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Additions to the rubiaceous flora of Papua New Guinea: *Psychotria stolonifera* and *P. ternatifolia*, two remarkable species from the Muller limestone

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Abstract

Psychotria stolonifera and *P. ternatifolia* are newly described from limestone environments in the Muller Range of Papua New Guinea. Both species have unique vegetative characteristics allowing for instant separation from their closest allies. *Psychotria stolonifera* has an astonishing stoloniferous habit and diminutive stems; *P. ternatifolia* is the only Papuasian *Psychotria* with whorled leaves.

Key words: doline karst, limestone, new species, Papua New Guinea, *Psychotria*, Rubiaceae

Introduction

Since April 2005, four scientific expeditions to the southern limestone area of Papua New Guinea (PNG) have been concluded with institutional and corporate funding. Ten bivouacs were collectively established in support of these operations, at elevations ranging from 210 to 2860 m. The most recent undertaking (September 4–24, 2009, to the Muller Range) represents the furthest penetration of the limestone biome by any of the combined schedules. Numerous biological discoveries, including more than 10 plant species of exceptional character, have been obtained during the latest assessment. A multidisciplinary synthesis of that survey is currently in preparation (Richards in prep.). As with previous expeditionary itineraries, the taxonomic findings will be formally presented as a series of papers focused on specific plant groups. The Muller botanical reporting was recently initiated with the description of *Barringtonia jebbiana* (Takeuchi 2010 in press) and continues here with descriptions for *Psychotria stolonifera* and *P. ternatifolia*.

Unless otherwise noted, the following diagnoses refer only to the features observed on dried specimens. Characters determined in situ from living plants are reported separately as "field characters."

Description

Psychotria stolonifera Takeuchi, *sp. nov.* (Figs. 1–4)

Inter species congeneris Papuasiae caulibus partim basalibus stoloniformis partim erectis vel ascendentibus 0.1–0.4(–1.0) m altis statim distinguitur.

Type:—PAPUA NEW GUINEA. Western Province: Muller Range, Expedition Camp 2, *Nothofagus*-emergent montane forest on doline karst, 5°39.652'S, 142°17.962'E, 1425 m, 16 September 2009, *Takeuchi, Ama & Gamui 24691* (holotype LAE; isotypes A, BO, K, L).

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FIGURE 1. *Psychotria stolonifera*. **A**, forming a dense groundcover on limestone karst, stems 15–20 cm tall (*Takeuchi et al. 24618A*); **B**, blue scale bar with white lines marked in 1 cm increments.

