Blumea 65, 2020: 12–24
www.ingentaconnect.com/content/nhn/blumea

RESEARCH ARTICLE

https://doi.org/10.3767/blumea.2020.65.01.03

Taxonomic notes on *Trigonostemon* (*Euphorbiaceae*) in the Philippines

R.-Y. Yu[1], E.M.G. Agoo[2], J.R. Callado[3], P.C. van Welzen[1,4]

Key words

Euphorbiaceae
Philippines
revision
taxonomy
Trigonostemon

Abstract Descriptions of five *Trigonostemon* species in the Philippines (four endemic) are updated with taxonomic notes based on herbarium collections and field observations. A new species of *Trigonostemon* is described. All species treated here are illustrated with photos. The formerly uncertain species, *T. stenophyllus*, is now synonymized with *T. filiformis*. In addition to *T. pentandrus*, three more *Trigonostemon* species are reported to cohabit with ants. A new identification key and an updated identification list of *Trigonostemon* species in the Philippines are provided.

Published on 12 February 2020

INTRODUCTION

Trigonostemon Blume belongs to the *Euphorbiaceae* subfamily *Crotonoideae* (e.g., Radcliffe-Smith 2001, Wurdack et al. 2005, Webster 2014) and includes four sections (based on molecular data by Yu et al. 2019). Fourteen species are present in the Philippines, of which eight are endemic and two are uncertain as based on the present study. This monoecious genus is mainly recognized by the 5-merous unisexual flowers (without staminodes or pistillode), colourful (often purple or yellow) petals present in both staminate and pistillate flowers, and the 3 or 5 connate stamens.

The earliest 16 species of *Trigonostemon* were described for the flora of the Philippines (all considered endemic then) by Stapf (1907), Elmer (1911), Robinson (1911) and Merrill (1912, 1913, 1914, 1916b, 1920, 1922) before 1923 when Merrill compiled all these names in his 'Enumeration of Philippine flowering plants'. Later, Quisumbing (1930) described *T. filiformis* Quisumb. and *T. stenophyllus* Quisumb. (both endemic, the latter was based on inadequate material). Airy Shaw (1983) updated Merrill's checklist by synonymizing *T. anomalus* Merr. with *T. laevigatus* Müll.Arg. and regarding *T. whiteanus* (Croizat) Airy Shaw under *Trigonostemon* instead of *Cheilosa* Blume even though staminate flowers, the most distinctive character for the genus, were lacking. Besides, Airy Shaw (1983) overlooked Quisumbing's (1930) two species. Yu & Van Welzen (2018) revised all *Trigonostemon* species in Malesia. In this revision, four *Trigonostemon* species (*T. angustifolius* Merr., *T. cumingii* Müll.Arg. (= *Tritaxis cumingii* (Müll.Arg.) Benth.; Bentham 1878, Yu et al. 2019), *T. stenophyllus* and *T. whiteanus*) in the Philippines were considered uncertain due to inadequate material.

Among the four major distribution centres of *Trigonostemon* in Malesia, the Philippines has the most endemic species of *Trigonostemon* (the other three centres: Malay Peninsula: 6 endemic species; Sumatra 3; Borneo 3; Yu & Van Welzen 2018), but relatively few specimens have been collected in this area. Only 56 collections (15 species) from the Philippines were included in the last revision (Yu & Van Welzen 2018), which is in marked contrast to the 299 collections from the Malay Peninsula (16 species), 81 collections from Sumatra (11 species) and 375 collections from Borneo (11 species). Moreover, herbarium collections often have an obvious limitation for a complete description of the plants, as only the young and immature leaves can fit on the specimen sheet whereas the mature ones (often much bigger) are ignored and generally only one sex or one generative phase (flower or fruit) is visible. Having visited the major Philippine herbaria (CAHUP, LBC, PNH, PUH, acronyms following Thiers et al., continuously updated, and the De La Salle University Herbarium (DLSUH)) and conducted field observations on the plants, we present this work to improve previous taxonomy treatments and to update the descriptions of the Philippine species of *Trigonostemon* with more accurate measurements. A newly discovered *Trigonostemon* species is also described here. In addition, more *Trigonostemon* species are found to cohabit with ants, just as *T. pentandrus* Pax & K.Hoffm. (an endemic species in Gunung Angsi, Malay Peninsula; Yu & Van Welzen 2018). The interactions between the plants and the ants are unknown. A possible mechanism is that the plants offer nectar, for instance via the basal leaf blade glands or the protruding appendage on the connective, in exchange for protection by the ants against herbivorous insects and overgrowing plants.

Key to the species in the Philippines

(the numbered taxa are fully described below, for the other taxa see Yu & Van Welzen (2018); the two uncertain species, *T. angustifolius* and *T. whiteanus*, are not included in the key)

1. Venation triplinerved (basal veins distinctly thicker than others); stigmas slightly or not bifid 2
1. Venation penninerved (basal veins identical to others); stigmas deeply bifid (to at least half length of stigma) 3
2. Leaves and petiole totally glabrous; inflorescences shorter than 4 cm . . . . . *T. laevigatus* var. *laevigatus*
2. Leaves slightly hairy beneath, petiole hairy; inflorescences usually longer than 4 cm . . *T. viridissimus* var. *viridissimus*
3. Petals yellow 4
3. Petals dark reddish or purplish 5

[1] Naturalis Biodiversity Center, P.O. Box 9517, 2300 RA Leiden, The Netherlands; corresponding author e-mail: peter.vanwelzen@naturalis.nl.
[2] Biology Department, De La Salle University, 2401 Taft Avenue, 1004 Manila, The Philippines.
[3] National Museum of Natural History, P. Burgos Drive, Rizal Park, 1000 Manila, The Philippines.
[4] Institute of Biology Leiden, Leiden University, P.O. Box 9505, 2300 RA Leiden, The Netherlands.

4. Inflorescences racemes, up to 4.5 cm long 4. *T. palustris*
4. Inflorescences panicles, (often much) more than 4.5 cm long . . . . . *T. philippinensis*
5. Petals abruptly narrowed at base (claw-like), disc (in both sexes) annular; fruits often warty 6
5. Petals gradually narrowed at base, disc divided into 5 lobes; fruits not warty 8
6. Inflorescences racemose; staminate flowers never cauliflorous, single per node . . . . . *T. longifolius*
6. Inflorescences paniculate; staminate flowers cauliflorous and/or clustered in glomerules per node 7
7. Leaves densely pubescent on both sides . . 3. *T. merrillii*
7. Leaves glabrous above and sparsely pubescent beneath . . . . . *T. oblongifolius*
8. Leaf blades often with 2 pairs of adaxial glands at base; petals without a honey mark 9
8. Leaf blades often with 1 pair of adaxial glands at base; petals with a flame-like honey mark in the centre 10
9. Stamens 5 . . . . . 2. *T. longipes*
9. Stamens 3 . . . . . 5. *T. victoriae*
10. Staminate inflorescences paniculate thyrses, densely branched (broom-like or paintbrush-like) and main rachis not visible at the end of the inflorescences . . . . . *T. polyanthus*
10. Staminate inflorescences racemose thyrses, not (much) branched, with a clear single main rachis still visible at the end of the inflorescences 11
11. Inflorescences often very slender, thinner than 0.6 mm diam; sepals in pistillate flower never accrescent . . . . . .1. *T. filiformis*
11. Inflorescences thicker than 0.8 mm diam; sepals in pistillate flower sometimes accrescent (in *T. villosus* var. *merrillianus*) 12
12. A few (often fewer than 10) staminate flowers in cymes per node; pistillate sepals not accrescent in fruit, always smaller than petals . . . . . .*T. villosus* var. *borneensis*
12. Many (often more than 20) staminate flowers in glomerules per node; pistillate sepals often accrescent in fruit, then larger than petals . . . . . 6. *T. villosus* var. *merrillianus*

TAXONOMIC TREATMENT

Throughout this part, an asterisk (*) refers to a specimen seen as image. The sections, as defined by Yu et al. (2019), are indicated for all species: sect. *Trigonostemon*, sect. *Pycnanthera* Benth., sect. *Spinipollen* R.Y.Yu & Welzen, and sect. *Tylosepalum* (Kurz) Benth. Full descriptions are provided for the new species and the taxa for which additional information was found; for the generic description and descriptions of the other taxa, see Yu & Van Welzen (2018).

