

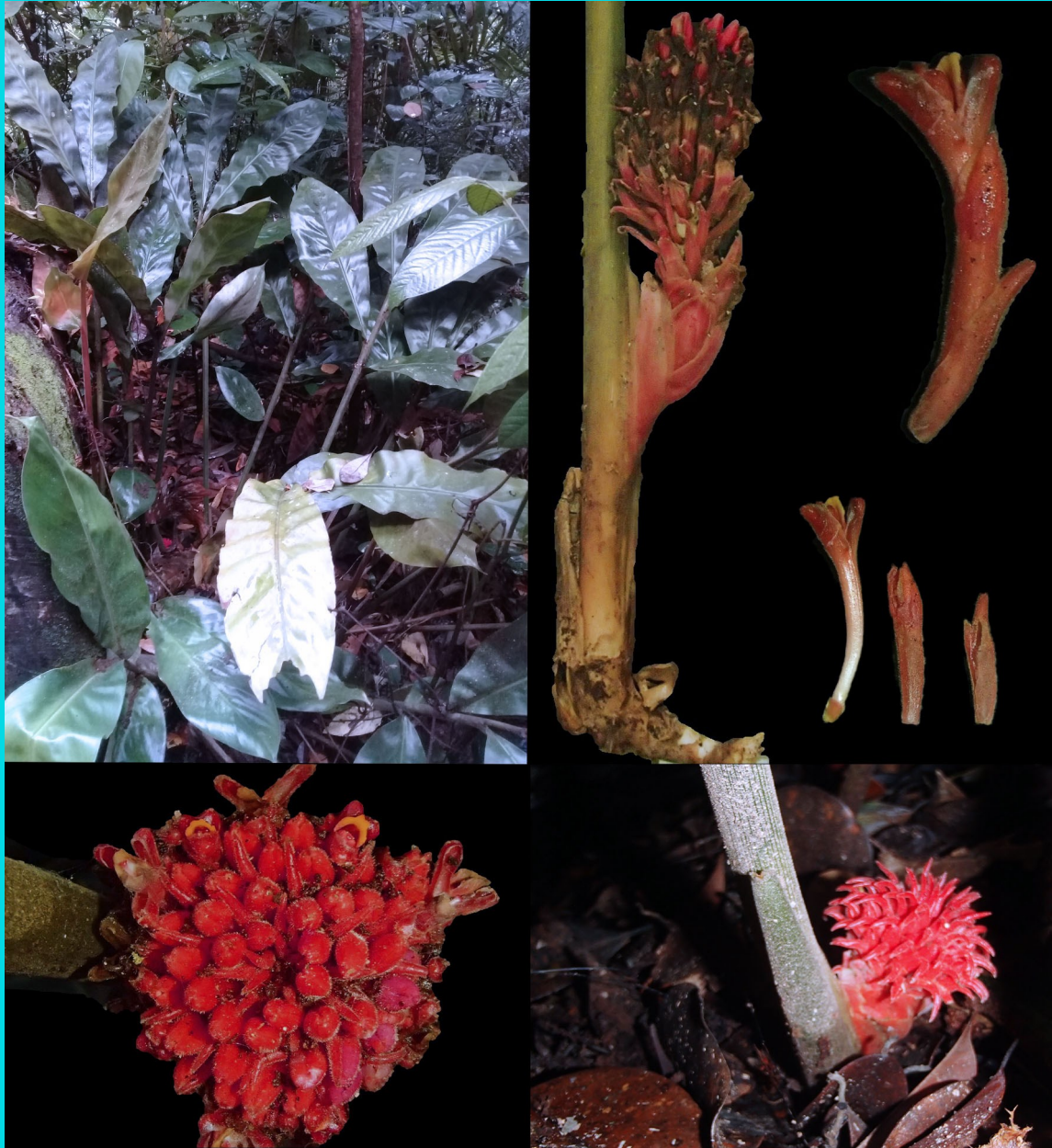


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***PLAGIOSTACHYS STROBILIFERA* VAR. *CONICA* (ZINGIBERACEAE), A NEW VARIETY FROM SARAWAK, BORNEO**

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ABSTRACT

SALASIAH, M. & MEEKIONG, K. 2020. *Plagiostachys strobilifera* var. *conica*, a new variety from Sarawak, Borneo. *Reinwardtia* 19(2): 109–116. — The new taxon varies from *Plagiostachys strobilifera* var. *strobilifera* in the broader lanceolate leaves, the bilobed ligule, the longer calyx, the rounded anther crests, the oblong lateral staminodes, and the non-free apical bracteole with conical apex (which gives the taxon its epithet). A key to species of Bornean *Plagiostachys* is also provided, along with a conservation assessment.

