



Three new species of *Vaccinium* L. (Ericaceae) from Mindanao Island, Philippines

MAVERICK N. TAMAYO^{1,7*}, VICTOR B. AMOROSO^{2,3,8}, FULGENT P. CORITICO^{2,3,9}, DARIN S. PENNEYS^{4,10}, JOHN REY C. CALLADO^{5,11}, JOHN D. HORNER^{1,12} & PETER W. FRITSCH^{6,13}

¹Department of Biology, College of Science and Engineering, Texas Christian University, South University Drive, Fort Worth, Texas, 76129 USA

²Center for Biodiversity Research and Extension in Mindanao (CEBREM), Central Mindanao University, Musuan, Bukidnon, 8710 Philippines

³Plant Biology Division, Institute of Biological Sciences, College of Arts and Sciences, Central Mindanao University, Musuan, Bukidnon, 8710 Philippines

⁴Department of Biology and Marine Biology, University of North Carolina Wilmington, 601 South College Road, Wilmington, North Carolina, 28403 USA

⁵Philippine National Herbarium, Botany and National Herbarium Division, National Museum of Natural History, National Museum of the Philippines, T.M. Kalaw St., Ermita, Manila, 1000 Philippines

⁶Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas, 76107 USA

⁷✉ m.n.tamayo@tcu.edu; <https://orcid.org/0000-0003-0157-5116>

⁸✉ victorbamoroso@gmail.com; <https://orcid.org/0000-0001-8865-5551>

⁹✉ cfulgent@cmu.edu.ph; <https://orcid.org/0000-0003-3876-6610>

¹⁰✉ pennysd@uncw.edu; <https://orcid.org/0000-0003-0727-2829>

¹¹✉ johnreycallado02@gmail.com; <https://orcid.org/0000-0001-6167-6184>

¹²✉ j.horner@tcu.edu; <https://orcid.org/0000-0001-5584-3273>

¹³✉ pfritsch@brit.org; <https://orcid.org/0000-0002-3606-663X>

*Author for correspondence

Abstract

Three new species of *Vaccinium* endemic to the island of Mindanao, Philippines are here described and illustrated. *Vaccinium fallax* most closely resembles *V. myrtooides*, but differs by having smaller leaves, caducous bracts, shorter pedicels, a broadly obconical hypanthium, broadly triangular calyx lobes, and a deep pink and broadly urceolate corolla. It grows on exposed areas and among sulfur vents at and near the summit of Mt. Apo. *Vaccinium gamay* most closely resembles *V. gitingense*, but differs in having shorter inflorescences, early caducous inflorescence bracts, shorter pedicels, presence of clavate glands on the hypanthium, and an absence of anther spurs. It grows on exposed areas in the ultramafic forest of Mt. Hamiguitan. It is one of only two Philippine *Vaccinium* species possessing distinctly callose-thickened calyx lobes, the other being *V. gitingense*. *Vaccinium vomicum* most closely resembles *V. carmesinum*, but differs by having smaller leaves, presence of glands on the extreme end of the leaf blade base, presence of clavate glands on the hypanthium, shorter stamens, and presence of stalked glands on the dentate apex of the tubules. It grows in the mossy rainforest of Mt. Kitanglad, and it is the only Philippine species of *Vaccinium* with glands on the extreme end of its leaf blade base. Following IUCN guidelines, we propose a conservation status of Critically Endangered for *V. fallax*, Endangered for *V. gamay*, and Data Deficient for *V. vomicum*. With these discoveries, the number of *Vaccinium* species in Mindanao Islands increases to 22 and in the Philippines to 44. Furthermore, the Mindanao Islands can now be considered the center of *Vaccinium* diversity in the Philippines.

Key words: blueberries, Malesia, sulfur vents, taxonomy, ultramafic soils, Vaccinieae

Introduction

The heath family (Ericaceae Jussieu 1789: 159) is a diverse plant group mainly adapted to high-elevation zones, montane forests, mossy rain forests, heathlands, exposed montane ridges, and alpine regions, typically on nutrient-poor, acidic, peaty, or sandy soils (Merrill 1908; Vander Kloet 1988; Schwery *et al.* 2015; Argent 2019; Tamayo *et al.* 2022). Ericaceae are represented by seven genera in the Philippines, viz. *Acrothamnus* Quinn (2005: 451), *Costera* J.J.Smith (1910: 324), *Dimorphanthera* (Drude 1889: 55) F.Muell. (1890: 63), *Gaultheria* L. (1753: 395), *Rhododendron* L. (1753: 392), *Styphelia* Smith (1795: 45), and *Vaccinium* L. (1753: 349). Of these, *Vaccinium* has

the highest number of species, with 41 accepted (Pelser *et al.* 2011; Tamayo *et al.* 2023). Taxonomic understanding of Philippine *Vaccinium* has been impeded by the rarity of species, scarcity of herbarium collections, and lack of *in situ* photographic documentation (Copeland 1930; Vander Kloet 1996; Pelser *et al.* 2011). Recent botanical surveys in under-explored areas of the country have facilitated the rediscovery of poorly known species of *Vaccinium* and discovery of species new to science (Salares *et al.* 2018; Fritsch *et al.* 2020; Tamayo *et al.* 2021, 2022; Tamayo & Fritsch 2022a, b; Tamayo *et al.* 2023).