1. ***Trigonostemon filiformis*** Quisumb. — sect. *Trigonostemon* — Fig. 1; Map 1

Trigonostemon filiformis Quisumb. (1930) 328, f. 7; R.Y.Yu & Welzen (2018) 194. — Lectotype (designated here): *Clemens 16751* (NY*; iso A, UC*), Philippines, Luzon, Isabela Prov., Mt Moises.

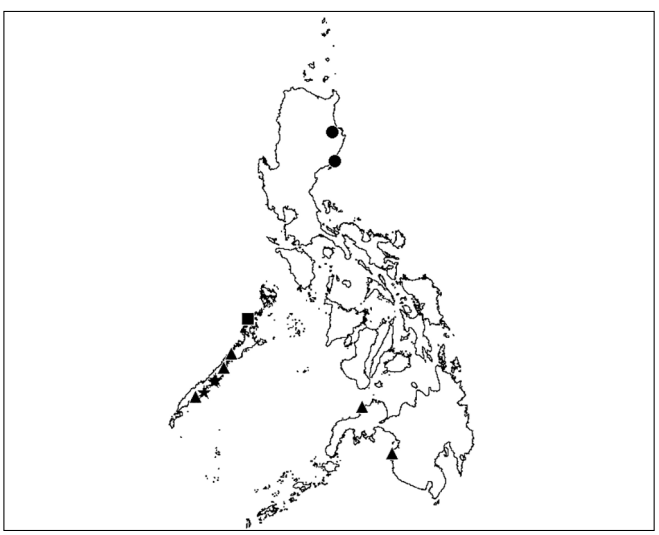
Trigonostemon stenophyllus Quisumb. (1930) 330, f. 8; R.Y.Yu & Welzen (2018) 225. — Type: *BS* (*Ramos* & *Edaño*) *47331* (A, K, NY*, UC*), Philippines, Luzon, Isabela Prov., Mt Moises.

Shrubs, up to 1 m tall; branches terete, 2.2–3.5 mm diam, pubescent when young, glabrescent. *Outer bark* 0.1–0.2 mm thick, brown when young, grey when old, glabrous; inner bark 0.1–0.4 mm thick, dark brown, sap red, low quantity; wood pale yellow to brown. *Stipules* subulate, 0.5–0.8 mm long, pubescent, caducous. *Leaves*: petioles terete, 1–6.5 cm long, 1–2.8 mm diam, sometimes grooved above, slightly pubescent when young; blade oblong to lanceolate (to almost linear), 8–26.5 by 1–4.5 cm, coriaceous, base acute to rounded, 2 adaxial glands present, margin slightly distantly serrate, teeth falcate to subulate, apex acuminate, both sides reddish brown and pubescent when young, upper surface green, somewhat pale, glabrous, lower surface paler green and sparsely pubescent when mature; midrib flat above and elevated beneath, nerves 8–11 pairs, veinlets reticulate. *Inflorescences* unisexual (staminate) or bisexual, thyrsoid, terminal or axillary, staminate flowers clustered in glomerules, main rachis 3.5–4.5 cm long, 0.5–0.6 mm diam, almost glabrous; bisexual ones axillary, racemose, very slender, 6–11 cm long, 0.2–0.6 mm diam, slightly pubescent, often a pistillate flower at top, a few staminate flowers per node below; involucral bracts as stipules; bracts single per node, oblong, 3–9.5 by 0.6–2.2 mm, apex acuminate, green, both sides pubescent. *Staminate flowers* (bud) c. 4 mm diam; pedicel c. 3 mm long, c. 0.3 mm diam, light green, glabrous; sepals elliptic, 1.8–2.5 by 0.6–1.5 mm, white, base connate, margin entire, apex rounded, slightly pubescent outside; petals elliptic, 1.8–2.2 by 1–1.5 mm, dark purple, base cuneate, margin entire, apex acute, both sides glabrous; disc lobes rectangular, 0.25–0.35 by 0.25–0.45 mm, apex truncate, c. 0.1 mm thick; stamens 3, androphore c. 0.3 mm long, anthers c. 0.8 mm long, apically divaricate. *Pistillate flowers* c. 4 mm diam; pedicel slightly thickened towards apex, 6.5–7.8 mm long, apically 0.6–0.9 mm diam (apex), pubescent; sepals oblong to lanceolate, 3.3–4 by 1.4–1.7 mm, margin entire, ciliate, apex acute to rounded, pubescent outside, glabrous inside; petals obovate, 4–5 by 2.1–2.9 mm, dark purplish, with a honey mark in the centre, base cuneately narrowed, margin entire, apex rounded, glabrous; disc lobes unequal, rectangular, 0.5 by 0.4–0.9 mm, white, apex truncate, corner rounded, glabrous; ovary c. 0.9 mm diam, densely pubescent; style 0.1–0.2 mm long; stigmas linear, 1.3–1.4 mm long, deeply bifid into 2 arms, each arm 0.9–1.1 mm long, slightly thickened near base. *Fruits* c. 1.2 cm diam, brown, sparsely puberulent, persistent sepals not accrescent; wall c. 0.35 mm thick, exocarp partly detaching. *Seeds* c. 7 mm diam.

Distribution — Borneo (Sabah?) and Philippines (Luzon).

Habitat & Ecology — In the Philippines, growing in forests, sometimes along riversides. Flowering: March to April.

Notes — 1. The description of the fruits is partly based on Quisumbing (1930). *Trigonostemon filiformis* was only known and described from the type collection from Mt Moises in the last revision (Yu & Van Welzen 2018). We found specimens with young staminate flowers and mature pistillate flowers in the forest behind Casapsapan beach in Aurora Province (c. 95 km



Map 1 Distribution of *Trigonostemon filiformis* Quisumb. (●), *T. merrillii* Elmer (▲), *T. palustris* R.Y.Yu & Welzen (■) and *T. victoriae* R.Y.Yu & Welzen (★).

Fig. 1 *Trigonostemon filiformis* Quisumb., from Casapsapan beach, Casiguran, Aurora, the Philippines. a. Young tree with staminate flowers; b. tree with pistillate flowers; c. bark and wood, showing reddish sap (low quantity); d. part of a leaf, showing the adaxial glands; e. staminate inflorescence; f. bisexual inflorescence with a pistillate flower at top; g. staminate flower buds; h. pistillate flower, top view; i. pistillate flower, lateral view. — Photos by Ren-Yong Yu.

