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A new and exceptional species of *Breynia* (*Phyllanthaceae*, *Phyllanthaeae*) from southwestern Thailand

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Keywords

Asperities
Breynia
New species
Phyllanthaeae
Pistillate flowers
Pollination

Abstract Based on molecular and morphological data a new species of *Breynia*, *B. aberrans*, is described from Kaeng Krachan National Park (SW Thailand), along the Thai border with Myanmar. An earlier published phylogenetic reconstruction of two nuclear (ITS, *PHYC*) and three chloroplast markers (*matK*, *accD-psaI*, *trnS-trnG*) placed the new species in *Breynia* subgenus *Sauropus*. Typical are the asperities along the branches on one side, the shape of the leaf blades and the pistillate flowers with a long-ovoid ovary ending in a sturdy style and three upright stigmas. This type of pistillate flower is rather unique within *Breynia* and almost certainly not pollinated by *Epicephala* moths.

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INTRODUCTION

The tribe *Phyllanthaeae* in the *Phyllanthaceae* is a taxon with fast evolution and extraordinary morphological changes (Kato & Kawakita 2017). The genus *Breynia* J.R.Forst. & G.Forst. is typical for the *Phyllanthaeae* with its phyllanthoid branching (leaves along stem stipule- or bract-like, normal leaves along branches), distichous aestivation with simple entire leaves, generally fascicles of unisexual flowers, flowers lacking a disc but staminate ones usually having scales instead which keep the flower closed as long as the anthers are undehiscent, stamens united in some way, pistillate flowers with 3-locular ovaries with two ovules in each locule and in most species with a flat upper surface with crescent moon-shaped stigmas flattened against it, or stigmas erect and often reduced in length, fruits capsular, often tardily dehiscent. The genus is found from India to southeast Asia (including southern China), throughout Malesia to eastern Australia. *Breynia*, with c. 70 species (van Welzen et al. 2014) originated 25–20 Ma in the western part of Thailand and likely the Malay Peninsula, also the area with most species; a second centre of speciation is in New Guinea (van Welzen et al. 2015). The fast speciation in the genus is partly shown by adaptations to different habitats, eight species are locally adapted to limestone (*B. asymmetrica* (Welzen) Welzen & Pruesapan, *B. calcarea* (M.R.Hend.) Welzen & Pruesapan, *B. carnosa* Welzen & Pruesapan, *B. lithophila* Welzen & Pruesapan, *B. micrasterias* (Airy Shaw) Welzen

& Pruesapan, *B. obscura* Welzen & Pruesapan, *B. poomae* (Welzen & Chayam.) Welzen & Pruesapan, *B. repens* Welzen & Pruesapan), and one is a rheophyte (*B. heteroblata* (Airy Shaw) Welzen & Pruesapan) (van Welzen et al. 2015). Likely, changes in pollination vectors created by far the largest diversity. Several species, independently, developed inflorescences on the branches and stems instead of groups of flowers in the leaf axils: *B. discocalyx* (Welzen) Welzen & Pruesapan, *B. poomae*, *B. suberosa* (Airy Shaw) Welzen & Pruesapan (up to 40 cm long), *B. thorelii* (Beille) Welzen & Pruesapan, and *B. thyrsiflora* (Welzen) Welzen & Pruesapan (up to 50 cm long) (van Welzen 2003). The longest inflorescences lie on the soil and are likely pollinated by ground dwelling insects. The most obvious morphological changes in flowers were brought about by (often species specific) obligate moth pollination. The non-moth pollinated species were placed in *Sauropus* Blume, nowadays a synonym of *Breynia*. No pollinators are known for any of these species. The moth pollinated species were classified in *Breynia* sensu stricto. Female moths of the genus *Epicephala* actively collect pollen from staminate flowers with their proboscis and pollinate the pistillate flowers, after which they lay an egg against the ovary or within the ovary. The plants have a high fruitset and the larvae are protected and eat part of the seeds (Kato & Kawakita 2017).

