Zingiberaceae of Maliau Basin, Sabah, Malaysia

Avelinah Julius[1], Atsuko Takano[2], Monica Suleiman[3] and Welly Frederick Tukin[4]

[1]Forest Research Institute Malaysia, 52109 Kepong, Selangor Darul Ehsan, Malaysia.

[2]Museum of Nature and Human Activities Hyogo, 6 Chome, Yayoigaoka, Sanda, Hyogo 669-1546, Japan.

[3]Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Locked Bag 2073, 88999 Kota Kinabalu, Sabah, Malaysia.

[4]Maliau Basin Studies Centre, P.O Box 60793, 91017 Tawau, Sabah, Malaysia.

ABSTRACT. The genera and species of Zingiberaceae in the Maliau Basin Conservation Area (MBCA) were studied based on fieldwork and herbarium specimens at the Forest Research Centre Herbarium, Sepilok (SAN). A total of 65 species in 14 genera of gingers were found and recorded from this area. Some important genera were *Plagiostachys*, *Etlingera*, *Elettariopsis* and *Hornstedtia*. The population in this area is relatively high compared to other areas in the western part of Sabah, e.g. Crocker Range and Kinabalu Park with 51 species in 12 genera and 58 species in 12 genera, respectively. Members of the tribe Alpinieae are predominant in the area surveyed. Two species, *Elettariopsis smithiae* var. *rugosa* and *Hornstedtia scyphifera* var. *fusiformis*, are new records for Borneo.

Keywords: Gingers, *Elettariopsis smithiae* var. *rugosa*, *Hornstedtia scyphifera* var. *fusiformis*, first report, Borneo, Zingiberaceae.

INTRODUCTION

With 53 genera and over 1200 species, Zingiberaceae is the largest family of the order Zingiberales (Kress *et al*., 2002) and it is widely distributed in the tropics. Nineteen genera and over 200 species have been reported so far from Borneo. Of these, 14 genera and ca. 156 species were recorded in Sabah (Gobilik & Yusoff, 2005). Though ca. 156 species have been recorded for this state, many species remain undescribed and are yet to be documented (e.g. Ibrahim, 1995; Takano *et al*., 2004; Julius *et al*., 2005).

Maliau Basin, which covers approximately 590 km², is located in the centre of the southern part of Sabah, and is famous among botanists for its richness in flora. Its forests rise from about 300 m to 1800 m above sea level, and has an uninterrupted range of forest types from lowland to upper montane.

To date, only 28 species of gingers were reported in Maliau Basin. Hazebroek *et al*. (2004) listed gingers found in that area based on specimens deposited in SAN, mostly collected by *Sidkan et al*. (not including Poulsen's specimens). The number given does not represent the diversity of gingers in Maliau Basin, and furthermore not all localities were studied.

Subsequently, further studies and collection was attempted to update the number of gingers harboured in that area during the Maliau Basin Scientific Expedition 2005, which was jointly organised by Universiti Malaysia Sabah, the Japanese International Cooperation Agency and Yayasan Sabah.

In this paper, we present the list of gingers species found in Maliau Basin based on the 2005 collection and the additional herbarium material studied in BORNEENSIS Herbarium, Institute for Tropical Biology and Conservation (BORH) and SAN (including specimens collected by Poulsen *et al*.), and to compare it to those of the other areas in Borneo.

METHODS

The survey was conducted in Maliau Basin at various localities namely Agathis Camp, Ginseng Camp, Lobah Camp, Bambangan Camp, Camel Trophy, Maliau Waterfall, Ginseng Waterfall and the trail to Giluk Waterfall. In addition, gingers were also collected along the trails between the camps. Plant collection and observation was done from 25 February 2005 to 9 March 2005. Collected plants were pressed for herbarium specimens, and parts of flowers or fruits (if available) were preserved in 70 % ethanol. Specimens were deposited either at BORH or SAN. Additional material from Maliau Basin were examined at BORH and SAN, and cited here as well. Keys included in publications by Cowley (1999), Kam (1982), Poulsen *et al.* (1999), Smith (1982, 1985, 1986, 1987, 1988, 1989, 1990) and Sakai & Nagamasu (2000, 2003) were used to identify the species. Collection number of recent collection, were given the initial ATW, which stands for Avelinah Julius, Takahashi, A. and Willey, F.T. The specimens of *Etlingera* were determined by A. D. Poulsen during his short visit at BORH in June 2005.

RESULTS

Including records at BORH and SAN herbaria, Maliau Basin harbours 66 species from 14 genera of gingers (Table 1). The genera *Amomum* has the highest number of species with ten species, followed by *Etlingera* and *Plagiostachys* (nine species each). Generally, these genera are mainly represented for Bornean gingers (Ibrahim, 1992; Gobilik & Yusoff, 2005). Brief description or short notes, where appropriate, are provided below.

Table 1. List of ginger species found in Maliau Basin.

No.	Tribe	Genus	Number of species
1.	Alpinieae	*Alpinia* Roxb.	3
2.		*Amomum* Roxb.	9
3.		*Elettaria* Maton	7
4.		*Elettariopsis* Baker	4
5.		*Etlingera* Giseke	10
6.		*Geostachys* (Baker) Ridl.	1
7.		*Hornstedtia* Retz.	2
8.		*Plagiostachys* Ridl.	9
9.	Riedelieae	*Burbidgea* Hook f.	1
10.	Zingibereae	*Boesenbergia* O. Kuntze	7
11.		*Hedychium* Konig.	2
12.		*Scaphochlamys* Baker	1
13.		*Zingiber* Mill.	3
14.	Globbeae	*Globba* L.	6
	TOTAL		65

Alpinieae A. Rich

Alpinieae is an evergreen herb. This tribe is characterised by the plane of distichy of leaves is tranverse to direction of rhizome, having fibrous rhizome rather than fleshy, lack of extrafloral nectaries, lateral staminodes are much more reduced or absent and never petaloid, labellum never connate to filament, having a medium length of filament that is sometimes arching, anther crest petaloid or absent, ovary trilocular, placentation is axial or free central and capsule is indehiscent or fleshy.

1. *Alpinia* Roxb.

The genus is easily distinguished by its terminal inflorescence on leafy shoot, which is emerging above its uppermost leaf sheath, rarely appearing lateral and if so then not densely congested and labellum large and showy (so far only two species, *A. havilandii* K. Schum and *A. hansenii* R.M. Sm., are known to have lateral inflorescence).

1.1 *Alpinia ligulata* K. Schum.

Maliau Basin. On trail to Ginseng Waterfall, moist area, 28 Feb. 2005, ATW14 (BORH); Pakis Camp, upper dipterocarp, alt. 800 m, fruits green, 18 Mar. 2001, *Sawantan & Sidkan* MB822 (SAN).

This plant has strong paniculate inflorescence similar to *A. nieuwenhuizii* and easily distinguished from other taxa by its prominent long ligule.

1.2 *Alpinia nieuwenhuizii* Valeton

This species is the only *Alpinia* found growing on steep slope at Ginseng Waterfall. Flowers were observed. No voucher specimens were made.

1.3 *Alpinia* cf. *havilandii* K. Schum.

Maliau Basin. Pakis Camp, upper dipterocarp, alt. 800 m, attaining to 1 m tall, 15 Mar. 2001, *Joel & Sidkan* MB772 and *Henry & Sidkan* MB780 (SAN).

This plant resembles to *A. havilandii* from its inflorescence which penetrate through the leafy stem and pubescent, petiolate leaves, capsule globose and hairy. No flowers observed.

2. *Amomum* Roxb.

Amomum is characterised by radical cone-like inflorescences without an involucre of sterile bracts, sometimes stilted root. Flowers either borne singly or in cincinni, bracteoles tubular or open to the base, corolla tube long exerted from calyx or having more or less equal to or shorter than the calyx, lateral staminodes present or absent, anther crested or ecristate and its anther thecae reportedly dehiscing either throughout the length or only upper half.

2.1 *Amomum* cf. *anomalum* R.M. Sm.

Maliau Basin. Trail to Ginseng Waterfall, on stream, 28 Feb. 2005, ATW17 (BORH).

The specimen above grows in clump, stilted, to 2 m tall. Inflorescence cylindrical, elongate to age, one flower per bract, bracts papery and markedly fine longitudinal striations.

2.2 *Amomum borealiborneense* I.M.Turner

Maliau Basin. Bambangan Camp, shaded, alt. 480 m, 6 Mar. 2005, ATW40 (BORH).

Terrestrial herb, in clump, to 1.7 m tall. Leaf sheath pale brown, striate, glabrous. Leaves sessile, ligule 3 mm long, entire; lamina narrowly elliptic, ca. 30 × 3.5 cm, base cuneate-attenuate, apex acuminate, ca. 2 cm long. Inflorescence appeared at base of

leafy stem, ca. 11 cm long, bracts pale brown, striate, papery, rachis hairy, one flower per bract. Flowers pale cream; calyx tubular, white, truncate; labellum obovate, clawed at base, median yellow, flanking with scarlet vein, anther pinkish, anther crest trilobe, median lobe reflexed backward; lateral staminodes whitish with red at base, reflexed outward to labellum, glabrous.

