

## TWO NEW SUBSPECIES OF *LASIANTHUS INODORUS* (RUBIACEAE) FROM KINABALU, BORNEO, AND THEIR BIOGEOGRAPHICAL IMPLICATION

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### SUMMARY

Two populations from Mount Kinabalu, Borneo, are recognised as two new subspecies of *Lasianthus inodorus* Blume (Rubiaceae), which occurs in montane habitats in mainland Southeast Asia, Sumatra and Java. The species and its subspecies are considered to compose a particular taxonomic group in the genus. Ecology and biogeography of the species group are discussed with the historical explanation of the tectonic history of Cenozoic Southeast Asia. The example strongly supports the concept of floristic connections between Malesia and mainland Southeast Asia.

**Key words:** *Lasianthus*, Borneo, biogeography.

### INTRODUCTION

*Lasianthus* Jack is a large genus in the family Rubiaceae with about 183 species. It occurs from tropical Asia (c. 160 species) and Australia (only one species) to tropical Africa (c. 20 species) as well as in tropical America (3 species) but has the centre of species diversity in tropical Asia. Most species of the genus occur in primary forests. They are usually shade-tolerant shrub or treelet species in rain forests of tropical Asia. Almost no herbarium specimens and living plants of the genus have been recorded from secondary and severely disturbed forests. The genus could be an important taxon in consideration of the biogeography of tropical and subtropical forests of Southeast Asia.

*Lasianthus inodorus* Blume, originally recorded from montane habitats of Java, has orbicular and coriaceous bracts that differ from other species of the genus. This species was recently collected from montane habitats of southern Yunnan. These specimens have red fruits that are recorded for the genus for the first time. Two populations from Mt Kinabalu, Borneo, are recognised to have close affinity to *L. inodorus* Blume and suggested as two new subspecies.

The species and its subspecies compose a particular taxonomic group in the genus. The possible dispersion and the present disjunct distribution of the species group agree well with the historical explanation of the tectonic history and the distribution

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Fig. 1. *Lasianthus inodorus* Blume subsp. *inodorus*. a. Habit; b. fruit; c. cross section of fruit; d. pyrene; e. bracts; f. stipule (all: Zhu & Wang 940401). — a:  $\times 0.6$ ; b–d, f:  $\times 3$ ; e:  $\times 2.4$ .

of land and sea and climatic change of Cenozoic Southeast Asia. They may offer a good example for research on evolution, ecology and biogeography in the speciation process.

## TAXONOMIC DESCRIPTIONS

### *Lasianthus inodorus* Blume

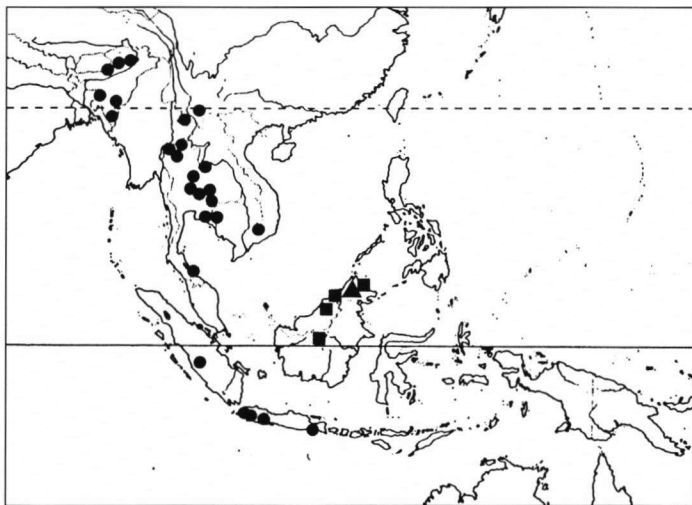
*Lasianthus inodorus* Blume, Bijdr. (1826–1827) 998; Miq., Fl. Ind. Bat. 2 (1857) 322; Backer & Bakh.f., Fl. Java 2 (1965) 339; H. Zhu, Acta Bot. Yunnan. 20, 2 (1998) 152. — *Mephitidia inodora* (Blume) DC., Prodr. Syst. Nat. 4 (1830) 453. — Type: *Blume s.n.* (holo L, barcode L 0000690), Java.

