

A PRELIMINARY SURVEY OF ORCHIDS IN TAWAU HILLS PARK, SABAH

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ABSTRACT

*In the one-week expedition to the Tawau Hills Park, Sabah to conduct a preliminary survey of orchids in the area, only a small portion of the vast 28, 000 ha forest reserve was covered. Despite the limited area surveyed, a total of 118 species from 42 genera was observed and collected. A wide array of both ground and epiphytic orchids was obtained. Many could not be identified to species level because of the absence of flowers. Amongst the interesting and attractive species collected were *Goodyera colorata?*, *Tainia latilingua*, *Calanthe pulchra*, *Grammatophyllum scriptum*, *Eria braddonii*, *Thecostele sp.* and *Coelogyne sp.* The collection also showed that 3 specimens were suspected to be new or previously undescribed in Borneo. Two of them, both *Dendrobium spp.* (Specimens 5.4 and 6 18) have been confirmed to be new species (J.J Wood of the Royal Botanic Gardens, Kew, private communication). The third resembled *Renanthera matutina* in flower appearance, but differed from it in plant morphology, colour of flower and other characteristics. Among the 4 new records is *Podochilus malabaricus* (Specimen 1.26), previously thought to occur in Sri Lanka and South India only. Other new records for Sabah include *Appendicula calcarata*, *Agrostophyllum hasseltii* and *Tainia latilingua*.*

INTRODUCTION

The broad objectives of the survey were to:

- i) Compile an up-to-date record of the orchid flora in Tawau Hills Park
- ii) Discover rare and perhaps new species of orchids and conserve them in the orchid collection centres at MARDI (Serdang) and Poring (Sabah) for future taxonomic and botanical studies or references.

METHODS

In view of the vastness of the area and the inaccessibility of much of the hilly terrain, it was not possible to cover a wide area. Discussions were therefore held with the Park Rangers on the accessibility of specific areas, the vegetation types, water source, etc. to identify areas where the survey could be conducted. Eventually six areas were decided on (refer to Fig. 1), namely:

- i) Area I -Base Camp to Hot Spring and area beyond (27/11/89)
- ii) Area 2 -Merotai Besar (28/11/89)
- iii) Area 3 -Gunung Pyramid (29/11/89)

- iv) Area 4 -Base Camp to Waterfall (30/11/89)
- v) Area 5 -Sg. Tiku (1/ 12/89)
- vi) Area 6 -Base Camp (2/12/89)

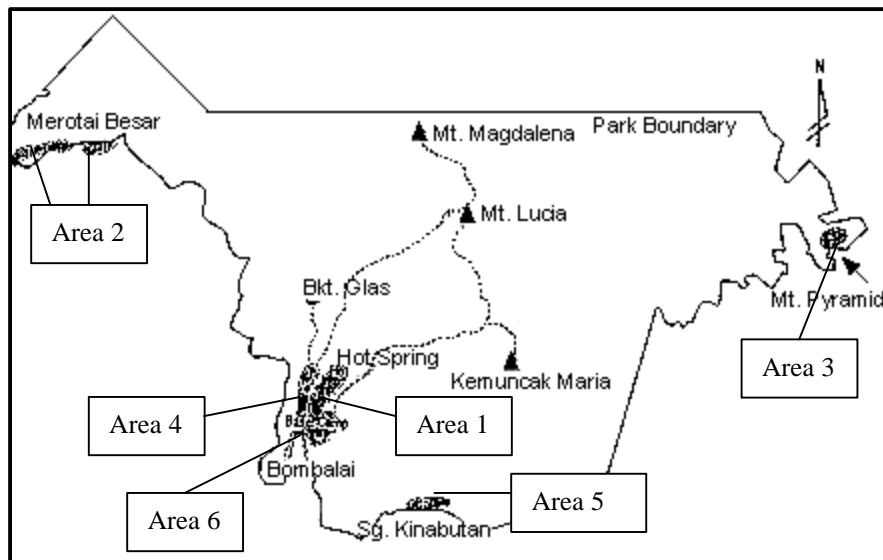


Figure 1

Showing Areas surveyed for orchids (Nos. 1-6)

Every plant collected was numbered and identified to species level wherever possible. The habitat, elevation, locality and frequency of occurrence of each plant collected were also noted. Where identification was in doubt, for example due to the absence of flowers, the plants were planted in MARDI, Serdang, to be identified later when flowers are produced. Difficult species or species that are suspected to be new or previously unrecorded were sent to Mr. J.J. Wood, Royal Botanic Gardens, Kew, England, for identification or confirmation.

