

The Genus *Sulettaria* A.D.Poulsen & Mathisen (Zingiberaceae) in Sarawak, Malaysia

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Abstract: Zingiberaceae is one of the most common herbaceous plant families in the tropical rainforests of Borneo, Malaysia. Many studies have been conducted on this family, yet the documentation of this family is still far from complete. Zingiberaceae also included many species that were reclassified, with many new genera introduced to accommodate the species based on the molecular work. *Sulettaria* A.D.Poulsen and Mathisen is one of the examples of a new genus introduced to accommodate such ginger species from Southeast Asia formerly from the genera *Elettaria* and *Amomum*. The majority of the species that are assigned to this new genus are found in Sarawak. This study aims to document information on *Sulettaria* with special reference to ecological and taxonomic aspects from Sarawak. A checklist of species found in Sarawak is included.

Keywords: Borneo, diversity, endemic, Malaysia, taxonomy, wild gingers

1. Introduction

The subclass Zingiberidae encompasses two orders, nine families and approximately 3,800 species worldwide. The two orders, Bromeliales and Zingiberales are nearly equal in size (number of species), but Bromeliales is represented solely by the Bromeliaceae, whereas Zingiberales is represented by eight families, namely Cannaceae, Costaceae, Heliconiaceae, Lowiaceae, Marantaceae, Musaceae, Strelitziaceae and Zingiberaceae. The largest family in the order Zingiberales is Zingiberaceae or previously known as Scitammineae, with 52 genera and approximately 1,400 species [1].

The classification of plants is being reorganised because of current advancements in technology, and several ranks are being reinstated. For instance, *Amomum*, one of the largest genera in Zingiberaceae, has been divided into six genera based on DNA data and field morphologies [2]. While some of the species were grouped into a new genus, e.g., *Sulettaria*. The documentation work on the Zingiberaceae in Sarawak is still far from complete. Although much work has been published, for example, Lamb et al. [3], Poulsen [4], [5], [6], Smith [7], Meekiong and Teo [1], yet many new species are being discovered and described in recent years [8], [9], [10].

1.1 *Sulettaria* A.D.Poulsen & Mathisen

The genus *Sulettaria* was introduced by Poulsen and Mathisen (Poulsen et al., 2018) to group species of *Elettaria* and *Amomum* based on the characteristics described below. The genus *Elettaria*, however, now only refers to the species that are native to India and Sri Lanka (e.g. *E. cardamomum* (L.) Maton.) Meanwhile, most of the species in the genus *Amomum* in Borneo (particularly) are segregated into different genera, and all the species named under the genus *Elettariopsis* were transferred into *Amomum*.

“Small to large clump-forming terrestrial herbs with distichous leafy shoots. Inflorescences arise close to the base of pseudostem, many-flowered, either in a dense, erect, globose to conical spike or along a creeping axis. Bracts always subtend two or more flowers and bracteoles are tubular. Flowers tubiform, rarely open, with obovate to elliptic labellum and entire, thin, crisp margin. Labellum white or pale yellow, centre yellow to orange or yellow greenish, rarely with red borders at the base. Staminodes absent. Anther sessile or on a short filament, dehiscence variable (throughout their entire length, in the upper half or by pores which in some species have hairy flaps); crest absent, entire or 3- to 4-lobed and irregularly serrate. Fruits globose or longer than wide (ellipsoid, ovoid, obpyriform), smooth.”

Generic description by Poulsen et al. [6]