Fig. 2 *Trigonostemon longipes* (Merr.) Merr., from Mt Daraitan, Tanay, Rizal, the Philippines. a. Flowering branch; b. inflorescence; c. infructescence, showing that the plant cohabits with ants; d. staminate flowers, top view; e. staminate flowers, lateral view; f. pistillate flower; g. pistillate flower, petals and a sepal removed, showing the blackish annular disc; h–i. fruit. — Photos by: a–c, f–g: Ren-Yong Yu; d–e, h–i: John Rey Callado.

south of Mt Moises). The description (both vegetative and reproductive characters) has now been fully updated.

2. *Trigonostemon stenophyllus* was also a poorly known species from Mt Moises. The species was treated as a doubtful species because no staminate flowers were seen during the last revision (Yu & Van Welzen 2018). It was considered different from *T. filiformis* by the broader leaves and thicker inflorescences. However, we found a continuous variation between the two species: the leaves can gradually vary from linear (as in the type of *T. filiformis*) to oblong or lanceolate (as in the type of *T. stenophyllus*), and the inflorescences can be very slender and pendulous (as in the type of *T. filiformis*) or thicker and erect (as in the type of *T. stenophyllus*). We therefore synonymized *T. stenophyllus* with *T. filiformis*. For illustrations of the typical *T. stenophyllus* and *T. filiformis* see Quisumbing (1930).

3. The species highly resembles *T. villosus* var. *merrillianus* (Airy Shaw) R.Y.Yu & Welzen, particularly in the glomerate staminate flowers, but the non-accrescent sepals in the pistillate flower appear to be a useful character to distinguish this species from the latter.

2. ***Trigonostemon longipes*** (Merr.) Merr. — sect. *Trigonostemon* — Fig. 2; Map 2

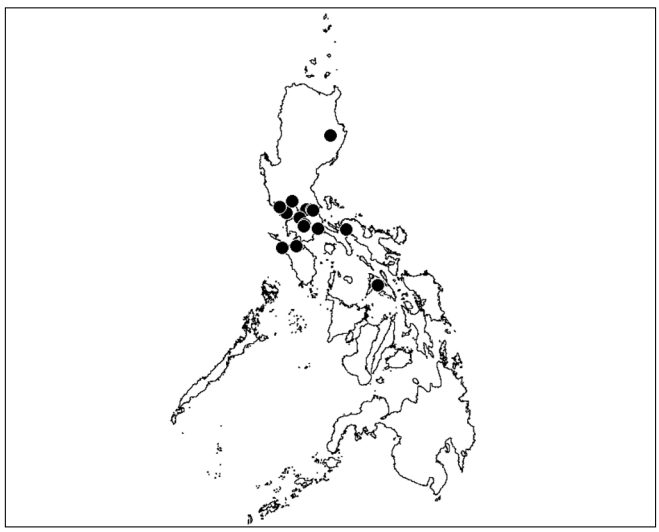
Trigonostemon longipes (Merr.) Merr. (1916b) 191; Pax & K.Hoffm. (1919) 41; Merr. (1923) 452; Airy Shaw (1983) 47; R.Y.Yu & Welzen (2018) 199. — *Dimorphocalyx longipes* Merr. (1906) 82. — Lectotype (designated by Yu & Van Welzen 2018): *FB (Whitford) 1066* (K; iso P), Philippines, Luzon, Bataan Prov., Mt Mariveles.

Trees, up to 6 m tall, stem up to 12 cm diam; flowering branches terete, 1.5–6 mm diam, glabrous or pubescent. *Outer bark* 0.1–0.2 mm thick, reddish or pale brownish, smooth, wrinkled; inner bark 0.1–0.3 mm thick, reddish brown; wood pale yellowish to brown. *Stipules* subulate, 0.5–1 mm long, pubescent at base. *Leaves*: petiole terete but grooved above, 1–11.5 cm long, often slightly thickening towards apex, 0.6–1.8 mm diam (apex), often pubescent when young, glabrous when mature; blade oblong, sometimes oblanceolate, 7.5–18 by 2.5–6 cm, coriaceous, base cuneate, with 1–2 pairs of adaxial glands, the inner pair often smaller and caducous or worn away in old leaves, margin entire or slightly crenate, apex acuminate to somewhat caudate, upper side dark green, lower side light green, both sides glabrous; midrib flat above and elevated underneath, nerves 7–11 pairs, curved and connected along margin, veinlets reticulate, often obscure. *Inflorescences* unisexual or bisexual, axillary or terminal, sometimes cauliflorous, thyrsoid, 3–15 cm long, 0.5–1 mm diam, glabrous or slightly pubescent, flowers often only growing in the upper half, some flowers single and cauliflorous; staminate flowers often 4–10 clustered in a glomerule at each node, pistillate flowers often single per node, sometimes only 1 (but up to 5 in extreme cases), at the apex of the rachis; involucral bracts 2, as stipules; bracts single per node, lanceolate to oblong, 1–3.4 by 0.3–1.1 mm, often pubescent; flowers with a bract and up to 2 bracteoles, triangular, up to c. 1 by 0.6 mm, densely pubescent. *Staminate flowers* 4–4.8 mm diam; pedicel 1.5–2 mm long, 0.4–0.6 mm diam, slightly pubescent; sepals orbicular to elliptic, light green, 1.6–2.5 by 1.3–2 mm, imbricate, base connate, apex rounded, pubescent outside; petals elliptic or spathulate, 2–2.7 by 1.8–3.5 mm, dark red to purple, contorted, base cuneate, margin sometimes ciliate, apex revolute; disc lobes obovate or semi-orbicular, 0.3–0.5 by 0.3–0.5 mm, 0.1–0.15 mm thick, pink, glabrous, apex acute; stamens 5, androphore 0.8–0.9 mm long, 0.1–0.2 mm diam, filaments free part c. 0.1 mm long, anthers 0.5–0.6 mm long, yellow, apically divaricate. *Pistillate flowers* c. 6 mm diam; pedicel 2.5–3.5 mm long, thickened towards apex, 0.9–1.2 mm diam (top); sepals orbicular to oblong, light greenish to pinkish, slightly accrescent in fruit, 3.5–4.5 by 2–3 mm, pubescent outside, margin ciliate, apex rounded, sometimes with an apical gland; petals caducous, oblong to spathulate, 2–3.5 by 1.8–3 mm, dark purplish, contorted, glabrous, margin entire, slightly ciliate, apex revolute; disc annular, c. 0.1 mm thick, blackish, glabrous, margin undulate; ovary green, c. 1.2 mm diam, glabrous, stigmas green, deeply bifid, arm 0.25–0.3 mm long when flowering. *Fruits* 0.7–1 cm diam, glabrous; wall 0.4–0.5 mm thick; columella 3.6–4.7 mm long. *Seeds* 4–4.5 mm diam, marbled, hilum rhombic, 0.7–1 by 0.4–0.5 mm.

Distribution — Philippines (endemic).

Habitat & Ecology — Secondary forest, on clay loam or limestone. Altitude: 200–460 m. Flowering: January to April, September; fruiting: January and April.

Note — Measurements have been updated from the last revision (Yu & Van Welzen 2018) and two characters are noteworthy: often 2 pairs of adaxial glands are present at the leaf base and the ovary is now certain to be glabrous. The species differs from *T. victoriae* in the 3 (vs 5) stamens and the non-accrescent pistillate sepals (vs much enlarged in *T. victoriae*). This species is found to cohabit with ants (Fig. 2c; RYY and JRC, pers. obs.).



