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# SYSTEMATIC STUDIES OF BORNEAN *ZINGIBERACEAE* IV. *ALPINIOIDEAE* OF LAMBIR HILLS, SARAWAK

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This paper completes an account of the subfamily *Alpinioideae* (*Zingiberaceae*) of Lambir Hills National Park, Sarawak, Malaysia, started in the first paper of this series (Sakai & Nagamasu, 1998), which lists 12 *Amomum* species from the park. Twenty-two species in the genera *Alpinia*, *Elettaria*, *Elettariopsis*, *Etlingera*, *Hornstedtia* and *Plagiostachys* (*Zingiberaceae*) are reported from Lambir Hills, Sarawak, with systematic and ecological notes. Four species, *Etlingera baramensis*, *E. inundata*, *E. newmanii* and *Plagiostachys glandulosa*, are described as new to science, and *Hornstedtia leonurus* is reported from Borneo for the first time. In *Etlingera inundata* floral dimorphism is reported. The informal grouping of *Etlingera* proposed by Smith (1986b) is re-examined. Synonymies of *Etlingera coccinea*, *Hornstedtia minor*, *H. affinis* and *H. phaeochoana* and the generic position and synonymies of *H. sarawacensis* and *H. conica* are discussed. Lectotypes of *Achasma brevilabrum* (=*Etlingera brevilabrum*), *Alpinia ligulata*, *Elettaria coccinea* (=*Etlingera coccinea*), *Elettaria speciosa* (=*Etlingera elatior*) and *Hornstedtia alliacea* (=*H. conica*) are designated. Keys are also provided to all Bornean genera and species of *Alpinioideae*.

*Keywords.* *Alpinieae*, *Alpinioideae*, Borneo, floral dimorphism, Lambir, pollination, Sarawak, *Zingiberaceae*.

## INTRODUCTION

In a recent paper, Kress *et al.* (2002) propose a new classification of the family *Zingiberaceae* based on molecular data. They recognize four subfamilies, *Siphonochileae* W.J. Kress, *Tamijioideae* W.J. Kress, *Alpinioideae* Link and *Zingiberoideae* Haask., of which the latter three occur in Borneo. Members of the *Alpinioideae* are characterized by the plane of leaf distichy being perpendicular to the rhizome, and reduced lateral staminodes (Kress *et al.*, 2002). The genera recorded from Lambir Hills National Park, Sarawak and covered in this paper are dealt with in the following order: *Alpinia* Roxb. (3 spp.), *Elettaria* Maton (3 spp.), *Elettariopsis* Baker (1 sp.), *Etlingera* Giseke (9 spp.), *Hornstedtia* Retz. (3 spp.) and *Plagiostachys* Ridl. (3 spp.).

## ALPINIA ROXB.

**1. Alpinia galanga** (L.) Willd., Sp. Pl. (ed. 5): 12 (1797); Ridl., J. Straits Branch Roy. Asiat. Soc. 32: 163 (1899) & Fl. Malay. Penin. 4: 279 (1924); R.M. Sm., Edinburgh J. Bot. 47: 45 (1990).

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Type: Rumphius, Herbarium Amboinense 5: t.63 (1747) (lecto. designated by Rangsiruji *et al.* [2000: 10]).
Syn.: *Maranta galanga* L., Sp. Pl. (ed. 2): 3 (1762); Sw., Observ. Bot. (Swarz): 8 (1791).

LAMBIR HILLS. Planted near longhouse, 4 iv 1995, *S. Sakai* 195 (KYO).

Widely cultivated in Southeast Asia as a source of medicine and spice (Larsen *et al.*, 1999). Rangsiruji *et al.* (2000) designate the lectotype of *Maranta galanga* L. (*A. galanga* (L.) Willd.), and discuss the authorship of the species.

**2. Alpinia glabra** Ridl., J. Straits Branch Roy. Asiat. Soc. 32: 168 (June 1899) & 46: 244 (1906); B.L. Burtt & R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 31: 307 (1972); R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 284, fig. 6 (1985) & Edinburgh J. Bot. 47: 45 (1990).
Type: Sarawak, 1st Division, Mt. Santubong, *Haviland* 444 (lecto. designated by Burtt & Smith [1972: 307], K!).

LAMBIR HILLS. c.1100ft, ridge of SW of Bt. Lambir, 28 ix 1967, *Burtt* 11630 (E); in mixed dipterocarp forest, 7 viii 1992, *Nagamasu* 4674 (KYO); 2 vii 1993, *Nagamitsu & Momose* 177 (KYO); 50ha plot, 25 v 1994, *R. Rahman* 92 (KYO); near lab., x 1994, *S. Sakai* 132 (KYO); on the way to Bt. Pantu, ridge, 2 iv 1995, *S. Sakai* 205 (KYO, SAR); 8ha plot, 24 v 1996, *S. Sakai* 278 (KYO, SAR); along Bt. Pantu trail, ridge, 26 xii 1998, *S. Sakai* 402 (KYO).

Easily distinguished from other species by its glabrous, prominently petiolate leaves. Smith (1985) noted that *A. glabra* (originally described as three separate species) shows considerable variation in many traits, and recognized two groups: group A with white bracteoles, calyces, petals and (usually) pedicels, and a generally red labellum with dark lines (rarely some yellow); and group B with dark red (rarely pink) pedicels, bracteoles, calyces and petals, and an orange yellow labellum with red lines or pink with darker lines. Both groups occur at Lambir (group A: *Burtt* 11630; group B: *S. Sakai* 132, 278). Although this species is abundant along trails, it is difficult to find flowers probably due to the short flowering period and the few-flowered inflorescences. Most specimens have fruits which turn orange when mature. The species is pollinated by *Amegilla* bees (Sakai *et al.*, 1999).

**3. Alpinia ligulata** K. Schum., Bot. Jahrb. Syst. 27: 275 (1899) & in Engler, Pflanzenr. IV. 46 (Heft 20): 326 (1904); B.L. Burtt & R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 31: 308 (1972); R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 276 (1985) & Edinburgh J. Bot. 47: 49 (1990).
Type: Sarawak, 1st Division, Pininjau, ix 1865, *Beccari* 987 (lecto. designated here, FI!).

LAMBIR HILLS. Swamp, 20 vii 1994, *S. Sakai* 47 (KYO); secondary forest, 7 iii 1995, *S. Sakai* 167 (KYO); 17 iii 1995, *S. Sakai* 176 (KYO, SAR); 10 iv 1995, *S. Sakai* 199 (KYO); Sg. Liam Libau, 27 xii 1998, *S. Sakai* 408 (KYO, SAR).

Schumann (1899: 275 & 1904: 326) cited two specimens, *Beccari* 987 and 1307, of which we select the former with both flowers and fruits as lectotype.

## ELETTARIA MATON

Sakai & Nagamasu (2000) reviewed *Elettaria* in Sarawak. The three species from Lambir Hills are pollinated by halictid bees (Sakai *et al.*, 1999).

**1. Elettaria linearicrista** S. Sakai & Nagam., Edinburgh J. Bot. 57: 236, figs 5, 8C (2000).
Type: Sarawak, Lambir Hills National Park, near the Third Waterfall, 26 iii 1994, *S. Sakai* 189 (holo. KYO!, iso. SAR!).

LAMBIR HILLS. Ridge E of B. Lambir, 1200–1500ft, 25 ix 1978, *Burtt* 11612 (SAR); Summit Trail, ridge, near the summit of Bt. Lambir, 5 viii 2001, *S. Sakai* 719 (KYO, SAR).

Although fruits of this species were unknown, a specimen from Brunei (Teraja forest reserve, *Hotta* 12831 [KYO]) has a slightly ribbed, ampulliform fruit c.1.6cm × 1.3cm, mounted with calyx base, with long hairs on the whole surface.

**2. Elettaria longipilosa** S. Sakai & Nagam., Edinburgh J. Bot. 57: 236, figs 6, 8E (2000).
Type: Sarawak, Lambir Hills National Park, Sungai Liku, on the slope of riverbank, 27 xii 1998, *S. Sakai* 413 (holo. KYO!, iso. SAR!).

LAMBIR HILLS. 3 xii 1994, *S. Sakai* 145 (KYO, SAR); ridge along the trail to Bt. Pantu, 3 xii 1994, *S. Sakai* 146 (KYO, SAR); Summit Trail, ridge, 5 viii 2001, *S. Sakai* 725 (KYO, SAR).

**3. Elettaria longituba** (Ridl.) Holttum, Gard. Bull. Singapore 13: 238 (1950); R.M. Sm., Bot. J. Linn. Soc. 85: 66 (1982) & Notes Roy. Bot. Gard. Edinburgh 43: 462, fig. 4b (1986); S. Sakai & Nagam., Edinburgh J. Bot. 57: 230, fig. 8A (2000).
Type: Malay Peninsula, Pahang, streams and wet spots, Tahan, *Ridley* 2403 (holo. SING!, iso. K!).
Syn.: *Elettariopsis longituba* Ridl., Trans. Linn. Soc. London, Bot. 3: 382 (1893) & J. Straits Branch Roy. Asiat. Soc. 32: 156 (1899).

LAMBIR HILLS. 20 iv 1995, *S. Sakai* 201 (KYO, SAR).

## ELETTARIOPSIS BAKER

Most species are small herbs with relatively short leafy shoots to 1m, bearing 1–8 petiolate leaves. The small inflorescences arising at the base of the leafy shoot are usually inconspicuous and easily overlooked; they are several-flowered and simple or branched. The flowers are loosely arranged with each bract subtending an open bracteole and a flower in Bornean plants. After reviewing the five Malayan *Elettariopsis* species, including two new species described by Kiew (1982), a further

species was described by Smith (1990) from Mulu, Sarawak. It is likely that there are many more species to be described.

**1. Elettariopsis kerbyi** R.M. Sm., Edinburgh J. Bot. 47: 371, fig. 2 (1990). **Fig. 1A.** Type: *Kerby* 140, flowered in cultivation, Royal Botanic Garden Edinburgh, acc. no. 773416 (holo. E!).

Lambir Hills. In the Canopy Plot, 12 x 1994, *S. Sakai* 114 (KYO, SAR).

Treated as *Elettariopsis* sp. 2, aff. *Kerbyi*, in Sakai *et al.* (1999).

*S. Sakai* 190 (KYO) from Lambir Hills is similar to *E. kerbyi* in floral characters and in its leafy shoots with a well-developed pseudostem and linear leaves, but differs in having inflorescences completely embedded in the ground, a longer corolla tube and a longer pseudostem below the first leaf. More material is needed to decide if this specimen is within the variation of *E. kerbyi* or represents a new species.

## Etlingera Giseke

Burtt & Smith (1986) united *Achasma* Griff., *Nicolaia* Horan. and *Geanthus* Valeton into *Etlingera*, which is characterized by adnation of the labellum and filament into a distinct tube above the insertion of the petals. The three previous genera were distinguished on: labellum (short in *Nicolaia* and *Geanthus*, with an elongate central lobe in *Achasma*), peduncle (short and usually subterranean in *Achasma* and *Geanthus*, long and erect in *Nicolaia*) and anther (strongly angled to the short, free part of the filament in *Achasma*, more or less erect in *Geanthus* and *Nicolaia*). However, the discovery of *Etlingera sessilanthera* R.M. Sm., in which the anther is held at an angle as in *Achasma* though the labellum is not elongate, justified the union of the three genera.

Smith (1986b) made five informal groups in the Bornean species, based on the old generic classification. Placement of the new species described by Poulsen *et al.* (1999) and this study necessitate changing her criteria, partly due to the high diversity in labellum size and shape. Thus, we unite her groups B (ii) and C, which are distinguished only by the elongated central lobe of the labellum. Descriptions of the modified groups are provided below with lists of species in each group from Lambir Hills and other parts of Borneo.

The labellum of the species from Lambir Hills is red or pink with or without yellow or white coloration except in *E. fimbriobracteata* (K. Schum.) R.M. Sm., which has yellow flowers with red petaloid anther crests. All the species studied at Lambir Hills (*E. coccinea* (Blume) S. Sakai & Nagam., *E. fimbriobracteata* (K. Schum.) R.M. Sm., *E. inundata* S. Sakai & Nagam., and *E. velutina* (Ridl.) R.M. Sm.) are pollinated by little spiderhunters (Sakai *et al.*, 1999; Sakai, pers. obs.).

