along major joints and a tubular cave about 40 ft. above sea level, and with a roof in places lined with small opaline silica stalactites, occurs at the top of the path to Telok Pandan Kechil.

WEATHERING

Many sandstone outcrops contain a variety of weathering phenomena. Most common are hemispherical cavities, commonly with cores of iron-stained rock, and which range from about an inch to a foot in diameter. They occur singly, in groups, or in honeycomb-like patterns, and are most common on steep surfaces. On almost horizontal surfaces, as on the plateau towards the northern end of the Lintang Path, solution pans have formed. These are circular, shallow depressions in the sandstone surface from 6 inches to 3 feet in diameter and as much as 6 inches deep; they commonly have horizontal floors and steep to overhanging rims. They appear to be formed and enlarged by rain water becoming acid due to the decay of plants (lichens and algae) which grow on the surface of the rock; the acid has apparently dissolved the content of the sandstone. Solution takes place mainly around the outside of a pan because the decayed vegetation and the loosened sand grains on the floor of the pan prevent downward solution. During heavy rain the pans overflow into one another commonly along channels developed along joints and the lower lip of many of the pans has become breached.

The surfaces of overhanging cliffs are commonly weathered into a honeycomb pattern of ridges an inch thick separating rounded concavities 1 to 2 inches in diameter. Others are weathered into an anastomosing irregular network of ridges separated by smooth areas of sandstone.

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Kinabalu National Park

Kinabalu National Park is 275 square miles. It is the second largest national park in Malaysia and lies northeast of Kota Kinabalu (formerly Jesselton) capital of Sabah. The park is centred on Mt. Kinabalu, 13,455 ft, the highest mountain between the Himalayas and New Guinea. Access to the park by road is easy, and the usual ascent route is well served by shelters. These factors combine to make the mountain an increasingly popular tourist attraction for Malaysian as well as foreign visitors.

The mountain rises to well above the tree line and its upper slopes have several plants from the cool parts of the world. Botanists especially flock to Kinabalu to see this high 'alpine' vegetation. The mountain is also famous for its birds. In the northern inaccessible part of the Park, north of Mt. Kinabalu in hilly rain forest country, there is still much animal life, but increasing protection and education of the populace will be needed for its permanent conservation as access improves and population inexorably increases.

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Geology and Topography of Kinabalu National Park

D. V. JENKINS[1]

INTRODUCTION

The topography of the Kinabalu National Park, and indeed the whole of Sabah, is dominated by the great granitic intrusion of Mount Kinabalu, which thrust its way up through the sandstone of the Crocker Range.

The terrain of the Park can truthfully be described as rugged, with steep sided ridges clothed in dense tropical hill forest. The ridges form deep 'V' shaped valleys with streams and rivers at their bottoms which have carved deep gorges out of the earth. These streams, which are usually crystal clear, fall swiftly from rock pool to rock pool between exposed granite boulders, and become raging torrents within minutes of a rain storm and have tremendous erosive power.

TOPOGRAPHIC DEVELOPMENT

In the early Miocene period (35 million years ago) much of Sabah was below sea level. During this period, the rocks which now form the Crocker Range were laid down as sandstone and other sedimentary beds. Following upheavals during the middle and late Miocene, the sea receded and the folding accompanying the upheavals lifted the sedimentary rocks clear of the old sea bed to form the Crocker Range. This range runs through Sabah in a southwesterly direction and has an average height of 2000 to 3000 ft with some of the high points reaching 6000 ft. The Kinabalu National Park straddles the northern end of the range.

During the Pliocene period (15 million years ago) there was an intrusion of granite[2] from deep below the surface of the earth into the base of the Crocker Range. This was followed during the late Pliocene to Pleistocene period (2 to 1 million years ago) by rapid uplift of the granite pluton up through the Crocker Range to form what is now called Mount Kinabalu.

The uplift, which has been estimated at 1/5 inch per year or more, not only pushed up the now familiar bare rocks of the summit, but carried with it an immense quantity of the soil and rock of the Crocker Range itself.

Koopmans and Stauffer of the University of Malaya who worked on the mountain in 1966 have shown that in the recent geological past, late Pleistocene to Holocene (geologically recent) the summit and flanks of the mountain were covered with an ice field of approximately 2 square miles and found abundant evidence of glacial action on the summit rocks.

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[1] Park Warden, Kinabalu National Park, Sabah.
[2] Strictly speaking granodiorite and related rocks (Eds.).

When the glaciers melted mud carrying boulders of granite and sandstone flowed off the mountain covering the whole of the surrounding areas with deep deposits of mud and rock debris. A mud flow from the southwest of the mountain formed a piedmont fan of between 20–25 square miles. This area, which consists of mud and boulder beds of a thickness of at least 450 ft is known as the Pinosuk plateau which sprawls irregularly from 4000 to 8000 ft and is deeply dissected by rivers and gullies having almost vertical sides.

In plan form, Mount Kinabalu is U-shaped opening to the north, with the ridges forming the arms of the U pointing west of north on the short western ridge, and east of north on the longer eastern ridge. The two ridges enclosed a deep cleft in the mountain known as Low's Gully whose walls are near vertical in places and fall from 3000 to 5000 ft from the summit. The cleft is thought to have been formed as a result of a tremendous fault in the granite. There is also some indication of glacial action in the gully as evidenced by the presence of moraine on the gully floor and 'U' shaped valleys leading into the main cleft.

The topography of the summit area has been well described by Koopmans & Stauffer (1966):—

'The upper parts of Mount Kinabalu above about 11500 ft are almost completely bare and unvegetated surfaces of rather fresh granodiorite..... The topography in these summit areas consists of smooth curved horns and spires that give the mountain its familiar "toothy" profile..... The bowls and slopes form large continuous surfaces having a distinctly abraded appearance..... yet almost totally devoid of loose rock debris. In contrast, the peaks and spires have often a blocky, broken surface, with much loose rock perched and clinging to them, yet very little talus at their bases. In a few places, especially at the summit of Low's Peak, there are small *felsenmere* of frost heaved blocks.....

The general form of the summit of West Kinabalu is that of a half-dome whose top has been breached and the smooth gently sloping summit areas carved into it, leaving the scattered peaks to mark the original dome surface.....'

It has been calculated from the studies of isotopes, that the age of the granite dome of Kinabalu is in the region of 9 million years and that the uplift of the granite through the Crocker Range occurred only 1.5 million years ago. From the sediments deposited on the slopes surrounding Kinabalu pieces of wood have been found and these dated by radiocarbon analysis show that they were deposited between 34000 and 3000 years ago.

CONCLUSION

Mount Kinabalu is probably the youngest granite intrusion in the world today, and with an age of around 1.5 million years is geologically very recent indeed. The radiocarbon ages of the wood found in the sedimentary beds around Kinabalu also show that the glacier on the summit was melting as recently as 3000 years ago.

The topography of the National Park is therefore very young. The easily eroded sediments combined with the heavy rainfall in the Park (110 in per annum at 5000 ft and over 200 in on the summit of Kinabalu) causes continual erosion to take place with the development of steep ridges and gorges cut by the ever running streams.

The topography is ever changing and still developing and will continue to do so until the loose sediments are washed down to the sea leaving vast areas of boulders and exposing again the original rocks of the Crocker Range. Nevertheless, Mount Kinabalu will continue to dominate the skyline and be the main topographical feature of the area.

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Animal Life of Kinabalu National Park

D. V. JENKINS[1]

Over the centuries before the creation of the Kinabalu National Park under the National Park Ordinance of 1962, the local kampong people supplemented their diet of hill padi by collecting jungle fruits and by hunting. All the meat they obtained—apart from a few domestic fowls—was taken from the jungle. The continual hunting over the years decimated the population of animals, especially that of the larger mammals.

The National Park Ordinance gives the wild life in the Park absolute protection, and hunting is illegal. Some poaching still takes place but it is hoped that the continual policing of the boundaries, the education of the people, and the firm prosecution of offenders will help to bring home the need for conservation; and will be followed in time by the re-establishment of the depleted animal populations.

The Kinabalu National Park covers an area of 275 square miles with the greater part of about 200 square miles being situated to the north of Mt. Kinabalu and therefore inaccessible to the general tourist. This area is wild country with deep valleys, gorges and precipitous ridges clothed in dense jungle ranging from 500–13000 ft above sea level on the northern ridge of Mt. Kinabalu itself. The area also encloses Mt. Tambuyokan, 8426 ft.

The northern part takes many days of hard jungle walking for any expedition to get into it. In time, with the development of new roads and tracks, the area may become more accessible than at present and be an excellent source of ecological information for scientists. There are no plans at present for its future development other than the establishment of ranger stations to help to protect it. The area to my mind should remain in its wild natural state and become a reservoir and breeding ground for the greatly depleted fauna of Sabah. It is known to be the haunt of the very rare Sumatran rhinoceros (*Didermocerus sumatrensis*) which has been senselessly hunted over the centuries for the supposed magical properties of its horn. This animal, without conservation measures, may well become extinct in our lifetime but it is hoped that the existence of the National Park will help in its re-establishment. In 1961 the Royal Society Expedition to Kinabalu found tracks of the rhinoceros high up on the eastern ridge of the mountain. An unauthenticated report of 1970 also recorded tracks high up on Mt. Tambuyokan.

Two other rare animals, the Tarsier (*Tarsius bancanus*) and Orang-utan (*Pongo pygmaeus*) are also to be found in the Park although away from inhabited areas. The protection given by the National Park Ordinance

[1] Park Warden, Kinabalu National Park, Sabah.

and outside its boundaries by the Fauna Conservation Ordinance of 1963 is having some effect, especially with the latter species as Park Rangers on boundary duties constantly report the presence of the animal or sight its nests. These reports however are all from the west, east and northern boundaries.

The mammals to be found in Sabah have been well described by Professor John Harrison in his book *An Introduction to the Mammals of Sabah*. They should all be present in the Park with the exception of the elephant and whale. Lord Medway's *Notes on the Mammals of Kinabalu National Park* (Park Information Leaflet 8) describes the mammals that a visitor to the Park can expect to see and also the zonal distribution by altitude of some of the small rodents on the mountain.

MAMMALS

Among the mammals known to be in the Park are the following:—

Insectivora

There are seven species of shrew, including the Kinabalu Shrews (*Crocidura baluensis*) known only from the higher levels of Mt. Kinabalu, the flying lemur (*Cynocephalus variegatus*) and Pangolin (*Manis javanica*).

Primitive Primates

There are ten species of tree-shrews in Sabah and they are the commonest animals seen around Park Headquarters. They are squirrel-like in habit and form but can be distinguished from the squirrel by their 'shrew-like' long pointed muzzles. Although called tree-shrews, they are often seen among low bushes and inspecting dead tree trunks at ground level. They make loud squeaking noises when disturbed which resemble in some way a bird alarm call. The Mountain Tree-shrew (*Tupaia montana*) is confined to Mts. Kinabalu and Trusmadi at elevations above 3000 ft.

The Slow Loris (*Nycticebus coucang*) and Tarsier (*Tarsius bancanus*) are also present but rarely seen. The Tarsier has only been reported on one occasion from the western side of the Park boundary.

Primates

Sabah has nine species of the apes and monkeys and it is surprising that none of them are ever seen in the areas surrounding the Park Headquarters at 5300 ft. This area was easily accessible to kampong people in the past and was much hunted over, which in all probability accounts for their absence.

To the north of the mountain and on the western and eastern boundaries, Macaques (*Macaca* spp.), Leaf Monkeys (*Presbytis* spp.), and the

Gibbon (*Hylobates moloch*) are often seen. The Orang-utan has been mentioned previously.

Bats

Fruit-eating and insectivorous bats are seen and heard at night. They are often caught in mist nets set up for bird banding causing much havoc to themselves and to the nets. The fruit bats are the worst culprits in this respect.

Rodents

Three species of porcupines are present, and in the whole of Sabah, 28 species of squirrels which include the flying, tree and ground varieties. Some of the smaller tree-squirrels are common at Park Headquarters, as are the ground-squirrels and should easily be seen by observant visitors.

There are also many species of rats present. The most interesting is the Kinabalu Rat (*Rattus baluensis*) which is only found on the summit zone of the mountain. This rat is unafraid of humans and is most inquisitive. Most visitors to the mountain who stay in one of the mountain huts will come across one of these rats, as they often enter the rooms to inspect the occupants. They seem to exist on the bare rocks of the summit by eating green matter and titbits left over by climbers.

Carnivores

There are several carnivores present in the Park but their presence have not been reported for the last few years.

Among the carnivores of Sabah are the Bear (*Helarctos malayanus*), weasels, otter, musangs and mongoose. The cat family is represented by the Clouded Leopard (*Neofelis nebulosa*) and four other smaller cats (*Felis* spp.).

Ungulates

This group includes the rhinoceros mentioned previously which it is hoped will re-establish itself in the Park.

The Bearded Pig (*Sus barbatus*, Fig. 1) is found in the Park and visitors walking the various trails may see signs of its presence from tracks and rootings.

Tracks of Mouse Deer (*Tragulus javanicus*) and Barking Deer (*Muntiacus muntjak*) may often be seen on the trails and occasionally, the Barking Deer may be heard to 'bark'. The Sambhur Deer (*Cervus unicolor*, Fig. 2) is also present but it has not been seen recently on the south side of the mountain. Medway reports that an antler of the species was once found at 13000 ft on the east summit of Kinabalu.

A herd of the wild cattle of Borneo, the Banteng (*Bos banteng*), was reported to me in 1969 by a Park Ranger who found them in the north eastern portion of the Park.

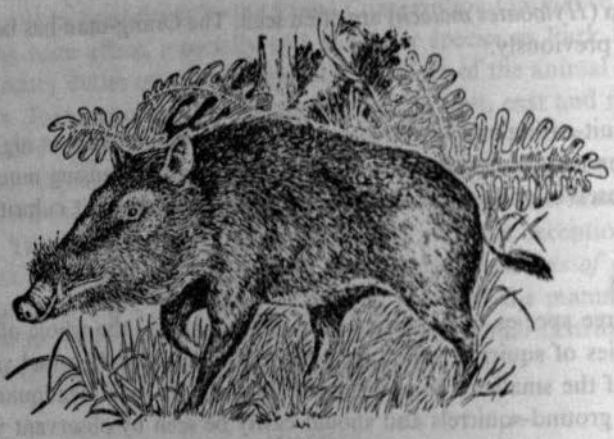

FIGURE 1. Bearded Pig.

FIGURE 2. Sambhur Deer.

BUTTERFLIES

Butterflies (Fig. 3) abound in the Park especially around the hot springs area at Poring. They are also protected under the Park Ordinance. Park Information Leaflet 9 gives notes on some of the commoner species.

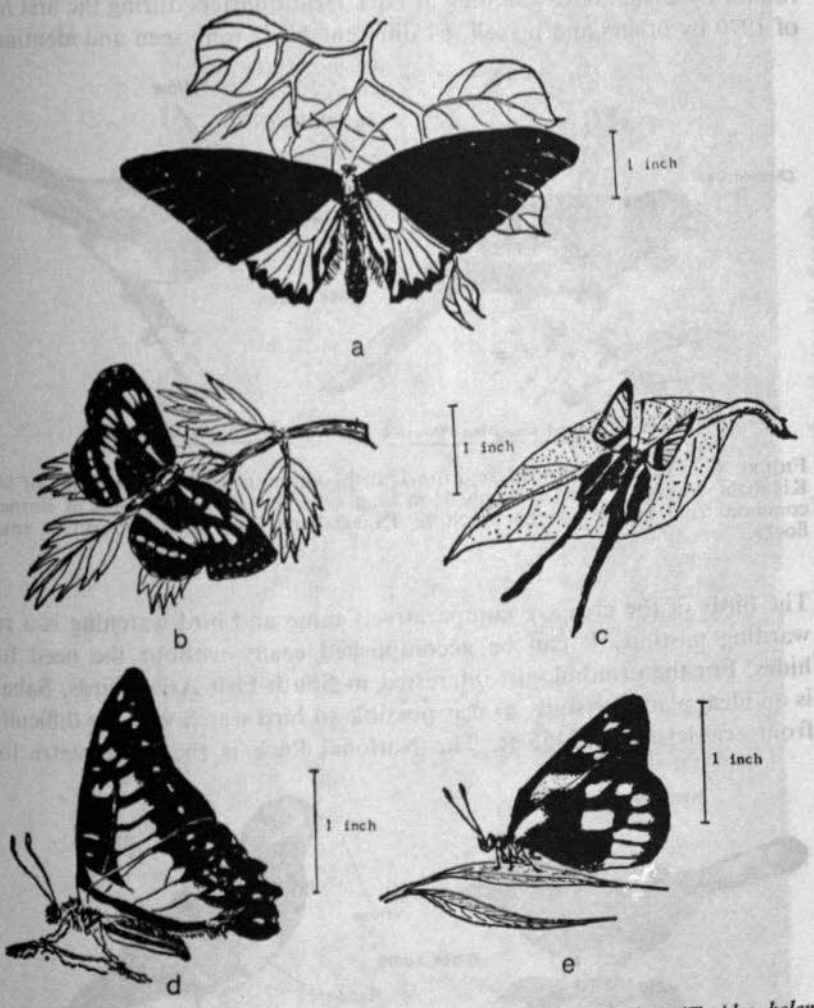

FIGURE 3. Some common butterflies: a. The Common Birdwing (*Troides helena cerberus*); b. The Common Sailor (*Neptis hylas mamaja*); c. The Green Dragontail (*Lamproptera meges virescens*); d. The common Jay (*Graphium doson evemomides*); e. A Pierid (*Delias georgina cinerascens*, this subspecies is only known from Mt. Kinabalu).—Drawings by J.D. Holloway.

BIRDS

The bird life in the Park is very rich and most of the birds except some of the sea and shore living birds mentioned in Smythies' *Birds of Borneo* should be found somewhere in the Park. Above 5000 ft at Park Headquarters, it is estimated that 107 different species of birds should be found. By casual bird-watching at Park Headquarters during the first half of 1970 by others and myself, 64 different birds were seen and identified.

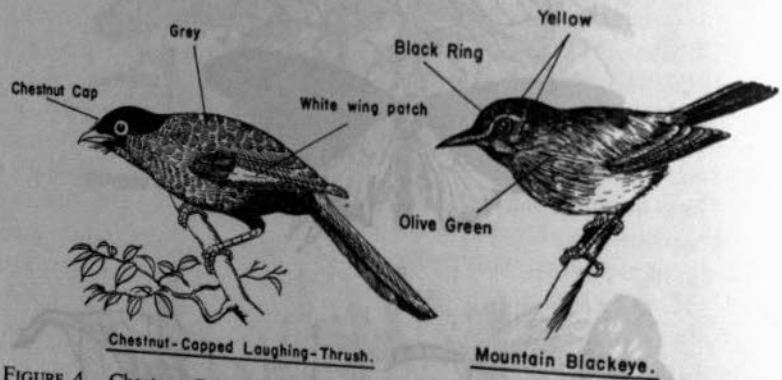

FIGURE 4. Chestnut-Capped Laughing-Thrush, common on the lower slopes of Mt. Kinabalu. Mountain Blackeye, only 4½ in long, only occurs on mountains of Borneo, common from below Kambarangoh to Panarlaban. Both species travel in small flocks.

The birds of the area are comparatively tame and bird-watching is a rewarding pastime. It can be accomplished easily without the need for hides. For the ornithologist interested in South-East Asian birds, Sabah is an ideal place for study as it is possible to bird watch with no difficulty from sea level to 13455 ft. The National Park is the ideal centre for

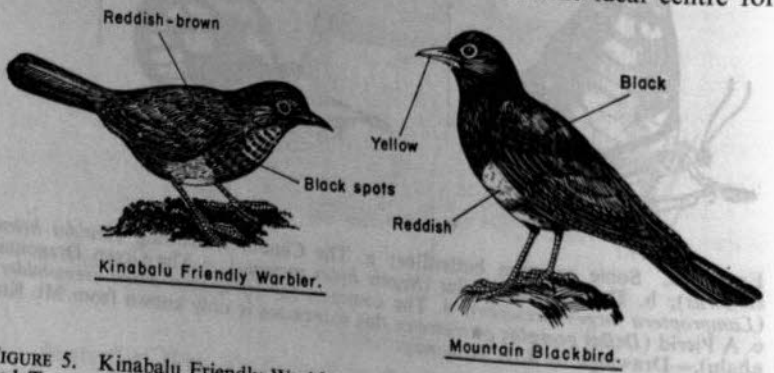

FIGURE 5. Kinabalu Friendly Warbler, only known from upper slopes of Kinabalu and Trusmardi, always seen hopping about on or near ground, very friendly to visitors. Mountain Blackbird, common from Layang Layang to Panarlaban, about 9 in long. These two species are generally seen single.

PLATE 59. Mt. Kinabalu from the south. (*photo—M. Renard*).

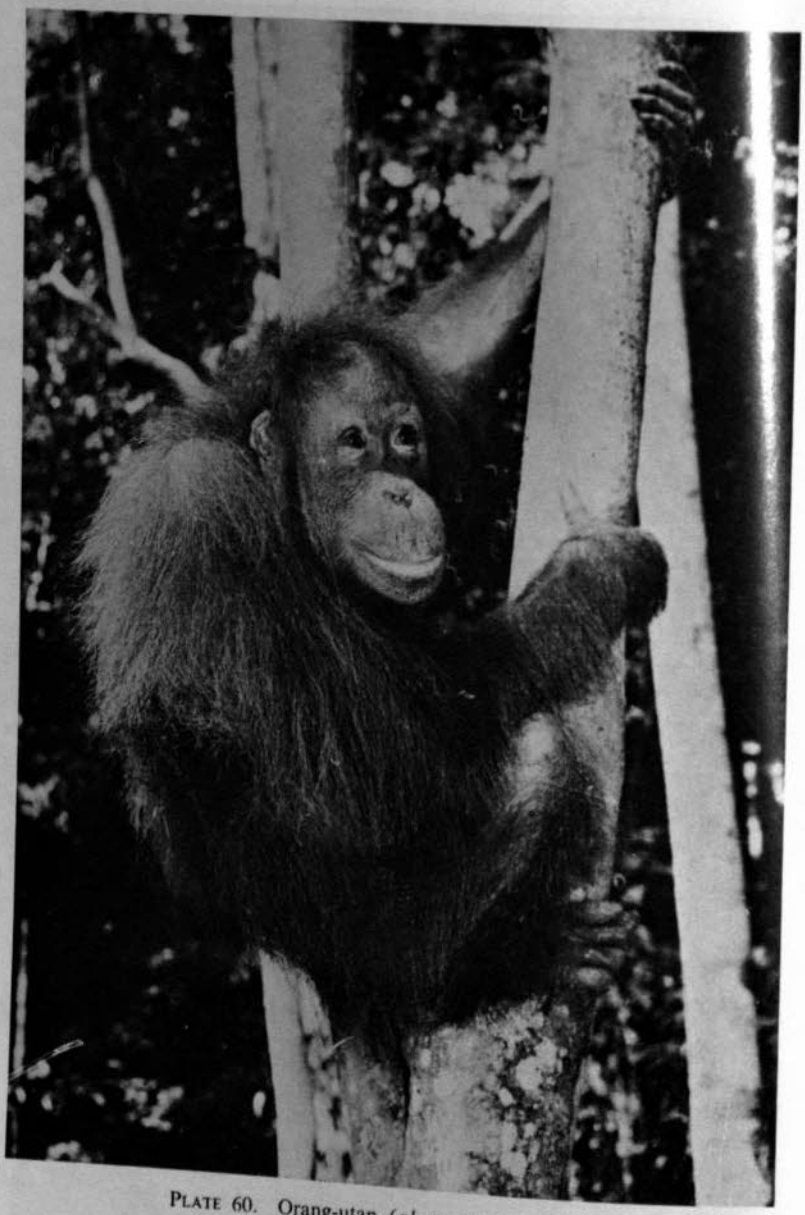

PLATE 60. Orang-utan. (*photo—G.S. de Silva*).

studying hill and mountain birds and also for the migratory species as they cross the Crocker Range.

Twelve common birds to be seen on the ascent of Kinabalu are described in Park Information Leaflet 7, by Smythies.

Despite the fact that the animal population of Sabah has been depleted over the years, there still remains a wealth of species within the National Park. With the protection given to them, it is hoped in time that their numbers will increase and that they will become easily seen again in the future.

Nevertheless, with keen observation, the general tourist can find much evidence of animal life and if lucky, catch an occasional glimpse of a wary animal.