Other individual also found growing near trail around Ginseng Camp, but no voucher specimen was made.

2.3 *Amomum coriaceum* R.M. Sm.

Maliau Basin, Agathis Camp, virgin forest, nature trail near camp, 4º42' N, 116º54'E, alt. 600 m, 29 Mar. 2002, L. M. Sm. 1830 (SAN); stream bank near camp, 8 Mar. 2005, ATW19 (BORH).

Terrestrial herb, in clump, to 2.5 m tall, stilted. Leaves narrowly elliptic, pubescent below, glabrous above; ligule ca. 1 cm long, entire, pubescent. Infructescent from base, 7–15 cm long. Bracts frilled, hairy in the margin, stiff at apex. Capsule sub-globose. Calyces remaining in fruiting. No flower observed.

2.4 *Amomum dimorphum* M.F. Newman

Maliau Basin. Km 35 from gate towards MBCA, roadside in open area, 4º37' N, 116º56'E, alt. 440 m, terrestrial herb, in clump, 2–3 m tall. Stem yellow-green, lamina dark green, midrib yellow, lamina plain green below, inflorescence at base, erect, flowers white, fruits green to pale yellow (when ripe), arillus with sour taste, seeds brown, 27 Mar. 2002, *Poulsen* 1811 (SAN); 700 m along trail from Bambangan Camp to Camp 88, regenerating landslide area, 4º46' N, 116º55'E, alt. 600 m, terrestrial herb, up to 3.5 m tall, in clump, stilt rooted, ca. 7 cm. Base of leafy shoot reddish brown, 4–5 cm in diam., lower 2 m leafless, inflorescent peduncle ascending from base up to 20 cm, two flowers per bract, flowers cream–white with orange-yellow patch in labellum, calyces remaining after flowering, 6 Oct. 2002, *Poulsen* 1653 (SAN); Agathis Camp, flat area, alt. 500 m, can reach height to 5 m, 5 Apr. 2000, *Diwol & Sidkan* MB38 (SAN); trail to Ginseng Waterfall, by a stream, 28 Feb. 2005, ATW20 (BORH).

2.5 *Amomum testaceum* Ridl.

Maliau Basin. Small stream near road between junction and Belian Camp, secondary forest, wet slope of stream bed, 4º44' N, 116º59'E, alt. 300 m, 28 Mar. 2002, *Poulsen* 1823 (SAN); trail from Lobah Camp to Maliau Waterfalls, alt. 550 m a.s.l., 6 Mar. 2005, ATW41 (BORH, SAN).

This species produces a lime smell when its leaves are crashed. It can be distinguished from other species by the papery, buff coloured bracts, that are strongly marked with longitudinal striations.

2.6 *Amomum* aff. *laxisquamosum* K. Schum.

Maliau Basin. Camel Trophy, alt. 910 m, 2 Mar. 2005, ATW24 (BORH).

Terrestrial herb, up to 1.60 m tall. Leaves ca. 5 pairs per shoot, lamina linear-elliptic, 35 × 3 cm, leaf apex acuminate, 5–10 mm long, leaf base unequal, cuneate-attenuate, petiole to 1 cm long, ± sessile in upper part of leafy shoot; ligule, bilobed, 2–5 mm long; sheath reticulate, densely short hairs. Infructescence at base of leafy stem, ca. 7 cm long, globose; bracts pale brown, papery, glabrous; calyx, ca. 1 cm long, densely hairy outside, pale brown in dry state; capsule oblong, ca. 2 × 1 cm, ribbed, densely hairy.

The plant is similar to *A. laxisquamosum* in its reticulate sheath, shorter ligule (up to 5 mm long), and ribbed capsule, but it differs by having oblong and pubescence capsule as opposed to spherical and glabrous capsule of *A. laxisquamosum*.

2.7 *Amomum* aff. *luteum* R.M. Sm.

Maliau Basin. Pakis Camp, upper dipterocarp, alt. 800 m, 15 Mar. 2001, *Ming, Sawantan & Sidkan* MB770 (SAN).

In having petiole to 2 cm long, the pubescence lamina on lower surface and the hairy ligule, this plant resembles to *A. luteum*, but it differs in lacking hairs on its petiole and leaf sheath.

2.8 *Amomum* aff. *testaceum* Ridl.

Maliau Basin. Belian Camp, secondary forest, relatively intact, about 15 m above river, 4º45' N, 116º58'E, alt. 250 m, terrestrial herb, ca. 1 m tall, in clump, more or less stilted, stem reticulate, petioles ca. 2 cm long, bracts brown, leaf sheath strongly reticulate, ligule, truncate-emarginate and glabrous, leaves elliptic, 18–35 × 7 cm, glabrous and shiny on upper surface, pubescent below, inflorescence ca. 10 cm long, bracts brown, papery, and striate, 27 Mar. 2002, *Poulsen* 1815 (SAN).

This plant resembles to a typical *A. testaceum* in having a strongly reticulate sheath and a conspicuous striation on its brown, papery bracts, but it differs in the following characters. It has rather elliptic leaves, with lamina pubescence below, petiolate and ligule are glabrous as opposed to the lanceolate leaves, lamina glabrous on both surfaces except at edges towards apex, sessile, and its ligule bears stiff hairs as in the latter.

2.9 *Amomum* sp. 1

Maliau Basin. Belian Camp, secondary forest, relatively intact, about 15 m above river, 4º45' N, 116º58'E, alt. 250 m, terrestrial herb, 1 m tall, leaves narrowly linear-elliptic, 35 × 5 cm, glabrous on both surfaces, shortly attenuate at base and apex shortly acute, inflorescence, 6–15 cm long, bract pale brown, papery, loose, fruits globose and hairy, 27 Mar. 2002, *Poulsen* 1816 (SAN).

3. *Elettaria* Maton

The genus *Elettaria* is characterised by frond-like leaf shoots, having prostrate inflorescence born separately from the leafy shoot, which is usually much elongated, flowers in cincinni with tubular bracteoles, bracts never imbricate, and anther crest absent or present (very minute).

3.1 *Elettaria* cf. *linearcristata* S. Sakai & Nagam.

Maliau Basin. Trail from Ginseng Camp to Lobah Camp, 5 Mar. 2005, ATW16 (BORH).

Perennial herb to 1 m tall. Leaves ca. 8 pairs per shoot; lamina ca. 15 x 4.5 cm, narrowly elliptic, crenulate along the margin, glabrous on both surface, but minutely pubescent in the midrib below, leaf base cuneate, apex caudate ca. 1.5 cm long; petiole to 7 mm long, hairy; ligule 2-4 mm long, emarginate, pubescent, with long hairs and stiff hairs at apex; sheath striate, hairy. The inflorescences elongate to ca. 15 cm long, pubescent. Flowers in cincinni.

Only dry immature inflorescence was observed in the field. It is densely hairy in all part ranging from minute to long hairs. Vegetatively it also shows similarity to *E. linearcristata* by its pubescent ligule, petiole, leaf sheath and midrib, and differ only in having narrowly elliptic lamina and more longer petiole as opposed to narrowly oblong-obovate lamina and petiole less than 7 mm long in the former. However, fertile and fresh living plant is essential to confirm the species. So far, *E. linearcristata* is only known from Sarawak.

3.2 *Elettaria* sp.1

Maliau Basin. Belian Camp, shaded, tall dipterocarp forest along streamlet, terrestrial herb, ca. 1 m tall. Flowers white on erect shootlet, on long subterranean runners to 70 cm, 11 July 2001, *J.T.Pereira, Postar, De Wilde et al.* SAN151211 (SAN).

3.3 *Elettaria* sp.2

Maliau Basin. Belian Camp, on damp shady ground along forest rivulet, alt. 250 m, terrestrial herb with almost 1 m tall, flower colour unknown but based on the label notes, labellum is purple red, 11 July 2001, *Postar, Ubaldus, De Wilde et al*. SAN144126 (SAN).

3.4 *Elettaria* sp.3

Maliau Basin. Agathis Camp, virgin forest, nature trail, near camp, 4º42' N, 116º54'E, alt. 600 m, terrestrial herb to 1 m tall, rhizome creeping, ca. 20 cm between shoots, inflorescence long-creeping, flowers 20–60 cm from base of stem, calyx reddish, petals and labellum white, stamen yellow-green, 29 Mar. 2002, *Poulsen* 1832 (SAN).

3.5 *Elettaria* sp.4

Maliau Basin. 100 m along trail to Aliyas Camp going to north from Camel Trophy Hut towards waterfall, 4º44' N, 116º53'E, alt. 1050 m, terrestrial herb, rhizome long creeping, base of petioles reddish, inflorescence creeping, flowers white, 4 Oct. 2000, *Poulsen* 1636 (SAN).

3.6 *Elettaria* sp.5

Maliau Basin. Belian Camp, secondary forest, relatively intact, close to small rocky stream, 4º45' N, 116º58'E, alt. 250 m, terrestrial herb to 1.5 m tall, in clump, stem green, leaves plicate, pubescent below, inflorescence creeping, bracts pale red, drying brown, dorsal petal reddish, labellum white with yellow centre, stamen red, 27 Mar. 2002, *Poulsen* 1812 (SAN).