Here we describe three new species of *Vaccinium* from Mindanao Island, under a morphological species concept (Cronquist 1978). All belong to *V.* section *Bracteata* Nakai in Nakai and Koidzumi (1927: 234) *sensu* Sleumer (1966–1967) by the combination of racemose multi-flowered inflorescences, a hypanthium markedly larger than the calyx lobes, the absence of a membranaceous wing at the corolla sinuses, and anthers opening by terminal pores. From the revised sectional treatment by Vander Kloet & Dickinson (2009), they can be treated as members of *V.* section *Euepigynium* Schlechter (1919: 174) by their evergreen habit, single monomorphic perennating buds on leaf axils, plinerved leaf venation, the peduncle longer than pedicels, a calyx tube (hypanthium) that is wholly fused to the ovary, and a pseudo-10-locular ovary. All three species are apparently micro-endemics. These discoveries raise the number of species of *Vaccinium* known from the Mindanao Islands to 22, making this area the center of *Vaccinium* species diversity in the Philippines (vs. 20 species in Luzon Islands, 11 in Mindoro, six in Negros, five in Palawan, four in Panay, and three in Leyte) (Tamayo *et al.* in prep.). The total number of *Vaccinium* species in the Philippines now stands at 44.

Material and methods

The species were described from spirit collections preserved in 70% ethyl alcohol solution, dried herbarium vouchers, and *in situ* photographs. The flowers and fruits were soaked in Pohl's solution for 15 minutes, dissected, examined, and their parts measured with the aid of a stereomicroscope under up to 64× magnification. Herbarium specimens were examined from A, BRIT, CAS, CMUH, NY, PNH, UC, and US, including digitized specimens at BISH, BM, CANB, E, HBG, K, L, MICH, and U [herbarium acronyms follow Thiers (2022), continuously updated] available online at JSTOR Global Plants (<https://plants.jstor.org>). Characters in descriptions were defined as in Beentje (2016), and relevant taxonomic literature on Philippine and Malesian *Vaccinium* was consulted (i.e., Copeland 1930; Sleumer 1966–1967; Veldkamp 1979; Co *et al.* 2002; Argent 2008, 2014; Salares *et al.* 2018; Argent 2019; Mustaqim & Ardi 2019; Argent & Wilkie 2020; Fritsch *et al.* 2020; Tamayo *et al.* 2021; Mustaqim *et al.* 2022; Tamayo *et al.* 2022; Tamayo & Fritsch 2022a, b; Tamayo *et al.* 2023). The area of occupancy (AOO) and extent of occurrence (EOO) of the three species were obtained with the use of GeoCAT (Bachman *et al.* 2011). The classification of Philippine forest formations was based on Fernando *et al.* (2008). Species conservation status was assessed with the use of IUCN guidelines (IUCN Standards and Petitions Committee 2022).

Taxonomic treatment

Vaccinium fallax M.N.Tamayo & P.W.Fritsch, *sp. nov.* (Figs. 1–2).

Type:—PHILIPPINES. Mindanao Island, Province of Davao del Sur, Davao City, Mt. Apo Natural Park, Mt. Apo summit area, 6.986306°N, 125.271944°E, 2907 m elevation, 2 May 2014, *D.S. Penneys* 2352 (holotype CAS 490395!, isotypes BRIT BRIT423194!, US 04131958!).

Paratypes:—PHILIPPINES. Mindanao Island, Province of North Cotabato, Ilomavis, Mt. Apo, 2900 m elevation, found near the summit, 16 March 1992, *PPI (Philippine Plant Inventory)* 9720 (BRIT BRIT26866!); *ibid.* Kidapawan, Mt. Apo, 7.0175°N, 125.05°E, 3000 m elevation, found along the trail to the peak of Mt. Apo, March–April 1991, *PPI (Philippine Plant Inventory)* 2521 (BRIT BRIT26920!); *ibid.* Province of Davao del Sur, Municipality of Santa Cruz, Barangay Sibulan, Sitio Colan, Mt. Apo boulders, 6.98423°N, 125.28214°E, 2329 m elevation, growing on volcanic and rhyolite boulder and bedrock in open, full sun, on southeast facing slope, 5 August 2022, *PLSPH 3735 (Plants and Lichens of the Southern Philippines Survey)* (BRIT!, CMUH!, PNH!).



FIGURE 1. *Vaccinium fallax*. **A.** Summit area of Mt. Apo showing a vent spewing sulfur fumes. **B & C.** Flowering branchlet *in vivo*. **D.** Flowering branchlet showing pedicel, hypanthium, and calyx lobes. Photos B–D from *PLSPH 3735*; photos by P.W. Fritsch.

Diagnosis:—*Vaccinium fallax* most closely resembles *V. myrtoides* (Blume 1826: 861) Miquel (1859: 1062) but can be distinguished by having smaller leaves [$0.7\text{--}2.0 \times 0.25\text{--}1.0$ cm vs. $1.3\text{--}2.0$ (-2.5) \times (0.6--) $0.7\text{--}1.3$ (-1.8) cm], caducous bracts (vs. partly persistent), shorter pedicels [$0.5\text{--}0.7$ cm vs. $0.5\text{--}1$ (-1.4 cm)], a broadly obconical hypanthium (vs. cupuliform), broadly triangular calyx lobes (vs. triangular), and a deep pink (vs. pale pink) and broadly urceolate corolla (vs. narrowly cylindrical-urceolate).

Description:—**Habit** shrubs, terrestrial, evergreen, $0.7\text{--}1.5$ m tall, densely branched. **Young branchlets** reddish brown *in vivo*, light to dark brown *in sicco*, puberulent, with simple erect trichomes $0.1\text{--}0.2$ mm long. **Mature branchlets** dark brown *in vivo*, obscurely ridged, glabrous, lenticellate, $4.0\text{--}6.0$ mm wide; perennating buds acute-triangular, $0.6\text{--}0.7$ mm long, with several obscurely overlapping scales, scale apices acute, margin entire with occasional simple erect trichomes ca. 0.1 mm long. **Leaves** persistent on older branchlets, densely crowded, spirally and evenly arranged; petiole reddish green, pubescent, with trichomes same as branchlets, with glands near leaf blade, in cross section abaxially rounded, adaxially nearly flat, $1.2\text{--}1.8 \times 0.8\text{--}1.5$ mm; leaf blade elliptic, larger leaves on each branchlet $0.7\text{--}2.0 \times 0.25\text{--}1.0$ cm, coriaceous, abaxial surface without punctae, pale green, adaxial surface leathery green, base obtuse to slightly rounded, margin entire, thinly revolute, with 2 to 3 pairs of impressed \pm evenly distributed glands per side, with first gland ca. 1 mm from leaf blade base and ca. 0.3 mm diameter, leaf blade apex acute, midvein strongly raised