Key words: Alpinieae, Alpinioideae, diversity, Borneo, Malesia, taxonomy, wild ginger, Zingiberales

ABSTRAK

SALASIAH, M. & MEEKIONG, K. 2020. *Plagiostachys strobilifera* var. *conica*, varietas baru dari Sarawak, Borneo. *Reinwardtia* 19(2): 109–116. — Varietas baru ini menampilkan beberapa variasi dari *Plagiostachys strobilifera* var. *strobilifera* yaitu daunnya yang melanset dan lebih lebar, lidah-lidah bercuping rangkap, kelopak yang lebih panjang, kepala sari membundar seperti jengger, staminodium lateral melonjong, mempunyai daun gantilan rebang yang tidak bebas dan mengerucut di bagian ujung (yang menjadi penunjuk takson ini). Kunci untuk jenis *Plagiostachys* Borneo disediakan berikut penilaian konservasinya.

Kata kunci: Alpinieae, Alpinioideae, Borneo, jahe-jahean, keanekaragaman, Malesia, taksonomi, Zingiberales.

INTRODUCTION

The ginger family, Zingiberaceae occurs in the tropics and subtropics, with approximately 1,500 species in at least 53 genera (Lamb *et al.*, 2013) and the number is growing with more botanical exploration in various localities. *Plagiostachys* is a genus in the tribe Alpinieae distributed from southern Thailand and Peninsular Malaysia to Indonesia (Sumatra, Kalimantan, Sulawesi) and the Philippines, with its highest diversity in Borneo. Of the thirty-two of so far-known species, seventeen species occur in Borneo, while nine species are distributed in the Philippines, three in Peninsular Malaysia, two in Indonesia, and one species each in India, Thailand and China (Newman *et al.*, 2004; Sabu *et al.*, 2008; Lamb *et al.*, 2013; Acma *et al.*, 2019; POWO, 2020).

The genus is recognised morphologically by its terminal inflorescence which breaks through the leaf sheaths laterally, either in the middle of the leafy shoot, at one-third of the way up or just above the ground (Smith, 1985). The small flowers are arranged in densely-congested inflorescences bearing up to nine branches, each subtending

rudimentary bract or none, as well as generally tubular bracteoles (Julius *et al.*, 2007; Lamb *et al.*, 2013). Primary forest to disturbed forest are the principal habitats of *Plagiostachys*.

In the past, the species in *Plagiostachys* were divided into two informal groups, one bearing mucilaginous inflorescences and the other non-mucilaginous inflorescences (Smith, 1985). The types of bracteole, calyx, and capsule, the colouration of labellum, as well as the style adnation to the corolla tube wall were the other main characters considered in the natural groupings. However, the groupings were shown to be unsatisfactory by the description of two non-mucilaginous species (*P. breviramosa* and *P. parva*) by Cowley (1999) which revealed that the style adnation character was not compliant with group II.

Based on several new species discoveries, Julius *et al.* (2007) pointed out that the presence of an anther crest, the colouration and surface of the capsule, and the occurrence of style adnation to the corolla wall were significant parameters in defining interspecific variation. More recently, *Plagiostachys* is classified into three subclades

and distinguished based on the combination of characters of the inflorescences (non- vs. mucilaginous) and the hairiness of the capsules (glabrous vs. pubescent). Members of subclade A exhibited non-mucilaginous inflorescences and pubescent capsules, those of subclade B displayed non- and mucilaginous inflorescences but glabrous capsules, while the remaining species of subclade C showed mucilaginous inflorescences and pubescent capsules (Julius *et al.*, 2008).

Recent findings based on molecular phylogenetic works, indicated that the *Plagiostachys* is nested deep within *Alpinia* (the *Zerumbet* clade IV) (Kress *et al.*, 2005; Julius *et al.*, 2008). Members of *Plagiostachys* may have to be transferred to another genus in the future, but currently, they are provisionally categorised based on the morphological characters, until a thorough molecular phylogenetic investigation of the complex *Alpinia* is resolved.

