



Revision of *Dicoelia* (Phyllanthaceae; Euphorbiaceae s.l.)

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Key words

Dicoelia
disc glands
Euphorbiaceae
gynophore
Malesia
Phyllanthaceae

Abstract *Dicoelia* was always considered to be a monotypic genus. Typical are the hooded (cucullate) petals that form cavities in which juvenile thecae of adjacent stamens are protected. Specimens of Sumatra appear to represent a new species. The Sumatran specimens have stipules that fall slightly later and they show morphological differences in the pistillate petals, pistillode, columella and hilum. Newly described structures are disc glands (thought to be absent), probably not functional, but present in the flowers of both sexes and a gynophore in the pistillate flowers. *Dicoelia* is considered as a member of the *Phyllanthaceae* conforming with the latest molecular phylogenetic results; a classification that agrees with the presence of two ovules per locule.

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INTRODUCTION

Bentham (1879) described the monotypic genus *Dicoelia* comprising *D. beccariana*. A second species was later described by Smith (1920), but this appeared to be a synonym. The genus was obviously euphorbiaceous because of the schizocarpous fruits, but difficult to place. Bentham (1879) compared it with *Galearia* and placed both in tribe *Galearieae* of *Euphorbiaceae* subfamily *Acalyphoideae* (nowadays *Pandaceae*), because both genera have highly typical cucullate (hooded) staminate petals that protect the juvenile stamens in bud. However, there are also major differences between both genera: the stamens in *Dicoelia* are alternipetalous, which means that one petal protects thecae of two adjacent stamens, while in *Galearia* the stamens are epipetalous, so that each petal protects the thecae of the same anther or two anthers in case the species has ten stamens. *Pandaceae* are mono-ovulate and have drupaceous fruits, while *Dicoelia* has bi-ovulate locules and euphorbiaceous schizocarps. Bi-ovulate *Euphorbiaceae* were always placed in the subfamilies *Phyllanthoideae* and *Oldfieldioideae*, and likewise, Pax (1890) and Pax & Hoffmann (1922, 1931) classified *Dicoelia* in subfamily *Phyllanthoideae*, tribe *Phyllanthae*, subtribe *Antidesminae*. Webster (1975) first agreed with Pax & Hoffmann, but in 1987 he changed his mind and followed Bentham and placed *Dicoelia* as a tribe in the *Pandaceae*. In his last classification of the *Euphorbiaceae*, Webster (1994) placed it in tribe *Dicoeliaeae* next to tribe *Galearieae* in the subfamily *Acalyphoideae*, a view later followed by Radcliffe-Smith (2001). This made *Dicoelia* quite enigmatic, being the only bi-ovulate genus in the otherwise mono-ovulate *Euphorbiaceae* s.s.

Kathriarachchi et al. (2005) used molecular evidence to show that *Dicoelia* is a member of the *Phyllanthaceae* (formerly *Euphorbiaceae* subfam. *Phyllanthoideae*). *Dicoelia* is part of their clade F4 and sister to *Leptopus diplospermus* (Airy Shaw) G.L.Webster (now *Chorisandrachne diplosperma* Airy Shaw). This nicely places *Dicoelia* among the bi-ovulates and validates the view of Pax & Hoffmann (1922, 1931). Tokuoka & Tobe (2006) confirmed the analyses by Kathriarachchi et al. (2005).

Radcliffe-Smith (2001) provided a really excellent description of the genus. Probably, he only evaluated Bornean specimens. These generally show a pistillate flower among a group of staminate buds/flowers per node of the inflorescence. The Sumatran specimens generally show unisexual inflorescences only, either groups of staminate flowers per node or a single pistillate flower without additional flower buds, very seldom a pistillate flower is found together with a few staminate flowers. The disc is reported to be absent, but there are five very small globular, alternipetalous (episepalous) structures with long hairs at the base of the andro- or gynophore that are interpreted and reported here as disc glands. They are probably too small to be functional. The pistillate flowers have an ovary placed on a (glabrous) gynophore, this structure was also not reported before.