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Plant Life in Kinabalu National Park

WILLEM MEIJER[1]

In order to realise the botanical wealth of Mt. Kinabalu, we have to visualize an area like Singapore island, about 220 square miles, completely covered with natural vegetation and ranging in altitude from about 500–13455 ft. The boundary does not follow the contours. It has been cut as far as possible above the zone of shifting cultivation but some old secondary forest at about 500 ft altitude on the steep western slopes with *Cratoxylon arborescens* has been included. Near the Tenompok pass the boundary reaches up to 5000 ft but it goes down in the east and west to 2000 ft or even slightly lower. This means that all the altitudinal variation of the Bornean flora from 2000–13000 ft is included. The best survey of this flora can be given when we start from the eastern side near Poring (hot springs) or along the new track to the copper mining site, just above or near the upper limit of some lowland dipterocarps like Borneo camphor (*Dryobalanops lanceolata*), red serayas like seraya tembaga (*Shorea leprosula*) and seraya majau (*S. johorensis*) and large fast growing lowland timber trees like binuang (*Octomeles sumatrana*) and magas (*Duabanga moluccana*).

Visitors can find a series of numbered and labelled trees near the Poring bungalow. Near the bungalow there is a good site for the famous flower bunga patma, *Rafflesia tuan-mudae*, with female flowers. They last about a week and produce a smell of rotten meat which attracts flies which pollinate them. Male flowers must be present somewhere in the vicinity. *Rafflesia* is a parasite on a woody vine belonging to the genus *Tetrastigma* (Vitaceae). Another place where visitors can see it is along the steep track to the copper mine near the origin of the Mamut river. Interested visitors can get detailed information about the trees along this trail from the Sabah Forest Dept. series of numbered trees and from a report on the wood samples collected from trees felled along this trail.

A few miles from Ranau the trail to Poring crosses Bukit Hampuan (rhymes with "perempuan") a mountain of about 4500 ft elevation on ultrabasic rocks. This is a very good locality of large sized *Agathis* trees—the Bornean Kauri, for a *Casuarina* only known from Sabah, for *Borneodendron aenigmaticum* and for the Sabah Philippine boxwood *Buxus rolfei*. *Borneodendron*, a good sized tree 4–6 ft girth, has a red bleeding inner bark when cut and stiff leaves in whorls. The nearest relatives in its family (Euphorbiaceae) occur in New Caledonia and Australia. Its localities in Borneo range from Mt. Kinabalu, through the ultrabasic mountains in the Labuk area to Mount Silam and Pulau Sakar near Lahad Datu on

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the East Coast of Sabah. The forest on ultrabasic rocks can be recognised from the air from the very small tree crowns which can easily be observed in good weather during commercial flights between Kota Kinabalu and Sandakan.

Poring and Ranau are still in the zone of the dipterocarp forests. Near Kundasan at 4000 ft the trail enters the zone of the oak-chestnut forests. Locally, the newly discovered Trig-oak (*Trigonobalanus verticillata*), with leaves in whorls of three and fruits triangular like beech nuts, is common. Oak belonging to the genera *Quercus* and *Lithocarpus* have many species on Mt. Kinabalu. A preliminary survey is given in Sabah Forest Dept. Botanical Bulletin 11 (1968), available in the National Park Library. Other groups which abound in this forest are some Magnoliaceae including two species new to science and various conifers belonging to the genera *Podocarpus* and *Dacrydium*. The most extensively explored part of the forest near Kundasan is the adjacent Sosopodon Forest Reserve with its trails with numbered trees, a kind of natural arboretum. Forestry people and National Park Rangers can show visitors around there. One of the rarest trees there is *Nyssa javanica*. Others are on the Pinosok plateau along another trail with numbered trees. Among those is the spiny fruited *Sloanea*, a genus also known from tropical America, and elsewhere on the plateau *Acer caesium* has been collected probably the only known locality in Borneo.

Then we go off to park headquarters where we enter the oak-chestnut (*Castanopsis*) forest with dense shade and with good graded trails leading along streams lined with red barked *Tristania* trees (pelawan). The most famous tree there is *Ascarina philippinensis* a woody Chloranthaceae. The pollen resembles the oldest known flowering plant pollen from the Cretaceous which means that *Ascarina* may be more than 100 million years old; it occurs also in New Zealand. *Phyllocladus hypophyllus* (the celery pine) has a similar range.

The oak forests resemble in many respects those of Formosa and Japan. From the analysis of a 2.5 acre sample plot here we found that not a single tree at this altitude occurs in the lowlands, and that among the smaller trees several species of *Eugenia* and *Garcinia* (kelat and kandis) are the most abundant. Among those occur also species new to science.

Orchids and Melastomaceae, Gesneriaceae (*Agalmyla*) and terrestial gingers draw the attention of visitors around headquarters. It is really worthwhile to study plants and birds in this area using the bungalows as base camp. Botanists can hunt here for a new species of *Terminalia* with leaves like *Campnosperma*.

Side trips can be made from here to Kiau where there is a good campsite near the river; local guides are available through the village headman for a visit to the famous Marai–Parai trail, an ultrabasic ridge full of botanical rarities and the best locality for the giant pitcher plant

Nepenthes rajah. Botanists will be interested to know that the famous treelet *Scyphostegia borneensis* still occurs here at its type locality and that recently the ripe fruits of it were discovered by me. Another Dutch botanist, Nooteboom, sent ripe seeds to Holland where they germinated.

All the localities mentioned so far can be reached conveniently on day trips along the main jeep tracks and except the trip to Kiau little tiring climbing is needed. The majority of visitors to the mountain rushes to the summit, trying to break a record. Naturalists do wisely to keep their breath and one of the best methods for older people is to pretend to have a great botanical interest, like a former Conservator of Forests who would try to stop me many times asking out of breath "please tell me what plant that is".

Finally we may have a look at the plants along the summit trail. From the power house up to the Panarlaban bungalow practically all the species of trees have been labelled or at least numbered and a list of those numbers should be with the Park Warden. Just at the power station we have a last bird's eye view over the montane oak forests. Detailed investigations at this altitude have been conducted in another 1 acre plot along the trail with all the trees permanently labelled. On the way to Kambarangoh we pass beautiful places with yellow *Rhododendron lowii* and red ones (*Rh. fallacinum*) and good spots with large pitcher plants (*Nepenthes lowii*), besides some typical montane species of *Calophyllum* and a yellow barked *Microtopis*. For botanical enthusiasts a visit to the waterfall near Kambarangoh is quite worth while. The rare bryophytes *Treubia*, a giant liverwort, and the large moss *Spiridens* occur there together with many ferns and a good show of balsams (*Impatiens*).

Above Kambarangoh we are gradually going to leave the zone of the oak-chestnut forest. This peters out at about 9000 ft where the bullate *Lithocarpus* reaches its highest altitude; *Castanopsis* has been recorded to about 7500 ft altitude. The trail goes in some places through groves of trees; one is rich in the *Drimys*-leafed *Magnolia*, a species still undescribed. At other places it passes low shrubby vegetation with *Leptospermum flavescens*, festooned with beard moss, and rich fern vegetation with all kinds of species of *Gleichenia* and also some *Matonia* and *Dipteris conjugata* in a montane form. Here also is abundant *Drimys piperita*, a member of the very primitive Winteraceae. The shrub vegetation is rich in Ericaceae (species of *Rhododendron*, *Vaccinium*, *Diplycosia*) and small treelets of *Eugenia*, some *Symplocos* (*Cordyloblaste*) and *Elaeocarpus congestifolius* with coppery coloured young shoots. The most beautiful flowering tree here besides the *Magnolia* and some *Talauma* is *Schima brevifolia* (Theaceae).

Then at about 8500 ft we see suddenly a sharp change in the vegetation. The dominant trees become the small-leafed *Dacrydium gibbsiae* and *Leptospermum recurvum*. All kinds of small herbs occur along the

trail, e.g. *Elatostemma bulbothrix*, *Didymocarpus* (Gesneriaceae), the tiny fern *Schizaea fistulosa*, the tree fern *Cyathea(?) havilandii*, the pitcher plant *Nepenthes villosa*, *Hedyotis macrostegia*, *Trachymene*, *Aletris foliosa* and the Bornean eyebright *Euphrasia borneensis*; and among the terrestrial liverworts is a large *Scapania*. This peculiar vegetation is related to the differences in soils. The rocks here are ultrabasic, serpentine and allied rocks. Before we reach Paka Cave (9700 ft) we pass some places on and off the ultrabasic, we see granite and granodiorite and in some groves the trees still reach about 10–20 ft high including *Daphniphyllum*, a new species of *Talauma* and *Eugenia houttuynii*. In more open vegetation we notice the first species of *Gentiana* reminiscent of the Swiss Alps and the Himalayas. Before the cave a trail leads off eastwards to an open place on ultrabasic rock almost bare of vegetation with some *Machaerina* and *Cladium falcatum* and a lot of *Euphrasia borneensis*. Most of the visitors miss that area. It allows a good sight of the sharp ragged range along the eastern edge of the summit peaks.

At Paka Cave we can see beautiful flowering *Rhododendrons*, Gesneriaceae, *Schima brevifolia*, the Pacific genus of Rubiaceae *Coprosma*, the 'blackberry' *Rubus niveus*, and various montane grasses and sedges. It is also a famous locality of a very primitive tiny liverwort *Takakia*, growing on the edges of the ice-cold water in the pool below the cave. This is now known from Borneo, Japan, Alaska and N.W. Canada mainly through the field work of Japanese bryologists.

Near the cave we see the lowest localities of Low's buttercup (*Ranunculus lowii*) and further on the interesting conifer *Podocarpus brevifolius* and various species of the holly genus (*Ilex*) some with opposite leaves, and *Rapanea*. Also not so far above Paka Cave we get a new *Podocarpus* formerly considered to be a variety of *Podocarpus imbricatus* which grows between 4000–7000 ft altitude, possibly still higher. Every time a new species of tree occurs along the trail it is numbered and may by now also have a label.

A new campsite has been put smack in a good locality of *Potentilla*; another species of this genus grows near Panarlaban. A boggy place full of the rare insectivorous plant *Utricularia orbiculata* has been converted into a helicopter-pad. The bungalows and the cutting of firewood for the visitors certainly cause quite a lot of damage to the natural vegetation. I hope that the *Sphagnum* peat bog with a small composite (*Hecatactis*) at about 10,000 ft is still intact. Near the Panarlaban campsite we come into the rocky shrubby area—a good locality for *Myrica* and nearby on a slope some *Gaultheria borneensis* and *Havilandia*. From here the trail goes up with ropes and through a steep gully where the remnants of vegetation have been removed by the climbing visitors. I cut a new trail through mossy forest just east of this. The shrubby *Rhododendron ericoides* is common at this altitude, but in general fewer and

fewer trees grow here. *Phyllocladus hypophyllus* grows up to 10,000–12,000 ft, but at Sayat Sayat we can really say we are above the forest line. Now we can start to look at the peculiar round cushions of *Centrolepis*, *Monostachya* (a grass) and *Sporobolus* (a sedge) and discover *Drapetes ericoides* (Thymeleaeceae), a species also known from New Zealand.

Orchids are abundant along the trail, *Habenaria* near Paka Cave, beautiful *Coelogynes*, some *Dendrobium*, plenty of *Dendrochilum* and up to Sayat Sayat *Eria grandis* (with large leaves). The Kinabalu flora contains about 800 species of orchids in about 72 genera. For fuller details see Meijer (1965).

The summit still has some plants—*Poa epileuca*, some *Rhododendron ericoides*. *Leptospermum recurvum* becomes a very small creeping shrub between the cracks of the rocks. The most beautiful herb here is *Potentilla* (see Kalkman, 1968). The temperature near the summit can be a few degrees below zero Centigrade and rain can change into hail at this altitude. There are definite signs that during the Pleistocene when the temperature must have dropped about 3–4 degrees Centigrade in the tropics, there were snow and ice on the summit area of Kinabalu, about 12,000 ft and upwards.

The various temperate plants like *Ranunculus*, *Potentilla*, *Euphrasia* and *Gentiana* are reminiscent of the mountains in the Himalaya region. Others like *Centrolepis*, *Sporobolus*, *Phyllocladus*, *Dacrydium* and *Drimys* point to contacts with high mountains in the Philippines, New Guinea, East Australia and New Zealand. From the work of the pollen specialist J. Muller it appears however that *Phyllocladus* is a rather late (Pliocene?) invader of Borneo. However it is also clear from Muller's work that during the Miocene Borneo had a mountain range far higher than the present Crocker Range with *Libocedrus* and other high altitude conifers, while in the lowlands there were dipterocarp forest and mangroves along the coast. Kinabalu, a peak not older than about 9 million years according to the geologists, probably picked up the remnants of this mountain flora and there may have been some nearby stepping stones to the Philippine mountains, unless we accept that all the species of high altitude were transported for thousands of miles by birds or by winds. The problems of tropical and Pacific plant dispersal, evolution and landbridges are still far from being solved but continuing pollen studies and geological discoveries will bring them gradually nearer to solution.

The mid montane region between 4000–8000 ft has a great abundance of species of Lauraceae, Myrtaceae, *Symplocos* and Theaceae which are very well established in the whole sub-tropical flora arching around the Pacific to Formosa, Japan and as far as Mexico. This way *Podocarpus* may have gone around the Pacific as far as Venezuela and also *Lithocarpus* has got as far as California. *Weinmannia* perhaps falls into the same category. Some families like Fagaceae and Magnoliaceae have developed downwards from the montane zone into the tropical lowlands, while the

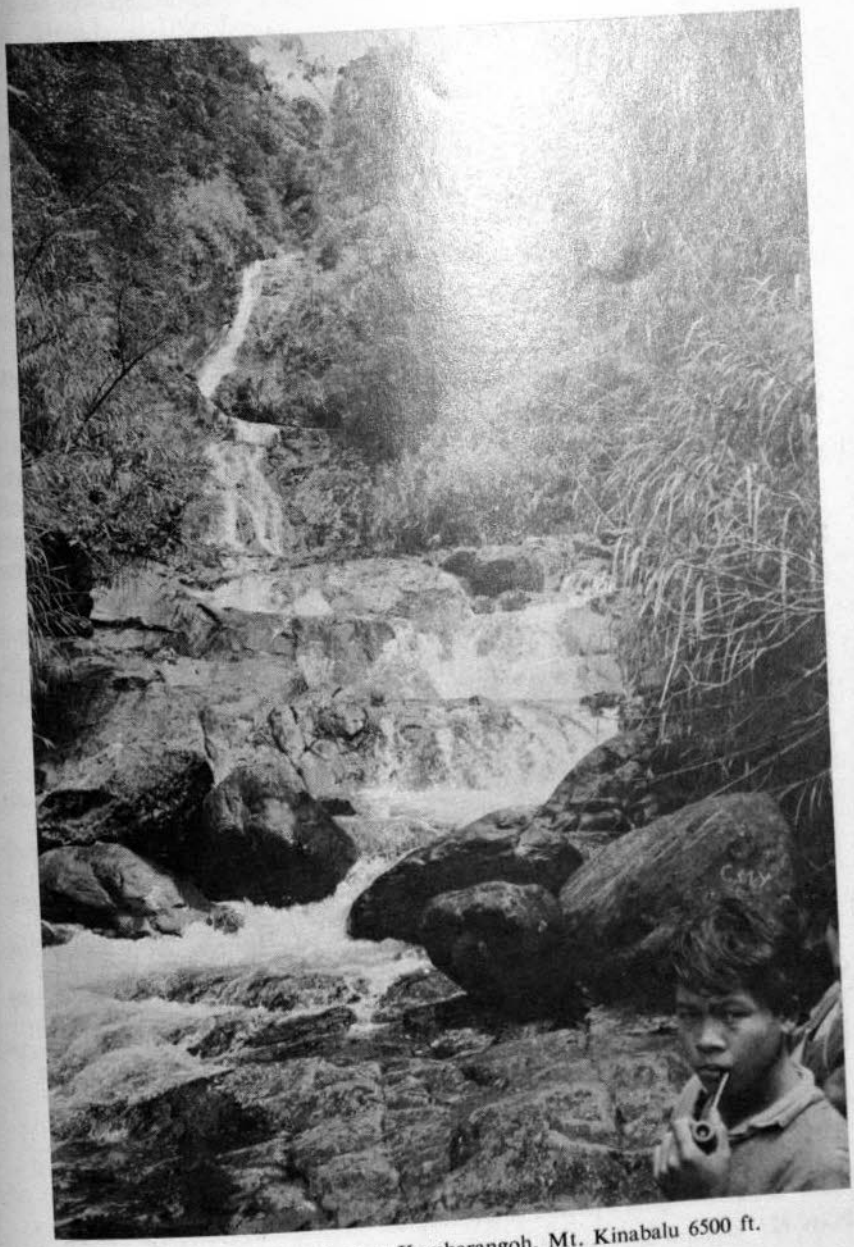

PLATE 61. Stream near Kambarangoh, Mt. Kinabalu 6500 ft.

PLATE 62. *Gunnera* near Powerhouse below Kambarangoh, Mt. Kinabalu 6500 ft.

tropical lowland families like Dipterocarpaceae, Annonaceae, Myristicaceae, Sapindaceae, Meliaceae and Anacardiaceae have not got much higher than 4000–6000 ft. It is interesting to compare the mid-mountain forests of 4000–7000 ft with those of Ceylon. There all Fagaceae are lacking. This family has probably evolved further east along the margin of Gondwanaland (New Caledonia?) and then the lowland species in Borneo have evolved from the mid-montane zones. The similarities, with species of *Eugenia*, often small-leaved, *Calophyllum* and Lauraceae are however very strong. Ericaceae have reached Ceylon in far smaller measure than Mt. Kinabalu which is one of the centres of that family in Malesia, the other being the mountains of New Guinea.

There is by now a large amount of plant geographic literature on Mt. Kinabalu, starting with Stapf (1894), Miss Gibbs (1914), the Clements expeditions, van Steenis (in Corner 1964—he has never visited the mountain himself) and by Corner (1964) in the reports of the 1961 Royal Society Expedition (there have been no published reports on the bigger 1964 Royal Society Expedition). The series of species new to science described from Mt. Kinabalu is still not finished. Various Magnoliaceae and I guess maybe ten to twenty species of *Eugenia* still await description.

I hope that this article will make it clear that the flora of Borneo can only be understood in relation to plant evolution and plant geography when we look upon the subject from the lofty point of view of the summit of Mt. Kinabalu.

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Malay. Nat. J. **24**: 190–191 (1971)

The First Ascent of Mt. Kinabalu

D. V. JENKINS[1]

The first written record of an ascent of Mt. Kinabalu is by Sir Hugh Low in 1851. He is generally thought of as being the first man to reach the summit of the mountain and was accorded the honour of having the highest peak on the mountain named after him.

While it is true that his climb was the first ascent recorded on paper, I often wondered if any of the local people had made the climb before him. I doubted if any had, or even dared contemplate such an undertaking in view of the mountain's sacred association to the Dusun people as the resting place of their dead.

In the Dusun village of Kampong Kiau which nestles in the Kadamaian Valley immediately below the western face of the mountain, I found that an earlier ascent than that of Low's is recorded in their traditional stories.

Enche Tingoh bin Sompot aged about 90 years has a fund of stories about the village and its people. Among the several stories that he told me was the following:—

"In the time of my grandfather's grandfather, much of the hunting at Kiau was done with dogs. One day, seven men and their dogs were out hunting deer, and on picking up the scent, followed the animal up as far as a cave which is now known as Paka Cave. At this spot, they lost track of the deer's footprints and, as it was late, decided to stay at the cave. The next two days were very wet and windy and they were forced to stay in the shelter.

The third day was fine, and they decided to carry on up the mountain to see if they could find any more animals to hunt. They reached Sayat Sayat and as the day was fine climbed up to the summit. On returning to Sayat Sayat, there was strong sunlight, and suddenly from the sky fell 'pearls' the size of eggs. On seeing the pearls fall, the seven men all ran to the spot and tried to collect as many as they could.

Suddenly, they realised that they were lost and could not find the way back to Paka Cave. They thought that it must be the effect of the pearls and threw them away. They all threw the pearls away except for one man who thought that the pearls would be useful and without telling the others tied one pearl in the tip of his loin cloth.

The six men without the pearls found the way back to Paka Cave, but the one who still kept a pearl could not find the way and

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had to be led back. They stayed the night and the following day decided to go back to Kiau.

By this time, the one who still had the pearl was so ill that he had to be carried all the way back to the kampong. On arrival at Kiau the man's loin cloth was taken off and the pearl fell out. The man immediately recovered.

It was then realised that the pearl had magical powers and the next time a person fell ill, the pearl was soaked in water for some time and the water given to the ill person who recoverd.

The people then knew that the pearl was good medicine and the same seven people were sent up the mountain to try to find more. They took with them seven white cockerels and seven eggs to sacrifice to the spirits that lived on Nabalu. They followed the same track and at the place now called Panarlaban they said their pagan prayers, killed the cockerels and placed the eggs on the ground. The cockerels were later taken back to Paka Cave and eaten.

While they were on the mountain some more pearls fell from the sky, but they were much smaller and did not affect anybody who picked them up. The pearls were then taken to Kiau but were found to have no medicinal properties.

The original pearl however continued to be good medicine and was kept by the man who brought it down. On the man's death, the pearl disappeared."

On completing his story, I asked Enche Tingoh whether the people of Kiau would have been afraid of the mountain because of its sacred associations. He said not, because the people of Kiau believed that their dead went to Gunong Sadok Sadok—a hill further down the Kadamaian Valley and that they had not climbed it previously because they could not find a way.

During the earlier expeditions to Mt. Kinabalu, guides were always obtained from Kampong Kiau and the track up the mountain was started from the Kampong and not via the trail now opened up for tourists. During these expeditions, following the precedent set by the seven original climbers, seven eggs and seven white cockerels were always sacrificed on the mountain, irrespective of the number of people in the party.

This tradition continued for many years and even in recent times eggs and a cockerel were taken up the mountain by the guide leading the party. This tradition has now lapsed and visitors may climb the mountain unencumbered by livestock.

The sacrifices are however still remembered on the mountain for one of the campsites is named Panarlaban. This name is a corruption of the Dusun word 'panarban' meaning 'place of sacrifice'.

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The Grounds for Conservation

Introduction

In this section we state the case for conservation, for present and future enjoyment, education and research, of adequate samples of the tropical rain forests which not so long ago clothed the whole of Borneo and the Malay Peninsula. This must be done if the full range of animals from tigers and tapirs down to earwigs and earthworms, and of plants from the lofty tualang (tallest tree in the tropics) to the tiny mosses on their trunks are all to be maintained living together and interdependently as they have evolved over millions of years. Once destroyed, as it so easily is, this treasure house is lost forever, and this is a bald statement of fact not a melodramatic exaggeration.

Most of the articles are slanted towards Taman Negara because that is the largest national park and is also where the most immediate threat to conservation lies. It is equally important that Sarawak and Sabah make similar extensive provision for conservation. Bako National Park in west Sarawak is a modest beginning for that state. Kinabalu National Park in Sabah, centred round the nation's highest mountain, is more adequate.

Ultimately the sanctity of Taman Negara, and indeed of all four national parks, depends upon public awareness of their importance, an awareness which at present exists only dimly in much of the community. Early in 1970 the Society issued a brief public statement on the case for conservation, especially of Taman Negara. This statement is printed below, in English and Bahasa Kebangsaan. It summarises the arguments developed in the remaining articles in this section.

The Status of Taman Negara

1. There may at some stage be a proposal that Taman Negara can serve the dual role of Forest Reserve and National Park.
2. After extensive discussion, the Malayan Nature Society believes unanimously and strongly that this proposal is impossible for the reasons given below.
3. The West Malaysian plants and animals form a community literally unique in the world. Nowhere else do so many different forms of life occur together. This situation exists because the area is geologically old and has been climatically stable for millions of years. Once destroyed this community is forever beyond replacement.
4. This forest community of plants and animals provides the background to the culture of the Malaysian nation. But it is also of world-wide interest, and in due course, as the country continues to develop, will attract visitors in increasing numbers. To biologists it is vitally important for re-

search, and for understanding the evolution of life on this planet. In addition it has been, and will continue to be, the source of important cultivated plants and domestic animals. It is likely that many more useful plants remain to be discovered.

5. By its very nature this rich and ancient community of the West Malaysian forest is intensely susceptible to the slightest disturbance of environment. Even small animals require large areas for their maintenance. Wild plants require large numbers for their continued propagation. Different species of plant and animal occupy different places within the community as a whole, and many are dependent on each other for their existence. Scientific research has shown without doubt that drastic changes and often extinction inevitably follow disturbance. For these reasons small scattered areas are totally inadequate for conservation.

