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MAP 2	Proposed Nabawan Kerangas Forest Reserve

## GLOSSARY

cm; cms	centimetres(s)
km; kms	kilometre(s)
ft	feet
ha	hectares
sp., spp.	species
ssp.	sub-species
Bukit; Bt.	Hill
G.; Gunung;	Mt., Mountain
Sungai, Sg.	River
Kg.; Kampung	Village
GFS	Gravity Feed (Water Supply) System
GIS	Geographical Information Systems
GPS	Global Positioning System
SCS	Sabah Conservation Strategy
DOA	Department of Agriculture
DID	Department of Irrigation and Drainage
ECD	Department of Environment Conservation
FELCRA	Federal Land Consolidation Rehabilitation Authority
FELDA	Federal Land Development Authority
IPPA	Identification of Potential Protected Areas
KPD	Korporasi Pembangunan Desa
LSD	Lands and Surveys Department
MOCET	Ministry of Culture, Environment and Tourism <sup>1</sup>
NGO	Non-governmental organisation
NRO	National Resources Office, Chief Minister's Department
SBCP	Sabah Biodiversity Conservation Project
SFD	Sabah Forestry Department
WWF	World Wide Fund for Nature, Malaysia

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<sup>1</sup> This is the new name of the Ministry of Tourism and Environmental Development which was adopted in 1998.

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## EXECUTIVE SUMMARY

### INTRODUCTION

1. The Identification of Potential Protected Areas (IPPA) component of the Sabah Biodiversity Conservation Project (SBCP) was initiated to investigate several geographical zones and habitats considered to be inadequately represented or not present within Sabah's Protected Area system.
2. This document and its Background Papers represent the final report on the Nabawan kerangas forest investigated under the IPPA component. Kerangas is a form of tropical heath forest and the Nabawan area is one of five geographical localities in Sabah where patches of kerangas forest may be found.
3. Kerangas are distinctive low stature forests that occur on nutrient-poor white sandy soils. Kerangas forests are known to support high levels of plant diversity and endemism and the Nabawan kerangas forest is no exception. Prior botanical explorations of the Nabawan kerangas had already found the area to be significant for plant biodiversity, particularly in rare orchids, rhododendrons and ant-plants, including several found exclusively in this locality.
4. A similar form of kerangas forest formerly occurred in the Sook Plain. It has since been destroyed in its entire extent by land conversion and fire. Today, the Nabawan kerangas forest is the last of its kind in Sabah. It was identified in the Sabah Conservation Strategy (1992) as a critical and sensitive habitat requiring further investigation and protective measures.
5. The IPPA component facilitated a more comprehensive assessment of plant biodiversity and an appraisal of the condition of the remaining the kerangas forests. Botanical assessments were carried between April and September 1998 (Background Papers 1 and 2) to better document the diversity of both woody and non-woody plants. Previous records of botanical diversity in the Nabawan area have also been compiled and evaluated.
6. A socio-economic and development study was conducted in September 1998 (Background Paper 3) to understand the relationship of local people with the forest; to ascertain the importance of forest resources to its user in terms of economic value; and to recommend appropriate development strategies that complement conservation objectives.

### FINDINGS

#### *Biodiversity*

7. Two main types of kerangas forest were found to occur at Nabawan: the *Dacrydium pectinatum-Tristaniopsis forest* (estimated area 970 hectares) and *Shorea venulosa-Hopea pentanervia forest* (915 hectares). Both forest types are found mainly outside the Milian-Labau Virgin Jungle Reserve.
8. The herb-flora assessment confirms the Nabawan kerangas forest to be an outstanding site of plant biodiversity in Sabah. Among the wild gingers 10 of the 17 genera known from Borneo may be found here. Two new ginger species are known to exist in Nabawan. There is a strikingly high diversity of rare and localised herbaceous plants, including rhododendrons, ant-hosting plants and pitcher plants.

9. Among the orchids, 160 species have been collected to date. Of these 130 have been identified, while the remaining 30 species have only been identified to genus level. Among the named species, 30 are known to be locally endemic, very rare or only recorded from this area in Sabah.
10. These kerangas forests are under serious threat from agricultural conversion, fire, unsustainable timber extraction and extreme weather conditions such as droughts. Once kerangas forest is disturbed, the organic matter on the surface layer becomes oxidised and nutrients are leached out. These cause kerangas forests to become unproductive grassland and scrub. However, it is possible that certain areas could regenerate naturally if protected from further disturbance.
11. Continued fragmentation and encroachment of kerangas forest pose an imminent threat to the survival of this forest ecosystem. There is a danger of rapidly losing these high biodiversity areas if pro-active steps are not taken to afford them protection.
12. This botanical richness of this area has substantial potential for the development of nature education and recreation activities. In addition to putting Nabawan on the ecotourism trail, such activities may contribute to biodiversity conservation and research.

*Local community perspective*

13. The local communities in Nabawan are predominantly Murut. Three villages (Kg. Fontas, Kg. Saup and Kg. Tetagas) were investigated for this study (Background paper 3). Villagers in Nabawan rely extensively on surrounding forests for subsistence farming, hunting, the harvest of fuelwood and of non-timber forest products. In principle, protecting the forest ecosystem may also benefit local people by maintaining natural environmental services and preserving the flow of economic benefits to local people.
14. Among local communities, a resurgence of the traditional dependence on forest products, hunting and unsustainable subsistence agriculture is being observed. This is in response to declining incomes from working in logging companies and is expected to intensify as most of the large trees have now been removed from the area. It is anticipated that there will be greater pressure on remaining forests for shifting cultivation because of the shortage of titled land. There is also a greater threat of unsustainable forest exploitation due to the increase in hunting and extraction of forest products.
15. The economic analysis concludes that in order to reduce forest exploitation and further loss of natural environmental services, the following measures should be taken to provide local communities the security and alternatives to sustain their economic livelihoods: (1) Granting land tenure to local residents for farming as an incentive for them to support forest conservation on land elsewhere and to qualify them for the benefits of government agricultural schemes; (2) Development of compatible small-scale cash crop projects; (3) Development of a market system to facilitate sales of agricultural products and forest harvests to buyers outside the District; and (4) Creating buffer zones around the kerangas forest with co-operative management with local communities to assure continued access to these areas.

## MAIN RECOMMENDATIONS

16. As most of the remaining kerangas forest in good condition is located within the contiguous tracts of forest outside (to the south and to the west of (the Milian-Labau VJR; Map 1), maintenance of this area provides the most secure means to ensure long-term survival of the full biodiversity of the Nabawan kerangas forest.

### **(i) State Level**

It is recommended that the ‘Nabawan Kerangas Forest Reserve’ (an area of approximately 4000 hectares; Map 2) be established under the Forest Enactment as a Virgin Jungle Reserve. No further licenses to be issued for felling and extraction of timber from the proposed Forest Reserve and no further land titles to be awarded for land within the area shown.

The Sabah Forestry Department and the Ministry of Culture, Environment and Tourism/ Department of Environmental Conservation to jointly brief the relevant government agencies at State level of the biodiversity significance of the Nabawan kerangas forest. Recommended agencies are the Ministry of Agriculture and Fisheries, Ministry of Rural Development, Natural Resources Office of the Chief Minister’s Department, Sabah Wildlife Department and Town and Regional Planning Department.

In order to ensure that the forest serves as a long-term reservoir of wild meat for the local community, a policy of issuing hunting licenses only to local communities to be introduced for forest land in and around the proposed Nabawan Kerangas Forest Reserve.

### **(ii) District Level**

Through the Pensiangan (Nabawan) District Office, SFD and MOCET/ECD to brief relevant Government agencies at the District level of the biodiversity and conservation significance of the Nabawan heath forest and explain the Nabawan Kerangas Forest Reserve proposal.

### **(iii) Community Level**

Local communities and non-government stakeholders should be informed and consulted on the Nabawan Kerangas Forest Reserve proposal with the intention of seeking further feedback and to build up local awareness and support.

The Sabah Wildlife Department will need to play a key role in facilitating a change in perception of its role from only controlling hunting, to managing wildlife in permanent forest areas. The Department should seek to support local use and control of the Nabawan Kerangas Forest Reserve for supply of wild meats for surrounding communities.

17. A small “germplasm” reserve of about 40 hectares close to Kg. Tetagas is already being initiated by the Department of Agriculture. This area (the Tetagas Agriculture Germplasm Reserve) is anticipated to be managed by the Department in collaboration with other government agencies and the local community. It is recommended that this site should be seen as complementary to the Nabawan Kerangas Forest Reserve and should be managed jointly.

18. The Tetagas Agriculture Germplasm Reserve has the potential to play a central role in raising awareness and cultivating an appreciation of kerangas forest among local residents and visitors. This is seen to be fundamental to ensuring the survival of these forests in the long term.
19. Suitable candidates from the local communities and relevant government agencies should be identified as potential guides to the Germplasm Reserve. Means to be identified to fund training and remunerate the guides. Residents of Kg. Tetagas to be consulted in relation to the management of the Germplasm Reserve.
20. Sabah Nature Clubs could take the initial steps to introduce nature education among Nabawan schools and to develop the area as a nature education centre. Nature Clubs, schools and visitors to Nabawan to be encouraged to visit the Germplasm Reserve.
21. There is a need for further understanding of the kerangas forest ecosystem. Further biological research should be encouraged, commencing initially at the Tetagas Germplasm Reserve and progressing to other sections of kerangas in Nabawan.
22. Relevant development agencies to be briefed on the importance of appropriate land use in the Nabawan area to support biodiversity conservation. This involves emphasising the limitations on commercial agricultural crops imposed by low soil fertility, rainfall patterns and altitude. The threat of fire to the sensitive kerangas forest during the development of farms and plantations should also be highlighted.

## **1 INTRODUCTION – WHAT IS KERANGAS FOREST?**

Kerangas refers to a form of tropical heath forest which exist on white sand that is poor in bases, highly acidic and commonly coarse-textured. In these soils, known as “podsoils”, a thin layer of peat overlies a layer, often several metres thick, of white silica sand over a hard humus- and iron-rich pan. These podsol soils are poor in nutrients available plants. They tend to become very dry in periods of dry weather and waterlogged during rainy periods.

Kerangas forest is strikingly different from other forest types. The trees in kerangas forest have small, dense crowns and a low, even canopy in comparison to dipterocarp forests. The species of trees and other plants which occur in kerangas forests are rarely or not found in other forest types. In kerangas forests, typical tree dimensions are small, both in diameter and in height. Leaves tend to be small and tough. Slender climbing plants, epiphytes (plants that grow on trees and other plants), ant plants (plants that contain spaces in which ants live) and insectivorous plants (plants that capture and digest insects) are typically common in kerangas forests.