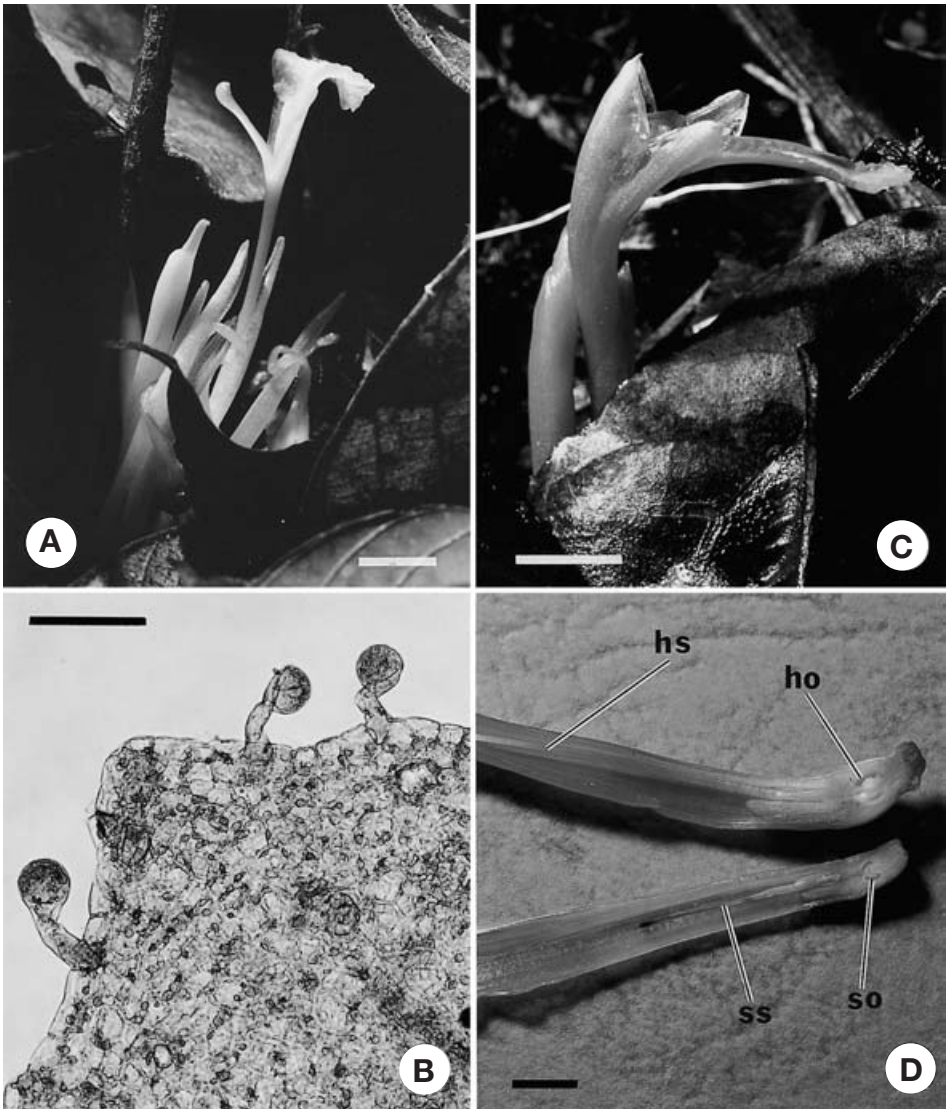


FIG. 1. A. Inflorescence of *Elettariopsis kerbyi* (*S. Sakai* 114), bar = 1cm. B. Glandular hairs on stamen of *Plagiostachys glandulosa* (*S. Sakai* 98), bar = 0.1mm. C. Inflorescence of *Etlingera inundata* (*S. Sakai* 412), bar = 1cm. D. Floral dimorphism in *Etlingera inundata*: top, hermaphrodite flower with functional stigma and style (hs) and ovary (ho) (*S. Sakai* 705); bottom, staminate flower with withered style (ss) and rudimentary ovary (so) (*S. Sakai* 704), bar = 1mm.

**Group A** (*Nicolaia*). Peduncle 10–130cm, inflorescence held above ground; involucral bracts very showy; central lobe of labellum not elongated; anther held more or less erect, thecae dehiscing in upper 1/2–2/3; flowers numerous.

From Lambir Hills: *E. elatior* (Jack) R.M. Sm., *E. newmanii* S. Sakai & Nagam.
Other species from Borneo: *E. pyramidosphaera* (K. Schum.) R.M. Sm.

**Group B′** (part of *Achasma*, Smith's B (i)). Peduncle very short, almost always entirely subterranean; involucral bracts usually at least partly embedded in the ground; central lobe of labellum elongated and often expanded; anther held at an angle to free part of filament; thecae dehiscing in upper 1/2–2/3 only; flowers numerous; petals more or less same length as calyx, dorsal lobe not hooded over anther; labellum (in Bornean plants) plain red or with some white on the margin.

From Borneo: *E. metriocheilos* (Griff.) R.M. Sm., *E. littoralis* (J. König) R.M. Sm., *E. triorgyalis* (Baker) R.M. Sm.
None recorded from Lambir Hills.

**Group C′** (part of *Achasma*, Smith's B (ii) and C). Peduncle and involucral bracts as in group B′, but involucre sometimes much reduced; central lobe of labellum elongated or not; anther held at an angle; thecae dehiscing more or less throughout their length; flowers 2–numerous; petals longer than calyx, dorsal lobe hooded over anther; labellum (in Bornean plants) red with some yellow centrally, rarely plain red.

From Lambir Hills: *E. baramensis* S. Sakai & Nagam., *E. inundata* S. Sakai & Nagam., *E. rubromarginata* A.D. Poulsen & J. Mood, *E. coccinea* (Blume) S. Sakai & Nagam.
Other species from Borneo: *E. belalongensis* A.D. Poulsen, *E. nasuta* (K. Schum.) R.M. Sm., *E. sessilanthera* R.M. Sm.

**Group D** (*Geanthus*). Peduncle and involucral bracts as in group B′, but involucre sometimes much reduced; labellum elongated or not; anther held erect or slightly angled, thecae dehiscing throughout their length or not.

From Lambir Hills: *E. brevilabrum* (Valeton) R.M. Sm., *E. fimbriobracteata* (K. Schum.) R.M. Sm., *E. velutina* (Ridl.) R.M. Sm.
Other species from Borneo: *E. brachychila* (Ridl.) R.M. Sm., *E. corrugata* A.D. Poulsen & J. Mood, *E. longipetiolata* (B.L. Burtt & R.M. Sm.) R.M. Sm., *E. muluensis* R.M. Sm., *E. pubescence* (B.L. Burtt & R.M. Sm.) R.M. Sm., *E. sanguinea* (Ridl.) R.M. Sm.

**1. Etlingera baramensis** S. Sakai & Nagam., **sp. nov. Figs 2A, 3A–F.**
*Etlingerae belalongensi* A.D. Poulsen & J. Mood lobo centrali labelli parvo et anthera ad tubum corollae filamentique valde angulata similis, sed differt foliis anguste obovatis minus quam 8cm latis ad medium frondis et lobo centrali labelli integro non bifido.
Type: Sarawak, Lambir Hills, Sungai Liam Libau, swamp forest, riverbank, ht. to 3m, inflorescence embedded in the ground, bracts red, paler at the base, 27 xii 1998, *S. Sakai* 404 (holo. KYO, iso. SAR).

Height 1.5–3m. *Leaves* distichous, sessile or with petioles to 1cm in middle of shoot (sometimes longer in upper leaves); lamina 40–70 × 3–8cm in middle of shoot, linear to narrowly obovate, apex obtuse, acuminate to 1.8cm, base cuneate, dark green above, often tinged purple below, glabrous except near the midrib, often with striations on lamina parallel to the midrib in life, margin ciliate; ligule 8–15mm long, entire, densely pubescent, margin ciliate; sheath striate with short hairs. *Inflorescence* c.10 × 3cm, cylindrical, embedded in ground, with c.20 flowers (Fig. 2A); peduncle

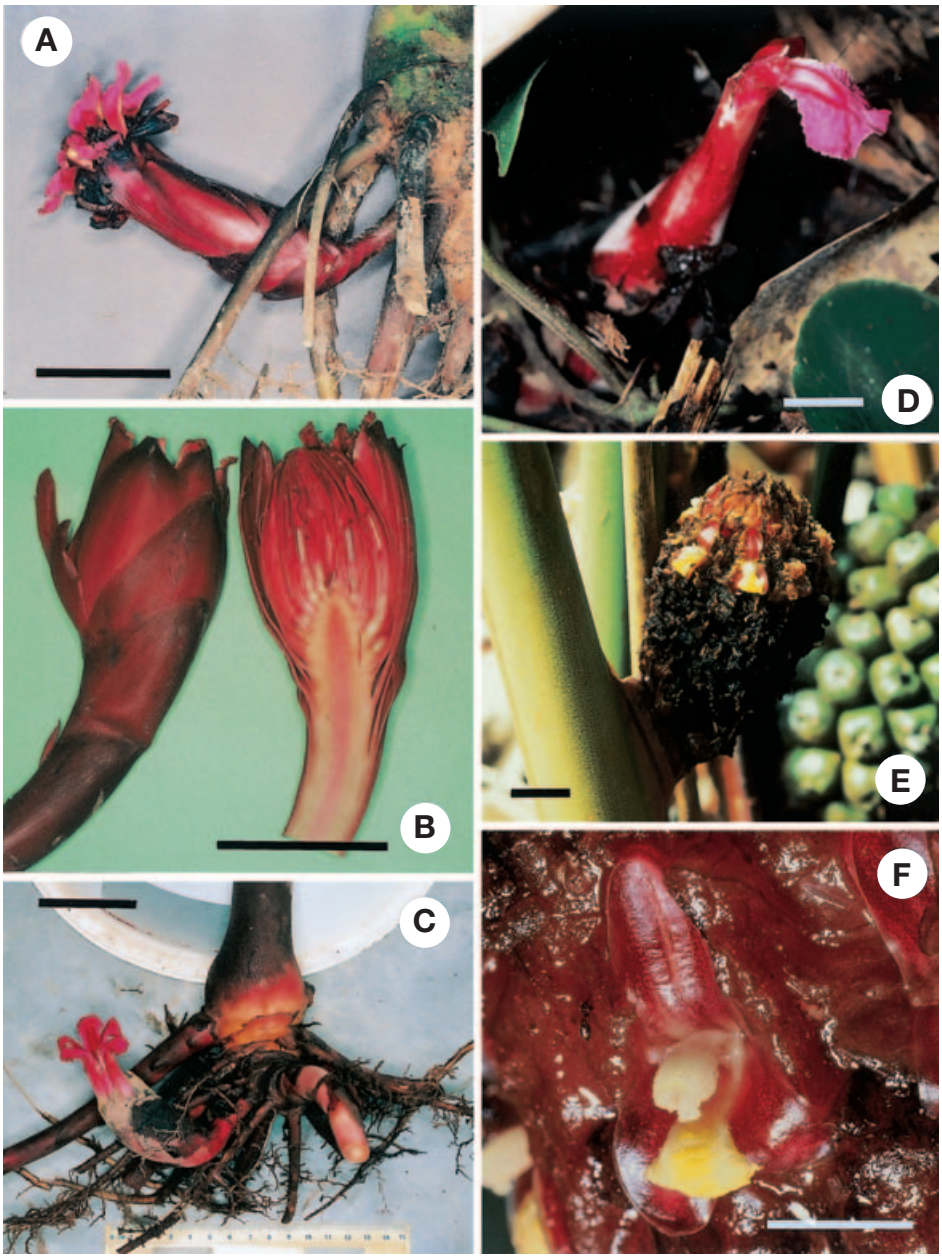


FIG. 2. A. Inflorescence and rhizome of *Etlingera baramensis* (*S. Sakai* 49), bar = 5cm. B. Inflorescence of *Etlingera newmanii* (*S. Sakai* 83), bar = 5cm. C. Inflorescence and rhizome of *Etlingera velutina* (*S. Sakai* 40), bar = 5cm. D. Inflorescence of *Hornstedtia conica* (*S. Sakai* 438), bar = 1cm. E. Inflorescence of *Plagiostachys glandulosa* (*S. Sakai* 234), bar = 1cm. F. Flower of *Plagiostachys glandulosa* (*S. Sakai* 703), bar = 5mm.

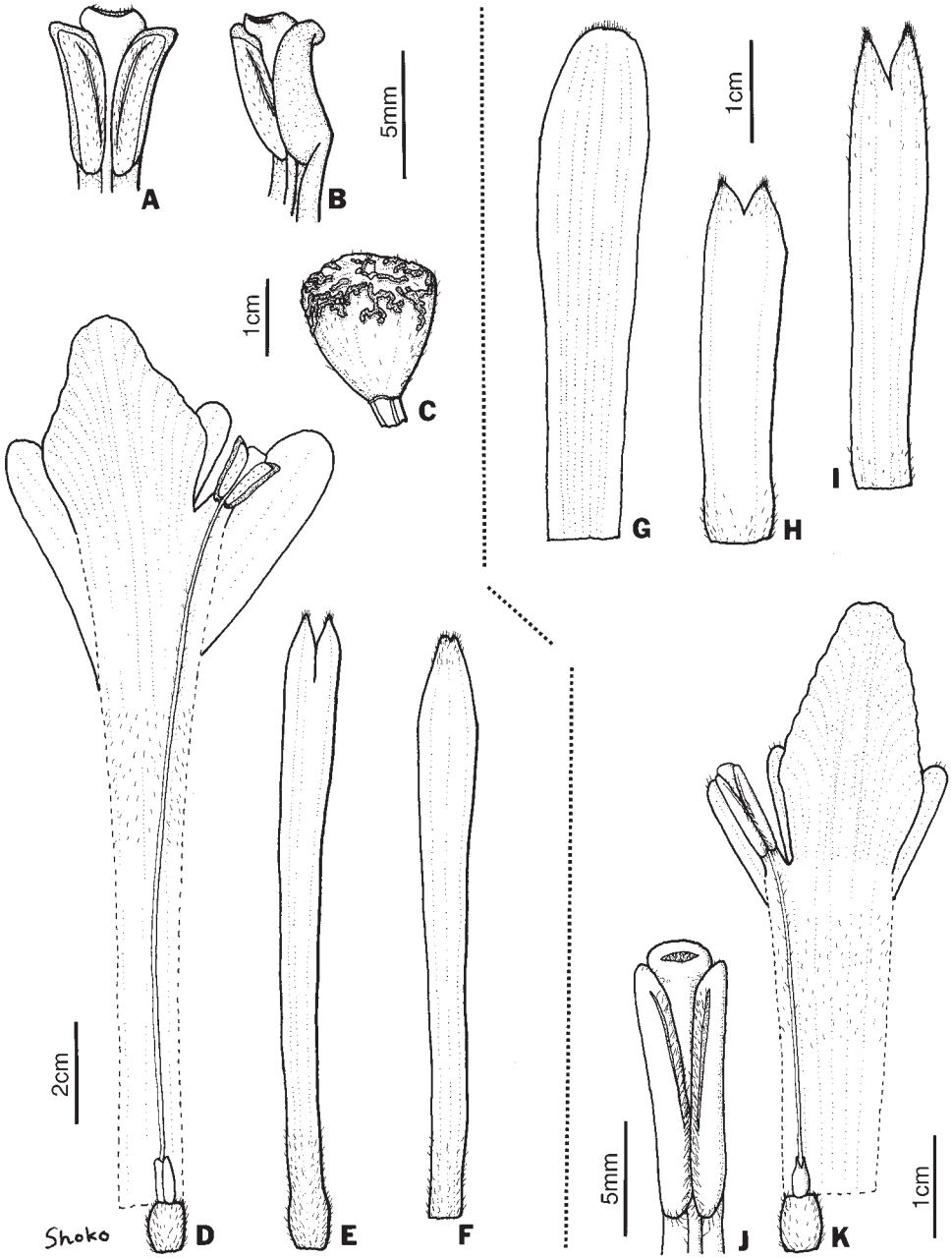


FIG. 3. A–F. *Etlingera baramensis*: A, B, anther and stigma; C, fruit; D, dissected flower; E, bracteole; F, calyx (A, B, D–F: from spirit material of *S. Sakai* 202; C: from dried material of *Tamura & Takano* S0107). G–K. *Etlingera newmanii*: G, floral bract; H, bracteole; I, calyx; J, anther and stigma; K, dissected flower (from spirit material of *S. Sakai* 83).