Map 2 Distribution of *Trigonostemon longipes* (Merr.) Merr.

3. ***Trigonostemon merrillii*** Elmer — sect. *Spinipollen* R.Y.Yu & Welzen — Fig. 3; Map 1

Trigonostemon merrillii Elmer (1911) 1304; Pax & K.Hoffm. (1914) 407; Merr. (1923) 452; Airy Shaw (1983) 47; R.Y.Yu & Welzen (2018) 203. — Lectotype (designated here): *Elmer 12819* (L; iso BISH*, BM, BO, F*, G*, HBG*, MO*, NY*, US*), Philippines, Palawan, Puerto Princesa (Mt Pulgar).

Small trees, 1.5–3 m tall, stem up to 2.5 cm diam, hardly branching. *Indumentum* densely sericeous, especially on young parts. *Outer bark* 0.1–0.2 mm thick, pale brownish, sericeous; inner bark 0.3–0.4 mm thick, white to pale yellow, sometimes black when sap is solidified, sap translucent when fresh; wood white to pale yellow; pith sometimes empty. *Stipules* lanceolate to linear, 1–3 mm long, base sericeous, caducous. *Leaves*: petioles terete, often wrinkled when dry, 1–5.5 cm long, 2–6.7 mm diam, densely sericeous; blade elliptic, lower half often cuneately narrowing, 10–46.5 by 7–11.9 cm, chartaceous, base rounded, 2 adaxial glands present but often caducous or covered by silky hairs, margin distantly serrate, teeth often apiculate, falcate when young, apex acute to acuminate to caudate, upper surface greenish, paler beneath, both sides covered by long silky

Fig. 3 *Trigonostemon merrillii* Elmer, from Mt Saint Paul, Puerto Princesa, Palawan, the Philippines. a. Growing habit; b. main branch with cauliflorous flowers; c. part of paniculate inflorescence with only staminate flowers; d. pistillate inflorescence; e. bisexual inflorescence, pistillate flower at top; f. bisexual inflorescence, pistillate flower at bottom; g. translucent sap; h. staminate flower, lateral view; i. staminate flower, top view; j. juvenile pistillate flower; k. fruit, back side; l. fruit, front side — Photos by: a, k–l: Danilo Tandang; b–j: Ren-Yong Yu.

Fig. 4 *Trigonostemon palustris* R.Y.Yu & Welzen, from Nagkalit-kalit Waterfalls, El Nido, Palawan, the Philippines. a. Growing habit; b. outer bark; c. inner bark and wood, showing reddish sap (low quantity); d. leaf, upper side; e. leaf, lower side; f. branchlet and petioles; g. flowering branch; h. staminate inflorescence; i. bisexual inflorescence, showing the plant cohabits with ants; j. staminate flower, top view; k. staminate flower, lateral view; l. pistillate flower; m. pistillate flower, sepals and petals removed, showing the pistil; n. fruit, lateral view, showing accrescent sepals; o. fruit, top view. — Photos by: a–c, h–m: Ren-Yong Yu; d–g, n–o: P.B. Pelser & J.F. Barcelona (Pelser et al. 2011 onwards).

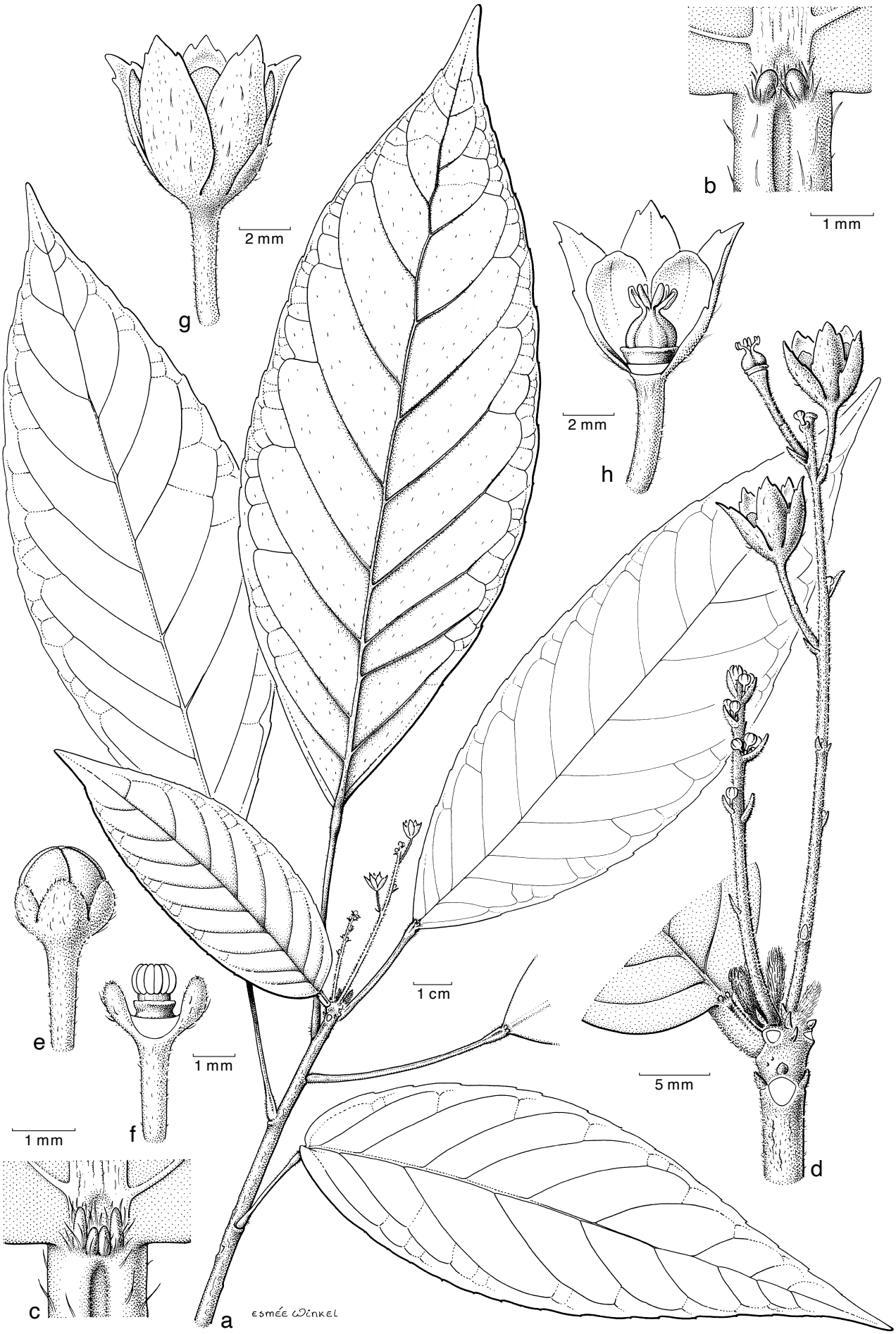


Fig. 5 *Trigonostemon palustris* R.Y.Yu & Welzen. a. Flowering branch; b. leaf blade base, showing 1 pair of adaxial glands; c. leaf blade base, showing 2 pairs of adaxial glands; d. inflorescences; e. staminate flower bud; f. staminate flower (3 sepals and all petals removed); g. pistillate flower; h. pistillate flower (2 sepals and 3 petals removed) (all: *Yu 260*, L). — Drawn by Esmée Winkel.