abaxially, flattened or slightly sunken adaxially, secondary veins 2 to 4 on each side of midvein with first pair arising from base and remainder along midvein, arc-ascending, raised abaxially, obscure or non-evident adaxially, tertiary veins faintly evident or obscure. **Inflorescences** pseudo-terminal or terminal, racemose, developing beyond confines of perennating bud, 1 per leaf axil, sub-densely 8- or 10-flowered, 1.5–2.0 cm long; peduncle and rachis reddish green *in vivo*, reddish brown *in sicco*, slightly ridged, glabrous, peduncle ca. 4 mm long, rachis ca. 5 mm long; bracts dark brown *in sicco*, caducous, non-foliaceous, broadly elliptic, planar or occasionally cucullate, coriaceous, glabrous, 5.0–9.0 × 2.0–3.5 mm, margin entire, ± minutely ciliolate, apex acute. **Flowers** with an articulation between the pedicel and hypanthium, 6.0–7.0 mm long. **Pedicel** red *in vivo*, nodding, glabrous, 5.0–7.0 × 0.5–0.6 mm at anthesis; bracteoles 2, subulate, early caducous, 1.0–1.5 mm long, borne at 3.0–5.0 mm from base or occasionally at base of pedicel. **Hypanthium** red *in vivo*, reddish brown *in sicco*, broadly obconical, 1.5–1.7 × 1.5–2.0 mm; calyx limb 1.5–2.0 mm long; calyx lobes 5 or 6, broadly triangular, glabrous on both sides, 1.2–1.5 mm long, margin entire, apex acute with a few simple hairs and a ± sessile terminal gland. **Corolla** deep pink or red, broadly urceolate, glabrous on both sides, 4.5–5.0 × 2.5–3.5 mm; lobes 5 or 6, broadly triangular, ca. 0.8–1.0 × 1.0–1.2 mm, apex acute or obtuse. **Stamens** 10 or 12, monomorphic, free from each other, 3.0–3.2 mm long; filaments straight or slightly curved, 1.8–2.0 mm long, white-pubescent, trichomes ca. 0.3 mm long, borne mainly at base with a few scattered distally; anthers 1.2–1.5 mm long, opening by short introrse slits or terminal pores, slightly shorter than filaments, cells oblong, minutely echinulate, 0.6–0.8 mm long, tubules parallel, broadly cylindrical, 0.7–0.9 mm long, slightly broader than cells, opening by oblique ventrally-oriented apical pores, pore apex rounded or oblong, spurs absent. **Ovary** 5- or 6-locular but appearing pseudo-10- to 12-locular with incomplete partitions extending 0.15–0.2 mm from inner wall; ovules in two columns per locule; disk non-bulky, nearly flat to slightly annular with obscure ridges on margin, with simple erect hairs ca. 0.1 mm long, ca. 1.5 mm in diameter; style not exerted from corolla, glabrous, 3.5–4.0 mm long, stigma truncate. **Fruit** deep purple at maturity, pyriform, subglobose, or globose, shiny, 5.0–6.0 × 5.0–7.0 mm.

Distribution and Habitat:—This species is restricted to Mt. Apo Natural Park (MANP). It grows in exposed areas at and near the summit among sulfur vents, rhyolite boulders, and on a recently burned area on the northern slope of the mountain. The latter suggests that it is a pioneer species in fire-disturbed areas at the locality.

Etymology:—The epithet “fallax” is Latin meaning deceptive. This is in reference to its close morphological resemblance to *Vaccinium myrtooides*.

Phenology:—Flowering and fruiting from March to August.

Proposed Conservation Status:—*Vaccinium fallax* has only been found at or near the summit of Mt. Apo, covering a small area (both AOO and EOO covering < 10 km²). MANP is a protected area (PA) and an Association of Southeast Asian Nations (ASEAN) Heritage Park; thus, a considerable level of protection is afforded to the species. However, increased tourism activities and anthropogenic wildfires are potential threats to the population. As such, we here assess its conservation status as Critically Endangered [CR: B1ab (i, ii, iii) + B2ab (i, ii, iii)] following IUCN guidelines (IUCN Standards and Petitions Committee 2022).

Discussion:—In the keys to the Malesian species of *Vaccinium* sect. *Bracteata* sensu Sleumer (1966–1967), and the artificial key to Philippine *Vaccinium* (Copeland 1930), *V. fallax* keys to *V. myrtooides*. *Vaccinium fallax* resembles *V. myrtooides*, especially in MANP where these two species occur sympatrically, often growing side-by-side. *Vaccinium fallax* can be readily distinguished from *V. myrtooides* by its deep pink corolla (vs. white to pale pink); red pedicels, hypanthium, calyx limb, and calyx lobes (vs. green with a tinge of red); and abaxially non-evident lateral veins (vs. evident). Moreover, the calyx limbs are longer, and the calyx lobes are broader compared to those of *V. myrtooides* (Figure 1D).

In the key to Bornean *Vaccinium* (Argent 2019), *V. fallax* keys to *V. philippisiae* Argent (2019: 99). The new species is distinct from *V. philippisiae* by having smaller leaf blades (0.7–2.0 × 0.25–1.0 cm vs. 2.5–4.0 × 1.3–2.0 cm), glabrous pedicels (vs. pubescent), a glabrous hypanthium (vs. pubescent), an absence of sessile glands on the margin of the calyx lobes (vs. presence), a shorter corolla (4.5–5.0 mm vs. 8.0–10.0), and an absence of anther spurs (vs. presence). An updated key, superseding that of Tamayo *et al.* (2023), of the small-leaved Philippine species of *Vaccinium* (i.e., species with leaf blades < 2 cm long) is provided here to accommodate *V. fallax*.