6. It is vitally important that somewhere in West Malaysia there should be retained entirely undisturbed at least one extensive tract of virgin forest of varied topography. Taman Negara is the obvious area for this purpose, already constituted in law.

7. The Malayan Nature Society is convinced that tourism, together with limited programmes of scientific research, are the only proper multiple functions that this important conservation area can serve. In South-East Asia as a whole, Malaya showed foresight in creating this magnificent Park. Malaysia should now lead the way in planned management for the vital and exclusive role of this unique part of the nation's heritage.

February, 1970.

Kedudokan Taman Negara

1. Dalam masa hadapan kelak mungkin ada ranchangan hendak menjadikan Taman Negara sebagai suatu kawasan Hutan Simpan dan juga sebagai Taman Rimba Negara.

2. Satelah diperbinchangkan sechara mendalam, Persatuan Penchinta Alam Malaysia perchaya dengan sepenohnya bahawa ranchangan ini tidak akan dapat dilaksanakan oleh sebab2 yang diterangkan dibawah ini:—

3. Pokok2 dan binatang2 di Malaysia Barat merupakan suatu kumpulan penghidupan Alam samula jadi yang paling aneh didunia. Tidak ada tempat lain didunia ini, dimana pelbagai chorak penghidupan terdapat bersama disuatu kawasan. Hal ini adalah disebabkan oleh kerana kawasan ini mempunyai umor geologi yang tua dan telah dipengarohi oleh suatu iklim yang kekal untok selama berjuta2 tahun. Sekali penghidupan Alam samula jadi ini dimusnahkan, nischayalah tidak akan dapat diganti.

4. Kumpulan penghidupan pokok2 dan binatang2 ini merupakan suatu latar belakang kebudayaan bagi Bangsa Malaysia. Disamping itu

ianya juga menjadi perhatian negara2 lain diseluroh dunia, dan dimasa dekat, sementara Negara kita ini mengalami kemajuan2 dan perkembangan2, Taman ini akan menjadi daya penarek bagi pelawat2 dari luar negeri. Bagi paka2 Kajihayat, kekekalan Taman Negara ini, bukan saja mustahak untok mengadakan kajian2 guna memahami kejadian2 ubahansor yang telah berlaku didunia ini, tetapi juga sebagai suatu sumber penghidupan samula jadi dimana banyak lagi bahan2 tanaman dan binatang yang berfaedah masih dapat dijumpai.

5. Kerana sifat2nya yang sangat chas, kumpulan penghidupan samula jadi di-hutan2 Malaysia Barat yang begitu tua umornya dan kaya dengan jenis2 ini adalah sangat mudah dipengarohi oleh apa jua pertukaran keadaan sekelilingnya. Untok dapat mempertahankan hidupnya, binatang2 kechilpun menghendaki kawasan yang luas. Begitu juga pokok2 liar berkehendakan kumpulan yang banyak untok dapat mengembangkan kehidupan mereka. Pokok2 dan binatang2 yang berlainan jenisnya mempunyai peranan tersendiri didalam kumpulan penghidupan serupa ini, dan masing2 bergantong kapada satu dengan lainnya untok menjaga penghidupannya. Kajian2 sains telah membuktikan dengan jelas bahawa pertukaran keadaan sekeliling akan menyebabkan perubahan2 yang terok ataupun kemusnahan kumpulan penghidupan serupa ini. Oleh kerana itu, jelaslah bahawa kawasan2 kechil yang tersebar merata dipelbagai tempat adalah tidak menchukopi keperluan untok menyimpan kumpulan penghidupan ini.

6. Dengan hal yang demikian adalah sangat mustahak bagi Malaysia Barat untok menyimpan se-kurang2-nya suatu kawasan hutan rimba yang chukop luas, yang mengandongi pelbagai chorak topografi, dan yang sekali2 tidak boleh diganggu ataupun dirosakan. Dalam hal ini Taman Negara adalah satu2nya kawasan yang sesuai yang dapat memenohi semua kehendak2 ini dan telah diluluskan oleh undang2.

7. Maka jelaslah kepada Persatuan ini, bahawa hanya pelanchongan dan kajian2 sains yang berhad sahaja, diantara lain2, yang boleh menepati tujuan2 menyimpan kawasan ini. Diantara Negeri2 diwilayah Asia Tenggara ini, hanya Malaysia sahaja-lah yang telah memikirkan masa hadapannya dengan mengadakan Taman Negara ini. Oleh kerana ini adalah sepatutnya sekiranya Malaysia juga memberikan tauladan2 dalam bagaimana mengatorkan agar supaya Taman ini dapat melaksanakan tugas2nya sebagai Pesaka Kebangsaan kita.

February 1970.

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The Need for the Conservation of Taman Negara

In this article the views of the Malayan Nature Society on the conservation and development of Taman Negara are set out in full.

It is considered that the whole of Taman Negara should be conserved intact in perpetuity as a reserve for the wild life of the Malay Peninsula as it has evolved over the last one hundred million or so years. The area should be primarily one for conservation of this, the most complex and species-rich community of plants and animals ever to develop anywhere on the earth, the pinnacle of natural creation. The Malaysian nation holds this community in trust for mankind. A National Park is a source of national pride and Taman Negara can help in nation building in a matter which quite transcends the interests of any single group living in the country.

The only feasible multiple use of the land besides conservation is for controlled scientific research, including the use of the Park's wild food plants to improve cultivated strains, and controlled tourism. These are both uses of the assets of the Park which can bring continuing and increasing benefit to the country including substantial financial return.

The principal reasons for the permanent conservation of Taman Negara are:—

(i) the area contains a wide range of rock types and has land from below 250 ft to over 7000 ft elevation, including the country's highest mountain,

(ii) therefore the area contains a wide range of vegetation types,

(iii) therefore it supports a wide and representative range of all sorts of animals and contains a wide and representative range species including the wild ancestors of many cultivated fruit trees (e.g. banana, rambutan, rambai: *Musa*, *Nephelium*, *Baccaurea*).

(iv) Taman Negara is a big area (1677 square miles) in which all these vegetation types and wildlife species live together and interact in the manner they have evolved. This is essential for their permanent well being. Large animals (e.g. elephant, rhinoceros, seladang) need large areas, such as the Park provides; small pockets scattered over the country are no substitute because they cannot sustain viable breeding groups.

(v) Taman Negara offers important tourist attractions and is a rapidly growing resort area (1963: 34 visitors, 1966: 448, 1970: 895 who on average stayed for 5 nights each). For sophisticated international tourists it is potentially the major attraction of West Malaysia and will play an increasing role

in bringing jumbo jet loads of visitors to the country. Such persons need have a reasonable chance of seeing wild animals. Experience in Africa and India, as well as in Taman Negara itself, has clearly shown that protected animals do become fearless of man and can be approached by them.

(vi) Dr. W. Stevens spent the two years 1966–8 in West Malaysia as a Colombo Plan expert and produced for Government a report on *The Conservation of Wildlife in West Malaysia* based on extensive observations throughout the country. His report (1968) develops a well argued case for conservation and central to the whole argument is the assumption that Taman Negara will remain inviolate as the main reserve of the lowland forests which contain most of the nation's animals (e.g. over 80% of the mammals).

Each of these reasons for conserving Taman Negara under virgin forest will now be considered in more detail.

GEOGRAPHY

The map on page 126 shows how Taman Negara lies on the boundaries of Kelantan, Trengganu and Pahang. It lies at the headwaters of three major river system (Lebir-Aring-Relai, Terenggan, Tembeling/Pahang). It is thus a natural area of retreat for big animals as the forests on the lower reaches of the rivers are destroyed or brought under commercial management. It acts as a gigantic sponge during the wet months of the north-east monsoon, and, under virgin forest, slowly releases the heavy monsoon rain into the main drainages. Forest felling would foul the streams, increase the rate of runoff and enormously increase the floods which already annually distress inhabitants along the lower reaches. About 57% of Taman Negara lies in Pahang, 24% in Kelantan, 19% in Trengganu. The map (p. 114) shows the land at different elevations in Taman Negara. The bulk, 57.6%, lies below 1000 ft (only 0.6% below 250 ft ; 28% lies between 1000–2500 ft, 11% 2500–4000 ft, 2% 4000–5000 ft and 1% over 5000 ft. In Taman Negara the steepland boundary lies at about 400 ft, roughly 30% of the Park lies below this level and is thus topographically suitable for agriculture. The poor sedimentary-derived soils of the part below the steepland boundary are however probably unsuitable for agriculture.

GEOLOGY

Figure 1, shows in outline the geology of Taman Negara. Salient features are firstly the wide range of rock types, especially sedimentary types, with a marked difference between the western and eastern parts

of the Park; secondly, no deposits of economic minerals have been reported; thirdly the granite (igneous rock) areas in the east, all in rough mountainous country, occupy about 17% of the Park; fourthly, there is Quaternary alluvium in the south-east; and mainly, within the Park lie numerous limestone hills including at Gua Peningat in the west the highest (2342 ft) and one of the largest in the country.

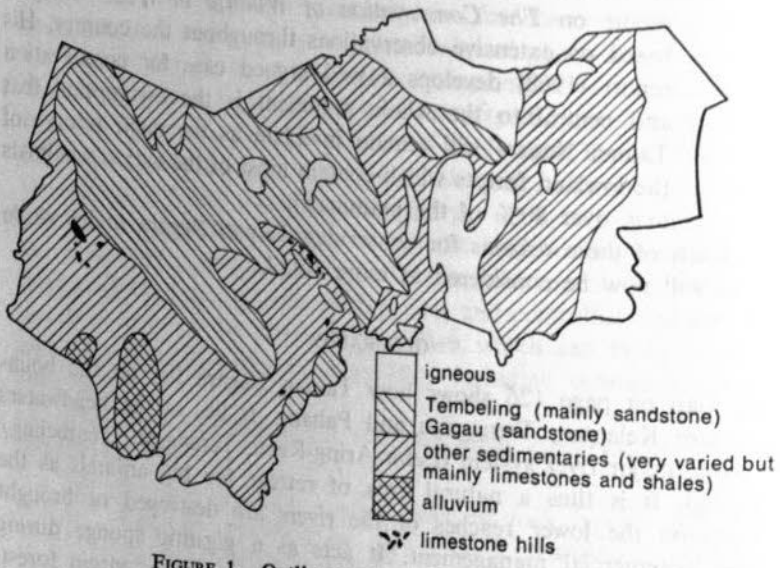

FIGURE 1. Outline geology of Taman Negara.

THE FORESTS

Figure 2, is a very approximate attempt, based on air photos, to separate the non-commercial montane forest, together with the other poor quality forest of the area, from the remaining forest which is of average to good commercial value. This is a very rough first approximation and more detailed interpretation of the aerial photos and further ground survey are certain to alter details and maps on a bigger scale will show small pockets of different forest types, but the broad picture is established. The salient features are that at least half the Park bears poor forest with small crowns which has small commercial potential or is non-commercial montane forest above about 2500 ft. Further, as with the geology, there is a difference between the western and eastern halves. The high yielding forest of trees with big crowns is principally in the foothills of the Gunong Tahan massif and the centre of the Park north of Sg. Tembeling. The area in the northeast in the Ulu Terenggan is of only average quality and is at the present day extremely inaccessible.

It would wreck the Park to log in the areas around G. Tahan and in the centre. The southwest and west portions which are now accessible by logging road carry poor quality forest and have ten of the fourteen known salt licks in the Park and big numbers of game animals — see below. These salt licks are all along the edges of the Park. They are an absolutely essential feature of the Park and to exclude them or in any way tamper with the forest round them is quite unthinkable, as it would completely defeat every purpose for which the Park exists.

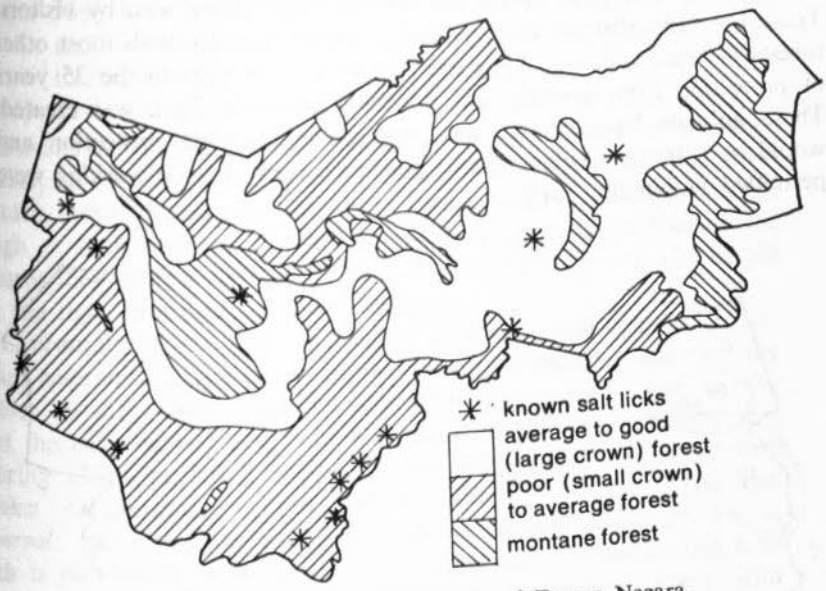

FIGURE 2. Outline forest types of Taman Negara.

It is essential for the future scientific management of the forests of the country for the commercial production of timber and for hydrological research that a representative range of undisturbed virgin forests remains as a control, against which the long term, sometimes insidious and cumulative, effects of management can be measured. Taman Negara is just such a control area. For forest research it needs to be supplemented by additional areas such as the Forest Department's Virgin Jungle Reserves provide.

THE ANIMALS

Mohd. Khan elsewhere in this issue has written fully on the distribution of large animals in Taman Negara. The map Fig. 3 summarises what is known of the distribution of seladang, elephant and Sumatran rhinoceros, based on his data. All the other *big mammals* known for West Malaysia are known or suspected to occur within Taman Negara,

there are no known absentees. By the end of this century, only 30 years hence, big animals which need big lowland rangers are likely to be extince outside extensive sanctuaries such as Taman Negara. No one knows if the estimated total populations in the Park of 58–67 elephants and 62–68 seladang are enough to preserve the species; the rhinoceros with 3–4 isolated individuals will probably become extinct unless man intervenes. Does the nation wish to ensure the extinction of elephant and seladang too? Taman Negara contains a high concentration of animals; they are less shy than elsewhere and some are relatively easily seen by visitors. These are both striking features and contrast strongly with most other forests of the Peninsula. They are due at least in part to the 35 years of protection from hunting and poaching since the Park was created. These animals have become accustomed to complete protection and would be extremely vulnerable to poachers if any timber working were permitted within the Park.

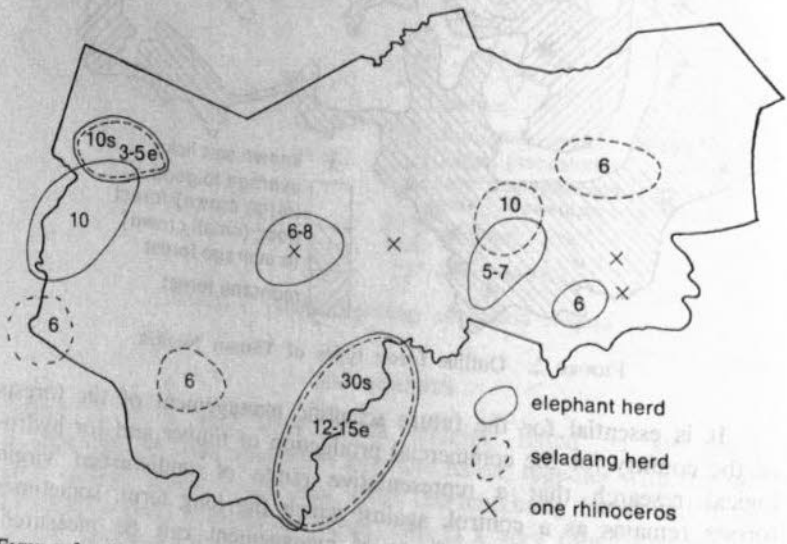

FIGURE 3. Known distribution of elephant and seladang herds and of Sumatran rhinoceros in Taman Negara.

Taman Negara probably contains virtually all the inland *birds* of the Malay Peninsula, 254 species had been reliably identified up to July 1970; 74% of the known species (168) of the lowlands and lower montane zone to 3000 ft, 66% (51) of the species of the montane zone over 3000 ft, and 20 species of common open country and river fringe birds; these figures do not include migrants, which remain largely unstudied in Taman Negara.

Lower animals remain little studied. These river headwaters probably act as important breeding grounds for fish which are caught for food in lower reaches outside the Park.

Concerning *small mammals*, Stevens, in appendix 1 to his report, analysed the habitat requirements of all Malayan mammals excluding bats. Important points from his conclusions are: —

(i) 51% of mammals live on the ground, 37% in trees, 8% both, 4% in water;

(ii) 53% are confined to primary forest, 25% live in primary and tall secondary forest, 12% live in either of these or cultivated areas;

(iii) 52% live below 1000 ft, 81% below 2000 ft.

Stevens concludes 'the only way in which the native land mammals of Malaysia can be preserved is in the undisturbed lowland rain forest in which they evolved ... establishing formal reserves and parks large enough ... such reserves and parks must be ... permanent because the treasures they protect have lived there for 30 million years and should have the right to expect a similar future".

Concerning *plants*, Taman Negara is and should remain an important reservoir of wild plant species growing, competing and evolving together as they have probably since the Cretaceous period, i.e. for about the last one hundred million years. It is not widely realised that flowering plants probably evolved in the tropics, possibly somewhere between Assam and Fiji (Takhtajan, *Flowering Plants, Origin and Dispersal*, 1969) and there are indications that the Malay Peninsula, which is part of the ancient Sunda continent and has the richest flora of any country in the world, lies at the heart of this area. Many plant species grow as widely scattered solitary plants, e.g. wild rambutan, durian and asam gelugor, (*Nephelium, Durio, Garcinia*), as described later in this issue by Ho and by Whitmore. To ensure they do not become extinct it is essential to conserve large tracts or virgin forest covering a wide range of rocks and altitudes. This is exactly what Taman Negara does. It is a huge 'bank' of wild plants many of which may have potential drug value or be valuable for improving cultivated strains of fruit trees etc. The map, Fig. 4 shows the approximate places where botanists have worked. It can be seen that exploration is very incomplete except for the tourist route to and up Gunong Tahan. Investigations by other scientists have been even more local. The high plateau (padang) of G. Tahan has several species of flowering plants and ferns which grow either nowhere else in the world or else are unique here for West Malaysia.

Concerning *tourism*, Taman Negara offers the tourist easy access by river and by well maintained paths into the interior of the Malayan

mixed lowland dipterocarp forests, the most magnificent and exciting forests the world has ever known, and which a little diligence he can see a wide range of mammals, besides birds and butterflies in profusion.

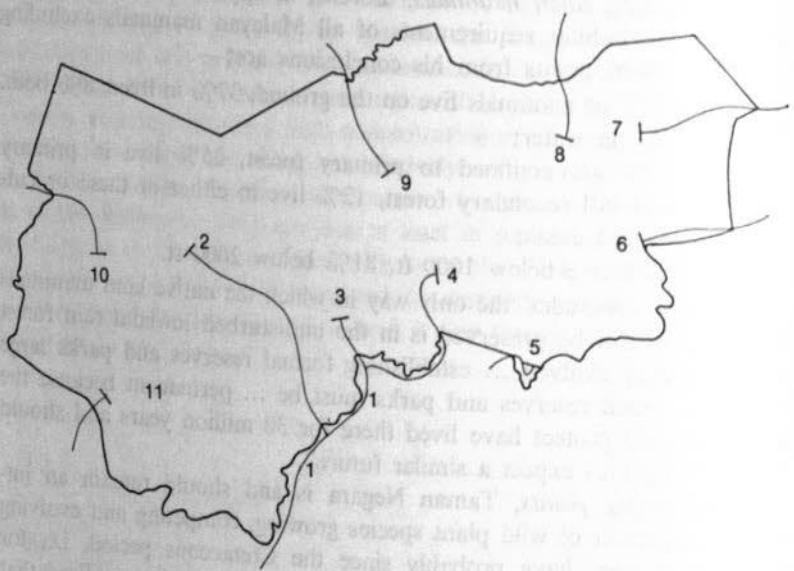

FIGURE 4. Botanical exploration of Taman Negara. **1:** (Sg. Tembeling) many persons; **2:** (G. Tahan) principally *Ridley, Low, Holttum, Corner, Henderson, Wyatt-Smith & Wong, Ng, Dransfield, Shah & Whitmore, Soepadmo,* 1906-70. **3:** *Dransfield, Shah & Whitmore,* 1968. **4:** *Henderson* 1929, *Whitmore* 1970. **5:** *Whitmore,* 1970. **6:** *Cockburn & Whitmore* 1968. **7:** *Moysey & Kiah* 1934, *Whitmore* 1969. **8:** *Cockburn* 1968. **9:** *Haniff & Nur,* 1923, *Cockburn & Whitmore,* 1967. **10:** *Burgess & Loh,* 1970. **11:** *Machado* 1903.

The limestone hills are tourist spectacles of the first order, Gua Peningat, of potentially easy access near Merapoh in the west, is the highest limestone hill in the country. Gua Kenyam has aboriginal cave paintings.

The cliffs of the Teku gorge (Plate 33b) south of Gunong Tahan are spectacular, as is the padang of Gunong Tahan itself. These are deservedly popular with the more energetic visitors who make the long trip to the mountain.

The Tembeling runs through a gorge from K. Kenyam down to K. Tahan (see the map) with high forested bluffs on both banks and numerous exciting rapids in the river bed, to be shot in small perahus. Most tourists experience this gorge as a highlight of their visit. The smaller streams, of which the Sg. Tahan and Sg. Kenyam are the most accessible, have the attraction of overhanging neram trees (*Dipterocarpus oblongifolius*).

These are all things which are 'different from home' and are therefore potentially powerful attractions to even the most jaded international tourist. However, this potential remains largely undeveloped, for although 80% visitors to the Park are foreigners (i.e. only 20% Malaysians), in 1970 up to end July only 68 of the visitors (11%) gave an overseas address when booking. Malaysia is already only 18 hours by air from Europe and only a day away from America, Japan is even nearer. There is already a small airstrip near Park Headquarters at K. Tahan.

The *boundaries* of Taman Negara are worth a moment's attention. The Sg. Tembeling is a natural boundary to much of the southern and eastern border. The other boundaries were laid down before the topographic survey and therefore in some places cut across the country in an arbitary manner. There is room for local minor realignment especially in the eastern mountainous part of the Park so that the boundaries follow ridges or run down to main kualas.

There have been minor *encroachments* on the park (i) in the north west near Merapoh where logging has penetrated two miles; (ii) in the southeast near K. Kelapah, Sg. Sat and (iii) between the Sg. Sat and Sg. Sepia north of Kg. Lanchar: both permanent padi areas penetrating several miles into the park; (iv) rubber is cultivated in the Ulu Lebir in the central north of the Park; (v) fish and rusa are probably poached along most borders, and rotan manau is extracted by orang asli from the Ulu Sat.

The Malayan Nature Society considers that there is no case at all for major realignment of the boundaries of Taman Negara. Its function as a conservation area are well met within its present boundaries which were established after exhaustive study and field investigation by T.R. Hubback, Malaya's first Chief Game Warden. The forests to its immediate south are now logged and roads penetrate close to its southern edge. But the forests within the Park at this place have little timber and better than being logged should be kept as a national reserve of virgin forest, a continuing asset, for the reasons expounded above. Moreover, ten of the fourteen known salt licks occur in this part and thus so do big concentrations of the wild animals.

It is important to make the following small extentions to Taman Negara, see map (Fig. 5):— (i) the east bank of the Tembeling gorge between K. Kenyam and K. Tahan must be included to protect the scenery which is already a major tourist attraction. The east bank is state land and very rugged hills. A belt about 1 mile wide is needed, excluding the flat inhabited area round K. Pagi. This is an urgent need because logging cannot be many years off and this is in the most visited part of Taman Negara. (ii) the southeast corner of the Park is on shale

and is very unstable with numerous big landslips even now under virgin forest. This area should remain under virgin forest to protect against serious erosion, if for no other reason. The unstable area extends southwards and a protective forest reserve should be created there. (iii) the high land west and north of G. Rabong should be included within Taman Negara. G. Rabong forms the northwest corner of the Park and its upper slopes will remain protective forest in any case.