hairs; midrib slightly raised above and much elevated beneath, more densely sericeous, nerves 10–13(–17) pairs, curved and connected near margin, veins and veinlets reticulate, sometimes obscure. *Inflorescences* bisexual or unisexual, paniculate thyrses, up to 31 cm long, 0.4–1.6 mm diam, sericeous; involucral bracts as stipules, nodal bracts lanceolate, variable in size, petiole up to 0.7 cm long, blade 0.4–3.6 by 0.1–0.7 cm, sericeous; staminate flowers partly single and ramiflorous, others glomerate, pistillate flowers single, above or below the staminate ones. *Staminate flowers* 2.8–4.5 mm diam; pedicel 1.5–4.6 mm long, 0.1–0.2 mm diam, pink, glabrescent; sepals unequal, orbicular to elliptic to spathulate, 0.9–1.4 by 0.5–1.2 mm, pink to red in the centre, base connate, margin entire or slightly undulate, apex acute to rounded, more or less pubescent outside; petals spathulate to flabellate, 2–2.9 by 1.5–2.4 mm, dark purple to black, without honey mark, base claw-like, apex rounded to truncate to sometimes slightly bilobed, glabrous on both sides; disc annular, c. 0.25 mm diam (inner margin), c. 0.1 mm thick, red; stamens 3, androphore erect, 0.4–0.5 mm long, anthers ellipsoid, 0.4–0.6 mm long, white, gathered on the top of androphore, slightly divaricate at apex, connective apically with some droplets (expanded cells) with secretion. *Pistillate flowers* (bud) c. 2 mm diam; pedicel 3.5–4.5 mm long, 0.35–4 mm diam (apex), sericeous; sepals elliptic, 1.8–2.2 by 0.7–1.5 mm, entire, apex acute, sericeous outside; petals spathulate, 1.6–2.1 by 1.1–1.2 mm, base cuneate, somewhat claw-like, apex rounded, both sides glabrous; disc lobes annular, less than 0.1 mm thick; ovary c. 0.6 mm diam, smooth or slightly warty, style indiscernible, stigmas partly bifid, arms c. 0.1 mm long, each pair horseshoe-shaped. *Fruits* c. 1.25 cm diam, slightly warty; pedicel 1.15–1.35 cm long, 1.2–1.3 mm diam (apex), sepals persistent, not much accrescent, red; columella c. 4 mm long. *Seeds* streaked or conspicuously mottled.

Distribution — Philippines (endemic).

Habitat & Ecology — Lowland dipterocarp forest. Altitude: 15–80 m. Flowering: March.

Note — The first author's (RYY) field observations have provided some new insights for the species: the leaves are clustered at the top of the main branch and the inflorescences can develop into a panicle when mature. The spathulate petals with a claw-like base strongly resemble those of the other species in sect. *Spinipollen*, e.g., *T. longifolius* Baill., *T. oblongifolius* Merr. The species is known from Palawan and Mindanao. The diameter of fruits is based on Elmer (1911).

4. ***Trigonostemon palustris*** R.Y.Yu & Welzen, *sp. nov.* — sect. *Trigonostemon* — Fig. 4, 5; Map 1

The species resembles the other endemic species in Palawan, *T. victoriae*, in the sepals being significantly larger than the petals in pistillate flowers, but it can be distinguished from the latter by the yellow, flat (vs dark red and revolute) petals and annular disc in both staminate and pistillate flowers (vs 5 lobes in *T. victoriae*). — Type: *Yu 260* (holo PNH; iso DLSUH, L), Philippines, Palawan Province, El Nido, trail to the Nakalit-kalit Waterfalls, 2 Apr. 2018.

Small trees, c. 2 m tall; flowering branches terete, 3–3.7 mm diam, pubescent in young parts. *Outer bark* grey, 0.1–0.2 mm thick; inner bark 0.1–0.2 mm thick, red, sap red; wood pale yellow. *Stipules* subulate or falcate, 0.7–1.4 mm long, caducous, base pubescent. *Leaves*: petioles terete, slightly thickening towards both ends, 3–7 cm long, 1.6–2 (middle part)–3 mm (apex or base) diam, glabrescent; blade elliptic, 12–23 by 5.5–7.7 cm, chartaceous to coriaceous, base acute, 1–2 pairs of adaxial glands present, margin distantly serrate, teeth subulate, apex acuminate to caudate, upper side (somewhat dark) green, glabrous, lower side pale green, often slightly pubescent, particularly on venation; midrib flat or very slightly grooved above, elevated beneath, nerves 8–11 pairs, curved and connected near margin, veins and veinlets reticulate. *Inflorescences* bisexual or unisexual, terminal or axillary, racemose thyrses; main rachis 2–4.5 cm long, 0.6–1.2 mm diam, densely pubescent, few (up to 10) staminate flowers clustered per node, pistillate flowers single per node; involucral bracts as stipules; bracts triangular, 0.7–2.6 by 0.5–0.7 mm, pubescent on both sides. *Staminate flowers* 5–7 mm diam; pedicel 1.5–2 mm long, 0.3–0.4 mm diam, green, slightly pubescent; sepals orbicular to elliptic, 0.8–1.3 by 0.4–0.9 mm, light green, base connate, margin entire, apex rounded to acute, pubescent outside, glabrous inside; petals flabellate, 1.5–1.9 by 1.4–1.6 mm, yellow, base cuneate, margin entire, apex slightly bilobed, glabrous on both sides; disc annular, c. 0.2 mm diam (inner margin), c. 0.2 mm thick, yellow; stamens 3, androphore erect, 0.4–0.5 mm long, anthers ellipsoid, 0.3–0.4 mm long, divaricate at apex. *Pistillate flowers* 4–6 mm diam; pedicel 3.5–5 mm long, thickening towards the apex, 0.6–0.9 mm diam (apex), light greenish to pinkish, pubescent; sepals elliptic, 5–7 by 2–3.5 mm, pink, base connate, margin serrate, apex acuminate, with 3 main teeth; petals obovate to spathulate, 3.4–4.2 by 2.5–3.4 mm, yellow, base cuneate, apex rounded, sometimes slightly plicate, glabrous on both sides; disc annular, 2.2–2.6 diam, c. 0.1 mm thick; ovary 1.9–2 mm diam, glabrous, style 0.1–0.2 mm long, stigmas completely bifid, arms 0.7–1 mm long. *Fruits* light green, glabrous; sepals persistent, not much accrescent, green, stigmas persistent, pinkish.

Distribution — Philippines (Palawan, endemic).

Habitat & Ecology — Lowland forest edge, in swamps (hence the specific epithet). Altitude: c. 25 m. Flowering: February, April; fruiting: February.

Note — This new species was first brought to our attention by images published on Co's Digital Flora of the Philippines (Pelser et al. 2011 onwards), and we are grateful to the owners of the photos who gave us permission to re-use them in this article. The species has two relatively unusual characters: pistillate sepals being larger than petals and yellow petals in both staminate and pistillate flowers. It is the only species with yellow petals in sect. *Trigonostemon*. These characters are only known to occur separately in a few species, e.g., *T. victoriae* (larger sepals than petals in pistillate flowers), and *T. laevigatus* and *T. philippinensis* (yellow petals), but they are all clearly different from this new species. The species is found to cohabit with ants (Fig. 4i; RYY pers. obs.).