2–8cm, scales papery, to 2.5 × 1.5cm, ovate, striate and variously pubescent outside, glabrous inside; involucral bracts papery, outermost c.5 × 4cm, lanceolate, inner narrower, c.6 × 3.5cm, with minute hairs on the outside, longer and denser at base, glabrous inside, margin ciliate; floral bracts c.7.5 × 0.8–2.3cm, linear-lanceolate, dark red, pubescent in lower half outside, glabrous inside; bracteole c.6.3cm, tubular, unilaterally fissured for c.3cm, apex 2-toothed, ciliate, red, pubescent outside below, glabrous inside (Fig. 3E). *Flower* red; calyx c.5.8cm long, tubular, with unilateral fissure c.2cm long, red, glabrous on both sides except pubescent outside at base and apex; apex 2-toothed, with tufted hairs (Fig. 3F); labellum and filament joined to form a tube c.1.5cm above dorsal petal, forming a corolla tube c.6.7cm long in total; corolla tube red in upper part, much paler below, glabrous outside, with long soft hairs at throat; petals red, glabrous on both sides, apex slightly ciliate, dorsal petal c.23 × 8mm, hooded over anther; laterals c.28 × 6mm, base of the laterals 5mm lower than that of dorsal petal; labellum c.2 × 1.5cm, rhomboid, red to pink with some yellow centrally, glabrous (Fig. 3D); anther c.6mm long, apex emarginate, held at an angle, bright red except for white thecae (Figs 3A, B); anther connective minute, recurved at tip of each theca (Fig. 3B); thecae dehiscing to base, white, pubescent especially around opening; free part of filament c.2mm, glabrous; stigma c.3mm wide, with dorsal opening, pale pink, ciliate around mouth; style c.7.5cm long, with sparse hairs on upper part; ovary c.4.5mm, strongly pubescent; epigynous gland c.4mm, 2-lobed. *Capsules* c.2.6 × 2.3cm, obovate cyathiform with irregular ridges on upper flat area when dried, pubescent (Fig. 3C).

LAMBIR HILLS. S. Lepoh, c.500ft, 17 ix 1978, *Burtt* 11484 (E, K, L, SAR); secondary forest, 20 vii 1994, *S. Sakai* 49 (KYO, SAR); 20 vii 1994, *S. Sakai* 50 (KYO, SAR); swamp, 19 iv 1995, *S. Sakai* 202 (KYO, SAR); 6 xii 1996, *Tamura & Takano* S0107 (HYO, OSA).

*Other material examined*. Sarawak, 4th Division, G. Mulu National Park, path from Melinau to Trekan, c.400ft, 18 vi 1975, *Burtt* 8323 (K, L, SAR); Bintulu, Ulu Segan, by river, sandy soil, subject to flooding, 23 viii 1968, *Wright* S27158 (K).

**2. Etlingera brevilabrum** (Valeton) R.M. Sm. ut *E. brevilabris*, Notes Roy. Bot. Gard. Edinburgh 43: 243 (1986) & Notes Roy. Bot. Gard. Edinburgh 43: 449, fig. 2 (1986). Type: Hort. Bot. Bog., XI B (V) 144 (lecto. designated here, L no. 913.153-37!). Syn.: *Achasma brevilabrum* Valeton, Icon. Bogor. 3: 3, t.202 (1906).

LAMBIR HILLS. Sungai Liam Libau, 19 ix 1978, *Burtt* 11536 (E, SAR); Sungai Liam Libau, swamp forest, riverbank, 27 xii 1998, *S. Sakai* 407 (KYO, SAR).

We designate a specimen at the Nationaal Herbarium Nederland, Leiden, as lectotype of *Achasma brevilabrum* Valeton. Valeton (1906: 4) cited the number of the plant cultivated at Bogor, "XI B (V) 144", in his description of the species. The herbarium specimen bears the identical number on the label, as well as annotation in Valeton's hand, and matches well the description and excellent figures in Valeton (1906). Although the origin of the plant is not mentioned on the label, Valeton (1906) described it as Borneo.

**3. Etlingera coccinea** (Blume) S. Sakai & Nagam., **comb. nov. Fig. 4A.**
Basionym: *Elettaria coccinea* Blume, Enum. Pl. Javae 53 (1827); Miq., Fl. Ned. Ind. III. 604 (1855).
Type: Java, humid forests, local name, Mantjieirian, Tepus or Tepus bener, *Kuhl & van Hasselt* s.n., p.p. quoad infl. dextr. (lecto. designated here, L no. 905.339-126!).
Syn.: *Geanthus coccineus* Reinw., Catalogus (Blume) 29 (1823), nom. nud.

*Amomum coccineum* (Blume) K. Schum., Bot. Jahrb. Syst. 27: 305 (1899) & in Engler, Pflanzenr. IV. 46 (Heft 20): 197 (1904); Valeton, Icon. Bogor. 2: 209, t.156, 157 (1904).

*Achasma coccineum* (Blume) Valeton, Bull. Inst. Bot. Buitenz. 20: 93 (1904).

*Achasma macrocheilos* Griff., Not. Pl. Asiat. 3: 429, t.357 (1851); Holttum, Gard. Bull. Singapore 13: 188 (1950). Type: Malay Peninsula, Malacca, Ayer Punnus, *Griffith* s.n. (specimen lost, Smith [1986b: 447]).

*Amomum macrocheilos* (Griff.) Baker in Hook.f., Fl. Brit. Ind. 6: 235 (1892).

*Amomum gomphocheilos* Baker in Hook.f., Fl. Brit. Ind. 6: 236 (1892). Type: Malay Peninsula, Perak, 1881, *King's collector* 1897 (K!).

*Etlingera punicea* auct. non (Roxb.) R.M. Sm.: R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 43: 249 (1986) & Notes Roy. Bot. Gard. Edinburgh 43: 447 (1986).

Lambir Hills. Secondary forest, 5 viii 1994, *S. Sakai* 62 (KYO, SAR); valley, near stream, 6 iv 1995, *S. Sakai* 226 (KYO, SAR).

We designate a specimen at the Nationaal Herbarium Nederland, Leiden, as lectotype of *E. coccinea* (Fig. 4A). The specimen has Valeton's annotation saying "original material of Reinwardt", an annotation "*Geanthus coccineus*" with vernacular name "Ta-poes" probably in Reinwardt's handwriting, and an annotation "*Elettaria coccinea*" by Blume. Unfortunately, the inflorescences of two different species are mounted together on the sheet (Fig. 4A). Schumann (1899) stated that the original material was contaminated since, in addition to an inflorescence of *A. coccinea*, an inflorescence of *Amomum cardamomum* was also mounted with it, and that the annotation "Kapol", probably written by Kuhl or van Hasselt, corresponded to the latter. The identity of a leaf on the sheet (Fig. 4A) is also uncertain. For this reason, we exclude the leftmost inflorescence (mounted on the left of the leaf) and the leaf from the lectotypification. Although the specimen lacks collectors' names, we cite the specimen as *Kuhl & van Hasselt* s.n. following Schumann (1899).

After Schumann (1904) united *Alpinia punicea* Roxb. and *E. coccinea*, Smith (1986a) further combined it with *Achasma macrocheilos* Griff. as suggested by Holttum (1950). Although the species may be variable, the essential characters are petals much longer than calyx, the dorsal lobe hooded over the anther and labellum yellow in the middle towards the base, the remainder scarlet (Holttum, 1950: 189; Smith, 1986b: 448). In the same paper, Smith (1986a) designated a figure in Icones Roxburghianae as the lectotype of *Alpinia punicea* following Reilly (1982). Drawings of dissected flowers in the figure clearly show the anther thecae dehiscing throughout and petals longer than the calyx, as observed in *E. coccinea*. In the drawing of the

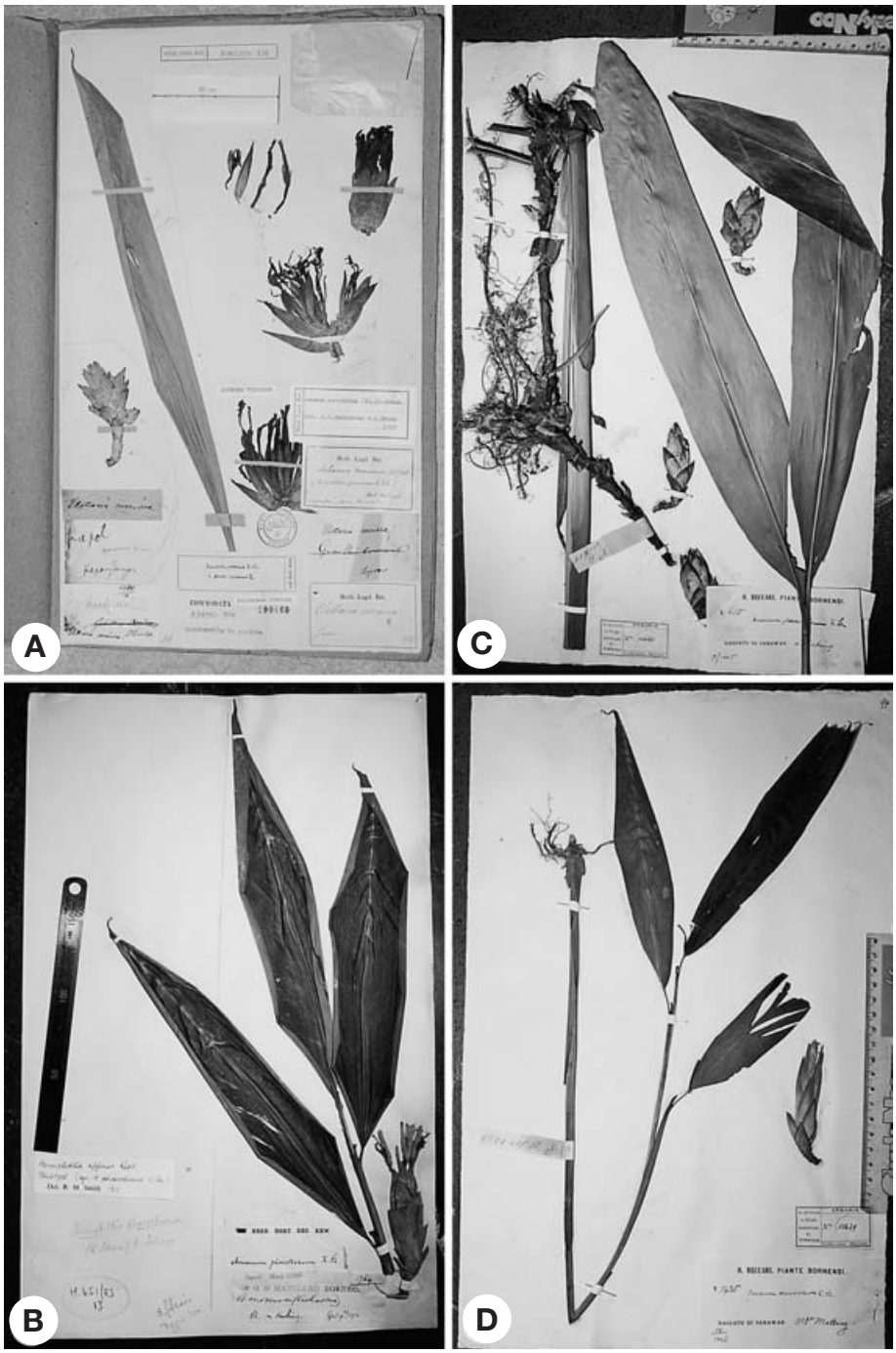


FIG. 4. A. Lectotype of *Elettaria coccinea* Blume (= *Etlingera coccinea* S. Sakai & Nagam.), *Kurl & van Hasselt* s.n. (L). The leftmost inflorescence and the leaf are excluded from the type. B. Type of *Hornstedtia affinis* Ridl., *Haviland* 1764 (K). C. Type of *Amomum phaeochoanum* K. Schum. (= *Hornstedtia phaeochoana* (K. Schum.) K. Schum.), *Beccari* 615 (FI). D. Type of *Amomum sarawacense* K. Schum. (= *Hornstedtia conica* Ridl.), *Beccari* 1435 (FI).

whole inflorescence, however, the dorsal surfaces of the anthers and stigmas are visible, not being covered by the dorsal petals. In addition, a red spathulate labellum, with a paler margin at the base, not inrolling to form a tube, recalls *Etlingera metriocheilos*. The original description of the species agrees reasonably well with the figures in its sub-parabolic labellum with linear lamina and entirely rounded or slightly emarginate apex. Thus, it is doubtful that *Alpinia punicea* is identical with *E. coccinea*. Further collection and investigation of gingers in Sumatra is badly needed to clarify the status of *Alpinia punicea*.