The change in pollination syndrome resulted in three general types of staminate flowers and two types of pistillate flowers. The staminate flowers of type 1 and 2 have scales (transformed disc glands), and either partly united filaments splitting into three horizontal branches with the anthers underneath (staminate type 1, former genus *Sauropus*; van Welzen et al. 2023: fig. 3a) or they have an androphore with the stamens vertically along it (staminate type 2, formerly *Breynia* sensu

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stricto; van Welzen et al. 2023: fig. 4a, b). Staminate type 2 has narrow flowers (the other two types have wide flowers) and this is an adaptation to moth pollination as discussed in van Welzen et al. (2023). Staminate type 3 (also former genus *Sauropus*) is like type 1 with partly united filaments, but the free parts carry much larger anthers than type 1 and 2 and they are diagonal in the flower, the tepals lack scales and the outer three tepals are apically folded inwards and the tips are grown together with the inside of the rest of the tepal blades, the inner three tepals are incurved (van Welzen 2003: fig. 2d). The pistillate flowers in all species lack a disc. The flowers of type 1 have ovaries with a very flat upper surface, with or without a rim along the edge and horizontal stigmas that split apically, thus resembling three crescent-moons (pistillate type 1, former genus *Sauropus*; van Welzen et al. 2023: fig. 3b, c); these are not moth pollinated (van Welzen et al. 2023). All species with type 1 pistils have staminate flowers of type 1. The moth pollinated species have subglobose ovaries with upright stigmas that are generally very reduced in length; the short length is an adaptation to moth pollination (pistillate type 2, formerly *Breynia* sensu stricto; see van Welzen et al. 2023: fig. 4c and discussion of morphology). This group has type 2 staminate flowers. The species with staminate flower type 3 have pistillate flowers that are somewhat in between both types of pistillate flowers (as far as the pistillate flowers are known). In some species the ovary has a flat top, in others more round, in all of them the style and stigmas are erect, but well developed.

In Kaeng Krachan National Park (SW Thailand, provinces Phetchaburi and Prachuap Khiri Khan, along the border with Myanmar), two specimens of an unknown *Phyllanthaceae* species were collected by different teams. We could previously not identify these specimens because of a pistillate flower (Figs. 2c, 3c) that did not match any *Phyllanthaceae* genus. Previous phylogenetic analyses of the *Phyllanthaceae* based on nuclear (ITS, *PHYC*) and chloroplast markers (*matK*, *accD-psal*, *trnS-trnG*) (see Fig. 1 for summary; see Bouman et al. 2021 for access to full information) included the two specimens as “*Phyllanthus* aff. *columnaris*”, which proved to be part of *Breynia* (the part formerly treated as *Sauropus* (Fig. 1; a well-resolved phylogeny of *Breynia* s.l. can be found in Pruesapan et al. 2012). The new species only had staminate buds, but these mainly resemble type 3 staminate flowers, as they do not have scales and the outer tepals are slightly infolded. This unidentified species will be described as new here.

MATERIAL AND METHODS

Two collections form the material used; they are presented below as type and paratype. Based on molecular evidence the new species is classified in the genus *Breynia* and based on a morphological species concept it will be distinguished from all other species of *Breynia* as described in van Welzen (2003) under *Sauropus* and the treatment for the Flora of Thailand (<https://www.nationaalherbarium.nl/ThaiEuph/ThBspecies/ThBreyniaT.htm>), and for Flora Malesiana (<https://www.nationaalherbarium.nl/Euphorbs/specB/BreyniaT.htm>).

Zeiss dissecting microscopes were used to make the species description. Staminate and pistillate flowers were rehydrated by shortly boiling them in a microwave, after which they could easily be dissected and described.

RESULTS AND DISCUSSION

The new species is markedly different from all other species of *Breynia* in the presence of a single row of asperities on the branches, the shape and size of the leaf blade (see description) and the type of pistillate flower. Asperities are stiff papillae, occurring often on *Breynia* species in various places. *Breynia bicolor* (Craib) Chakrab. & N.P.Balakr. and *B. garrettii* (Craib) Chakrab. & N.P.Balakr. also have asperities on the branches, but then in grooves and not particularly in one row. In addition, their leaf blade shapes and sizes are different, *B. bicolor*: ovate (to per plant few elliptic), 1.1–5.6 by 0.5–2.9 cm; *B. garrettii* ovate (to elliptic) 2.7–12.8 by 1.2–4.2 cm, in both blade sizes $\pm$ similar along branches; new species: broadly ovate-oblong to ovate-oblong, 0.6–5.3 by 0.8–2.2 cm (proximal leaves smaller than distal ones).