Plagiostachys has its centre of diversity in Borneo, and has been the subject of more intensive taxonomic study here than in other regions. Smith (1985) was the earliest botanist who worked on ginger species in northern Sarawak, at Gunung Mulu National Park, and reported ten *Plagiostachys* species including one new species (*P. bracteolata*) while the two mucilaginous species (*Burtt & Martin B5616* and *Lehmann S29434* from Semenggoh Forest Reserve, Sarawak) have still not been formally described. Further exploration by S. Sakai and H. Nagamasu at Lambir Hills National Park then reported three species from the area including one

new species, *P. glandulosa* (Sakai & Nagamasu, 2003). Systematic accounts of *Plagiostachys* in other parts of Borneo continued with reports from Cowley (1999) who described two more new species (*P. breviramosa* and *P. parva*), Gobilik *et al.* (2005) who described two new species (*P. lasiophylla* and *P. oblanceolata*), Julius *et al.* (2007) who described five new species (*P. brevicealcarata*, *P. longicaudata*, *P. megacarpa*, *P. roseiflora* and *P. viridisepala*) and, more recently, Meekiong & C.K.Lim who described *P. altistachya* from Lanjak Entimau Wildlife Sanctuary, Sarawak (Meekiong *et al.*, 2011). Table 1 presents the updated list of Bornean *Plagiostachys* species.

Beyond Borneo, only four species are known to occur in Peninsular Malaysia; *P. albiflora* Ridl., *P. lateralis* (Ridl.) Ridl., *P. mucida* Holttum and *P. odorata* C.K.Lim (Newman *et al.*, 2004; POWO, 2020). One of these, *P. albiflora*, extends to Narathiwat and Yala provinces of Thailand (POWO, 2020). Nine species of *Plagiostachys* have been recorded in the Philippines including *P. albiflora* and the newly described species *P. lourdesiae* Docot (Docot, 2020) and, eight of them endemic (Acma *et al.*, 2019). Two species are found in Indonesia particularly Sumatra and the Moluccas; *P. sumatrensis* Ridl. and *P. uviformis* (L.) Loes. respectively (Newman *et al.*, 2004; POWO, 2020), though it is known that the genus is also represented in Sulawesi by one or more undescribed species. A single endemic species was reported in 2008 from the Nicobar Islands, India, *P. nicobarica* M.Sabu, Sanoj & Prasanthk., highlighting *P. sumatrensis* Ridl. as the most

Table 1. List of the known Bornean *Plagiostachys* species

Taxa	Inflorescence Type	Distribution
<i>P. albiflora</i> Ridl.	Mucilaginous	Peninsular Malaysia, Thailand, Sarawak, Sabah, the Philippines
<i>P. altistachya</i> Meekiong & C.K.Lim	Non-mucilaginous	Sarawak
<i>P. bracteolata</i> R.M.Sm.	Non-mucilaginous	Sarawak, Sabah
<i>P. brevicealcarata</i> Julius & A.Takano	Mucilaginous	Sarawak, Sabah
<i>P. breviramosa</i> Cowley	Non-mucilaginous	Brunei, Sabah, Kalimantan
<i>P. crocydocalyx</i> (K.Schum.) B.L.Burtt & R.M.Sm.	Mucilaginous	Sarawak, Sabah
<i>P. glandulosa</i> Sakai & Nagam.	Mucilaginous	Sarawak
<i>P. lasiophylla</i> Gobilik & A.L.Lamb	Non-mucilaginous	Sabah
<i>P. longicaudata</i> Julius & A.Takano	Mucilaginous	Sabah, West Kalimantan
<i>P. megacarpa</i> Julius & A.Takano	Non-mucilaginous	Sarawak, Sabah, East Kalimantan
<i>P. oblanceolata</i> Gobilik & A.L.Lamb	Non-mucilaginous	Sabah
<i>P. parva</i> Cowley	Non-mucilaginous	Sabah, Brunei
<i>P. roseiflora</i> Julius & A.Takano	Non-mucilaginous	Sabah
<i>P. strobilifera</i> (Baker) Ridl.	Non-mucilaginous	Sarawak, Sabah, West Kalimantan
<i>P. viridisepala</i> Julius & A.Takano	Mucilaginous	Sarawak, Sabah, East Kalimantan
<i>P. sp. 1</i> (<i>Burtt & Martin B5616</i>)	Mucilaginous	Sarawak
<i>P. sp. 2</i> (<i>Lehmann S29434</i>)	Mucilaginous	Sarawak

similar species (Sabu *et al.*, 2008) and, in China, *P. austrosinensis* T.L.Wu & S.J.Chen from Guangxi province represents the only *Plagiostachys* species in the country (POWO, 2020), though early indications from molecular systematic studies are that this is not a true *Plagiostachys*.