Updated key to the small-leaved species of *Vaccinium* in the Philippines

- | | | |
|-----|--|------------------------|
| 1a. | Leaf margin entire; leaf marginal glands one or two pairs confined near leaf base..... | 2 |
| 2a. | Inflorescence terminal, or pseudoterminal; flowers in racemes..... | 3 |
| 3a. | Hypanthium cupuliform; calyces triangular; pedicel 5–14 mm long..... | <i>V. myrtooides</i> |
| 3b. | Hypanthium broadly obconical; calyces broadly triangular; pedicel 5–7 mm long..... | <i>V. fallax</i> |
| 2b. | Inflorescence axillary; flowers solitary..... | <i>V. microphyllum</i> |

- 1b. Leaf margin crenulate; leaf marginal glands distributed along length of margin.....4
 4a. Corolla long-conical (ampullaceous), without pronounced sulci and/or ridges..... *V. whitfordii*
 4b. Corolla urceolate, with pronounced sulci and/or ridges.....5
 5a. Bracteoles caducous before anthesis, ≤ 1 mm long; pedicels 6–7 mm long; anther tubules 0.6–0.8 mm long *V. hamiguitanense*
 5b. Bracteoles persistent until anthesis, > 1 mm long; pedicels 2–5 mm long; anther tubules 0.8–1.9 mm long.....6
 6a. Leaves with raised glands on each crenation; hypanthium glabrous *V. exiguum*
 6b. Leaves with sunken glands on each crenation; hypanthium white-hirsutulous *V. coarctatum*

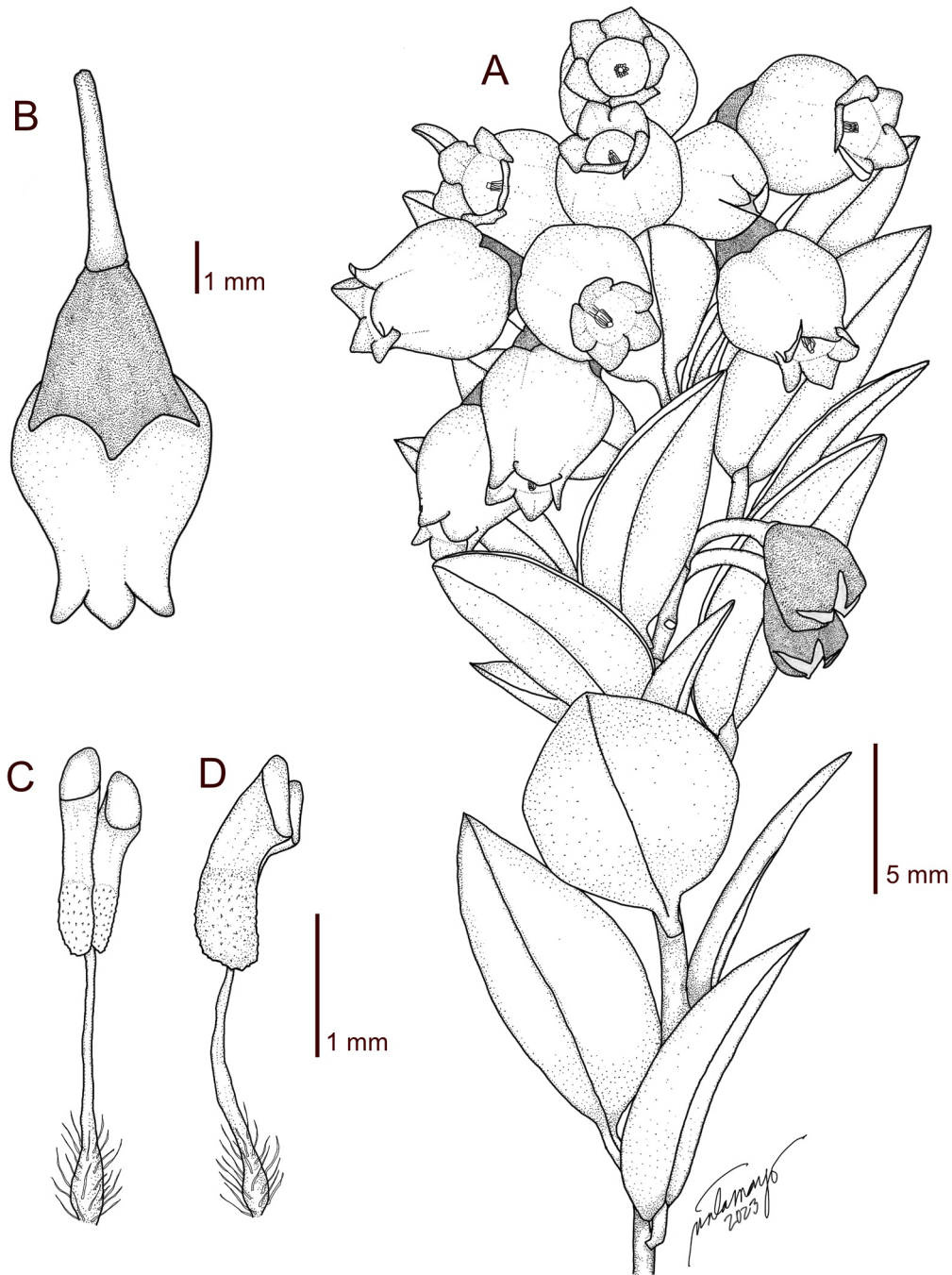


FIGURE 2. *Vaccinium fallax*. **A.** Flowering branchlet. **B.** Lateral view of flower showing pedicel, hypanthium, calyx, and corolla. **C.** Ventral view of stamen. **D.** Lateral view of stamen. Illustration by M.N. Tamayo.