3.7 *Elettaria* sp.6

Maliau Basin. Belian Camp, shaded, along muddy stream, on drained place, alt. 250 m, terrestrial herb with rootstock, flowers on subterranean runners (60 cm) on upright lateral shoots, 15 Mar. 2001, Postar, Ubaldus, De Wilde *et al.* SAN144126 (SAN).

4. *Elettariopsis* Baker

Few-bladed leafy shoots characterised the genus *Elettariopsis*. Non-tubular bracteoles, prominent thin expanded anther crest, which is often longer than the thecae, and obconic, triangular-mouthed stigma are the characteristics that distinguish the genus from other genera.

4.1 *Elettariopsis kerbyi* R.M. Sm.

Maliau Basin. Agathis Camp, virgin forest, nature trail near camp, 4º41' N, 110º54'E, alt. 600 m, terrestrial herb to 1 m tall, rhizome short-creeping, lamina dark green, 29 Mar. 2002, *Poulsen* 1831 (SAN).

Elettariopsis kerbyi resembles to *E. smithiae* in almost all aspects of the inflorescence (Smith, 1990), but differs from the latter in having linear leaves with long caudate apex and the petioles, when present, never exceed to 1 cm long.

4.2 *Elettariopsis* aff. *kerbyii* R.M.Sm.

Maliau Basin. Ginseng Camp, around waterfall, on slope, alt. 555 m, 4 Mar. 2005, ATW14 (BORH).

By having linear leaves, long caudate apex, shortly bilobed pubescent ligule and short inflorescence, which arise at base of the leafy shoot, this specimen is remarkably similar to *Elettariopsis kerbyi.* However, this specimen differs from the description by Smith (1990) in having long pubescent petiole which is to 4.5 cm long. This plant could be new or only a variation within the species. Only the dry inflorescence was observed. Further fertile and fresh living plant is essential to confirm the species.

4.3 *Elettariopsis smithiae* var. *rugosa* Kam

Maliau Basin. Bambangan Camp, near trail, covered with thin layer of leaf litter, surrounding areas, alt. 480 m, 6 Mar. 2005, ATW44 (BORH).

Rhizomatous herb, ca. 1.3 m tall. Leafy shoot bearing up to six leaves, with petiole 2.5–7 cm long, glabrous; lamina, elliptic-oblanceolate, ca. 29–35 × 4–7 cm, glabrous, rugose, base cuneate-attenuate, apex short caudate, ca. 1.5 cm long; ligule bilobed, ca. 3 mm long, lobes rounded, glabrous; bracts and bracteoles totally open. Flower, ca. 7 cm long, whitish-pale cream; calyx tubular, ca. 3 cm long, bilobed at apex, glabrous; corolla tube, slender, ca. 5 cm long, pale yellow and pinkish at base; corolla hardly equal length, ca. 1.5 cm long, dorsal petal spatulate, cuculate, laterals ovate; labellum ovate, with conspicuous throat, crispy along the margin, yellow band in the middle flanking by scarlet dots at base; stamen ca. 7 mm long, with anther ca. 3 mm long, thecae whitish; anther crest thin, broadly triangular; stigma protruding 1 mm above anther, obconical, with dorsal opening, ciliated mouth; epigynous gland, two, slender, pale yellow, ca. 5 mm long; ovary globose, ca. 5 × 3 mm, pubescence with short hair, surrounded by a thin line of tinted pink at base and apex.

The creamy white flower, and its labellum being yellow centrally, which is flanking by the two red lines, the crested anther, and the short inflorescence that appears at base of leafy shoot, could confuse this plant with *Amomum*. However, the conspicuously longer petiole (to 7 cm long), in its obconical stigma, and loosely few blades, are not characteristics of *Amomum*.

It is readily recognised from *Elettariopsis curtisii* Baker and *E. burttiana* Y.K. Kam in its not decurrent leaf base, petiole not exceeding 7 cm long, ligule not more than 3 mm long, and absence of lateral staminodes. The conspicuously caudate leaf apex, and in its ligule being short, bilobed and glabrous, ATW44 appears similar to *E. triloba*, but it differs by lacking of lateral staminodes, has triangular anther crest, obtuse bract apices, and having an entire labellum as opposed to the presence of lateral staminodes, anther crest is more or less quadrate, thin, expanded, with a small tooth-like lobe at base on each side, broadly pointed bract, and trilobed labellum of the latter.

This plant can not be separated from *E. smithiae* var. *rugosa,* from the structure of its inflorescence and flowers, as compared the type illustration of the former (fig. 5, *Kam* 228; Kam, 1982). The remarkable characters in having rugose lamina, and the absence of lateral staminodes distinguished this plant from typical form of *E. smithiae.*

4.4 *Elettariopsis* sp.

Maliau Basin. Lake Linumunsut, at slope, alt. 440 m, terrestrial herb to 50 cm tall and having green inflorescence, 17 Oct. 2001, *Sidkan* s.n. (SAN).

5. *Etlingera* Giseke

Etlingera is characterised by an involucre of sterile bracts, a short or much elongated peduncle, tubular and elongated bracteoles, and distinct petal lobes, base of filament and labellum (Poulsen *et al.,* 1999).

5.1 *Etlingera brachychila* (Ridl.) R.M. Sm.

Maliau Basin. Agathis Camp. 8 Mar. 2005, ATW47 (BORH); riverside forest, alt. 300 m, herbs plant, ca. 1.5 m tall, upper leaves green, lower part dark purple, 24 July 2003, *Diwol* SAN136232 (SAN).

This species is easily identified by the purple colour underneath the lamina, leaves distinctly undulate and flowers scarlet, many open at one time, and lip is short.

5.2 *Etlingera brevilabrum* (Valeton) R.M. Sm.

Maliau Basin. Trail between Camel Trophy Hut towards Bambangan Camp, ridge top, 4º46' N, 116º55'E, alt. 600 m, *Poulsen* 1646 (SAN); Rafflesia Camp, near the river, alt. 500 m, 24 Apr. 2000, *Henry* & *Sidkan* MB223 (SAN).

It is easy to recognise this species by its short rounded red labellum with prominent white stigma, which is one to two in an inflorescence. Another distinguishing character of this species is the presence of many purple blotches on the surface of its lamina.

5.3 *Etlingera coccinea* (Blume) S. Sakai & Nagam.

Maliau Basin. Ginseng Waterfall, on slope, moist area, 28 Feb. 2005, ATW46 (BORH).

This plant is edible and used by local people as food. Its young shoot is collected as vegetable and for pickle. It is easily identified by its strong unpleasant smell and red labellum with yellow in the middle.

5.4 *Etlingera fimbriobracteata* (K. Schum.) R.M. Sm.

Maliau Basin. Rafflesia Camp, hilly-helipad, alt. 500 m, 2 m tall, flower yellowish red, 23 Apr. 2000, *Sidkan, A*. MB216 (SAN); along the trail from Bambangan Camp to Camp 88, regenerating landslide area, 4º46' N, 116º55'E, alt. 600 m, *Poulsen* 1654 (SAN).

5.5 *Etlingera inundata* S. Sakai & Nagam

Maliau Basin. Around Camel Trophy, alt. 910 m, 2 Mar. 2005, ATW23 (BORH); Pakis Camp, upper dipterocarp, alt. 500 m, attaining to 1.5 m tall, 15 Mar. 2001, *Linus* MB767 (SAN).

Terrestrial herb, can attain to 2 m height. Leaf sheath covered with dense hairs. Leaves pubescent below, ca. 45 × 11 cm, with petiole 1 cm long. Inflorescence ca. 10 cm long, produced from long stolon, sessile, subtends two flowers. Flowers pink, lateral petals equal length to dorsal petal, anther short, sessile, stigma whitish, labellum red, trilobed, crispy. No fruit observed.

This newly described species is, so far, only known from Danum Valley (Sakai & Nagamasu, 2003). This is the second record of this species from southeastern part of Sabah. Based on these two localities, this species inhabits hill and lowland dipterocarp forests. It can easily be distinguished from its inflorescence, which is subtending two flowers, with few imbricate fertile and sterile bracts. Only perfect flowers observed.

5.6 *Etlingera rubromarginata* A.D. Poulsen & J. Mood

Maliau Basin. Trail from Bambangan Camp to Maliau Falls, 4º46' N, 116º55'E, alt. 550 m, 6 Oct. 2000, *Poulsen* 1647 (SAN, BORH); Secondary forest, small stream near road between junction and Belian Camp, wet slope of stream bed, 4º44' N, 116º59'E, alt. 300 m, 28 Mar. 2002, *Poulsen* 1821 (SAN, BORH).

No further plant has been seen during the survey. The species, however, is easily identified by its white with red margins bracts.

5.7 *Etlingera sessilanthera* R.M. Sm.