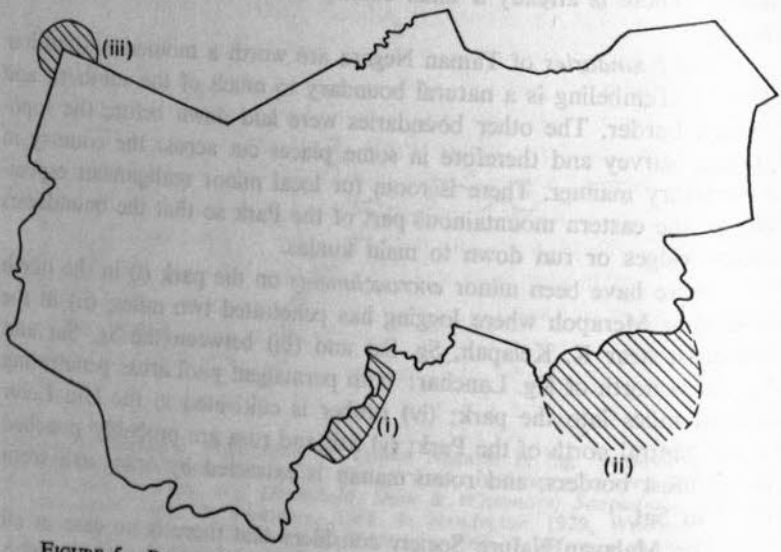

FIGURE 5. Proposed extensions to Taman Negara, for details see text.

Forest felling licences have been given out for much of Ulu Kelantan to the north of Taman Negara and logging approaches it from the west and south as well. At its narrow point the Park is only 24 miles from north to south. Already a certain amount of poaching takes place wherever people live near to the boundary. We consider it absolutely essential that a broad buffer zone of forest is maintained everywhere round the boundary of Taman Negara. This means that as land development proceeds the whole area around the Park should become either protective or productive forest and not plantations or padi land. Otherwise poaching will get worse and, more important, the big animals will wander outside the park into what they like much more, succulent padi, oil palm and young rubber.

Finally we wish to make a few suggestions for the main lines along which the potential of Taman Negara could be developed.

The Game Dept. (under which the Park is vested) should continue to develop tourist facilities, for instance there is an urgent need for

descriptive leaflets for the visitor arrived at Kuala Tahan. As access to Taman Negara becomes easier it will be essential to take stringent precautions against illegal encroachment by agriculturists and poachers.

The Game Dept. could usefully begin the collection of basic data for future scientific research projects, for instance by installing rain gauges and river height posts at all ranger posts and making daily observations.

Land use planning authorities should make provision for the buffer zone of forest all round the boundaries of Taman Negara discussed above.

Steps should be taken to make the small increases in the size of Taman Negara described above.

Steps should be taken by the Game Dept to attract the attention of visiting and resident biological scientists when research projects are being planned. Whenever possible these projects should be sited within the Park.

The Krau Game Reserve in west Pahang is an additional important reservoir of wild life. It contains Gunong Benom, a high granite mountain, one of the highest peaks in the country, 6916 ft. The one major range of forest types missing from Taman Negara is that which develops on high granite country, and if certain plants and animals are restricted to these habitats, which may well be the case, the Park does not include them, and the Krau Game Reserve forms an obvious additional area for continued conservation.

Malay. Nat. J. **24**: 206–209 (1971)

A Plea for the Inviolacy of Taman Negara

H. M. BURKILL[1]

A critical survey of the position of nature conservation in the Malay[2] Peninsula up to 1961 was given by various authors in *Nature Conservation in Western Malaysia* (Kuala Lumpur, 1961) issued by the Malayan Nature Society to mark the 21st anniversary of the Society's foundation. Another significant Malayan document is T.R. Hubback's *Report of the Wild Life Commission* (Singapore, 1932). This publication is not as widely known as it ought to be. It sets out in great detail the growing awareness of public opinion on conservation matters, on problems related to the aborigines, forestry, agriculture and the defence of crops from animal depredations, on the steps of the legislative machinery from the beginning of a modern administration, and it ends with the Commission's recommendations on wild life management in the Peninsula. Much of what follows here is taken from this report as the conditions then are not so radically different from what they are now as to make the recommendations inapplicable.

The earliest Malayan protective legislation dates from 1884 in the Straits Settlements concurrent with the creation of forest reserves. This was repeated in Selangor in 1889. Only birds were covered, but in Pahang in 1896 legislation was enacted to protect elephants, rhinoceros and seladang. More embracing legislation for 'big game', 'deer' and 'wild birds' followed in 1902 and 1903 in Perak, Selangor and Negri Sembilan. It was in Perak that the basic necessity was recognised that proper protection required the protection of the habitat. The Chior Game Reserve (10700 acres) was created in 1903. Appropriate though this was, it was not till 1922 that game wardens were appointed in the Federated Malay States to administer the game laws. Legislation in the Unfederated Malay States (excepting Kedah where no action was taken) was also enacted at various dates.

Consequent on the appointment of game wardens, new game reserves were created, some to be as soon deleted for agriculture. The Serting Game Reserve (68140 acres) in Negri Sembilan and the Sungei Lui Game Reserve (42500 acres) in Pahang were established in 1925 and both were deleted in 1929. The Krau Game Reserve (131000 acres) in Pahang was established in 1923 and proposals in 1929 to delete it too raised such acrimonious opposition that the reserve was saved. In northern-most Pahang the Gunong Tahan Game Reserve (354200 acres) was created in 1925, and this was too remote to fall under the avaricious eyes of commerce so

[1] Royal Botanic Gardens, Kew, England; lately Director, Botanic Gardens, Singapore.
[2] Malay and Malayan is used here in a geographic, non-political sense to cover the Malay Peninsula.

that its land was not coveted. In Johore all the game reserves were cancelled in 1928. No other state had reserves.

This stop-start-stop position in itself was unsatisfactory, but it was in fact the growing demands for agricultural land and the consequent damage to crops by wild animals that really brought the issue of game protection to a head. Elephants dispossessed of their ancestral homegrounds returned to estates and settlements to do extensive damage to trees and crops and to terrorise the villagers. Not only elephants, but deer, pigs, even rats were blamed. Even the F.M.S. Railway complained of extensive damage in Pahang, and as late as 1940 the traveller on the East Coast line could see the railway gangers' quarters on the Pahang–Kelantan divide behind anti-elephant barricades. How sad to think that the necessity for this has gone, the railway trace now being a hideous broad belt of 'ribbon development', a criminally large proportion of it abandoned to belukar after the forest wealth has been lifted off—and year after year authority wrings its hands in pious, offended sorrow at the lowland flooding, a retribution of course, for accelerated run-off and erosion on the denuded foothills, and silted-up rivers of the riparian plains.

There had been proposals for the creation of a National Park in 1927, and there was general public unease that 'something ought to be done', and that the on-off attitude of officialdom was not achieving anything. It was not just that the depredations of wild animals to agri-horticultural holdings were viewed with reasonable disfavour by the planters and farmers. The fate of certain animals, the seladang, rhinoceros, tapir, serow and others gave concern. The many aspects of conservation needed to be brought into a national scheme for the overall benefit of the country. The Wild Life Commission of Malaya under the Chairmanship of T.R. Hubback was set up in 1930 with a mandate covering all the States to make recommendations for a course of action.

The Commission recommended the establishment of a National Park with a guaranteed permanency, and for national parks generally proposed '.....such Parks shall be maintained and made use of so as *to leave them unimpaired* for the enjoyment of future generations.' [Italics mine]. The Commission deplored the stroke-of-the-pen policy whereby earlier reserves had been revoked, and the Commission made certain recommendations regarding those revoked and other game reserves. These do not concern us here except insofar as the recommendations expressed the basic tenet of conservation that an indisturbed permanence was an essential factor. The Commission's major recommendation was the creation of a national park based on the Gunong Tahan Game Reserve to which should be added contiguous areas in Kelantan and Trengganu, together making a total area of 1890 sq miles to be known as the Gunong Tahan National Park. In the event, when the park was established it was called the King

George V Park in commemoration of the Silver Jubilee of the King's reign. The park is now known as Taman Negara.

The foregoing is thus briefly the circumstances whereby the National Park came into being, but before the Commission reached its decision it did very carefully consider the possibility of a system of wild life protection within the framework of the Forest Department in the Forest Reserves. However, the example of the failures of a similar administrative arrangement in Burma and the background of Malayan conditions led the Commission to reject such a scheme. Very detailed reasoning is given, but it must suffice to quote here the conclusion:

> 'I cannot consider that the Forest Reserves should be looked upon, in any way, as ultimate sanctuaries, breeding grounds or refuges of wild life in anything but its smallest forms. .....The commercial exploitation of the forest will destroy all the larger forms of wild life. I would oppose .. the idea that forest reserves in Malaya can be looked upon as substitutes for properly constituted game reserves .. entirely ..., and I am quite sure that if such steps were taken the death-knell to efficient wild life preservation in Malaya would be struck. ...It is to be hoped that future generations will not be able to point to the first half of the Twentieth century as the crucial years which were responsible for the passing of the Larger Fauna in Malaya.' [*Report*, vol. 2, pp. 185 et seq.].

Looking back now in retrospect 40 years later and in the second half of the Twentieth century, one must express an admiration that the Administration, even though guilty at times of dragging its feet, had the foresight, prescience and courage to establish the National Park, and whatever Government's failings in more recent years over wild life protection generally in areas other than in the Park, the maintenance of the Park is a creditable achievement. To many other countries not so fortunate to possess such an institution, it is an envy. It is with great alarm, therefore, that one learns of a serious proposal to open up the Park, or parts of it, to forest exploitation. One hears, too, with even greater anxiety that 'The Planners' scheme the alienation of all or nearly all forest areas in Malaya under 500 feet altitude, and this includes much of the Park, for agriculture and settlement. One is aware already of geological prospecting within the Park. This is deplorable back-sliding, and an abandonment of a national policy. Of even greater significance is the reneging of an international human responsibility.

Though the concept behind the creation of the Park was the protection and preservation of the larger species of the Malayan fauna, the hub of the matter was the preservation of the habitat, a *sine qua non*. This meant the preservation of the vegetation, the rivers and streams, the soil and rocks without disturbance. Upset one, and there is a chain effect on

all the interrelated factors. Introduce logging, and the whole balance of nature is set on the 'Gadarene slope', and in the words of Hubback, 'the death-knell of wild life preservation would be struck.' But it is more serious than this. The modern concept is the preservation of the living biological entity, the biota, the earth, air and water, the plants and animals, whatever their size, wherever and however they live, as unique samples of the world's biological wealth, a gene pool on which Man, by his capacity for such things, can call upon to study and use for the understanding and betterment of life. In this day, as administrations become aware of the perils attached to pollution of the environment and the loss of natural resources through the virus of human greed and destructiveness, it is an inescapable international obligation of every country towards the comity of mankind to protect and to preserve samples of its natural biological heritage. The present Malaysian Government has in the National Park the means of making a very big contribution towards this. Let it not be said that in this International Conservation Year, Government failed, not by the lesser error of inaction, but by the greater sin of premediated reversal of an existing policy.

Sebab berkelahi dengan perigi, akhir-nya mati dahaga.

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National Parks, Pests and Possibilities

by

J.A. BULLOCK[1]

Insects and other invertebrates receive little mention in this number, not because they do not occur, but because so little is known of them. Apart from butterflies, few groups of insects attract collectors, and even those which do, such as beetles, cicadas and dragonflies, have not received the concentrated attention devoted to mammals, birds, plants and even snakes and fish. In the main, only those groups which are of medical or agricultural importance have been studied extensively and even here, knowledge is often scanty, particularly of how they exist, and how their numbers are limited, in their natural habitat.

Superficially one may think that the world would be a better place in which to live if there were no insects, apart perhaps from the more beautiful and striking ones. Certainly with the quantities of insecticides we use we are doing our best to eliminate many kinds of insects while the unlimited collection of the 'beauties' such as the Raja Brooke Birdwing, often for sale to tourists, forms a major threat to these species.

But despite the almost uniform disregard for insects and their relatives, such as spiders, millipedes and mites, without them the world would change drastically. Insects may eat our crops and timber trees, but often they are the pollinators which mediate reproduction. They are amongst the most important agents in the break-down of dead material, particularly of wood, a process which is an essential step in the flow of nutrient materials, making them available for uptake by the growing plants. And there is good evidence that without their intervention, the diversity of plant species which is so characteristic of Malaysian forests would not be maintained (*cf.* Bullock, 1967). Even those forms which we regard as unpleasant or inimical such as mosquitoes have a definite role to play. Thus the tiger mosquitoes (*Aedes* spp.) are carriers of dengue fever not only to mankind but also to monkeys. Without their intervention as disease carriers, it is possible that monkey populations would build up to a level where they damaged the trees and invaded plantations.

Apart from this, and perhaps most important for mankind, insects are amongst the most effective checks to others of their own kind, because many species of insects feed on other species, and all spiders, scorpions and so on are exclusively predatory. As agriculturists have

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found to their cost, insecticides are more effective in controlling the predators of their pests than they are in controlling the pests (e.g. Conway and Wood, 1964). The potential for encouraging the biological control agents is great and largely unexplored.

As land is cleared, crops planted and the habitat changed, so vital changes occur in insect populations. Uvarov (1964) showed that far fewer species of insects occurred on cleared land, but that those which did were often very abundant. The reason is quite clear; few insects can cope with the changed habitat, but those which can, are freed from their predators and thus increase greatly. The remedy would be to restore the balance by encouraging the predators but this takes time and requires research.

The relevance of this to National Parks is obvious. Most Malaysian pests have originated from the forests, and within the forests their numbers are kept down by predators. If we are to utilise these natural agencies, it is necessary to preserve the habitats in which they operate so that we may find out how to use them to best advantage. Important as this is at present, the need will increase as plantations of both endemic and exotic tree species are developed, for then surely shall we see pest problems increasing in crops in which insecticidal control will be entirely uneconomic. It is no accident that the countries in which biological control is most advanced are those, like Canada, which depend upon timber-cropping.

There is no one over-riding reason for National Parks, as I have said elsewhere (Bullock, 1969), but the maintenance and study of our National Parks is a sound and economic investment for future development, not only in biological control, but for development of utilisable crops, and crop improvement, for an understanding of how we may improve our agricultural, plantation and forestry techniques and as a general insurance for the future.

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Importance of Taman Negara in the conservation of mammals

LORD MEDWAY[1]

To the majority of mankind, mammals are a familiar and attractive group of animals. Malaysians are fortunate to live in a country which, in relation to its size, contains one of the richest and more diversified mammal faunas in the world. A long tradition of awareness and close relationship between Malaysians and their wild mammals is shown by the wealth of legend and other cultural associations that can be traced.

A total of 198 species of wild mammals are known from the States of Malaya.[2] The most numerous groups are the least familiar — the bats with 80 species, and the rodents with 53 species. Many of the mammals, including several larger and better known species, are not confined to Malaysia, but are widely distributed in South and Southeast Asia. These mammals, which include tiger, leopard, elephant, sambhur (known locally as rusa), muntjak (= kijang) and gaur (= seladang), flourish in parts of their range where a monsoonal climate prevails and the vegetation is open. They are less well adapted to the forest environment of Malaysia, and may live largely on the forest edge.

By contrast, the more characteristic Malaysian mammals are specialised for life in the all evergreen tropical rain forest which originally covered most of the country. Few are entirely restricted to the States of Malaya. The mammals endemic to Malaya (found nowhere else in the world) consist of one rat and four very rare bats, each known only from one or two specimens. In addition to these five, there are another 72 species of Malayan mammals which have a limited regional distribution, being confined to Malaysia and part of western Indonesia. This restricted regional fauna includes the gymnures or moonrats, many bats, more than half the Malayan rodents, the bearded pig, the two common leaf monkeys, a gibbon and the siamang.

Because they are specialized for life in this particular environment, the characteristically Malaysian mammals are conspicuous and biologically important members of the rain forest community. The leaf monkeys and gibbons, in particular, are the dominant leaf-, fruit- and shoot-eating mammals of the forest, and therefore the most significant primary consumers of living plant tissue. The sight of siamang, gibbons or troops of leaf monkeys moving through the tree-tops, the sounds of

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2 Two additional species have been found since the publication of Medway (1969). *The Wild Mammals of Malaya and Offshore Islands* (obtainable from the Malayan Nature Society, P. O. Box 750, Kuala Lumpur, at M$30.00, post free, or from bookshops).

their loud distinctive calls, or the flick and chatter of a brightly coloured squirrel — these vivid impressions are the true image of Malaysian forests.

Unfortunately, the very specializations which make them successful in the rain forest spell doom to these mammals if their natural habitat is disturbed. More widely distributed mammals such as elephant, sambhur, wild pig or gaur, subsist principally off the vegetation of clearings, riverbanks, logged forest, secondary growth or cultivation; but gibbons, leaf monkeys and most squirrels are totally dependent for their existence on the presence of tall forest cover. For their survival large areas of undisturbed forest must be retained, of sufficient extent to contain a self-perpetuating breeding population.

The Taman Negara is one such area. It is centrally placed in Malaya and topographically varied. Although no complete list of the

TABLE 1. The number of species of mammals of Malaya, tabulated by family or larger group. Figures in parentheses give the number of species known or confidently believed to occur within the Taman Negara.

Group	WORLD DISTRIBUTION		Total species	Number of species dependent on forest
	Malaysian region	Widespread		
Gymnures	2 (2)	0	2	2
Mole	0	1 (0)	1	0
Shrews	0	4 (3)	4	2
Flying lemur	1 (1)	0	1	1
Fruit bats	8 (4)	7 (4)	15	11
Other bats	26 (10)	39 (22)	65	51
Treeshrews	2 (2)	1 (1)	3	2
Slow loris	0	1 (1)	1	0
Monkeys	2 (2)	4 (2)	6	3
Gibbons	2 (1)	1 (1)	3	3
Pangolin	0	1 (1)	1	0
Squirrels	9 (9)	5 (5)	14	12
Flying squirrels	7 (3)	3 (3)	10	9
Bamboo rats	0	2 (1)	2	1
Rats	9 (6)	15 (7)	24	16
Porcupines	3 (2)	0	3	1
Red dog	0	1 (1)	1	1
Sun bear	0	1 (1)	1	1
Otters, weasels	1 (1)	5 (3)	6	1
Civets, etc.	4 (4)	11 (7)	15	10
Cats	1 (0)	6 (5)	7	6
Elephant	0	1 (1)	1	1
Tapir	0	1 (1)	1	1
Rhinoceros	0	2 (1)	2	2
Pigs	1 (0)	1 (1)	2	2
Mouse-deer	0	2 (2)	2	1
Deer	0	2 (2)	2	1
Cattle, serow	0	3 (2)	3	1
Totals	78 (47)	120 (78)	198	142

mammals of the Park has been published, a preliminary compilation can be made from reported collections in the area before it was gazetted, together with later observations by Park staff and visitors, and supplemented by the addition of mammals known to be common and widespread in central Pahang. Comparison with the total mammal fauna of the States of Malaya shows that the Park contains a good representative sample. Within its limits moreover, 60 percent of the specialized Malaysian regional endemics occur, including all the more characteristic and biologically important members of this group (Table 1).

In such a large and topographically varied tract of forest as the Taman Negara, mammals are not evenly distributed. The richest assemblage, including a major proportion of the distinctively Malaysian species, is found in the lowland dipterocarp rain forest, up to about 1000 ft above sea level. At higher elevations the number of species becomes progressively smaller. At the same time, specialized lowland mammals are replaced by species characteristic of the highlands. To conserve adequately the entire mammal fauna of the Park, it is necessary to retain sufficient areas of forest at all elevations, but most importantly in the lowlands.

It is unlikely that any other comparable reserve in Malaya contains such a rich community of mammals, including such a high proportion of Malaysian forms. This fauna cannot survive unchanged the alterations to its habitat that result from logging, even on the basis of selective felling. As noted above, the most susceptible species are the specialized Malaysian mammals, and it is for these above all that the Park at present provides an essential refuge.

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The importance of Taman Negara as a gene pool of major cultivated plants

Ho Coy-Choke[1]

INTRODUCTION

Malaysia and the surrounding countries in Southeast Asia are one of the main world centres of the origin of cultivated plants (Vavilov 1951, Li 1970). In Malaysia, Taman Negara is one of the most significant areas where wild genetic relatives of major crops can be discovered, collected and utilized for agricultural improvement and diversity. According to the studies of N.I. Vavilov and his student, P.M. Zhukovsky, there are only twelve major regions of gene centres and plant resources (Leppik 1969). These are: I Chinese-Japanese; II Indonesian-Indochinese; III Australian; IV Indostanian; V Middle-Asian; VI Near Eastern; VII Mediterranean; VIII African, including Ethiopia; IX Euro-Siberian; X Central American; XI South American and XII North American.

In contrast to the other regions of crop origins, the Indonesian-Indochinese centre, which includes Malaysia, has produced mainly tree fruit crops, with the major exception of the bananas (Simmonds 1962). The following genera from diverse families are of economic importance in Malaya: *Durio* (durian), *Nephelium* (rambutan, pulasan), *Lansium* (langsat, duku), *Baccaurea* (rambai, tampoi), *Garcinia* (mangosteen), *Artocarpus* (jackfruit, chempedak), *Sandoricum* (sentul), *Mangifera* (mango), *Parkia* (petai) and *Eugenia* (jambu). With the exception of *Parkia* which is eaten as cooked vegetable, the rest produced sweet and juicy fruits, which are eaten raw. Each of the above genera, have several edible members which are extensively cultivated, while its relatives of poor edibility can be found in the forests. For example, in *Garcinia*, there are about 40 different species in Malaya, but only 5 species, *G. mangostana, G. dulcis, G. prainiana, G. cowa* and *G. atroviridis* produced good edible fruits and are cultivated (Allen 1967).

THREATENING HUMAN FACTORS AND CASE FOR CONSERVATION OF WILD RELATIVES OF CULTIVATED PLANTS

Two major factors arising out of organised human planning threaten the survival of the wild relatives of locally originated crops including bananas.

(1) *New Land Development for Agriculture, Building and Mines*

Present land hunger enforces large scale clearing of forests for

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conversion into farms, new towns, industrial complexes and mines. In this process, there is complete destruction of the original vegetation through cutting and burning.

(2) *Timber Industry and Forest Regeneration Programme*

There is large scale felling for timber in forests, and their planned regeneration (Wyatt-Smith 1963) hinders the perpetuation of the wild relatives of these crops. In fact, these plants of low timber value can sometimes be considered as weeds in forest regeneration programme.

VALUES OF WILD RELATIVES OF CULTIVATED PLANTS

Wild genetic relatives of crops are of importance towards the improvement of Malaysian agriculture because they may posses highly valuable genes of varied agronomic characters which may be wanting in presently cultivated varieties.

Firstly, a number of such species can be introduced immediately into cultivation for long term economic benefits and for promoting agricultural diversification. A few examples may be given. In *Durio*, the most widely cultivated species is *Durio zibethinus*, but several other species also produce good edible fruits. Soegeng (1962) reported that *D. kutejensis* has good edible fruits and is cultivated in the eastern part of Indonesian Borneo and Sabah. Meijer (1969) also mentioned that *D. graveolens*, *D. kutejensis* and *D. oxleyanus* have edible fruits and are cultivated in Sabah. In *Baccaurea*, the most commonly cultivated species is B. *motleyana* (rambai), while another species, *Baccaurea griffithii* (tampoi) with very large and pleasant fruits still remain to be cultivated extensively; the fruits from wild trees are sold in various towns including Petaling Jaya. Both Corner (1940) and Allen (1967) praised the superior quality of the fruits and reported that the species was not known to be cultivated. However, on 16 May 1970 a cultivated fruiting tree was found in the mixed orchard of Haji Taib bin Bujang located beside the Kuala Lumpur-Seremban trunk road, 22 miles from Kuala Lumpur.

The green seeds of Petai (*Parkia speciosa*) are a very popular vegetable among the Malays and aborigines. The pods are collected mainly from wild trees and sold in markets all over Malaysia. There is still very little extensive cultivation but one does find a few trees growing in Malay mixed orchards along the Seremban-Kuala Lumpur trunk road.