In a recent paper Lim (2001) united *E. punicea* (Roxb.) sensu R.M. Sm. non Roxb. and *Amomum rubroluteum* Baker, and proposed the new combination *Etlingera rubrolutea*. However, the calyx of the type specimen of *A. rubroluteum* (Malacca, *Maingay* 1588 [K!]), being more or less the same length as the petals, indicates that the species belongs in group B′ (including *E. littoralis*) rather than in group C′ (including *E. coccinea*), and the colour of the labellum of *A. rubroluteum*, bright crimson with a yellow margin according to Baker (1892: 236), agrees well with that of *E. littoralis*. Thus we prefer Ridley's treatment (Ridley, 1899, 1907), which united *A. rubroluteum* with *Hornstedtia megalocheilos* (Griff.) Ridl. (= *Etlingera littoralis*), rather than replacing the species name *E. punicea* with *E. rubrolutea* as proposed by Lim (2001).

Smith (1986b) noted great variation in the vegetative parts of this species, but the material identified as *E. punicea* (=*E. coccinea*) in her paper includes more than one species. Three of the specimens, *Burtt* 8323, *Burtt* 11484 and *Wright* S27158, belong to *E. baramensis*, a new species described above.

Although the caption says that all the figures of flowers and fruit of *E. punicea* in Smith (1986b: 444) are based on *Burtt* 11484 (E), examination of the specimens at the Herbarium, Royal Botanic Garden Edinburgh suggests that the figures of flowers (figs Ca–Cc) were based on *Burtt* 11480 and that of the fruit (fig. Cd) was based on *Burtt* 11484, which is *E. baramensis*.

This species is exclusively pollinated by little spiderhunters at Lambir, but Kato *et al.* (1993) also reported long-tongued *Amegilla* bees as effective pollinators in West Sumatra.

**4. Etlingera elatior** (Jack) R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 43: 244 (1986) & Notes Roy. Bot. Gard. Edinburgh 43: 442 (1986).
Type: W coast of Sumatra, Pulo Nias and Ayer Bangy, *Jack* s.n. (n.v.).
Syn.: *Alpinia elatior* Jack, Malayan Misc. 2(7): 2 (1822), reimp. in Hook., J. Bot. 1: 359 (1834).

*Elettaria speciosa* Blume, Enum. Pl. Javae 51 (1827). Type: Java, forest near Kapang Dungan, *Kuhl & van Hasselt* s.n. (lecto. designated here, L no. 905.339-130!).

Lambir Hills. Edge of the forest, 10 vi 1995, *S. Sakai* 244 (KYO, SAR).

We designate a specimen at the Nationaal Herbarium Nederland, Leiden, as the lectotype of *Elettaria speciosa* Blume. The specimen has a leaf and inflorescence, and

is annotated "*Geanthus speciosus*" probably by Reinwardt and Blume. Kuhl and van Hasselt, the collectors, are known to have travelled and botanized in Java in 1820–1823.

This species is commonly known as Torch Ginger and is cultivated for its distinctively flavoured flowers and fruits. Iban people grow it near their houses, but it also occurs in the wild, especially around forest edges.

**5. Etlingera fimbriobracteata** (K. Schum.) R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 43: 245 (1986) & Notes Roy. Bot. Gard. Edinburgh 43: 453 (1986).
Type: Sarawak, 4th Division, Tubao R., trib. of Bintulu, viii 1867, *Beccari* 3735 (FI!).
Syn.: *Amomum fimbriobracteatum* K. Schum., Bot. Jahrb. Syst. 27: 317 (1899) & in Engler, Pflanzenr. IV. 46 (Heft 20): 252 (1904).

Lambir Hills. Main trail to the first tree tower in the 8ha plot, ridge, bush after fire in 1998, 27 vii 2001, *S. Sakai* 701 (KYO, SAR).

**6. Etlingera inundata** S. Sakai & Nagam., **sp. nov. Figs 1C, 1D, 5.**
*Etlingerae pauciflorae* (Ridl.) R.M. Sm. inflorescentia 2–3 floribus et anthera ad stamen valde angulata similis, sed differt floribus et bracteis involucri multo minoribus, et floribus omnino roseis et rubris sine parte flavis.

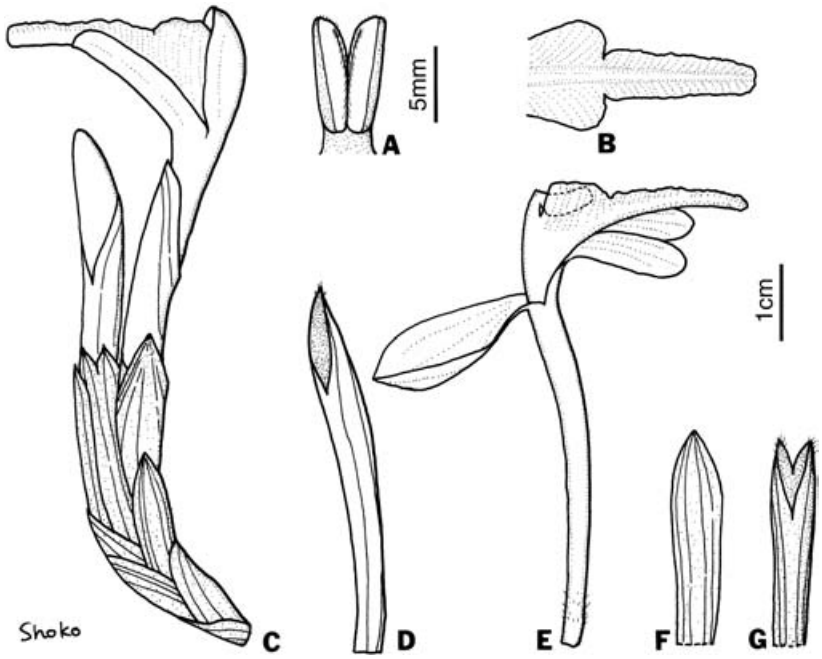


Fig. 5. *Etlingera inundata*: A, anther; B, labellum; C, inflorescence; D, calyx; E, flower; F, floral bract; G, bracteole (from spirit material of *S. Sakai* 412). The 5mm scale bar applies to A only.

Type: Sarawak, 4th Division, Lambir Hills National Park, Sungai Liku, on the marshy ground, ht. 1.5m, bracts and bracteoles pink, calyx, corolla and labellum reddish pink except central whitish part, 28 xii 1998, *S. Sakai* 412 (holo. KYO, iso. SAR).

Perennial herb c.1.5m tall; leafy shoots to 2 × 1m including stalk, ovate. *Leaves* in 7–10 pairs, distichously arranged; petiole absent or to 5mm; lamina to 60 × 15cm, obovate, apex obtuse and acuminate to 2cm, base cuneate or slightly attenuate, glabrous on upper surface, with long hairs below especially near midrib, the hairs may be sparse and less obvious in old leaves; ligule 7–15mm long, entire or shallowly bilobed, glabrous to minutely hairy towards the base, margin ciliate; sheath with small velvety cushions towards base sometimes visible as black spots but not obvious in smaller shoots. *Inflorescence* 2–4-flowered, borne on a long stolon of 3–5mm in diameter in dried state, embedded in the ground; peduncle c.2.5cm long, rarely to 10cm; the uppermost scale c.3 × 1cm (much smaller at basal part of scape), elliptic, glabrous, sometimes with sparse hairs at the base, apex glabrous or ciliate; involucral bracts few, to 25 × 9mm (Fig. 5C), fertile bracts papery, 24–35 × 7–10mm, obovate, apex acute, white tinged brownish green at apex, sometimes sparsely hairy at base and apex on the outside, glabrous inside (Fig. 5F); bracteole c.26mm long, tubular, unilaterally fissured for c.10mm, apex 2-toothed for c.5mm, minutely ciliate, glabrous on both sides or sometimes sparsely hairy at base (Fig. 5G). *Flower* red, calyx 48–63mm long, tubular, unilaterally fissured for 12–15mm, red, glabrous or sparsely hairy outside at base, apex sparsely ciliate (Fig. 5D); labellum and filament joined to form a tube 11–14mm long above insertion of petals, forming a corolla tube 54–63mm in total (Fig. 5E); corolla tube glabrous outside, with long soft hairs at throat on inner surface; dorsal petal c.22 × 12mm, elliptic, glabrous on both surfaces; lateral petals c.23 × 7mm, obovoid, adnate to labellum for basal c.7mm, glabrous on both surfaces; labellum c.28 × 15mm, 3-lobed, basal part c.10 × 15mm, broadly obovate, central lobe c.18 × 6mm, linear to narrowly ovate, red tinged pink centrally, glabrous (Fig. 4B); filament c.3mm long; anther c.7mm long, strongly angled, dehiscing throughout its length, apex emarginate without crest, red though thecae white, pubescent between thecae (Fig. 4A); stigma c.3mm wide, with dorsal opening, ciliate around mouth, pink; style glabrous, c.73mm long in perfect flowers, pubescent with long hairs on upper part; ovary c.6mm; epigynous glands c.6mm, bilobed; gynoecium rudimentary in staminate flowers, pistil c.20mm, ovary c.4mm with rudimentary ovules, epigynous gland c.3mm (Fig. 1D). *Fruit* unknown.

Lambir Hills. 28 iii 1995, *S. Sakai* 236 (KYO, SAR); along the trail to the waterfall, 30 v 1996, *S. Sakai* 287 (KYO, SAR); Jl. Apai Unpin 21, valley, 29 vii 2001, *S. Sakai* 704 (KYO); Jl. Apai Unpin 19, valley, 29 vii 2001, *S. Sakai* 705 (KYO).

*Other material examined*. Sarawak, 3rd Division, Hose Mts, hill W of Ulu Melinau Falls, 19 iii 1967, *Burtt & Martin* B4983 (E). Kalimantan, N of Tarakan, Nunukan, from old forest garden to bivouac 1, S or Kg, low alt., dipterocarp forest, xi 1955, *Meijer* 1946 (BO); Sabah, Ulu Segama, Danum Valley, East Trail, lowland dipterocarp forest, 17 ii 1986, *Andrews* 710 (K).

Treated as *Etlingera* aff. *brevilabris* in Sakai *et al.* (1999).

The species shows sexual dimorphism, bearing perfect flowers and staminate flowers with reduced female organs. Two flowers each of *S. Sakai* 236 and 412 and one flower of *S. Sakai* 704 have rudimentary pistils, stigmas and ovaries. The styles do not reach the anthers. The stigmas are much smaller than in a perfect flower, and are usually blackish and withered. Locules in the ovaries are visible but much reduced (ss and so in Fig. 1D). A single flower of *S. Sakai* 287 and two of *S. Sakai* 705 have well-developed pistils and ovaries (hs and ho in Fig. 1D). Their anthers look identical to those of the staminate flowers of *S. Sakai* 236, 412 and 704. The perfect flowers are slightly larger than the staminate flowers. Whether both flower types can occur on the same individual is unknown. Although sexual dimorphism is rarely observed in the family (see Burtt & Smith, 1972; Gordon-Gray *et al.*, 1989; Sakai & Nagamasu, 1998; Li *et al.*, 2001), it may not be as uncommon as previously thought.

We observed this species on an alluvial stream bank at Lambir, where the ground is often flooded after heavy rain; it may also occur in disturbed or open places with well-drained soils (A.D. Poulsen, pers. comm.). Few-flowered, short-lived inflorescences may be an adaptation to unstable ground conditions. This species has sometimes been confused with *E. brevilabrum* among other Bornean congeners, with which it shares long, prostrate, underground stolons and inflorescences with a few red flowers. However, flowers of the two species are quite different in labellum shape and the straight or angled anther. The two species are also easily distinguished vegetatively by the unequally truncate leaf base in *E. brevilabrum*.

**7. Etlingera newmanii** S. Sakai & Nagam., **sp. nov. Figs 2B, 3G–K.**
*Etlingerae elatiori* (Jack) R.M. Sm. inflorescentia aeria grandi cum numerosis floribus similis, sed differt bracteis pedunculi imbricatis, et bracteis involucri non extrinsecus effusis.
Type: Sarawak, Lambir Hills National Park, next to Sungai Latak near entrance to Lambir National Park, large herb, forming loose clumps, bracts dark red, bracteoles, calyx and corolla lobes slightly paler red, especially towards the base, labellum with red mid-line and pink margin, anther red, stigma dark red, 27 viii 1994, *S. Sakai* 83, coll. M. Newman (holo. KYO, iso. SAR).