This paper describes a new variety of *P. strobilifera* from Similajau National Park, northeast Sarawak. Although it was the first totally protected area established in Bintulu Division, no collection of the ginger flora had ever been made until recent fieldwork by the authors. It is important to document plant species mainly in lowland Sarawak which currently faces the threat of rapid deforestation. Furthermore, considering issues with *Plagiostachys* especially on the mucilaginous nature of the inflorescence, occurrence of easily-decayed labellum, calyx and bracteole as well as limited collection of the floral part in herbarium specimens, close observation in the field, collection of complete flora material as well as photographs are critical to document this understudied genus and its habitats.

MATERIALS AND METHODS

Documentation and collection of the ginger flora at Similajau National Park was performed from April 2018 to November 2019. Specimens were described and verified with protologues and type material. Examination from several herbaria (SAR, HUMS), digital images of types (IPNI, 2020; Newman *et al.*, 2020; POWO, 2020), protologues and published materials of relevant species including Holttum, 1950; Smith, 1985; Cowley, 1999; Sakai & Nagam, 2003; Newman *et al.*, 2004; Gobilik *et al.*, 2005; Julius *et al.*, 2007; Sabu *et al.*, 2008; Meekiong *et al.*, 2011 & Docot, 2020 were also carried out.

Herbarium specimens were prepared accordingly including preserving the flowers in 70% ethanol. Voucher specimens were deposited at the Herbarium of the Forest Department Sarawak (SAR) while duplicate specimens were kept at herbarium of Universiti Malaysia Sarawak (HUMS).

Besides random sampling, a study plot measuring 1.2 ha was also established between the main trail and Batu Anchau trail. Based on the occurrence of lowland mixed dipterocarp forest and streams, those trails were preferred compared to other trails closer to the coastline where the habitat is less favourable for gingers. Transects were laid at 50 m intervals and individual gingers of all species up to 10 m either side of the transect were documented.

In addition, assessment of the conservation status of the new variety followed the International Union for Conservation of Nature

(IUCN) criteria (IUCN Standards and Petitions Subcommittee, 2019).

RESULTS AND DISCUSSION

Plagiostachys strobilifera* var. *conica Salasiah & Meekiong var. *nov.*— TYPE: MALAYSIA, Borneo, Sarawak, Bintulu Division, Bintulu District, Similajau National Park, main trail, on forest floor with thick leaf litter, 45 m, 33° 21'10.3"N 113°09'30.0"E, 24 Feb 2018, *Salasiah 0003* (Holotype SAR, Isotype HUMS). Figs. 1 & 2.

Plagiostachys strobilifera var. *conica* varies from the type variety in the broader lanceolate leaves (*vs.* narrower), the bilobed ligule (*vs.* truncate or emarginate), the tubular-at-base persistent bracteoles, non-free apical and long conical apex (*vs.* free apical), the longer calyx, *ca.* 2.5 cm long (*vs.* shorter calyx *ca.* 1 cm long), the rounded anther crests (*vs.* truncate), and the oblong lateral staminodes (*vs.* linear).

A perennial terrestrial herb with subterranean short creeping rhizome. *Leafy shoot* 60–160 cm tall with 4–5 leaves, base 1–3 cm in diameter, height of first lamina 39–114 cm from the base; sheath brownish green, striate, pubescent to velvety; ligule 4–6 mm long, bilobed, densely pubescent; sessile to very short petiolate *ca.* 3 mm long, pubescent. *Lamina* 24–59 × 12–13 cm, lanceolate to oblanceolate, bullate, dark green and glossy above, pale green below, pinkish when young, upper surface glabrous to puberulent, lower surface velvety, margin ciliate, undulate, base attenuate to cuneate, apex acuminate with an acumen 1–2 cm long. *Inflorescence* 5–16 cm long, borne 2.5–71 cm above the base of leafy shoot, peduncle 1–9.5 cm long, spike 3–7 cm long, unbranched, pubescent, non-mucilaginous; bracts 6.5 × 3 cm, elliptic, subtending a single flower, pubescent; bracteoles 2–2.4 cm long, tubular at very base for 3–4 mm, centre slit open, apex conical 5–6 × 2–4 mm, non-decaying, pubescent outside, glabrous inside, pinkish-red. *Flower* 3.4–4 cm long, pinkish-red, pubescent; calyx 2.5–2.7 cm long, tubular, slanted, apex tridentate, fissured for 4–9 mm, persistent, pubescent outside, glabrous inside; corolla tube 2.1–2.5 cm long, whitish pink, pubescent outside, glabrous inside with hairy band near the labellum; corolla lobes oblong, cucullate, hooded, pubescent outside, glabrous inside; dorsal corolla lobes 10.5 × 5.5 mm; lateral corolla lobes 8 × 4.5 mm; labellum 8 × 7 mm, oblong, papery, scarlet with red venation, tip yellow, apex entire to shallowly bilobed; lateral staminodes 3.5 mm long, oblong, red; filament *ca.* 2 mm long, anther 5 × 4 mm, scarlet with white thecae; anther crest *ca.* 2 mm long,