Secondly, the wild relatives of the crop plants may possess genes conferring resistance to microbial pathogens and pests to which the cultivated varieties may be susceptible. Generally, the wild relatives have most to contribute in this aspect of plant breeding. The following

are notable examples in Malaysia. The high yielding rubber clones are susceptible to the devastating 'South American Leaf Blight', caused by the fungus, *Dothidella ulei*. Fortunately, a gene or genes conferring resistance to the attack of this pathogen can be found in some collections of wild *Hevea brasiliensis* and its wild relative, *Hevea benthamiana*. Breeding work by the Rubber Research Institute seeks to incorporate this valuable gene or genes into the high yielding cultivated clones (Subramaniam 1969).

In bananas (Simmonds 1959), the 'Panama Disease' caused by *Fusarium oxysporum* f. *cubense*, which was responsible for the destruction of many thousands of acres of bananas in the American tropics, can only be controlled by growing resistant plants. The wild ancestors of bananas, *Musa acuminata* and *M. balbisiana* are resistant. Resistance to insect pests may also be found in wild relatives of crops. I have noticed that the fruits of cultivated *Durio zibethinus* are often damaged by lepidopterous larvae. It is possible that the fruits of some wild durians may be resistant to this pest as has been shown for stem-borer resistance in the wild rice, *Oryza ridleyi* (Van & Goh 1959), while most of the cultivated rice varieties including the recently selected high yielding varieties, Mahsuri and Ria are susceptible to stem-borers (Ho, Vohra and Rao 1970).

Lastly, many important crops have originated and evolved through hybridization between related species. Notable examples are bananas (Simmonds 1959, 1962), cotton (Hutchinson 1959) and wheat (Riley 1965). Most of the fruit trees in Malaysia with the possible exception of *Nephelium lappaceum* (rambutan) have been scarcely improved for quality. It is most likely that hybridization between cultivated varieties and its wild relatives may produce progeny of superior quality.

TAMAN NEGARA AS A SOURCE OF WILD GENETIC RELATIVES OF FRUIT CROPS

In consideration of Taman Negara as a site for the preservation of the wild relatives of the locally originated fruit crops, four important facts must be considered. These are: (1) the number of individuals per unit area of these plants in the forests so as to calculate the minimum areas required for the survival of the species and permitting inter-breeding between individuals (2) the actual presence of these species in Taman Negara (3) the ecological requirements of these species and (4) the economics of conserving vast areas of primary forests to preserve these potentially useful plants and its integration with other conservation programme.

Number of individuals of wild fruit trees in Malaya

It is extremely difficult to assess the total number of individuals of the

wild fruit trees in the forests. At the species level, data were available only from a few small localities. In the absence of detailed species data, it is more profitable to provide information on the number of individuals at generic level collected from all over the country. Fortunately, this information can be extracted from the Forest Resources Reconnaissance Survey carried out by the Forest Research Institute, Kepong. This survey however only includes trees over 4 feet girth and so leaves out most individuals of many fruit tree species.

Table 1 shows the number of individuals of ten genera of important wild fruit trees collected from 136 samples in Rompin, Pekan, Kuantan and Temerloh administrative districts in Pahang, where Taman Negara is mainly situated (Anonymous 1932).

TABLE 1. Number of wild fruit trees in part of Pahang.

Genera	Common names	Number of individuals
Artocarpus	chempedak, jackfruit	433
Durio	durian	348
Mangifera	mangga, pauh, mango	150
Parkia	petai	83
Baccaurea	rambai, tampoi	32
Garcinia	manggis, mangosteen	27
Nephelium or *Xerospermum*	rambutan or rambutan pachat	6
Lansium	langsat	5
Sandoricum	sentul, kechapi	5
Total		1089

Extracted from the Forest Resources Reconnaissance Survey (Chong 1965, 1966; Lee 1966a, b). Most of the individuals recorded were over 4 ft girth. Total acreage from 136 samples = 2484 acres. Total number of all trees = 42799.

The following points may be noted:

1. The figures given must be taken only as a rough estimate, since the survey was primarily undertaken to obtain data on timber trees, with little emphasis on wild fruit trees. Furthermore, in the reports, the plants were listed in semi-standardized Malay names which consequently requires translation into botanical names leading to possible introduction of minor errors.
2. With the exception of *Artocarpus* and *Durio*, the number of wild fruit trees was extremely few, expressed either in terms of plants per acre or as a fraction of total number of all trees in the forests.

The large numbers of *Durio* may be caused by the collection of fruits by aborigines and depositing of seeds around their temporary settlements, but most of them are more likely to be wild species. It

is clear that large areas are required for the preservation of some of the wild fruit trees. For example, to conserve 100 wild *Lansium*, it may require areas up to about 50000 acres. There is a greater danger of potential extinction of some of the rare species of wild fruit trees, if the present extensive clearing of forests is maintained.

Occurrence of wild fruit trees in Taman Negara

There have been extremely few botanical studies in Taman Negara. Ridley (1888-94) visited the montane woods of the Tahan district and reported the occurrence of the following plants: *Garcinia kunstleri*, *Durio griffithii*, *Xerospermum noronhianum*, *Nephelium lappaceum*, *Baccaurea brevipes*, *Baccaurea parviflora*, *Artocarpus rigida* and *Artocarpus polyphema*. Later Ridley (1915-1916) gave an account of the plants found on Gunong Tahan, the highest mountain in the park and Malaya and noted the presence of a new species of wild mangosteen, *Garcinia monantha* on the banks of streams of the padang plateau. The wild fruit trees recorded in a survey of a small area near Kuala Tahan in 1958 is given in Table 2.

TABLE 2: Occurrence of genera of plants which have edible fruit in Taman Negara as recorded at Kuala Tahan.

Genus	Species
Durio	*D. lowianus*
	D. griffithii
Nephelium	*N. lappaceum*
	N. aff. eriopetalum
	N. glabrum
Xerospermum	*X. intermedium*
Baccaurea	*B. wrayi*
	B. brevipes
	B. motleyana
	B. kingii
	B. aff. kunstleri
	B. parvifolia
	B. maingayi
Garcinia	*G. rostrata*
	G. sp.
Artocarpus	*A. rigidus*
	A. integer
	A. maingayi
	A. sp.
Mangifera	*M.* sp.
Lansium, Sandoricum, Parkia	*Nil*

The genus *Eugenia* was excluded from the table above, due to the occurrence of large number of species in Malaya, a few of which have edible fruits and most do not.

It is gratifying that in spite of the limited studies on the vegetation of Taman Negara, it is possible to conclude that most of the wild genetic relatives of the locally originated crops occurred in the park.

Ecological requirements of wild relatives of crops

Taman Negara with an area of 1677 square miles is the largest national park in Malaysia. There is a range of environmental conditions in the park ranging from rivers, valleys, lowland forests, limestone hills to mountains offering conditions favourable to the survival of the wild fruit trees and other plants. However, it must be mentioned that nothing is known about the exact ecological requirements of each species. Furthermore, there is an absence of coastal habitats in the park. Conservation of coastal swamp species, for example *Durio carinatus* (Wyatt-Smith 1953) requires the establishment of other natural reserves.

ECONOMICS OF PRESERVATION OF PLANT GENETIC RESOURCES AND ITS INTEGRATION WITH OTHER CONSERVATION PROGRAMMES

It is certainly uneconomical to use vast areas of precious land specifically for the conservation of the few potentially useful wild relatives of crops alone. Genetic conservation must be integrated with conservation programmes and other land utilization programmes provided the ecosystem can be maintained intact. These usages should include tourism, flood control, prevention of soil erosion, preservation of pharmacologically interesting plants like the tuba climber, *Derris* and ipoh-tree, *Antiaris toxicaria* (*Burkill* 1935), horticultural plants especially orchids, rattans, timber and other forest plants and faunal conservation.

From all this consideration, it is very clear that the total biological heritage of Taman Negara must be preserved intact, studied, properly utilized and appreciated by all.

ACKNOWLEDGEMENTS

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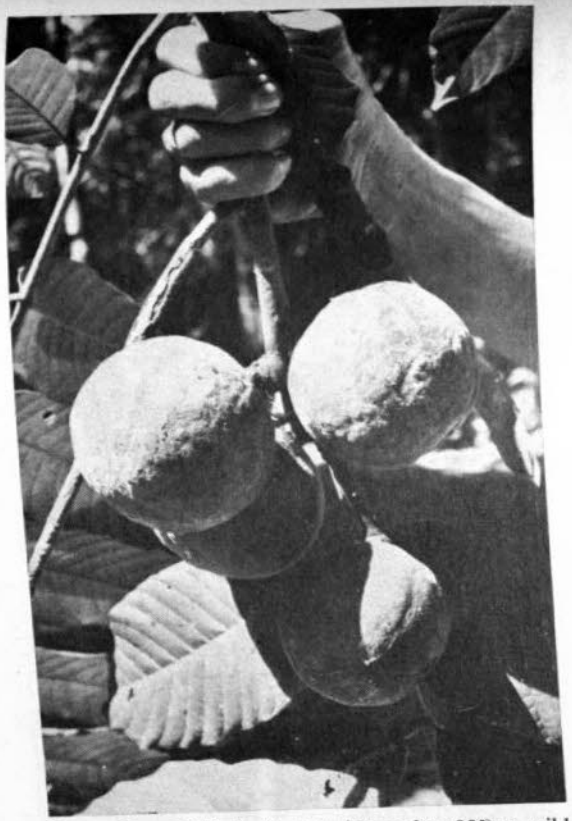

PLATE 63a. *Chisocheton* sp. (*Soepadmo 855*) a wild relative of the sentul.

PLATE 63b. *Xerospermum intermedium* (*Soepadmo 847*) gigi buntal or rambutan pachat, a wild relative of the rambutan (*photos—E. Soepadmo*).

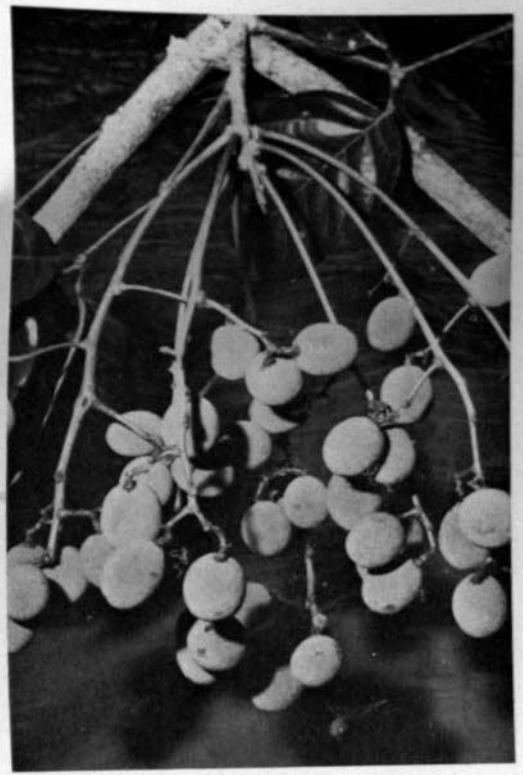

PLATE 64a. *Walsura neuroides* (*Soepadmo 884*), a wild relative of the langsat

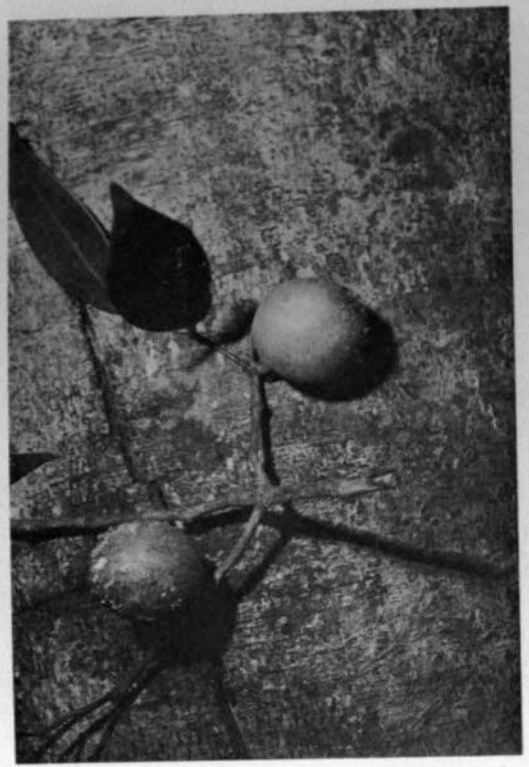

PLATE 64b. A wild *Garcinia* (*Soepadmo 883*), relative of the mangosteen (*photos—E. Soepadmo*).

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Malay. Nat. J. **24**: 222–224 (1971)

Wild fruit trees and some trees of pharmacological potential in the rain forest of Ulu Kelantan

T. C. WHITMORE[1]

In 1967 the Forest Resources Reconnaissance Survey of the Forest Department worked over the Ulu Kelantan administrative district, in northeast Malaya. The district is 4817 miles square and was then still about 80 percent primary rain forest. The resource survey, designed to sample a representative but small fraction of the Lowland Rain Forest formation, covered 1672 acres, mostly below 2800 ft though with a few samples as high as 3800 ft elevation. All trees equal to or over 4 ft girth were enumerated by vernacular species name, a total of 26628 trees in all.

A fuller analysis of these data with details of the layout of the sample will be published elsewhere (Whitmore, in press). Here I wish only to draw attention to the rarity in the forest of tree species useful to man for their edible or pharmacological products.

In Table 1 are listed the species and genera of trees in Ulu Kelantan which in a very broad sense can be considered to have horticultural potential as cultivated fruit or nut trees and some others which have known pharmacological interest at the present day.

The figures are presented as stems (equal to or over 4 ft girth) per 100 acres, both on average and in four different habitats.

Amongst the fruit trees only one species of *Garcinia* (mangosteen),[2] *Parkia speciosa* (petai)[3], *Lansium domesticum* (langsat), *Artocarpus integer* (chempedak),[4] *Nephelium lappaceum* (rambutan) and *Sandoricum koetjape* (sentul) are the direct wild ancestors of cultivated species; all are common in planted fruit orchards.

The wild *Mangifera* (mangoes) and *Durio* (durians) are inedible or scarcely edible.[5] *Elateriospermum tapos* (perah) is a wild nut tree and *Baccaurea griffithii* (tampoi) is a wild fruit tree. None of these species is cultivated. The other wild *Artocarpus* species and *Coelostegia* are included in the list as relatives to the others which might contain characters useful to man in plant breeding programmes.

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1 Forest Research Institute, Kepong.

2 There are in total about 30 wild species of *Garcinia* in lowland forest in Malaya.

3 *P. singularis* and *P. javanica* are also likely to have been enumerated.

4 Represented wild in our forests by *A. integer* var. *silvestris* with odourless fruits.

5 The cultivated durian *D. zibethinus* has never been found wild in Malaya (Kochummen, in press).

TABLE 1. Species and genera with horticultural or pharmacological potential.

Family	Genus/Species	Average	Granite below 750 ft	Granite above 750 ft	Sedimentary below 750 ft	Sedimentary above 750 ft
(a) With horticultural potential						
Anacardiaceae	*Mangifera* (mangoes)	6.7	1.8	7.8	7.1	6.1
Bombacaceae	*Coelostegia* (punggai)	0.5	1.8	0.4	0.6	0.3
	Durio (durians)	3.7	4.4	4.5	4.0	2.0
Euphorbiaceae	*Baccaurea griffithii* (tampoi)	2.3	3.5	2.0	2.4	2.3
	Elateriospermum tapos (perah)	33	16	45	20	49
Guttiferae	*Garcinia* (mangosteen)	0.9	—	0.5	1.4	0.8
Leguminosae	*Parkia* (petai, p. meranti)	8.8	19	11	7.3	6.1
Meliaceae	*Lansium domesticum* (langsat)	0.2	0.9	0.2	0.1	—
	Sandoricum koetjape (sentul)	0.8	0.9	2.0	0.4	—
Moraceae	*Artocarpus integer* (bangkong, chempedak)	1.3	1.0	1.8	2.0	1.1
	A. lanceifolius (keledang)	18	12	25	15	17
	A. rigidus (temponek)	7.4	13	8.0	7.1	5.6
	A. scortechinii/elasticus (terap)	3.4	7.9	5.6	2.4	1.5
Sapindaceae	*Nephelium lappaceum* (rambutan)	5.9	2.6	7.6	5.9	5.1
(b) With pharmacological potential						
Apocynaceae	*Alstonia* (pulai)	0.8	—	1.1	0.6	1.0
	Dyera costulata (jelutong)	7.2	6.2	8.7	6.7	6.9
Moraceae	*Antiaris toxicaria* (ipoh)	0.5	—	—	0.1	1.8

The Table very clearly shows how rare these horticultural and pharmacological species are; except for perah (33 trees/100 acres) and keledang (18) none exceeds 10 trees/100 acres and 11 of the 18 species have fewer than 5 stems/100 acres. The wild relatives of the currently cultivated langsat, rambutan and sentul have only 0.2, 5.9 and 0.8 stems/100 acres respectively. The ipoh tree (*Antiaris toxicaria*), whose latex is an important component of aborigine dart poison, occurs at 1 tree/200 acres or only about 3 to a square mile. Most of these economically important species are so rare that the survey reveals little of their habitat preferences.

These fruit and nut tree species are the wild stock from which plants of direct importance to man have been culled or await to be culled. Any major crop improvement depends on the availability of this wild ancestral stock as a source of new locally adapted variability. The wild stock forms what in current jargon is known as the 'gene pool'. To maintain the pool, breeding populations of these species have to be maintained under their natural conditions so that trees can continue to cross with each other and in the long term evolve new races. Nobody yet knows the size of the breeding population in rain forest trees, or indeed how such scattered plants maintain breeding contact. In the very different case of conifer species of restricted distribution in Japan 10000 trees was considered the minimum (Toda 1965 in Richardson 1970). At 1 tree/100 acres 10000 trees occupy about 1500 square miles. It will be circumspect in laying the development plans of West Malaysia

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	A. rigidus (temponek)	7.4	13	8.0	7.1	5.6
	A. scortechinii/elasticus (terap)	3.4	7.9	5.6	2.4	1.5
Sapindaceae	*Nephelium lappaceum* (rambutan)	5.9	2.6	7.6	5.9	5.1
(b) With pharmacological potential						
Apocynaceae	*Alstonia* (pulai)	0.8	—	1.1	0.6	1.0
	Dyera costulata (jelutong)	7.2	6.2	8.7	6.7	6.9
Moraceae	*Antiaris toxicaria* (ipoh)	0.5	—	—	0.1	1.8

The Table very clearly shows how rare these horticultural and pharmacological species are; except for perah (33 trees/100 acres) and keledang (18) none exceeds 10 trees/100 acres and 11 of the 18 species have fewer than 5 stems/100 acres. The wild relatives of the currently cultivated langsat, rambutan and sentul have only 0.2, 5.9 and 0.8 stems/100 acres respectively. The ipoh tree (*Antiaris toxicaria*), whose latex is an important component of aborigine dart poison, occurs at 1 tree/200 acres or only about 3 to a square mile. Most of these economically important species are so rare that the survey reveals little of their habitat preferences.

These fruit and nut tree species are the wild stock from which plants of direct importance to man have been culled or await to be culled. Any major crop improvement depends on the availability of this wild ancestral stock as a source of new locally adapted variability. The wild stock forms what in current jargon is known as the 'gene pool'. To maintain the pool, breeding populations of these species have to be maintained under their natural conditions so that trees can continue to cross with each other and in the long term evolve new races. Nobody yet knows the size of the breeding population in rain forest trees, or indeed how such scattered plants maintain breeding contact. In the very different case of conifer species of restricted distribution in Japan 10000 trees was considered the minimum (Toda 1965 in Richardson 1970). At 1 tree/100 acres 10000 trees occupy about 1500 square miles. It will be circumspect in laying the development plans of West Malaysia

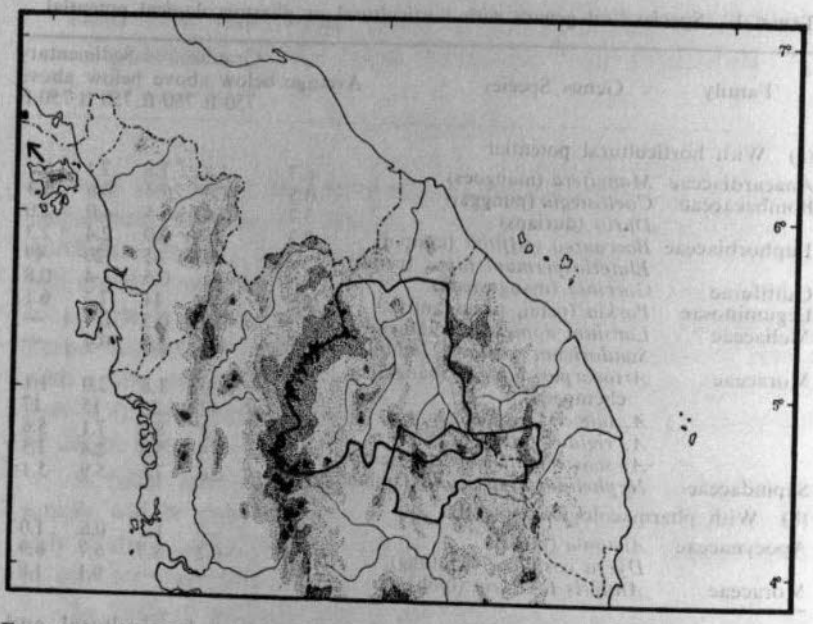

FIGURE 1. The Ulu Kelantan district which lies northwest of Taman Negara.

that an area of lowland forest of this sort of magnitude be conserved in its virgin state as a gene pool for future generations to tap. And that is about the area of Taman Negara, due south of and partly overlapping the present survey area (Fig. 1) and which is already constituted in law as an inviolate nature reserve.

ACKNOWLEDGEMENTS

I am grateful to Enche Salleh b. Mohd. Nor for allowing me to have a set of the stand tables prepared from Mr. Cerra's forest survey; to Mr. P.F. Burgess for encouraging me to undertake the analysis; and for considerable assistance with the computation to Enche2 Loh Hoy-Shing, T. Suppiah, P. Selveraj, Chan Yee-Chong and Zainuddin b. Sohadi.

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Conserving the Forest — A Phytochemical View

J. B. Lowry[1]

In talking about utilization of tropical rain forest one encounters a variety of views. There is the hardened philistine who sees it only as an assemblage of raw timber rather untidily covered with branches and creepers, or who wants to replace a splendid 250 ft high mixed canopy with a 6-inch herb layer and call it progress. Then the naturalist so enthralled by the richness of life forms and their interrelationships that all he can say is "conserve! until we know more about it" to which one may reply — how long will that take? Here I want to put forward an additional view — that of the forest as a complex store-house of a vast array of potentially valuable chemical substances. There is nothing very new about this — many people vaguely feel that the forest is or should be a source of various drugs, dyes, oils, and so on. I merely want to make this idea rather more concrete.

Firstly, let us distinguish between "primary" and "secondary" metabolites. The first, found in all plants, are substances such as lignin, cellulose, lipids, proteins etc. Obviously big industries can be based on these—rubber and oil palm need no further comment. New developments in industry elsewhere can create a demand for a product with slightly different properties making a neglected species suddenly of economic importance. As well as this new industries may arise, with demands difficult to foresee. One based on extraction of leaf protein is bound to come soon, and again it may be some insignificant member of the forest flora that gives the best protein most cheaply.

However most people are aware of these points. It is the potentialities among the "secondary" metabolites that are less known. These include chemical compounds of many types, and characteristically they do not occur uniformly but in particular plants or plant taxa (the mere fact that some plants smell or taste better than others is a reflection of this). Literally thousands of organic compounds are known from plant sources. The Indo-Malaysian rain forest with so many species that have never been studied undoubtedly harbours many of these and many more new compounds. Some are of direct economic value. More subtly, others *would* be valuable if it was merely known they were available. Let us take a hypothetical example. A U.K. manufacturer is making a drug by a laborious and expensive series of steps. The firm's chemists may be aware that a compound very similar to one of their intermediates is in the chemical literature but it was ob-

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tained in poor yield 30 years ago in Java, from a tree which (after frustrating enquires) appears to be extinct in the area. They give up. Meanwhile a scientist in Malaysia working with an obscure tree of different name but in fact (when the taxonomists get around to revising the family) synonymous with the long-gone Javanese species, finds a compound crystallising beautifully from his crude extracts. He works for a couple of months, finds that it is a known compound ("why, half of the Chem. Abs. references were to patents. Wonder what on earth they do with that?") and grumbles at the time "wasted". End of story. The point here of course is the information gap. But also there is the fact that the plant is perfectly capable of synthesising a complicated organic molecule more cheaply than the chemical industry. The spectacular demise of such industries as those based on indigo or quinine perhaps has weighted opinion too much one way. Both the above went out because synthetic products were cheaper and also better, together with circumstances that created a rush to find synthetic substitutes. In general a natural product would be subject to the same economic law as an entirely industrial product. Productivity must increase to match costs; and there is always the possibility of a new product that will supersede it. Neither should prevent a new industry getting started. Further, the increasing complexity of civilisation is always creating demands for substances that were not in demand before, as well as widening the market for existing products.