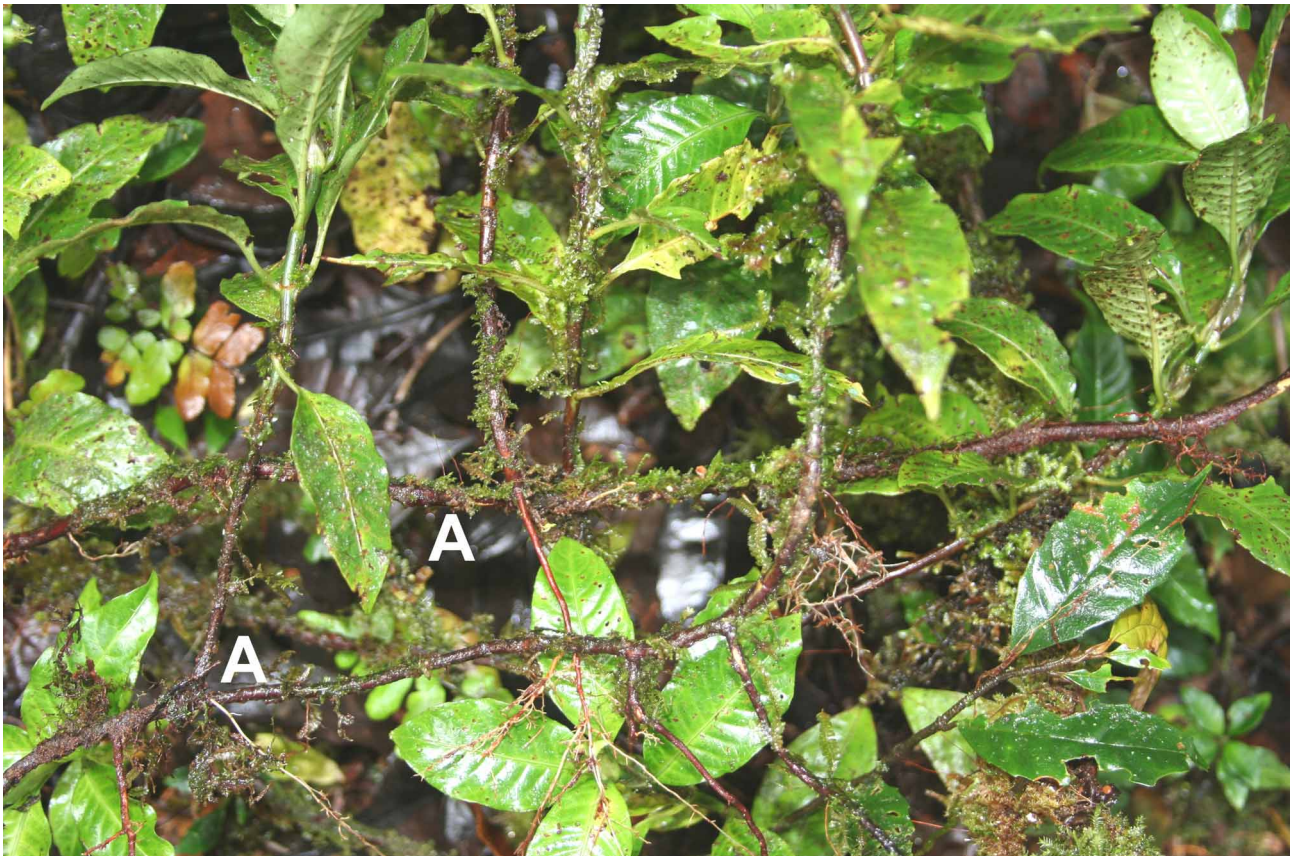

FIGURE 2. *Psychotria stolonifera*. **A**, uprooted plants, showing runner-like shoots with adventitious roots and erect stalks (*Takeuchi et al. 24707*).

FIGURE 3. *Psychotria stolonifera*. **A**, vegetative stems; **B**, stipules. **A**–**B** from *Takeuchi et al. 24707*.