Vaccinium gamay M.N.Tamayo & P.W.Fritsch, *sp. nov.* (Figs. 3–4).

Type:—PHILIPPINES. Mindanao Island, Province of Davao Oriental, City of Mati, Barangay Macambol, Mt. Hamiguitan Range Wildlife Sanctuary (MHRWS), 13–20 March 2022, *J.R.C. Callado* 2633 (holotype PNH!, isotypes BRIT!, CMUH!).

Paratypes:—PHILIPPINES. Mindanao Island, Province of Davao Oriental, City of Mati, Barangay Macambol, Mt. Hamiguitan Range Wildlife Sanctuary (MHRWS), 13–20 March 2022, *J.R.C. Callado* 2628 (PNH!); *ibid.* *Nepenthes* garden landslide area (lantawan), tropical lowland evergreen rain forest on SW-facing slope, 0–10% slope, trail to camp 4, 792 m, 6.72415°N, 126.15855°E, 21 June 2015, *P.W. Fritsch* 1969 (BRIT BRIT554028!, CAS 490403!); *ibid.* *Nepenthes* garden landslide area (lantawan), tropical lowland evergreen rain forest on SW-facing slope, 0–10% slope, 1,181 m, 6.73169°N, 126.17803°E, *P.W. Fritsch* 1992 (BRIT BRIT554023!, CAS 490409!).

Diagnosis:—*Vaccinium gamay* most closely resembles *V. gitingense* Elmer (1912: 1490) but is distinguished by having shorter inflorescences (3–4 cm vs. 4–6 cm), early caducous inflorescence bracts (vs. persistent), shorter pedicels [8–9 mm vs. (7–)10–15 mm], presence of clavate glands on the hypanthium (vs. absence), and an absence of anther spurs (vs. presence).



FIGURE 3. *Vaccinium gamay*. **A.** Fructing branchlets *in vivo*. **B.** Fertile branchlets with flower buds and flowers in full anthesis. **C.** Lateral view of inflorescence. **D.** Fertile branchlet showing flowers in full anthesis and immature infructescence. **E.** Longitudinal section of flower showing stamens and style. All from *J.R.C. Callado* 2633; photos by J.R.C. Callado.

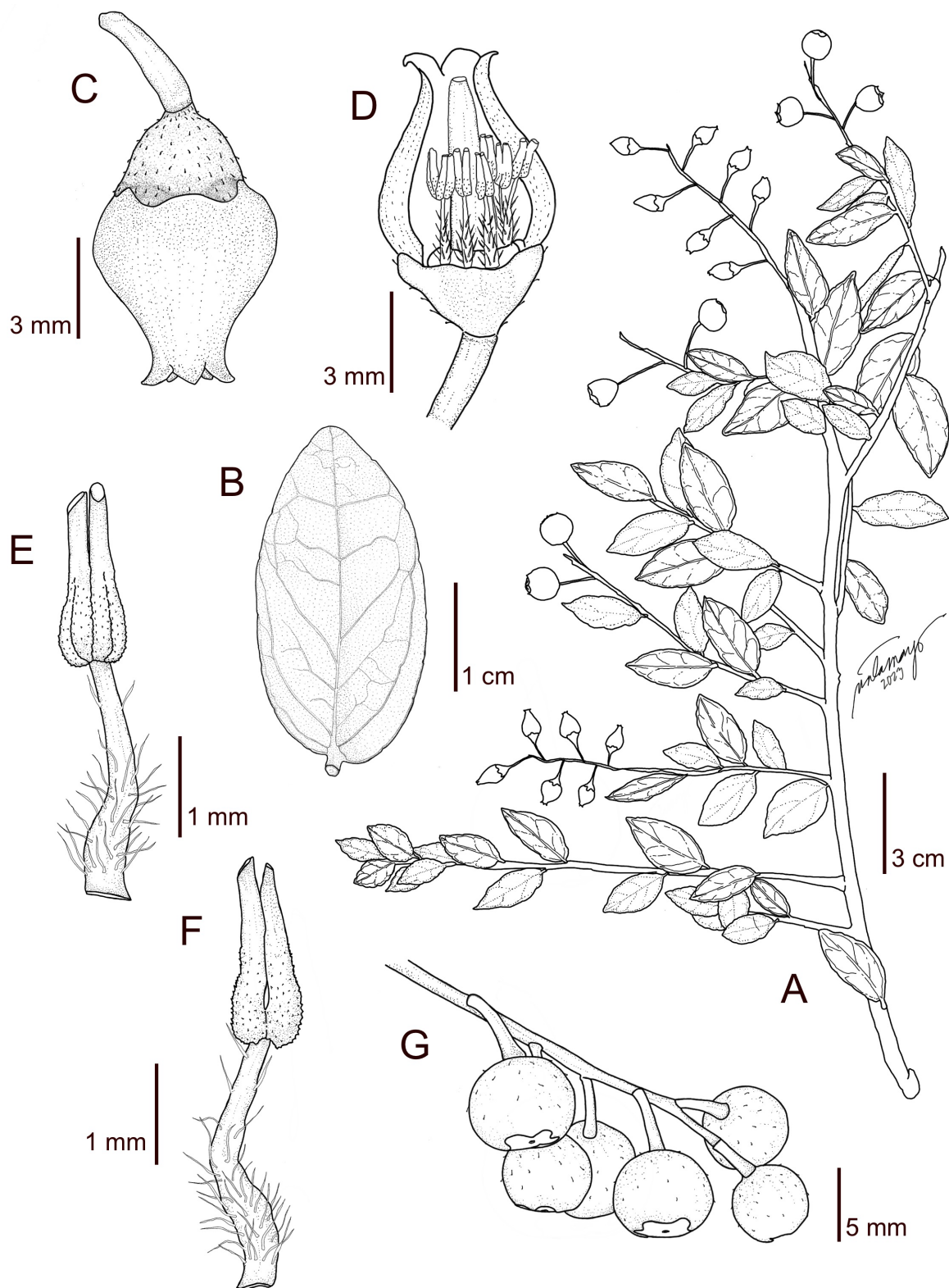


FIGURE 4. *Vaccinium gamay*. **A.** Flowering and fruiting branchlets. **B.** Abaxial surface of leaf. **C.** Lateral view of flower showing pedicel, hypanthium, calyx, and corolla. **D.** Longitudinal section of corolla showing stamens and style. **E.** Ventral view of stamen. **F.** Dorsal view of stamen. **G.** Inflorescence. Illustration by M.N. Tamayo.