The staminate flowers on specimens of the new species were not yet fully developed, but appear to be like type 3 as scales are absent and the outer three tepals are slightly folded inwards. However, the folding is not as much as in type 3 as the incurved tip of the tepals is not grown together with the tepal blade, and the inner tepals are straight, not folded inwards. *Breynia bicolor* and *B. garrettii* have staminate flowers of type 1. Type 3 staminate flowers occur in a few species in Thailand, *B. granulosa* (Airy Shaw) Welzen & Pruesapan, *B. kerrii* (Airy Shaw) Welzen & Pruesapan, *B. pulchella* (Airy Shaw) Welzen & Pruesapan, *B. subterblanca* (C.E.C.Fisch.) C.E.C.Fisch. and *B. temii* (Welzen & Chayam.) Welzen & Pruesapan (*B. temii* also occurs on Sumatra and Borneo); outside Thailand, the only other species with type 3 staminate flowers is *B. shawii* (Welzen) Welzen & Pruesapan, which occurs on Borneo. Several of these species with type 3 staminate flowers have asperities, but only *B. temii* also has asperities on the branches. These are located between broad rims, but not in a single row (rims absent in the new species). All species differ from the new species in their shape of the leaf blade and often in sizes. The pistillate flowers in this group are more or less in between both types. The ovary in *B. temii* is flat above, those of the others are more convex, but none has the long, ovoid spindle-shaped ovary of the new species. All of them have upright stigmas, but usually without a style (stigmas free from each other), although *B. kerrii* has a short style. The new species deviates in having a sturdy, prominent style, forming more or less a gradual continuation of the ovary.

Van Welzen et al. (2023) show that certain morphological aspects of staminate and pistillate flowers in *Breynia* indicate moth pollination (see above). The likely wide staminate flowers of the new species, as compared to the other species with staminate flower type 3, and the sturdy style and long stigmas are indicative of non-moth pollination.

In conclusion, the new species agrees with a classification in *Breynia* based on the absence of a disc and the presence of scales and asperities and staminate flowers like type 3. Within *Breynia* the species with staminate flowers type 3 are classified in *Breynia* subgen. *Breynia* section *Cryptogynium* (Müll.Arg.) Welzen & Pruesapan (van Welzen et al. 2014; only *B. kerrii* represented in Fig. 1). However, as the immature staminate flowers of the new species deviate from true staminal type 3 and the ovary has a unique shape, the new species is classified