The group involved in the orchid (and ornamental) survey comprised the following:-

- 1) Lim Weng Hee (MARDI) – orchids
- 2) Khelikuzzaman Meera Hussein (MARDI) – Ornamentals
- 3) Harry Lohok (Sabah Parks) – orchids
- 4) Masrom bin Hasran (MARDI)
- 5) Hj. Yassin bin Tan (MARDI)
- 6) Shohimi bin Ramli (MARDI)

RESULTS AND DISCUSSION

A vast forest reserve like the Tawau Hills Park is as expected quite heterogeneous, varying widely in elevation, water regimes, vegetation types and others. The Base Camp, for example, is at an altitude of about 275m above sea level (asl) while the mountains such as Mt. Lucia and Mt. Magdalene rise up to 1200 and 1310m asl, respectively. Because of the tendency of orchids to be specific in their nutritional and environmental requirements, it is not surprising to find certain

types of orchids confined to certain localities only. Since the selected areas surveyed are fairly diverse in nature, each area will be discussed separately.

Area 1 - Base Camp to Hot Spring

This area is very humid with a river (Sg. Tawau) passing through it. The vegetation is luxuriant with many huge trees. There are signs of previous logging activities. Collection was done along the river and surrounding areas. At the time of the year when the survey was conducted, many of the orchid plants were not in bloom - which made identification to species level difficult. Listed below (Table 1) are orchids collected from this area.

From the first day's collection itself, a large diversity of orchids was obtained - about 50 different species from 25 genera. Amongst them were two species which were suspected to be new or previously unrecorded, namely, *Appendicula sp.* I (specimen 1. 15) and *Podochilus sp.* (specimen 1.26) (also see plate) It was later confirmed that specimen 1.26 closely matches *Podochilus malabaricus* Wight, a species previously recorded from southern India and Sri Lanka only (J.J. Wood, personal comm.). This find, therefore, represents a new record for Borneo. Specimen 1.15 was identified as *Appendicula calcarata*, which has been recorded in Sarawak.

The jewel orchid, specimen 1.31, which was suspected to be a *Cystorchis sp.?* (not in bloom) has an unusual but attractive foliage with dark green to purple venation. It should make an attractive foliage plant.

Area 2 - Merotai Besar

The original plan was to explore the waterfall area in Merotai Besar where *Phalaenopsis gigantea* was reported to be present. Unfortunately we lost our way and ended up in a secondary jungle and an oil palm plantation. However, we still managed to collect some orchids from a small patch of primary jungle and the adjacent logged area (Table 2).

Table 1
Orchids collected from Area I

	NAME	CODE	RELATIVE ABUNDANCE
A.	Ground orchids		
	<i>Cystorchis sp.?</i> (jewel)	1.31	+
	<i>Eulophia squalida</i>	-	+
	<i>Liparis wrayi</i>	1.7,1.9	+++
	<i>Plocoglottis acuminata</i>	1.44	+++
B.	Epiphytes		
	* <i>Appendicula calcarata</i>	1.15	+
	<i>Appendicula anceps</i>	1.2	+++

<i>A. reflexa?</i>	1.3	+
<i>A. torta</i>	1.19	+
<i>A. undulata?</i>	1.28	+
<i>Agrostophyllum bicuspidatum</i>	1.5	+++
<i>A. xathiforme?</i>	1.11	+
<i>A. majus</i>	1.10	+
<i>Adenoncus</i> sp.	1.20	+
<i>Bulbophyllum</i> (<i>patens</i> / <i>Imacranthum?</i>)	1.30	+
<i>B. vaginatum?</i>	-	+
<i>B. stella</i>	-	+
<i>B. flavescens</i>	1.37	+
<i>Bulbophyllum</i> s p. 1	1.38	+
<i>Bulbophyllum</i> sp. 2	1.40	+
<i>Bulbophyllum</i> sp. 3	1.41	+
<i>Cleisostoma</i> Sp.?	1.15	+
<i>Coelogyne membranifolia</i>	1.8	+
<i>Coelogyne</i> sp. 1	1.18	+++
<i>Coelogyne</i> sp. 2	1.42b	+++
<i>Coelogyne</i> sp. 3	-	+
<i>Cymbidium finlaysontanum</i>	-	+
<i>Camarotis</i> sp.	-	+
<i>Dendrobium leonis</i>	1.17	+
<i>Dendrobium</i> sp. 1	1.33	+
<i>Dendrochium</i> sp. 1	1.35	+
<i>Dendrochilum</i> sp. 2	1.49	+
<i>Eria neglecta</i>	1.1	+++
<i>E. pudica</i>	1.12	+
<i>Eria</i> sp. 1	1.21	+
<i>Eria</i> sp. 2	1.29	+
<i>Eria</i> sp. 3	1.36	+
<i>Flickingeria kelsalii?</i>	1.14	+