The name “kerangas” is an Iban word, used in western and northern Borneo, that refers to areas that will not grow rice. Indeed, most plant species will not grow on the podsol soils that support kerangas forest. In the Nabawan area, the term “kapayan” is used for these forests.

During dry periods, kerangas forest is highly susceptible to fire. Once disturbed by fire or logging activities, or cleared for agriculture, the peaty layer and podsol soil beneath are rapidly degraded, and useless scrub or grassland replaces the original forest.

Although similar in the general characteristics outlined above, the plant species composition of kerangas forest varies in different parts of Borneo and in different situations. Some kerangas forests contain plant species which appear to occur only locally, and not in any other forests elsewhere. In Sabah, there are five geographical areas where kerangas forests occur : (1) raised marine terraces on the west coast just above sea level, (2) dip slopes on sandstone hills on the east coast (about 150 metres above sea level), (3) the Sook-Nabawan area (about 490 metres above sea level; the forests at Sook have been wiped out by fire), (4) Maliau Basin (about 1,000 metres above sea level), and (5) Ulu Padas (above 1,600 metres). Even within each of these five areas, the plant species composition varies from one patch of forest to another.

The kerangas forests of Nabawan were identified in the Sabah Conservation Strategy (1992) as a critical and sensitive habitat that required further investigation and protective measures.



## **2 STUDY APPROACH AND ACTIVITIES**

### **2.1 BIODIVERSITY ISSUES**

Prior to the IPPA study, some botanical explorations had been made in the more accessible kerangas forests at Nabawan, by Mr. Anthony Lamb and colleagues in the Department of Agriculture. Based on these explorations, it was known that the biodiversity significance of the Nabawan kerangas forests would lie in the occurrence of rare and localised plant species. However, the extent, location and condition of remaining kerangas forests in the Nabawan area were not known. Furthermore, it was not known if additional unrecorded or undescribed plant species remained to be discovered.

Therefore, one priority in investigating the Nabawan kerangas forests was to ascertain and map the extent and location of kerangas forests remaining in good condition. Another priority was to carry out further surveys and botanical collections with the aims of adding to existing lists of plant species and of identifying rare and previously undiscovered species. Two linked botanical assessments were conducted (Table 1), one involving mapping and description of the Nabawan kerangas forests, concentrating on non-woody plants (Lamb, 1998; Background Paper 1) and the other concentrating on trees and woody plants (Ong et al., 1998; Background Paper 2). From existing knowledge of kerangas forests, it was known that the Nabawan forests would not be of special significance for vertebrate animal conservation.

### **2.2 OTHER NATURAL RESOURCE ISSUES**

The podsollic soils under kerangas forest are well known to be unsuitable or of very marginal suitability for cultivation. The Nabawan kerangas forests are of no special significance for water supply or catchment management.

### **2.3 LOCAL COMMUNITY ISSUES**

Prior to botanical field work, discussions were held with: the Pensiangan (Nabawan) District Officer, District Agriculture Officer, District Forestry Officer, Brother Peter Phelan (author of various articles and books on local cultures; a Nabawan resident since 1990), and heads of Kg. Tetagas, Kg. Fontas and Kg. Saup (see Map 1). These meetings provided useful perspectives on local community issues in the Nabawan area.

An analysis was conducted of the forest-based aspects of household economy in villages nearest to the main areas of Nabawan kerangas forests (Table 3 and Wong, 1998; Background Paper 3). Apart from specialist studies, an additional event was arranged for the Nabawan schools. It has been recognised that the kerangas forest near to Kg. Tetagas (Map 1) would potentially benefit local students, as it can be utilised as a centre for nature related activities. For this reason, Sabah Nature Club (a Sabah Foundation education scheme in collaboration with the Sabah Education Department) was invited to help establish new Nature Clubs in schools in Nabawan. A report on this event is found in Appendix 3.

**TABLE 1 IPPA SPECIALIST STUDIES CARRIED OUT IN NABAWAN**

DESCRIPTION OF STUDY	MAIN FIELD STUDY PERIOD	SPECIALIST ADVISER/ EXPERTISE
<p><b>The Kerangas Forests of Nabawan - A Botanical Assessment and Recommendations for Conservation</b></p> <p>A botanical assessment of the kerangas forests in the Nabawan area:</p> <p>(1) to describe the tree flora and woody plants within the Nabawan kerangas forests;</p> <p>(2) to determine the extent of remaining kerangas forest in Nabawan which are still in good condition;</p> <p>(3) to examine if there are any kerangas forests worthy of conservation existing in the exterior surroundings of Milian-Labau Virgin Jungle Reserve;</p> <p>(4) to assess the potential threats to the Nabawan kerangas forests and advise on appropriate actions for conservation.</p>	<p><b>April 1998</b></p>	<p>Forest Research Centre, Sabah Forestry Department (Robert Ong, George Petol, Reuben Nilus, Joan Pereira, Lim Sheh Ping)</p> <p><i>Forest ecologists and botanists</i></p>
<p><b>The Kerangas Forests of Nabawan Pt. II - A Botanical Assessment of the Non-Tree Flora and Recommendations for Conservation</b></p> <p>This second botanical assessment of the kerangas forests in the Nabawan area supplements the first:</p> <p>(1) to describe and identify the non-tree flora or forest herbs within the Nabawan kerangas forests;</p> <p>(2) to evaluate the threats and suggest pertinent recommendations in support of conservation of the kerangas forests of Nabawan.</p>	<p><b>Sept. 1998</b></p>	<p>Anthony Lamb</p>

<p><b>An Analysis of the Forest-Based Economies of Rural Households in Nabawan, Sabah</b></p> <p>A development study in the selected villages neighboring the kerangas forests of interest:</p> <ul style="list-style-type: none"><li>(1) to gain a clear perception of the relationship between local people and forest;</li><li>(2) to ascertain the importance of forest resource to its user in terms of economic value;</li><li>(3) to recommend appropriate development strategies for the area that compare favorably with conservation objectives.</li></ul>	<p><b>Sept. 1998</b></p>	<p>Grace Wong</p> <p><i>Resource Economist</i></p>
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## 3 FINDINGS

### 3.1 BOTANICAL ASSESSMENT OF NABAWAN KERANGAS FORESTS

Two types of kerangas forest were found to occur at Nabawan (see Background Paper 2 by Ong et. al., 1998 for details):

**(I) *DACRYDIUM PECTINATUM-TRISTANIOPSIS* SP. FOREST**

This forest is dominated by two tree species (*Dacrydium pectinatum-Tristaniopsis* sp.). The trees have small crowns and forest canopy height averages 15 – 25 metres. Mosses, orchids, ferns, pitcher plants and ant plants are common. This forest occurs in patches mainly outside and to the west and south-west of Milian-Labau Virgin Jungle Reserve. Total area of this forest type is estimated at about 970 hectares.

**(II) *SHOREA VENULOSA-HOPEA PENTANERVIA* FOREST**

This forest is dominated by two tree species (*Shorea venulosa-Hopea pentanervia*). The trees have larger crowns than in the other kerangas forest type, and forest canopy height averages 30 - 40 metres. Mosses, orchids, ferns, pitcher plants and ant plants are less common than in the other kerangas forest type. This forest occurs mainly outside and to the south of Milian-Labau Virgin Jungle Reserve. Total area of this forest type is estimated at about 915 hectares.

The herb flora survey revealed that the Nabawan kerangas forests hold a strikingly high diversity of rare and localised herbaceous plants. A detailed description is in Background Paper 1 by Lamb (1998). Of wild gingers (family *Zingiberaceae*), there are 10 genera out of 17 recorded for Borneo. Two new ginger species, *Hornstedtia leonurus* and a *Burbridgea* species are known to exist in Nabawan only.

In the Asclepiadaceae family, a high nine species were recorded. The families Gesneriaceae and Ericaceae are represented, including four species of rhododendron. Both these plant families are of great horticultural value. There are three *Nepenthes* species (pitcher plants) as well as one hybrid in the Nabawan kerangas forests.

The Orchidaceae is the plant family with the greatest number of species in the Nabawan kerangas forests. About 160 species have been collected there to date of which 130 have been identified to genus and species level. Another 30 orchid species have yet to be identified to species level. Of those fully identified, about 30 are locally endemic, or very rare, or only recorded in this area in Sabah.

Threats to the kerangas forests include farming, fire, unsustainable timber extraction and extreme weather conditions such as the El Nino droughts. Once the kerangas forest is disturbed by either felling of trees for the timber market or slashed and burnt for agriculture, the organic matter on the surface layer becomes oxidised and nutrients leached out. Such impacts cause kerangas forest to become unproductive grassland and scrub.

## 3.2 ECONOMIC ANALYSIS

Three villages (Kg. Fontas, Kg. Saup and Kg. Tetagas, Map 2) were investigated for this study (see Background Paper 3, by Wong, 1998). All three villages are adjacent to the Nabawan kerangas forests. Villagers in Nabawan rely extensively on the surrounding forests for subsistence farming through shifting cultivation, hunting, collection of fuelwood and harvesting of various non-timber products. Therefore, protecting the forest ecosystem can have significant benefits not only in terms of conserving species diversity and maintaining natural environmental services, but also in terms of preserving the flow of economic benefits to local people.

The primary income source for local households was found to be wages earned by working for the logging companies. However, when these companies close their operations in Nabawan, those wage-earning households accustomed to a steady flow of cash income and material purchases find it difficult to adjust to these drastic changes. There is a rapidly reducing importance of logging in the Nabawan area, in terms of the village economy, due to the fact that most large tree have already been removed from the district. This is leading to the return of the traditional dependence on the forest and agriculture, but now at a greater pressure than previously as most forest has been lost by logging activities, fire and unsustainable shifting farming.

Local income pressures have resulted in more intensive use of fallow lands for agro-forestry to generate higher income. Fruit trees and cash crops, such as rubber and coffee, are important crops that act as buffers against rice crop failures. Government assisted schemes, e.g. yam by the Department of Agriculture at Kg. Tetagas and Kg. Fontas and oil palm (approximately 8,500 ha proposed) by FELCRA, are also well received by the villagers. However, allocation of plots per household is small for the yam planting scheme and the oil palm scheme is restricted to farmers with land titles. Only 10% of the households surveyed for this study own land titles.

Forest use among the Muruts includes mainly hunting and harvest of non-timber forest products. Although wildlife abundance is generally greater in mixed dipterocarp forests than in kerangas, deer and wild pigs occur in the latter. Villagers consulted for this study claim that hunting is being strictly regulated by Wildlife Department. A major concern is that local hunters regard wild meat as a resource not only for family consumption but as a source of extra income through sale of meat in the local market.