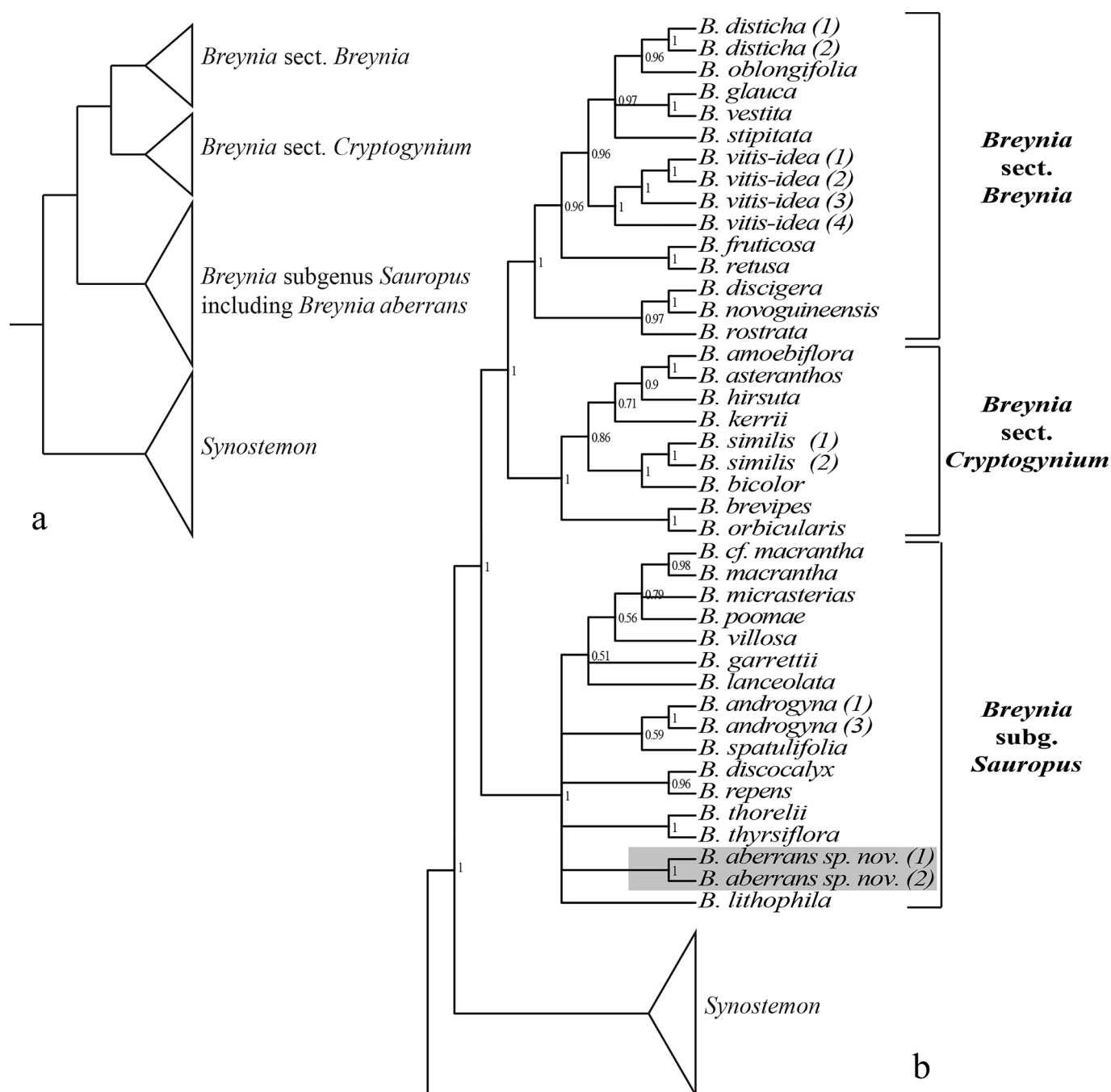


Fig. 1 Phylogenetic reconstruction of *Breynia* with subgeneric classification (phylogeny after Bouman et al. 2021: supplementary fig. 10). **a.** Overview of the summarized phylogeny. **b.** Detailed phylogeny showing the new species, *Breynia aberrans* R.W.Bouman, Welzen & Tagane is highlighted and was previously listed as *P. aff. columnaris*. Sample *B. aberrans* (1) refers to collection Middleton 1715 and (2) refers to Tagane et al. T570.

in subgenus *Sauropus* as suggested by its phylogenetic placement.

TAXONOMY

Breynia aberrans R.W.Bouman, Welzen & Tagane, sp. nov.
— Fig. 2–3

Shrub, monoecious, with phyllanthoid branching. *Staminate flowers* (young): tepals 6, 3 inner slightly infolded, scales lacking, stamens 3, filaments likely united into androphore, anthers large, along androphore, overtopping latter. *Pistillate flowers*: tepals 6, disc lacking, ovary ovoid spindle-shaped, style distinct, stigmas 3, upright, spreading, bifid in upper part, apices somewhat recurved and flattened. — Type: *D.J. Middleton, C. Hemrat, S. Lindsay, S. Suddee & S. Suwanachat* 1715 (holo L [L.2252576]); iso likely in A, BKF, as indicated on the label, but not yet in databases of A and BKF), Thailand, Phetchaburi Province, Kaeng Krachan District, Kaeng Krachan National Park, Bang Krang Camp area, trail near ranger substation 12°47.8' N, 99°27.4' E, 26 March 2003. Paratype: *S. Tagane, K. Fuse, S. Rueangrua & S. Suddee* T570 (FUI, LI), Thailand, Phetchaburi, Kaeng Krachan National Park, Transect Line 1, 12°48'11.4" N, 99°26'31.6" E, 6 October 2012.