NAME	CODE	RELATIVE ABUNDANCE
<i>Flickingeria plicatile</i>	1.22	+
<i>Grammatophyllum scriptum</i>	1.2	+
<i>Liparis</i> sp.	1.24	+
<i>Microsaccus javensis</i>	1.23	+
<i>Malleola</i> sp.	1.45	+
<i>Oberonia</i> sp.	1.27	+
* <i>Podochilus malabaricus</i>	1.26	+
<i>Podochilus microphyllus</i>	1.42a	+

<i>Phalaenopsis maculata</i>	1.43	+
<i>Thecostele sp.</i>	1.47	+
<i>Thrixspermum duplocallosum?</i>	1.48	+
<i>Trichotosia ferox?</i>	1.25	+

* Probably new or previously unrecorded species in Sabah.

Table 2
Orchids from Area 2

NAME	CODE	RELATIVE ABUNDANCE
Jungle		
<i>Aerides odorata</i>	2.2	+
<i>Malleola penangiana</i>	2.4	+
* <i>Renanthera? sp.</i>	2.3	+
<i>Sarcochilus caligaris</i>	2.1	+
Secondary forest/oil palm		
<i>Eulophia squalida</i>	-	+
<i>Cymbidium finlaysonianum</i>	-	+
<i>Cymbidium atropurpureum?</i>	-	+
<i>Cymbidium sp.</i>	-	+
<i>Grammatophyllum speciosum</i>	-	+

* Probably new or previously unrecorded species in Sabah.

Of interest here is specimen No. 2.3 which is probably a new or previously unrecorded species of *Renanthera* (based on plant morphology and nature of the remnant inflorescence stalk). The plant is being nurtured carefully in MARDI Serdang. (Taman Sabah has an off-shoot of it). The plant has recently flowered and it does not conform to any of the known Malaysian *Renantheras* described by Holttum. The flower resembles *R. matutina* and appears to be closely allied to it. However, it differs in certain aspects of flower morphology (see description and plate) and in having longer and pointed leaves. *Malleola penangiana* (specimen 2.4) is another interesting collection from the area. *Phalaenopsis gigantea* was not found by us, since we lost our way, but another group was able to collect this species from the waterfall area.

Table 3
Orchids from Area 3

NAME	CODE	RELATIVE ABUNDANCE-
Ground orchids		
<i>Eulophia sp.</i>	-	+
<i>Goodyera colorata?</i>	3.8	+

<i>Hetaeria sp. (nitida?)</i>	3.4	+
<i>Liparis sp. (compressa?)</i>	3.21	+
<i>Malaxis lowii</i>	3.17	+
<i>Plocoglottis Sp.</i>	3.23	+
Epiphytes		
<i>Appendicula anceps</i>	-	+++
<i>Bulbophyllum sp. 1</i>	3.13	+
<i>Bulbophyllum sp. 2</i>	3.16a	+
<i>Bulbophyllum sp. 3</i>	3.18	+
* <i>Dendrobium lamellatum</i> var. 'Sabah'	3.7	+
<i>Dendrobium sp. (secundum?)</i>	3.10	+
<i>D. spurium</i>	3.12	+
<i>D. kentrophyllum</i> var. 'Sabah'	3.16b	+
<i>D. setifolium</i>	3.3	+
<i>Eulophia sp.</i>	-	+
<i>Flickingeria sp. I (plicatile?)</i>	3.6	+
<i>Microsaccus javensis</i>	3.14	+
<i>Pholidota sp.</i>	3.23	+
<i>Podochilus lucescens</i>	3.5	+
<i>Sarcochilus caligaris</i>	3.2,3.11	+
<i>Trichoglottis lanceoloria</i>	3.20	+
<i>Vanilla sp.</i>	3.9	+

* *Distinct in flower and vegetative characteristics from D. lamellatum found in P. Malaysia.*

Area 3 - Gunung Pyramid

Gunung Pyramid is a relatively small but steep hill located on the north-eastern corner of the reserve (Fig. 1). The area appeared relatively dry and no stream was found in the locality. The foot-hill, at an altitude of about 275m (asl) was planted with cocoa. The hill peaks are at about 610m (asl). The orchids (Table 3) collected from the area were quite diverse and different from those collected from Areas 1 and 2.