Perennial herb, 3–4m tall. *Leaves* distichously arranged, lamina to 90 × 16cm, oblong, glabrous on both surfaces, apex obtuse, acuminate to c.1cm, base unequally cuneate or attenuate, margin ciliate; petiole to 3cm, glabrous; ligule 1–2cm long, entire, hairy on apex and margin; sheaths coriaceous, striate, almost glabrous, margin membranous. *Inflorescence* c.6 × 5cm when dry, c.50-flowered, obovoid, raised 10–40cm above the ground on peduncle to 45cm, deep red (Fig. 2B); uppermost scales on peduncle coriaceous, c.8 × 2cm, linear-lanceolate, striate, glabrous, overlapping, lower scales papery, shorter and broader; involucral bracts many, outermost coriaceous, c.7 × 3cm, ovate, almost glabrous on both surfaces, margin ciliate at apex; floral bracts papery, c.5 × 1cm, linear, glabrous inside, glabrous or sparsely hairy

outside, apex obtuse, incurved, usually with long tufted hairs at tip, margin membranous (Fig. 3G); bracteole c.37mm long, tubular, unilaterally fissured for c.17mm, apex 2-toothed, red, glabrous inside, almost glabrous outside except at apex and base, with tufted hairs on top of teeth (Fig. 3H). *Flower*: calyx c.48mm long, tubular, unilaterally fissured for c.24mm, apex usually unequally 2-toothed, with tufted hairs, red, glabrous inside, sparsely hairy at apex and base outside (Fig. 3I); dorsal petal c.23 × 4mm, linear, glabrous on both sides, apex ciliate; lateral petals c.23 × 3mm, linear, glabrous on both sides, apex ciliate; labellum and filament joined to form a tube c.13mm above petals; corolla tube c.32mm long in total, pink, glabrous outside, with long soft hairs on upper part of inner surface; free part of labellum c.25 × 15mm, rhomboid-ovate, entire, red with pink margin (Fig. 3K); anther c.11mm long, held erect with distinct c.3mm long filament, red; anther crest 0, apex of anther emarginate and slightly pubescent; anther thecae white, dehiscing in upper 2/3, densely hairy between thecae and at the bottom (Fig. 3J); style c.48mm long, with long sparse hairs on upper half; stigma c.3mm wide, with a dorsal opening, dark red, ciliate around mouth; epigynous glands c.4.5mm, surrounding base of style, split to base on one side, apex 2-lobed; ovary c.6 × 5mm, densely pubescent with long hairs. *Fruit* unknown.

Lambir Hills. Swamp, secondary forest, 14 vi 1995, *S. Sakai* 249 (KYO, SAR).

Treated as *Etlingera* aff. *brachychila* in Sakai *et al.* (1999).

This species, characterized by dark red aerial inflorescences not raised very high above the ground, is named for Dr Mark F. Newman of the Royal Botanic Garden Edinburgh in honour of his contribution to systematic studies in the *Zingiberaceae*. He has also provided invaluable help for our studies and kindly collected specimens for us during his visit to the park in 1994, one of which is the type specimen of this species.

**8. Etlingera rubromarginata** A.D. Poulsen & J. Mood, Nord. J. Bot. 19: 139 (1999). Type: Brunei, Temburong District, Batu Apoi Forest Reserve, 28 iii 1991, *Poulsen* 35 (holo. AAU!; iso. BRUN, n.v., K!).

Lambir Hills. Swamp, 12 iii 1995, *S. Sakai* 171 (KYO, SAR).

The specimen from Lambir differs from the description of the species in Poulsen *et al.* (1999) in the labellum being emarginate to c.3mm at the tip.

**9. Etlingera velutina** (Ridl.) R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 43: 250 (1986). **Figs 2C, 6.**
Type: Sabah, Bongaya River, x 1987, *Ridley* s.n. (K!).
Syn.: *Hornstedtia velutina* Ridl., J. Straits Branch Roy. Asiat. Soc. 32: 146 (1899).

Lambir Hills. Riverside, 15 vii 1994, *S. Sakai* 40 (KYO, SAR); secondary forest, *S. Sakai* 51 (KYO, SAR); in the Canopy Plot, 13 viii 1994, *S. Sakai* 74 (KYO, SAR).

Treated as *Etlingera* aff. *metriocheilos* in Sakai *et al.* (1999) and Sakai (2000).

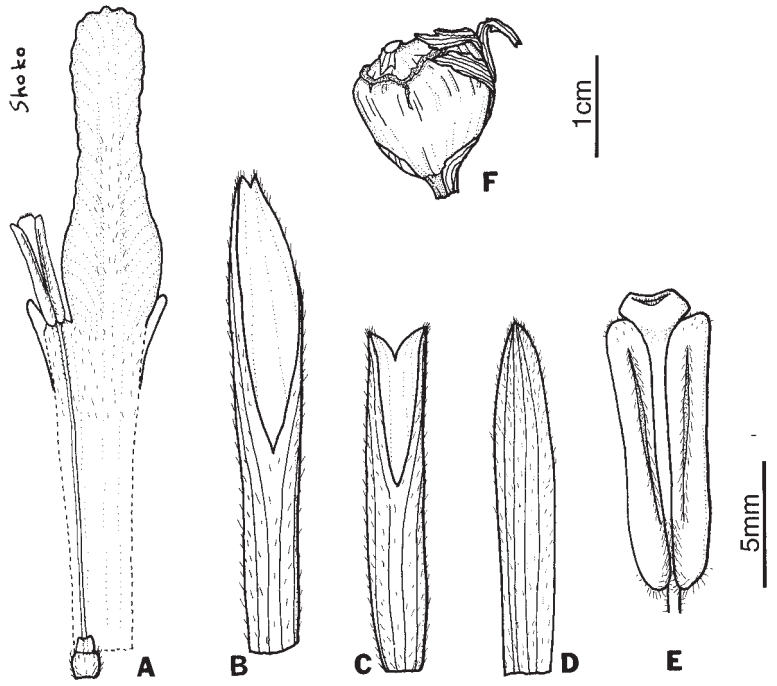


FIG. 6. *Etlingera velutina*: A, dissected flower; B, calyx; C, bracteole; D, floral bract; E, anther and stigma; F, fruit (A–E: from spirit material of *S. Sakai* 51; F: from dried material of *S. Sakai* 74).

While Smith (1986b) excludes this species from her grouping as an imperfectly known species, the slightly angled anthers show it to be a member of group D. The anther thecae dehisce in the upper three-quarters (Fig. 6E). This is the most abundant *Etlingera* in the park, and recently specimens have been collected at other sites in eastern Borneo (e.g. *A.D. Poulsen* 83 from Brunei [AAU], *B.C. Stone & E.F. Anderson* 12896 from Sandakan, Sabah [E], *R.M. Smith* 3/86, Crocker Range, Sabah [E]). Individuals usually flower more than once a year, and flowering is weakly synchronized among individuals (Sakai, 2000). The infructescences, half-embedded in the ground, are shiny red when mature, frequently with tooth marks of rodents.

*Notes on other species from Borneo*

**10. Etlingera pyramidosphaera** (K. Schum.) R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 43: 249 (1986) & Notes Roy. Bot. Gard. Edinburgh 43: 443 (1986).
Syntypes: Sarawak, 3rd Division, prov. Bintulu, Tubao, ix 1867, *Beccari* 4042 (FI!, K!); Kalimantan, prov. Pontianak, Sungai Kanta, v 1867, *Beccari* 3452 (FI!); Sulawesi, SE, Lepo-Lepo, near Kandari, vii 1874, *Beccari* s.n. (FI!).
Syn.: *Amomum pyramidosphaera* K. Schum., Bot. Jahrb. Syst. 27: 306 (1899).

This is one of the two species in Smith's group A (*Nicolaia* group) from Borneo, prior to this study, and no recent material has been collected (Smith, 1986b). In his original description, Schumann (1899) cited three specimens from different localities in Borneo and Sulawesi, which probably represented more than one species. *Beccari* 4042, the only specimen with leaves, looks very similar to *E. elatior*. The globose flowering head with ovate bracts to $10 \times 4$cm is on a stalk of at least 90cm. The glabrous leaves are petiolate for c.1cm and unequally cordate at the base. *Beccari* 3452 has a semi-globose inflorescence with elliptic and striate bracts $9 \times 1.5$cm. *Beccari* s.n. from Sulawesi has a globose flowering head with ovate bracts to $7 \times 2$cm.

Schumann (1899) distinguished *E. pyramidosphaera* (as *Amomum pyramidosphaera*) from *E. elatior* (as *Amomum magnificum*) by the brush-like hairs at the base of the anther. In the key to the species of *Phaeomeria* in his subsequent monograph (Schumann, 1904), he placed *E. pyramidosphaera* (as *P. pyramidosphaera*) in a group having inflorescence stalks 30–50cm rather than 1m, to which *P. elatior* (as *P. magnifica*) belonged. In the same monograph, however, he inconsistently described the stalk of *E. pyramidosphaera* as being about 1m long. On the other hand, Smith (1986b) used bract size and shape of inflorescence to distinguish *E. pyramidosphaera* from *E. elatior*. Apparently, she examined only two of the syntypes of *E. pyramidosphaera*: *Beccari* 4042 from Kew, which had a leaf and infructescence without bracts (the duplicate at FI has both inflorescence and infructescence), and *Beccari* 3452 from Florence, with a semi-globose inflorescence bearing narrow bracts. Thus, she was unable to compare the inflorescence and bracts of *Beccari* 4042 and *Beccari* 3452, which look so different, although she doubted the identity of the specimens from Borneo and Sulawesi (Smith, 1986b: 443). In our key to species, we use the hairs on the base of the anther, the only reliable character distinguishing *E. pyramidata* from *E. elatior*, as suggested by Schumann (1899), although we hesitated to open flowers of the syntypes to examine the point. Flowers of *E. elatior* also have hairs at the base of the anthers, but they are not brush-like (Schumann, 1904: 261, fig. 32).

## HORNSTEDTIA RETZ.

*Hornstedtia* produces radical inflorescences with a rigid involucre. Valeton (1921) subdivided the genus into three subgenera, *Scyphifera* Valeton (now subgenus *Hornstedtia*), *Elettariostemon* Valeton and *Rosianthus* Valeton. The former two are known from Borneo. Holttum (1950) indicated that there were species that could not be placed in any of them, including *H. leonurus* reported below.

All three species in the park have red flowers with a slender corolla tube, and are pollinated by little spiderhunters (Kato, 1996; Sakai *et al.*, 1999).

**1. Hornstedtia leonurus** (J. König) Retz., Observ. Bot. (Retz.) 6: 18 (1791); Ridl., J. Straits Branch Roy. Asiat. Soc. 32: 142 (1899) & Fl. Malay Penin. 4: 269 (1924); Holttum, Gard. Bull. Singapore 13: 177 (1950). **Fig. 7.**
Type: *König* s.n. (C!).
Syn.: *Amomum leonurus* J. König in Retz., Observ. Bot. 3: 69 (1783); Baker in Hook.f., Fl. Brit. Ind. 6: 236 (1892).

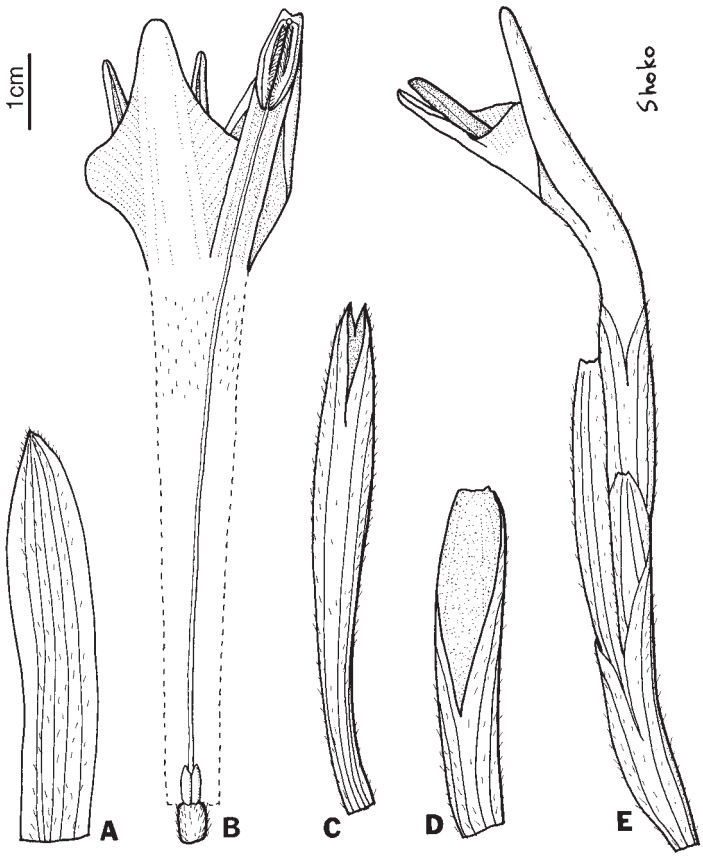


FIG. 7. *Hornstedtia leonurus*: A, floral bract; B, dissected flower; C, calyx; D, bracteole; E, open flower and remaining calyx after flowering enclosed in outer bracteole (from spirit material of *S. Sakai* 298).

*Stenochasma convoluta* Griff., Not. Pl. Asiat. 3: 433, t.359 (1851). Type: Malacca, Rhim, *Griffith* s.n. (n.v.).

*Amomum ridleyi* Baker, Kew Bull. [1892]: 127 (1892). Type: Singapore, Panjang Reserve, *Ridley* 96 (iso. K!) non *A. ridleyi* R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 311 (1986).

LAMBIR HILLS. 1 viii 1994, *S. Sakai* 58 (KYO, SAR); main WF, 8 xi 1996, *S. Sakai* 289 (KYO, SAR); along main trail, riverside, 25 xii 1998, *S. Sakai* 392 (KYO, SAR).

This is the first record of this species from Borneo. *Hornstedtia leonurus* is unique in the genus, in having more than one flower per bract and tubular bracteoles (which are occasionally open to the base in Lambir plants). The outer bracteole embraces both flowers, and the inner bracteole only one (Fig. 7E). The lateral petals are enclosed in the dorsal petal, and the lateral petals and labellum look like a beak of

a bird. The anther thecae of plants from the Malay Peninsula dehisce throughout their length (Holttum, 1950), but those of the Lambir plants dehisce in the upper 2/3 only (Fig. 7B). No other significant difference was found.

The flowers of this species are inconspicuous on the dark forest floor, though it can be recognized easily in the field by the leaves with dense brown hairs on the margin, truncate or subcordate leaf bases and prominent petiole (1–2cm).

**2. Hornstedtia minor** (Blume) K. Schum. in Engler, Pflanzenr. IV. 46 (Heft 20): 199 (4 Oct. 1904); Valeton, Bull. Inst. Bot. Buitenz. (Oct. 1904) & Icon. Bogor. 2: 241, t.167 (Dec. 1904); R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 294 (1985). **Fig. 8.**

Type: Java, in montane forest, *Blume* (L!).