In the following, a number of likely prospects are considered. Many other products have been in use and may still be used, particularly in rural life — substances such as dammar, arrow poisons, etc. Here we consider some of those likely to contribute to a modern economy.

INSECTICIDES

Two groups of compounds have been in use for a long time; the pyrethrins (from *Chrysanthemum* flowers) and the rotenoids (from roots of *Derris, Tephrosia, Milletia* and other rain forest Leguminosae). Both groups are of low toxicity to higher animals, are biodegradable and do not accumulate in the organism. Synthetic insecticides of the organochlorine and organophosphate classes are much cheaper and dominate the market. However increasing bans on the use of organochlorines in particular, together with a rapidly enlarging market (insecticides are essential with modern high-yielding crops such as "miracle rice"), ensure that there will be a huge demand for rotenone if the price is right. There is therefore required a screening programme to discover those species or varieties with good rotenoid content or which may contain more active compounds of that group.

The rotenoids became known only because they have an older use as fish poisons ("tuba root"). There must be many other plants that contain substances that defend against insect attack, especially in such a plant – and insect-rich environment as the tropical rain forest, and some of these can surely be employed by man. In some cases the chemical effect may not be directly toxic — soluble polyphenols may discourage insects simply by tying up protein and reducing the nutritive value of the plant. A particularly sophisticated case is that of plants which produce insect moulting hormones ("ecdysones") in their leaves or bark. As these are extremely active, but only towards insects, they are of great potential value in plant protection. Presumably insects ingesting extra ecdysones suffer a discouraging metabolic upset. Many Podocarpaceae are so equipped, but most of the Malaysian species have not been investigated yet. These compounds are steroid in character and as with the rotenoids would be too complicated to synthesise cheaply.

COLOURING MATTERS

Although synthetic dye-stuffs have completely captured the textile market, there is one area where compounds of natural origin are likely to hold out, and that is in food colourings. Restrictions and safety standards have become more stringent in most countries and make it quite difficult to market new synthetic compounds. Plant pigments that have an attractive function in nature, e.g. carotenoids in fruit, are very unlikely to have mammalian toxicity and are difficult to synthesise cheaply. One such compound in steady use today is bixin ("anatto") from *Bixa orelleana* — here grown as an ornamental shrub — the "lipstick plant." Over 1000 tons of anatto are produced each year — in other tropical countries.

ESSENTIAL OILS

There is a steady trade in the traditional products used in the perfumery and other trades — e.g. in adding to detergent powders to make washing smell clean in case it does not look clean. As well as this, some essential oils can be good sources of a particular compound — eugenol from oil of cloves, vanillin from vanilla and so on. A glance at the chemical literature shows that there is quite a large uptake of natural essential oils by industry, for incorporating into other processes. Again, development of new products and processes somewhere else, may create a demand for something which is of little value today.

DRUGS, MEDICINES ETC.

A browse through Burkill's *Dictionary of Economic Products of the Malay Peninsula* gives one the impression that almost every plant has been used for treating some complaint at some time. However folk medicine has led to some very rewarding discoveries, such as reserpine from *Rauvolfia*, and there will be more to come. A continual search goes on for new drugs and the commercial rewards for being able to launch a successful new compound ahead of competitors are so great that this aspect of phytochemical prospecting is often carried on with considerable secrecy. It is certainly not possible to know the total picture of who has been looking for what in the forest of Malaysia. However any successful result is to be welcomed — if the active compound proves to be easily synthesised then medical science benefits, if it can only be obtained by cultivating the plant then a tropical economy benefits. At present the large-scale cultivation of an *Uncaria* species for the production of a flavonoid drug is about to be launched in Malaysia, after a search for the most suitable of all the locally-growing varieties that could be located. As well as illustrating the continuing development in this field, another trend may be evident here, namely that the tremendous biological activity of (say) hormonal drugs and antibiotics has overshadowed the effectiveness of more "homely" substances. The fact that certain substances are already present in our diet is an indication that when such a substance is effective against a particular organism or condition, it should be used first in preference to the "high-powered" compounds which bring in new problems of their own.

OTHER CASES

Among the secondary metabolites are substances called saponins, because they possess soap-like activity. This allows the leaves of some plants to be actually used instead of soap. In Ethiopia an alert scientist realised that one plant used in this way appeared to cause the death of large numbers of water-snails downstream from the washing-place. Development work in London by the Tropical Products Institute has now reached the stage of large-scale cultivation of the plant for a molluscicide which will be very important in the fight against the snail-borne disease schistosmiasis.

Finally one could mention the possibilities of bizarre substances such as that in the "miracle fruit" *Synsepalum* sp. After eating this fruit one has the experience of finding that highly sour substances turn sweet! Taste-modifying substances have large applications in the food and pharmaceutical industries today. The cyclamate controversy shows

that the search is still on for a suitable non-nutritive sweetening agent. The fruits of several tropical African plants are being investigated for their extraordinary sweetness and recently we have found a Malaysian plant with the same property. An obvious factor here is that if the plant produces these substances to attract animals to the fruit, they are unlikely to have toxic effects.

OTHER COMPOUNDS

In the above cases the required compound was present in the plant. In principle one can look for it by making use of its valued property — colour, biological activity, and so on. But recently a larger field has become evident, that of compounds which are chemically modified to fit new needs. Screening here is not so simple because the valuable property of the final product is not evident in the plant. In effect one is using the plant to put together a complicated structure that is too expensive to synthesise, and then modifying the details to obtain the desired compound. The example *par excellence* is the field of steroid drugs (cortisone and relatives, pro- and anti- fertility pills, muscle builders, etc.). These had a market value of £20,000,000 in the U.K. in 1968 alone. About 90 percent of the world's supplies are obtained by chemical manipulation of plant sterols, mostly diosgenin, largely obtained in Mexico from species of *Dioscorea* (yams). There is every prospect that demand for these compounds will continue to grow. It is inconceivable that the big pharmaceutical companies have overlooked the Malaysian species of *Dioscorea;* perhaps they are not good sources, perhaps they do not want to develop the supply here for their own reasons. What is almost certain is that other plants also contain these compounds and many will not have been investigated in any way.

Another example of a known compound which suddenly moves from the area of pure science into that of commerce is the diterpene alcohol, manol. This happens to be abundant in the wood of a New Zealand *Dacrydium*, it also happens that when oxidised in a certain way the product serves as a substitute for ambergris in the perfume industry. Overnight a new product and a new commercial enterprise have come into being. A search of the Malaysian species of *Dacrydium* by the author has been unproductive but there are still a few more to look at!

CONCLUSIONS

The case here for conserving species rests both on potential value which can be exploited today — if it is only discovered — and on that which may arise in the future for compounds not utilised today. Even if an

active group was engaged in examining the Malaysian flora for economic products it would take many years to do the job. In any event such a group does not exist, and so one wishes to see representative habitats securely preserved so that no species are lost, and that as many wild varieties as possible remain. The smallest herb is just as likely to contain a useful compound as is the forest giant, so size or abundance are not necessarily important. If it is valuable it can be brought into cultivation. However direct exploitation of an abundant hardy species would be simpler in the first instance. The bulk of the world's steroids still come from wild plants. If only they occurred in sendudok, simpoh or lalang!

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The Effect of Logging on Hill Dipterocarp Forests

P. F. BURGESS[1]

No one concerned with the conservation of nature can watch the countless laden timber trucks on the roads without wondering what effect all this timber exploitation is having on the forest; each truck-load represents the logging of nearly one acre and this means, for example, that over three quarters of a square mile of forest crosses the Singapore causeway every day on logging trucks! Only a part of the timber comes from the country's permanent forests, the remainder being from land under clearance for agricultural development, but the part which comes from the permanent forests is drawn increasingly from the steep hills, which are all that is likely to be left to Forestry when agricultural development is complete. It is with these steep permanent hill forests that this paper is concerned.

Let us first consider the effect of logging on the forest stand itself, deferring a discussion of its effect on the land on which the forest grows to the last part of this paper. There are often misconceptions about the proportion of the forest stand which is felled in logging operations in a given area; many people think that, as in the temperate forests of the world, the whole forest is felled and used for timber, and replanting may or may not follow. In fact, the Malaysian rain forest is of so mixed a constitution that only a small proportion of the trees is suitable for exploitation under present market conditions, and natural regeneration, of course, takes the place of replanting. There are some 8000 species of flowering plant in West Malaysia (it has one of the richest floras in the world), but only some 2500 of these are trees. Of these trees only about 700 species reach a size large enough for use as timber (a tree needs to be at least 4½ ft in basal girth before it is merchantable), and less than 150 of these species are regularly exploited for timber, the remainder being of scattered occurrence or possessing timber characters which make them unsuitable for use. Reducing the above data to give the number of trees likely to be felled on an acre, an average would be about six (which would mean a stump every 85 ft or so if the trees were evenly spaced), rising to thirty on rich seraya (*Shorea curtisii*) ridges and in kapor (*Dryobalanops aromatica*) forest, giving a stump about every 40 ft, and falling to about three (a stump every 120 ft) at the lower limit of exploitability. These exploitable trees are, however, all large emergents, with crowns often 50 ft across, and when they fall they smash up a considerable part of the lower stories of the forest; this damage can be reduced by directional felling and in many Forest Reserve areas the Forest Department marks trees for felling

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and directs within reasonably narrow limits which way a tree shall be felled so that it does the minimum of damage. A forest after felling the timber trees thus consists of an irregular pattern of islands of almost undisturbed forest, pock-marked with patches where the tree crowns have fallen. The amount of opening caused by the felling depends very much on the density of stocking of exploitable trees, and on heavily stocked seraya ridges very little indeed remains standing, though such heavily stocked areas are the exception rather than the rule. Until recently no data were available on the exact proportion of the stand removed in felings, the amount damaged in exploitation, and the amount remaining, but as a first step in such an investigation we have recently completed a study of an area of approximately 100 acres of average lower hill forest in Trengganu which gave the proportions of basal area of trees over 4 ins in diameter shown in Fig. 1. It will be seen that only 35 percent of the stand in the area disturbed by logging remained undamaged (the survey

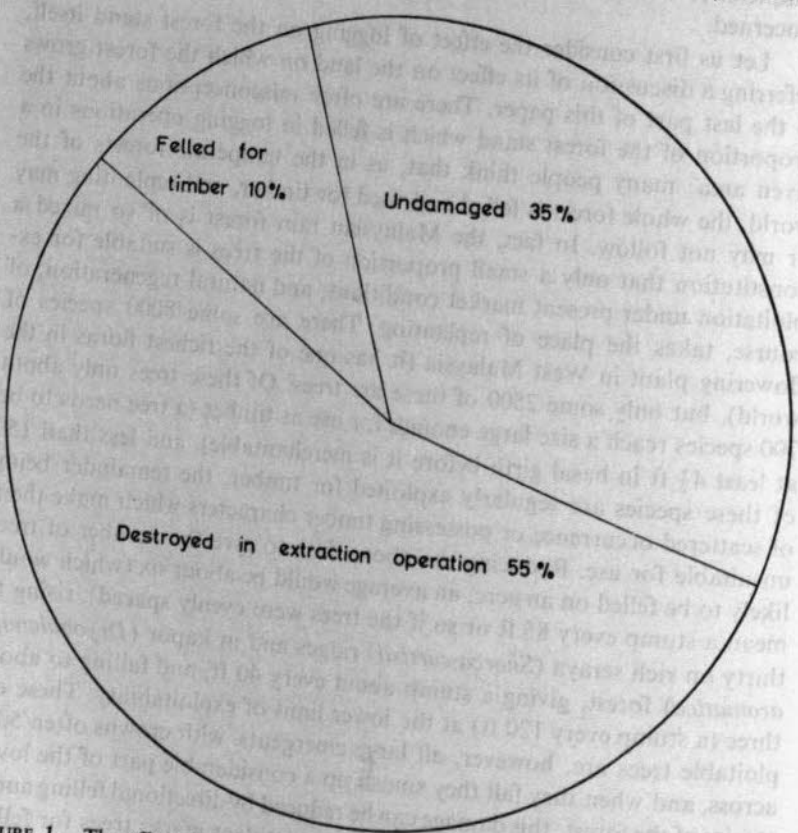

FIGURE 1. The effect of logging on the basal area of the stand. Total basal area to 4 in diameter taken as 180 sq ft per acre. Compartment 90 Gn. Tebu Forest Reserve Trengganu: 215 acres.

also excludes all islands of forest untouched by exploitation) and one would expect this figure to be rather lower in more intensively logged hill areas on the west coast, and somewhat lower still in lowland forest where the timber stand is more evenly distributed. The appearance of logged forest from within is shown in Plate 65b, and that of a logged hillside in Plate 65a. The trees after felling are trimmed out and cross cut at stump into logs commonly about 16 to 20 ft long, and it is not until extraction operations begin that any material disturbance takes place to the land upon which the forest stands.

Road making is probably the greatest damaging factor in hill forest exploitation, and in practice it generally takes place ahead of felling to enable the fallers to get into the forest easily and also to give the road time to settle before hauling begins. The first operation in road building is to locate the trace, and in West Malaysia little attempt is made to limit gradients or to plan the road location so that the maximum amount of timber is tapped with the minimum of earth work. The main reason for the somewhat haphazard location of road is the extreme versatility of the main extraction machine, the *san tai wong*, a (usually ex-military) winch lorry (Plate 66a) which is used both for hauling the logs from stump to the extraction roads (yarding) and for carrying the logs down the steep main extraction road to a point where log trucks licenced to run on the public roads can take over. *San tai wong* have remarkable traction and are very manoeuverable so that apart from the rough-and-ready alignment the roads can also be built to a very low specification. They are never metalled and are about 12 ft wide (Plate 66b). The maximum gradient depends very much on soil texture, but gradients with the load of nearly 30° are not uncommon. The amount of drainage required depends very much on how roads are located, and there is much to be said for siting them as far as possible on ridges; not only are no bridges and culverts required, but the amount of earth cutting is far less than on sidelong ground, and there is no danger of streams being obstructed by fill. Ridge sited roads have disadvantages to the forester, since the richest stand is usually on the ridge crests and so is the best regeneration of timber species; much of this is destroyed if the road is located along the crest. So long as loggers use winch lorries (*san tai wong*) ridge roads are likely to be popular, since these vehicles are so light that they cannot be used with safety to yard logs downhill. It is, nevertheless an uneconomic use of power to yard logs uphill unless the slopes are very steep. Roads following the hill-side are frequently necessary in steep hill country to enable height to be gained gradually, but in country steeper than the natural angle of repose of the excavated earth (say about 30°) such road making will cause great damage to regeneration below the road by the movement of loose fill down the hillside, and such spoil will eventually find its way into streams. In general loggers pay little attention to drainage on their roads, and the road is usually 'daylighted'

to a width of one chain on either side by felling all trees and most undergrowth to enable the sun to dry out the surface. Permanent culverts are never used (a hollow log makes a temporary substitute which soon becomes blocked) and no attempt is made to keep the drainage water on the inside of the road (to prevent it from eroding the exposed outer face of the road and the hillside below) or to reduce its velocity by keeping road gradients down or by building check dams. The result is that erosion goes on during logging, and is repaired as necessary, but when the operation closes a vast number of eroding surfaces are left and erosion often continues on the inner side of logging roads for many years until ultimately whole sections of the road slip (Plate 67). Erosion gullies of this kind are often deeper than the height of a man (Plate 68) and I saw one on the easily eroded granite soil of the Ulu Sat hills in Kelantan recently which had been scoured to over 12 ft in depth in one monsoon! By comparison with road building the yarding of logs does relatively little damage; the *san tai wong*, being a rubber-tyred vehicle, is considerably kinder to regeneration than a crawler tractor. In a study of a logging area on flat to gently undulating topography in Sabah, Nicholson (1958) found that about 14 percent of the land area was disturbed by tractor paths, but the yield from this forest was about three times as heavy as the West Malaysian average, and yarding was entirely by tractor, so it is unlikely that so high a percentage of disturbed ground will be reached here. We have, as yet, no logging operations in West Malaysia using cable yarding, but high-lead[1] might well prove economical on ridges where there is a heavy stand of seraya. Though this method of extraction causes heavy damage near the spar tree where all the logs are concentrated, the damage becomes progressively less with increasing distance from the spar, and the high-lead effect of raising the leading end of the log to avoid obstructions still further reduces damage. In suitable country, swinging timber from one ridge to another by 'skyline' (a cable stretched taut between two spar trees, the log travelling entirely in the air and away from ground obstructions) can reduce road building and its attendant damage very considerably. All cable logging methods give an impression of catastrophic damage near the spar trees and landings (and this is all the visitor usually sees), but on balance they are likely to cause less damage than tractor yarding.

After logging is completed the Forest Department normally carries out a poison girdling operation to remove the unlogged trees of the overwood so that the young regeneration of timber species may grow through

[1] A system of logging where a pulley block is secured to the top of a spar-tree, or a portable steel spar, and a wire cable from a winch passed over the pulley. Logs are attached to the cable and hauled by the winch to the foot of the spar tree, where they are loaded on trucks. The essential feature of the system is that the leading end of the log is lifted from the ground during haulage, by the cable passing over the spar tree block, and thus the log rides easily over snags on the ground.

PLATE 65a. Logged forest.

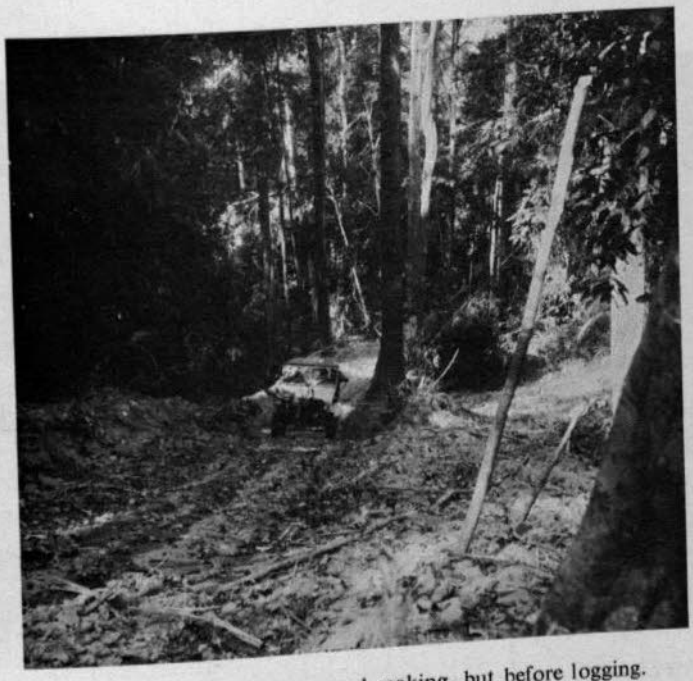

PLATE 65b. Forest after road making, but before logging.

PLATE 66a. A *san tai wong* winch lorry (*photo—T.C. Whitmore*).

PLATE 66b. An extraction road with winch lorry loading logs.

PLATE 67a. The start of an erosion gully on the inside of a logging road.

PLATE 67b. An erosion gully where the run-off from two roads meets.

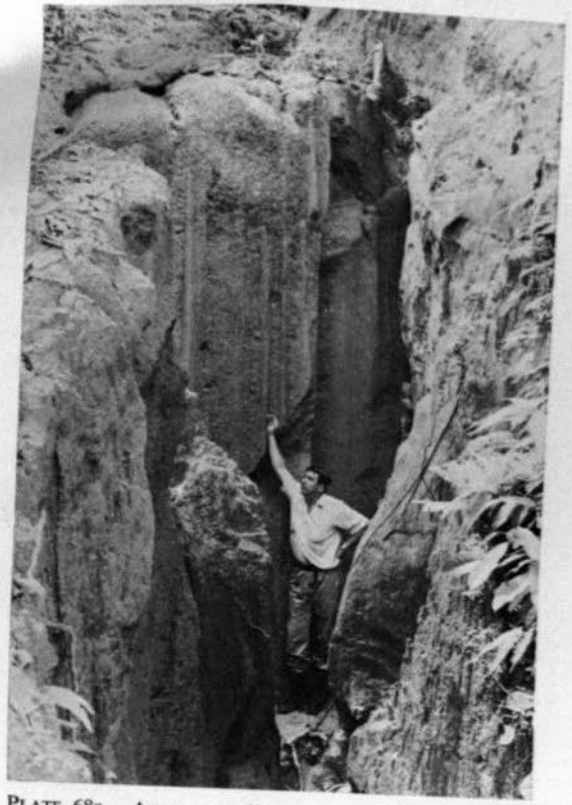

PLATE 68a. An unusually severe erosion gully in granite country, three years after the closure of logging.

PLATE 68b. A land-slip between two logging roads.

PLATE 69. Logged forest where the relic stand has been poisoned girdled.

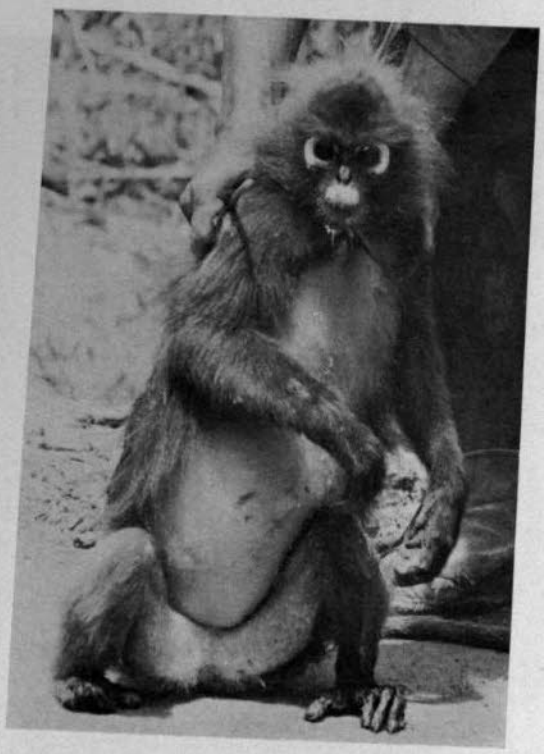

PLATE 70. Dusky leaf monkey (top), siamang (bottom). Tree living animals such as these are seriously disturbed by logging (*photos—T.C. Whitmore*).

without suppression. At this stage the forest looks very unsightly (there examples at the 12th mile Ulu Gombak near Kuala Lumpur, and on Keledang hills near Ipoh) but it is hoped that it may be possible to duce the intensity of this operation in steep hill forest where the young generation has access to more side light than in level forest, and there certainly every silvicultural reason to stop the uncritical girdling of rest in areas where there is no regeneration of commercial species; such practice results in the systematic elimination of the most valuable family timber trees, the Dipterocarpaceae. Poison girdling, while it is an excellent silvicultural practice when carefully controlled, undoubtedly does much to increase the loss of species in exploited forest and by the long-delayed effects of the falling of poisoned trees it extends the period of disturbance to the ecosystem. There should, however, be little difficulty in designing girdling prescriptions which would reduce considerably the deleterious effects of the process upon the regenerating forest. While the roadsides and cleared areas remain uncolonised by new vegetation they are subject to rain-drop erosion, but it seems doubtful whether much material is removed in this way since areas of unconsolidated bare earth are few. As soon as logging finishes the roadsides are rapidly colonised by pioneer trees such as *Trema orientalis*, *Mallotus paniculatus*, and *Macaranga* spp. and by wild bananas, principally *Musa malaccensis* and *M. truncata* and the sites become stabilised quite rapidly. Apart from a few samplings to check the development of regeneration, and minor tending to release suppressed trees, the forest now remains undisturbed until the second rotation, seventy years from now.

Though logging must, by its very nature, remove the big trees and replace them locally with dense regrowth, the extent to which invasion by secondary species occurs is greatly exaggerated if the area is examined solely from the logging roads; it is along roadsides that increased light from roadside clearing results in almost complete regrowth by secondary species. Many forests in accessible areas have been logged several times as the price of timber increases, more species become exploitable, and middle-sized trees put on enough growth to make them exploitable. Re-logging of exploited forest is a most undesirable practice silviculturally, since the whole plant succession process is set back every time the forest is disturbed, and the forest becomes progressively poorer in desirable timber species and progressively richer in weed species and bamboo; many of the forests on the Ulu Gombak and Gap roads are the result of this long-continued exploitation which no silviculturist would defend.