*Lasianthus tubiferus* Hook.f., Fl. Brit. India 3 (1880) 183; Craib, Fl. Siam. 2 (1934) 219; Deb & M.G. Gangop., J. Econ. Taxon. Bot. 15 (1991) 305, f. 14; H. Zhu, Acta Phytotax. Sin. 32, 1 (1994) 59. — Lectotype (Deb & Gangopadhyay, 1991): *Hooker f. & Thomson s.n.* 'Mephitidia 9' (holo K), Khasia.

*Lasianthus poilanei* Pit. in Lecomte, Fl. Gén. Indo-Chine 3 (1924) 398. — Type: *Poilane 234* (holo P; iso E, K), Cambodia, Mt Elephant, 1000 m.

#### **a. subsp. *inodorus*** — Fig. 1, Map 1

Shrubs 2–3 m tall. *Branches* and *branchlets* glabrous. *Leaves* 10–20 cm long, 2.5–6 cm broad, elliptic or elliptic-lanceolate, apex acuminate, base acuminate, coriaceous, glabrous above, glabrous or sparsely puberulous beneath; nerves 5–7-paired, tertiary nerves parallel, nerves and tertiary nerves conspicuous beneath, petioles 6–10 mm long, glabrous or sparsely puberulous; stipules triangular or ovate-lanceolate, 3–5 mm long, glabrous, coriaceous. *Inflorescences* sessile; bracts persistent, 3–6 mm long, orbicular or ovate-orbicular, thick coriaceous, glabrous or pubescent. *Flowers* sessile, 10 mm long, calyx tube 2 mm long, glabrous, with 5 ovate-lanceolate lobes, puberulous



Map 1. Distribution of *Lasianthus inodorus* Blume subsp. *inodorus* (●) (1000–2500 m), subsp. *montigenus* H. Zhu (▲) (1700–3000 m) and subsp. *pubescens* H. Zhu (■) (400–2000 m).