Many additional genera and species were collected from Area 3. Some interesting plants which have horticultural potential are *Goodyera colorata?* (specimen 3.8) and *Dendrobium lamellatum* (specimen 3.7). The former is a jewel orchid, which is in demand for its strikingly beautiful leaves. It has been recorded once (but a doubtful record) in Pahang. The latter, *D. lamellatum*, is also found in Peninsular Malaysia but its vegetative and floral characteristics are distinct from those found in P. Malaysia. The Sabah variety produces much bigger leaves and only one leaf is produced per pseudobulb. The leaf colour is also different - the undersurface is dark purple. The flowers are white, flushed pink, compared with the yellow to yellow-green of the Peninsular Malaysian variety. Differences in flower morphology were also observed. Further work is needed to determine whether they are of distinct species.

Table 4
Orchids from Area 4

NAME	CODE	RELATIVE ABUNDANCE
<i>Appendicula anceps</i>	-	+
<i>Agrostophyllum bicuspidatum</i>	-	++
<i>Bulbophyllum sp. 1</i>	4.1	+
<i>Bulbophyllum sp. 2</i>	4.2	+++
<i>Bulbophyllum sp. 3</i>	4.3	+
<i>Bulbophyllum sp. 4</i>	4.4	+++
<i>Coelogyne sp. 1</i>	4.6	+
<i>Coelogyne sp. 2</i>	4.14	+
<i>Cymbidium sp. (afropurpureum?)</i>	4.5,4.8	+
<i>Dendrobium aloefolium</i>	4.7	+
<i>Dendrochilum sp. (=1.49)</i>	4.9	+
<i>Dipodium sp.</i>	4.11	+
<i>Eria sp. (densa?)</i>	4.12	+
<i>Eria neglecta</i>	-	+++
<i>Malleola sp.</i>	4.10	+
<i>Podochilus microphyllus</i>	-	+
<i>Pomatocalpa sp.</i>	4.16	+
<i>Taeniophyllum sp.</i>	4.15	+

Similarly, the *Dendrobium kentrophyllum* (specimen 3.16) obtained was distinct from the P. Malaysian species, producing more colourful (distinct purple veins), longer (6cm) and more terete leaves.

Table 5
Orchids from Sg. Tiku (Area 5)

NAME	CODE	RELATIVE ABUNDANCE
Ground orchid		
* * <i>Tainia latilingua</i>	5.1	+
Epiphytes		
<i>Agrostophyllum bicuspidatum</i>	-	+++
<i>A. majus</i>	5.15	+
<i>Bulbophyllum lepidum</i>	5.7	+
<i>B. stella</i>	5.11	+
<i>Bulbophyllum sp. 1</i>	5.2	+
<i>Bulbophyllum sp. 2</i>	5.3,5.9	+
<i>Bulbophyllum sp. 3</i>	5.5	+
<i>Bulbophyllum sp. 4</i>	5.12	+
<i>Coelogyne sp. 1</i>	5.8	+

<i>Coelogyne sp. 2</i>	-	+
<i>Coelogyne sp. 3 (Mayeriana)</i>	5.18	+
* <i>Dendrobium sp. I (Sect. Rhopalanthe)</i> 5.4		+
<i>Dendrobium sp. 2</i>	5.13	+
<i>Dendrobium sp. 2 (=1.49)</i>	-	+
<i>Eria braddonii</i>	5.6	+
<i>Eria neglecta</i>	-	+
<i>rammatophyllum speciosum</i>	-	+
<i>Hippeophyllum Sp.</i>	5.14	+
<i>Liparis sp.</i>	5.17	+
<i>Trichotosia velutina?</i>	5.16	+

* Previously undescribed species (J. J Wood, 1990 personal communication)

* * New record for Sabah

Area 4 - Base Camp to Waterfall

Orchids collected from Area 4 are listed in Table 4. Many of the plants collected were similar to those collected or observed in Area 1, which is adjacent to it, e.g. *Agrostophyllum*, *Bulbophyllum*, *Eria*, *Coelogyne*, *Cymbidium*, *Dendrobium* and others. However, there were a number of genera which were different, namely, *Dipodium sp.*, *Eria densa?*, *Pomatocalpa sp.* and *Taeniophyllum sp.*

Area 5 - Sg. Tiku

This is an undulating area with a stream running through. The elevation is estimated at about 215-275m (asl). The reserve is bordered by a cocoa plantation. The orchids collected are listed in Table 5.