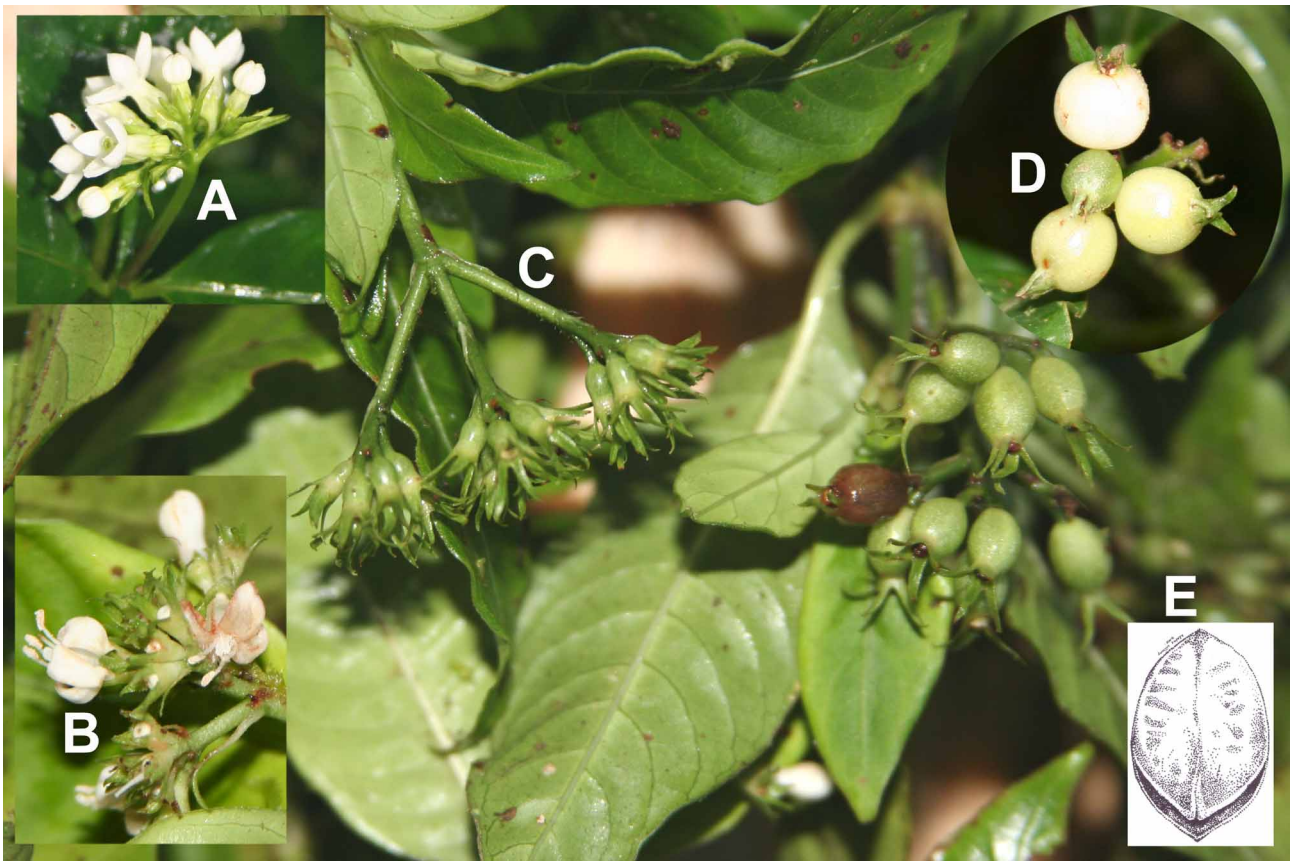

FIGURE 4. *Psychotria stolonifera*. **A**, long-styled flowers with stigma exserted; **B**, short-styled flowers with anthers exserted; **C**, developing (immature) fruits; **D**, ripe drupes; **E**, pyrene (6 × 4 mm), adaxial surface with preformed germination slits on margins. **A** from *Takeuchi et al. 24691*; **B**–**C** from *Takeuchi et al. 24683*; **D**–**E** from *Takeuchi et al. 24618A*.