5. ***Trigonostemon victoriae*** R.Y.Yu & Welzen — sect. *Trigonostemon* — Fig. 6; Map 1

Trigonostemon victoriae R.Y.Yu & Welzen (2018) 215, f. 15. — Type: *PNH* (*Sulit*) *12317* (holo L; iso PNH), Philippines, Palawan Province, Victoria Mts, Panacan, Aborlan.

Small trees, up to 6 m tall, dbh c. 10 cm; flowering branches (1.5–) 2–3 mm diam, pubescent near apical buds and glabrescent in mature parts. *Outer bark* 0.1–0.2 mm thick, brown when young, pale greyish in old parts, somewhat shiny; inner bark 0.1–0.2 mm thick, dark red, sap red; wood pale yellowish. *Stipules* subulate, 0.5–1 mm long, caducous, base pubescent, apex often glabrous. *Leaves*: petiole terete but grooved above, 1–13.5 cm long, 0.8–1.4 mm diam, pubescent when young; blade elliptic to oblong, 8.5–20.5 by 2.5–5.5 cm, chartaceous to coriaceous, base acute, 2 pairs of adaxial glands present, often pubescent, inner pair often smaller, margin distantly serrate, teeth glandular, apex acuminate to slightly caudate, upper side glabrous, green, lower side sparsely pubescent, pale green; venation penninerved, often pubescent on the lower side, midrib more or less raised above and elevated beneath,

Fig. 6 *Trigonostemon victoriae* R.Y.Yu & Welzen, from Karaniogan River, Narra, Palawan, the Philippines. a. Branch, showing the plant grows on a river bank; b. outer bark; c. inner bark and wood, showing reddish sap; d. branchlet, showing the plant cohabits with ants; e. staminate inflorescence and cauliflorous staminate flower; f. staminate flowers, lateral view; g–h. pistillate flowers; i. fruit, lateral view; j. fruit, top view. — Photos by Ren-Yong Yu.

Fig. 7 *Trigonostemon villosus* Hook.f. var. *merrillianus* (Airy Shaw) R.Y.Yu & Welzen, from Mt Saint Paul, Puerto Princesa, Palawan, the Philippines. a. Growing habit; b. translucent sap; c. branchlet; d. bark with cauliflorous staminate flower; e. staminate inflorescence; f. staminate flower, top view; g. juvenile staminate flower, lateral view; h. pistillate flower, four of the five petals fallen; i. pistillate flowers, lateral view, petals fallen; j. fruits, lateral view; k. fruits, top view. — Photos by: a–b, d–i: Ren-Yong Yu; c, j–k: Danilo Tandang.

nerves 5–8 pairs, curved and narrowed along margin, veinlets reticulate. *Inflorescences* unisexual, often terminal or subterminal, involucral bracts as stipules; staminate flowers partly single and cauliflorous, others in racemes, rachis 1–5 cm long, 0.5–0.6 mm diam, appressed pubescent, flowers often only in upper half, bracts lanceolate to triangular, 1–3 by 0.3–0.6 mm, appressed pubescent; pistillate inflorescences often with only 1 flower at the top of inflorescences and sometimes a few abortive buds below; peduncles 1–5 cm long, 0.5–1 mm diam, pubescent; bracts lanceolate to elliptic, 1–4 by 0.3–0.7 mm, pubescent. *Staminate flowers* 3.7–4.6 mm diam; pedicel 0.5–1.5 mm long, 0.35–0.5 mm diam, pubescent; sepals triangular when young, ovate to elliptic when mature, 1–1.5 by 0.8–1.4 mm, green, imbricate, margin entire, apex acute to acuminate, pubescent outside; petals elliptic, 2.8–3 by 2.3–2.5 mm, dark red, base cuneate, margin entire, apex rounded, glabrous on both sides; disc lobes rhomboid, 0.2–0.25 by 0.3–0.4 mm, c. 0.1 mm thick, fleshy, apex acute; stamens 3, androphore c. 0.7 mm long, anthers ellipsoid, 0.6–0.7 mm long. *Pistillate flowers* 3–4.5 mm diam; pedicel 1.5–3 mm long, 0.4–0.7 mm diam, green, slightly sericeous; sepals lanceolate, 1.6–4 by 0.6–1.6 mm when flowering, accrescent to 10–13 by 2.5–4.5 mm when fruiting, green, margin with a few indistinct teeth, apex acute to acuminate, sericeous on both sides, denser outside; petals elliptic to ovate, 1.1–1.4 by 1–1.2 mm, glabrous except for ciliate margin; disc lobes rectangular, 0.15–0.2 by 0.2–0.25 mm, apex truncate, glabrous; ovary c. 0.65 mm diam, glabrous; style c. 0.1 mm long, stigmas deeply divided and reniform, arms straight, c. 0.3 mm long. *Fruits* c. 1.1 cm diam, sericeous, green; pedicel 1.05–1.25 cm long, thickening towards apex, 1.7–2.2 mm diam (apex), pubescent; sepals persistent, oblong, 9.5–11.2 by 3–4 mm, pubescent on both sides; columella c. 4.6 mm long. *Seeds* unseen.

Distribution — Philippines (Victoria Mountains, endemic).

Habitat & Ecology — Dipterocarp forests, growing on clay, near rivers. Altitude: 78–195 m. Flowering: March to May; fruiting: March to April.

Note — The species is found at the foot of the Victoria Mountains. The petiole can be as long as 13.5 cm, which is similar to *T. longipes*. New descriptions of inflorescences, mature staminate and pistillate flowers and fruits are presented. One of the striking characters of the species is the enlarged sepals in the pistillate flowers. The species is seen to cohabit with ants (Fig. 6d, f–h; RYY pers. obs.).

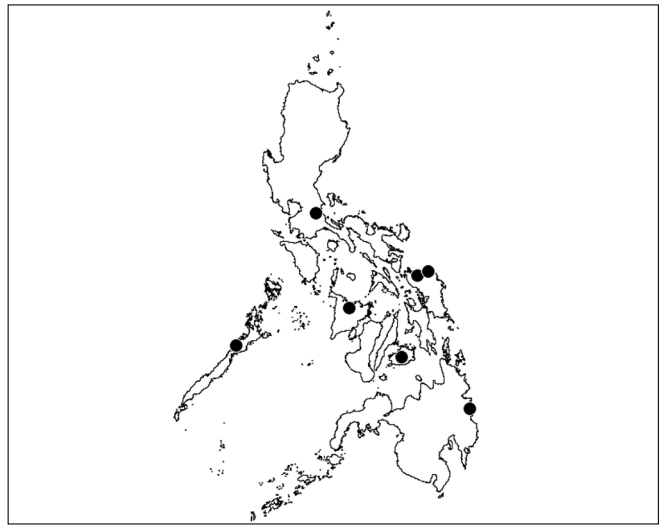
6. ***Trigonostemon villosus*** Hook.f. var. ***merrillianus*** (Airy Shaw) R.Y.Yu & Welzen — sect. *Trigonostemon* — Fig. 7; Map 3

Trigonostemon villosus Hook.f. var. *merrillianus* (Airy Shaw) R.Y.Yu & Welzen (2018) 218. — *Trigonostemon merrillianus* Airy Shaw (1971) 549; (1975) 203. — *Dimorphocalyx* (?) *borneensis* Merr. (1916a) 73. — Lectotype (designated here): *Hose 420* (L; iso K), Sarawak, 4th Division, Baram District, Entoyut River.