2. Checklist of *Sulettaria* in Sarawak

1. ***Sulettaria anomala*** (R.M.Sm.) A.D.Poulsen & Lofthus, [6]
Synonym: *Amomum anomalum* R.M.Sm. [12]
Description: Forms a large clump of several leafy shoots, pseudostems up to 40 cm long, often with short stilt roots with an erect inflorescence. The flowers are yellow without anther crest. Fruits are oval or ellipsoid, purple to maroon and turning orange-red when matured.
Ecology and Distribution: on poor soil, open space by the roadsides of logging roads, altitude from 250–1,700 meters above sea level. Endemic to Borneo.
Notes: This species can be differentiated from others by having two flowers per bract.
2. ***Sulettaria brachycalyx*** (S.Sakai & Nagam.) A.D.Poulsen & M.F.Newman, [6]
Synonym: *Elettaria brachycalyx* S.Sakai & Nagam., [13]
Description: Herb of about 1 m tall, leaves c. 8 pairs, narrowly elliptic. Inflorescence radical c. 60 cm long, flower white, calyx tubular, labellum spatulate, densely hairy at the centre.
Ecology and Distribution: On wet soil, shaded forests. Endemic to Borneo
Notes: This species can be identified by the leaves glabrous with minute pubescence on the midrib lower surface, and calyx short about 6 mm long, and fissured for two third of its length.
3. ***Sulettaria burttii*** (R.M.Sm.) A.D.Poulsen & M.F.Newman, [6]
Synonym: *Amomum burttii* R.M.Sm. [11]
Description: For a time being, information on this species is very limited.
Ecology and Distribution: Lowland mixed dipterocarp and foothill of a limestone hill, on a wet place in shaded areas. Endemic to Borneo.
Notes: The species can be identified by the leaf tips with long caudate, flowers 2.5–3 cm long, and anther connective deeply emarginate with a small appendage in the cleft. This species was described by Smith [11] based on a specimen collected by Burt (Burt 12881) from Mulu National Park.
4. ***Sulettaria kapitensis*** (S.Sakai & Nagam.) A.D.Poulsen & Bjorå, [6]
Synonym: *Elettaria kapitensis* S.Sakai & Nagam., [13]
Description: Herb of about 70 cm tall, leaves 6–9 pairs per shoot, leaves narrowly oblong–obovate. Inflorescence trailing on the ground, 40–60 cm long, flower white, labellum white with a yellow spot in the throat.
Ecology and Distribution: Submontane forest at altitude 800–1100 meters above sea level. Endemic to Borneo.
Notes: This species can be differentiated from others by the anther dehiscing throughout their length, calyx length up to 17 mm long, corolla tube and calyx free above the ovary.
5. ***Sulettaria lambirensis*** (R.M.Sm.) A.D.Poulsen & M.F.Newman, [6]
Synonym: *Amomum lambirensis* R.M.Sm., [11]
Description: At the moment, information on this species is very limited.
Ecology and Distribution: Lowland mixed dipterocarp forest, on wet soils near the stream. Endemic to Borneo.
Notes: Can be differentiated from others by erect and spike globose inflorescence (that elongates when maturity), bracts firmly textured with a short pungent tip and fruit round with a short neck. This species was

described by Smith [11] based on the specimen collected by Sakai (*S.Sakai 217 (KYO)*) from Bukit Pantu and since then never been collected.