Subshrubs 0.1–0.4(–1.0) m tall. *Basal stems* runner-like, internodes adventitiously rooting or not. *Ascending stems* unbranched (or sparingly branched), terete, 1–3 mm diameter, ± compressed near apices, glabrous, without lenticels; surfaces nigrescent, smooth or obscurely wrinkled; internodes (0.5–)2.0–6.0(–8.5) cm, often with raised decussate lines. *Leaves* cauline, 4–7 pairs and/or with 2–4(–6) pairs on short branches, equal, glabrous; stipules subpersisting, disclosing a nodal ring of appressed hairs after falling, free, ovate, 9–19 × 4–8 mm, notched 2–6(–9) mm from the top, dull black, densely tomentose-lanate on the inner side, glabrous on the outside; petioles 5–15 × 0.4–0.9 mm, planoconvex; leaf-blades chartaceous-subcoriaceous, elliptic (or lanceolate), (2.8–)4.5–8.0(–9.5) × (0.9–)1.6–3.3 cm; base cuneate-subattenuate; margin entire, inconspicuously furnished with antrorse hairs; apex acuminate; lamina surfaces fuliginous (or rufescent), cystoliths linear, infrequent; domatia absent; venation camptodromous, secondary veins 7–12(–16) per side, 2–6(–10) mm apart, arcuate, filiform, at the lamina center with divergence angles of 50–75°; reticulum irregular, coarsely areolate, obscure or invisible; midribs prominulous on both sides; higher order nerves weakly raised or planate above, more raised beneath. *Inflorescence* terminal, paniculiform, dichasial, 15–37 × 10–20 mm, erect, papillate-puberulent, glabrescent; axes black, terete or compressed; peduncle 3–10(–21) × 0.5–1.0 mm, (6–)15–28 × 0.5–1.2 mm in fruit; axis ca. 10 × 0.8 mm, to ca. 13 × 1.1 mm in fruit; branches opposed, contracted, crowded; primary (axis) bracts hair-like, (3.5–)7.5–12.0 × 0.3–1.0 mm, diverging, crispate; higher order bracts 3–5 × 0.1–0.2 mm. *Flowers* (measurements from spirit-preserved material) heterostylous, dimorphic, pentamerous; pedicels 0.5–3.0 mm long, not articulate. *Short-styled flower*: hypanthium synsepalous, infundibular, calyx tube (with ovary) 2.0 × 1.8–2.0 mm, calyx lobes 3 × 0.7–1.0 mm; corolla valvate in bud, obtuse, fleshy, exterior surfaces glabrous at anthesis, inside with a 2 mm wide hair-ring starting at the throat, corolla tube cylindrical, 5 × 1.5–2.0 mm, corolla lobes elliptic, 4.0–4.5 × 1.5–2.0 mm, reflexed; stamens antesepalous, glabrous, erect, inserted within the hair-ring, filaments ca. 2 × 0.2 mm, anthers exserted, oblongoid, 1.5 × 0.5–0.7 mm, basifixed, introrse; ovary bilocular, ovule erect, one per cell; disk globuliform, fleshy, glabrous, recessed at the summit; style cylindrical, ca. 3 × 0.2 mm, stigma included, ca. 1.5 × 0.5 mm, bilobed, papillate. *Long-styled flower* as for the short-styled form but with the following differences: hypanthium subglobose, ± compressed, calyx tube (with ovary) 2.5 × 1.5–2.8 mm, calyx lobes triangular, ca. 1 × 1 mm; corolla tube 4–5 × 2–3 mm, wider at the base, corolla lobes ovate, 4–5 × 3.0–3.5 mm, costate, hair-ring ca. 0.3 mm wide, positioned at the throat and not extending to the staminal insertion; stamens included, filaments ca. 0.5 × 0.2 mm, anthers 1.3–1.4 × 0.6 mm; style ca. 5 × 0.2 mm, stigma exserted, capitate, ca. 0.8 × 1.5 mm. *Fruits* arranged in congested cymules, ellipsoid-obovoid, 5.5–8.0 × 3.5–5.5 mm, compressed or not; pedicels cylindrical, (0.8–)1.2–3.0 × 0.3–0.5 mm; exocarp black, usually set with pale raphides; calyx lobes persisting to fruit maturity, ligulate, 2.7–4.0 × 0.2–0.5(–1.0) mm, ascending; pyrenes 2, hemispherical; endocarp crustaceous, ± corrugate but not dorsally ridged, weakly furrowed on the commissural face; preformed germination slits 2, marginal, extending 1/4–1/3 the pyrene length; endosperm conspicuously ruminate.

Field characters:—Subshrubs growing in congested thickets, never as solitary plants; basal stems plagiotropic, tenaciously rooted; ascending stems green, smooth, fragile; stipules hyaline; leaf-blades fleshy or herbaceous, bifacially green, rugose, undulate; corolla white; stamens white; drupes spongious, white; pyrene black.