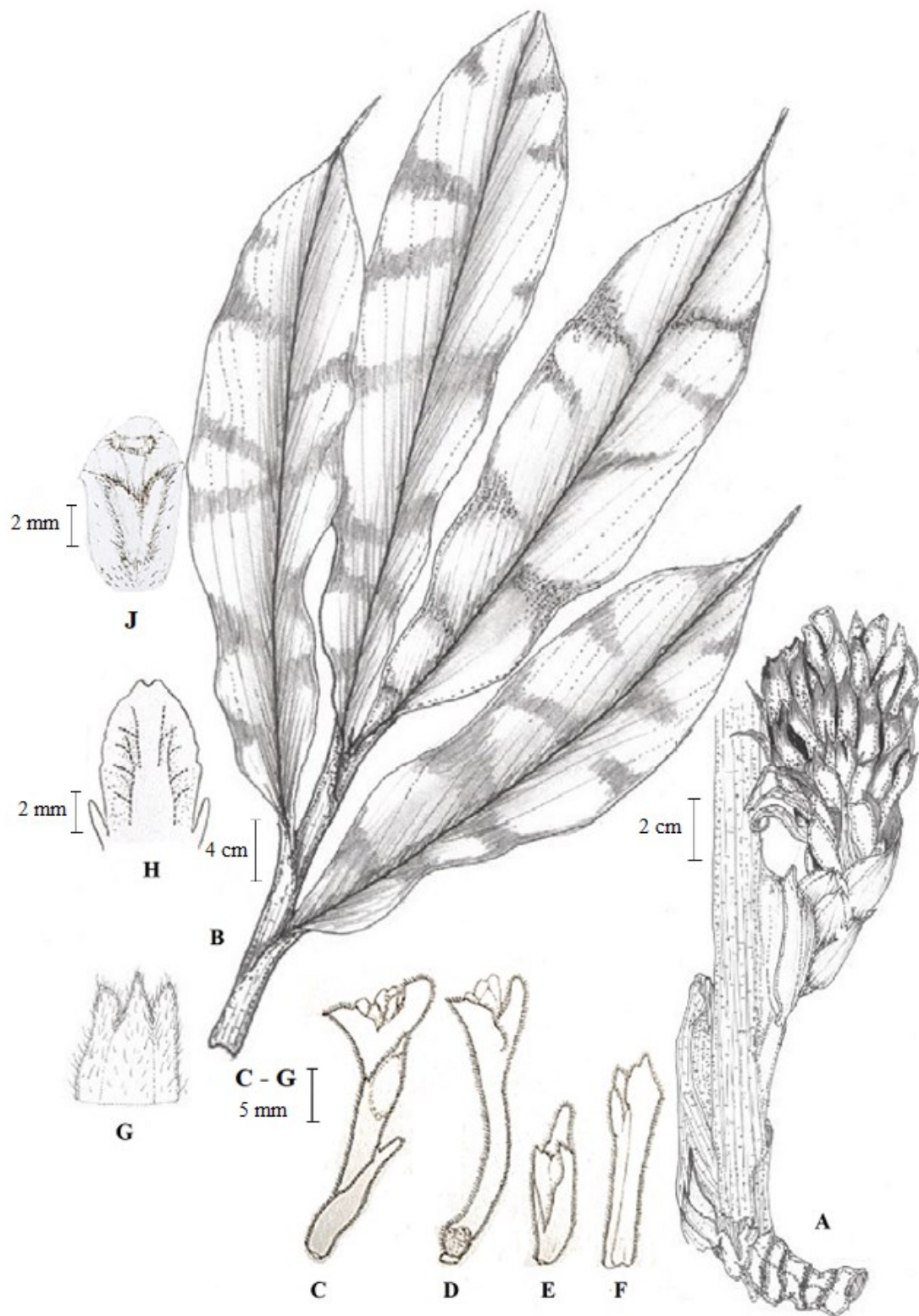


Fig. 1. *Plagiostachys strobilifera* var. *conica* Salasiah & Meekiong. A. Pseudostem base with lateral inflorescence. B. Leafy shoot. C. Flower, lateral view. D. Flower with calyx removed. E. Bracteole. F. Calyx. G. Calyx apex. H. Labellum with staminodes, ventral view. J. Anther showing anther crest and stigma, ventral view. From *Salasiah 0003*, drawn by Meekiong Kalu.