Apart from firewood, other uses of non-timber forest products include collection of wild fruits and vegetables, rattan and bamboo (mainly used for constructions) and medicinal plants. Collection activities are primarily to supplement household diets and needs.

The economic analysis concludes that in order to reduce forest exploitation and further loss of beneficial natural environmental services, the following measures should be taken to provide local communities the security and alternatives to sustain their economic livelihoods:

- 1) Granting land tenure rights to local residents for farming, as an incentive for them to support forest conservation on land elsewhere, and to qualify them for the benefits of government agricultural schemes.
- 2) Development of compatible small-scale cash crop projects, such as quick-yield cultivation projects, expansion of agro-forestry to a commercial scale, and co-operative based oil palm smallholdings.
- 3) Development of a market system to facilitate sales of agricultural products and forest harvests to buyers outside the District.
- 4) Creating buffer zone areas around the kerangas forests with co-operative management among the local communities for continued access to these areas.

It is important to note that each of the above recommendations are inter-linked and therefore require collective implementation.



## **4 RECOMMENDATIONS**

### **4.1 OVERVIEW**

Most of the remaining kerangas forest in good condition in the Nabawan area is located within contiguous tracts of forest outside of (and to the south and west of) the Milian-Labau Virgin Jungle Reserve (Milian-Labau VJR; see Map 1). Maintenance of this area provides the most secure means to ensure long-term survival of the full biodiversity of the Nabawan kerangas forests. Since this forest area does not have special interest or functions in terms of vertebrate animal life, water management or local culture, protection of this area as a Forest Reserve is appropriate.

It is recommended that the “Nabawan Kerangas Forest Reserve” (about 4,000 hectares), as shown on Map 2, be established under the Forest Enactment as a VJR.

On its own, a proposal for establishment of a new Forest Reserve may not be adequate to ensure long-term protection of the unique plant diversity of the Nabawan kerangas forests. Thus, the recommendations of this report take a regional view.

The key elements are :

- (a) Actions associated with providing protection for the largest remaining areas of kerangas forest land (that is, the proposed Nabawan Kerangas Forest Reserve), to ensure long-term survival of the full biodiversity of the Nabawan kerangas forests.
- (b) Actions associated with providing protection for the proposed “Agriculture Germplasm Reserve” at Kampung Tetagas, to provide a focus for kerangas forest education, awareness, recreation and research.
- (c) Actions associated with management of both these Reserves, to ensure that they remain protected and supported locally, and to help ensure that local benefits are linked to conserving these forests.
- (d) In general, carrying out actions that favour appropriate and equitable long-term land use, in the region containing the Nabawan kerangas forests.

The following specific recommendations and actions are aimed at fulfilling the above general recommendations.

## **4.2 ESTABLISHMENT OF NABAWAN KERANGAS FOREST RESERVE**

### ***4.2.1 Steps to be taken at State level***

The procedure required under the Forest Enactment (and any amendments to the Enactment) for establishment of a new Forest Reserve should be initiated and seen to completion for the proposed Nabawan Kerangas Forest Reserve (as shown on Map 2).

#### **ACTION 1**

***Nabawan Kerangas Forest Reserve to be established under the provisions of the Forest Enactment, as a Virgin Jungle Reserve (VJR).***

**Lead Agency:** Sabah Forestry Department

**Supporting Agencies:** Natural Resources Office of the Chief Minister's Department; Lands and Surveys Department; Ministry of Culture, Environment & Tourism/ Department of Environmental Conservation.

**Timing :** As soon as possible. Other actions outlined below will be done as part of and/or in parallel with the process of establishment of the Forest Reserve.

It is necessary for Ministry of Culture, Environment & Tourism / Department of Environmental Conservation, as overall implementer of IPPA, to determine (a) how Sabah Forestry Department intends to pursue the process of establishing the Nabawan Kerangas Forest Reserve, and (b) how other relevant agencies might provide support for biodiversity conservation in the Nabawan heath forests. Ministry of Culture, Environment & Tourism / Department of Environmental Conservation should maintain contact with Sabah Forestry Department and other relevant agencies to ensure that all follow-up is done as a concerted and focused effort.

#### **ACTION 2**

***Ministry of Culture, Environment & Tourism to write to Sabah Forestry Department, seeking feedback on how the Department intends to pursue the Nabawan Kerangas Forest Reserve proposal. The letter should request that no further licences be issued for felling or extraction of timber from the proposed Forest Reserve.***

**Lead Agency:** Ministry of Culture, Environment & Tourism

**Timing:** February 1999

It is advisable that the key features of the Nabawan kerangas forest plant diversity are explained to relevant government agencies at State level, so that these agencies are informed of the reasons for the Forest Reserve recommendation.

Points to be presented for discussion should include not only the features of plant diversity in the Nabawan kerangas forest, but also the unsuitability of kerangas soils for cultivation and the potential future value of a Forest Reserve in sustaining wild meat supplies for local residents. It will be necessary to explain that the Forest Reserve recommendation provides essential complementary support for the "Agriculture Germplasm Reserve" establishment already underway (section 5.3). It will be necessary to explain further that merely excluding sites of kerangas forest from land titles will NOT be a sufficient means to conserve these forests because (a) kerangas forests are likely to be destroyed by fire in future dry periods if adjacent lands are prepared for cultivation by burning, (b) "edge effects" (such as desiccation and wind) are likely to lead to death of sensitive plants in small forest fragments, and (c) the potential value of any remaining forests as a reservoir of wild meats would be lost.

### **ACTION 3**

*Sabah Forestry Department and Ministry of Culture, Environment & Tourism / Department of Environmental Conservation, to jointly organise a briefing meeting, to explain the biodiversity significance of the Nabawan heath forests to relevant government agencies at State level, and also to seek feedback.*

*Botanists and other personnel involved in the IPPA studies should be invited to present the briefing. Apart from the organising Departments, the agencies to be invited to participate should include : Ministry of Agriculture and Fisheries, Ministry of Rural Development, Natural Resources Office of the Chief Minister's Department, Sabah Wildlife Department, and Town & Regional Planning Department.*

*Copies of this report and the background papers should be provided to each agency invited to the meeting.*

*At this meeting, any steps already taken to establish the Nabawan Kerangas Forest Reserve should be clarified and minuted.*

*The minutes of this meeting should include a statement of the need to reject land applications in the proposed Forest Reserve.*

*Following the meeting, a letter should be sent to the Natural Resources Office of the Chief Minister's Department, with a copy of the meeting minutes, outlining the reasons for establishing the Forest Reserve and requesting that land applications within the Forest Reserve area should be rejected.*

**Lead Agencies:** Sabah Forestry Department and Ministry of Culture, Environment & Tourism / Department of Environmental Conservation

**Supporting Agencies:** IPPA Consultants

**Timing :** February – March 1999

**ACTION 4**

*Applications for title to land in the proposed Forest Reserve area to be rejected (also see Action 8).*

**Lead Agency:** Natural Resources Office of the Chief Minister's Department to inform Lands and Surveys Department, Pensiangan (Nabawan) District Land Utilisation Committee and Kinabatangan District Land Utilisation Committee.

**Supporting Agencies:** Ministry of Culture, Environment & Tourism / Department of Environmental Conservation, Sabah Forestry Department, Department of Agriculture.

**Timing:** March 1999

Although wildlife conservation is not a main reason for establishment of Nabawan Kerangas Forest Reserve, Sabah Wildlife Department has a potentially significant role to play if this Reserve is seen as a long-term reservoir of wild meat for local community consumption. This role for the proposed Reserve can be initiated immediately if hunting licences are issued only to local village residents for the forest land within and around the proposed Forest Reserve. See section 5.2.3 and Action 7, below.

**ACTION 5**

*Policy of issuing hunting licences only to local communities to be introduced for forest land in and around the proposed Nabawan Kerangas Forest Reserve.*

**Lead Agency:** Sabah Wildlife Department

**Timing:** Starting March 1999

#### ***4.2.2 Steps to be taken at District Government level***

Soon after key State level agencies have been consulted on the Nabawan Kerangas Forest Reserve proposal, relevant government agencies need to be approached at District level in order to seek feedback and to build up local awareness and support. Through initiatives already taken by the Department of Agriculture / Ministry of Agriculture and Fisheries, Sabah Forestry Department and Ministry of Culture, Environment & Tourism (through IPPA), local government agencies are already aware of interest in the kerangas forests and the unsuitability of kerangas soils for cultivation. However, a specific proposal for a relatively large conservation area will be new at District level.

Government agencies which at State level have been involved in or invited to comment on the Forest Reserve proposal (Action 3) should act collaboratively to formalise presentation of the proposal at District government level. Points to be presented should include:

- (a) the features of plant diversity in the Nabawan kerangas forest, emphasising locally endemic species (to be presented by the IPPA consultants and Sabah Forestry Department);
- (b) the potential future value of a Forest Reserve in sustaining wild meat supplies, notably pigs and deer, for local residents (to be presented by Sabah Wildlife Department); and
- (c) the unsuitability of kerangas soils for cultivation (to be presented by Department of Agriculture).

It is proposed that presentation of the Nabawan Kerangas Forest Reserve proposal be made initially at District through a special briefing meeting to key agencies, at the District Office. Alternatively or in addition, the presentation could be made to the District Land Utilisation Committee (LUC) as a special briefing at a routine LUC meeting. It should be noted that a part of the proposed Nabawan Kerangas Forest Reserve lies within Kinabatangan District; thus, the Kinabatangan District Office and Land Utilisation Committee must be informed of this proposal.

## **ACTION 6**

*Sabah Forestry Department and Ministry of Culture, Environment & Tourism / Department of Environmental Conservation, through the Pensiangan (Nabawan) District Office, to arrange a briefing meeting, to explain the biodiversity significance of the Nabawan heath forests to relevant government agencies at District level. The Nabawan Kerangas Forest Reserve proposal should be noted and feedback sought from local agencies.*

*Botanists and other personnel involved in the IPPA studies, together with Sabah Forestry Department, Sabah Wildlife Department and Department of Agriculture, should be invited to present the briefing.*

*In addition to the District Office, District level government agencies to be invited to attend and participate should include (but need not be limited to): District Land Office, District Surveyor, District Forestry Office, District Agriculture Office, Keningau office of the Sabah Wildlife Department. The Kinabatangan District Office should be invited to attend.*

*The meeting should decide whether it would be useful to make a similar presentation to the District Development Committee or District Action Committee, in order to reach a wider audience at District level. If so, the Chairman of the District level Committee should arrange to include a briefing on the agenda of a Committee meeting.*

**Lead Agency:** Sabah Forestry Department and Ministry of Culture, Environment & Tourism / Department of Environmental Conservation, with Pensiangan (Nabawan) District Office

**Supporting Agencies:** IPPA Consultants, Department of Agriculture, Sabah Wildlife Department

**Timing :** April 1999

### ***5.2.3 Steps to be taken at local community level***

As soon as District level government agencies have been informed and consulted on the Nabawan Kerangas Forest Reserve proposal, steps should be taken to inform local communities and other non-government stakeholders, with the intention of seeking further feedback and to build up local awareness and support.