6. ***Sulettaria linearicrista*** (S.Sakai & Nagam.) A.D.Poulsen & BJORÅ, [6]
Synonym: *Elettaria linearicrista* S.Sakai & Nagam., [13]
Description: Perennial herb, 60–100 cm tall. Leaves *c.* 10 pairs, narrowly oblong to obovate. Inflorescence radical, up to 40 cm long, flower white, labellum spatulate, pubescent on the centre of the basal limb, white except for the central greenish- yellowish line.
Ecology and Distribution: Lowland and hill mixed dipterocarp forests, from 30 to 400 melevations, on ridges or slopes. Endemic to Borneo.
Notes: This species can be differentiated from others by anther crest with three linear lobes, an inflorescence axis and a calyx densely pubescent.
7. ***Sulettaria longipilosa*** (S.Sakai & Nagam.) A.D.Poulsen & Lofthus, [6]
Synonym: *Elettaria longipilosa* S.Sakai & Nagam., [13]
Description: Perennial herb, up to 1.3 m tall, leaves *c.* 12 pairs, narrowly oblong, glabrous on the upper surface, with long soft hairs on the lower surface, especially around the midrib. Flower white, labellum spatulate, reniform, white with central yellow lines.
Ecology and Distribution: Lowland mixed dipterocarp forest, on the slope of riverbank or wet soils in the gullies. Endemic to Borneo.
Notes: Can be identified by the leaves are prominently pubescent on the lower surface with long hairs, calyx 10–14 mm long, and fissured less than half of its length.
8. ***Sulettaria longituba*** (Ridl.) A.D.Poulsen & Mathisen, [6]
Synonym: *Elettaria longituba* Ridl., [14]
Description: Perennial herb, up to 2 m tall. The inflorescences are prostrate, and mostly subterranean, buried a few centimetres in the soil, trailing up to 5 m long. Flower white, labellum white with a yellowish-green spot in the throat.
Ecology and Distribution: Lowland to submontane forests, up to 1,600 meters above sealevel. Often on wet soils, near the stream. The only species with a wide distribution recorded from Southern Thailand, Peninsular Malaysia, Sumatra, Borneo and southern the Philippines.
Notes: Differs from others by anther dehiscing by pores without a hairy flap, petiole *c.* 2.5 cm long, robust plant with leaves up to 80 cm long.
9. ***Sulettaria meekiongii*** Ripen & S.P.Teo, [9]
Description: Form a moderate-large clump, up to 15 shoots, often with stilt roots. Leaves 8–10 pairs, narrowly elliptic. Flower small, white, labellum deeply bilobed, white.
Ecology and Distribution: Lowland primary mixed dipterocarp forest, on wet soils, nearstreams or on slopes. Endemic to Borneo.
Notes: This species can be identified by the typical stilt-roots, erect inflorescence, spindle-shaped, bracts chocolate-brown with transparent margins and white flowers.
10. ***Sulettaria polycarpa*** (K.Schum.) A. D.Poulsen & M.F.Newman, [6]
Synonym: *Alpinia polycarpa* (K.Schum.), [15]
Amomum polycarpa (K.Schum.) R.M.Sm., [11]
Amomum dimorphum M.F.Newman, [16]
Description: Perennial herb, up to 1.7 m tall, often with stilt roots. Leaves many up to 15 pairs, narrowly elliptic to oblong. Inflorescences from the rhizomes, 1–many at a time. Fruits rounded and greenish turning orange when matured. Eaten by animals.
Ecology and Distribution: On the ridges or slopes, by the roadsides of logging roads at altitudes up to 1,700 meters above sea level. Endemic to Borneo.
Notes: *Sulettaria polycarpa* can be differentiated from others by the long ligule, *c.* 3 cm and calyx lobes with prominent subapical spurs. The flowers are white with a yellow centre to the labellum.
11. ***Sulettaria rubida*** (R.M.Sm.) A.D.Poulsen & Mathisen, [6]
Synonym: *Elettaria rubida* R.M.Sm., [12]
Description: Perennial herb. Leaves broadly obovate with attenuate base. Inflorescence red, flowers plain yellow; labellum darker yellow in centre, anther ecristate.
Ecology and Distribution: Lowland mixed dipterocarp forest and foothill of a limestone hill, on clay soils and ridges, elevations 30 to about 200 meters above sea level. Endemic to Borneo.
Notes: Easily distinguished from others by the inflorescence red with yellow-orange flowers, anther ecristate, leaves broadly obovate with attenuate base.
12. ***Sulettaria stoloniflora*** (K.Schum.) A.D.Poulsen & Mathisen, [6]
Synonym: *Amomum stoloniflorum* K.Schum., [15]
Cyphostigma stoloniflorum (K.Schum.) K.Schum., [17]
Elettariopsis stoloniflora (K.Schum.) Ridl., [18]

Elettaria stoloniflora (K.Schum.) S.Sakai & Nagam., [13]

Description: Perennial herb, 80–150 cm tall, leaves c. 9 pairs, congested in the upper half of the shoots, blade narrowly oblong. Inflorescence radical, 25–60 cm long, flower white, labellum obovate, white except central green line.

Ecology and Distribution: Lowland mixed dipterocarp forest, on clay soil. Endemic to Borneo.

Notes: Can be differentiated from others by anther dehiscing in the upper half only, calyx 8–10 mm long, corolla tube and calyx fused into a solid elongation for up to 1.5 cm above the ovary.

13. *Sulettaria surculosa* (K.Schum.) A.D.Poulsen & Mathisen, [6]

Synonym: *Amomum surculosum* K.Schum., [15]

Cyphostigma surculosum (K.Schum.) K.Schum., [17]

Elettariopsis surculosa (K.Schum.) Ridl., [18]

Elettaria surculosa (K.Schum.) S.Sakai & Nagam., [13]

Description: Perennial herb, up to 2 m tall, leaves 15 pairs per shoot, narrowly obovate, glabrous on both surfaces. Inflorescence creeping just below the ground surface, to 2 m long. Flower white, labellum reniform, white except for central green line.

Ecology and Distribution: Lowland mixed dipterocarp forest to submontane mossy forest at an altitude 850 m above sea level, on the slope near streams. Endemic to Borneo.

Notes: This species can be identified by the leaf shoots glabrous, labellum broadly obovate, 16–28 mm wide, and bracts 20–60 mm long.