Description:—**Habit** shrubs, terrestrial, evergreen, 0.4–3 m tall, densely branched. **Young branchlets** reddish *in vivo*, white-hirsutulous, with simple erect trichomes 0.1–0.2 mm long. **Mature branchlets** reddish *in vivo*, grayish brown *in sicco*, obscurely ridged, glabrescent, sparsely lenticellate, 3.0–5.0 mm wide; perennating buds compressed-ovoid or broadly triangular, 0.6–0.7 mm long, with several overlapping scales, scale apices acute, margin entire, minutely ciliolate, trichomes 0.2–0.3 mm long. **Leaves** persistent on older branchlets, densely crowded, spirally and evenly arranged; petiole dark green, occasionally tinged red, pubescent, with trichomes same as branchlets, in cross section abaxially rounded, adaxially nearly flat and slightly grooved, 1.0–1.5 × 0.8–1.0 mm; leaf blade elliptic to oblong, young leaves with sparse clavate glands ca. 0.10 mm long scattered on both surfaces, larger leaves on each branchlet 0.9–2.5 × 0.5–1.3 cm, coriaceous, abaxial surface light green *in vivo*, light brown *in sicco*, with scattered clavate glands, adaxial surface light green to reddish when young, glossy green and nitid at maturity, brown *in sicco*, glabrous except the puberulent base, base obtuse to rounded, margin entire, thinly revolute, with 5 or 8 impressed ± evenly distributed glands per side and scattered along length forming shallow crenations, first gland 0.5–1 from base, ca. 0.2 mm diameter, leaf blade apex acute, with occasional minute hairs and a terminal gland on tip, midvein slightly raised on both surfaces, secondary veins 3 to 6 on each side of midvein with first pair arising from base and remainder along midvein, arc-ascending, slightly raised or obscure abaxially, obscure adaxially, tertiary veins faintly evident. **Inflorescences** pseudo-terminal or terminal, racemose, developing beyond confines of perennating bud, 1 per leaf axil, densely 8- or 12-flowered, 3.0–4.0 cm long; peduncle and rachis light green with a tinge of red *in vivo*, slightly ridged, glabrous, peduncle ca. 1 cm long, rachis 2–3 cm long; bracts early caducous. **Flowers** with an articulation between the pedicel and hypanthium, 5.0–6.2 mm long. **Pedicel** light green *in vivo*, nodding, puberulent, with occasional clavate glands ca. 0.1 mm long, 8.0–9.0 × 0.5–0.6 mm at anthesis; bracteoles 2, subulate, early caducous, ca. 1 mm long, margin entire, with a few simple trichomes ca. 0.2 mm long. **Hypanthium** green *in vivo*, cupuliform or broadly obconical, glossy, 1.0–1.2 × 1.3–1.5 mm, with scattered clavate glands; calyx limb 1.2–1.5 mm long; calyx lobes green, 5 or 6, semicircular, glabrous on both sides or with occasional clavate glands, callose-thickened, 0.8–1.0 mm long, margin entire, minutely ciliolate, apex rounded, with occasional sessile terminal gland. **Corolla** white or pale pink, darker pink at base, urceolate, broad at base, gradually constricted to the lower half, tapering distally, glabrous on both surfaces, 4.2–5.0 × 3.0–3.5 mm; lobes 5 or 6, narrowly triangular, ca. 1.2 × 1.0 mm, apex rounded. **Stamens** 10 or 12, monomorphic, free from each other, 3.0–3.5 mm long; filaments straight or slightly curved, 1.7–2.2 mm long, pubescent, trichomes simple, undulate, ca. 0.5 mm long, borne mainly at base, with a few scattered distally; anthers 1.5–1.8 mm long, opening by short introrse slits or terminal pores, slightly shorter than filaments, cells narrowly oblong, minutely echinulate, 0.9–1.3 mm long, tubules parallel, narrowly to broadly cylindrical, 0.8–1.0 mm long, ± narrower than cells, opening by apically or ventrally oriented pores, pore apex rounded or truncate, spurs absent. **Ovary** 5- or 6-locular but appearing pseudo-10- to 12-locular with incomplete partitions extending 0.2–0.3 mm from inner wall; ovules in two columns per locule; disk bulky, annular, with ridges on margin, glabrous, ca. 1.5 mm in diameter; style not exerted from corolla, glabrous, 4.0–4.5 mm long, stigma truncate or rounded. **Fruit** deep red turning dark purple at maturity, globose, glabrous or with occasional clavate glands, 3.0–4.5 × 3.0–5.0 mm, fruiting pedicels becoming longer, ca. 13 mm, disk becoming bulged outwards as fruit progresses to full maturity with calyx lobes appressed to disk.

Distribution and Habitat:—This new species is known only from the tropical lowland evergreen rainforest of MHRWS. Flowering and fruiting individuals were observed on a 0–30% southwest-facing slope near a landslide area adjacent to a lantawan (a small, cleared area serving as resting site, view deck, or natural landslide area) on ultramafic substrate. Individuals of *Vaccinium gamay* are restricted to ultramafic substrate and occur sympatrically with *V. gitingense* along ridges and lantawans in MHRWS.