One species is newly described. The Sumatran specimens mainly have unisexual inflorescences, the type of pistillode is different (stigmas on top of the pistillode instead of stigmas alternating with bulbous 'locules'), the pistillate flowers have straight, persistent petals in fruit (non-persistent and cucullate in *D. beccariana*), the columella is pyramidal in Sumatran specimens, but slightly T-shaped in specimens from Borneo, the hilum is different in size and the stipules in the Sumatran specimens are later caducous, also present with the top most leaves instead of only covering the terminal bud as in *D. beccariana*.

REVISION

Dicoelia Benth.

Dicoelia Benth. (1879) 70, t. 1289; Pax (1890) 27; Merr. (1921) 330; Pax & K.Hoffm. (1922) 15; (1931) 46; Croizat (1942) 38; Whitmore (1973) 86; Airy Shaw (1975) 95; G.L.Webster (1975) 594; (1987) 6; Mennega (1987) 122, t. 2; G.L.Webster (1994) 67; Stuppy (1995) 158, 166; Radcl.-Sm. (2001) 124. — Type species: *Dicoelia beccariana* Benth.

(Shrubs to) trees, monoecious, terminal branches angular, pilose, early glabrescent soon. *Indumentum* simple hairs. *Stipules* linear-triangular, caducous, apex acute, hairy on both sides. *Leaves* alternate, simple; petiole mainly round, basally slightly pulvinate, apically clearly pulvinate; blade elliptic to obovate, symmetric, margin entire, upper surface usually glabrous except some hairs on the basal part of the midrib, lower surface usually slightly hairy, venation raised beneath, pinnate, nerves looped and closed near the margin, veins scalariform, veinlets

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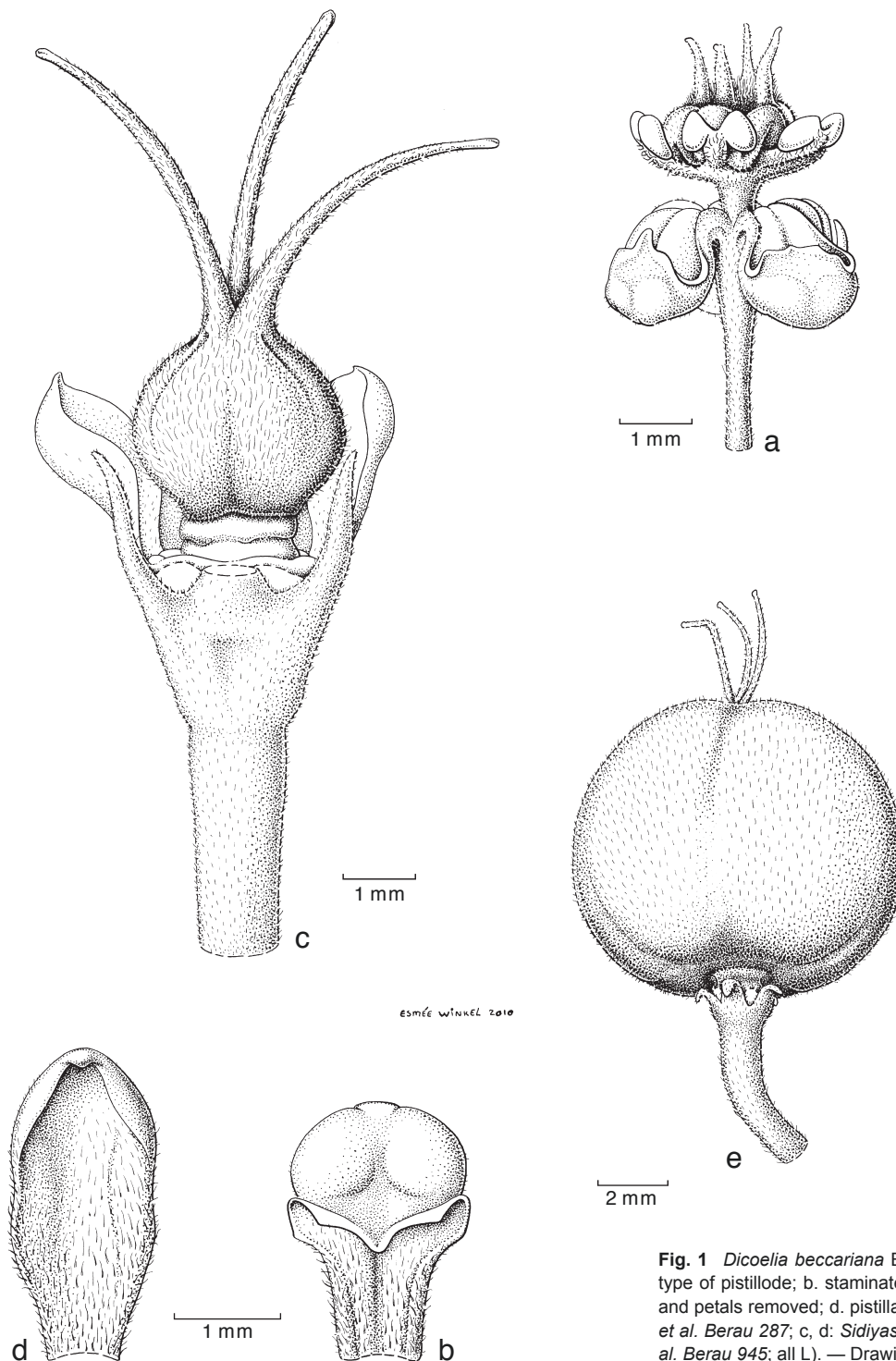