Many of the species in Area 5 have already been observed or collected in the other areas. However, several plants, e.g. *Bulbophyllum lepidum* and unidentified *Bulbophyllum spp.* I & 2, *Hippeophyllum*, *Tainia latilingua* and *Trichotosia velutina?*, were new additions to the collection. Of utmost interest is *Dendrobium sp. I* (specimen 5.4) belonging to the section *Rhopalanthe*, which is believed to be a previously undescribed species. The flowers of this specimen are characteristic of members of this section but its vegetative characteristic is atypical as it is devoid of an obvious swelling at the base of the stem. Samples sent to the Royal Botanic Gardens, Kew, were confirmed by Mr. J.J. Wood (personal comm.) as a new species. The ground orchid, *Tainia latilingua* (specimen 5. 1), is a new record for Borneo.

Area 6 - Base Camp

Many diverse species were found and collected around the base camp, along the streams and on the nearby hills. A detailed list is given in Table 6. A number of species collected in Area 6 were not observed earlier, namely, *Aphyllorchis pallida*, *Calanthe pulchra*, *Bulbophyllum trichoglottis*, *Dendrobium pumilum?*, *D. teres?*, *D. bifarium*, *Eria cepifolia*, *E. pannea* and *Thrixspermum acuminatissimum*. Of great interest is specimen 6.18 (see plate), which is suspected to be a new *Dendrobium* species (Section *Pedilonum*) with some horticultural potential. The plant was replanted at MARDI and has since flowered and sent to the Royal Botanic Gardens, Kew for identification. The plant was confirmed by Mr. J.J. Wood (personal comm.) to be a previously undescribed species.

Table 6
Orchids from around Base Camp (Area 6)

NAME	CODE	RELATIVE ABUNDANCE
A. Ground Orchids		
<i>Aphyllorchis pallida</i>	6.15	+
<i>Calanthe pulchra</i>	6.35	+
<i>Liparis wrayi</i>	6.13	+++
<i>Malaxis latifolia</i>	6.20	+++
B. Epiphytes		
<i>Agrostophyllum bicuspidatum</i>	-	+++
* <i>Agrostophyllum hasseltii</i>	6.16	+
<i>Appendicula anceps</i>	-	+++
<i>Appendicula sp. 1</i>	6.17	+
<i>Bulbophyllum stella</i>	-	+
<i>Bulbophyllum trichoglottis</i>	6.8	+
<i>Bulbophyllum flavescens?</i>	6.6	+
<i>Bulbophyllum sp. 1</i>	6.2	+
<i>Bulbophyllum sp. 2</i>	6.5	+
<i>Bulbophyllum sp. 3</i>	6.11	+
<i>Camatotis sp.</i>	6.22	+
<i>Cleisostoma sp. 1</i>	6.21	+
<i>Cleisostoma sp. 2</i>	6.31	+
<i>Coelogyne sp. 1</i>	-	+++
<i>Coelogyne sp. 2</i>	6.25	+
<i>Coelogyne sp. 3</i>	6.26	+
<i>Dendrochilum sp.</i>	-	+
<i>Dendrobium lobatum</i>	6.15a	+
<i>D. crumenatum</i>	6.24	+
<i>D. pumilum?</i> (sect. <i>Bolbidium</i>)	6.29	+
<i>D. ifarium</i>	6.30	+
<i>D. secundum?</i>	6.36	+

<i>D. teres?</i>	6.37	+
* <i>Dendrobium</i> sp. (Sect. <i>Pedilonum</i>)	6.18	+
<i>Eria cepifolia</i>	6.1	+
<i>E. neglecta</i>	-	+
<i>E. floribunda?</i>	-	+
<i>E. pannea?</i>	6.19	+
<i>E. densa?</i>	6.32	+
<i>Eria</i> sp. 1	6.12	+
<i>Eria</i> sp. 2	6.33	+
<i>Flickingeria kelsalii?</i>	6.26	+
<i>Liparis</i> sp. 1	6.10	+

NAME	CODE	RELATIVE ABUNDANCE
<i>Liparis</i> sp. 2	6.23	+
<i>Thrixspermum acuminatissimum</i>	6.9,6.28	+
<i>Trichotosia ferox?</i>	6.4	+

* Probably previously undescribed species
 ** New record for Sabah.