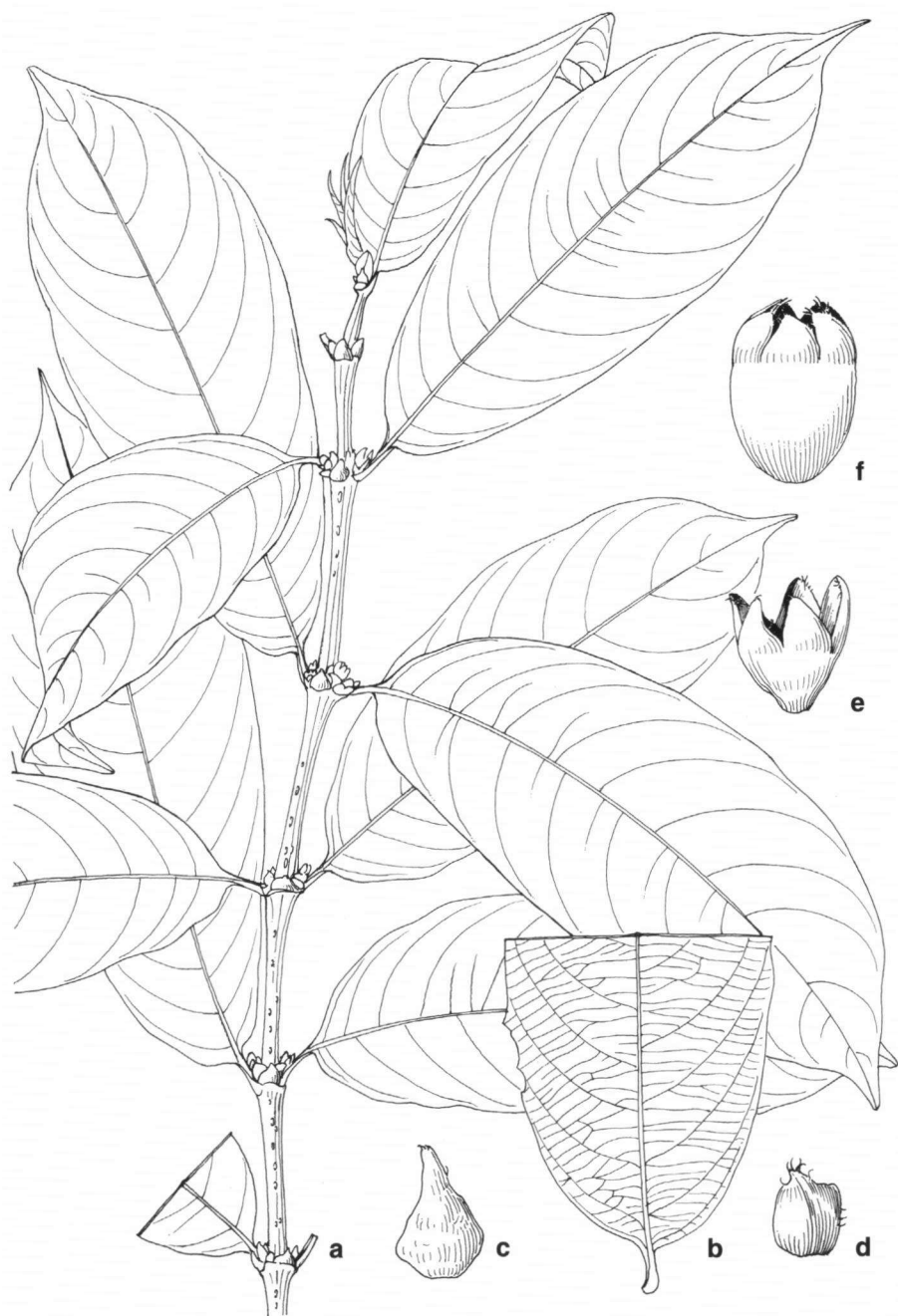


Fig. 2. *Lasianthus inodorus* Blume subsp. *montigenus* H. Zhu. a. Habit; b. enlarged part of the lower surface of leaf; c. stipule; d. bract; e. calyx; f. young fruit (all: H. Zhu 98-7-01). — a, b:  $\times 0.6$ ; c, e:  $\times 3.6$ ; d:  $\times 3$ ; f:  $\times 4.8$ .

outside; corolla puberulous outside, villous inside. *Fruits* red, ovoid, 10 mm long, glabrous. *Pyrenes* 5.

**Distribution** — China (Yunnan), India (north-east part), Bangladesh (eastern part), Thailand, Cambodia, Vietnam and Indonesia (Sumatra, Java).

**Habitat & Ecology** — Shrubs to treelets, in montane evergreen forest over 1000 m altitude. Flowering: November, December; fruiting: March, April.

**Note** — Subsp. *inodorus* has a wide, disjunct distribution. However, the specimens from mainland Southeast Asia and the ones from Sumatra and Java are almost identical so that clear variation within this subspecies cannot be recognised.

**b. subsp. *montigenus* H. Zhu, subsp. nov.** — Fig. 2, Map 1

A typo ramulis conspicue lenticellis, foliis oblongis basi subrotundis, nervis lateralibus utrinsecus 9–11, nervulis subreticulatis, bracteis subcoriaceis caducis differt. A subsp. *pubescenti* H. Zhu planta magniore, ramulis robustis glabris conspicue lenticellis, foliis majoribus oblongis basi subrotundis, nervis lateralibus utrinsecus 9–11 subtus glabris, floribus majoribus, calycibus glabrescentibus differt. — Typus: *H. Zhu* 98-7-01 (holo HITBC), Borneo, Kinabalu, in upper montane forest, 2400 m.

Shrubs 2–3 m tall. *Branches* subterete or slightly tetragonous, striate and conspicuously lenticellate, glabrous, incrassate at nodes, internode 3.5–4 cm long, nigrescent when drying. *Leaves* 12–15 cm long, 5–5.5 cm broad, oblong, apex brevi-caudate, base subrotund, coriaceous, both sides glabrous; nerves 9–11-paired, tertiary nerves subreticulate, nerves and tertiary nerves conspicuous at both sides, petioles 5 mm long, glabrous; stipules ovate-triangular, 3–5 mm long, apex acuminate, pubescent. *Inflorescences* sessile; bracts orbicular, subcoriaceous, caducous. *Flowers* sessile; calyx glabrescent, tube 2.5 mm long, lobes 5, broad-triangular, 2 mm long, apex and margin pubescent. *Fruit* oblong, 10 mm long, glabrous. *Pyrenes* 5.