Through initiatives already taken by the Department of Agriculture/Ministry of Agriculture and Fisheries, Sabah Forestry Department and Ministry of Culture, Environment & Tourism (through IPPA), some local residents are aware of interest in the kerangas forests and the unsuitability of kerangas soils for cultivation. However, a specific proposal for a relatively large conservation area will be new to local communities.

Three main groups of local stakeholders need to be informed of and consulted on the Forest Reserve proposal, as follows :

- (1) Residents of the existing village communities situated nearest to the proposed Forest Reserve. These are Kampung Tetagas, Kampung Fontas and Kampung Saup. Except for individuals who might have applied for land in the proposed Forest Reserve area and individuals involved in supplying logs to sawmills, the proposal will be neutral or positive for most residents of these communities.
- (2) People who have applied for land within the area of the proposed Forest Reserve. It is important that land applicants are (a) made aware of the soil limitations within the proposed Forest Reserve area and (b) given the opportunity to apply for alternative areas, suitable cultivation, for example in the Kinabatangan District, to the north of the Milian-Labau VJR (see Map 1).
- (3) Inhabitants of the Nabawan township area in general. Although most of these stakeholders may not incur any specific gains or losses from establishment of a new Forest Reserve, it is important that they appreciate the reasons of this conservation proposal.

Points to be presented to these local stakeholders should include those presented to District level government agencies (section 5.2.2), but the emphasis and means of presentation may vary between groups.

In particular, it will be necessary to explain that the Forest Reserve recommendation provides essential complementary support for the “Agriculture Germplasm Reserve” establishment already underway.

Sabah Wildlife Department will need to play a key role in facilitating a change in perception that its role is one of managing wildlife in permanent forest areas (instead of only controlling hunting). In the case of Nabawan, the Department should seek to support local use and control of the Nabawan Kerangas Forest Reserve for supply of wild meats for residents of surrounding communities.

Issues that may be raised for discussion by Sabah Wildlife Department with local village communities include: (1) reasons why certain animal species are protected by law, (2) the animal species that are under the protected list, (3) legal hunting methods, (4) the purpose of the Animal Kampung Licence (permitted under the Wildlife Conservation Enactment) and the procedure to obtain it, and (5) how the proposed Nabawan Kerangas Forest Reserve could best be managed for local village needs without damaging the integrity of the forest.

#### **ACTION 7**

*Residents of the existing village communities situated nearest to the proposed Nabawan Kerangas Forest Reserve (Kampung Tetagas, Kampung Fontas and Kampung Saup) to be informed of the proposal. Potential benefits in terms of working jointly with the Sabah Forestry Department for long-term management, and use for wild meat supply, should be discussed.*

**Lead Agencies:** Sabah Forestry Department, Sabah Wildlife Department and Department of Environmental Conservation, jointly.

**Supporting Agencies:** Pensiangan (Nabawan) District Office, IPPA Consultants

**Timing :** May 1999

#### **ACTION 8**

*Applicants for title to land in the proposed Nabawan Kerangas Forest Reserve to be informed that applications are rejected for reasons of soil unsuitability and importance of the area for biodiversity conservation (also see Action 4).*

*Suitable alternative areas, for example in the Kinabatangan District, to the north of Milian-Labau VJR, should be identified and made known to applicants whose land applications have been rejected.*

**Lead Agency:** Lands and Surveys Department

**Supporting Agencies:** Sabah Forestry Department, Department of Agriculture, Ministry of Culture, Environment & Tourism / Department of Environmental Conservation. These agencies should assist in ensuring that applicants who are local residents receive and understand the rejection letters; also, if appropriate, to assist in identifying alternative areas for local applicants. **Timing :** May 1999

#### **ACTION 9**

*Key technical agencies involved in establishment of the Nabawan Kerangas Forest Reserve should seek appropriate means to inform residents of the Nabawan area in general of the reasons for the Forest Reserve proposal.*

**Lead Agencies:** Sabah Forestry Department, Sabah Wildlife Department, Department of Agriculture, and/or Ministry of Culture, Environment & Tourism / Department of Environmental Conservation

**Timing:** Whenever appropriate

### **4.3 ESTABLISHMENT AND USE OF TETAGAS AGRICULTURE GERmplasm RESERVE**

#### ***4.3.1 Background***

A process of establishing a “germplasm” reserve at Kampung Tetagas has already been initiated. This site, referred to here as Tetagas Agriculture Germplasm Reserve, is a remnant patch of kerangas forest (approximately 40 hectares) within the Tetagas village area. It is anticipated that this site will be reserved under the Land Ordinance and will be managed by the Department of Agriculture in collaboration with other government agencies and the local community.

The main advantages of retaining natural forest in this Germplasm Reserve is that the site is easily accessible by road, and potentially can be protected and enjoyed by village residents. For these reasons, the site has good potential for research, recreation, education and awareness in relation to kerangas forests.

However, the Germplasm Reserve is much too small to protect the full biodiversity of the Nabawan kerangas forests. It can protect only a small sample of the natural plant life. As indicated in section 5.2.1, reasons why small patches of forest, such as the Tetagas Agriculture Germplasm Reserve, are insufficient to conserve biodiversity include the following: (a) kerangas forests are especially at risk from spread of fire during dry periods and are likely to be damaged or even destroyed if adjacent lands are prepared for cultivation by careless burning during droughts, (b) “edge effects” (such as dessication and wind) are likely to lead to death of sensitive plants and change in plant species composition in small forest fragments, and (c) small forest patches cannot sustain populations of most vertebrate animal species. For these reasons, the Tetagas Agriculture Germplasm Reserve must be seen as complementary to the Nabawan Kerangas Forest Reserve. The two sites should be managed jointly, even though the statutory management authority may be different for each.

#### ***4.3.2 Establishment of the Germplasm reserve***

To provide security of land tenure, the Tetagas Agriculture Germplasm Reserve should be reserved under the Land Ordinance and management authority delegated to the Department of Agriculture.

##### **ACTION 10**

***Steps to be taken to reserve and gazette the Tetagas Agriculture Germplasm Reserve.***

**Lead Agency:** Lands and Surveys Department

**Supporting Agency:** Department of Agriculture

**Timing :** During 1999

Pending availability of guides, steps should be taken to allow the Tetagas Agriculture Germplasm Reserve to be utilised by any interested visitors.

##### **ACTION 11**

***Trails, signage and other basic amenities to be established at and within the Tetagas kerangas forest.***

**Lead Agency:** Department of Agriculture

**Supporting Agency:** Sabah Forestry Department; Lands and Surveys Department

**Timing :** During 1999

### ***4.3.3 Education, Awareness and Recreation***

Awareness of the significance and uniqueness of the Nabawan kerangas forests is fundamental to ensuring the survival of these forests long term. Many local residents take the natural forests around them for granted, unsuspecting of the uniqueness and rarity of the forest types near the place they live.

Suitable candidates should be identified from Kampung Tetagas or Nabawan or the District Forestry or Agriculture offices to be trained by staff of the Agricultural Park (Tenom), Forest Research Centre (Sepilok) and Sabah Nature Club secretariat (Kota Kinabalu) as guides to the Germplasm Reserve. Means will need to be identified to fund training and remunerate the guides.

#### **ACTION 12**

***Relevant agencies to liaise with one another to determine a possible scheme for training of locally-based guides for the Tetagas Agriculture Germplasm Reserve.***

**Lead Agency:** Department of Agriculture

**Supporting Agencies:** Sabah Forestry Department, Pensiangan (Nabawan) District Office, Sabah Nature Club secretariat, school authorities at Nabawan, Sabah Wildlife Department.

**Timing :** During and after 1999

Incorporating community participation into the management of Tetagas Agriculture Germplasm Reserve is also an important matter to be considered to gain local support for the government's effort in retaining the area.

#### **ACTION 13**

***Local residents to be consulted in relation to management of Tetagas Agriculture Germplasm Reserve.***

**Lead Agency:** Department of Agriculture

**Supporting Agencies:** Sabah Forestry Department, Pensiangan (Nabawan) District Office, Sabah Nature Club secretariat.

**Timing :** During and after 1999

Nature Clubs have been initiated in two schools in Nabawan (Appendix 3). Such clubs can play a leading role in raising awareness in schools by encouraging participation in nature activities through guidance in planning and organising trips or activities, and also potentially rendering financial assistance when necessary. School trips can be arranged whereby the range of participants can be extended to include local adult residents. Other schools should also be encouraged to take the initiative to start their own nature clubs.

**ACTION 14**

*School visits, especially through Nature Clubs, to be encouraged to Tetagas Agriculture Germplasm Reserve.*

**Lead Agencies:** Individual school authorities

**Supporting Agencies:** Nabawan Education Office, Pensiangan (Nabawan) District Office, Department of Agriculture, Sabah Nature Club secretariat

**Timing:** 1999 onwards

As an unusual site readily accessible from Nabawan township, Tetagas Agriculture Germplasm Reserve is suitable for visitors from outside the District. Promoting the site as a tourism destination at the present time is unrealistic. However, encouraging visitors to Nabawan to see the site can help to emphasise the special nature of the Nabawan kerangas forests and may serve to stimulate the economy of Kampung Tetagas.

**ACTION 15**

*Visitors to Nabawan township to be encouraged to visit Tetagas Agriculture Germplasm Reserve.*

**Lead Agencies:** Pensiangan (Nabawan) District Office

**Supporting Agencies:** Department of Agriculture, Sabah Forestry Department

**Timing:** 1999 onwards

#### **4.3.4 Research**

Research into the Nabawan kerangas forests is to be encouraged, not only to learn more of the species and ecological interactions between species, but also to provide additional support for conserving these forests. For example, insect-plant relationships are expected to represent important elements in the functioning and survival of the forests. For convenience, research activities could be focused initially at the Tetagas Agriculture Germplasm Reserve.