Etymology:—The epithet “gamay” is a Cebuano word meaning small. This refers to the relatively small and dainty flowers of the new species.

Phenology:—Flowering in March, fruiting in January.

Proposed conservation status:—Only a few mature individuals (< 20) were observed in the type locality. The EOO = 21.573 km² and AOO = 20.0 km², suggesting a narrow distribution of this plant. Although the plant is in a protected area (PA) and an ASEAN Heritage Park, natural disasters such as typhoons may pose a threat and lead to a decline of its population. With this, we hereby assess the conservation status of *Vaccinium gamay* as Endangered [EN: B1b (i, ii, iii) + B2b (i, ii, iii)] (IUCN Standards and Petitions Subcommittee 2022).

Discussion:—During a floristic survey conducted by Central Mindanao University (CMU) and Botanical Research Institute of Texas (BRIT) in 2015, an unknown *Vaccinium* bearing flower buds and fruits was vouchered from one of the lantawans of MHRWS. This plant morphologically resembles *V. gitingense* in its shallowly crenate leaf blade margin and callose-thickened calyx lobes. Examination of the available material revealed the presence

of clavate glands on the young leaves, pedicels, and hypanthium of this species, leading to consideration that this plant is undescribed, in part because neither of the other species of *Vaccinium* known from MHRWS exhibit this character. JRCC, during a floristic survey in MHRWS, encountered some flowering and additional fruiting individuals of this unknown *Vaccinium*. Photographs were also taken *in situ* and vouchers were made, thereby permitting thorough diagnosis and description of this new species.

In the key to the Malesian species of *Vaccinium* sect. *Bracteata* sensu Sleumer (1966–1967), the new species best keys to *V. apiculatum* Sleumer (1961: 95) endemic to New Guinea. *Vaccinium gamay* can be distinguished from *V. apiculatum* by having shallow crenations throughout the length of the leaf blade margin (vs. crenulate only in the upper third), longer inflorescences (3–4 cm vs. 1.5–2.5 cm), a hypanthium with clavate glands (vs. glabrous), a rounded calyx lobe apex (vs. acute), and an absence of anther spurs (vs. presence).

In the artificial key to Philippine *Vaccinium* (Copeland 1930), *V. gamay* best keys to *V. tenuipes* Merrill (1908: 375). *Vaccinium gamay* is distinguishable from *V. tenuipes* by having an acute leaf apex (vs. shortly caudate-acuminate), leaf glands distributed along the length of the leaf blade margin (vs. one pair confined to the leaf blade base), eglandular inflorescences (vs. bearing stipitate glands), shorter pedicels (0.8–0.9 cm vs. 1.0–2.0 cm), semicircular calyx lobes (vs. triangular-ovate), and a broadly urceolate corolla (vs. narrowly conical). In the key to Bornean *Vaccinium* (Argent 2019), *V. gamay* best keys to *V. philippisae* but differs by having a shallowly crenulate leaf blade margin (vs. entire), leaf glands distributed along the length of the leaf blade margin (vs. 1–2 pair/s confined to the leaf blade base), the presence of clavate glands on the pedicel (vs. absence of such glands), semicircular calyx lobes (vs. triangular), and the absence of anther spurs (vs. presence).

Vaccinium gamay is one of two micro-endemic blueberries documented in MHRWS, the other being *V. hamiguitanense* P.W.Fritsch (2020: 282). Although these two species occur sympatrically in MHRWS, albeit at different elevations [*V. gamay* restricted to elevations of ca. 700–1181 m (vs. ca. 1600–1641 m for *V. hamiguitanense*)], *V. gamay* can be distinguished by its acute leaf apex (vs. obtuse to rounded or emarginate), early caducous bracts (vs. persistent), absence of corolla sulci and ridges (vs. presence), semicircular calyx lobes (vs. broadly deltoid), and absence of anthers spurs (vs. presence). *Vaccinium gamay* is one of two Philippine species known to have distinct callose-thickened calyx lobes, the other being *V. gitingense*.

Vaccinium vomicum M.N.Tamayo & P.W.Fritsch, *sp. nov.* (Figs. 5–6).

Type:—PHILIPPINES. Mindanao Island, Province of Bukidnon, Municipality of Impasug-ong, Sitio Intavas, La Fortuna, Mt. Kitanglad, 2090 m, 6 September 2007, *JMS 117* (holotype PNH!, isotype CMUH 2173!).

Diagnosis:—*Vaccinium vomicum* most closely resembles *V. carmesinum* M.N.Tamayo & P.W.Fritsch (2020: 174) but differs by having smaller leaves (5.0–9.0 × 1.8–5.2 cm vs. 7–15 × 0.4–9 cm), the presence of glands on the extreme end of the leaf blade base (vs. ca. 1–2 cm from the leaf blade base), the presence of clavate glands on the hypanthium (vs. absence), shorter stamens (4.5–5.5 mm long vs. 5.5–7.2 mm long), and the presence of stalked glands on the dentate apex of the tubules (vs. glandless, entire).