Syn.: *Elettaria minor* Blume, Enum. Pl. Javae 53 (1827).

*Amomum ophiuchus* Ridl., Trans. Linn. Soc. 2 ser. 3: 381 (1893), syn. nov. Type: Tahan River, vii 1891, *Ridley* s.n. (lecto. designated by Turner [2000: 17], SING!).

*Hornstedtia ophiuchus* (Ridl.) Ridl., J. Straits Branch Roy. Asiat. Soc. 32: 141 (1899); K. Schum. in Engler, Pflanzenr. IV. 46 (Heft 20): 194 (Oct. 1904); Holttum, Gard. Bull. Singapore 13: 176 (1950).

*Donacodes minor* Teijsm. & Binn., Cat. Hort. Bot. Bogor. 58 (1866), nom. nud., unpublished.

*Amomum minus* K. Schum., Bot. Jahrb. Syst. 27: 305 (1899). Type: Java, *Teijsmann* s.n. (n.v.).

Lambir Hills. Secondary forest, 5 viii 1994, *S. Sakai* 64 (KYO, SAR); 3 v 1995, *S. Sakai* 227 (KYO, SAR); 8 vi 1995, *S. Sakai* 245 (KYO, SAR); swamp, 16 vi 1995, *S. Sakai* 250 (KYO).

Treated as *H. tomentosa* in Kato (1996), and *H.* aff. *minor* in Sakai *et al.* (1999).

Schumann (1899) published Teijsmann's invalid name as *Amomum minus* K. Schum. citing a specimen from Java. We could not find the specimen at BO or L. Valeton (1921) tentatively placed *H. ophiuchus* from the Malay Peninsula in synonymy under *H. minor* which is from Borneo and Java. Although Schumann (1904) distinguished the two species in his key by the absence of bracteoles in *H. minor*, we confirmed a linear bracteole c.3.5cm long in the type material of Blume as well as in Lambir plants (Fig. 8B). The distinctive indumentum on the outermost bracts of *H. minor* and *H. ophiuchus* looks identical, and there is no good reason to separate them.

The apex of the inflorescence, from where open flowers appear, and the inside of the inflorescence are covered with mucilage. The corolla tube never protrudes from the inflorescence, and only the tip of one or two flowers can be seen at a time. The upper parts of the flower are pushed out and fall from the inflorescence after flowering. Plants from Lambir are more pubescent on the lower surface of the leaves and the ligule than the type of *H. minor*.

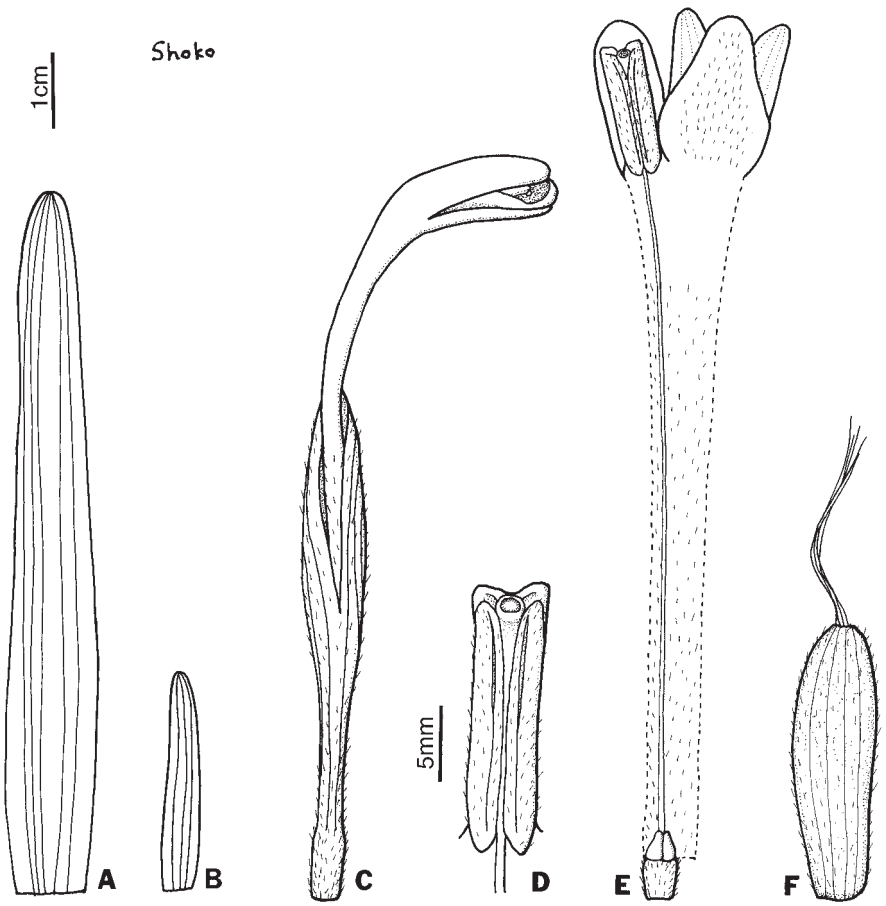


FIG. 8. *Hornstedtia minor*: A, floral bract; B, bracteole; C, ventral view of flower; D, anther and stigma; E, dissected flower; F, fruit (A–E: from spirit material of *S. Sakai* 245; F: from dried material of *S. Sakai* 64). The 5mm scale bar applies to D only.

**3. Hornstedtia reticulata** (K. Schum.) K. Schum. in Engler, Pflanzenr. IV. 46 (Heft 20): 193 (1904); R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 292 (1985).
Type: Sarawak, 1st Division, Kuching, 1865, *Beccari* 32 (K!, FI!, P!).
Syn.: *Amomum reticulatum* K. Schum., Bot. Jahrb. Syst. 27: 303, t.4, figs F, G (1899).

LAMBIR HILLS. 21 ix 1978, *Burtt* 11560 (E); in 50ha plot, 27 xii 1994, *S. Sakai* 84 (KYO, SAR); ridge, 21 iii 1995, *S. Sakai* 228 (KYO, SAR).

This species is characterized by the aerial rhizome being supported by stilt roots and the cup-shaped inflorescence which collects water. This may protect the flowers from nectar robbers such as ants.

*Notes on other species from Borneo*

**4. Hornstedtia affinis** Ridl., J. Straits Branch Roy. Asiat. Soc. 32: 143 (1899); K. Schum. in Engler, Pflanzenr. IV. 46 (Heft 20): 195 (1904); R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 294 (1985), p.p. excl. syn. *H. phaeochoana* K. Schum. (sphalm. *phaecochoana*). **Fig. 4B.**
Type: Sarawak, 1st Division, Kuching, *Haviland* 1764 (K!).

See notes under *H. phaeochoana*.

**5. Hornstedtia phaeochoana** (K. Schum.) K. Schum. in Engler, Pflanzenr. IV. 46 (Heft 20): 191 (1904). **Fig. 4C.**
Type: Sarawak, 1st Division, *Beccari* 615 (FI!).
Syn.: *Amomum phaeochoanum* K. Schum., Bot. Jahrb. Syst. 27: 304 (1904).

*Hornstedtia affinis* auct. non Ridl.: R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 294 (1985), p.p.

Smith (1985) united *H. affinis* and *H. phaeochoana*, because she saw Schumann's note on the type specimen of *H. affinis* identifying it as *H. phaeochoana*, though he had distinguished the two species in his monograph in 1904. However, our examination of the type specimen of *H. phaeochoana*, which Smith could not locate, revealed that it differed considerably from *H. affinis* in inflorescence size, hairs on leaves and ligules, and petiole (Figs 4B, C).

The only Bornean records for both species are the type specimens, and Schumann's descriptions lack floral detail. Holttum (1950) reported *H. phaeochoana* from Johor, Malay Peninsula (*Corner* 31946, n.v.). He noted that the plant had white bracts with rose-red tips in fresh material and flowers similar to those of *H. scyphifera*, and that it belonged to the subgenus *Hornstedtia*.

**6. Hornstedtia conica** Ridl., J. Straits Branch Roy. Asiat. Soc. 32: 142 (Jan. 1899). **Figs 2D, 4D.**
Type: Selangor, Bukit Hitam, v 1894, *Ridley* 7803 (lecto. designated by Turner [2000: 34], SING!, isolecto. K!).
Syn.: *Donacodes alliaceum* Teijsm. & Binn., Cat. Hort. Bot. Bogor. 58 (1866), nom. nud., unpublished.

Non *Zingiber alliaceum* K. Schum. in Engler, Pflanzenr. IV. 46 (Heft 20): 179 (1904) (see Valeton [1912: 167]).

*Hornstedtia alliacea* Valeton, Icon. Bogor. 4: 165, t.350 (1912) & Bull. Jard. Bot. Buitenz. III. iii. 174 (1921). Type: Hort. Bog. (lecto. designated here, BO no. 0083324!).

*Amomum sarawacense* K. Schum., Bot. Jahrb. Syst. 27: 304 (Sept. 1899), syn. nov.; R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 304 (1985), quoad nom. (excl. *Anderson* S30713). Type: Sarawak, 1st Division, Mt. Matang, iv 1866, *Beccari* 1435 (FI!).

*Hornstedtia sarawacensis* (K. Schum.) K. Schum. in Engler, Pflanzenr. IV. 46 (Heft 20): 191 (1904).

*Material examined*. BORNEO. Sarawak, 4th Division, Bintulu district, northeast of Bt. Kana, foot of mountain, alt. 50–150m, 22 xi 1963, *M. Hotta* 15501 (KYO); Kuching Division, Kubah National Park, 2 i 1999, *S. Sakai* 423 (KYO, SAR); ibid., 11 i 1999, *S. Sakai* 438 (KYO, SAR); W. Kalimantan, Gn. Palung Natural Reserve, c.100km S of Pontianak, dipterocarp forest, swampy soil, alt. 30m, 27 vi 1986, *v. Balgooy & v. Setten* 5628 (L).

MALAY PENINSULA. Singapore, Bukit Panjang, *Ridley* s.n. (syntype of *H. conica*, K); Johor, base of Gunong Panti, xii 1892, *Ridley* s.n. (syntype of *H. conica*, K); Langat near Jugra Hill, 2 vii 1889, *Ridley* s.n. (syntype of *H. conica*, SING); Jerantut, xi 1924, *Burkill & Hanif* S.F.N.15835 (BO, K); Trengganu, Ulu Kajang, Kemaman, 500ft, in swamp, 13 xi 1935, *Corner* S.F.N.30433 (BO); Pahan, S. Sat, Ulu Tembeling, *Henderson* S.F.N.21987 (BO, K).

We designate a specimen at the Herbarium Bogoriense as the lectotype of *Hornstedtia alliacea*. This specimen, from the plant cultivated at Bogor, has in Valeton's handwriting: "specimen authenticus T. et B! Cat. 1866", "*Hornstedtia alliacea* (T. et B!) Thv, 1907" and anonymously: "*Donacodes alliaceum* T. et B.", and it may be the specimen cited as "an authentic specimen in the Herb. Bog." by Valeton (1921: 175). Although a specimen at the Nationaal Herbarium Nederland, Leiden, has an anonymous note "type of *H. alliacea*", it is unlikely since it is from a plant cultivated at Daubanton rather than Bogor, and the date of Valeton's annotation (1917) is later than the description of the species.

Smith (1985) moved *H. sarawacensis* to *Amomum*, because she could not locate the type specimen and identified *Anderson* S30713 (E), collected in a peat swamp forest between Ulu Sungei Karap and Batang Tinjar, 4th Division, Sarawak, as this species based on a figure of an inflorescence in Schumann's monograph (fig. 25 in Bot. Jahrb. Syst. 27: 190 [1904]). However, *Beccari* 1435 (FI) (Fig. 4D) is considerably different from *Anderson* S30713 (SAR) in its long petiolate (to 2cm) glabrous leaves and bracts with aristate apex rather than sessile leaves pubescent below and bracts with long acuminate apex. *Anderson* S30713 may represent an undescribed species.

Examination of recent collections from the type locality, *S. Sakai* 423 and 438, revealed that this species has rigid involucral bracts and belongs to *Hornstedtia*. Although Schumann (1904) described the species as having leafy shoots 55cm high (probably based on the type material of a single sheet), the plant is usually much more robust and up to 2m high with laminas to $65 \times 11$cm, and petioles to 4.5cm. *Hornstedtia conica* is easily recognized in the field by its fusiform inflorescences enclosed by red bracts with white centrally, embedded in the ground (Fig. 2D). The central parts of the bracts are covered with short appressed hairs and are velvety to the touch. The most interesting character is the sessile anther dehiscing only in the lower 1/2–2/3. The anther connective has a deep central fissure extending between the thecae. In these points, fig. 9A in Smith (1985: 302) based on S30713 (E), and her description, do not agree with *S. Sakai* 423 and 438. *Hornstedtia sarawacensis* differs from *H. conica* in its inflorescences embedded in the ground rather than held

above it, according to Holttum (1950). Bornean plants seem to have a smoother pubescence on the involucral bracts, and smaller inflorescences (7–9cm including short peduncle), than those of Peninsular plants with their more or less floccose bracts and inflorescences 9–11cm long. However, the variation is continuous and floral details as well as vegetative characteristics are identical.

## Plagiostachys Ridl.

The genus is characterized by the inflorescences pushing out laterally through the side of the leaf sheaths. Smith (1985) classified Bornean *Plagiostachys* into two groups based on inflorescence mucilage, style adnation to the corolla tube, shape of calyx, bracteole, capsule and ligule, and floral colour. However, Cowley (1999) described two non-mucilaginous species belonging to neither group, and indicated that the grouping was unsatisfactory. The new species described here, *P. glandulosa*, falls into Smith's group I (mucilaginous group).