Fig. 1 *Dicoelia beccariana* Benth. a. Staminate flower, showing different type of pistillode; b. staminate petal; c. pistillate flower with part of sepals and petals removed; d. pistillate petal, always hooded; e. fruit (a, b: Keßler et al. Berau 287; c, d: Sidiyasa & Ambriansyah B 1490; e: Ambriansyah et al. Berau 945; all L). — Drawing: Esmée Winkel.

reticulate. *Inflorescences* axillary to subterminal racemiform thyrses (to pseudo-paniculate when subterminal), inserted slightly above the leaves, single per axil (to 2 together, second one much shorter), hairy, round to ribbed when dry, sexes variable, either only staminate with groups of flowers per node, pistillate with single flowers per node, or bisexual with groups of staminate and a central pistillate flower; bracts triangular, apex acute, hairy on both sides; bracteoles like bracts, but smaller; staminate flowers with even smaller subtending bracts. *Flowers* mainly white: pedicel round, hairy, light green; sepals 5, triangular, valvate, apex acute, hairy on both sides, white or greenish; petals 5, obovate, thick, white hairy on both sides, basal part stipe-like, patent when flowering, pinkish to distally red; disc glands indistinct, especially in staminate flowers, episepalous, small, global, hairy. *Staminate flowers*: petals cucullate, patent after anthesis, apex involute, hooded, grown

together with the raised midrib, forming two cavities on both sides of midrib, midrib elongated as extended, free tip pointing horizontally; stamens 5, basally connate in an androphore, latter widening towards the top, hairy, filaments hairy, rose-pink, anthers elliptic, basifixed, opening introrse with lengthwise slits, both thecae separate, each in cavity of adjacent petals when young, yellow; pistillode hairy, with 5 stigmas extending above petals. *Pistillate flowers*: petals either straight, with an acute apex or cucullate with rounded apex; gynophore subglabrous, ovary 3- (or 4-)locular, tomentose, 2 ovules per locule, style absent or a short conical extension of the ovary, tomentose, stigmas linear, spatially separate from each other, hairy, apex widened, flat, spatulate, not split, differently coloured when dry. *Fruits* ovoid, not to slightly lobed, basally concave around gynophore, greyish green when young to brown, brown tomentose, dehiscing septifragally and partly loculicially from above;