#### **ACTION 16**

*Biological research to be encouraged in the Nabawan kerangas forests, initially at the Tetagas Agriculture Germplasm Reserve.*

**Lead Agencies:** University Malaysia Sabah, Department of Agriculture, Forest Research Centre

**Timing:** 1999 onwards

#### **4.4 PROMOTING APPROPRIATE LAND USE IN THE NABAWAN AREA**

Promoting appropriate land use in the Nabawan area in general represents an important element to conserving the biodiversity of the kerangas forests. For example, it is necessary to emphasise the limitations imposed on commercial agricultural crops imposed by low soil fertility, rainfall patterns and altitude. The threat of fire escaping into sensitive kerangas forest during farm or plantation development also merits attention.

#### **ACTION 17**

*Briefing on main biodiversity findings and key actions proposed in this report, and on agricultural limitations of soil under kerangas forests to be given to FELCRA, FELDA (Federal Land Development Authority), KPD (Korporasi Pembangunan Desa) and any other land development / rural development agencies that may be active in the Nabawan area.*

**Lead Agency:** Department of Agriculture

**Supporting Agencies:** Ministry of Culture, Environment & Tourism / Department of Environmental Conservation, Sabah Forestry Department, Pensiangan (Nabawan) District Office

**Timing:** May 1999



## **APPENDIX 1: SABAH NATURE CLUB – INTRODUCTION TO NABAWAN SCHOOLS (30-31 July 1998)**

Field report by Flory Siambun

**This event was held at SMK Nabawan (Nabawan Secondary School) assembly hall. The sessions were spread over two days to accommodate both morning and afternoon session students. Relevant government agencies were invited to attend the first half of the morning session, followed by a tour of the kerangas forest adjacent to Kg. Tetagas.**

### ***1 Objectives***

The introduction of Sabah Nature Club (SNC) to schools and school children in Nabawan was an initiative to invoke nature appreciation and to promote environmental awareness into this region. This was also an opportunity to highlight the existence and importance of the kerangas forests in Nabawan. Of immediate interest was the kerangas forest near Kg. Tetagas.

### ***2 Participants***

<b>NAME</b>	<b>DESIGNATION</b>
Siriman MF Basir	<i>Nabawan District Officer, District Office</i>
Laindon Tangkong Herbert Lim	<i>Agriculture Officer, Botanist, Department of Agriculture</i>
Mohammed Hatta Arabi	<i>Assistant Environmental Officer, Environmental Conservation Department</i>
–	<i>Assistant School Supervisor, District Education Department</i>
Ami Talu	<i>Kg. Tetagas Representative</i>
Epol Talu	<i>Kg. Tetagas Representative</i>
Rolok Kopio	<i>Kg. Tetagas Representative</i>
Ansimin Anbaris	<i>Kg. Fontas Representative</i>
Cikgu Azman Che Mat	<i>Teacher, SMK Nabawan</i>
Cikgu Medi Marau	<i>Teacher, SMK Nabawan</i>
All students from SMK Nabawan Students from Tahun 5 & 6 of SK Pekan Nabawan (Nabawan Junior School)	
Jimmy Omar	<i>Executive Secretary, Sabah Nature Club (Speaker)</i>
Albinus Ongkodon	<i>Officer, Sabah Nature Club (Speaker)</i>
Flory A. Siambun	<i>Project Biologist, SBCP-IPPA</i>

### **3 Events**

Sabah Nature Club (SNC) was formally introduced to Sekolah Menengah Kebangsaan Nabawan and Sekolah Kebangsaan Pekan Nabawan by Jimmy Omar and Albinus Ongkodon. The objectives, aims and activities of SNC were explained, followed by elaboration on the importance of nature to humankind. Towards the end of each presentation, students raised numerous questions.

Overall, the Sabah Nature Club slide presentation was well received by the students. This was expressed through their questions and interest in becoming members of SNC. The kampung representatives were enlightened and motivated to have a conservation area in Nabawan similar to Danum Valley.

The District Officer was supportive of the idea to have a conservation area that has potentials for nature recreation and education. He felt the proposal of conservation forest would have a positive impact towards the development of Nabawan. The uniqueness of the kerangas forest can be developed to boost the district's economy through ecotourism. He encouraged the teachers to establish SNCs in their schools and to include nature related activities among the extra curricula activity for students.

All participants, except the students, participated in the exposure tour of the Tetagas kerangas forest led by Herbert Lim of the Department of Agriculture. This activity was carried out to educate and to further enhance their appreciation of the kerangas forest.

It is hoped that the Department of Agriculture will carry out all the necessary work to prepare the Tetagas kerangas forest for visits by the general public. Nature trails, signboards and basic amenities need to be constructed, especially a Nature Guide. More Sabah Nature Clubs will be established in schools in the Nabawan area. It is proposed that the Tetagas kerangas forest is included among their activities to raise awareness of the importance of this area for biodiversity conservation.

## **APPENDIX 2 : CHECKLIST OF PLANTS ARRANGED IN FAMILY OR FUNCTIONAL GROUPS FOUND IN THE PEDAWAN VALLEY HEATH FORESTS NEAR NABAWAN**

By Anthony Lamb

This list is a partial representative collection of terrestrial herbs, smaller shrubs, climbers and epiphytic herbs found in the Pedawan valley heath forests (= Nabawan kerangas forests). The list is based on observations and collections made during and before 1998. This list excludes trees and treelets that are covered by the Forestry Department report (Ong et al, 1998). Time was limited for the 1998 field survey. Therefore, sedges, grasses, ferns and some other plant families were excluded on account of the lack of expertise available. The format follows that used by the Forestry Department Forest Research Centre in their checklist of trees and plants in Appendix 1.

Rarity in the tables refers to the frequency of occurrence of a species within the forest habitat.

Rarity Class	Individuals/ha.
A - abundant	> 75
C - common	20-75
O - occasional	1-20
R - rare	< 1

In the rarity column, 1 denotes kerangas forest dominated by *Dacrydium/Tristanopsis* trees and 2 denotes kerangas forest dominated by the dipterocarps *Shorea* and *Hopea*.

### **A) Lists of plants by family.**

Family	Genus/species	Rarity	Notes
Costaceae	<i>Costus globosus</i>	0-1	Fringe invader.
	<i>C. speciosus</i>	0-1	Fringe invader.
Zingiberaceae	<i>Burbridgea sp.nov.</i>	C-1+2	Endemic to Nabawan, great horticultural potential.
	<i>Hedychium muluense</i>	0-1+2	
	<i>Hornstedtia sp.</i>	0-1	
	<i>H. leonurus</i>	R-1	Also Sarawak/Pen.Mal.
	<i>H. havilandii</i>	O-1	Fringe invader.
	<i>Etlingeria punicea</i>	O-1+2	Fringe invader. This is 'tuhau'.
	<i>E. metriocheilos</i>	O-1	Associated with poorer soils.
<i>E. pyramidosphaera</i>	R-1	Fringe invader.	

	<i>E.aff.nasuta</i>	R-1		
	<i>E.aff.pauciflora</i>	O-1		Associated with sandy soils.
	<i>E.sp.</i>	?		Fringe invader, inflorescence not seen.
	<i>Boesenbergia aff. grandis</i>	R-1		The form found had purple under- sides to the leaf.
	<i>B.sp.</i>	O-1		Fringe.
	<i>B.flavoalba</i>	R-1		Also elsewhere in Borneo.
forests.	<i>Zingiber coloratum</i>		R-1	Common in montane
	<i>Z.sp.</i>		R-1	Also elsewhere in Sabah.
	<i>Plagiostachys albida</i>		O-1	Widespread.
	<i>P.sp.1</i>		O-1	Elsewhere in Sabah.
	<i>P.sp.2</i>		O-1	Possible new species.
	<i>Amomum sp.</i>		R-1	Probably new species endemic to Nabawan.
	<i>A.coriaceum</i>		O-1	Widespread.
	<i>Elettaria longituba</i>		O-1	Fringe.
	<i>E.aff.multiflora</i>		R-1	Not known.
	<i>Elettariopsis sp?</i>		R-1	Flowers not seen.

All the above were collected from Site I

Family	Genus/species	Rarity	Site	Notes
Asclepiadaceae (Milkweeds)				
	<i>Hoya coronaria</i>	O-1	1	Widespread.
	<i>H.mitrata</i>	O-1+2	1,3,4	In Sabah, only seen in Nabawan; ant-plant.
	<i>H.gracilis?</i>	R-1	1	Variegated leaf.
	<i>H.scortechinii</i>	R-1	1	
	<i>H.lacunosa</i>	O-1	1,3	White fls, only seen in Nabawan.
	<i>H.aff.lacunosa</i>	R-1	1	White+pink fls.
	<i>H.sp.1</i>	R-1	1	Thick round leaves.
	<i>H.sp.2</i>	R-1+2	1	Thick lanceolate
leaves.				
	<i>H.sp.3</i>	O-1	1	Thin large leaves.
	<i>Dischidia major</i>	C-1+2	1,2,3,4	Ant plant.
	<i>D. imbricata</i>	R-1	1	Ant plant.
	<i>D. dolichantha</i>	O-1	1,2	Only seen in
Nabawan.				
	<i>D. hirsuta</i>	O-1	1	Pretty pink flowers.
	<i>D. nummularia</i>	C-1	1,2,3,4	
Gesneriaceae (Lipstick flowers)				
	<i>Aeschynanthus</i>			

<i>tricolor</i>	O-1+2	1,2,3	Climbing and epiphytic, widespread in Sabah.
<i>A.parvifolius</i>	R-1	1	Widespread in Sabah.
<i>A.sp.</i>	O-1	1	Unknown, flowers not seen.
Ericaceae (Heath family)			
<i>Rhododendron malayanum</i>	O-1+2	1,2	Only site known in Sabah; white fls. form 'alba' seen at Site 2.
<i>R. longiflorum</i> var. <i>subcordatum</i>	C-1	1,2,4	
<i>R.javanicum</i> aff. <i>ssp. moultonii</i>	R-1	1	Long yellow flowers.
<i>R.javanicum</i> aff. <i>ssp. javanicum</i>	R-1	1	Spp. not yet determined.
<i>Vaccinium bancanum</i>	C-1	1,2,3	
Nepenthaceae (pitcher-plants)			
<i>Nepenthes ampullaria</i>	C-1	1,2,3,4	All sites, horticultural importance.
<i>N.gracilis</i>	R-1	2	Very common in Sabah.
<i>N.x hookeriana</i>	R-1	1,2	Natural hybrid, few plants seen.
<i>N.rafflesiana</i>	C-1	1,2,4	Horticulturally important.
Burmanniaceae			
<i>Burmannia coelestis</i>	O-1	1,2	Wet, open depressions.
Orchidaceae (classification after Kores et.al. (1997))			
Subfamily Apostasioideae			
<i>Apostasia sp. wallichii.</i>	R-1	1	Not in fl., aff.
Subfamily Vanillioideae (not recorded)			
Subfamily Cypridioideae (not recorded)			

Subfamily Orchidoideae

*Cryptostylis acutata*

R-1

1

Rare in Sabah.