Maliau Basin. Agathis Camp, virgin forest, Nature Trail near camp, 4º42' N, 116º54'E, alt. 600 m, 29 Mar. 2000, *Poulsen* 1826 (SAN); trail from Bambangan Camp to Maliau Falls, 4º46' N, 116º55'E, alt. 550 m, 6 Oct. 2000, *Poulsen* 1651 (SAN).

This species is reported to be common in wet areas. The red flower with ecristate anther resembles that of to *E. brevilabrum*. However, the former is differentiated by having red labellum with yellow in the centre and bifid middle lobe.

5.8 *Etlingera* aff. *belalongensis* A. D. Poulsen.

Maliau Basin. Around Ginseng Camp, on slope, shaded, surrounding areas, 4 Mar. 2005, ATW31 (BORH); 2 km along trail to Aliyas Camp going north from Camel Trophy Hut towards waterfall, 4º44' N, 116º53'E, alt. 1050 m, 4 Oct. 2000, *Poulsen* 1637 (SAN).

Only one individual found in the study area. The inflorescence is subterranean, produced from long creeping rhizome. Peduncle ca. 7 cm long, pubescent. Only three flowers open at a time. The bracts are whitish with pink or greenish at edges, with sparse, long hairs becoming denser to the base outside, mucronate, ca. 1 mm long. Corolla lobes oblanceolate, dark pink and shimmers, hardly equal in length. The red, nodding ecristate anther is similar to *E. belalongensis* A. D. Poulsen, but filament and labellum joined to form a tube 1.7–2.0 cm above insertion of corolla. Stigma whitish, heart-shape, flattened, with dorsal opening mouth, ciliate. Labellum red-orange with yellow line in the middle, slightly trilobed, and lateral lobes clasping the anther, margin crispy. It appears similar to another collection, *Julius* 182 (BORH) from Sayap, in the northern part of Mount Kinabalu. However, the bract is deep pink rather than whitish, and 3–5 flowers open at one time.

5.9 *Etlingera baculutea* A.D. Poulsen & H. Ibrahim

Maliau Basin. Trail to Ginseng Waterfall, on rotten tree, shaddy and moist area, 28 Feb. 2005, ATW13 (BORH).

Terrestrial herb, ca. 2 m tall, stilted roots, with a medium clump. Leaves petiolate in uppermost part of leafy shoot, petiole to 7 cm long, swollen on both lateral side; leaf sheath strongly reticulate; ligule thin texture, fragile, deeply bilobed, acute, ca. 1.5 cm long; lamina elliptic, ca. 47 × 7 cm, glabrous on both surface, base attenuate, apex pungent. Sterile bracts few, markedly striate; fertile bracts narrowly elliptic, ca. 5 × 1 cm, striate, papery, at base velvety. The labellum is yellow with red at tip. Ovary globose, covered with smooth, dense hairs. Pedicels ca. 3 mm long, velvety. No fruit observed.

Only one individual found in the study area. It is characterised by brittles, bilobed ligule and prominent reticulate leaf sheath. From its red and yellow labellum, the plant above resembles to *E. coccinea*, but it is easily recognised by having shorter labellum and the midlobed is linear as opposed to the expanded labellum and the spathulate-shaped in the midlobed of *E. coccinea.*

5.10 *Etlingera* aff. *velutina* (Ridl.) R.M.Sm.

Maliau Basin. Trail from Lobah Camp to Bambangan Camp, 6 Mar. 2005, ATW39 (BORH).

Terrestrial herb, can attain ca. 3.5 m tall. Leaves ca. 6 pairs per shoot; lamina papery at dry state, glabrous on upper surface, hairy below, more densely at midrib, ca. 60 × 12 cm, crenulate along the margin, ciliate, apex caudate, ca. 2 cm long, leaf base shortly attenuate; petiole ca. 1.5 cm long, pubescent with more densely hair underside; ligule ca. 2 cm long, entire, apex acute, covered with smooth, brown densely hairs, ciliate; sheath also pubescent covered with brown hairs. Inflorescence ca. 13 cm long, half buried on ground, appeared on long running rhizome, globose or cyathiform; rhizome velvety with densely brown hairs; sterile bracts 7 pairs, elliptic to 5 × 2.5 cm, distichously arranged at base, pubescent and more densely hairy at base, ciliate, markedly striate; fertile bracts ca. 5.5 × 1 cm, linear, striate, thin texture, pubescent outside,, densely hairy at base; calyx tubular, ca. 4.7 cm long, outside covered with sparse, straw-colour hairs becoming denser to the base and tufted hairs at apex; calyx tubular, densely hairy at base and sparsely long straw-colour hair towards apex. Flower with labellum pink

and yellow in the middle on both upper and below surface.

Descriptions for bract, bracteole and calyx were taken from flower bud using dry specimen. The conspicuous dense hairs on rhizome, bracts, ligule and petiole cannot separate this specimen from *E. velutina*. However, by having pink labellum with yellow in the middle on both upper and below surface of this specimen differentiates it from the type of *E. velutina*. Further collections are needed to clarify the status of this plant.

6. *Geostachys* (Baker) Ridl.

Geostachys has a lax and either erect or deflexed inflorescence, without overlapping bracts that are commonly borne on stilt roots, is similar to *Alpinia*. The labellum is entire or shallowly trilobed and filament is not dentate.

6.1 *Geostachys maliauensis* C.K. Lim & K.H. Lau

Maliau Basin. Trail to Giluk Waterfall, on rotten tree and rich with humus, alt. 800 m, 3 Mar. 2005, ATW29 (SAN).

Terrestrial herb, attaining height less than 1 m, bearing 3–5 blades per shoot, prominent veins. Lamina elliptic-lanceolate, 25–35 × 8–7 cm, glabrous on both surfaces, slightly undulate, apex acuminate, shortly caudate, leaf base cuneate, with petiole 1–3 cm long, ligule to 1 cm, truncate or emarginate. Inflorescence elongate to 6 cm long, bracts brown, markedly longitudinal striate, bracteoles brown, pedicels and peduncles red, only dry flowers observed.

7. *Hornstedtia* Retz.

The genus *Hornstedtia* produces radical inflorescence, which is enclosed by an involucre of rigid sterile bracts. The inflorescences, that are often held above ground on stilt roots, are fusiform or occasionally cyatiform. Normally, flowers emerged a few at a time and only their tips visible. It is also lack of lateral staminodes, and the corolla lobes and labellum are hardly equal in length.

7.1 *Hornstedtia scyphifera* (J.König) Steud. var. *fusiformis* Holttum

Maliau Basin. 18 Aug. 2000, MB577, as *Cenolophon* sp. (SAN); around Maliau Waterfall, surrounding areas, 6 Mar. 2005, ATW23 (BORH).

ATW23 (BORH) reaching ca. 2 m tall and stilted. Leaves ca. 5 pairs per shoot; lamina elliptic, ca. 40 × 11 cm, glabrous on upper surface, densely hairy on lower surface and midrib with longer, pale brown and straight hairs at base; ciliate in the margin, apex to 2.5 cm long, caudate, leaf base asymmetric, attenuate; leaf sheath reticulate, glabrous except densely long pale brown hairs ca. 5 mm in the uppermost towards ligule and petiole; ligule ca. 2 cm long, entire, hairy in the middle, ciliate with long straight hairs. Infructescence ca. 12 cm long, fusiform, glabrous; sterile bracts broadly elliptic, ribbing and the cross-bars, whitish half below, and brown (in the dry state) on upper half; fertile bracts, oblong-linear, glabrous; bracteoles non-tubular, linear, ca. 2.5 cm long, thin texture, glabrous, subtend one fruit. Capsule ca. 2.5 × 1.2 cm, obovate, glabrous, striate and pale brown (at dry stage). The tubular calyx remaining in the fruiting.

As seen in the type specimen (S.F.N. 30236), which is cited at E, the characteristics of the rhizome being raised on the short stilt roots, narrowly fusiform inflorescence, to about 12 cm long, and prominent long hairs up to 5 mm at ligule, petiole and the adjacent parts of sheath, cannot separate the plants above from var. *fusiformis*. However, the leaves of these Bornean plants are lacking hairs on its upper surface. So far, this species is only known from Peninsular Malaysia.

7.2 *Hornstedtia* sp. 1

Maliau Basin. Around Ginseng Camp, 4 Mar. 2005, ATW30 (BORH).

This plant is ca. 1.6 m tall, stilted; lamina oblong-elliptic, pubescent below and denser with white hairs at midrib, leaf base ± attenuate and asymmetric, apex acuminate; petiole ca. 1 cm long, pubescent, ligule ca. 2.5 cm long, glabrescent, ciliate; leaf sheath reticulate and minutely pubescent near petiole; inflorescences ca. 11 cm long including peduncle ca. 2 cm long, fusiform; bracts reticulate in upper half, apex mucronate, velvety at edges.

8. *Plagiostachys* Ridl.