**1. Plagiostachys crocydocalyx** (K. Schum.) B.L. Burtt & R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 31: 315 (1972); R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 268 (1985).
Syntypes: Sarawak, 1st Division, Siul, near Kuching, x 1865, *Beccari* 718 (FI!, see note below); Marop, Batang Lupar, v 1867, *Beccari* 3477 (FI!, K!).
Syn.: *Alpinia crocydocalyx* K. Schum., Bot. Jahrb. Syst. 27: 281 (1899) & in Engler, Pflanzenr. IV. 46 (Heft 20): 310 (1904).

Lambir Hills. 23 xi 1994, *S. Sakai* 97 (KYO, SAR); 14 iii 1995, *S. Sakai* 232 (KYO, SAR).

Although the original description by Schumann (1899: 281) does not include the serial number of one of the type specimens, it is likely to be *Beccari* 718, which agrees with the citation in date (Oct. 1865) and locality (Siul, near Kuching).

The species stands out in the genus for its immense size, and the golden indumentum on the lower surface of leaves (Smith, 1985). Some collections from Sarawak (*Hotta* 6118, *Murata et al.* B3124) and Kalimantan (*Hirano & Hotta* 522) look identical with *P. crocydocalyx* in inflorescences, infructescences and size, but lack dense pubescence on the lower leaf surface although some pubescence can be observed.

**2. Plagiostachys glandulosa** S. Sakai & Nagam., **sp. nov. Figs 1B, 2E, 2F, 9.**
*Plagiostachyi albifloro* Ridl. inflorescentia mucilagina et stylo supra glandem epigynam ad tubum corollae adnato similis, sed differt foliis fere sessilibus pubescentibusque et filamento cum pilis glanduliferis.
Type: Sarawak, Lambir Hills, near entrance of the 8ha plot, swamp, ht. c.3m, inflorescence borne c.25cm above the ground, flower white, labellum yellow, petals red, 4 viii 2001, *S. Sakai* 703 (holo. KYO, iso. SAR).

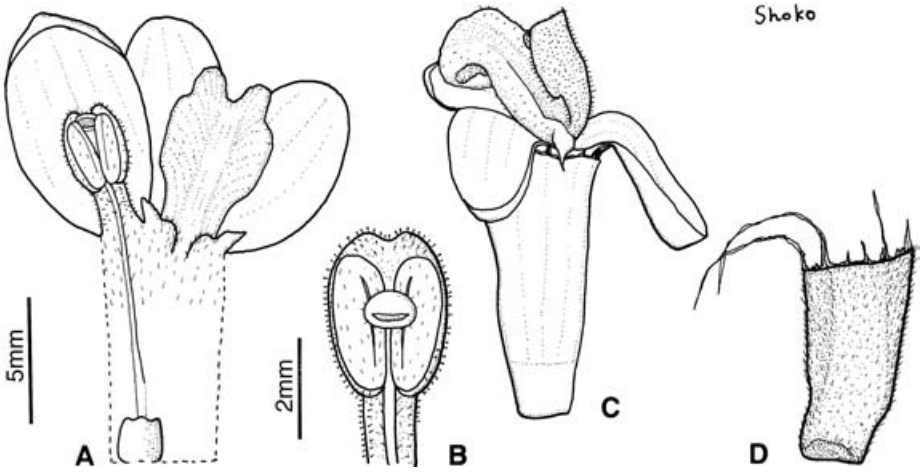


FIG. 9. *Plagiostachys glandulosa*: A, dissected flower; B, anther and stigma; C, lateral view of flower; D, bracteole (from spirit material of *S. Sakai* 703). The 2mm scale bar applies to B only.

Perennial herb c.2m tall. *Leaves* c.4 pairs per shoot, with petioles to 1cm; lamina to 90 × 10cm, narrowly oblanceolate, apex long caudate to 4cm, base shortly attenuate, pubescent on both surfaces, with longer and denser hairs below, ciliate; ligule coriaceous, to 1.2cm long, bilobed to the base, densely hairy, ciliate; sheaths striate, sometimes slightly reticulate, variously pubescent. *Inflorescence* borne 20–30cm above ground, 5–10cm long, longer in fruit, almost sessile, branched or unbranched, mucilaginous (Fig. 2E); bracts 0; bracteoles tubular for c.7.5mm, decaying to leave only veins remaining above tube, glabrous inside, densely pubescent outside (Fig. 9D). *Flower* with pubescent pedicel c.2mm; calyx c.7.5mm long, tubular, decaying to leave only veins remaining above tube, glabrous on both surfaces or sparsely hairy outside (Fig. 9C); corolla tube c.9mm, pubescent on both surfaces in upper half (Fig. 9A); dorsal petal c.9 × 6mm, obovate, red, glabrous on both surfaces; laterals c.6.5 × 5mm, elliptic, red, glabrous on both surfaces (Figs 2F, 9A); labellum thick, c.7 × 5mm, spathulate with two auricles at apex, yellow, hairy on lower surface, covered with glandular projections on central upper surface, sparsely hairy below (Fig. 9A); lateral staminodes triangular with swelling at base covered with dense hairs; anther c.3 × 2.5mm, apex slightly emarginate, connective 0, with straight hairs on thecae and short glandular hairs elsewhere (Figs 1B, 9B); filament c.2mm long, covered with short glandular hairs; style c.14mm long, with long sparse hairs on upper half, adnate to corolla tube for basal c.3.5mm (Fig. 9A); stigma c.0.7mm wide with dorsal opening, ciliate around mouth, with long sparse hairs; epigynous gland c.1.5mm; ovary 1.5–2.5mm × c.2mm, glabrous. *Capsule* to 12 × 10mm, pyriform, with short calyx base, dark red when fresh, wrinkled and light brown when dry, glabrous except on and around calyx base.

LAMBIR HILLS. 24 ix 1994, *S. Sakai* 98 (KYO, SAR), 14 v 1995, *S. Sakai* 234 (KYO, SAR).

*Other material examined*. East Kalimantan, Malinau. Punjungan, Lg. Belaka (Sg. Lurah), Kayan-Mentarang National Park, 18 vii 2002, *M. Koizumi & Lalo* 829 (BO).

Treated as *Plagiostachys* sp. 1 in Sakai *et al.* (1999) and Sakai (2000).

Similar to *P. crocydocalyx* in having leaves pubescent on the lower surface, but plants much smaller throughout. Papillose hairs on the anthers have also been reported in *P. mucida* Holttum, a mucilaginous species from the Malay Peninsula, which differs in having petioles to 5cm and red flowers.

In the two mucilaginous species from Lambir, the emerging inflorescence is covered with bright pink fleshy bracteoles overlapping to form a pyramid shape at the top. The bracteoles start to decay with a pungent smell even before the flowers open, and often attract flies and beetles. The mucilage may function to keep ants away from the rich floral nectar, which is often exploited by little spiderhunters, although the most effective pollinators are *Amegilla* bees (Sakai *et al*., 1999).

**3. Plagiostachys strobilifera** (Baker) Ridl., J. Straits Branch Roy. Asiat. Soc. 32: 151 (1899) & J. Straits Branch Roy. Asiat. Soc. 46: 242 (1906); R.M. Sm., Notes Roy. Bot. Gard. Edinburgh 42: 271 (1985).
Type: Sabah, near Sandakan, *Creagh* (K!).
Syn.: *Alpinia strobilifera* Baker, Kew Bull. [1898]: 235 (1898).

LAMBIR HILLS. Sungai Lapoh, streambank in forest, 29 ix 1978, *Burtt* 11551 (E); Sungai Liam Libau, streamside in forest, 22 ix 1978, *Burtt* 11588 (E); ridge SW of Bukit Lambir, c.1100ft, 26 ix 1978, *Burtt* 11632 (E); in mixed dipterocarp forest, 5 viii 1993, *Nagamasu* 6162 (KYO); valley, sandy clay soil, x 1993, *Nagamitsu* 390 (KYO); Sg. Liam Libau, ht. 2.5m, 12 viii 1984, *S. Sakai* 71 (KYO); next to Sg. Latak near entrance to Lambir NP, 27 viii 1994, *S. Sakai* 87 (KYO, SAR); 10 iv 1995, *S. Sakai* 198 (KYO, SAR); on the slope near the third waterfall, 25 xii 1998, *S. Sakai* 393 (KYO, SAR).

Smith (1985) recognized a group of plants with glabrous leaves and sheaths otherwise very similar to *P. strobilifera*. They occur sympatrically with *P. strobilifera* at least in Lambir Hills and Gunung Mulu National Parks. We could not find any significant differences except for hairs on the leaves, which is acceptable variation within a species, and it seems reasonable to include them in *P. strobilifera*. Among nine collections collected at Lambir Hills, *S. Sakai* 71, 87, 198 and *Burtt* 11588 are of the glabrous type.

This species is very abundant, and its pink inflorescences are conspicuous in the forest. Visits by the pollinators, little spiderhunters, are frequently observed (Sakai *et al.*, 1999). A single plant usually flowers more than once a year; flowering is not synchronized among individuals (Sakai, 2000).

## KEY TO THE BORNEAN GENERA OF *ALPINIOIDEAE*

Ten genera of *Alpinioideae* have been recorded from Borneo. All but *Burbidgea* (tribe *Riedelieae* W.J. Kress) belong to the tribe *Alpinieae* Link in Kress's sense

(Kress *et al.*, 2002). Keys to species are provided for genera whose names are in capitals.

1a. Inflorescence terminal on leafy shoot — 2
1b. Inflorescence borne separately from leafy shoot — 4

2a. Labellum narrow, no wider than and held erect against the stamen; flowers plain yellow-orange, unmarked — **Burbidgea**
2b. Labellum not as above; flower colour various, always with some form of patterning on labellum — 3

3a. Inflorescence breaking through leaf sheaths laterally (but actually terminal), densely congested and often becoming mucilaginous; labellum not or barely exceeding petals — **PLAGIOSTACHYS**
3b. Inflorescence emerging above the uppermost leaf sheath, rarely appearing lateral, if so then not densely congested and labellum large and showy **ALPINIA**

4a. Inflorescence compact; bracts imbricate — 5
4b. Inflorescence lax; bracts never imbricate — 7

5a. Inflorescence enclosed by an involucre of sterile bracts, fusiform or occasionally cyathiform; flowers opening 2 or 3 at a time — **HORNSTEDTIA**
5b. Inflorescence with or without an involucre of sterile bracts, if present then involucre not markedly rigid, usually cone-shaped or flat-topped, often with many flowers open at a time — 6

6a. Sterile involucre absent; infructescence elongating with age; labellum and filament not forming a tube above petals — **Amomum**
6b. Sterile involucre present (rarely reduced to 3–4 bracts); infructescence not elongating; labellum and filament always joined to form a distinct tube above petals — **ETLINGERA**

7a. Lip and filament joined to form a distinct tube above petals; free part of labellum divided to at least 1/2 way into two linear lobes — **Geocharis**
7b. Lip and filament not so joined; labellum never deeply split — 8

8a. Leafy shoots few bladed; bracteoles open to base; anther crest prominent — **ELETTARIOPSIS**
8b. Leafy shoots frond-like, generally many bladed; bracteoles tubular; anther crest absent or minute — 9

9a. Inflorescence prostrate, sometimes almost entirely subterranean — **ELETTARIA**
9b. Inflorescence erect, always held above ground — **Geostachys**

## Key to the Bornean species of *Alpinia*

1a. Bracts to 10cm, concealing flowers; inflorescence pendulous — **A. capitellata**
1b. Bracts, when present, very much smaller (unknown in *A. amentacea*), never concealing flowers; inflorescence generally erect, occasionally pushed out laterally below the leafy shoot — 2

2a. Bracteoles tubular, persistent; flowers in cincinni; labellum c.6mm or shorter, deeply 2-lobed or obscurely 3-lobed — 3
2b. Bracteoles, if present, usually soon deciduous, open to base or initially calyptrate around unopened flower; flowers in cincinni or not; labellum over 1cm long, if less, then 4-lobed — 5

3a. Flowers always hermaphrodite; labellum obscurely 3-lobed — **A. sumatrana**
3b. Flowers on upper part of cincinnus functionally male with rudimentary gynoecium; labellum deeply 2-lobed — 4

4a. Leaves linear-lanceolate, 30–40 × 2–3.5cm; inflorescence pubescent — **A. beamanii**
4b. Leaves lanceolate, to 35 × 6cm; inflorescence glabrous — **A. amentacea**

5a. Lip usually just under 1cm long, 4-lobed, central sinus very deep **A. aquatica**
5b. Lip 1cm long or more, not shaped as above — 6

6a. Inflorescence strongly paniculate; bracts calyptrate* round buds, soon deciduous, bases sometimes remaining — 7
6b. Inflorescence simple or occasionally with one or two short lateral branches at base; bracts, if present, not calyptrate — 8

7a. Ligule to 6cm long; calyx lobes prominently apiculate — **A. ligulata**
7b. Ligule to 1.5cm long; calyx lobes not strongly apiculate — **A. nieuwenhuizii**

8a. Flowers borne singly on main axis; bracteoles absent; bracts soon deciduous, usually only seen as scars — 9
8b. Flowers in cincinni, if solitary then at top of inflorescence only; bracteoles present; bracts present or not — 14

9a. Anther without crest — 10
9b. Anther with well-developed crest — 13

10a. Leaves pubescent below — 11
10b. Leaves glabrous below — 12

11a. Ovary yellow-orange tomentose; ligule to 5mm — **A. havilandii**
11b. Ovary glabrous; ligule 2mm — **A. ptychanthera**

12a. Petiole absent, leaf margins with widely spaced bristle-like hairs; flowers to 6cm long — **A. hansenii**
12b. Petioles 1.5–3cm, leaf margins occasionally with bristles; flowers to 3.5cm long — **A. martinii**

13a. Leaves with a striking silver indumentum; flowers to 5cm long — **A. argentea**
13b. Leaves glabrous; flowers to 3cm long — **A. tamacuensis**

14a. Leaves pubescent on both surfaces; labellum 1cm long — **A. microlophon**
14b. Leaves glabrous or pubescent on lower surface only; labellum 2.5–4.5cm long — 15

15a. Anther without crest; bracteoles open to base — 16
15b. Anther crest well formed; bracteoles initially calyptrate around unopened flower, usually pushed off as flower opens (*A. glabra*) — 17

16a. Cincinni 2-flowered (flowers at top of inflorescence solitary); bracteole enfolding bud — **A. latilabris**
16b. Cincinni 3–4-flowered; bracteoles not enfolding flower buds — **A. mutica**

17a. Leaf sheaths glabrous, striate — **A. glabra** var. **glabra**
17b. Leaf sheaths pubescent, strongly reticulate — **A. glabra** var. **reticulata**

*Care should be taken not to confuse the initially calyptrate bracts of *A. ligulata* and *A. nieuwenhuizii* with the much larger calyptrate bracteoles of *A. glabra*.