Overview of orchids found in Tawau Hills Park

The orchids found in the six areas explored in Tawau Hills Park are summarized and presented in Table 7. As shown the above table, the orchid collection obtained from the Park comprises 118 species from 42 genera. Among them are 3 probably undescribed species and 4 new records for Sabah. Descriptions of the important species are given below.

DESCRIPTION OF PREVIOUSLY UNDESCRIBED SPECIES AND NEW RECORDS

1 *Dendrobium* sp. nov. - Specimen 5.4

Section *Rhopalanthe*

Stem 20 to 90cm long (average 60cm) by 1.88mm wide, thin and wiry, tending to hang downwards, green, base with no obvious swelling although it is very slightly enlarged on close examination; internodes 35cm. Leaves terete, not grooved, slightly curved, 4.5 to 12cm long by 1.7mm wide, dark green, tip pointed, produced along stem.

Flowers produced singly, at apex of stem from a tuft of dried chaffy bracts (0.3cm by 0.15cm), pink, 1.5cm long (from top to tip of spur) by 0.5cm wide; upper sepal white, light pink at base, elliptical, 0.6cm long by 0.3cm wide; petals oblong, white, 0.5cm long by 0.25cm wide. Lower

sepals, white, pink towards spur, 0.9cm long (excluding spur) by 0.7cm wide; spur prominent, 0.5cm long by 0.12cm wide, pointing forwards.

Lip white, turning pink at base, tip rounded and bilobed, 3.6mm wide, with a dark pink spot at the base of each lobe. Pedicel 5mm long; point of attachment to flower pink.

2. *Dendrobium* sp. nov. Specimen 6.8 (see plate)

Section Pedilonum

Pseudobulbs thick and long, from 45 to 105cm long, narrowest at base and tip, erect to semi-erect. Old stems covered by hairless leaf sheaths, cross-section round; young stems leafy throughout. Leaves 9cm long by 2cm wide, thin, ovate with acute pointed tip. Nodes 2.5 to 3cm apart. Flowers produced on pendulous inflorescence, on leafless or leafy stem, usually at or near apex. Inflorescence to 14cm long (scape 4cm, rachis 10cm), flushed purple, bearing up to 16 flowers. Flowers medium-sized, 4cm wide by 2.7cm high, outside yellow speckled with fine purple lines, inside cream yellow flushed light purple at margins. Sepals and petals elliptical with acute tips, 2.6cm long by 0.9cm wide. Spur 1.5cm long, light green speckled with fine purple streaks, slightly elbowed (curving downwards) at 5mm from tip. Lip cream, deep yellow towards base, boat-shaped, no side-lobes, tip obtuse, with diffused purple spots or streaks which are more pronounced on the reverse. Callus at base of lip, raised and pointed, yellow, fringed with purple at base. Column with broad triangular wings pointing downwards. Pedicel 2cm long. Distance between flowers 0.4-1.3cm.

3. *Renanthera* sp. Specimen 2.3 (see plate)

Stem 90cm long, bearing a 74cm-long flowerless inflorescence stalk with a developing fruit at the end. Judging from the empty points on the rachis (27cm) it was estimated that there were probably 13 flowers on the main rachis and 7 flowers on the side branch. The flowers were spaced 1.5 to 2cm apart. Leaves long and narrow, 27cm long by 1.9cm wide, coriaceous, dark green, tip pointed. The plant flowered recently in MARDI, Serdang. The flowers are bright cream-yellow with numerous distinct red spots on the petals and sepals (see plate). The flower resembles *Renanthera matutina* in appearance but is smaller, measuring 3.4cm long by 3.5cm wide. Other differences include colour of flower and lip (cream with red spots), intensity and distribution of red spots on petals and sepals, and leaf morphology (tip pointed). A plant fitting the above description was collected by A. Lamb in 1983 from Kampung Nabawan, Keningau district, and described as a variant of *R. matutina* (Wood, personal communication, 1990). Further studies are recommended to determine whether it is sufficiently different to be considered as a distinct species.