**Distribution** — Endemic to Borneo.

**Habitat & Ecology** — Shrubs to treelets, in mossy forests of Mt Kinabalu over 1700 m altitude. Fruiting: July, August.

**c. subsp. *pubescens* H. Zhu, subsp. nov.** — Fig. 3, Map 1

A typo planta minore, ramulis dense pubescentibus, foliis minoribus subtus pubescentibus, nervulis subparallelis, stipulis pubescentibus, bracteis subcoriaceis caducis, calycibus pubescentibus differt. A subsp. *montigeno* H. Zhu planta minore, ramulis pubescentibus, foliis minoribus oblongis basi cuneatis subtus pubescentibus, nervis lateralibus utrinsecus 6–7, calycibus pubescentibus differt. — Typus: *H. Zhu* 98-7-02 (holo HITBC), Borneo, Kinabalu, in lower montane forest, 1600 m.

*Lasianthus* sp.1, Davis in Coode et al., Checklist Fl. Pl. Gymn. Brunei Darussalam (1986) 277, pro parte quoad specimen Sands 5244.

Shrubs 1–1.5 m tall. *Branches* subterete, densely appressed pubescent, incrassate at nodes, internode 2.5–3 cm long. *Leaves* 6–11 cm long, 2.2–3 cm broad, oblong-lanceolate, apex subacute to brevi-acuminate, base broad-cuneate, coriaceous, glabrous above, pubescent beneath; nerves 6- or 7-paired, tertiary nerves subparallel, nerves and tertiary nerves conspicuous at both sides, petioles 3 mm long, pubescent; stipules triangular, 5 mm long, apex acuminate, densely pubescent. *Inflorescences* sessile; bracts