Distribution:—Known thus far only from the type locality (Fig. 5).

Habitat and ecology:—*Nothofagus*-emergent montane forest on doline karst, 1425–1495 m.

Phenology:—Flowering and fruiting in September.

Additional specimens examined:—PAPUA NEW GUINEA. Western Province: Muller Range, Expedition Camp 2, *Nothofagus*-emergent montane forest on doline karst, 5°39.530'S, 142°18.105'E, 1495 m, 13 September 2009, *Takeuchi, Ama & Gamui 24618A* (A, LAE); 5°39.638'S, 142°18.018'E, 1460 m, 15 September 2009, *Takeuchi, Ama & Gamui 24683* (A, K, L, LAE); 5°39.610'S, 142°18.018'E, 1450 m, 17 September 2009, *Takeuchi, Ama & Gamui 24707* (A, BISH, K, LAE).

The new species is known only as radially-spreading plants on doline limestone. Its diminutive stems (mostly <50 cm, rarely to 1.0 m tall), are sequentially produced from near-surface stolons. Although

Psychotria leptothyrsa var. *defretesiana* (Takeuchi 2009: 176) was recently characterized as being the smallest *Psychotria* in Papuasia, *P. stolonifera* is often of similar stature. Many plants are fruit-bearing when only 15–20 cm tall.

The presence of a corolline hair-ring and the insertion of stamens within that ring, are (*inter alia*) defining generic traits for *Psychotria* (Davis & Bridson 2001, 2004, Davis *et al.* 2001). Short-styled flowers of *P. stolonifera* show these features clearly, but in the long-styled form the hair-band is considerably contracted (0.3 mm versus 2.0 mm wide), with the stamens distinctly positioned below the hairs. Except for this dimorphism, the new species conforms in detail to the generic circumscriptions established by modern study of the Psychotrieae (e.g., in Davis & Bridson 2001, 2004, Davis *et al.* 2001, Sohmer 1988, Sohmer & Davis 2007). Irrespective of the hair-band discrepancies, the preformed germination slits (2) on pyrene margins are indicative of *Psychotria* (Sohmer & Davis 2007) and provide diagnostic support for the generic assignment.