4. *Podochilus malabaricus* Wight Specimen 1.26

(New record for Borneo)

Plant to 9cm long. Leaves laterally compressed, resembling *Dendrobium* in the section Aporum. Width of plant, including stem, 4.5mm across. Leaves tapering, pointed at tip, narrow, 8 mm long x 1 mm wide. 1-2 small flowers produced at apex, white with pink tips, not opening fully, 3 mm long by 2mm high, spur laterally flattened, 1 mm long by 1 mm wide. Pedicel dark purple, 2 mm long.

Table 7
Orchids of Tawau Hills Park - a preliminary list

NAME	AREA FOUND
Ground Orchids	
<i>Aphyllorchis pallida</i>	6
<i>Calanthe pulchra</i>	6
<i>Cystorchis?</i> sp. (1)	1
<i>Eulophia squalida</i>	1
<i>Eulophia</i> sp. (1)	3
<i>Goodyera colorata</i>	3
<i>Hetaeria</i> sp. (nitida?)	3
<i>Liparis compressa?</i>	3
<i>Liparis wrayi</i>	6
<i>Malaxis latifolia</i>	6
<i>Malaris lowii</i>	3
<i>Plocoglottis</i> sp. (1)	3
<i>Plocoglottis acuminata</i>	1
** <i>Tainia latilingua</i>	5

Ground orchids: 11 genera, 14 species

Epiphytes

<i>Appendicula anceps</i>	1,3,4,6
<i>A. reflexa?</i>	1
<i>A. pendula</i>	1
<i>A. torta</i>	1
<i>A. undulata ?</i>	1
** <i>A. calcarata</i>	1
<i>Appendicula</i> sp. (1)	2
<i>Agrostophyllum bicuspidatum</i>	1,4,5,6

NAME	AREA FOUND
** <i>A. hasseltii</i>	6
<i>A. cyathiforme?</i>	1
<i>A. majus</i>	1,5
<i>Adenoncus</i> sp.	1
<i>Aerides odoratum</i>	2
<i>Bulbophyllum (patens)macranthum?</i>	1
<i>B. vaginatum?</i>	1
<i>A stella</i>	1,5,6
<i>B.flavescens</i>	1,6
<i>B. lepidum</i>	5

<i>B. trichoglottis?</i>	6
<i>Bulbophyllum</i> spp. (9)	1,3,4,5,6
<i>Camarotis</i> sp.?	1,6
<i>Cleisostoma</i> spp. (3) (Fig.5)	3
<i>Coelogyne membranifolia</i>	1
<i>Coelogyne</i> spp. (7)	1,4,5,6
<i>Cymbidium finlaysonianum</i>	1,2
<i>Cymbidium atropurpureum?</i>	2,4
<i>Cymbidium</i> sp.	2
<i>Dendrobium aloefolium</i>	4,6
<i>A crumenatum</i>	6
<i>D. leonis</i>	1
<i>A lobatum</i>	6
<i>D. lamellatum</i> var. 'Sabah'	3
<i>D. secundum?</i>	3,6
<i>D. teres?</i>	6
<i>D. spurium</i>	3
<i>D. kentrophyllum</i> var. Sabah	3
<i>D. setifolium</i>	3
<i>D. pumilum?</i>	6
<i>D. bifarium</i>	6
* <i>Dendrobium</i> sp. (Section <i>Rhopalanthè</i>)	5
* <i>Dendrobium</i> sp. (Section <i>Pedilonum</i>)	6
<i>Dendrochilum</i> spp. (2)	1,4,5,6
<i>Dipodium</i> sp. (1)	4
<i>Eria neglecta</i>	1,4,5,6
<i>Eria pudica?</i>	1
<i>E. dens?</i>	4,6
<i>E. Braddonii</i>	5
<i>E. cepifolia</i>	6
<i>E. pannea</i>	6
<i>Eria</i> spp. (5)	1,6

NAME	AREA FOUND
<i>Flickingeria Kelsalii?</i>	1,6
* <i>Flickingeriaplicatilis?</i>	3
<i>Flickingeria</i> spp. (2)	1,3
<i>Grammatophyllum scriptum</i>	1
<i>G. speciosum</i>	2,5
<i>Hippeophyllum</i> sp. (1)	5
<i>Liparis</i> spp. (4)	1,5,6
<i>Microsaccus javensis</i>	1
<i>Malleola penangiana</i>	2