3. Discussion

The distribution of *Sulettaria* species in Sarawak is mapped as shown in Figure 1 below. The majority of species recorded are found in lowland mixed dipterocarp forests, preferably on moist soils near streams or on the ridges or slopes, at elevations from 30 to 1,800 m above sea level. Based on Figure 1, it showed that no collection of *Sulettaria* has been made from the coastal peat areas from Samarahan to Mukah divisions. As a result, one of the objectives of this project is to investigate the ecological factors that contribute to *Sulettaria* species' occurrence in Sarawak.

Herein this paper, we propose to divide the genus *Sulettaria* into two informal groups. The groups are divided into two categories based on their morphologies and field characteristics: (1) inflorescences that ascend to upright, spikes that are globose to conical, and (2) inflorescences that creep along the ground. Group (1) is known as "*Polycarpa*", and Group (2) is known as "*Longituba*" (Figure 2). The members of the *Polycarpa* group include *S. anomala*, *S. burttii*, *S. lambirensis*, *S. polycarpa* and the newly described species, *S. meekiongii*. While the *Longituba* group includes *S. brachycalyx*, *S. kapitensis*, *S. linearicrista*, *S. longipilosa*, *S. longituba*, *S. rubida*, *S. stoloniflora* and *S. surculosa*. Figure 2 provides photographs of informal groups and selected species of *Sulettaria* that occur in Sarawak.