*Corybas piliferus*

R-1

1

Type spec. from site 1.  
Also Maliau and  
Crocker Range.

**Subfamily Epidendroideae**

Tribe Malaxideae

<i>Liparis lacerata</i>	O-1	1,2,4	Beautiful pendulous inflorescence.
<i>Malaxis latifolia</i>	O-1	1,2,4	Common.
<i>Malaxis sp.</i>	O-1+2	1,3	Common.
<i>Oberonia sp.</i>	O-1		

Tribe Cymbidieae

Sub-tribe Bromheadinae

<i>Bromheadia finlaysoniana</i>	A-1+2	1,2,3,4	Common.
<i>B.scirpoidea</i>	O-1	1,2	Large fls, thin leaves.
<i>B.aff.aporoides</i>	O-1	1,2	
<i>B.aff.brevifolia</i>	O-1	1,2,4	Lg. fls.
<i>B.sp.</i>	O-1	1,2	

Sub-tribe Eulophiinae

<i>Dipodium aff. scandens</i>	R-1	1	
<i>D.pictum</i>	O-1	2,4	Horticultural value.

Sub-tribe Thecostelinae

<i>Thecopsis secunda</i>	O-1	1,2	Podsol forest.
<i>Thecostele alata</i>	O-1	1,2	Widespread in Sabah.

Sub-tribe Cyrtopodiinae

<i>Claderia viridiflora</i>	O-1	1,2,4	Showy green fls; creeping.
<i>Cymbidium rectum</i>	R-1	1,2,4	Nabawan only known in Sabah.
<i>C.bicolor</i>	O-1+2	1,2,3,4	Widespread in Sabah.
<i>C.atropurpureum</i>	O-1	1,2	Widespread in Sabah.
<i>Grammatophyllum speciosum</i>	O-1	1,2,3	Widespread; a leaf-litter gatherer; largest of the orchid plants in mass.
<i>Porphyroglottis maxwelliae</i>	R-1	1,2,4	V.rare; Nabawan only known site in Sabah; also v.rare in Sarawak.

Sub-tribe Acriopsidinae

<i>Acriopsis densiflora</i>	R-1	1,2,4	Only known site in Sabah.
<i>A.gracilis</i>	R-1	1,2,4	Type spec.from Sook; Nabawan and Maliau now only sites known.

<i>A.indica</i>	O-1	1,2,4	Widespread.
<i>A.javanica</i>	O-1+2	1,2,3,4	Widespread.
<i>A.ridleyi</i>	O-1	1	Widespread.
Tribe Arethusae			
Subtribe Bletinae			
<i>Calanthe salaccensis</i>	R-1	1	Only known site in Sabah.
<i>C.speciosa</i>	R-1	1	Locally very rare.
<i>C.undulata</i>	R-1	1	Only known site in Sabah.
<i>Spathoglottis plicata</i>	O-1	1,2,4	Common on edge of forest.
Subtribe Arundinae			
<i>Dilochia aff. wallichii</i>	R-1	2	Seen once.
Sub-tribe Glomerinae			
<i>Agrostophyllum</i>			
<i>aff. bicuspidatum</i>	O-1	1,2	Widespread.
<i>A.majus</i>	O-1	1,2	Widespread.
Other <i>Agrostophyllum</i>			species also seen, not
in			fl.
Tribe Coelogyneae			
Subtribe Coelogyneae			
<i>Coelogyne cummingii</i>	R-1	1,2,4	Rare in Sabah but widespread.
<i>C. distans</i>		R-1	1,2
known in			Only site in Sabah
<i>C.foerstermannii</i>	C-1+2	1,2,3,4	Widespread.
<i>C.rochussenii</i>	O-1	1,2	Widespread.
<i>C.swaniana</i>	O-1	1,2	Widespread.
<i>C.testacea</i>	R-1	1,2	Only site known in Sabah.
<i>C.zerowetzii</i>	A-1+2	1,2,3,4	Rare in Sabah.
<i>Dendrochilum aff.</i>			
<i>crassum</i>	O-1	1,2	
<i>D. aff.imbricatum</i>	O-1	1,2	Widespread.
<i>D.kingii</i>	O-1	1,2	Widespread.
<i>D.oxylobum</i>	O-1	1	
<i>D.aff. pallicleflorus</i>	O-1	2	
<i>D.aff. simplex</i>	O-1	1,2	
<i>Geesinkorchis</i>			

<i>alaticallosa</i>	O-1	1,2	
<i>Pholidota imbricata</i>	O-1	1,2	
<b>Tribe Podochilae</b>			
<b>Subtribe Eriinae</b>			
<i>Ceratostylis subulata</i>	O-1	1	
<i>Eria atrovinosa</i>	O-1	1,2	Only known site in Sabah.
<i>E.bractescens</i>			
<i>E.cepifolia</i>	O-1	1	
<i>E.densa</i>		O-1	1 Uncommon.
<i>E.floribunda</i>			
<i>E.ignea</i>	O-1	1,2,4	Very showy fls.
<i>E.leiophylla</i>	O-1	1,2,4	Widespread.
<i>E.neglecta</i>	O-1	1,2	Widespread.
<i>E.nutans</i>	C-1+2	1,2,3,4	Common.
<i>E.pannea</i>	O-1	1,2,4	Widespread.
<i>E.pellipes</i>		O-1	
<i>E.pudica</i>	O-1	1,2,4	Widespread.
<i>E.pulchella</i>	O-1	1,2,4	
<i>E.xanthocheila</i>	O-1	1,2,4	Colourful fls.
Other <i>Eria</i>			species seen but not in flower.
<i>Trichotosia ferox</i>	O-1	1,2	Showy fls.
<i>T.aff.vestita</i>		O-1	1
<b>Subtribe Podochilinae</b>			
<i>Appendicula sp.</i>	O-1	1	Fls. not seen.
<i>Poaephyllum pauciflorum</i>			
<i>Podochilus microphyllum</i>	O-1	1,2,3,4	Widespread.
<i>P.secunda</i>			
<b>Subtribe Thelasinae</b>			
<i>Thelasis micrantha</i>	O-1	1,2	Widespread.
<i>T.pygmaea</i>	O-1	1,2	
<i>Phreatia secunda</i>	O-1	1,2	
<b>Tribe Dendrobieae</b>			
<b>Subtribe Dendrobiinae</b>			
<i>Dendrobium crumenatum</i>	O-1+2	1,2	Widespread
<i>D.hosei</i>	O-1	1,2	Widespread.
<i>D.indivisum</i>	O-1	1,2	Widespread.
<i>D.leonis</i>	C-1	1,2,4	

<i>D.microglaphys</i>	O-1	1,2,4	Only known site in Sabah.
<i>D.nabawanense</i>	O-1+2	1,2,3,4	Only known from Nabawan.
<i>D.pachyphyllum</i>	O-1	1,2	
<i>D.pinifolium</i>	O-1	1,2	
<i>D.prostratum</i>	R-1	2	
<i>D.rosellum</i>	C-1	1,2,4	
<i>D.smithianum</i>	O-1	1	
<i>D.trullatum</i>	O-1	1,2,4	Only known from Nabawan.
<i>D.villosulum</i>	O-1	1,2	
<i>Epigeneium speculum</i>	O-1	1,2,3,4	
Subtribe Bulbophyllinae			
<i>Bulbophyllum</i>			
<i>acuminatum</i>	O-1	1,2	Widespread.
<i>B.apodum</i>	O-1	1	
<i>B.beccarii</i>	O-1+2	1,3,4	Borneo endemic.
<i>B.botryophorum</i>	O-1	1	Quite rare.
<i>B.epicrianthes</i>	O-1	1	
<i>B.flammuliferum</i>	O-1	1	
<i>B.macrochilum</i>	O-1	1	
<i>B.aff.makoyanum</i>	O-1	2	
<i>B.marudiense</i>	C-1	1,2,4	
<i>B.medusae</i>	O-1	1,2	Spectacular fls.
<i>B.mutabile</i>	O-1	1,2	Widespread.
<i>B.nabawanense</i>	R-1+2	1,2,3,4	Only known from Nabawan
<i>B.nematocaulon</i>	O-1	1	Not common.
<i>B.patens</i>		O-1	1 Not common.
<i>B.penduliscapum</i>	R-1	1,2	Not common.
<i>B.pupurascens</i>	C-1+2	1,2,3	Widespread.
<i>B.refractilingue</i>	O-1	1,2	Not common.
<i>B.salaccense</i>	O-1	1,2	Widespread.
<i>B.trifolium</i>	O-1	1,2	Locally common.
<i>B.vaginatatum</i>	O-1	1,2,3,4	Widespread.
<i>B.vesiculosum</i>	O-1	1,2	Not common.
<i>Trias antheae</i>	R-1	1	Only known site.
Tribe Vandaeae			
Sub-tribe Aeridinae			
<i>Adenoncos parviflora</i>	O-1	1	Widespread
<i>Cleisostoma discolor</i>	O-1	1	
<i>Cordiglottis sp.</i>	R-1	1	Rare.
<i>C.aff.filiformis</i>	R-1	1	Rare.
<i>Pomatocalpa kunstleri</i>		O-1	1,2 Not common.

<i>Renanthera</i>			
<i>angustifolia</i>	R-1	1,2	Not seen recently.
<i>Sarcoglyphis</i>			
<i>aff. comberi</i>	R-1	2	Once collected.
<i>Thrixspermum</i>			
<i>acuminatissimum</i>	O-1	1,2	Not common.
<i>T.centipeda</i>	O-1	1	Widespread.
<i>T.sp.</i>	R-1	1	Only seen once.
<i>Trichoglottis retusa</i>	O-1	2	Only seen once.
<i>Phalaenopsis</i>			
<i>pantherina</i>	O-1	3	Only seen once.
<i>Chamaenthus</i>			
<i>brachystachys</i>	O-1	1	Widespread.

