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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

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 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 (P. brevicalcarata, 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

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Inflorescence Type</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. albiflora Ridl.</td>
<td>Mucilaginous</td>
<td>Peninsular Malaysia, Thailand, Sarawak, Sabah</td>
</tr>
<tr>
<td>P. altistachya Meekiong &amp; C.K.Lim</td>
<td>Non-mucilaginous</td>
<td>Sarawak</td>
</tr>
<tr>
<td>P. bracteolata R.M.Sm.</td>
<td>Non-mucilaginous</td>
<td>Sarawak, Sabah</td>
</tr>
<tr>
<td>P. brevicalcarata Julius &amp; A.Takano</td>
<td>Mucilaginous</td>
<td>Sarawak, Sabah</td>
</tr>
<tr>
<td>P. brevirmosasa Cowley</td>
<td>Non-mucilaginous</td>
<td>Brunei, Sabah, Kalimantan</td>
</tr>
<tr>
<td>P. crocydocalyx (K.Schum.) B.L.Burtt &amp; R.M.Sm.</td>
<td>Mucilaginous</td>
<td>Sarawak, Sabah</td>
</tr>
<tr>
<td>P. glandulosa Sakai &amp; Nagam.</td>
<td>Mucilaginous</td>
<td>Sarawak</td>
</tr>
<tr>
<td>P. lasiophylla Gobilik &amp; A.L.Lamb</td>
<td>Non-mucilaginous</td>
<td>Sabah</td>
</tr>
<tr>
<td>P. longicaudata Julius &amp; A.Takano</td>
<td>Mucilaginous</td>
<td>Sabah, West Kalimantan</td>
</tr>
<tr>
<td>P. megacarpa Julius &amp; A.Takano</td>
<td>Non-mucilaginous</td>
<td>Sarawak, Sabah, East Kalimantan</td>
</tr>
<tr>
<td>P. ob lanceolata Gobilik &amp; A.L.Lamb</td>
<td>Non-mucilaginous</td>
<td>Sabah</td>
</tr>
<tr>
<td>P. parva Cowley</td>
<td>Non-mucilaginous</td>
<td>Sabah, Brunei</td>
</tr>
<tr>
<td>P. roseiflora Julius &amp; A.Takano</td>
<td>Non- mucilaginous</td>
<td>Sabah</td>
</tr>
<tr>
<td>P. strobilifera (Baker) Ridl.</td>
<td>Non-mucilaginous</td>
<td>Sarawak, Sabah, West Kalimantan</td>
</tr>
<tr>
<td>P. viridisepala Julius &amp; A.Takano</td>
<td>Mucilaginous</td>
<td>Sarawak, Sabah, East Kalimantan</td>
</tr>
<tr>
<td>P. sp. 1 (Burtt &amp; Martin B5616)</td>
<td>Mucilaginous</td>
<td>Sarawak</td>
</tr>
<tr>
<td>P. sp. 2 (Lehmann S29434)</td>
<td>Mucilaginous</td>
<td>Sarawak</td>
</tr>
</tbody>
</table>
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 3.4–4.4 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,
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 2.3‒3 × 1.8‒2.7 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 km². 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 Burtt 8155 (E) (from Gunung Meraja, Bau) and Burtt & 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 (Burtt 8273 (E), Argent & Kerby 812 (E) (from Mulu National Park), Burtt 11588 (E) (from Lambir National Park), Burtt 8164 (E) (from Gunung Tabai, Bau) and Burtt & 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

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

1. Inflorescence borne very close to the terminal of the leafy shoot, non-mucilaginous…… *P. altistachya*  
2. Inflorescence borne near the base or in the middle of the leafy shoot, mucilaginous or non-mucilaginous.  
3. Inflorescence non-mucilaginous; calyx and bracteole papery, sometimes disintegrate before anthesis……………………………………………………………………………………………………… *P. breviramosa*  
4. Inflorescence mucilaginous; calyx and bracteole fleshy and decaying………………………… *P. brevicalcarata*  
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*  
6. Anther crested…………………………………………………………………………………………..… *P. glandulosa*  
7. Inflorescence mucilaginous…………………………………………………………………………………………………………………………..… *P. crocydocalyx*  
8. Flowers to 5 cm long; anther *ca. 10 mm long*, ecristate; labellum broadly oblong, whitish yellow, margin crenulate………………………………………………………………………………………………………………… *P. viridisepala*  
9. Bracteoles open to base, *3–5 mm long*, labellum pale yellow…………………………………………………………………………………………… *P. bracteolata*  
10. Style adnate to the corolla wall; labellum entirely red……………………………………………………………………………………………………… *P. parva*  
11. Leaf base unequally cordate; anther crest deeply bilobed; staminodes spathulate…………………………………………………………………………………………………… *P. lasiophylla*  
12. Leaves pubescent on both surfaces; labellum ovate………………………………………………………………………………………………………….. *P. oblanceolata*  
13. Bracteoles tubular at base; sheaths pubescent…………………………………………………………………………………………………………… *P. strobilifera var. strobilifera*  
14. Bracteoles free above; ligule truncate; anther crest truncate; staminodes linear………………………………………………………………………………………………………………… *P. strobilifera var. conica*  
15. Inflorescence branch 2-5; calyx trilobed; fruit subglobose, *ca. 1.8 × 1.2 cm*, apex tinged red, turning brown at maturity……………………………………………………………………………………………………………… *P. roseiflora*  
16. 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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REFERENCES


INSTRUCTION TO AUTHORS

Scope. *Reinwardtia* is a scientific regular journal on plant taxonomy, plant ecology and ethnobotany published in June and December. Manuscript intended for a publication should be written in English.

Titles. Titles should be brief, informative and followed by author’s name and mailing address in one-paragraphed.

Abstract. English abstract followed by Indonesian abstract of not more than 250 words. Keywords should be given below each abstract.

Manuscript. Manuscript is original paper and represent an article which has not been published in any other journal or proceedings. The manuscript of no more than 36 pages by using Times New Roman 11, MS Word for Windows of A4 with double spacing, submitted to the editor through <reinwardtia@mail.lipi.go.id>. New paragraph should be indented in by 5 characters. For the style of presentation, authors should follow the latest issue of Reinwardtia very closely. Author(s) should send the preferred running title of the article submitted. Every manuscript will be sent to two blind reviewers.

Identification key. Taxonomic identification key should be prepared using the aligned couplet type.

Nomenclature. Strict adherence to the International Code of Nomenclature is observed, so that taxonomic and nomenclatural novelties should be clearly shown. English description for new taxon proposed should be provided and the herbaria where the type specimens area deposited should be presented. Name of taxon in taxonomic treatment should be presented in the long form that is name of taxon, author’s name, year of publication, abbreviated journal or book title, volume, number and page.

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