Shrubs, at least 1 m high, monoecious, protogynous; orthotropic axes terete, light brownish when dried, glabrous, thin bark flakes detaching; branching phyllanthoid. *Brachyblasts* absent. *Cataphyllary stipules* triangular, c. 1.4 by 1 mm, stiff, relatively persistent, dark brown, margin entire, apex acute. *Cataphylls* like cataphyllary stipules, c. 1.1–1.8 by 0.8–1.2 mm. *Plagiotropic branchlets* usually solitary, sometimes two close together, terete, 15–31 cm long, dark brown when dry, not thickened at base, bearing 18–30 leaves, internodes 8–12 mm long, glabrous except for a row of asperities at underside of branchlet. *Stipules* long-triangular, 2–3.3 by 0.5–1 mm, completely coriaceous, persistent, brown, glabrous on both surfaces, base emarginate, slightly eared at

both sides, margin entire, apex long acute. *Leaves* distichous, increasing in size upwards along the branchlets; petiole terete, 1–2 mm long, wrinkled when dry, flattened above, with asperities on upper surface; blade widest at base, basally at branchlet broadly ovate-oblong, 0.6–1.7 by 0.8–1.4 cm, up to ovate-oblong, 4–5.3 by 1.5–2.2 cm apically on branchlet, the latter 2.4–3.3 times longer than wide, slightly asymmetric at base and apex, papery, base truncately attenuate, margin entire, apex mucronate to shortly acuminate, both surfaces smooth, glabrous, upper surface mid-green, lower surface glaucous, lighter brown than upper surface when dry, abaxial epidermal cells domed, venation pinnate, midrib slightly raised at both sides, veins in level of leaf, lateral veins 8–12 per side in apical leaves, anastomosing near margin, higher order veins reticulate. *Inflorescences* axillary fascicles, usually unisexual, staminate flowers up to 5 together, at end of short peduncle of c. 0.5 mm long, usually proximal to pistillate flowers along branchlets, pistillate flowers solitary or two together, at distal end of branchlets; bracts long-triangular, 0.6–0.9 by c. 0.3 mm, coriaceous, glabrous, margins light coloured, apex long-acute. *Staminate flowers* still young, some buds just opening and used for measurements, 1.3–1.5 mm in diameter; pedicel up to 4 mm long, terete, glabrous, thin; tepals 6, ovate, free, pointing upwards, margins entire, apex acute, midrib raised on inside, outer three c. 0.8 by 0.6 mm, apex slightly bent inwards, inner three c. 0.9 by 0.5 mm, apex straight; disc glands or scales absent; stamens 3, filaments likely united into an androphore, still very short, c. 0.3 mm long, anthers large, thecae oblong, c. 0.5 by 0.7 mm, straight along androphore, overtopping androphore, dehiscing along vertical slits. *Pistillate flowers* 1.3–2 mm diameter; pedicel up to 10 mm long, terete, glabrous, slightly thickening towards apex; tepals 6, long-ovate, 1.5–1.8 by 0.3–0.5 mm, free, pointing upwards, glabrous on both surfaces, margins entire, apex obtuse; disc absent; ovary long-ovoid spindle-shaped, widest basally, transitioning into style, 1–3.3 by 0.9–2 mm,