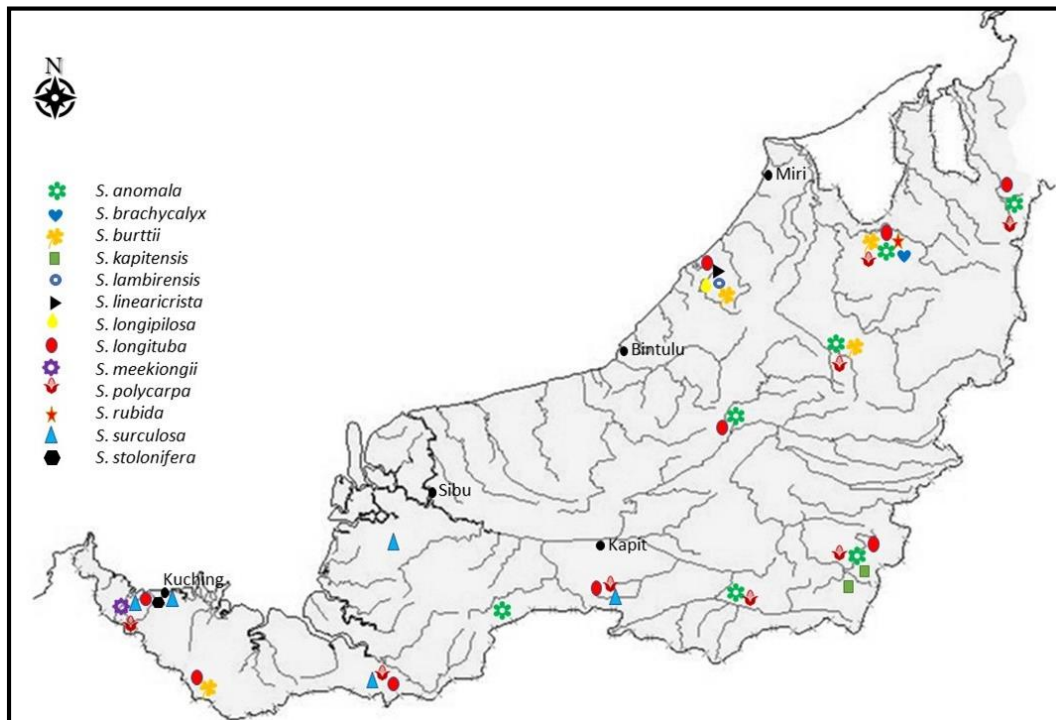
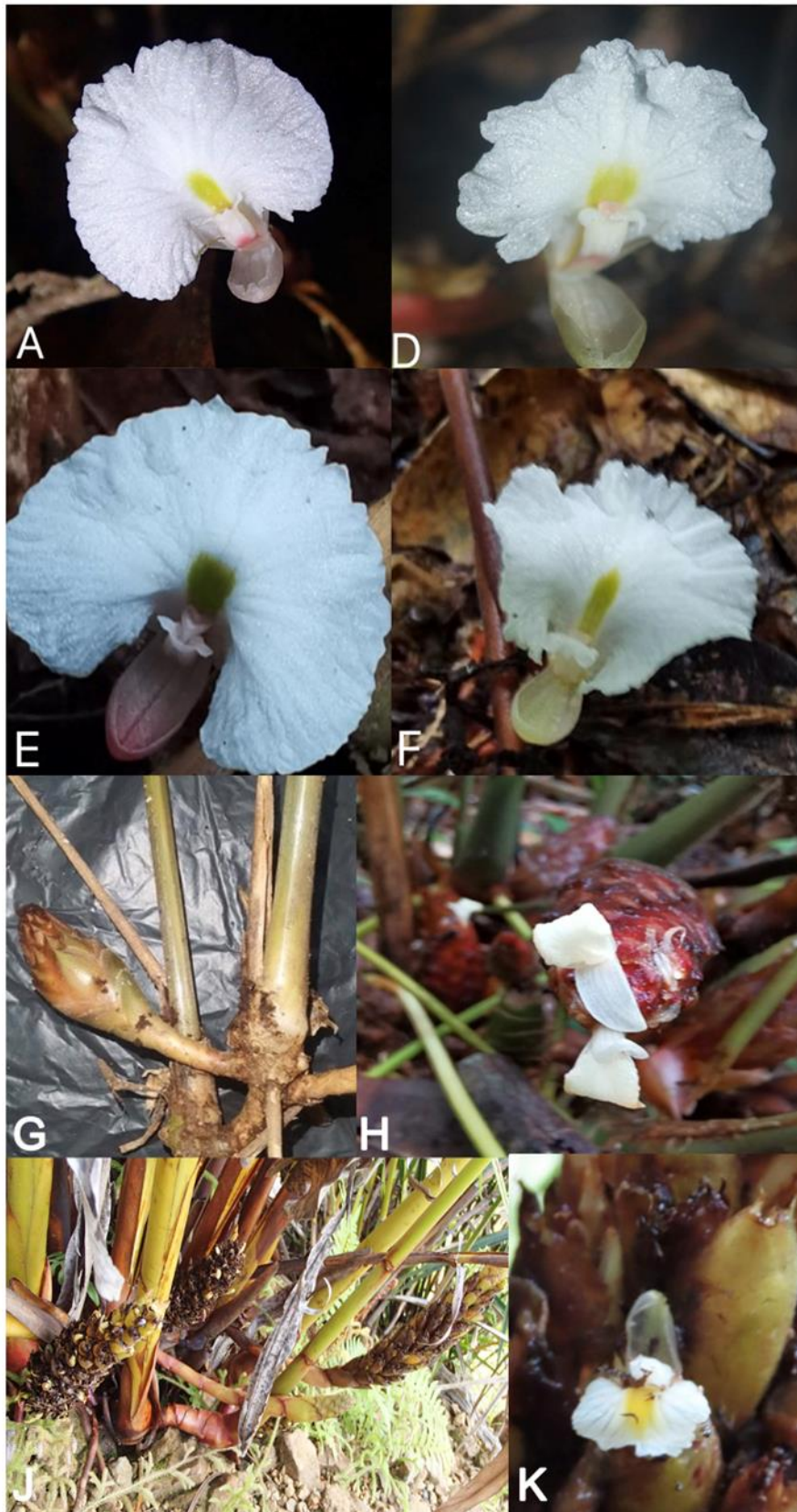


Fig. 1 - Distribution of *Sulettaria* species in Sarawak based on published reports and specimens deposited at SAR, Sarawak



**Fig 2 - Inflorescence types of *Sulletaria* species in Sarawak. *Polycarpa* group (G–K) and *Longituba* group (A–F).
A *S. surculosa*; D *S. longipilosa*; E *S. longituba*; F *S. stolonifera*; G & H *S. meekiongii*; J & K *S. polycarpa*.
Photos: D, E, F, G & H by Meekiong Kalu; A, D, J & K by Salasiah Mohamad**

4. Conclusion

This paper serves as a preliminary report on the status of our investigation of *Sulettaria* in Sarawak. It is best to consider that there is still a lot to learn about this tiny genus, especially concerning its ecology and classification. There are now 13 species listed for Sarawak, however, given that many specimens need to be validated, we estimated that there may be as many as 20 or more species

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