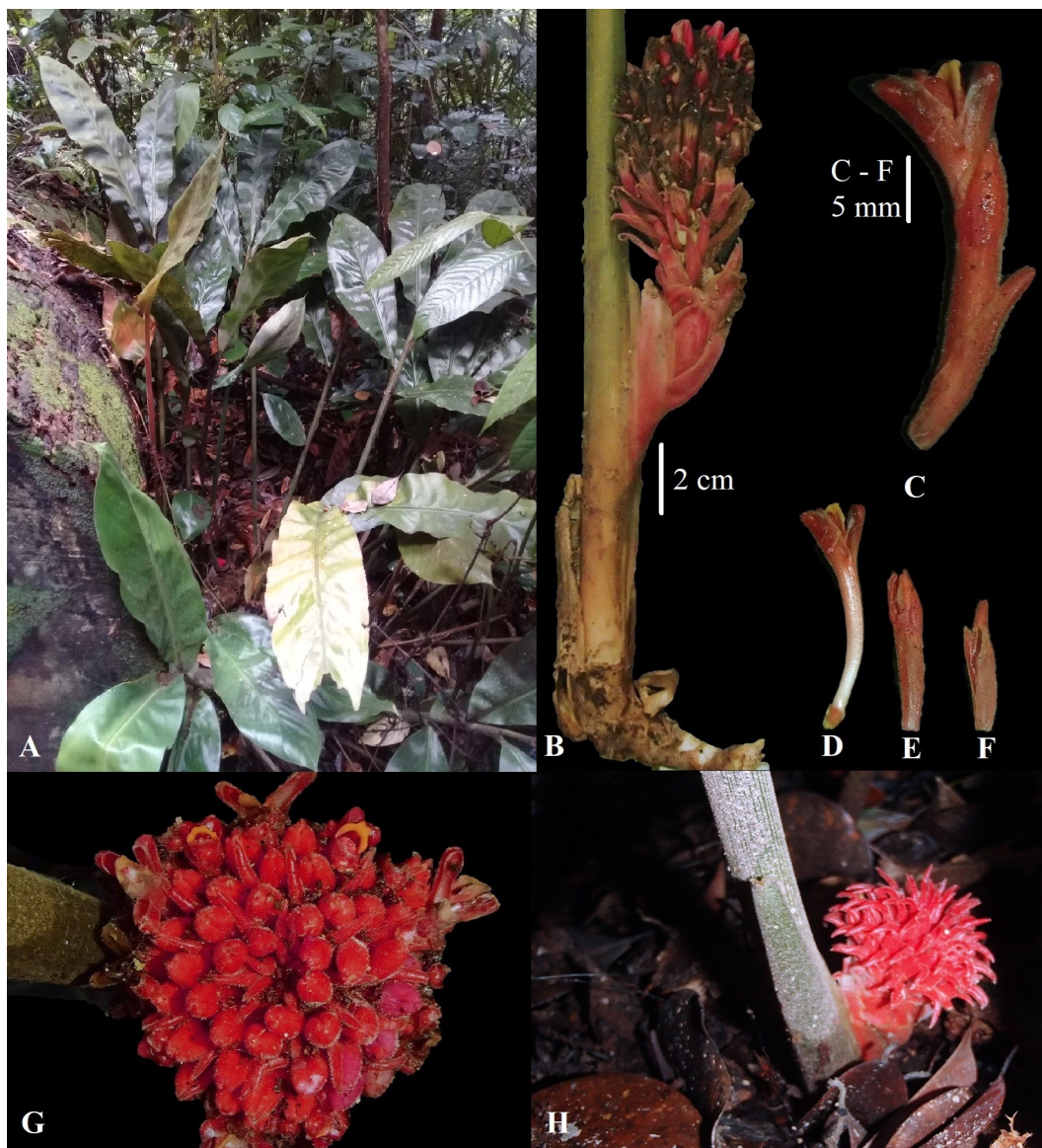


Fig. 2. *Plagiostachys strobilifera* var. *conica* Salasiah & Meekiong. A. Habit. B. Inflorescence, lateral view. C. Whole flower, lateral view. D. Flower with calyx removed. E. Calyx. F. Bracteole. G. Inflorescence, aerial view. H. Young inflorescence. A–G. Salasiah 0003; H. Salasiah et al. 0014. Photos by Salasiah Mohamad.

rounded, glabrous; style *ca.* 3.3 cm long, puberulous near apex, free from corolla tube wall; stigma *ca.* 1.3 mm wide, infundibuliform; ostiole apical, transverse, hirsute; ovary 4×3 mm, pink covered with dense straw-coloured silky hairs; epigynous glands $2.3\text{--}3 \times 1.8\text{--}2.7$ mm, glabrous. *Fruit* not seen. Figs. 1 and 2.