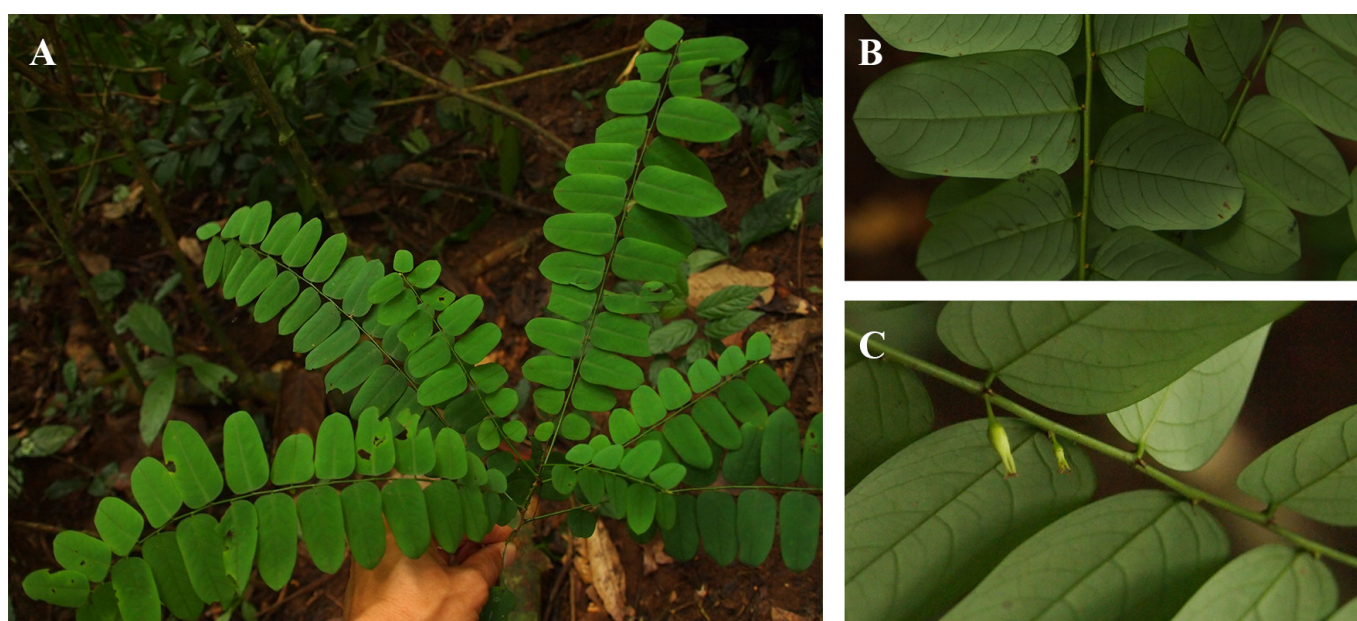


Fig. 2 Images of *Breynia aberrans* R.W.Bouman, Welzen & Tagane. **a.** Habit showing the regularly spaced leaves along the branchlets. **b.** Detail of the underside of leaves. **c.** Pistillate flowers hanging under the branchlets. Photos by Shuichiro Tagane.