Plagiostachys produces inflorescence which penetrates laterally from the leafy shoot. The recent molecular analysis by Julius *et al.* (2008) has divided the genus into three subclades; subclades A, B and C. These subclades can be differentiated using the combination characters of inflorescence (mucilaginous vs. not-mucilaginous) and hairiness of capsules (pubescent vs. glabrous). The species of subclade A, is characterized by having not-mucilaginous inflorescence and pubescent capsules, those species of subclade B show not- or mucilaginous inflorescence but glabrous capsules, while the species of subclade C has mucilaginous inflorescence but pubescent capsule.

8.1 *Plagiostachys albiflora* Ridl.

Maliau Basin. Agathis Camp, riverine forest, well drained, alt. 400-500 m, herb 1–1.2 m, fruits green ca. 2 cm long, short rootstock, 14 July 2001, *Postar et al.* SAN144105 (SAN); flat area, alt. 500 m, 5 Apr. 2000, *Edward & Sidkan* MB41 (SAN); Rafflesia Camp, alt. 515 m, 0.5 m tall, flowers orange, 23 Apr. 2000, *Edward & Sidkan* MB214 (SAN); around Ginseng Camp, at slope, shaded and wet area, alt. 610 m, 27 Feb. 2005, ATW4 (BORH).

Plagiostachys albiflora is belonging to subclade B as it has glabrous capsules with mucilaginous inflorescence. In Maliau Basin, the plant is conspicuously petiolate, has broadly oblanceolate leaves, and inflorescence/infructescence is branching to 2-3.

8.2 *Plagiostachys oblanceolata* Gobilik & A. Lamb

Maliau Basin. Camel Trophy Camp, northern direction, mountainous-heath, alt. 1018 m, herb ca. 1 m tall, flower red, 11 Apr. 2000, *Henry & Sidkan* MB124 (SAN); Rafflesia Camp, flat area, alt. 500 m, flower red, 22 Apr. 2000, *Sidkan* MB187 (SAN); km 6, trail from Agathis Camp to Ginseng Camp, 26 Feb. 2005 ATW1 (BORH); around Ginseng Camp, alt. 610 m, 27 Feb. 2005, ATW15 (BORH); Agathis Camp, nature trail, 8 Mar. 2005, ATW45 (BORH); around Camel Trophy Hut, 27 Feb. 2005, ATW25 (BORH); around Lobah Camp, 7 Mar. 2005, ATW33 (BORH).

This species is abundant in the study areas. It is also known from Imbak Canyon (*Gobilik* 1006 and HN7268). So far, no collection has been seen from the western part of Sabah, such as Crocker Range and Long Pasia.

8.3 *Plagiostachys parva* Cowley

Maliau Basin. Ginseng Camp, alt. 610 m, 27 Feb. 2005, ATW10 (BORH, SAN); trail from Lobah Camp to Maliau Waterfall, 7 Mar. 2005, ATW32 (BORH); trail to Camel Trophy, 3 Mar. 2005, ATW42 (BORH).

Plagiostachys parva's distribution is very little known. So far, it is only found to occur in Temburong District, Brunei and Poring, Ranau (Cowley, 1999). In Maliau Basin, it is mainly found at Ginseng Camp and further up to Lobah Camp and Camel Trophy.

8.4 *Plagiostachys strobilifera* (Baker) Ridl.

Maliau Basin. Upstream from Agathis Camp, top ridge, alt. 500 m, ca. 1 m tall, fruit cauliflorus, pale pink, 4 Apr. 2000, *Henry & Sidkan* MB11 (SAN); around Agathis Camp, 8 Mar. 2005, ATW48 (BORH).

Plagiostachy strobilifera is easily recognised by its sessile leaves, pubescence on both surface, often denser on lower surface, densely hairy leaf sheath, short truncate-emarginate (sometimes bilobed) ligule and densely hairy. The pinkish, short and densely hairy flower, and pubescence, whitish (rarely red) and globose capsule are characterics of this species.

8.5 *Plagiostachys* aff. *breviramosa* Cowley

Maliau Basin. Agathis Camp, virgin forest, nature trail near camp, 4º42' N, 116º54'E, alt. 600 m, terrestrial herb in clump, leaves lightly plicate, inflorescence/infructesence 20 cm above the base, dorsal petal white, labellum yellow, fruit red, 29 Mar. 2002 *Poulsen* 1652 (SAN); Agathis Camp, slope, alt. 500 m, 5 Apr. 2000, MB35 (SAN); trail from Agathis Camp to Ginseng Camp, 27 Feb. 2005, ATW16 (BORH); trail from Ginseng Camp to Lobah Camp, 7 Mar. 2005, ATW6 (BORH); around Agathis Camp, 8 Mar. 2005, ATW49 (BORH); around Ginseng Camp, 27 Feb. 2005, ATW7 (BORH).

This species is easily recognised as it is bearing many small scapes in the main axis of its inflorescences. It is flowering and fruiting at one time. Many observed and collected specimens at several localities in Sabah, including the above collections, have ecristate anther.

8.6 *Plagiostachys* aff. *parva* Cowley

Maliau Basin. Agathis Camp, alt. 400–500 m, herb with root stock, flowers pink red, some purplish tinged, 13 July 2001, *Pereira et al.* SAN144354 (SAN); around Agathis Camp, near stream, at slope with surrounding areas, 8 Mar. 2005, ATW43 (BORH).

Vegetatively, the specimens resembles to that of *P. parva* but differs in its flower structure as it lacks of anther crest or, if present, very minute. Further collections from other areas in Sabah is being carried out to determine whether this character is only a variation within species or represents a new taxa.

8.7 *Plagiostachys* aff. *strobilifera* R.M. Sm.

Maliau Basin. Km 6, trail from Agathis Camp to Ginseng Camp, alt. 560 m, 26 Feb. 2005, ATW2 (BORH); around Ginseng Camp, 27 Feb. 2005, ATW3 (BORH); *ex.*, 4 Mar. 2005, ATW34 (BORH); trail from Ginseng Camp to Camel Trophy, alt. 1000 m,1 Mar. 2005, ATW21 (BORH).

The status of the specimen above is still uncertain. At the moment, it is identified as an affinity to *P. strobilifera* because of its distinctly petiolate leaves and flower structure resembles to a collection by *Burtt & Martin* B4873 in Smith (1985).

8.8 *Plagiostachys brevicalcarata* Julius & A.Takano

Maliau Basin. Agathis Camp, near to stream bank at the entrance of nature trail, alt. 400-500 m, 8 Mar. 2005, ATW50 (BORH).

Perrenial herb, up to 3.5 m tall. Lamina ca. 90 × 10 cm, oblanceolate, glabrous on upper surface except midrib, pubescent, densely hairy below, base attenuate, apex acuminate-caudate, ca. 2.5 cm long; petiole to 2.5 cm long, densely hairy on upper surface, and sparsely beneath; leaf sheath glabrous; ligule ca. 4 mm long, shortly bilobed, apex rounded, ciliate. Infructescens 15–20 cm long, 3-branched, dorsal longer than lateral branch, penetrate through leafy stem, ca. 10 cm from ground level. Capsule glabrous, globose to subglobose, dull green (mature).

This plant is widely distributed in Sabah. A few other collections have been seen at SAR (e.g. Hewit series 141 and Lai *et al*. S7116). It can be found either in primary or secondary forest. It resembles *P. glandulosa* in its striate leaf sheath, petiolate leaves, and glabrous, deep red immature fruit. However, *P.*

brevicalcarata can be distinguished by having its lamina pubescence only on the lower surface, and inflorescence branching to three.

8.9 *Plagiostachys* sp.1

Maliau Basin. Trail from Camel to Giluk Waterfall, alt. 800 m, 3 Mar. 2005, ATW26 (BORH).

This plant is less than 1 m tall, leaves narrowly elliptic, ca. 21 × 4 cm, acuminate at apex, ca. 2.5 cm long, leaf base cuneate, pubescent on both surface; petiole short less than 1 cm, hairy; ligule bilobed, ca. 2 mm long, hairy. Infructescence penetrates laterally ca. 12 cm above ground level. Immature capsule apple green colour, glabrous and globose.

This plant resembles to *P. albiflora* in its fruits colour, and being glabrous, but the mucilaginous nature of its inflorescence separates it from the latter species. Its bracteoles structure, which is partially decay, is similar to *P. breviramosa*, but specimen ATW26 is unbranched, and the capsule is not flask-shape.

Riedelieae W.J. Kress

The tribe Riedelieae that proposed by Kress *et al.* (2002) encompasses five genera, namely *Burbidgea*, *Pleuranthodium*, *Riedelia*, *Siamanthus* and *Siliquamomum*. This tribe shared the characteristics of Alpinieae, and only differs in having fleshy rhizomes, the presence of extrafloral nectarines on leaf blades and the capsule is silique-like, opening by longitudinal slits.

9. *Burbidgea* Hook.*f.*

Burbidgea is formerly placed under Alpinieae and was transferred to Riedelieae recently. It has fleshy rhizomes and silique-like capsule, which is opening by longitudinal slits. This genus is characterised by narrow labellum, which held erect against the stamen, and the flowers are plain yellow-orange, unmarked.