**B) Summary of endemic, rare and horticulturally valuable species of orchids (sites not given, for protection). Rarity in Sabah, and Borneo as whole.**

Family	Genus/species	Rarity in Sabah	Notes
Orchidaceae	<i>Acriopsis densiflora</i>	R	Unknown in Sabah except Nabawan.
	<i>A.gracile</i>	R	Type locality.
	Endemic.		
	<i>Cryptostylis acutata</i>	R	
	<i>Corybas piliferus</i>	R	Type specimen from Site 1.
	<i>Cymbidium rectum</i>	R	Horticulturally important; only known from Nabawan.
	<i>Porphyroglottis maxwelliae</i>	R	Only known from Nabawan in Sabah.
	<i>Calanthe salaccensis</i>	R	“
	<i>C.undulata</i>	R	“
	<i>Coelogyne distans</i>	R	
	<i>C.testacea</i>	R	Unknown in Sabah except Nabawan.
	<i>C.zerowetzii</i>	?	Rare elsewhere in Sabah.
	<i>Eria atrovinosa</i>	R	Previously only known from Malaysia.
	<i>Diplocaulobium vanleenwenii</i>	R	Only site known
	Sabah.	<i>Dendrobium microglaphys</i>	R
	<i>D.nabawanense</i>	R	Only known
Nabawan.	<i>D.trullatum</i>	R	“
	<i>Bulbophyllum beccarii</i>	R	Spectacular orchid with large leaves.
	<i>B.botryophorum</i>	Not common	Rare elsewhere in Sabah.
	<i>B.penduliscapum</i>	Uncommon	Difficult to find.
	<i>B.refractilingue</i>	"	
	<i>B.singaporeanum</i>	Locally common, otherwise rare.	
	<i>B.trifolium</i>	Locally common, otherwise rare.	
	<i>Trias antheae</i>	Very rare	Only site known.
	<i>Renanthera angustifolia</i>	R	Widespread

<i>Sarcoglyphis comberii</i>	R	Only found once.
<i>Cordiglottis sp.</i>	R	Only 1-2 plants.
<i>Cordiglottis aff. filiformis</i>	R	

**C) Overall list of plants associated with ants**

Family	Genus/species	Rarity	Site	Notes
Polypodiaceae (ferns)				
	<i>Polypodium sinuosum</i>	O-1	1,2,3,4	Epiphytic climbing fern with hollow stems/rhizomes housing ants.
	<i>Lecanopteris sinuosa</i>	R-1	1,2	This is a much commoner fern at higher altitudes. It has a bulbous stem base with chambers housing ants.
Rubiaceae (coffee family)				
	<i>Hydnophytum sp.</i>	O,C-1	1,2,4	Epiphytic plant with swollen base full of holes and chambers housing ants.
	<i>Myrmecodia sp.1</i>	O-1	1,2,4	Spiny bulbous base full of ant chambers.
	<i>Myrmecodia sp.2</i>	R-1	1,2,4	Ridged bulbous tubers with ant chambers.
Asclepiadaceae (Milkweeds)				
	<i>Hoya mitrata</i>	O-1	1,3,4	The basal leaves form a "ball" inside which the ants build a nest.
	<i>Dischidia major</i>	O-1	1,2,3,4	Leaves are formed into a hollow pitcher with roots inside, in which the ants build a home; detritus and insect remains provide nutrients for the ants.
	<i>Dischidia imbricata</i>	R-1	1	Leaves form 'cups' against the tree trunk providing a hollow umbrella-like home for the ants.
Orchidaceae				

roots.	<i>Thecopsis secunda</i>	O-1	1,2	Ants build nests among
	<i>Thecostele alata</i>	O-1	1,2,4	"
	<i>Cymbidium rectum</i>	O-1	1,2,4	"
	<i>Grammatophyllum speciosum</i>	O-1	1,2,3,4	"
	<i>Porphyroglottis maxwelliae</i>	R-1	1,2,4	"
	<i>Acriopsis densiflora</i>	R-1	1,2,4	"
	<i>A.gracilis</i>	R-1	1,2,4	"
	<i>A.indica</i>	O-1		"
	<i>A.javanica</i>	O-1		"
	<i>A.ridleyi</i>	O-1		"
 Nepenthaceae				
	<i>Nepenthes rafflesiana</i>	O-C-1	1,2,4	<i>Nepenthes</i> , though they 'catch' ants as their prey, also have other ant associations.

### APPENDIX 3 : CHECKLIST OF PLANTS ENCOUNTERED DURING 1998 SURVEY OF KERANGAS AND DIPTEROCARP FORESTS AT NABAWAN

By Robert C. Ong, George H. Petol, Reuben Nilus, Joan T. Pereira and Lim S.P.

The following tables provide a checklist of plants encountered during the vegetation survey of Nabawan forests conducted by the Forest Research Centre team in 1998. Emphasis was on the tree flora and other woody plants. This checklist is far from being complete. Nevertheless, it provides a good indication of the most dominant and common plants that may be encountered in the kerangas forest. A cursory survey was also carried out in the mixed dipterocarp forest of the Milian-Labau VJR. This survey focused mainly on the trees exceeding 20 cm diameter at breast height.

#### Rarity

*Rarity* in the tables refers to the frequency of occurrence of a species within its usual habitat, i.e. its local frequency rating, taking into account mainly trees > 5 cm dbh.

<u>Rarity class</u>	<u>Individuals/ha</u>
A - Abundant	> 75
C - Common	20 - 75
O - Occasional	1 - 20
R - Rare	> 1

In the *rarity* column of the kerangas checklist, '1' denotes *Dacrydium-Tristaniopsis* kerangas, and '2' denotes *Shorea-Hopea* kerangas. The alphabets, A, C, O, and R denotes the rarity class. Therefore, A-1 means abundant in *Dacrydium-Tristaniopsis* kerangas. Where a cell is left blank, the rarity of the plant could not be determined with the available information.

## KERANGAS FOREST PLANT CHECKLIST

### Trees and shrubs.

Family	Species	Rarity	Notes
Anacardiaceae	<i>Buchanania sessilifolia</i>		Widespread, to 500 m asl.
	<i>Gluta oba</i>	O-1, C-2	Bornean endemic, common on sandy ridges and kerangas.
Annonaceae	<i>Goniothalamus</i> sp.	C-1	
	<i>Mezzettia havilandii</i>	O-1	
	<i>Polyalthia sumatrana</i>		
	<i>Polyalthia</i> sp.		
	<i>Xylopia ferruginea</i>		
	<i>X. stenopetala</i>		
Aquifoliaceae	<i>Ilex cymosa</i>		Also in peat swamp, ultramafic and kerangas forests.
Burseraceae	<i>Canarium caudatum</i>	C-2	Scattered, uncommon, 2 forms, to 500 m asl in PSGN (Nabawan).
Convolvulaceae	<i>Erycibe glomerata</i>	O-2	
Chrysobalanaceae	<i>Parastemon urophyllus</i>		Common, BFT, KGU, PSGN, PPR, SPTG, LDU & SAN, good firewood.
Dilleniaceae	<i>Dillenia suffruticosa</i>		Widespread all over Sabah, to 500 m in PSGN (Nabawan).
Dipterocarpaceae	<i>Cotylelobium melanoxyton</i>		Common, SAN, L-S, PSGN, SPTG, KPU, BFT, KK & KDT, sandy soils.
	<i>Hopea pentanervia</i>	C-1, A-2	Bornean endemic, peaty kerangas, SAN, L-S, KBTGN, SPTG, BFT & PSGN, to 610 m asl.
	<i>Shorea venulosa</i>	A-2	Bornean endemic, podsols, ridges, locally common, to 1600 m asl.
Ebenaceae	<i>Diospyros evena</i>	A-2	Peat swamps and kerangas.
Elaeocarpaceae	<i>Elaeocarpus marginatus</i>	O-1	
Ericaceae	<i>Vaccinium bancanum</i>	A-1, O-2	Treelet.
	<i>Rhododendron longiflorum</i>		Understorey shrub, ornamental.
	<i>R. malayanum</i>		Understorey shrub, ornamental.
Euphorbiaceae	<i>Antidesma coriaceum</i>		Lowlands, also peat swamps.
	<i>Aporosa nitida</i>		Bornean endemic, various soils, very similar to <i>A. aurea</i> , to 600 m asl.
	<i>Baccaurea</i> sp. A		
	<i>Baccaurea</i> sp. B		
	<i>Cleistanthus podopyxis</i>		Bornean endemic, TNM, PSGN, LDU & TWU, to 600 m asl.
	<i>Croton leiophyllus</i>	C-2	

	<i>Omalanthus populneus</i>		Very common, fruits for treating wounds, to 1750 m asl on Kinabalu.
	<i>Macaranga anceps</i>		
	<i>M. gigantea</i>		Common in secondary forest, to 800 m asl.
	<i>M. pearsonii</i>		Bornean endemic, more common in secondary forest.
	<i>Mallotus griffithianus</i>	0-2	To 360 m asl.
Fagaceae	<i>Lithocarpus</i> sp.		Common genus, 45 spp. in Sabah.
Guttiferae	<i>Calophyllum</i> sp.	0-2	
	<i>C. gracilipes</i>		
	<i>Garcinia</i> sp.	C-2	
Hypericaceae	<i>Cratoxylum formosum</i>		Common, widespread, deciduous.
Icacinaceae	<i>Stemonurus malaccensis</i>		Scattered, to 150 m asl.
Lauraceae	<i>Actinodaphne borneensis</i>		Bornean endemic, widespread, not recorded in the N, to 800 m asl.
	<i>Lindera pipericarpa</i>		Crocker Range & Interior, to 1610 m asl.
Leguminosae	<i>Dialium indum</i>		
	<i>Koompassia malaccensis</i>	C-2	Common emergent.
	<i>Sindora irpicina</i>		
Magnoliaceae	<i>Magnolia</i> sp.		
Melastomataceae	<i>Memecylon argentium</i>	C-2	
Moraceae	<i>Ficus aurata</i>		
	<i>F. bracteata</i>		
	<i>F. deltoidea</i> var. <i>arenaria</i>		
	<i>F. deltoidea</i> var. <i>deltoidea</i>		Acclaimed medicinal property is treating post-natal women.
	<i>F. sundaicus</i>		
Myristicaceae	<i>Myristica</i> sp.		
Myrtaceae	<i>Baeckia frutescens</i>		Treelet, open conditions on podsolic soils.
	<i>Syzygium acuminatissima</i>	0-1, C-2	
	<i>S. bankensis</i>	0-1, A-2	Treelet, potential ornamental.
	<i>S. chloranthum</i>	0-2	
	<i>S. clavatum</i>		
	<i>S. subdecussata</i>	A-1, 2	
	<i>Tristaniopsis</i> sp.	A-1, C-2	Very common in kerangas forest of Nabawan, unable to ID to species level.
Myrsinaceae	<i>Ardisia</i> sp.		
	<i>Rapanea borneensis</i>	C-1, 0-2	
Ochnaceae	<i>Euthemis minor</i>		Common, to 1250 m asl.
	<i>Gomphia serrata</i>	C-1	Shrub, common, widespread, to 1500m asl.
Oleaceae	<i>Chionanthus crispus</i>		
Oxalidaceae	<i>Sarcotheca diversifolia</i>		
Podocarpaceae	<i>Dacrydium pectinatum</i>	A-1, C-2	Very common in kerangas forests near Nabawan. Large trees produce valuable timber.
	<i>Podocarpus confertus</i>		
Polygalaceae	<i>Xanthophyllum affine</i>		
Proteaceae	<i>Helecia pterygota</i>		Previously known only from Mt. Kinabalu.
Rosaceae	<i>Parastemon urophyllus</i>	C-1, 2	Common in Kerangas.
Rubiaceae	<i>Canthium confertum</i>		
	<i>Diplospora singularis</i>	0-2	