Distribution. The taxon is currently known from the type locality; Similajau National Park, Bintulu.

Habitat and Ecology. Grows in loose clumps in shaded primary forest, on alluvial soil near stream as well as on forest floor with thick leaf litter.

Etymology. The variety epithet refers to the peculiar conical shape of the apex of the bracteole.

Phenology. Flowering were recorded in February to April.

Provisional conservation status. This taxon is known so far from Similajau National Park. A total of five clumps have been recorded with each clump bearing about four mature individual plants. The area of occupancy (AOO) is estimated at 4 km^2 . Based on the IUCN red list categories and criteria (IUCN Standards and Petitions Subcommittee, 2019), *Plagiostachys strobilifera* var. *conica* here provisionally categorised as Least Concern (LC). Although the population size is very small, Similajau National Park is a totally protected area that can provide a stable habitat for the taxon with least anthropogenic or other plausible threats. An update on the assessment is necessary if any significant threats or more

individuals found from other localities in the future.

Other specimen examined. MALAYSIA, Borneo, Sarawak, Bintulu Division, Bintulu District, Similajau National Park, Batu Anchau trail, on forest floor near stream, 3°21'7.68"N, 113°9'32.46"E, 40 m, 5 Apr 2018, *Salasiah et al. 0014* (Para: SAR, HUMS).

Notes. The newly described taxon was shown to deserve recognition and the level of variation is appropriate due to clear differences between var. *strobilifera* and var. *conica* in several vegetative and floral characters. There was no sign of decay in the persistent bracteoles in the new variety, yet specimens collected were not seen in the fruiting stage. Nonetheless, the features of the ± sessile leaves, the densely pubescent sheaths and on the underside of the leaves, the very short ligule, as well as the red labellum with yellow tip that similar with *P. strobilifera* have made it classified as the species variety.

Additionally, specimens that were described as *Plagiostachys* sp. (aff. *strobilifera*) based on materials from *Burt 8155* (E) (from Gunung Meraja, Bau) and *Burt & Martin B4873* (E) (from Hose Mountains, Kapit) showed close relationship to this taxon in the rounded entire anther crest (Smith, 1985). Materials from the first and fourth divisions of Sarawak (*Burt 8273* (E), *Argent &*

Kerby 812 (E) (from Mulu National Park), *Burt 11588* (E) (from Lambir National Park), *Burt 8164* (E) (from Gunung Tabai, Bau) and *Burt & Woods B2703* (E) (from Gunung Perigi, Lundu) were described as *P. strobilifera* by Smith (1985) although they exhibited glabrous leaves and sheaths and broad leaves. Minor variations in the vegetative features may have been the reason why Smith (1985) put these collections under *P. strobilifera*. The characteristics of having non-decaying bracteole, oblong staminodes and pubescent ovary might resemble *P. bracteolata*. However, *P. bracteolata* showing the non-tubular bracteole whilst the new variety displayed the tubular at base bracteole, with centre slit open and conical apex. Another main difference from *P. bracteolata* is the red labellum with yellow tip and red venation (vs. pale yellow labellum with red markings on throat), bilobed ligule (vs. truncate ligule), and sessile to short petiole *ca.* 3 mm long (vs. petiolate up to 2.5 cm long). Table 2 elucidates several morphological characteristics comparing the new taxon and the related species.

KEY TO BORNEAN *PLAGIOSTACHYS*

The key provided here is mainly based on types and protologues of Bornean *Plagiostachys*. Due to inadequate details, the two imperfectly recognised and unidentified mucilaginous species in Smith (1985) are not included in the key.