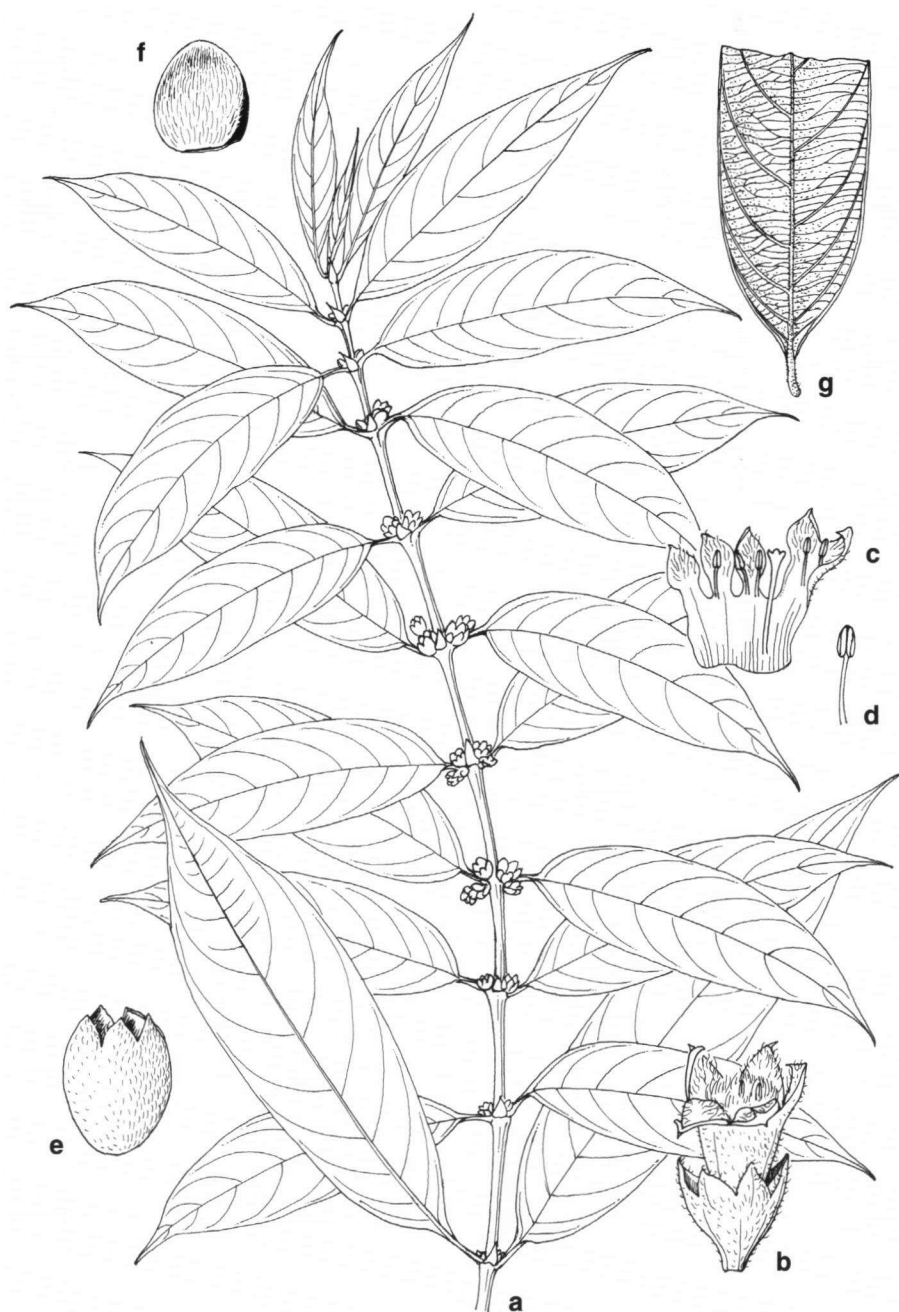


Fig. 3. *Lasianthus inodorus* Blume subsp. *pubescens* H. Zhu. a. Habit; b. flower; c. corolla split open; d. stamen; e. young fruit; f. bract; g. enlarged part of the lower surface of leaf (all: H. Zhu 98-7-02). — a:  $\times 0.6$ ; b:  $\times 3.6$ ; c:  $\times 2.4$ ; d-f:  $\times 4.8$ ; g:  $\times 0.72$ .

orbicular, subcoriaceous, pubescent, caducous. *Flowers* sessile, calyx tube 2 mm long, pubescent outside, lobes 5, 2 mm long, broad-triangular, pubescent outside, apex and margin densely pubescent; corolla 8 mm long, tube 4–5 mm long, glabrescent outside, lobes subspathulate, pubescent outside, villous inside; stamens 5; anther oblong. *Mature fruit* not seen.

Distribution — Endemic to Borneo (Sabah, Brunei, Sarawak and Kalimantan).

Habitat & Ecology — Shrubs, in montane evergreen forest between 400–2000 m. Flowering: July, August.

## ECOLOGY

*Lasianthus inodorus* Blume is a montane species, occurring in habitats over 1000 m altitude from NE India through S Yunnan, mainland Southeast Asia to Sumatra, Java and Borneo. No specimens were seen from Peninsular Malaysia, neither is '*L. inodorus*' listed in the Tree Flora of Malaya (could be the case of no mountains being high enough). In Yunnan, it flowers in November and December during the dry season. The conspicuous coriaceous bracts seem to offer protection to flowers and young fruits. Subsp. *inodorus* is distributed in regions with a seasonal dry climate. Subsp. *pubescens*, which has smaller and hairy leaves and deciduous bracts, occurs on mountains between 400–2000 m altitude with a slightly seasonal dry climate which is regularly affected by El Niño droughts. Subsp. *montigenus* occurs at elevations over 1700 m in mossy forests of Mt Kinabalu. It has larger glabrous leaves and deciduous bracts, which seem adapted to wet, cloudy habitats. There is a collection of subsp. *pubescens* from Mt Alab, Sabah at 2000 m altitude, but it occurs in relatively dry habitats of montane evergreen forest between 1400–1700 m on Mt Kinabalu and does not occur together with subsp. *montigenus*. The morphological differentiation of the species and its subspecies agree well with the habitats in which they occur.

## BIOGEOGRAPHY

Direct land connection between mainland Southeast Asia and Borneo existed until early Pliocene (5 million years ago) (Hall, 1998), and there was no geographical barrier to natural distribution of plants between mainland Southeast Asia and Borneo during most of the Tertiary (Morley, 1998). During Miocene to early Pleistocene the moist tropical rain forest climate developed in the largest extension in Southeast and East Asia (Kubitzki & Krutzsch, 1996; Morley, 1998) and the genus *Lasianthus* could have diversified during that time in Southeast Asia.