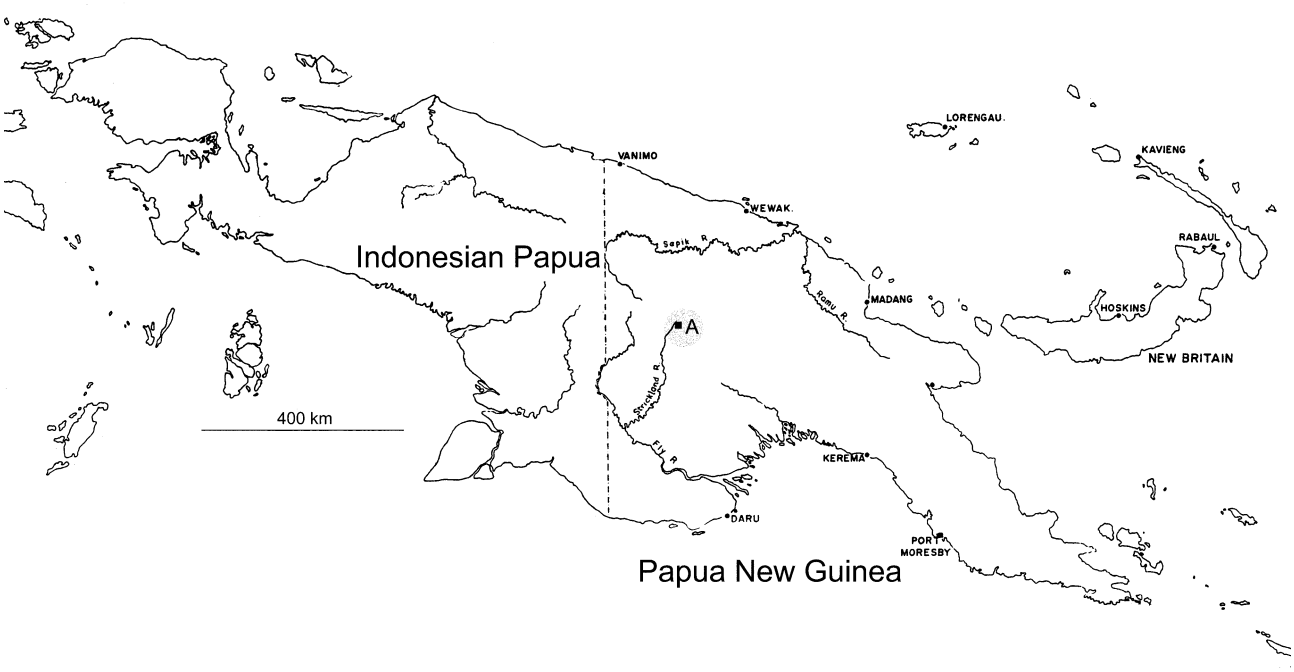

FIGURE 5. Island of New Guinea. **A**, Muller Range, Bivouac 2, type locality for *Psychotria stolonifera* and *P. ternatifolia.* Shaded circle for visual emphasis only (not indicative of observed or potential distribution).

Psychotria ternatifolia Takeuchi, *sp. nov.* (Figs. 6–8)

Ab omnibus speciebus Psychotriae Papuasiae foliis ternatis differt.

Type:—PAPUA NEW GUINEA. Western Province: Muller Range, Expedition Camp 2, *Nothofagus*-emergent montane forest on doline karst, 5°39.610'S, 142°18.018'E, 1450 m, 13 September 2009, *Takeuchi, Ama & Gamui 24621* (holotype LAE; isotypes A, BO, K, L, MO).

Understory shrubs 1–3(–5) m tall, glabrous on all parts (stipules excepted). *Branchlets* terete, apically compressed or planate, 1–3(–4) mm across, furrowed, pithy; surfaces nigrescent (or light brown), dull, longitudinally wrinkled, without lenticels; internodes 1.8–8.5(–12.5) cm. *Leaves* ternately whorled, obliquely spreading; stipules cylindrical, 2.5–4.0 × 4.5–5.0 mm, denticulate, ciliate, adaxially appressed-hairy, abaxially glabrous, the upper part (ca. 2/3) caducous, base persisting as a collariform ring, later disintegrating irregularly; petiole 4–17(–21) × 0.7–1.0 mm, planoconvex, proximally articulate or not; leaf-blades chartaceous, elliptic-oblanceolate, (5.9–)8.0–17.4(–20.1) × (2.3–)3.0–7.1 cm; base cuneate-decurrent, often

FIGURE 6. *Psychotria ternatifolia*. Habit, 1.5–2.0 m shrub in limestone forest (*Takeuchi et al. 24716*).