	<i>Gaertnera vaginans</i>		
	<i>Lasianthus</i> sp.		
Sapindaceae	<i>Nephelium rambuotan-ake</i>		
	<i>Lepisanthes</i> sp.		
Sapotaceae	<i>Madhuca</i> sp.	C-2	
	<i>Palaquium rostratum</i>		High value timber tree.
Simaroubaceae	<i>Eurycoma longifolia</i>	C-2	Treelet, acclaimed aphrodisiac, tonic, anti-malaria & hypothermic properties.
Tetrameristaceae	<i>Tetramerista glabra</i>	0-2	
Theaceae	<i>Adinandra</i> sp.		
	<i>Ternstroemia aneura</i>	A-1, C-2	

## Ferns

Family	Species	Rarity	Notes
Davalliaceae	<i>Humata</i> cf. <i>angustata</i>		
	<i>H. repens</i>		
Lycopodiaceae	<i>Huperzia phlegmaria</i>		Bornean endemic.
Polypodiaceae	<i>Drynaria sparsisora</i>		
	<i>Lecanopteris sinuosa</i>		
	<i>Pyrrhosia longifolia</i>		
	<i>Pyrrhosia</i> sp.		
	<i>Selliguea heterocarpa</i>	A-1, 2	
Schizaeaceae	<i>Schizaea dichotoma</i>		

## Pitcher plants

Family	Species	Rarity	Notes
Nepenthaceae	<i>Nepenthes ampullaria</i>	C	To 500 m asl, kerangas and peat swamps.
	<i>Nepenthes gracilis</i>		Common; kerangas, peat-swamp & ultramafic forests; in association with other <i>Nepenthes</i> species; to 860 m asl in the Crocker Range.
	<i>Nepenthes x hookeriana</i>		Natural hybrid of <i>N. ampullaria</i> and <i>N. rafflesiana</i> , 'kerapah' forest.
	<i>N. rafflesiana</i>	C	Variable pitcher size, sun-exposed areas, associated with Drummer ants.

## Rattans and other palms

Family	Species	Notes
Palmae	<i>Calamus marginatus</i>	Widespread throughout Sabah, slightly commercial, to 1,800 m asl.
	<i>Eugeissona utilis</i>	Common palm tree, starch from stem, used by rural communities.
	<i>Korthalsia rigida</i>	Widespread throughout Sabah, avoiding ultramafic and peat swamp areas, to 900 m asl.
	<i>Pholidocarpus? maiadum</i>	Uncommon palm tree, normally fresh water swamps, used by rural

		communities, ornamental.
	<i>Plectocomia mulleri</i>	Widespread throughout Sabah, common in disturbed forests, very characteristic of some facies of kerangas forest.

## Orchids and other epiphytes

Family	Species	Rarity	Notes
Orchidaceae	<i>Acriopsis gracilis</i>		First described from Nabawan.
	<i>Bromheadia finlaysonianum</i>	C	Terrestrial
	<i>Bulbophyllum nabawanense</i>		Bornean endemic, so far only recorded in Sabah.
	<i>Bulbophyllum beccarii</i>		Bornean endemic.
	<i>Bulbophyllum refractilingue</i>		
	<i>Bulbophyllum acuminatum</i>		
	<i>Calanthe undulata</i>		Bornean endemic.
	<i>Coelogyne distans</i>		
	<i>Coelogyne testacea</i>		
	<i>Coelogyne zurowetzii</i>	A	
	<i>Cymbidium rectum</i>	C	Kerangas endemic.
	<i>Dendrobium trullatum</i>		Bornean endemic.
	<i>Dendrobium nabawanense</i>		Bornean endemic.
	<i>Epigeneium speculum</i>		
	<i>Eria ignea</i>		Bornean endemic.
	<i>Gramatophyllum speciosum</i>	O	
	<i>Porphyroglottis maxwelliae</i>		Kerangas endemic.
Rubiaceae	<i>Hydnophytum</i> spp.		3 species encountered, traditional medicine.

## MIXED DIPTEROCARP FOREST PLANT CHECKLIST (MILIAN-LABAU VJR)

### Trees

Family	Species	Rarity	Notes
Anacardiaceae	<i>Gluta oba</i>		Bornean endemic, common, type from Sabah.
	<i>Gluta wallichii</i>	C	Widespread, to 500 m asl.
	<i>Mangifera foetida</i>	C	Uncommon, fruits edible, also cultivated, to 1000 m asl.
Apocynaceae	<i>Alstonia angustifolia</i>		Lowlands, usually in seasonal swamps, also peat swamps.
Bombacaceae	<i>Durio acutifolia</i>		
	<i>D. grandiflorus</i>		
	<i>D. zibethinus</i>		Most widespread, esp. in cultivation, also wild in lowlands and hills.
Burseraceae	<i>Dacryodes rostrata</i>		2 forms, forma rostrata widespread, forma cuspidata recorded only from KDT, SPTG, and RNU, to 800 m asl.
Combretaceae	<i>Terminalia subspathulata</i>		
Dipterocarpaceae	<i>Anisoptera costata</i>		Uncommon, E coast & PSGN, to 700 m asl.
	<i>Dipterocarpus confertus</i>		Bornean endemic, widespread in Sabah, to 800 m asl.
	<i>Dipterocarpus conformis</i>		Uncommon, BFT to TWU, also L-S, to 500 m asl.
	<i>D. gracilis</i>		E coast, KDT, lower Interior, rarely SPTG, to 800 m asl.
	<i>Hopea ferruginea</i>		Locally frequent, deep fertile soils, to 750 m asl.
	<i>Parashorea malaanonan</i>		Abundant in E coast, uncommon in W, important tree for plywood.
	<i>Shorea argentifolia</i>	C	Bornean endemic, widespread in Sabah, valleys, to 600 m asl.
	<i>S. atrinervosa</i>	C	Wood very durable, widespread in Sabah, locally common.
	<i>S. fallax</i>	C	Bornean endemic, widespread in Sabah, common.
	<i>S. gibbosa</i>		E coast, Interior, PPR & SPTG, clay rich soils, to 800 m asl.
	<i>S. johorensis</i>		Common, fertile or alluvium soils, to 600 m asl.
	<i>S. laevis</i>	C	Widespread & common, ridges, to 1000 m asl.
	<i>S. leprosula</i>		Widespread, common, below 700 m asl.
	<i>S. macroptera</i>	C	2 sp. endemic to Sabah, widespread, clay soils, to 600 m asl.

	<i>S. ovalis</i>	C	Widespread, moist areas, to 500 m asl.
	<i>S. parvifolia</i>		Perhaps most common & widespread, below 800 m asl.
	<i>S. pilosa</i>		Bornean endemic, uncommon, BFT, SPTG, PSGN (Nabawan) & TWU, clay soils, to 520 m.
	<i>S. slooteni</i>	C	Bornean endemic, W coast and Nabawan, to 500 m asl.
	<i>S. smithiana</i>		Endemic to Borneo, common, chief source of light red meranti, to 500 m asl.
	<i>S. symingtonii</i>		Endemic to Sabah, E coast & Nabawan, common, to 500 m asl.
	<i>Vatica dulitensis</i>		Bornean endemic, wood very durable and strong.
Elaeocarpaceae	<i>Elaeocarpus clementis</i>		
Euphorbiaceae	<i>Elateriospermum tapos</i>	A	Roasted kernels edible, to 600 m asl.
Fagaceae	<i>Lithocarpus leptogyne</i>		With stilt-roots, common, to 1500 m asl.
Guttiferae	<i>Mesua macrantha</i>		
Lauraceae	<i>Cinnamomum parthenoxylon</i>		Scattered, E coast, PSGN & RNU (including Kinabalu), to 1500 m asl.
	<i>Eusideroxylon zwageri</i>		Common, E coast & Interior, disappearing fast, to 500 m asl.
Leguminosae	<i>Archidendron ellipticum</i>		
	<i>Dialium indum</i>		
Meliaceae	<i>Aglaiia</i> sp.		Taxomic revision needed.
Moraceae	<i>Artocarpus odoratissimus</i>		Fruits edible, always available when in season, to 1300 m asl.
Myrtaceae	<i>Syzygium</i> sp.		Taxonomic revision needed.
	<i>Tristaniopsis grandifolia</i> .	C	Very common in the kerangas forests near Nabawan.
Polygalaceae	<i>Xanthophyllum</i> sp.		
Sterculiaceae	<i>Scaphium longipetalum</i>		
Tiliaceae	<i>Pentace laxiflora</i>	O	

## Rattans and other palms

Family	Species	Rarity	Notes
Palmae	<i>Calamus conirostris</i>		Widespread throughout Sabah, usually most abundant in ridge top forest or in transitional forest between kerangas and MDF, highly commercial, to 1000 m asl.
	<i>C. marginatus</i>		Widespread throughout Sabah; slightly commercial, to 1,800 m asl.
	<i>C. scabrifolius</i>		In Sabah, Nabawan only, in transitional forest between kerangas and MDF; Bornean endemic; to 500 m asl.
	<i>Daemonorops longipes</i>		Very widespread in Sabah, very variable; to 1600 m asl.
	<i>D. rutilis</i>		Widespread & very common, Bornean endemic; also on ultramafic forest; to 700 m asl.
	<i>D. sabut</i>		Widespread in Sabah; easily identifiable because of ant-galleries but very variable.
	<i>D. fissa</i>		Widespread, Bornean endemic; abundant in disturbed lowlands; also on hills, to 800 m asl.
	<i>Korthalsia echinometra</i>		Very widespread and most common, avoiding ultramafic and peat swamp areas; to 1000 m asl.
	<i>K. rigida</i>		Widespread, avoiding ultramafic and peat swamp areas; used by rural communities, to 800 m asl.
	<i>Oncospermum horridum</i>	C	Hill forests, common in Nabawan in MDF.
	<i>Plectocomiopsis mira</i>		Scattered localities; to 900 m asl.