9.1 *Burbidgea* cf. *schizocheila* Hackett

Maliau Basin. Agathis Camp, on rotten tree trunk over the river, alt. 480-500 m, herb, slightly tufted, to 40 cm tall, fruits green, 13 July 2001, *Pereira, Postar, De Wilde et al*. SAN144370 (SAN).

This plant is easily identified in its more robust habit and distinctly petiolate leaves, as compared to *B. stenantha*.

Zingibereae Meisn.

The genera embedded within the tribe Zingibereae have plane distichy leaves that are parallel to rhizome. It is distinguished from Globbeae in having trilocular ovary with axial, basal or free columnar placentation, and labellum are usually not connate to filament.

10. *Boesenbergia* O. Kuntze

A small herb with shoots single to many, leaves are characterised by two-ranked and arranged bracts. According to Smith (1987) each bract subtended single boat shape bracteole and flower. The flowers bloom from apex to base, and usually with a saccate labellum, never flat.

10.1 *Boesenbergia* cf. *pulchella* (Ridl.) Merr.

Maliau Basin. Trail from Bambangan Camp to Maliau Falls, 4º46’ N, 116º55’E, alt. 550 m, 6 Oct. 2000, *Poulsen* 1652 (SAN); 2.5 km above Maliau Falls, G. Rara Reserved, mixed dipterocarp forest over sandstone, alt. 530 m, 9 Apr. 1996, *Hay* 12037 (SAN); Ginseng Camp, mixed dipterocarp forest, wet shaded area, alt. 630 m, 27 Feb. 2005, ATW9 (BORH).

Terrestrial herb, to 40 cm, tubers ca. 5 × 2 cm. Lower sheath purple to speckled purple. Petiole green, lamina obovate (broadest just above the middle), plicate, plain green, base unequally cordate, pale yellow, young leaves, purplish tinged below. Fertile bracts green, no flowers observed.

The specimen *Hay* 12037 is to 40 cm tall as in *Poulsen* 1652 where the height is reportedly very uncommon. Furthermore, the solitary flower is white and red colour, while petioles speckled dark red as opposed to green in the latter. The specimen ATW9, however, can reach to 60 cm tall, and all parts are green, while the flowers are white with red at the tips of labellum.

10.2 *Boesenbergia* aff. *aurantiaca* R.M. Sm.

Maliau Basin. Belian Camp, flat area, alt. 300 m, 3 May 2000, *Henry* MB325 (SAN).

This plant resembles to *Boesenbergia aurantiaca* from its yellow (or pale orange) flowers, and the lamina is pubescence, with long and pale brown hairs on both surfaces. However, the hairs are sparsely distributed and become denser on lower surface as opposed to the velvety leaves of *B. aurantica*. Furthermore, the petiole of the former is pubescence with long sparsely hairs, a characteric which is not found in the latter species.

10.3 *Boesenbergia* cf. *parva* R.M.Sm.

Maliau Basin. Agathis Camp, virgin forest, nature trail, near camp, 4º42' N, 116º54'E, alt. 600 m, 29 Mar. 2002, *Poulsen* 1833 (SAN).

This plant is closely resembles that of *B. parva* in its small stature, less than 30 cm, the elliptic (ca. 10 × 3 cm) and plain green leaves, and the floral colour. Furthermore, its leaf sheath is reddish which is similar to the latter species. More materials are needed to confirm the identity of this species.

10.4 *Boesenbergia* aff. *parva* R.M. Sm.

Maliau Basin. Lake Linumunsut, 18 Oct. 2001, *Sidkan* MB1066 (SAN).

In its small, glabrous, and elliptic leaves, ca. 10 × 3 cm, this plant resembles to *Boesenbergia parva*, but it has dark green leaves, and longer petiole (5–8 cm long). Specimen *Sidkan* MB1066 (SAN) is similar to *B. ornata* by its longer ligule (1–1.5 cm long), but it differs from the latter species by having white flower, and the labellum is yellow centrally and pink at base.

10.5 *Boesenbergia* aff. *variegata* R.M. Sm.

Maliau Basin. Ginseng Camp, mixed dipterocarp forest, 27 Feb. 2005, ATW8 (BORH).

The collection above grow in small clump, ca. 15 cm tall, lamina dark green above and purple underneath, lanceolate, corrugate. This plant resembles *B. variegata* but the latter species has more rounded leaf shape and less purple on the lower surface.

10.6 *Boesenbergia* sp. 1

Maliau Basin. Belian Camp, primary dipterocarp forest, alt. 300 m, 12 July 2001, *Pereira, Postar, De Wilde et al.* SAN151243 (SAN).

Tufted herb, up to 30 cm tall. Leaves elliptic-oblanceolate, 22(–30) × 4 cm, pubescence with scattered long hairs and become denser at midrib on lower surface, glabrous above, acute at apex, leaf base attenuate, darkish brown on dry specimen. Inflorescence densely hairy on the rachis and at base of bracteole; bracteole narrowly elliptic, subtend only one flower, and distichously arranged. Capsule oblong, 10 × 3 mm, sparsely long hairs, calyx remain above, densely hairy around the base.

10.7 *Boesenbergia* sp. 2

Maliau Basin. 21 July 2000, MB386 & MB398 (SAN).

The collection above was formerly identified as *Alpinia fraseriana* Oliv. (Hazebroek *et al*., 2004) but renamed to *Boesenbergia* here.

11. *Hedychium* J. König

Hedychium is a medium-sized gingers and sometime epiphytic. The genus is well distinguished by the many-flowered terminal inflorescence, cylindrical with closely imbricating bracts, narrow petals, bilobed labellum and often long linear filament.

11.1 *Hedychium* cf. *muluense* R.M. Sm.

Maliau Basin. In the western part, entrance, kerangas forest, alt. 890 m, 18 Mar. 2001, *Linus et al.* MB824; 18 Aug. 2000, *Linus et al.* MB557, MB581 & MB559 (SAN).

Epiphytic plant, to 30 cm tall. Leaves four, sessile, leaf base attenuate and acute at apex. Flowers yellow-orange.

11.2 *Hedychium* cf. *cylindricum* Ridl.

Maliau Basin. In the western part, near rim, mossy forest, 15 Mar. 2001, *Sidkan* MB807; Rafflesia Camp, forest ridge, alt. 515 m, 23 Apr. 2000, *Edwards & Sidkan* MB213 (SAN).

Epiphytic plant, to 25 cm tall. Leaves elliptic, with petiole 0.5–4 cm long, ligule 1–2.5 cm long.

12. *Scaphoclamys* Baker

Scaphoclamys is characterised by spirally arranged inflorescence, flowers in cincinni, first bracteole lying directly opposite the bract, and the anther thecae free at the base.

12.1 *Scaphochlamys* cf. *petiolata* (K. Schum.) R.M. Sm.

Maliau Basin. Belian Camp, riverine forest, shaded near rotten wood, alt. 250 m, 15 July 2001, *Postar, Ubaldus, De Wilde et al.* SAN144129 (SAN).

This collection is distinctly petiolate and have elliptic-shaped leaves, making it fit to *S. petiolata*. The white-flower form with a red inside throat, differentiate it from Ibrahim's collection, HI501 from Tawau Hills Park, which has white petals with yellow in the midlobe of labellum. More collections are needed to clarify the status of this species.

13. *Zingiber* Mill.

Zingiber is a monophyletic group (Kress *et al.*, 2002), which produces radical inflorescence and characterised by having pulvinus petiole and anther crest wrapped around the exerted style.

13.1 *Zingiber coloratum* N.E. Br.

Maliau Basin. Lake Linumunsut, alt. 440 m, 24 Oct. 2001, *Jeprin et al.* MB1091 (SAN).

This species is ca. 0.5 m tall, ca. 4 leaves per shoot, elliptic, pubescent on lower surface, glabrous above, apex pungent, leaf base cuneate. Inflorescence elongate to 15 cm long and red colour. Flowers white and fruits red.

13.2 *Zingiber* cf. *puberulum* Ridl. var. *borneense* R.M. Sm.

Maliau Basin. Camel Trophy, alt. 910m, 2 Mar. 2005, ATW22 (BORH); trail to Giluk Waterfall, ATW27 (BORH); trail from Agathis Camp to Camel Trophy, mountainous top ridge, alt. 1005 m, 8 Apr. 2000, *Henry & Sidkan* MB66 (SAN).

This plant is reaching to 1.8 m tall, and bearing one or two inflorescences per shoot. Leafy stem, small in diameter, pubescent with dense hairs, ligule shortly bilobe, ca. 3 mm long, pubescent. Leaves ca. 12 pairs per shoot, narrowly oblong to lanceolate, ca. 25 × 4 cm, apex pungent, leaf base cuneate, pubescent below surface, ciliate along margin. Inflorescences ca. 13 cm long, fusiform, purple-pink, bracts pubescent in the margin.

13.3 *Zingiber* sp. 1

Maliau Basin. Around Ginseng Camp, shady, damp, surrounding areas, alt. 610 m, 27 Feb. 2005, ATW5 (BORH).