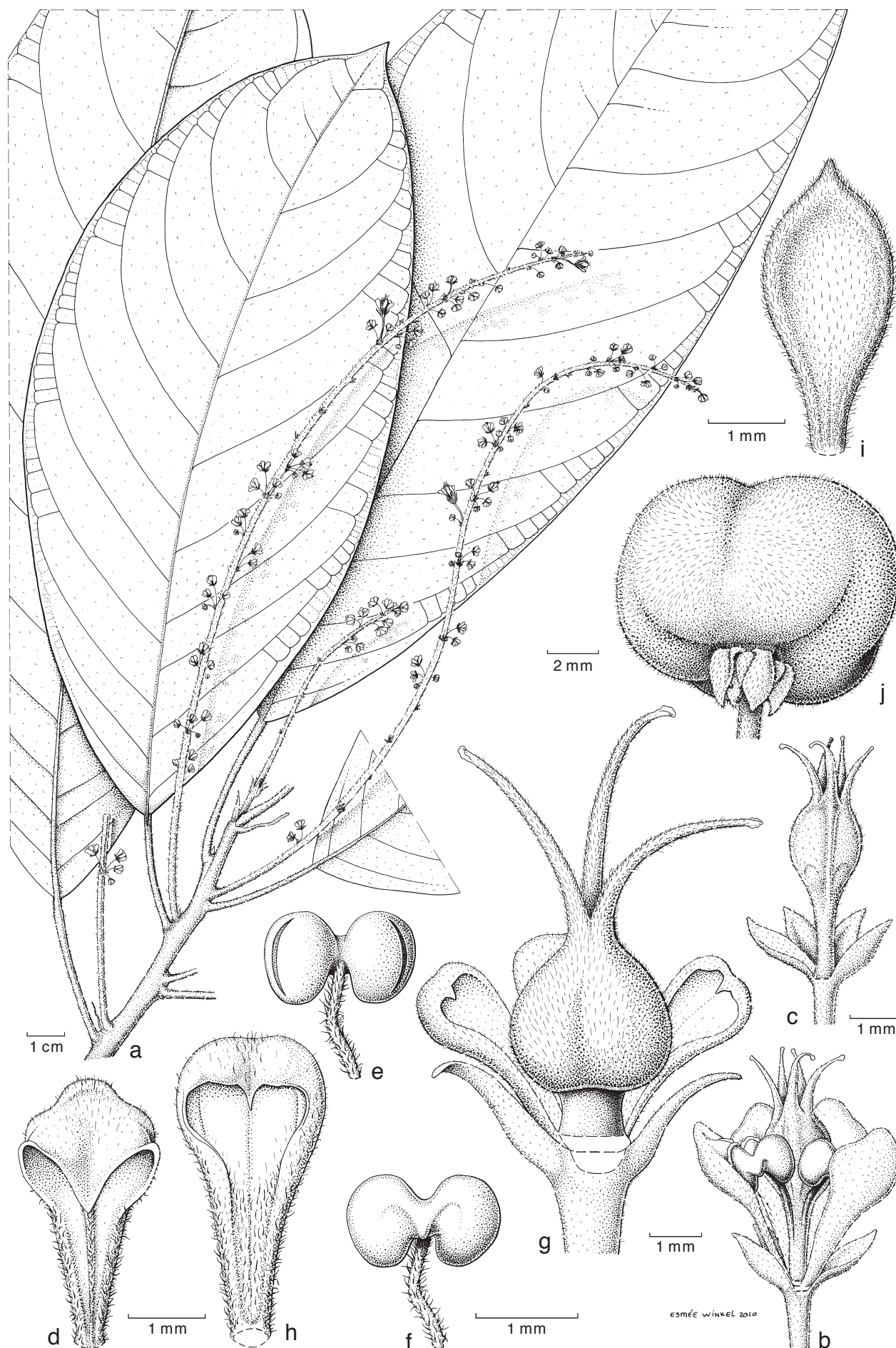


Fig. 2 *Dicoelia sumatrana* Welzen. a. Habit; b. staminate flower with sepal and petal removed; c. staminate flower with petals and stamens removed showing androphore with pistillode; d. staminate petal; e. stamen in abaxial view; f. stamen in adaxial view; g. pistillate flower with part of sepals and petals removed; h. young pistillate petal still slightly hooded; i. old pistillate petal under fruit; j. fruit (a–h: Achmad 1281; i, j: Forbes 3246a; all L). — Drawing: Esmée Winkel.

wall woody, thin, c. 0.8 mm thick; sepals and on Sumatra petals persistent, reflexed; columella pyramidal or slightly T-shaped. *Seed* ovoid, flattened-triangular on inside, smooth, often slightly notched near hilum, arilloid absent.

Distribution — Two species, both endemic in Malesia, one found on Sumatra, the other on Borneo.

Wood — Wood shows resemblance to *Cleistanthus*, also part of the *Phyllanthaceae* (Mennega 1987). See also Kathirachchi et al. (2005) for information on pollen and seed anatomy.

KEY TO THE SPECIES

1. Pistillate petals cucullate (apically hooded), caducous in fruit. Pistillode consisting of 5 small, hairy globes alternating with ridges extending into 5 stigmas. Columella slightly T-shaped, c. 6 mm long. Stipules only protecting terminal bud of branchlets. Hilum elongate to obtriangular 1. *D. beccariana*