## Key to the Bornean species of *Elettaria*

Our earlier key (Sakai & Nagamasu, 2000) is partly based on anther dehiscence patterns and shape of anther crest and labellum, which can be observed only in specimens with flowers in good condition. The following key may be useful for identifying material without open flowers.

1a. Leaves broadly obovate with attenuate base, 20–30 × 7–12cm; inflorescence red; flowers orange-yellow — **E. rubra**
1b. Leaves narrowly obovate, elliptic or oblong with cuneate base, to 7cm wide, if wider then much longer than 30cm; inflorescence greenish brown; flowers white and yellow — 2

2a. Robust plant with leaves to 80cm long; leaves pubescent below, petiole usually 1.5–2.5cm — **E. longituba**
2b. More delicate plant with leaves to 40cm long; leaves glabrous or slightly pubescent below, if prominently pubescent then sessile — 3

3a. Leaves covered with long soft hairs below, inflorescence axis glabrous — **E. longipilosa**
3b. Leaves glabrous or pubescent only around lower midrib, never prominently pubescent; inflorescence axis glabrous or pubescent — 4

4a. Calyx free, glabrous, c.17cm long — **E. kapitensis**
4b. Calyx free, rarely fused with corolla tube for 0–1.5cm above the ovary (*E. stolonifera*), free part of calyx pubescent or glabrous, to 11mm — 5

5a. Calyx with long thick hairs; bracts 1–2cm, strongly overlapping especially at tip of inflorescence — **E. linearicrista**
5b. Calyx glabrous or with soft hairs; bracts 2–6cm, slightly overlapping; intervening gaps mostly equal to or longer than bracts — 6

6a. Leaves glabrous, to 35 × 7cm; calyx pubescent — **E. surculosum**
6b. Leaves pubescent on lower midrib, to 4cm wide; calyx glabrous except at tip 7

7a. Calyx fused with corolla tube for 0–1.5cm above the ovary; free part of calyx c.10mm; bracts 10–40mm, glabrous — **E. stolonifera**
7b. Calyx not fused with corolla tube above the ovary; calyx c.6mm; bracts 10–16mm, partly pubescent — **E. brachycalyx**

### Key to the Bornean species of *Elettariopsis*

1a. Leaves linear-lanceolate, under 3cm wide, sessile or with petiole to 1cm — **E. kerbyi**
1b. Leaves elliptic or oblanceolate, 4cm wide or more, petioles longer — 2

2a. Inflorescence to 18cm, many-flowered; petioles 5–18cm — **E. curtisii**
2b. Inflorescence to 7cm, 5-flowered; petioles to 4cm — **E. stenosiphon**

### Key to the Bornean species of *Etlingera*

1a. Inflorescence 10–130cm above ground; anther more or less erect, never strongly angled to free part of filament, thecae dehiscing in upper 1/2–2/3 — 2
1b. Inflorescence partially or almost wholly embedded in ground, rarely slightly raised; anther erect or angled, thecae dehiscing to base or not — 4

2a. Inflorescence 60–130cm above ground; scales on most of peduncle rarely overlapping — 3
2b. Inflorescence 10–40cm above ground; scales on most of peduncle overlapping — **E. newmanii**
3a. Anther with brush-like hairs at base — **E. pyramidosphaera***
3b. Anther without brush-like hairs at base — **E. elatior**

4a. Anther at an angle to free part of filament or corolla tube — 5
4b. Anther more or less erect — 14

5a. Sterile bracts 0–6, shorter than 3cm; flowers 2–3 per inflorescence **E. inundata**
5b. Sterile bracts usually many, the largest longer than 3cm; flowers 4–many — 6

6a. Central lobe of labellum elongate, longer than 2cm, or labellum 4cm long or more; labellum plain red or red with white or yellow — 7
6b. Central lobe of labellum not elongate, labellum much less than 4cm long, red or pink with yellow in centre — 11

7a. Petals about same length as calyx, dorsal lobe not hooded over anther; anther thecae dehiscing in upper 1/2–2/3 only, slits usually hair-fringed, inner

faces of thecae never totally pubescent; labellum plain red or with some white at the edges — 8

7b. Petals longer than calyx, dorsal lobe hooded over anther; anther thecae dehiscing more or less to base, inner faces densely pubescent; labellum red with some yellow centrally, rarely plain red — 10

8a. Involucral bracts to 8 × 5cm, markedly striate; flowers 12–13cm long — **E. triorgyalis** vel sp. aff.†

8b. Involucral bracts to 1–6 × 2–3cm, not markedly striate; flowers 9–10cm long — 9

9a. Leaves sessile, with appressed hairs below (in Borneo); labellum at least partially white-edged — **E. metriocheilos**

9b. Leaves with petioles 1–2.5cm, glabrous below; labellum plain red (in Borneo) — **E. littoralis**

10a. Involucral bracts under 1cm wide; labellum plain red — **E. nasuta**‡

10b. Involucral bracts 1.5cm wide or more; labellum red, usually with some yellow in the centre — **E. coccinea**

11a. Petiole c.5cm, glabrous; anther sessile — **E. sessilanthera**

11b. Petiole absent or to 2cm, pubescent below or glabrous; free part of filament 2–3.5mm — 12

12a. Leaves sessile, glabrous; involucral bract white to light cream or light green, upper bracts with deep red margin — **E. rubromarginata**

12b. Leaves sessile or petiole to 1.5cm, pubescent below; involucral bracts not as above — 13

13a. Leaves linear to narrowly obovate, 40–70 × 3–8cm in middle of the shoot; labellum entire — **E. baramensis**

13b. Leaves oblong to obovate, 30–60 × 9–15cm; central lobe of labellum bifid — **E. belalongensis**

14a. Flowers few per inflorescence, to 12cm long, deep red with a white stigma — **E. brevilabrum**

14b. Flowers many per inflorescence, to 10cm long, red, white, white and yellow, red and yellow, or red and white; stigma (where known) red or pink — 15

15a. Leaves pubescent, sparsely papillose or hairy below — 16

15b. Leaves glabrous or hairs confined to margins and midrib — 18

16a. Petiole absent or c.5mm; labellum pink with white margin at base; anther sessile — **E. velutina**

16b. Petiole 1–4cm; labellum white or yellow; filament c.3mm or more — 17

17a. Leaves corrugated and sparsely papillose or hairy below; involucral bracts not ciliate; labellum white — **E. corrugata**
17b. Leaves not corrugated, conspicuously hairy below; involucral bracts densely hairy marginally; labellum yellow — **E. pubescens**

18a. Petioles 7–9cm — 19
18b. Petioles absent or to 4cm — 20

19a. Petals yellow; anther crested — **E. sanguinea**
19b. Petals red; anther crest rudimentary — **E. longipetiolata**

20a. Labellum red, sometimes with yellow margin, more or less equalling stamen — 21
20b. Labellum yellow, occasionally orange in centre, to 1.5cm longer than the stamen — 22

21a. Petioles absent; ligule ciliate; labellum red with yellow margin — **E. sp. nov.?** of R.M. Smith (1986b: 452)
21b. Petioles 1.5–2cm; ligule glabrous; labellum red — **E. brachychila**

22a. Anther crest prominent; receptacle of inflorescence usually less than 1cm long — **E. fimbriobracteata**
22b. Anther crest absent or reduced to a thickened rim; receptacle of inflorescence 3–4cm long — **E. muluensis**

*See discussion under *E. pyramidosphaera* (p. 198).
†Smith (1986b) identified two specimens from Sarawak as *E. triorgyalis* (Baker) R.M. Sm., a species from Peninsular Malaysia and Sumatra. Although she found some differences, she thought them insufficient to warrant specific distinction. In addition, she tentatively included *Hornstedtia winkleri* Ridl. described from Kalimantan as a synonym of *E. triorgyalis* though it was impossible to examine flowers of the type specimen, *Winkler* 3175 (WRSL, n.v.).
‡Smith (1986b: 446) suggested that *E. nasuta* might have inflorescences not deeply embedded in the ground and used this point to distinguish it from *E. coccinea*. We omitted this point, because we observed inflorescences of both *E. coccinea* (*S. Sakai* 62 and 226 from Lambir Hills) and *E. nasuta* (*S. Sakai* 56 from Semangoh FR, *S. Sakai et al.* 710 from Ulu Baram) and found no significant difference in inflorescence depth.

### Key to the Bornean species of *Hornstedtia*

1a. Inflorescence small (c.6 × 2cm) with short peduncle (c.2cm), bracts striated and light brown with darker edge in dried state — **H. phaeochoana**
1b. Inflorescence and bracts not as above — 2

2a. Each bract subtending 2 flowers — **H. leonurus**
2b. Each bract subtending 1 flower — 3

3a. Anther with distinct filament; thecae fertile in upper half only; connective

prolonged into rounded crest; stigma more or less cup-shaped with apical opening (subgen. *Hornstedtia*) ____ 4

3b. Anther sessile; thecae fertile throughout their length or in lower 1/2–2/3; connective emarginate with small lobe at apex of each theca; stigma rounded with dorsal opening (subgen. *Elettariostemon* Valeton) ____ 8

4a. Flower resembling beak of duck-billed platypus (*Ornithorhynchus*); labellum lacking side-lobes and free from lateral petals; filament broader than anther ____ **H. tomentosa**

4b. Flower not as above; labellum with prominent side-lobes; lateral petals adnate to centre of the labellum; filament not broader than anther ____ 5

5a. Sterile bracts velvety tomentose, sometimes with a few obscure reticulations; calyx much more than 1/2 as long as (and sometimes equalling) corolla tube ____ **H. incana**

5b. Sterile bracts prominently reticulate-areolate; calyx c.1/2 as long as corolla tube ____ 6

6a. Rhizome not on stilt roots; indumentum of sterile bracts soft _ **H. scyphifera**

6b. Rhizome on stilt roots; indumentum of sterile bracts scabrid ____ 7

7a. Inflorescence cyathiform; sterile bracts very strongly reticulate with pronounced longitudinal ribs, cross bars glabrous towards apex **H. reticulata**

7b. Inflorescence fusiform; sterile bracts with much less pronounced longitudinal ribs; cross bars pubescent throughout ____ **H. pininga** var. **borneense**

8a. Anther thecae fertile in lower 1/2–2/3; division of anther connective extending between thecae ____ **H. conica**

8b. Anther thecae and connective not as above ____ 9

9a. Peduncle to 40cm long ____ 10

9b. Peduncle 2–3cm long ____ 11

10a. Inflorescence 1.5–2cm in diameter; sterile bracts scarcely reticulate, glabrous; apex of labellum expanded ____ **H. gracilis**

10b. Inflorescence much larger; sterile bracts reticulate; apex of labellum not expanded ____ **H. havilandii**

11a. Sterile bracts glabrous ____ **H. affinis**

11b. Sterile bracts with silky, felt-like indumentum especially in lower 1/3 ____ **H. minor**

## Key to the Bornean species of *Plagiostachys*

The three imperfectly known and un-named mucilaginous species in Smith (1985) are omitted from the key below due to insufficient information.

1a. Inflorescence mucilaginous — 2
1b. Inflorescence non-mucilaginous — 4

2a. Leaves to 1.5m long, inflorescence elongating to 30cm or more with age — **P. crocydocalyx**
2b. Leaves to 0.9m long; inflorescence sometimes elongating to 20cm — 3

3a. Leaves glabrous; petioles 2.5–6cm long; filament glabrous — **P. albiflora** s.l.
3b. Leaves pubescent on both surfaces; petioles c.1cm; filament with glandular hairs — **P. glandulosa**

4a. Style connate to corolla tube at base, above epigynous glands — 5
4b. Style free to base or very shortly adnate below epigynous glands — 7

5a. Bracteole long apiculate and open to base, remains persistent on infructescence — **P. bracteolata**
5b. Bracteole not apiculate and tubular at least at base, partially decayed at fruiting — 6

6a. Leafy shoot to 60cm; petioles 0.6–4.5cm, leaf base unequally cordate; inflorescence arising near ground level (1–3cm above base) — **P. parva**
6b. Leafy shoot to 4m; leaves sessile, base long attenuate; inflorescence arising 12–30cm above base — **P. breviramosa**

7a. Ligule bilobed, to 1.5cm long; lateral staminodes oblong — **P. sp. nov.?** of R.M. Smith (1985: 271)
7b. Ligule truncate or emarginate, 2–3mm long; lateral staminodes linear — 8

8a. Petioles absent; anther connective truncate — **P. strobilifera**
8b. Petioles to 3cm; anther connective distinctly crested — **P. sp.** (aff. **strobilifera**) of R.M. Smith (1985: 272)

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