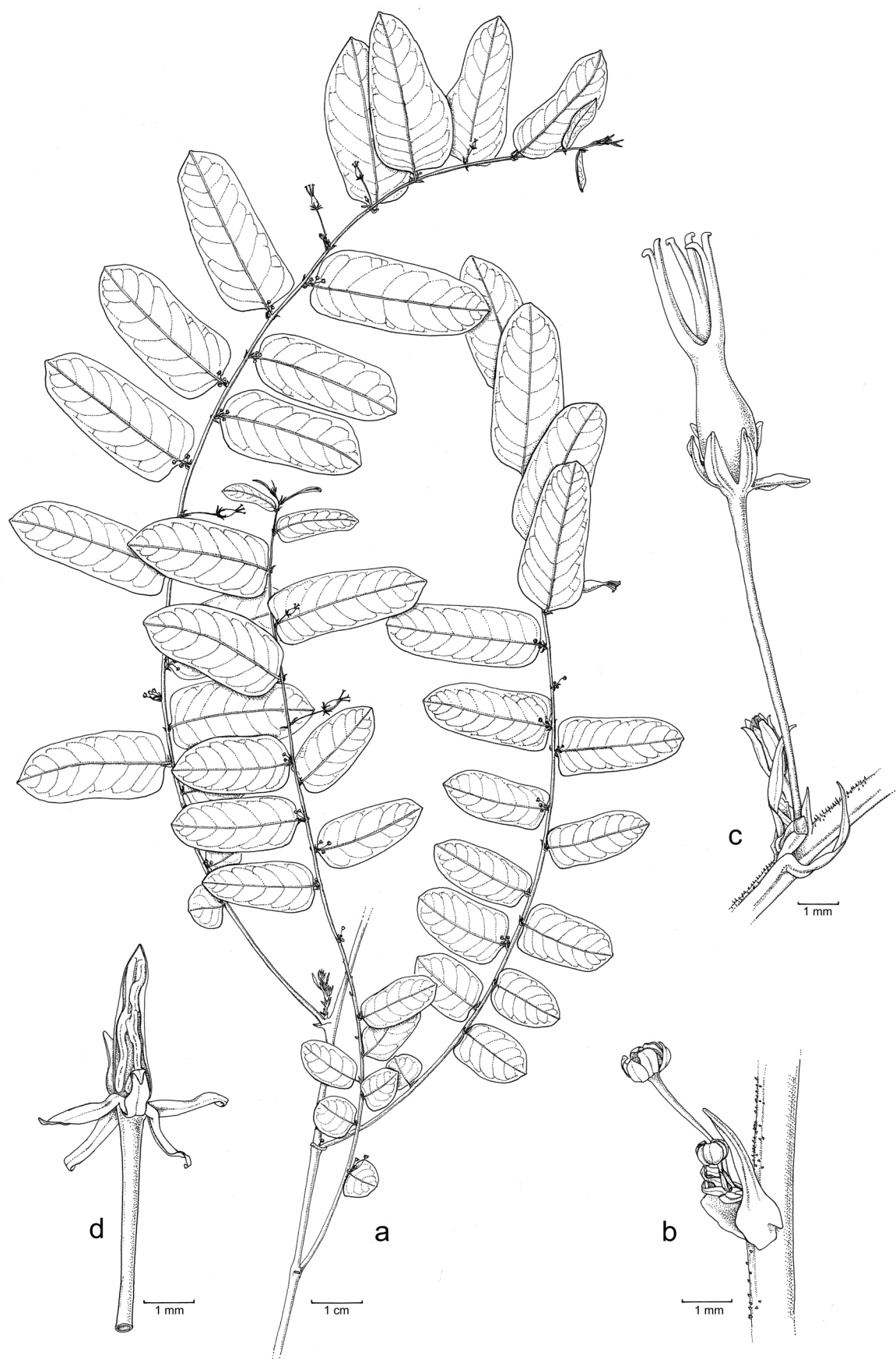


Fig. 3 Drawing of *Breynia aberrans* R.W.Bouman, Welzen & Tagane. **a.** Habit. **b.** Young staminate inflorescence. **c.** Pistillate inflorescence, note the single row of asperities. **d.** Fruit columella (D.J. Middleton, C. Hemrat, S. Lindsay, S. Suddee & S. Suwanachat 1715, L). Illustration by Hilde Orye, 2026.

yellowish green, 3-locular, ovules 2 per locule; style 0.8–2.1 mm long, sturdy; stigmas 3, upright, spreading somewhat, 1.8–2.3 mm long, bifid for c. 1 mm long, apices somewhat recurved and flattened, likely containing stigmatic tissue. *Fruit remnants*: columella c. 3 mm long, tapering towards the apex; tepals persistent. *Seeds* unknown.

Distribution — Endemic to southwestern Thailand (Kaeng Krachan National Park; Fig. 4).

Habitat & Ecology — Secondary forest, seasonally dry evergreen forest. Altitude: c. 370 m. Flowering: March and October. Fruiting: October.



Fig. 4 Map of Thailand with a focus on Phetchaburi province with the distribution of *Breynia aberrans* R.W.Bouman, Welzen & Tagane.

Etymology — The epithet refers to the aberrant ovary shape, so far unknown within *Breynia*.

Vernacular name — ไตไบ (tai bai).

Note — The paratype was collected by the last author in the same national park. The distance between the two collection sites is c. 1.7 km.

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