1. Pistillate petals slightly cucullate when young, straight and persistent in fruit. Pistillode with basal part ovary-like, with 5 stigmas on top. Columella pyramidal, 1–2 mm long. Stipules also present with uppermost leaves. Hilum small, round. 2. *D. sumatrana*

1. *Dicoelia beccariana* Benth. — Fig. 1; Map 1

Dicoelia beccariana Benth. (1879) 70, t. 1289; Pax (1890) 27; Merr. (1921) 330; Pax & K. Hoffm. (1922) 17, f. 3; (1931) 46; Croizat (1942) 38; Airy Shaw (1972) 3; Whitmore (1973) 86; Airy Shaw (1975) 95. — *Beccari PB* 1397 (holo K; iso FI?, n.v.), Borneo.

Dicoelia affinis J.J.Sm. (1920) 392, t. 41, 42; Pax & K. Hoffm. (1922) 17. — Lectotype (selected here): *Hallier 1255* (holo L; iso K, L, 2 sheets), Indonesia, Borneo, Soengei Smittouw [= Sungai Semitau]; other former syntype: *Jaheri s.n.* (L, barcode L0146478), Indonesia, Borneo, Poeloe Madjang [= Pulau Majang].

(Shrubs to) trees, up to 20 m high, bole up to 15 m high, dbh up to 25 cm, monoecious; flowering branches 3–5.5 mm diam, brown. *Stipules* 4–6.3 by 1.2–1.3 mm, early caducous, only protecting terminal bud. *Leaves*: petiole 1.7–5 cm long; blade elliptic to obovate, 11.4–46 by 4.5–14.3 cm, length/width ratio 1.9–3.7, subcoriaceous, base (somewhat rounded to) cuneate, margin flat to recurved, apex (rounded to) acuminate, upper surface dark green, glabrous except some hairs (to hirsute) on the basal part of the midrib, lower surface lighter green, slightly