Since late Tertiary, seasonal climates were extensive in mainland Southeast Asia, Sumatra, Java and Borneo which allowed migration of seasonal climate plants across the areas (Morley & Flenley, 1987). The species *L. inodorus* could have existed in Borneo until the Pleistocene, because the land connection between Borneo, mainland Southeast Asia and some of the Sunda Islands, such as Sumatra, is inferred to have existed until the Plio/Pleistocene, which allowed direct gene flow between these areas (Moss & Wilson, 1998). Mount Kinabalu (4101 m above sea level), the highest mountain in West Malesia, is geologically young, and radiometric age determinations range between 9 and 4.9 million years (Jacobson, 1978). The mountain has been diapiroically

uplifted in the last 1.5 million years and is still rising at a rate of about 0.3 cm/year (Myers, 1978). It has an extremely rich flora with more than 5000 species of vascular plants. As suggested by Beaman & Beaman (1990), frequent speciation events in the recent past may have contributed significantly to the great diversity of the flora of Mt Kinabalu, which resulted from several factors including a vast range of climatic conditions, numerous geologically recent habitats on a diversity of substrates, regularly recurring El Niño droughts that may drive catastrophic selection, precipitous topography resulting in strong reproductive isolation over short distances and small population size of many species which may be susceptible to genetic drift. *Lasianthus inodorus* subsp. *montigenus* differs from the typical subspecies by characteristics which appear to adapt it to wet, cloudy upper mountain habitats, while subsp. *pubescens* differs from subsp. *montigenus* by characteristics adapted to drier lower mountain habitats. It is possible that the species *L. inodorus* diverged into two vicarious subspecies in Borneo after isolation from mainland Southeast Asia and Sumatra and Java.

The floristic connections between islands of the Malay Archipelago and mainland Southeast Asia were mostly explained on the basis of stepping stones of various mountains or bridges in the region before wide acceptance of plate tectonic theory (Van Steenis, 1962, 1964), and now better explained by plate tectonic theory based on more geological and biogeographical evidence. The distribution patterns of this species and its subspecies suggest the historical connection between mainland Southeast Asia and the Malay Archipelago and supports tectonic explanation.

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### IDENTIFICATION LIST

The numbers behind the collector numbers refer to the following taxa:

#### *Lasianthus inodorus* Blume

- 1 = subsp. *inodorus*
- 2 = subsp. *montigenus* H. Zhu
- 3 = subsp. *pubescens* H. Zhu

- Anderson 4512: 3 — Aya Nitta 15186: 1.
- Beaman 8204: 3; 8209: 3; 8258: 3; 8751: 3.
- Clarke 1785: 1; 15241: 1; 43722: 1 — Clemens 32536: 2.
- De Monchy 114: 1.
- Elbert 253: 1.
- Forbes 1085: 1 — Fukuoka T-63785: 1.
- Garrett 384: 1; 879: 1 — Geesink 9271: 3 — Griffith 2923:1; 2924:1; 2925:1
- Hochreutiner 1172: 1 — Huisman et al. 8674: 3.
- Junghuhn 316: 1.
- Kerr 4063: 1; 6063: 1 — Koorders 23209: 1; 26710: 1.
- Larsen et al. 40945: 1.
- Meebold 7421: 1 — Murata et al. 42896: 1.
- Ogata 11310: 3.
- Phengkklai et al. 7029: 1.
- Sands 5244: 3 — Shigeyuki et al. 45322: 1 — Shimizu et al. T-23198: 1 — Shoheikokawa et al. 4236: 2 — Smitinand 11857: 1.
- Tajawa et al. 473: 1; 1214: 1 — Tirvengadam et al. 1560: 1.
- Van Beusekom et al. 4558: 1 — Van Beusekom & Charoenpol 1697: 1 — Van Beusekom & Smitinand 2202: 1 — Van Steenis 6985: 1; 8328: 1; 12772: 1.
- Zhu 98-7-01: 2; 98-7-02: 3 — Zhu & Wang 940401: 1 — Zollinger 4817: 1.