Terrestrial herb, 80-90 cm tall, rhizome purle-blue. Leaves ca. 5 per shoot, glabrous and shiny on upper surface, pubescence below, apex pungent, leaf base cuneate, sessile. Sheath distinctly bearing densely straw-colour hairs, pulvinus also pubescence. This plant has longer ligule, to 5 cm, membranous, brittle and lobe ca. 1 cm. Inflorescence radical, to 25 cm long, sterile, bracts hairy, pink.

Globbeae Meisn.

The tribe *Globbeae* is characterised by unilocular ovary with parietal placentation, and labellum is often connate to filament in a slender tube.

14. *Globba* L.

The genus *Globba* is easily distinguished by having flower with lip joined to the stamen and long exserted, curved stamen. The anther, with either one or two triangular appendages along either margin, is a diagnostic character of this genus.

14.1 *Globba atrosangiunea* Teijsm. & Binn.

Maliau Basin. Lake Linumunsut, slope, alt. 440 m, 0.5 m tall, flower red, 18 Oct. 2001, *Jeprin et al.* MB1046 (SAN); Agathis Camp, virgin forest, trail near camp, 4º42' N, 116º54'E, alt. 600 m, epiphyte on log, bracts red, flowers orange yellow, 29 Mar. 2002 (SAN); Agathis Camp, flat area, alt. 500 m, 5 Apr. 2000, *Jeprin et al.* MB44 (SAN); MB706 (SAN); 18 Aug. 2000, MB571 (SAN); Pakis Camp, upper dipterocarp, alt. 800 m, 0.5 m tall, flower red and yellow, 15 Mar. 2001, *Linus et al.* MB760 (SAN).

Globba atrosangiunea is easily recognised from its broad brilliant red bracts and yellow-orange flowers. It occurs throughout Borneo and Sumatra.

14.2 *Globba franciscii* Ridl.

Maliau Basin. Lake Linumunsut, slope, alt. 440 m, herb 0.5 m tall, flower yellow, 18 Oct. 2001, *Henry et al.* MB1047 & MB1050 (SAN); *ex*., 18 Aug. 2000, MB574 & MB576 (SAN).

This species is easily recognised by having long cincinni inflorescence, yellow-orange flower, anther appendages spreading from the middle of thecae, deeply bilobed labellum, long cucullate dorsal petal and the glabrous, lanceolate-caudate leaves.

14.3 *Globba pendula* Roxb.

Maliau Basin. Rafflesia Camp, near the river, alt. 500 m, 0.5 m tall, flower orange, fruit green, 26 Apr. 2000, *Ming* & *Sidkan* MB257 (SAN); Corridor Greek, near river, alt. 500 m, flowers orange, 25 Apr.2000, *Edward* & *Sidkan* MB253 (SAN); Belian Camp, secondary forest, relatively intact, close to small rocky stream, 4º45' N, 116º58'E, alt. 250 m, terrestrial herb, alt. 0.7 m, flowers yellow, 27 Oct. 2001, *Poulsen* 1814 (SAN); Lake Linumunsut, valley, alt. 440 m, 23 Oct. 2001, *Sidkan* MB1055 (SAN); trail to Giluk Waterfall, near stream, on slope, shaddy and damp place, 28 Feb. 2005, ATW12 (BORH).

This species is common to Borneo. It has orange-yellow flower, often with a dark spot at base of labellum. The specimen ATW12's inflorescence is not elongated as in the typical *G. pendula*; this character is similar to other collections from Danum (Smith, 1988).

14.4 *Globba propinqua* Ridl.

Maliau Basin. Agathis Camp, near the river, flat area, alt. 500 m, 1 m tall, flower yellow, 5 Apr. 2000, *Henry* & *Sidkan* MB16 (SAN); around Ginseng Camp, 28 Feb. 2005, ATW11 (BORH).

This species resembles to *G. atrosangiunea* in having two appendages on each side of the anther, but *G. propinqua* differs from the latter by its green bracts, much longer lateral staminodes and more deeply lobed labellum.

14.5 *Gobba tricolor* var. *gibbsiae* R.M. Sm.

Maliau Basin. Pakis Camp, upper dipterocarp, alt. 810 m, 15 Mar. 2001, *Webb* MB442 (SAN); trail to Giluk Waterfall, on ridge, surrounding areas, 28 Feb. 2005, ATW18 (BORH).

This variety is easily identified by its white flower with bright yellow-orange labellum and anther.

14.6 *Globba* sp.

Maliau Basin. Belian Camp, damp forest, near stream, alt. 300 m, herb 40 cm tall, flowers orange and fruits light green, 11 July 2001, *Pereira et al*., SAN151218 (SAN).

DISCUSSION

In this survey, the tribe Alpinieae is well represented, with 45 species, including two new records for Borneo, namely *Elettariopsis smithiae* var. *rugosa* and *Hornstedtia scyphifera* var. *fusiformis,* and three possibly undescribed species. This is followed by the tribe Zingibereae, with 13 spesies from four genera. Tribe Riedelieae and Globbeae are represented by only one and six species, respectively. About 78% of the collected taxa have so far been identified to species, and about 21% or 14 species are only to genus level.

There are many unidentified species in our list, either due to insufficient materials for identification such as flowers or some of their characteristics did not fit to any of the described species. These specimens are believed to be new to science. Although many systematic studies have been conducted for gingers in Borneo (e.g., Smith 1985, 1986, 1988, 1989, 1990; Cowley 1998, 1999; Ibrahim 1992, 1995; Sakai & Nagamasu 1998, 2000a, 2000b, 2003; Poulsen, Mood & Ibrahim 1999; Takano *et al*. 2003, 2004; Gobilik *et al*. 2003, 2004, 2005; Julius *et al*. 2005), there are still many species that remain undescribed, and yet to be documented particularly in Sabah and Kalimantan.

Compared to other areas in Borneo, e.g., Danum Valley (11 genera and c. 36 spp., Magintan 2000), Tabin Wildlife Reserve (13 genera and ca. 46 spp., Gobilik 2002), Mt. Kinabalu (12 genera and ca. 58 spp., Beaman & Beaman 1998, Smith 1985, 1986, 1987, 1988, 1989, 1990), Mt. Mulu (15 genera and c. 50 spp., Smith 1982, 1985, 1986, 1987), Crocker Range (12 genera and ca. 51 spp., Takano *et al.* 2004, Julius *et al.* 2005), Lambir Hills (11 genera and ca. 44 spp., Sakai & Nagamasu 1998, 2000a, 2000b, 2003, Nagamasu & Sakai 1996) and Kayan Mentarang (11 genera and ca. 34 spp., Takano *et al.* 2003), with 66 species, Maliau Basin yields higher number of gingers. This number make up to 44% and 32% of the Zingiberaceae in Sabah and Borneo, respectively.

Some important genera collected are *Elettariopsis, Etlingera, Hornstedtia* and *Plagiostachys*. The genus *Elettariopsis* is well distributed in Peninsular Malaysia with five known species. *Elettariopsis curtisii* Baker is the first record of this genus in Borneo. *Elettaiopsis smithiae* var. *rugosa*, which is originally described from Penang, was also found during the present study. So far, four species of *Elettariopsis* are known from Borneo. *Elettariopsis* aff. *kerbyi,* one of our collections is remarkably similar to the type of *E. kerbyi,* but differs in having longer petiole which is not reported by Smith (1990). This indicates further material is needed to decide if the specimen above is within the variation of *E. kerbyi*'s or represents a new taxa. It is likely that there are more species to be described and documented in the study area.

Currently, there are 12 species of *Hornstedtia* described from Borneo. However this number will increase soon as there are over five species from Sabah that are waiting to be described. Interestingly, *H. scyphifera* var. *fusiformis,* which is formerly known only from Peninsular Malaysia is also found in Maliau Basin. This species might be distributed in other parts of Sabah, Sarawak and Kalimantan.

Etlingera, on the other hand, represents the second largest genus of Bornean gingers with 40 known species after *Amomum* (41 spp.). Sabah is less studied for the genus as compared to Sarawak and Brunei. Another species, *E. inundata*, which is originally described from Sarawak is a second report for Sabah. While, *E. brachychila* has a potential to be an ornamental plant as its brilliant red flowers and the red-purple colouration beneath the leaves are an attraction for every ginger enthusiast. At Agathis Camp itself, it has been planted around the hut together with several species such as *Amomum coriaceum, Plagiostachys strobilifera, P. brevicalcarata* and *P.* sp.1 either planted or grow naturally.

Ginseng Camp is a new site in MBCA, which was opened for research purposes. The vegetation in that area is mainly dipterocarps. We found that *Plagiostachys* dominates in such a huge area within a short walking distance at this site, with three common species, i.e. *P. parva*, *P.* aff. *strobilifera* and *P.* sp. 1. It is also common along the trails system in all the sites. The same condition was observed in intact forests, such as Danum Valley and Ulu Nalumad, Poring. Zingiberaceae is the most important family contributing to ground herbs (Magintan *et al*., 1999). The species number of *Plagiostachys* in Maliau Basin is almost equivalent to other areas, e.g. Crocker Range (eight spp.) or Danum (seven spp.), but the species composition between the areas is significantly different. The common species found in the study area is similar to that found throughout Borneo, i.e. *P. albiflora*, *P. strobilifera* and *P.* aff. *breviramosa*.