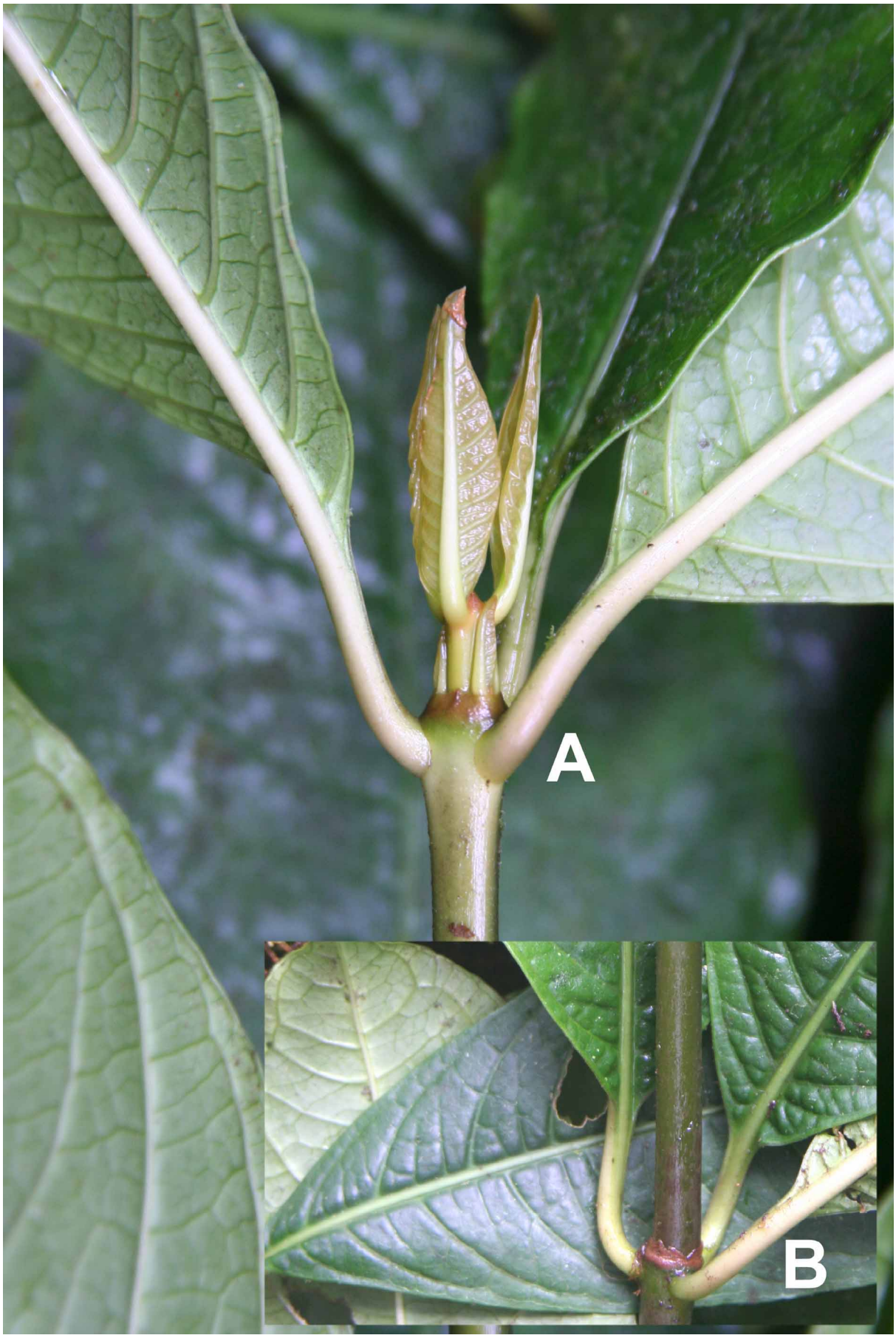

FIGURE 7. *Psychotria ternatifolia*. **A**, cylindrical stipule and two developing leaf whorls; **B**, stipule at lower node, basal part of cylinder persisting. **A–B** from *Takeuchi et al. 24716*.