Trigonostemon acuminatus Merr. (1916b) 190; Pax & K.Hoffm. (1919) 41; Merr. (1923) 451; Airy Shaw (1983) 46. — Type: *BS* (*Ramos*) *24528* (BM, BO, K, L), Philippines, Samar, Catubig River.

Trigonostemon laxiflorus Merr. (1920) 567; (1923) 451; Airy Shaw (1983) 47. — Type: *BS* (*Ramos* & *Edaño*) *31097* (A*, K, P, US), Philippines, Panay, Capiz Privince, Jamindan.

Small trees, 1–4 m tall, dbh up to 6 cm; flowering branches 2.5–4.5 mm diam, often pubescent when young, glabrescent when mature, buds pubescent. *Outer bark* 0.1–0.2 mm thick, dark brown, sometimes fissured; inner bark 0.1–0.2 mm thick, dark greenish or reddish, sap watery, translucent; wood white. *Stipules* subulate, 0.5–1.9 mm long, base pubescent. *Leaves*: petiole terete but often furrowed above, 1–11 cm long, glabrous to hirsute, sometimes slightly thickened at base and apex, 1.2–2.1 (middle)–3.5 mm (base and apex) diam; blade oblong, 8–29 by 2.2–9 cm, chartaceous, base acute to rounded, 2 adaxial glands present, margin distantly serrate, teeth subulate or glandular, apex acuminate to caudate, upper side glabrous, dark green, lower side paler green, slightly pubescent, particularly on venation; midrib flat or slightly raised above and distinctly elevated beneath, nerves 8–13 pairs, often bow-shaped, connected along margin, veins reticulate, sometimes obscure. *Inflorescences* unisexual, often axillary, staminate flowers partly single and cauliflorous, others clustered in cymes or glomerules, rachis 10–18 cm long, 0.8–1 mm diam, bracts linear to lanceolate, 0.5–10.5 (Palawan)–18 (Samar) by 0.3–3.3 (Palawan) –6.5 (Samar) mm, margin entire, pubescent; pistillate ones racemose, often only 1–3 flowers present at top, rachis 5.5–22 cm long, 0.4 (Mindanao) –0.6–1.3 (Samar and Palawan) mm diam, pubescent, bracts lanceolate, 4.2–11 (Mindanao and Palawan)–19 (Samar) by 0.4 (Mindanao)–2.5–7.3 (Samar and Palawan) mm, margin distantly serrate, teeth glandular, pubescent outside. *Staminate flowers* 5–6.7 mm diam, pedicel 1.3–3 (Palawan)–4.5 (Samar) mm long, 0.2–0.5 mm diam, light green, glabrous; sepals elliptic, 1.2–2 by 0.6–1 mm, imbricate, white, margin ciliate, apex rounded, slightly pubescent outside; petals elliptic, 2.4–3.8 by 1.2–2 mm, purplish black, with a flame-like honey mark in the centre (Palawan), margin entire, apex rounded, glabrous on both sides; disc lobes rectangular or obtrapezoid, 0.25 (Samar)–0.4–0.5 (Palawan) by 0.2 (Samar)–0.45–0.6 (Palawan) mm, yellowish, apex truncate or rounded; stamens 3, androphore 0.5–0.9 mm long, anthers ellipsoid, 0.65 (Samar)–0.9–1.1 (Palawan) mm long, pinkish red, connective apically with numerous reddish droplets with secretion. *Pistillate flowers* 6–8 mm diam, pedicel often slightly thickened towards apex, 5–6 (Palawan)–10.5 (Samar) mm long, apically 0.5–1.5 mm diam, green, appressed pubescent; sepals lanceolate to elliptic, 2–2.4 (Samar)–6.5 (Palawan) by 0.8–2 mm when flowering, sometimes accrescent when fruiting (Palawan), green or red when flowering, red when fruiting, margin serrate, apex acuminate, appressed pubescent outside, sometimes with an apical gland (Palawan); petals as staminate flowers but longer and caducous, 3–3.6 by 1–1.2 mm; disc lobes rectangular, 0.3–0.9 by 0.5–0.6 mm, membranous, apex rounded or truncate; ovary 1–1.1 mm diam, densely villose, style short, indistinct, stigmas 3, completely bifid, free arm 0.8–1.3 mm long. *Fruits* c. 0.9–1.2 cm diam, villose; pedicel c. 1.5 cm long, thickening towards apex, c. 1.4 mm diam (apex); sepals persistent, red; wall 0.4–0.5 mm thick; columella 4–6 mm long. *Seeds* globose, c. 5 mm diam, marbled.



Map 3 Distribution of *Trigonostemon villosus* Hook.f. var. *merrillianus* (Airy Shaw) R.Y.Yu & Welzen.

Distribution — Borneo and Philippines (new record for Palawan).

Habitat & Ecology — In the Philippines, growing in the understorey of dipterocarp forests, on red clay loam soil, along the coast. Altitude: 10–40 m. Flowering: March to April (Samar and Palawan); May to June (Mindanao); fruiting: February to March (Samar).

Note — The description is only based on collections from the Philippines. *Trigonostemon villosus* var. *merrillianus* is an extremely variable taxon, but in the Philippines it is less variable in the length of the petiole and the size of the leaf blade. Taxa that are easy to confuse with *T. villosus* var. *merrillianus* are *T. villosus* var. *borneensis* (differs from the former by the shorter petiole and non-accrescent sepals in the pistillate flowers), *T. oblongifolius* (differs by flabellate petals with a claw-like base and lacking a honey mark), *T. polyanthus* (differs by the paintbrush-like instead of glomerate staminate inflorescences) and *T. filiformis* (differs by the narrower leaf blade, slender inflorescences and non-accrescent sepals in pistillate flowers).

Acknowledgements We are grateful to the curators of the following herbaria for their permission to investigate their collections: CAHUP, L, LBC, PNH, PUH and the De La Salle University Herbarium. Mohamed Jefte Ashed and Reynaldo Majaducon are thanked for their assistance with the field work. Pieter B. Pelser and Julie F. Barcelona are thanked for providing photos and the location of the new species, *T. palustris* (Pelser et al. 2011 onwards). Danilo Tandang is thanked for providing the photos and the location of *T. merrillii* and *T. villosus* var. *merrillianus*. Esmée Winkel is thanked for making a beautiful and precise illustration of *T. palustris*. The first author (R.-Y. Yu) thanks the Leiden University Fund (Leids Universiteits Fonds) and Alberta Mennega Stichting for financially supporting his trip to the Philippines. The last author (P.C. van Welzen) thanks the Treub-Maatschappij for supporting the Ornstein chair in Tropical Plant Biogeography. This work was carried out under the Wildlife Gratuitous Permit Nos. R5-94-2017 (Region 5), 2018-02 (Region 1) and 2018-41 (Palawan) for the Conduct of Field Research Involving Plant Species and Wildlife Transport Permit No. 2019-03-0025 granted by the Palawan Council for Sustainable Development. Mr. Johnny Fabregas, Barangay Chairman of Villa Libertad, El Nido, and Ms. Felomina Janiva of Malinao, Narra, Palawan are thanked for granting the Prior Informed Consent.