hairy (to hirsute on venation), venation flat to slightly sunken above, nerves 10–13 per side. *Inflorescences* up to 43 cm long, green to yellowish or pinkish green, per node groups of staminate flowers (or their buds or scars) and a central, single pistillate flower, sometimes only staminate flowers; bracts 1.5–2 by c. 0.5 mm. *Staminate flowers* 3.8–5.1 mm diam; pedicel 4.3–5 mm long; sepals 1–1.3 by 0.6–0.7 mm; petals 2–4 by 1.5–2.3 mm, 1–1.4 mm thick; stamens: androphore 1–2 mm high, filaments 0.8–1 mm long; pistillode consisting of 5 small, hairy globes alternating with ridges extending into 5 stigmas, latter pinkish. *Pistillate flowers* 5–6.3 mm diam; pedicel in fruit 3–8.3 mm long; sepals 1.5–3 by 0.7–1.4 mm; petals 3–4.2 by 0.7–1.1 mm, apex culcate with extended midrib, caducous, leaving thick, diamond-shaped scars; gynophore c. 1 mm high, ovary 2.5–3 by 1.7–3 mm, style absent, stigmas 2.7–6.5 mm long, greenish. *Fruits* 8–10 by 10–12 mm, not lobed; only sepals persistent, reflexed; columella slightly T-shaped, c. 6 mm long. *Seeds* 6–9 by 5.3–6.4 by 5–6 mm, hilum elongate to obtriangular.

Distribution — Endemic on Borneo.

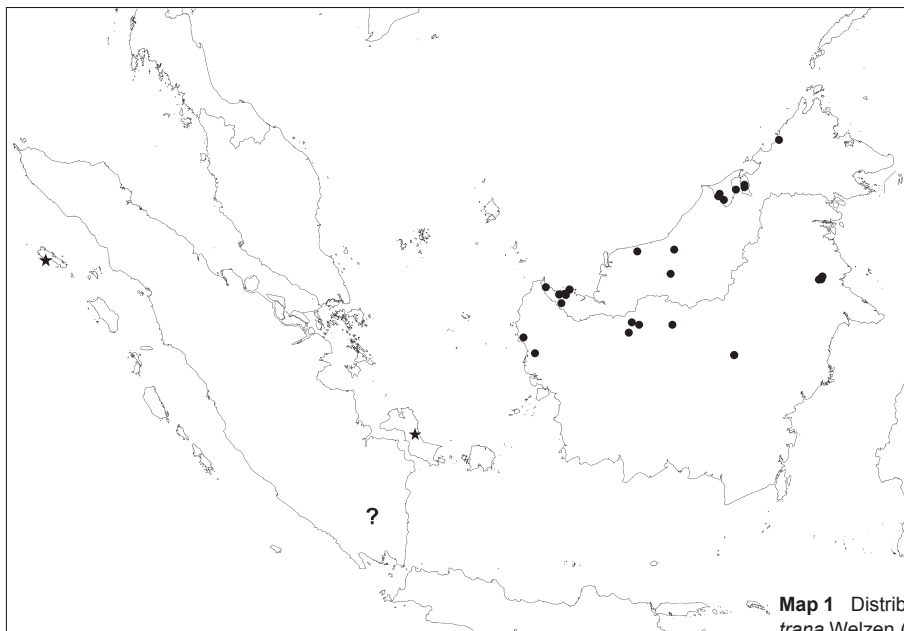
Habitat & Ecology — Primary lowland dipterocarp forest, riverine forest, primary kerangas forest, swamp forest seasonally inundated for at least 2–3 months, secondary forest, logged over forest; soil: Acid kaolin clay (pH 4), yellow sandy clay to leached pale yellow sand. Altitude: 10–400(–800) m. Flowering: February to November; fruiting: more or less whole year through.

Vernacular names — Indonesian Borneo: Belet, Kemelat.

2. *Dicoelia sumatrana* Welzen, *sp. nov.* — Fig. 2; Map 1

A Dicoelia beccariana foliis distalibus longiore stipulatis, petalis pistillatis juvenibus aliquantum cucullatis rectis persistentibus in fructu, pistillodio parte basali ovario similis apicaliter stigmatibus 5, columella pyramidalis 1–2 mm longa, hilo minuto rotundato differt. — *Typus: Achmad 1281* (holo L; iso L, 2 sheets), Sumatra, Simaloer Island [= Pulau Simeulue].