<i>Malleola</i> spp. (2)	1,4
<i>Oberonia</i> sp.	1
" <i>Podochilus malabaricus</i>	1
<i>P. microphyllus</i>	1
<i>P. lucescens</i>	3
<i>Phalaenopsis maculata?</i>	1
<i>Pholidota</i> sp.?(1)	3
<i>Pomatocalpa</i> sp? (1)	4
* <i>Renanthera?</i> sp.	2
<i>Sarcochilus caligaris</i>	2,3
<i>Thecostele</i> sp. (1)	1
<i>Thrixspermum duplocallosum?</i>	1
<i>T. acuminatissimum</i>	6
<i>Trichotisia ferox?</i>	1,6
<i>T. velutina?</i>	5
<i>Trichoglottis lanceolaria</i>	3
<i>Taeniophyllum</i> sp. (1)	4
<i>Vanilla</i> sp. (1)	3

Epiphytes: 32 genera, 104 spp.

Total: 43 genera, 118 spp.

*probably new or previously underscribed species

** new record for Sabah

CONCLUSION

As seen in Table 7, a host of diverse orchid genera and species were found in Tawau Hills Park. A total of 118 species from 42 genera was collected. Considering the limited human resources, the relatively small area covered and the short time spent, the large numbers of species obtained reflects the wealth of the orchid flora in the area. Probably many more orchids escaped our detection in the areas covered. Undoubtedly, many others, including some new ones, occur in the unexplored area, especially at the less accessible higher elevations. A detailed follow-up survey is recommended for an in-depth study of the orchid flora in the area.

Of special interest is the discovery of 3 probable new species and 4 new records for Sabah. Two of them have been confirmed to be new Q.J. Wood of Royal Botanic Gardens, Kew personal communication). These are *Dendrobium* sp. nov., Section *Rhopalanthe* (specimen 5.4) and *Dendrobium* sp. nov., Section *Pedilonum* specimen 6.18). The third, a *Renanthera* species (specimen 2.3), is still being studied. The plant flowered recently and it appeared to be closely allied to *R. matutina*. It differed from the latter by having longer leaves which are pointed and smaller yellow flowers with distinct red spots. Among the new records for Sabah, specimen 1.26, *Podochilus malabaricus*, is the most interesting as it was until now thought only to occur in Sri

Lanka and South India, *Appendicula calcarata* (specimen 1.15), *Agrostophyllum hasseltii* (specimen 6.16), and *Tainia latilingua* (5.1) are the other new records for Sabah. Probably some of the other recorded species are also new to Sabah, but these can only be confirmed after the author has received the detailed check-list of orchid species from Sabah.

Some of the plants collected from the area, including the new species, have horticultural potential. Amongst them are the jewel orchids *Goodyera colorata?* and *Cystorchis? sp.*, *Dendrobium lamellatum* var. 'Sabah', and the new species of *Dendrobium* (specimen 6.18) and *Renanthera* (specimen 2.3).

Considering the vast wealth of the orchid flora, as well as other flora, in the Tawau Hills area, the move by the State Government to conserve the area as a Forest Reserve and State Park is indeed timely and right. Some of the orchids in the Tawau Hills area are not found on the West Coast of Sabah, and are probably endemic to the area. Stricter enforcement is essential to ensure that the existing forest, although 40% of it is already logged, does not experience any further encroachment. The penalty for the removal of plants from the area should be increased substantially, as in the case of Taman Laut in P. Malaysia, where the fine is RM50,000.

ACKNOWLEDGEMENTS

The interest, support, technical advice and direction given by Dr. Saharan b. Hj. Anang, the Deputy-Director General (Commodity Research), MARDI, on the project, is gratefully acknowledged. Thanks are also due to the organizers, Universiti Kebangsaan Malaysia, Sabah Campus and Taman-Taman Sabah for their invitation and for providing the camp infrastructure and facilities that made working enjoyable. The assistance and cooperation given by members of the team, namely, M. Khelikuzzaman, Harry Lohok, Masron b. Hasran, Hj. Yassin b. Tana, and Shohimi b. Ramli is deeply appreciated. The expertise and help given by Mr. J.J. Wood of the Royal Botanic Gardens, Kew, in examining and identifying the difficult specimens and the cooperation of Mr. Ong Boon Thuan, MARDI, Serdang, in maintaining the plants are gratefully acknowledged.

ARTICLE CITATION

The above article should be cited as:

Lim, Weng Hee; "A Preliminary Survey of Orchids in Tawau Hills Park, Sabah" *ASEAN Review of Biodiversity and Environmental Conservation (ARBEC)*, Website: <http://www.cyberct.com.my/arbec>; Article VII, January-February 1999