Erosion is not of course confined to forest disturbed by logging. Some of the most spectacular examples of erosion under primary forest are to be found in the granite hills of Bt. Berkelah and G. Serudong to the west of Kuantan. Here the 1926–7 monsoon caused such tremendous landslides that today about one-third of these hills is still covered by erosion

scars and the sound of falling rocks and debris during the 1926–7 monsoon was audible in Gambang, some ten miles away (Fitch 1952). Similar erosion under primary forest on granite occurs on parts of the Trengganu-Pahang boundary range, and in Ulu Sat in Kelantan where the padi fields are full of coarse sand from the eroding hills. The reason for this kind of catastrophic erosion on granite is that the rock weathers to tremendous depths (up to 100 ft) and core boulders of considerable weight remain in the weathered matrix. When the whole becomes saturated by long continued rain, slips develop which no forest cover has the power to restrain as was vividly demonstrated in the January 1971 floods. Douglas (1968) has described the normal erosion processes which continue under a forest cover in Ulu Gombak and it is clear that they are by no means inconsiderable.

I have, I hope, shown that harvesting the forest crop *need* not lead to devastation and erosion, but it must be admitted that there is frequently more of the latter than there ought to be. To the naturalist one of the worst effects of logging is the driving away of wild life, and there is no denying that logged forests seem to be conspicuously lacking in game. I have heard that the noise of mechanical equipment, and particularly chain saws, is very disturbing to game animals, though one would have thought that the lush regrowth on roadsides and landings would equally be very attractive to them; Stevens (1969) records that 48 per cent of mammals move out of exploited forest. Steps which could be taken to reduce the damaging effects of logging in the hill forests are stricter control over the location of roads (and especially insistance on reduction of gradients, so as to reduce the velocity of drainage water), the provision of permanent culverts and proper drainage especially where two roads join, the maintenance of culverts and drains at least on major roads after logging has ceased and until regrowth has stabilised all eroding surfaces, a regular check that erosion gullies are not forming, and if they are, remedial action to close them, the imposition of higher girth limits where the stand is so dense that the exploitation of all of it would lead to an excessively open stand, the acceptance of a greater proportion of pole-sized trees of timber species as regeneration rather than poisoning them, and the protection of such trees to ensure that they are not damaged during exploitation, higher penalties for unnecessary felling damage, more cautious girdling rules, and strict control over logging labour to ensure that wild life is not killed or disturbed unnecessarily.

Research is required on the stocking of wild life in logged over areas, on the reasons for its apparent absence, and on the length of time after logging during which wild life abandons such forest. Little information is available on the total extent to which logging increases erosion on different soil and topography types, and the length of time during which erosion continues. Carefully planned studies on calibrated catchments on

ifferent rock formations so that logged catchments can be compared th unlogged controls, are long overdue. More research is also needed n the amount of surface wash and soil creep under primary forest, and n the proportion of the stand left undamaged under different intensities f exploitation.

The nation's forests are an economic asset which, by careful manage- nent, will produce wealth not once but in perpetuity. Unexploited forest s essential for the protection of water catchments and for the preser- vation, in National Parks, of examples of the richest ecosystem the world has ever known, for the enjoyment and relaxation of both Malaysian and foreign tourists and for study by scientists from all over the world. While the vast majority of the nation's jungles must be regarded as commercial forests for the exploitation and growing of timber, the loss of amenity which logging produces, by damage to the magnificent neram (*Diptero- carpus oblongifolius*) groves along East Coast rivers, by silting of streams, destruction of fish and wild life, and the loss of big trees and their replace- ment, for half a century, by comparatively thick regrowth must be quite unacceptable in National Parks and Game Sanctuaries where in addition the preservation of all species of plants and animals in an undisturbed habitat is a trust which Malaysia holds on behalf of scientists throughout the world.

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TABLE 1. Bird recorded at Kuala Lompat. Common names follow the Malayan Nature Society pocket checklist of birds of Malaya and Singapore, 1963.+

Cinnamon Bittern3**
Crested Honey Buzzard4**
Roulroul4
Malay Peacock Pheasant4
Barred Bustard Quail1
Little Green Pigeon4
Emerald Dove4
Blue-crowned Hanging Parakeet4
Indian Cuckoo4**
Violet Cuckoo4**
Drongo Cuckoo4**
Raffles' Malcoha4
Chestnut-breasted Malcoha4
Common Coucal3
Collared Scops Owl4
Bay Owl4
Frogmouth (indet.)4
Malaysian Spinetail Swift5
Migrant Swift5*
White-whiskered Tree Swift5
Diard's Trogon4
Red-rumped Trogon4
Red-backed Kingfisher4
Chestnut-collared Kingfisher4
Red-bearded Bee-eater4
Black Hornbill4
Rhinoceros Hornbill4
Gold-whiskered Barbet4
Yellow-crowned Barbet4
Brown Barbet4
Rufous Piculet4
Crimson-winged Woodpecker4
Great Slaty Woodpecker4
Maroon Woodpecker4
Green Broadbill4
Banded Broadbill4
Garnet Pitta4
Barn Swallow5*
Lesser Greybird4
Ashy Minivet4*
Crested Brown Bulbul4
Black-headed Bulbul4
Stripe-throated Bulbul4
White-eyed Brown Bulbul4
White-throated Bulbul4
Hairy-backed Bulbul4
Green Iora4
Yellow-headed Green Leafbird4
Crow-billed Drongo4*
Large Racket-tailed Drongo4
Crested Malay Jay4
Slender-billed Crow4
Grey-headed Flycatcher4
Pale Blue Flycatcher4
Orange-breasted Flycatcher4
Chestnut-winged Flycatcher4
Black-naped Blue Flycatcher4
Black-capped Babbler4
Storm's Stork3
Serpent Eagle4
Crestless Fireback Pheasant4
Great Argus4
Larger Thick-billed Green Pigeon4
Jambu Fruit Pigeon4
Blue-rumped Parrot4
Lesser Hawk Cuckoo4
Fan-tailed Cuckoo4
Malay Cuckoo1
Rufous-bellied Malcoha4
Red-billed Malcoha4
Short-toed Coucal4
Reddish Scops Owl4
Oriental Hawk Owl4**
Malaysian Eared Nightjar5
Grey-rumped Swiftlet5
White-rumped Spinetail Swift5
Crested Tree Swift5
Red-naped Trogon4
Cinnamon-rumped Trogon4
Black-backed Kingfisher4**
Black-capped Kingfisher3*
Blue-throated Bee-eater5***
Bushy-crested Hornbill4
Southern Pied Hornbill3
Helmeted Hornbill4
Gaudy Barbet4
Little Barbet4
Malay Honey-guide4
Rufous Woodpecker4
Olive-backed Three-toed Woodpecker4
White-bellied Black Woodpecker4
Orange-backed Woodpecker4
Black-and-yellow Broadbill4
Dusky Broadbill4
Blue-tailed Pitta4
Barred Greybird4
Black-winged Flycatcher Shrike4
Scarlet Minivet4
Black-and-white Bulbul4
Yellow-crowned Bulbul3
Red-eyed Brown Bulbul4
Scrub Bulbul4
Finsch's Bulbul4
Crested Olive Bulbul4
Lesser Green Leafbird4
Fairy Bluebird4
Bronzed Drongo4
Malaysian Black-headed Oriole4
Black-crested Magpie4
Sultan Tit4
Brown Flycatcher4*
Blue-throated Flycatcher4*
Migratory Jungle Flycatcher4*
Maroon-breasted Flycatcher4
Paradise Flycatcher4**
Short-tailed Babbler4

+ Obtainable from the Society, P.O. Box 750, Kuala Lumpur, @ 25(M) cts per copy.

Blyth's Jungle Babbler[4]
Abbot's Jungle Babbler[3]
Lesser Red-headed Tree Babbler[4]
Chestnut-backed Scimitar Babbler[4]
Large-footed Wren Babbler[4]
Fluffy-backed Tit Babbler[4]
Black-necked Tree Babbler[4]
Red-winged Tree Babbler[4]
Fly-eater[4]
Yellow-bellied Wren Warbler[1]
Black-necked Tailor Bird[4]
Siberian Blue Robin[4*]
Common Shama[4]
Grey Wagtail[3*]
Yellow-throated Flowerpecker[4]
Ruby-cheeked Sunbird[4]
Van Hasselt's Sunbird[4]
Long-billed Spiderhunter[4]
Long Myna[4]
White-bellied Munia[4]
Ferruginous Babbler[4]
Greater Red-headed Tree Babbler[4]
Brown-headed Tree Babbler[4]
Striped Wren Babbler[4]
Striped Tit Babbler[4]
Grey-headed Tree Babbler[4]
Red-rumped Tree Babbler[4]
Common Nun Babbler[4]
Lesser Brown Wren Warbler[1]
Ashy Tailor Bird[1]
Long-tailed Tailor Bird[1]
Magpie Robin[1]
White-crowned Forktail[4]
Thick-billed Shrike[4*]
Brown-throated Sunbird[1]
Purple-naped Sunbird[4]
Little Spiderhunter[4]
Grey-breasted Spiderhunter[4]
Sharp-tailed Munia[4]
Tree Sparrow[2]

1 Observed exclusively in deforested areas.
2 At least two individuals were present on 19 November 1969, remaining close to the houses. None were observed on later visits, and the species is not (yet) established at Kuala Lompat.
3 Observed primarily along the rivers and/or in river-bank vegetation.
4 Observed in the forest or forest-edge.
5 Aerial insectivores observed above the forest canopy, clearings and rivers.
* Migrant, not breeding in West Malaysia.
** Partial migrant; at least some individuals leave Malaysia to breed further north.
*** Wintering populations do not breed locally.

hard to identify unless caught and handled. Nonetheless, we recorded 64 species within the 480 acre plot (Table 2). Of this total, only two species exclusively frequent clearings or the habitations of man. The remainder were found in the forest, and again are probably dependent on the continued presence of lowland forest for their survival.

Density

The Krau Game Reserve was established primarily to protect the large game mammals and most of the effort of the Game Department staff is directed towards the management of the game present, i.e. elephant, gaur (seladang) and deer. Elephant and gaur were not found in the area during our survey in February 1970, although old traces were seen. The presence of sambhur, muntjak and pig was attested by fresh tracks, but the number of individuals resident in the area could not be assessed. Mouse-deer were common, but again no census could be made. As an indication, in one morning's walk covering perhaps a third of the area, one of us disturbed three, apparently all Lesser Mouse-deer.

TABLE 2. Mammals recorded at Kuala Lompat. Common names follow usage in Medway, *Wild Mammals of Malaya and Offshore Islands*, Oxford University Press, Kuala Lumpur, 1969.

Malaysian Fruit Bat	Horsfield's Fruit Bat
Dusky Fruit Bat	Spotted-winged Fruit Bat
Long-tongued Fruit Bat (indet.)	Cave Fruit Bat
Hollow-faced Bat	Lesser Brown Horseshoe Bat
Glossy Horseshoe Bat	Trefoil Horseshoe Bat
Great Eastern Horseshoe Bat	Lawas Roundleaf Horseshoe Bat
Common Roundleaf Horseshoe Bat	Great Roundleaf Horseshoe Bat
Diadem Roundleaf Horseshoe Bat	Whiskered Bat
Brown Tube-nosed Bat	Round-eared Tube-nosed Bat
Common Treeshrew	Lesser Treeshrew
Dusky Leaf Monkey	Banded Leaf Monkey
Long-tailed Macaque	Pig-tailed Macaque
White-handed Gibbon	Siamang
Malayan Pangolin	Black Giant Squirrel
Common Giant Squirrel	Plantain Squirrel
Grey-bellied Squirrel	Prevost's Squirrel
Horse-tailed Squirrel	Slender Squirrel
Low's Squirrel	Shrew-faced Ground Squirrel
Red Giant Flying Squirrel	Large Bamboo Rat
Malaysian Wood Rat	Ricefield Rat[1]
Polynesian Rat[1]	Mueller's Rat
Bowers' Rat	Dark-tailed Tree Rat
Red Spiny Rat	Brown Spiny Rat
Whitehead's Rat	Long-tailed Giant Rat
Malayan Porcupine	Brush-tailed Porcupine
Common Palm Civet	Binturong
Tiger	Leopard
Clouded Leopard	Leopard Cat
Indian Elephant	Tapir
Wild Pig	Lesser Mouse Deer
Large Mouse Deer	Barking Deer
Sambhur	Gaur

1 Recorded only in clearings or buildings.

Similarly, during this brief survey, it was also impossible to make a reliable census of any species of smaller bird or mammal. Only with two groups, the hornbills and the higher primates, were we able to achieve a tentative estimate of numbers.

Of the five species of hornbill, the Helmeted Hornbill was not contacted in the plot during the survey of February 1970. It was present on previous visits, but apparently the plot area constitutes only part of a much extensive individual activity range. Rhinoceros Hornbills were observed on two days (Fig. 1). In the southwestern corner of the plot two birds were contacted simultaneously at 1150 hrs on 25 February, eventually flying off in a direction slightly east of north. A bird registered by another observer 40 minutes later at a point some 600 m distant was directly on this flight line and could have been one of the same pair. The third contact, at 1815 hrs on 23 February, does not force us to conclude that more than two Rhinoceros Hornbills utilized the area as part of more extensive range of daily movement.

FIGURE 1. Registrations of hornbills contacted in the study area, giving the time (by 24 hours notation) and the date in February 1970 of each contact. Black symbols indicate the actual number of birds confidently recorded at one time; the large open circle indicates a small flock of Bushy-crested Hornbills. Arrows show the direction of flight of moving birds.

Simultaneous observations (i.e. contemporary contacts, in the recommended terminology) of the small hornbills by different cooperators spread through the area can be matched in the same fashion, to give estimates of the minimum numbers of individuals making use of this 480 acre tract of forest. Thus, all contacts with the Southern Pied Hornbill were explicable in terms of one pair centred on the Krau-Lompat river junction, frequenting the eastern third of the survey area (but also extending out of it, eastward along the river), and another bird or birds with a home range centred higher on the Lompat and entering the southwestern corner of our area (Fig. 1).

There were many observations of Black Hornbills, in most cases far from the riverbanks (Fig. 1). Up to five birds were seen simultaneously and, assuming that this group separated at times into two pairs and a singleton, other observations do not indicate a larger population present in the area. At 1530 hrs on 24 February, these five birds were seen in flight near the river junction, outside the survey plot, indicating that their normal range was not restricted to the 480 acre area. Both Black and Southern Pied Hornbills were feeding together at a fruiting fig in the eastern sector of the plot (observations at 0700-0800 hrs on 26 February) and the movements of these and other hornbills are likely to be strongly affected by the fruiting cycles of their principal food trees.

Bushy-crested Hornbills are permanently gregarious. All contacts are consistent with one small flock, composed of at least five birds. The distribution of contacts suggests that the range of movement of this flock was contained within a central area of the plot; but this again may have been a temporary situation.

The higher primates — monkeys and gibbons — are also gregarious. While troops tend to be noisy and conspicuous, individuals are very difficult to tally accurately under normal conditions in the forest. Most numerous were the two leaf monkeys, which occurred in their separate troops throughout the area. Comparison of many observations indicates that the 480 acres supported at least four and probably five troops of the Banded Leaf Monkey (*Presbytis melalophos*) and four troops of the Dusky Leaf Monkey (*Presbytis obscura*); one additional troop of the latter, noted on the south bank of the Lompat river, may enter the area. The critical contacts leading to this interpretation are registered in Fig. 2.

Troop size was not reliably determined. Among the Dusky Leaf Monkeys, troop I consisted of at least four adults including a female carrying a new-born (orange-furred) young, and in troop II five full-grown monkeys were seen, without dependent young. Among the Banded Leaf Monkeys only troop II was counted, with 15 members (Fig. 2).

FIGURE 2. The critical observations of troops of leaf monkeys in the study area. Different troops are indicated by roman numerals. Each contact is timed and dated in February 1970. The solitary male *melalophos* seen at 0815–25 hrs on 24 February may have been an outlier of troop III.

Also numerous were Long-tailed Macaques. One troop on the northern border of the area comprised at least six monkeys; a series of contacts in the centre of the plot indicated a troop of at least three, and a large fruiting petai (*Parkia* sp.), overhanging the jeep track near the rangers' post, attracted up to 13 at a time, temporarily concentrating several smaller groups which ranged along the eastern border of the plot. Pig-tailed Macaques were less common; one small troop was seen, consisting of at least three individuals.

Siamang, as known from the intensive study of Mr. D.J. Chivers, were represented by a single family group of two adults and three offspring. White-handed Gibbons were more numerous. Our contacts indicated two groups in the north-centre of the plot (one party of four including an infant, and another of two adults), with one or two troops impinging on the northwest and another recorded just outside the plot in the southwest, across the river.

DISCUSSION

These observations at Kuala Lompat illustrate the richness of the indigenous fauna of a typical stretch of lowland forest in central West Malaysia, of which the Taman Negara is also representative. Among both birds and mammals, the great majority of species recorded are dependent for their survival on the continued presence of undisturbed forest. Such diverse animal communities have not evolved and cannot exist in the much less complex environments of cleared land, plantation, or secondary growth of the type that develops after the tropical forest has been felled.

The area of forest required to support viable populations of each species can only be estimated after censuses have been conducted. Our survey yielded preliminary data for the hornbills[1] and the higher primates (see Table 3). All species concerned are of great interest to conservationists, since they are relatively large in size, conspicuous, attractive to tourists, and restricted in their distribution to the Malaysian region.

The total number of individuals needed to ensure the perpetuation of a viable world population will vary from species to species, depending on peculiarities of biology, but the figure of 5000 is provisionally

[1] The following hornbills were recorded in a *c.* 1 x ½ mile strip of lowland primary forest on the Sat river, south-east Taman Negara during 8-13 July 1970: 2 Rhinoceros Hornbills, consistently seen together; 2 Wreathed Hornbills, heard; 1 Helmeted Hornbill, heard; 1 small flock each of Bushy-crested and Black Hornbills, neither seen well enough to count; 2-4 Southern Pied Hornbills along the river. Apart from the presence of the Wreathed Hornbills, these observations indicate a population density roughly similar to that found at Kuala Lompat.

TABLE 3. Density of hornbills and higher primates, based on observations at Kuala Lompat.

Species	Kuala Lompat: indicated number totally supported (200 ha, 480 acres)	Estimated area need to support 5000 individuals (sq km).
Helmeted Hornbill	1	10000±
Rhinoceros Hornbill	c.1	10000
Southern Pied Hornbill	2	5000
Black Hornbill	4	2500
Bushy-crested Hornbill	5	2000
Banded Leaf Monkey (*troops*)	4	—
(*individuals* @ 10 *per troop*)	40	250
Dusky Leaf Monkey (*troops*)	4	—
(*individuals* @ 5 *per troop*)	20	500
Long-tailed Macaque	22	500
Pig-tailed Macaque	3	3333
White-handed Gibbon (*groups*)	2	—
(*individuals* @ 3 *per group*)	6	1667
Siamang	5	2000

suggested as an approximate general minimum. Below this figure, it is probable that most vertebrate species would have poor chances of permanent survival. The corresponding minumum area of undisturbed forest required is seen to vary from 250 sq km (98 sq mi) for the Banded Leaf Monkey (assuming an average of 10 monkeys per troop), to 10000 sq km (3906 sq mi) for the large hornbills.

The largest area apparently is required by the hornbills. The Helmeted and the Rhinoceros Hornbills are the most distinctive members of their group in Malaysia. The former, with its extraordinary laughing call, has entered Malay folklore as 'burong tebang rumah mentua', and the latter not only figures on a popular set of stamps but is also of central cultural importance to the people of East Malaysia. Results of the survey at Kuala Lompat indicate that, if either species is to survive in the long run, a continuous tract of at minimum 10000 sq km must be reserved, permanently inviolate, for their conservation.

ACKNOWLEDGEMENTS

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Survival of the Malaysian Bird Fauna

D. R. WELLS[1]

About 800 species of birds occur on the lands situated within the 200 m (666 ft) depth of the line of Sunda Shelf and some 660 are known or presumed to breed here. About 70 percent of these are birds of the forest (mangrove excluded) and it is this large element of the avifauna, as opposed to the communities of open country and mangrove, that is distinctive of the region. Many of its species occur nowhere else in the world (see Table 1). To the south they are characteristically bounded by the edge of the Sunda Shelf and northwards, despite a broad geographical link with Asia in the geologically recent past, most range only to about 10° N. Beyond this latitude there is a minor extension of the community into peninsular Burma and it reappears as an impoverished outlier on the southern fringe of Cambodia and Vietnam, marking, perhaps, an ancient continental limit of the Sundaland rain forest fauna.

The forest bird fauna of this region has attained a spectacular diversity of species and West Malaysia, which marks the centre of the Pleistocene Sunda Peninsula on which this has evolved, has a major share. Some notion of the richness particularly of the lowland bird fauna of this country, in terms of the number of species that live together in any one piece of forest, can be gained by comparing surveys of forests sites in different parts of the humid tropics. A few statistics are available for the rain forests of Africa and tropical America. Transects through about 20 square miles of lowland forest in the eastern Congo yielded 128 breeding species (Moreau 1966); 2 areas, of about 80 and 25 square miles, in southern Nigeria produced *c.* 100 and 117 species, respectively, over several years' intermittent observation (Moreau 1966; Button 1967; 1968). These compare with West Malaysian scores of 175 over 2 years in about 4 square miles of forest at Pasoh, Negri Sembilan, 141 in 200 hectares (480 acres) over just 3 days at Kuala Lompat, Pahang (see Medway & Wells — this issue) and 127 over 6 days in 2 small areas of forest totalling about 1 square mile on the lower reaches of the Sungei Sat and Sungei Spia in the eastern part of Taman Negara. Only in tropical America have equivalent or greater diversities been reported; 175 species in 6 square miles at Barro Colorado, Panama (MacArthur 1969) and the fantastic figure of 269 species in 1 square mile of lowland forest in Costa Rica (Moreau 1966). But neither of these totals are known specifically to exclude clearing species or non-breeding migrants, as do the African and Malaysian figures.

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TABLE 1. A comparison of the resident forest and non-forest bird faunas of West Malaysia to show the relative proportion of Sunda region endemics to species occurring elsewhere in Asia and/or Australasia. Note that each species has only one entry in the tables. The 18 species shared between forest and non-forest are scored according to what is considered to be their original habitat in West Malaysia.

Families	Forest		Non-forest (and Mangrove)	
	Widespread	Sundaic	Widespread	Sundaic
Grebes	–	–	1	–
Herons, Storks	–	1	11	–
Hawks, Falcons	9	3	2	–
Pheasants	4	9	2	–
Button-quails	–	–	1	–
Rails, Finfoots	1	–	8	–
Painted Snipe, Plover, Pratincoles	–	–	3	1
Pigeons	11	5	5	–
Parrots	–	3	–	–
Cuckoos	10	7	3	–
Owls	9	3	2	–
Frogmouths, Nightjars	–	4	2	–
Swifts, Tree Swifts	3	3	3	1
Trogons	2	4	–	–
Kingfishers	4	2	5	–
Bee-eaters, Rollers, Hoopoes	1	1	5	–
Hornbills	4	7	–	–
Barbets, Honey-guides	4	6	2	–
Woodpeckers	10	10	4	–
Broadbills, Pittas	7	5	–	–
Swallows	–	–	2	–
Campephagids	6	3	–	1
Leaf-birds, Bulbuls	9	18	3	2
Drongos	3	–	1	–
Orioles	–	2	2	–
Crows	2	2	3	–
Tits, Nuthatches	2	1	1	–
Babblers	23	24	–	–
Thrushes	7	3	2	–
Warblers, Whistlers	5	3	6	1
Flycatchers	14	7	–	2
Pipits	–	–	1	–
Shrikes	–	–	1	–
Starlings	1	–	6	–
Sunbirds, Flowerpeckers, White-eyes	10	14	6	–
Weavers, Sparrows, Munias, Finches	4	2	5	2
Totals	165	152	98	10
	317		108	

Such a large number of species can live together without excluding one another only by great specialisation of way of life so that each has reserved to it a very narrow segment of the total resources of the forest. Just what the 'ecological niche' of any one species is requires much patient field work to elucidate but the specialisation that must be involved manifests itself in two broad patterns of distribution of birds

in forest. The most obvious of these is an altitudinal zonation of avian communities according to forest type. A major discontinuity exists where the Lowland (dipterocarp) forests meet Lower Montane (oak-laurel) forest of higher elevations, at between 3000-4000 ft elevation on the Main Range in West Malaysia. These two types of forest have quite different bird faunas with comparatively few species in common, and the sharpness of the division is striking. Other discontinuities occur at about 500-600 ft elevation on the Main Range where, for reasons still obscure, a number of strictly lowland species drop out and again at the interface around 5000 ft of the montane oak-laurel forest and the dwarf Upper Montane (ericaceous) forests of the high summits. Many montane species, particularly those that feed in the forest canopy do not live in this summit vegetation but it, in turn, has a number of species which are found nowhere else, for example, the Chestnut-tailed Siva (*Mina strigula*), the Brown Bullfinch (*Pyrrhula nipalensis*), the Blue-and-Orange Flycatcher (*Muscicapa sundara*) and the White-breasted Hill Warbler (*Prinia atrogularis*). The last is known in Malaya only on G. Tahan in Taman Negara.