Shrubs, monoecious, up to 1.5 m high, probably also small trees; flowering branches 3–5.5 mm diam. *Stipules* 4–9 by 1.5–1.6 mm, caducous, but present with several apical leaves. *Leaves*: petiole 3–5 cm long; blade 12–34 by 4.8–14.3 cm, length/width ratio 2.1–2.7, symmetric, papery to somewhat coriaceous, base cuneate, margin flat, apex acuminate, upper surface glabrous except some hairs on the basal part of the midrib, lower surface slightly hairy, venation slightly raised above, nerves 12–15 per side. *Inflorescences* up to 24 cm long, hairy, round, generally



Map 1 Distribution of *Dicoelia beccariana* Benth. (●) and *D. sumatrana* Welzen (★).

either staminate or pistillate, seldom both sexes together; bracts 1.8–2 by c. 0.7 mm. *Staminate flowers* c. 5 mm diam; pedicel 3.5–6 mm long; sepals 2.1–2.6 by c. 0.8 mm; petals 3–4 by 1.7–2.2 mm, c. 1.1 mm thick; stamens: androphore c. 1 mm high, filaments 0.7–1 mm long; pistillode with basal part c. 8 mm diam; pedicel 8.5–14 mm long; sepals 2.8–3.7 by 0.9–1.1 mm; petals 4.2–5 by 1.7–2 mm, apex acute, slightly infolded when young, straight, not infolded when in fruit; gynophore c. 1 mm high; ovary c. 3.2 by 3 mm, style generally absent, conical when present, then 0.8–1 mm long, stigmas 3–3.5 mm long. *Fruits* 9–11 by c. 13 mm, slightly lobed; sepals and petals persistent, reflexed, straight, not cucullate; columella pyramidal, 1–2 mm long, apically not T-shaped. *Seeds* 6.5–9 by 5.8–6 by 4.2–5 mm, hilum small, round.

Distribution — Endemic on Sumatra.

Habitat & Ecology — Soil: granitic sand. Altitude: c. 50 m.

Flowering: May, August, September; fruiting: February, May.

Vernacular names — Ketoeh hetoeh or Ketoeh hetoeh pajo (Simalur Island).

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IDENTIFICATION LIST

1 = *Dicoelia beccariana*; 2 = *Dicoelia sumatrana*

- Achmad 924: 2; 1106: 2; 1281: 2 – Afriastini 860: 1 – Ambriansyah & Arbainsyah Berau 600: 1 – Ambriansyah et al. Berau 945: 1 – Arbainsyah Berau 636: 1.
- Beccari PB 1397: 1 – BRUN series 16711: 1.
- Forbes 3046a: 2; 3246a: 2.
- Giesen 71: 1 – Goverse Berau 513: 1 – Goverse & Adriansyah Berau 462: 1.
- Hallier 1255: 1 – Hirano & Hotta 409: 1 – Hotta 12960: 1.
- Keßler & Arbainsyah B 1398: 1 – Keßler et al. Berau 279: 1; Berau 287: 1; Berau 322: 1; Berau 378: 1; PK 2618: 1; PK 2632: 1; PK 2680: 1 – Kirkup et al. 236: 1 – Kostermans & Anta 741: 2 – Kramadibrata 208: 1.
- Middleton et al. 800: 1.
- S series 8325: 1; 12613: 1; 13150: 1; 19588: 1; 32361: 1; 37766: 1; 37819: 1; 45980: 1; 49980: 1; 66750: 1; 68717: 1; 81802: 1 – SAN series 134080: 1 – Schatz et al. 3270: 1 – Sidiyasa & Ambriansyah B 1490: 1 – Slik BE4-21: 1; BE4-24: 1; BE4-171: 1; BE4-215: 1; BE4-258: 1; BE4-271: 1; BE4-778: 1; BE4-802: 1; BE4-844: 1; BE4-850: 1; BE4-859.
- Teijsmann HB 8394: 1; HB 8610: 1.
- Zulkarnain & Giesen 378: 1.