Table 2. Comparison on some key characteristics of *Plagiostachys strobilifera* var. *conica* and the closely allied species

Characters	<i>P. strobilifera</i> var. <i>conica</i>	<i>P. strobilifera</i> var. <i>strobilifera</i>	<i>P. bracteolata</i>
Leaf blade size	24–59 × 12.2–13 cm, broadly lanceolate	54 × 3.5 cm, usually narrowly lanceolate	25–50 × 7–8 cm, lanceolate
Ligule	4–6 mm long, bilobed	3 mm long, truncate	2–3 mm long, truncate
Petiole length	Sessile to shortly petiolate up to 3 mm long	Sessile to petiolate	1.5–2.5 cm long
Bracteole length	2–2.4 cm long	5 mm long	1.5–3 cm long
Bracteole shape	Tubular at base, apex conical 5–6 mm long	Tubular at base, apex decayed leaving only veins	Open to the base, apex long apiculate 3–5 mm long
Calyx length	2.5–2.7 cm long	<i>ca.</i> 1 cm long	<i>ca.</i> 1 cm long
Labellum	Ovate, scarlet with yellow tip	Ovate, red with yellow tip	Oblong, pale yellow
Lateral staminodes	3.5 mm long, oblong, glabrous	3 mm long, linear, pubescent	4 mm long, oblong, pubescent
Anther crest shape	Rounded	Truncate	Truncate
Style adnation	Free from the corolla wall	Free from the corolla wall	Adnate to the corolla wall

Key to all species of Bornean *Plagiostachys*

1. Inflorescence borne very close to the terminal of the leafy shoot, non-mucilaginous..... *P. altistachya*
1. Inflorescence borne near the base or in the middle of the leafy shoot, mucilaginous or non-mucilaginous..... 2
2. Ovary glabrous..... 3
2. Ovary pubescent..... 7
3. Inflorescence non-mucilaginous; calyx and bracteole papery, sometimes disintegrate before anthesis..... *P. breviramosa*
3. Inflorescence mucilaginous; calyx and bracteole fleshy and decaying..... 4
4. Labellum whitish yellow with pink venation along margins..... *P. albiflora*
4. Labellum plain yellow, venation not as above..... 5
5. Fruit bicolored, basal part green, apex dark purple; dorsal petal hooded, with a spur, shortly obtuse; leaf apex long caudate, *ca.* 4 cm long..... *P. longicaudata*
5. Fruit unicolor either green, yellow, purplish red or dull green; dorsal petal hooded, apex acute; leaf apex acuminate, *ca.* 3 cm long..... 6
6. Anther crested..... *P. brevicealcarata*
6. Anther ecristate..... *P. glandulosa*
7. Inflorescence mucilaginous..... 8
7. Inflorescence non-mucilaginous..... 9
8. Flowers to 5 cm long; anther *ca.* 10 mm long, ecristate; labellum broadly oblong, whitish yellow, margin crenulate..... *P. crocydocalyx*
8. Flowers *ca.* 2.7 cm long; anther *ca.* 7 mm long, anther crest *ca.* 2 mm long; labellum obovate, yellow..... *P. viridisejala*
9. Bracteoles open to base, 3–5 mm long, labellum pale yellow..... *P. bracteolata*
9. Bracteole totally tubular or tubular at base, labellum not uniformly yellow..... 10
10. Style adnate to the corolla wall; labellum entirely red..... 11
10. Style free from the corolla wall; labellum reddish with yellow orange tip..... 13
11. Leaf base unequally cordate; anther crest deeply bilobed; staminodes spatulate..... *P. parva*
11. Leaf base cuneate; anther crest entire; staminodes oblong..... 12
12. Leaves pubescent on both surfaces; labellum ovate..... *P. lasiophylla*
12. Leaves glabrous on upper surface, pubescent beneath; labellum elliptic..... *P. oblanceolata*
13. Bracteoles tubular at base; sheaths pubescent..... 14
13. Bracteoles tubular; sheaths reticulate..... 15
14. Bracteoles free above; ligule truncate; anther crest truncate; staminodes linear.....
..... *P. strobilifera* var. *strobilifera*
14. Bracteoles with conical apex; ligule bilobed; anther crest rounded; staminodes oblong
..... *P. strobilifera* var. *conica*
15. Inflorescence branch 2-5; calyx trilobed; fruit subglobose, *ca.* 1.8 × 1.2 cm, apex green tinged red, turning brown at maturity..... *P. roseiflora*
15. Inflorescence branch 2, rarely 3; calyx bilobed; fruit globose, up to 3.5 × 2 cm, dull green when young, dark brown at maturity..... *P. megacarpa*

CONCLUSION

The number of *Plagiostachys* taxa has increased to 33 as a result of our current exploration, and of these, 18 taxa (55%) occur in Borneo. Moreover, based on authors' observation, there are several potentially new species of *Plagiostachys* remained undescribed from several localities in Sarawak and in the herbaria. Nonetheless, further exploration from less-collected areas such as Kalimantan and other parts of Indonesia would suggest more highly localised species to be discovered.

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