The second type of distribution is a vertical zonation within the profile of the forest, particularly pronounced in the tall, dipterocarp forest of lower elevations. Each species has a characteristic zone in which it feeds and it is possible to resolve the bird fauna into three separate communities. The ground storey community, of which pheasants, pittas, most thrushes and many babblers are characteristic, feeds mainly on insects but also on fallen fruit on the forest floor and in the stemless palm/sapling layer. The top storey community utilises the fruit and insects of the crowns of the big trees and typically includes the hornbills, barbets, most of the pigeons, campephagids, leafbirds, flower-peckers and sunbirds. There is also a middle storey community of trogons, woodpeckers, bulbuls, flycatchers, babblers, drongos etc., the habitat of which is harder to delimit but which is, nonetheless, real, living among trunks and in the foliage to the smaller, non-emergent trees. Quite different though sometimes related species inhabit highland forests, where ground and canopy communities are just as readily distinguished from one another although the stature and structure of the forest make it difficult to separate a middle-storey community.

Another very important corollary of their specialised way of life is that few forest birds have managed to invade open country habitats, many species of which are characterised by a rather broad ecological tolerance. The familiar Magpie Robin is, for example, equally at home along uninhabited inland river banks, in suburban gardens and in mangrove swamp. I can list only 18 species that use both forest and non-forest habitats in Malaya and 16 of these may hardly be classed as

forest birds proper since they inhabit no more the riparian fringe vegetation of the larger rivers through forest. Only two, the Striped Tit Babbler (*Macronus gularis*) and the Flycatcher (*Gerygone fusca*), have really adapted both to high forest and to the thickets and trees of cultivation and belukar. Parenthetically, both are also found in mangrove (Nisbet 1968) and neither is a Sunda region endemic.

The long term survival of Malaysia's forest bird fauna as a whole therefore, depends first of all on the continued existence of forest in all its altitudinal zones and with its entire range of subtle infra-habitats intact. In so highly and finely evolved an ecosystem as rain forest this is clearly incompatible with any form of industrial exploitation. As currently practised in this country, mechanised logging with its attendant earth-moving and road-building activities, fouling of water courses and excessive human interference probably damages or destroys an unnecessarily wide range of habitats. But even the most carefully controlled timber extraction (a theoretical situation) must fundamentally disturb the enviroment not only by selective removal of tree species but more generally by physical break-up of the canopy and exposure of the forest floor to massive invasion by plants of secondary growth, thereby changing its entire character.

We have a small amount of direct information on what happens to birds when the forest is disturbed, where logging operations have passed through previously established study areas. Selective felling on the slopes of G. Angsi in Negri Sembilan, for example, caused the direct disappearance of birds such as trogons (Manning unpublished) and in Pasoh Forest Reserve, Negeri Sembilan, destruction in part of a study plot caused agitated and apparently random wandering of affected populations through the surrounding area. What happens to birds displaced in this way is not yet certain but there are some indications. In 1962 a section of the Subang Forest Reserve, Selangor, was clear-felled to make way for a new village. This felling affected part of a large bird-ringing study area and by continued mist-netting in the rest of the area it was possible to show not only that the original fauna had been completely displaced by clearing but that very few of the affected individuals subsequently managed to re-establish themselves in the surrounding forest (McClure & Hussein 1965). The fate of the majority is unknown but the implication, as might be expected, is that density of population in undisturbed forest is near the maximum that can be sustained so that the likelihood of displaced individuals being able to find themselves a new home is slight. Most, probably, die without breeding again. If this is the case then even selective, rotation logging as a suggested dual function for wild life reserves would not be compatible with maintaining the numbers of a species, particularly

should the reserve ultimately become isolated from other forest by agriculture or mining etc. This would be most serious for species only able to recolonise forest towards the latter stages of its regeneration (there are a number of forest birds that ornithologists in this country have not been able to find in any kind of regenerating growth).

What we know so far makes it reasonably certain that conservation of a sample of the complete forest bird fauna will require retention of tracks of undisturbed, primary forest at all altitude zones, from the flat lowlands to the high mountain summits. Just how much forest is needed for survival of this fauna in perpetuity is hard to estimate though, as an obvious general observation, it is unrealistic to consider birds in isolation and to conserve a sample of the whole forest ecosystem, with viable populations of its biggest trees and animals, will require inviolate National Parks of considerable size.

The big consideration beyond retention of habitat is maintenance of breeding populations large enough to possess a pool of genetic variability sufficient to permit their adaption to slow, long-term changes and hence allow long-term survival. It is obviously impossible to measure directly how many individuals are needed to support an adequate gene pool and hence how large an area of habitat is required. One can, however, make a guarded estimate and thence, by measuring population density in the field, arrive at a figure for the area of habitat needed (see Medway & Wells — this issue).

Ringing studies of forest birds suggest that most are distributed more thinly than the familiar open country species and while the majority are still moderately common some are rare or very rare, eluding ornithologists for years at a time. An example is Kuhl's Ground Thrush (*Zoothera interpres*) a pair of which was recently identified in lowland primary forest of the Pahang section of Taman Negara, only the third locality in Malaya in which the species has been found. Such apparent rarity indicates either an extremely local, patchy distribution, in which case this thrush may be a forest bird on its way to natural extinction, or an unusually low density of individuals, in which case the area needed to maintain a viable population would be unusually large. The same is true of most of the spectacular, large birds of the forest, hornbills and eagles which may be 'common' by virtue of mobility and conspicuousness but which in reality live at very low population densities.

The effect of limited living space on bird populations can be investigated circumstantially by considering the avifaunas of naturally circumscribed areas such as off-shore islands and isolated mountains which to montane species, because they cannot easily penetrate lowland forest, are also effectively islands. The largest Malayan islands on

which the birds have been reasonably thoroughly worked out are Pulau Tioman (Johore) and P. Langkawi (Kedah). Except for possible colonisation over the sea they have been cut off from mainland bird populations for several thousand years and though they have fairly extensive tracts of tall forest (Tioman to this day is almost entirely forested) both have markedly impoverished forest avifaunas (Medway 1966; Wells in prep.). Tioman, with an area of *c.* 44 square miles has only 25 forest species, 5 of which are well-known partial migrants, and Langkawi, with an area of about 150 square miles at least 70 percent of which is, or was recently, covered in tall forest has only 41 possible forest breeding species, 8 of which are partial migrants. The scores are only small fractions of the avifauna of even small study sites on the mainland and, granted that some species may have been locally absent when the islands were cut off, it seems likely that a considerable number have become extinct subsequently. Small climatic variations etc. since isolation may have led to temporary or permanent 'ecological deficiencies', affecting some species more than others and it is a reasonable assumption that extinction of the most adversely affected was aided by populations which were too small and, therefore, too stereotyped to be viable in the face of environmental changes.

The same argument could apply to isolated mountain peaks, whether or not one considers that they were populated mainly by random colonisation or by past direct habitat links. In West Malaysia only the large Benom and Tahan massifs are known to carry anything approaching the number of montane bird species found on the Main Range. G. Tahan has 52 recorded species, or 70 percent of the Main Range total. Compare this with scores of one and two montane species, respectively, on two smaller isolated mountains, G. Ledang (Mt. Ophir) and G. Jerai (Kedah Peak). Of the two birds involved, the Grey-throated Babbler (*Stachyris nigriceps*) occurs on both peaks and this hardly qualifies as 'montane' since it regularly ranges down to 800 ft elevation or less and is widespread on hills throughout the country, even on Pulau Tioman. Both mountains are capped by Upper Montane forest and, although this may never have been suitable for all mountain birds, the inescapable conclusion is that, now or in the past, the area of habitat available on the peaks has been too small to support viable populations and that many species have become extinct. The one true montane bird still on G. Jerai, the Streaked Wren Babbler (*Napothera brevicaudata*), seems to be unusually good at surviving in small pockets as it is also the only known montane bird of the far more isolated G. Kajang on Pulau Tioman (Robinson 1928).

These arguments are admittedly very indirect but they are intended to stress the importance, for the ultimate survival of the most distinctive

part of our bird fauna, of retaining in perpetuity primary forests not only inviolate but also in sufficient area. It is unlikely that, with present exploitation rates and techniques, primary forests, at least of the lowlands and foothills, will survive in sufficient area without National Parks. Of the present reserves in West Malaysia the only one that covers a large area over a wide range of vegetation types is Taman Negara. 172 of the 241 known lowland forest birds and 52 out of 76 known highland species breeding in West Malaysia have so far been identified within its boundaries and it is likely at most or all, at least of the lowland species, will eventually be found there. This does not necessarily mean that the area of Taman Negara will ultimately prove adequate once surrounded forests have been eliminated but there is a chance that for a large part of the fauna it will, provided no loss of territory or habitat is permitted now or in the future.

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APPENDIX

Birds identified within the boundaries of Taman Negara up to July 1970. This is an edited list drawn from expedition reports and both published and unpublished notes. Common names are used and these follow the Malayan Nature Society Pocket Checklist of the Birds of Malaya and Singapore.

A. *Lowland and foothill forest species.* (N.B. All records in this section come from the Pahang section of Taman Negara)

Crested Goshawk
Wallace's Hawk-eagle
Changeable Hawk-eagle
Serpent Eagle
Red-breasted Falconet
Long-billed Partridge
Black Wood Partridge
Roulroul
Crestless Fireback Pheasant
Crested Fireback Pheasant

Malay Peacock Pheasant
Great Argus
Larger Thick-billed Green Pigeon
Little Green Pigeon
Jambu Fruit Pigeon
Emerald Dove
Blue-rumped Parrot
Blue-crowned Hanging Parakeet
Indian Cuckoo
Rufous-bellied Malcoha
Raffles' Malcoha
Red-billed Malcoha
Chestnut-breasted Malcoha
Short-toed Coucal
Reddish Scops Owl
Collared Scops Owl
Oriental Hawk Owl
Bay Owl
Gould's Frogmouth
Malaysian Eared Nightjar
Malaysian Spinetail Swift
White-rumped Spinetail Swift
White-whiskered Tree Swift
Red-naped Trogon
Diard's Trogon
Cinnamon-rumped Trogon
Orange-breasted Trogon
Deep Blue Kingfisher
Red-backed Kingfisher
Banded Kingfisher
Chestnut-collared Kingfisher
Red-bearded Bee-eater
Bushy-crested Hornbill
Wreathed Hornbill
Black Hornbill
Rhinoceros Hornbill
Helmeted Hornbill
Gold-whiskered Barbet
Many-coloured Barbet
Gaudy Barbet
Yellow-crowned Barbet
Little Barbet
Brown Barbet
Malay Honey-guide
Rufous Piculet
Crimson-winged Woodpecker
Checker-throated Woodpecker
Banded Red Woodpecker
Olive-backed Three-toed Woodpecker
Fulvous-rumped Woodpecker
Buff-necked Woodpecker
Great Slaty Woodpecker
Orange-backed Woodpecker
Green Broadbill
Black-and-yellow Broadbill
Banded Broadbill
Dusky Broadbill
Giant Pitta
Garnet Pitta
Blue-tailed Pitta
Hook-billed Greybird
Barred Greybird
Lesser Greybird
Bar-winged Flycatcher-shrike
Scarlet Minivet
Crested Brown Bulbul
Black-and-white Bulbul
Black-headed Bulbul
Scaly-breasted Bulbul
Grey-bellied Bulbul
Red-eyed Brown Bulbul
White-eyed Brown Bulbul
Lesser Brown Bulbul
Scrub Bulbul
White-throated Bulbul
Finsch's Bulbul
Hairy-backed Bulbul
Crested Olive Bulbul
Streaked Bulbul
Ashy Bulbul
Green Iora
Lesser Green Leafbird
Greater Green Leafbird
Yellow-headed Green Leafbird
Fairy Bluebird
Bronzed Drongo
Large Racket-tailed Drongo
Malaysian Black-headed Oriole
Crested Malay Jay
Black Crested Magpie
Slender-billed Crow
Sultan Tit
Velvet-fronted Nuthatch
Spotted Fantail Flycatcher
Grey-headed Flycatcher
Verditer Flycatcher
White-tailed Blue Flycatcher
Pale Blue Flycatcher
Malaysian Blue Flycatcher
Tickell's Blue Flycatcher
Orange-breasted Flycatcher
White-throated Jungle Flycatcher
Chestnut-winged Flycatcher
Maroon-breasted Flycatcher
Black-naped Blue Flycatcher
Paradise Flycatcher
Rail Babbler
Black-capped Babbler
Short-tailed Babbler
Blyth's Jungle Babbler
Ferruginous Babbler
Horsfield's Jungle Babbler
Greater Red-headed Tree Babbler
Lesser Red-headed Tree Babbler
Brown-headed Tree Babbler
White-throated Babbler
Chestnut-backed Scimitar Babbler
Striped Wren Babbler
Large-footed Wren Babbler
Striped Tit Babbler
Fluffy-backed Tit Babbler
Grey-headed Tree Babbler
Black-necked Tree Babbler
White-eared Tree Babbler
Red-rumped Tree Babbler
Red-winged Tree Babbler
Hume's Tree Babbler
Common Nun Babbler
White-bellied Crested Babbler
Fly-eater
White-throated Flycatcher Warbler

Black-necked Tailor Bird
Orange-tailed Shama
Common Shama
White-crowned Forktail
Chestnut-naped Forktail
Chestnut-headed Ground Thrush
Blue Whistling Thrush
Orange-bellied Flowerpecker
Yellow-vented Flowerpecker
Scarlet-breasted Flowerpecker
Yellow-throated Flowerpecker
Plain-coloured Sunbird
Rufous-throated Sunbird
Ruby-cheeked Sunbird
Purple-naped Sunbird
Scarlet Sunbird
Little Spiderhunter
Long-billed Spiderhunter
Great Yellow-eared Spiderhunter
Grey-breasted Spiderhunter
Hill Myna
White-bellied Munia

B. *Highland forest species.*

Black Eagle
Rothschild's Peacock Pheasant
Crested Argus
Wedge-tailed Green Pigeon
Mountain Imperial Pigeon
Little Cuckoo Dove
Large Hawk Cuckoo
Mountain Scops Owl
Pygmy Owlet
Golden-throated Barbet
Müller's Barbet
Speckled Piculet
Black-naped Green Woodpecker
Long-tailed Broadbill
White-vented Greybird
Mountain Minivet
Crested Bulbul
Mountain Streaked Bulbul
Lesser Racket-tailed Drongo
Green Magpie
Blue Nuthatch
White-throated Fantail Flycatcher
Niltava
Pygmy Blue Flycatcher
Rufous-breasted Blue Flycatcher
Little Pied Flycatcher
White-throated Flycatcher
Large Scimitar Babbler
Streaked Wren Babbler
Small Wren Babbler
Pygmy Wren Babbler
Grey-throated Tree Babbler
Golden Tree Babbler
Chestnut-capped Laughing Thrush
Red-headed Laughing Thrush
Silver-eared Mesia
Red-winged Shrike Babbler
Black-eared Shrike Babbler
Chestnut-headed Nun Babbler
Mountain Nun Babbler
Chestnut-tailed Siva
Long-tailed Sibia
White-breasted Hill Warbler
Green Leaf Warbler
Yellow-breasted Flycatcher Warbler
Ashy-naped Tailor Bird
Lesser Shortwing
Slaty-backed Forktail
Javan Fire-breasted Flowerpecker
Black-breasted Sunbird
White-eye Everret's
Brown Bullfinch

C. *Riverine and clearing species.*

Little Green Heron
Cotton Teal
Lesser Fishing Eagle
Common Coucal
Fish Owl
Grey-rumped Swiftlet
Palm Swift
Crested Tree Swift
Common Kingfisher
Blue-banded Kingfisher
Stork-billed Kingfisher
White-breasted Kingfisher
Blue-throated Bee-eater
Southern Pied Hornbill
Rufous Woodpecker
Black-and-red Broadbill
Pacific Swallow
Red-rumped Swallow
Yellow-crowned Bulbul
Stripe-throated Bulbul
Yellow-vented Bulbul
Common Iora
Abbott's Jungle Babbler
Lesser Brown Wren Warbler
Yellow-bellied Wren Warbler
Magpie Robin
Brown-throated Sunbird
Sharp-tailed Munia

D. *Non-breeding migrants.*

Rufous-bellied Hawk-eagle
Osprey
Common Sandpiper
Migrant Swift
Black-backed Kingfisher
Black-capped Kingfisher
Brown-breasted Bee-eater
Hoopoe
Barn Swallow
Ferruginous Flycatcher
Crowned Leaf Warbler
Grey Wagtail
Thick-billed Shrike

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Information for Visitors to the National Parks

The Malaysian Government Dept. of Tourism has prepared a general brochure on the National Parks.

TAMAN NEGARA (WEST MALAYSIA)

How to get there

By road to Jerantut (from Kuala Lumpur via Mentakab), then 11 miles by a recently completed unmetalled road north to Kuala Tembeling, journey time $4\frac{1}{2}$ — 5 hours. Cars may be garaged at the Game Dept. Office at Kuala Tembeling. Then by boat for 3 — 4 hours up the Sungei Tembeling to Park Headquarters at Kuala Tahan. Until recently there was no road to Kuala Tembeling and the journey there was more complicated. Park boats are stationed at Kuala Tahan and only meet visitors at Kuala Tembeling by prior arrangement.

Further Information

The Officer in Charge of Taman Negara is the Chief Game Warden, West Malaysia, 202 Jalan Temiang, Seremban, Negri Sembilan (telephone Seremban 4533, telegrams Chiefward.). Details of charges are available from him.

Accommodation

There are a comfortable modern Rest House and chalets at Park Headquarters, Kuala Tahan, also a hostel with 40 beds. There are simpler Visitors' Lodges at Kuala Atok, Kuala Trenggan and Kuala Kenyam and Fishing Lodges at Lata Berkoh and Kuala Perkai. Reservations are made through the Officer in Charge at the above address.

TEMPLER PARK (WEST MALAYSIA)

How to get there

Templer Park lies adjacent to and east of the trunk road about 45 minutes drive north of Kuala Lumpur, just across the Kanching pass. The paths within the Park are well signposted. At the north end of the Park are two coffee shops.

Further information

Friends of Templer Park, c/o Institute for Medical Research, Kuala Lumpur.

BAKO NATIONAL PARK (SARAWAK)

How to get there

Bako National Park is easily accessible from Kuching. A large speedboat is available for hire and a single trip to Telok Asam takes just over an hour.

Further information

Bookings of accommodation and transport may be arranged through the Park Warden, Bako National Park, c/o Section Forest Officer, Kuching, Sarawak (telephone Kuching 24474).

Accomodation

There are two bungalows — Rest House and Laboratory — at Telok Asam. They are fully furnished and equipped with butane stoves for cooking. Visitors need only bring their own personal clothing, towels and foodstuffs. Scientific visitors are given priority in the Laboratory bungalow. In addition there are two hostels, the larger of which can take about 40 persons and the smaller about 10. The furnishing of the hostels is somewhat spartan and visitors need to bring bedding, cooking utensils, crockery etc. Electricity is installed in all buildings. In addition there is a camping area and there are two day shelters.

KINABALU NATIONAL PARK (SABAH)

How to get there

From Kota Kinabalu by road to Park Headquarters at Simpang Kinabalu is 57 miles and takes about $3\frac{1}{2}$ — 4 hours. There is a daily bus service, and vehicles can be hired. Alternatively it is possible to fly from Kota Kinabalu to Ranau (30 minutes) and then travel by Land Rover to Park Headquarters, about 15 miles away.

Further information

An excellent series of leaflets and a brochure have been prepared by the Sabah National Parks Trustees. These are obtainable from the Park Warden. P. O. Box 626, Kota Kinabalu, (telephone Kota Kinabalu 2234).

The leaflets cost $1 for 1 — 8; 9 is free. They are entitled:

1. The National Park Ordinance 1962.
2. A short guide to the ascent of Mt. Kinabalu.
3. Mt. Kinabalu as a mountain.
4. Accommodation, Porters etc.

5. Notes on the birds of Mt. Kinabalu National Park.
6 The vegetation of Kinabalu.
7. Twelve common birds to be seen on the ascent of Mt. Kinabalu.
8. Notes on the mammals of Kinabalu National Park.
9. The Lepidotera (butterflies) of Mt. Kinabalu.

Accommodation

There is a government Rest House at Ranau. Applications to stay there must be made to the District Officer, Ranau, Sabah (telephone Ranau 36).

Within the Park there is a youth hostel accommodating 20 persons and a 3 person chalet at Park Headquarters. On the mountain there are four climbers' huts at approximately 2½ hours walking distance from each other. All applications for accommodation within the Park must be made to the Park Warden at the above address.

Malay. Nat. J. **24**: 261–262 (1971)

Review

UNITED NATIONS LIST OF NATIONAL PARKS AND EQUIVALENT RESERVES. Published by Hayez, Brussels and I.U.C.N. International Commission on National Parks.

It is particularly appropriate that the second edition of this valuable work should have been published, in its English version, in time for review in this National Parks special issue of the Journal.

The first edition, published in two parts in 1961 and 1962, was prepared at the suggestion of IUCN by the Secretariat of the United Nations with substantial assistance from IUCN, and was an uncritical compilation of data supplied by member nations in response to a request by the Secretary-General of the United Nations.

As a result of discussion at the 1962 World Conference on National Parks it was decided that there was a need for United Nations sponsorship of succeeding editions of the List, but that Parks must meet minimum standards of size, protection, access, and administration for entry in subsequent editions.

The present edition was first published in the definitive French form in 1967, and included material available up to the end of May 1967, but the opportunity has been taken in the preparation of the English version to include certain additional material up to the end of June 1970. The author, Professor Jean-Paul Harroy, has spent three years of detailed work on this compilation and an impressive amount of information is now available on the status, area, location, staff, budget, history, and ecology of the Parks included in the List.

To qualify for inclusion a Park must be protected by decree of the central Government of the country in which it is situated, and tourism must be permitted. Different standards of minimum size, staffing, and financial support are specified, depending on the density of population of the country, and these range from a minimum size of 2000 ha., one person per 10,000 ha engaged full-time on management and protection, and an expenditure of at least U.S. $50 per year for each 1000 ha where the country's population density does not exceed 50 persons per sq km, up to minima of 500 ha, one person per 4000 ha, and U.S. $100 per 1000 ha where the population exceeds 50 persons per sq km. Areas are entered as Equivalent Reserves where the above standards are met with the exception that either access is limited (as in strict nature reserves) or the status is not derived from the central Government.

Clearly there must be minimum standards in a list of this kind if dilution by large areas of inadequately protected and supported reserves is to be avoided, but the statement of areas excluded from the

List by the enforcement of these standards makes frightening reading and one wonders perhaps if this is not an open invitation to less responsible Governments to remove protection entirely from the excluded areas. In the case of Malaysia only four areas qualify for entry, Taman Negara, Templer Park, Kinabalu National Park, and Bako National Park, a total of 507090 ha while ten proposed National Parks in Sarawak with a total area of 90219 ha are excluded, and the Game Reserves of West Malaysia, including the vital Krau and Sg. Dusun Reserves suffer a similar fate.

May we hope that in future editions a way will be found to include vital conservation reserves, and especially game sanctuaries and game reserves, even though they fall short of the, perhaps rather high, standards set for inclusion in the present edition? May we also hope that future editions will include a 'balance sheet' in tabular form so that the reader can readily see the progress made in reservation in each country and in the world as a whole?

P.F.B.

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