REFERENCES

Airy Shaw HK. 1971. Notes on Malesian and other Asiatic Euphorbiaceae. Kew Bulletin 25: 473–553.

Airy Shaw HK. 1975. The Euphorbiaceae of Borneo. Kew Bulletin, Additional Series 4: 1–245.

Airy Shaw HK. 1983. An alphabetical enumeration of the Euphorbiaceae of the Philippine Islands. Royal Botanic Gardens, Kew.

Bentham G. 1878. Notes on Euphorbiaceae. The Journal of the Linnean Society, Botany 17: 185–267.

Elmer ADE. 1911. Euphorbiaceae collected on Palawan Island. Leaflets of Philippine Botany 4: 1271–1306.

Merrill ED. 1906. The forest of the Lamao Forest Reserve. The Philippine Journal of Science 1, C. Botany, Supplement: 1–139.

Merrill ED. 1912. Notes on Philippine Euphorbiaceae. The Philippine Journal of Science 7, C. Botany: 379–410.

Merrill ED. 1913. Plantae Wenzelianae. The Philippine Journal of Science 8, C. Botany: 380–381.

Merrill ED. 1914. Notes on Philippine Euphorbiaceae, II. The Philippine Journal of Science 9, C. Botany: 461–493.

Merrill ED. 1916a. Notes on the Flora of Borneo. The Philippine Journal of Science 11, C. Botany: 49–100.

Merrill ED. 1916b. New plants of Samar. The Philippine Journal of Science 11, C. Botany: 175–206.

Merrill ED. 1920. Notes on Philippine Euphorbiaceae, III. The Philippine Journal of Science 16: 539–579.

Merrill ED. 1922. New or noteworthy Philippine plants, XVII. The Philippine Journal of Science 20: 367–476.

Merrill ED. 1923. An enumeration of Philippine flowering plants 2. Bureau of Printing, Manila.

Pax F, Hoffmann K. 1914. Euphorbiaceae-Acalypheae-Mercurialinae. In: Engler A (ed), Das Pflanzenreich IV.147.vii. Engelmann, Leipzig.

Pax F, Hoffmann K. 1919. Euphorbiaceae-Additamentum VI. In: Engler A (ed), Das Pflanzenreich IV.147.xiv. Engelmann, Leipzig.

Pelser PB, Barcelona JF, Nickrent DL (eds). 2011 onwards. Co's digital Flora of the Philippines. www.philippineplants.org.

Quisumbing E. 1930. New or interesting Philippine plants, 1. The Philippine Journal of Science 41: 315–371.

Radcliffe-Smith A. 2001. Genera Euphorbiacearum. Royal Botanic Gardens, Kew.

Robinson CB. 1911. Alabastra Philippinensia, III. The Philippine Journal of Science 6: 319–358.

Stapf O. 1907. A new Trigonostemon. Leaflets of Philippine Botany 1: 206–207.

Webster GL. 2014. Euphorbiaceae. In: Kubitzki K (ed), The families and genera of vascular plants 11: 51–216. Springer, Heidelberg, New York, Dordrecht, London.

Thiers B. Continuously updated. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/science/ih/.

Wurdack KJ, Hoffmann P, Chase MW. 2005. Molecular phylogenetic analysis of uniovulate Euphorbiaceae (Euphorbiaceae sensu stricto) using plastid rbcL and trnL-F DNA sequences. American Journal of Botany 92: 1397–1420.

Yu RY, Slik FJW, Van Welzen PC. 2019. Molecular phylogeny of Trigonostemon and its relatives (Euphorbiaceae). Taxon 68: 918–936.

Yu RY, Van Welzen PC. 2018. A taxonomic revision of Trigonostemon Blume (Euphorbiaceae) in Malesia. Blumea 62: 179–229.

IDENTIFICATION LIST OF PHILIPPINE SPECIMENS

Species fully described in text:

1 = *T. filiformis* Quisumb.
2 = *T. longipes* (Merr.) Merr.
3 = *T. merrillii* Elmer
4 = *T. palustris* R.Y.Yu & Welzen
5 = *T. victoriae* R.Y.Yu & Welzen
6 = *T. villosus* Hook.f. var. *merrillianus* (Airy Shaw) R.Y.Yu & Welzen

Additional Philippine species:

7 = *T. laevigatus* Müll.Arg. var. *laevigatus*
8 = *T. longifolius* Baill.
9 = *T. oblongifolius* Merr.
10 = *T. philippinensis* Stapf
11 = *T. polyanthus* Merr.
12 = *T. villosus* Hook.f. var. *borneensis* (Merr.) Airy Shaw
13 = *T. viridissimus* (Kurz) Airy Shaw var. *viridissimus*
doubtful 14 = *T. angustifolius* Merr.
doubtful 15 = *T. whiteanus* (Croizat) Airy Shaw

* tentative identifications due to incomplete specimens

Baker 2811: 10; 3295: 10 – BS series 1645: 11; 7257: 7; 10431: 6*; 13965: 9; 15458: 8; 16171: 8; 22018: 7; 22633: 10; 22848: 6; 24528: 6; 24890: 6; 26228: 6; 26911: 2; 28494: 9*; 29167: 6; 30800: 10; 31097: 6; 32424: 6; 33109: 9; 33539: 9; 34041: 2; 36560: 14*; 36612: 7*; 36642: 3*; 36764: 14; 37297: 7; 37326: 7; 39575: 2; 41718: 10; 42630: 6*; 42686: 6; 45242: 8*; 47043: 2; 47205: 10*; 47331: 1; 48717: 2 – Burley 151: 2.

Clemens 16751: 1 – Co 5107: 12.

Elmer 7264: 8; 8326: 10; 12819: 3; 17583: 2; 17600: 10; 18212: 10.

FB series 1066: 2; 1801: 2; 2699: 2; 4153: 3; 13237: 10; 15366: 10; 17733: 15; 19604: 9; 20122: 2 – Fernando 1739: 2.

Iwatsuki P-309: 9.

LBC series 1343: 6; 4305: 2.

Madulid 8394: 7 – Merrill 739: 3; 8198: 8*.

Piper 325: 8* – PNH series 6894: 2; 6895: 10; 6898: 10; 6908: 10; 6910: 2; 9526: 10; 9536: 10; 12317: 5; 14361: 6; 33483: 10; 33511: 10; 34145: 10; 34167: 10; 34196: 10; 34215: 10; 38184: 12; 38399: 3; 39433: 11; 40751: 10; 42096: 8; 42098: 8; 42105: 8; 42283: 8*; 42405: 12*; 42408: 7; 42411: 12; 42416: 12; 91852: 10; 98242: 12; 118089: 10; 169837: 12*; 169838: 12*; 170325: 10 – PPI series 2950: 9*; 12212: 2; 12682: 2; 14746: 9*; 15219: 9*; 17300: 9*; 37553: 6.

Ridsdale 1002: 5.

Santos 4270: 10.

Unknown 3764: 2.

Wenzel 186: 12; 1513: 8; 1616: 10; 1716: 8; 1794: 10; 2706: 6*; 3063: 12; 3322: 12 – R.C. Williams 550: 2 – R.S. Williams 2185: 8.

Yu 226: 2; 227: 2; 230: 2; 240: 1; 242: 1; 243: 1; 247: 5; 248: 5; 249: 5; 251: 6; 252: 6; 253: 6; 254: 6; 255: 3; 256: 3; 257: 3; 258: 5; 260: 4.