poorly delimited from the petiole; margin reflexed; apex acuminate-cuspidate, acumen to ca. 2.5 × 0.5 cm; lamina surfaces bifacially olivaceous or fuliginous, copiously black-puncticulate, cystoliths white, numerous; domatia absent; venation camptodromous or brochidodromous, secondary veins 7–11(–14) per side, (3–)8–20(–26) mm apart, arcuate, at the lamina center with divergence angles of (50–)70–85°; reticulum irregular, coarsely areolate, conspicuous; midrib and lateral veins channeled above, prominent beneath; tertiary nervation slightly raised on both sides. *Inflorescence* (known only from immature fruiting stage) terminal, paniculate, to ca. 10 × 7 cm, subpyramidal, verticillately branched, diffuse, ascending; axial surfaces black, striate; peduncle 17–35(–46) × 0.5–1.2 mm; axis to ca. 28 × 1 mm; lateral branches to ca. 24 × 1 mm; pedicels cylindrical, (2.5–)4.0–8.0(–9.5) × 0.4–0.7 mm, not articulate; bracts scalelike, cuneate-deltate, persisting, diverging; primary (axis) bracts (1.5–)2.0–3.0 × 0.6–1.2 mm; higher order bracts (0.6–)1.0–1.5 × 0.2–0.5 mm. *Flowers* unknown. *Fruits* globose-obovoid, 7–10 × 6.5–9.5 mm, compressed or not, exocarp black, set with pale raphides; calyx residue annulate or 5-dentate; pyrenes 2, sharply ridged on the back, crests linear (in cross-sectional view), 1–2 mm high; endocarp crustaceous, inconspicuously furrowed on the commissural face; preformed germination slits 2, marginal, extending 1/3–1/2 the pyrene length; endosperm not ruminate.

FIGURE 8. *Psychotria ternatifolia*. **A**, fruiting branchlets, drupes immature; **B**, pyrene (9 × 8 mm, shown inverted), adaxial surface with germination slits on margins; **C**, pyrene, ridged abaxial surface. **A**–**C** from *Takeuchi et al. 24621*.

Field characters:—Branchlets cylindrical, fleshy, smooth, green or pinkish-brown; leaf-blades rugose, undulate, firm, dry-textured, adaxially mid-green, abaxially pale green to glaucescent; panicles erect, axial surfaces green; immature drupes dark green with white longitudinal lines.

Distribution:—Known thus far only from the type locality (Fig. 5).

Habitat and ecology:—*Nothofagus*-emergent montane forest on doline karst, 1450–1660 m.

Phenology:—Fruiting in September.

Additional specimens examined:—PAPUA NEW GUINEA. Western Province: Muller Range, Expedition Camp 2, *Nothofagus*-emergent montane forest on doline karst, 5°39.610'S, 142°18.018'E, 1450 m,

13 September 2009, *Takeuchi, Ama & Gamui 24619* (A, K, L, LAE); 5°39.385'S, 142°18.294'E, 1660 m, 17 September 2009, *Takeuchi, Ama & Gamui 24710* (A, K, LAE); *Takeuchi, Ama & Gamui 24716* (A, K, L, LAE); *Takeuchi, Ama & Gamui 24723* (A, BO, K, L, LAE).

The 3-whorled leaves of *P. ternatifolia* are manifestly distinguishing, but the undulate leaf-blades and their stiffly-dry texture (in vivo) are also unusual for this genus. Even sterile plants can be easily recognized. Scores of individuals were seen on the limestone in spatial association with *P. stolonifera*.

Although the flowers of *Psychotria ternatifolia* are unknown, there is little doubt that the species is a *Psychotria* in the contemporary sense (*sensu* Davis & Bridson 2001, 2004, Davis *et al*. 2001). The terminal panicles, double pyrenes with sharply raised ridges, and marginal germination slits (2) on endocarps, are salient characteristics consistent with the assigned genus.

The CI Muller Range Expedition delivered extraordinary biological results from all participating disciplines (Richards in prep.). Bivouac 2 (type locality for *Psychotria stolonifera* and *P. ternatifolia*) was an exceptional site, yielding novelties in *Barringtonia*, *Begonia*, *Octamyrtus*, and a remarkable four new species of *Psychotria*–-all with singular qualities permitting immediate determination as nova. The multidisciplinary discoveries now in hand are a convincing corroboration of conservation estimates regarding limestone environments in the southern ranges (e.g., Beehler 1993, Sekhran & Miller 1994).

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