Scaphochlamys, with 30 described species, only has six known species in Borneo. Sarawak and Brunei are the centre of distribution of this genus with a record of five species. *Scaphochlamys petiolata* is the only species found in Tawau Hills Park by Ibrahim (1992). Another specimen (SAN No. 144129), collected from Belian Camp is fairly similar to *S. petiolata* in having elliptic-shaped leaves and distinctly petiolate. However, the species was not verified due to limited collection available. Furthermore, there is no spirit collection of the inflorescence so identification was solely based on herbarium labels.

CONCLUSION

This preliminary study has listed 65 species in 14 genera of Zingiberaceae from the Maliau Basin Conservation Area. Among the collection, there are several unidentified species that could be new to science. Further studies are needed in order to understand clearly the diversity of gingers in this area. There are two important conclusions that can be drawn from this study: (1) Maliau Basin has a high number of ginger species as compared to other areas in Borneo. (2) Based on observation, the diversity of *Etlingera* and *Plagiostachys* from Maliau Basin are closely related to Sarawak, rather than the western part of Sabah. It is interesting to pursue a study on their geographical relationships in the future.

ACKNOWLEDGEMENT

The authors wish to thank the expedition organisers, UMS, JICA and YS, who allowed this study to be conducted. We also thank the curator of SAN for allowing us to examine their specimens of gingers. Finally, we would like to express our sincere gratitude to Dr. A. D. Poulsen for identifying the *Etlingera* specimens.

REFERENCES

Beaman, J.H. & R.S. Beaman. 1998. The Plants of Mount Kinabalu *3. Gymnosperms and Non-Orchid Monocotyledons*. Kota Kinabalu: Natural History Publications (Borneo).

Cowley, J. 1999. Two new species of *Plagiostachys* (Zingiberaceae) from Borneo. *Kew Bulletin* 54:139-146.

Gobilik, J. 2002. *Some aspects of abundance and distribution of Zingiberaceae and Costaceae in Tabin Wildlife Reserve, Sabah*. M. Sc. Thesis, Universiti Malaysia Sabah, Kota Kinabalu (unpublished).

Gobilik, J., A. Lamb & A.D. Poulsen. 2004. A new species of *Amomum* (Zingiberaceae) from Borneo. *Sandakania*14: 51-56.

Gobilik, J., A. Lamb & M.M. Yusoff. 2005. Two new species of *Plagiostachys* (Zingiberaceae) from Sabah, Borneo. *Sandakania*16 : 49-56.

Gobilik, J., D. Magintan, A.D. Poulsen, & M.M Yusoff. 2003. Gingers at the Dagat Limestone Ridge, Tabin Wildlife Reserve. In: Maryati, M., Menno, S. & Mahedi, A. (eds.) *Tabin Limestone Scientific Expedition* 2000. Universiti Malaysia Sabah, Kota Kinabalu. Pp. 49-60.

Gobilik, J. & M.M. Yusoff. 2005. Zingiberaceae and Costaceae of the Trus Madi Range. *Journal of Tropical Biology and Conservation* 1: 79-93.

Hazebroek, H. P., Tengku Azlin Zainal & W. Sinun. 2004. Maliau Basin Sabah's Lost World. Kota Kinabalu: Natural History Publications.

Holttum, R.E. 1950. The Zingiberaceae of the Malay Peninsula.*The Gardens' Bulletin Singapore* 13: 1-249.

Ibrahim, H. 1992. Zingiberaceous species of Tawau Hills Park, Sabah. In: Ghazally, I., S. Omar & L. B. Din (eds.), *A Scientific Journey Through Borneo: Tawau Hills Park, Sabah*. Pelanduk Publications, Selangor. Pp 95-106.

Ibrahim, H. 1995. Diversity, distribution and some notes on gingers of Sayap-Kinabalu Park, Sabah. In: Ghazally, I., S. Omar & L. B. Din (eds.), *A Scientific Journey Through Borneo: Sayap-Kinabalu Park, Sabah*. Pelanduk Publications, Selangor. Pp 55-66.

Julius, A., M. Suleiman & A. Takano. 2008. Preliminary molecular phylogeny of Bornean *Plagiostachys* (Zingiberaceae) based on DNS sequence data of internal transcribed spacer (ITS). *Journal of Tropical Biology and Conservation* 4: 67-80.

Julius, A., A. Takano, J. Gisil & M.M. Yusoff. 2005. Zingiberaceous species of Melalap: A preliminary survey and checklist. In: Maryati, M., Nurhuda, M. & Takahashi, A (eds.) *Proceeding of Melalap Scientific Expedition*. BBEC Publication No. 43, Universiti Malaysia Sabah. Pp. 33-41.

Kam, Y.K. 1982. The genus *Elettariopsis* (Zingiberaceae) in Malaya. *Notes Royal Botanic Garden Edinburgh* 40: 139-152.

Kress, W.J., L.M. Prince & K.J. Williams. 2002. The phylogeny and a new classification of the gingers (Zingiberaceae): Evidence from molecular data. *American Journal Botany* 89: 1682-1696.

Magintan, D. 2000. *Diversity, abundance and distribution of ground herbs in primary and selectively logged forest of Danum Valley (North Eastern Borneo)*. M. Sc. thesis, Universiti Malaysia Sabah, Kota Kinabalu (unpublished).

Magintan, D., F. Borchsenius, A.D. Poulsen & P. Langi. 1999. Preliminary list of seed plants in Tabin Wildlife Reserve. In: Maryati, M., Mahedi, A., Mohd. Noh Dalimin & T. P. Malim (eds.). *Tabin Scientific Expedition*. Kota Kinabalu: Universiti Malaysia Sabah. Pp. 43-48.

Nagamasu, H. & S. Sakai. 1996. *Amomum roseisquamosum* (Zingiberaceae), a new epiphytic ginger from Borneo. *Edinburgh Journal of Botany* 53: 39-42.

Poulsen, A.D. 2006. *Etlingera of Borneo.* Kota Kinabalu: Natural History Publications (Borneo) Sdn. Bhd. pp. 1-263.

Poulsen, A.D., J. Mood & H. Ibrahim. 1999. Three new species of *Etlingera* (Zingiberaceae) from Borneo. *Nordic Journal of Botany* 19: 139-147.

Sakai, S. & H. Nagamasu. 1998. Systematic studies of Bornean Zingiberaceae I. *Amomum* in Lambir Hills, Sarawak. *Edinburgh Journal of Botany* 55: 45-64.

Sakai, S. & H. Nagamasu. 2000a. Systematic studies of Bornean Zingiberaceae II. *Elettaria* of Sarawak. *Edinburgh Journal of Botany* 57: 227-243.

Sakai, S. & H. Nagamasu. 2000b. Systematic studies of Bornean Zingiberaceae III.. *Tamijia*: A new genus. *Edinburgh Journal of Botany* 57: 245-255.

Sakai, S. & H. Nagamasu. 2003. Systematic studies of Bornean Zingiberaceae IV. *Alpinioideae* of Lambir Hills, Sarawak. *Edinburgh Journal of Botany* 60: 181-216.

Smith, R.M. 1982. Systematic notes on and new species of Zingiberaceae of the Gunung Mulu National Park. *Botanical Journal of the Linnaen Society* 85: 36-73.

Smith, R.M. 1985. A Review of Bornean Zingiberaceae I: (Alipineae). *Notes Royal Botanical Garden Edinburgh* 43: 261-314.

Smith, R.M. 1986. A Review of Bornean Zingiberaceae II: (Alipineae, concluded). *Notes Royal Botanical Garden Edinburgh* 43: 261-314.

Smith, R.M. 1987. A Review of Bornean Zingiberaceae III: (Hedycheae). *Notes Royal Botanical Garden Edinburgh* 44: 203-232.

Smith, R.M. 1988. A Review of Bornean Zingiberaceae IV: (Globbeae). *Notes Royal Botanical Garden Edinburgh* 45: 1-19.

Smith, R.M. 1989. A Review of Bornean Zingiberaceae V: (Zingibereae). *Notes Royal Botanical Garden Edinburgh* 45: 409-423.

Smith, R.M. 1990. Four new species of Zingibereceae from Borneo. *Edinburgh Journal of Botany* 47: 367-373.

Takano, A., J. Gisil, M. Suleiman & W. Harry. 2003. Preliminary Study on the Ginger Flora of Kayan Mentarang National Park, Kalimantan, Indonesia. In: Ani, M. & T. Soehartono (eds.) *Joint Biodiversity Expedition in Kayan Mentarang National Park*. Jakarta: Ministry of Forestry-WWF Indonesia-ITTO.

Takano, A., M.M. Yusoff & J. Gisil. 2004. The Zingiberaceae of Crocker Range Park. In: Maryati, M., Z. Hamzah, T. Tachi & Jamili, N. (eds). *Crocker Range Scientific Expeditions 2002.* Kota Kinabalu: Universiti Malaysia Sabah. Pp. 17-26.