Description:—**Habit** shrubs, terrestrial, evergreen, sub-densely branched. **Young branchlets** reddish brown *in sicco*, glabrous. **Mature branchlets** light brown, obscurely ridged, glabrous, lenticellate, 3.0–8.0 mm wide; perennating buds acute, 1.2–2.0 mm long, with several obscurely overlapping scales. **Leaves** persistent on older branchlets, not densely crowded, spirally and evenly arranged; petiole reddish brown *in sicco*, glabrous, in cross section abaxially rounded, adaxially nearly flat, 0.6–1.0 × 0.18–0.28 cm; leaf blade narrowly to broadly elliptic, larger leaves on each branchlet 5.0–9.0 × 1.8–5.2 cm, coriaceous, abaxial surface light reddish brown *in sicco*, glabrous, adaxial surface dark reddish brown *in sicco*, glabrous, base cuneate, margin entire, thinly revolute, leaf blade glands 10 to 13 on each side, impressed ± evenly distributed, 0.2–0.3 mm diameter, the first pair of glands immediately at junction with petiole, 1.0–1.2 mm diameter, leaf blade apex acuminate, acumen 1.5–1.7 cm long, midvein raised abaxially, flattened adaxially or nearly so, secondary veins 2 to 4 on each side of midvein with first pair arising from base and remainder along midvein, arc-ascending, slightly raised abaxially, obscure adaxially, tertiary veins faintly evident or obscure. **Inflorescences** pseudo-terminal or terminal, racemose, developing beyond confines of perennating bud, 1 per leaf axil, densely flowered, 10- to 12-flowered, 6.0–6.5 cm long; peduncle and rachis reddish brown *in sicco*, slightly ridged, glabrous or with occasional clavate glands 0.15–0.2 mm long, peduncle ca. 1 cm long; rachis 5.0–5.5 cm long; bracts dark brown *in sicco*, narrowly elliptic, planar or occasionally cucullate, coriaceous, glabrous, caducous, ± foliaceous, 10.0–12.0 × 5.0–6.0 mm, margin entire, apex acuminate. **Flowers** with an articulation between the pedicel and hypanthium, 1.6–2.3 cm long. **Pedicel** reddish brown *in sicco*, nodding, with occasional clavate glands, 8.0–16 × 0.9–1.2 mm; bracteoles 2, borne at base of pedicel, early caducous. **Hypanthium** reddish brown *in sicco*, cupuliform, broadly obconical, 1.2–2.0 × 2.0–2.5 mm, with clavate glands; calyx limb 1.3–1.5 mm long, with clavate glands same as hypanthium; calyx

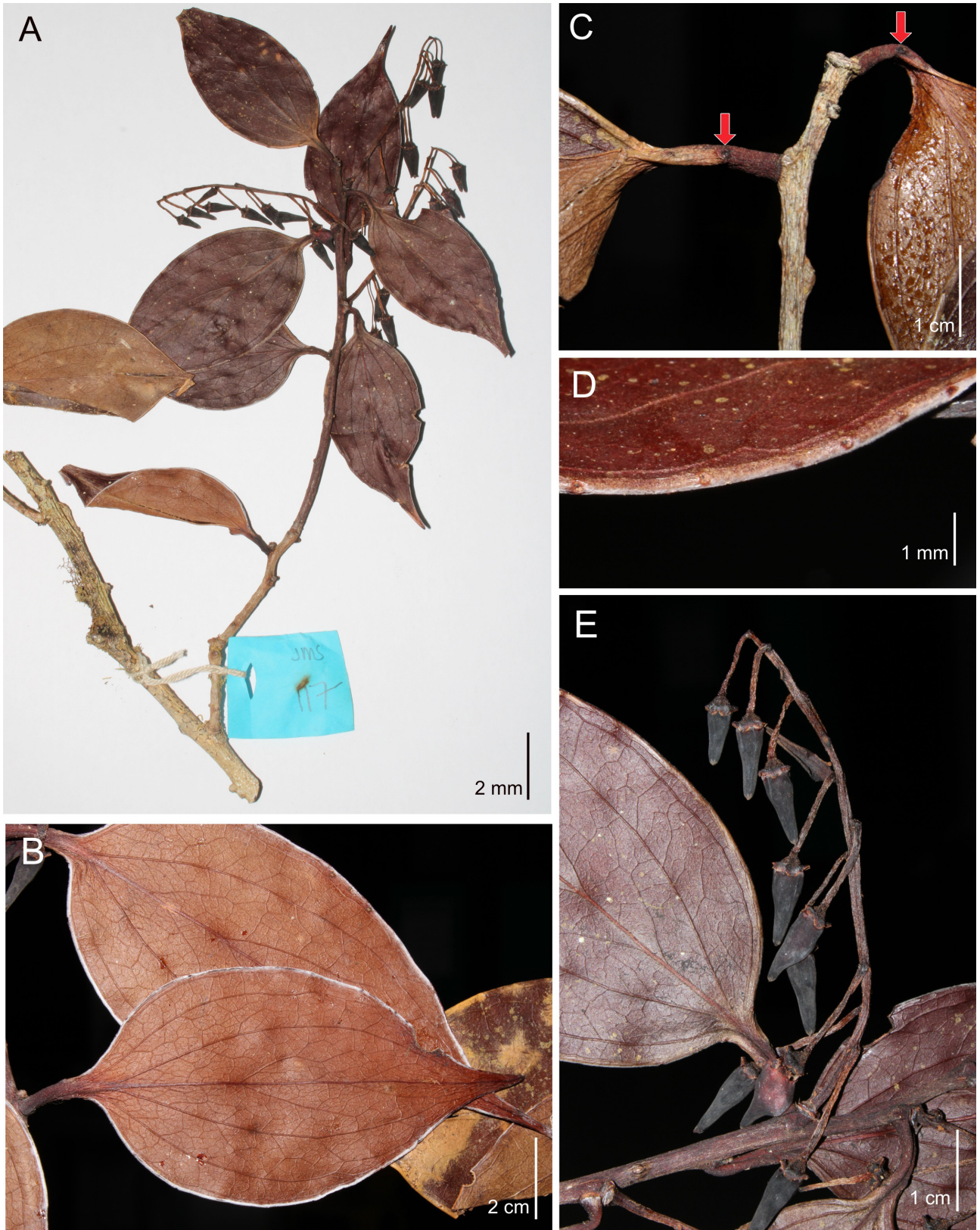


FIGURE 5. *Vaccinium vomicum*. **A.** Flowering branchlet. **B.** Abaxial view of leaf. **C.** Glands on the extreme end of the leaf blade base (red arrows). **D.** Adaxial view of leaf blade margin showing marginal glands. **E.** Inflorescence. All from *JMS 117*; photos by M.N. Tamayo.

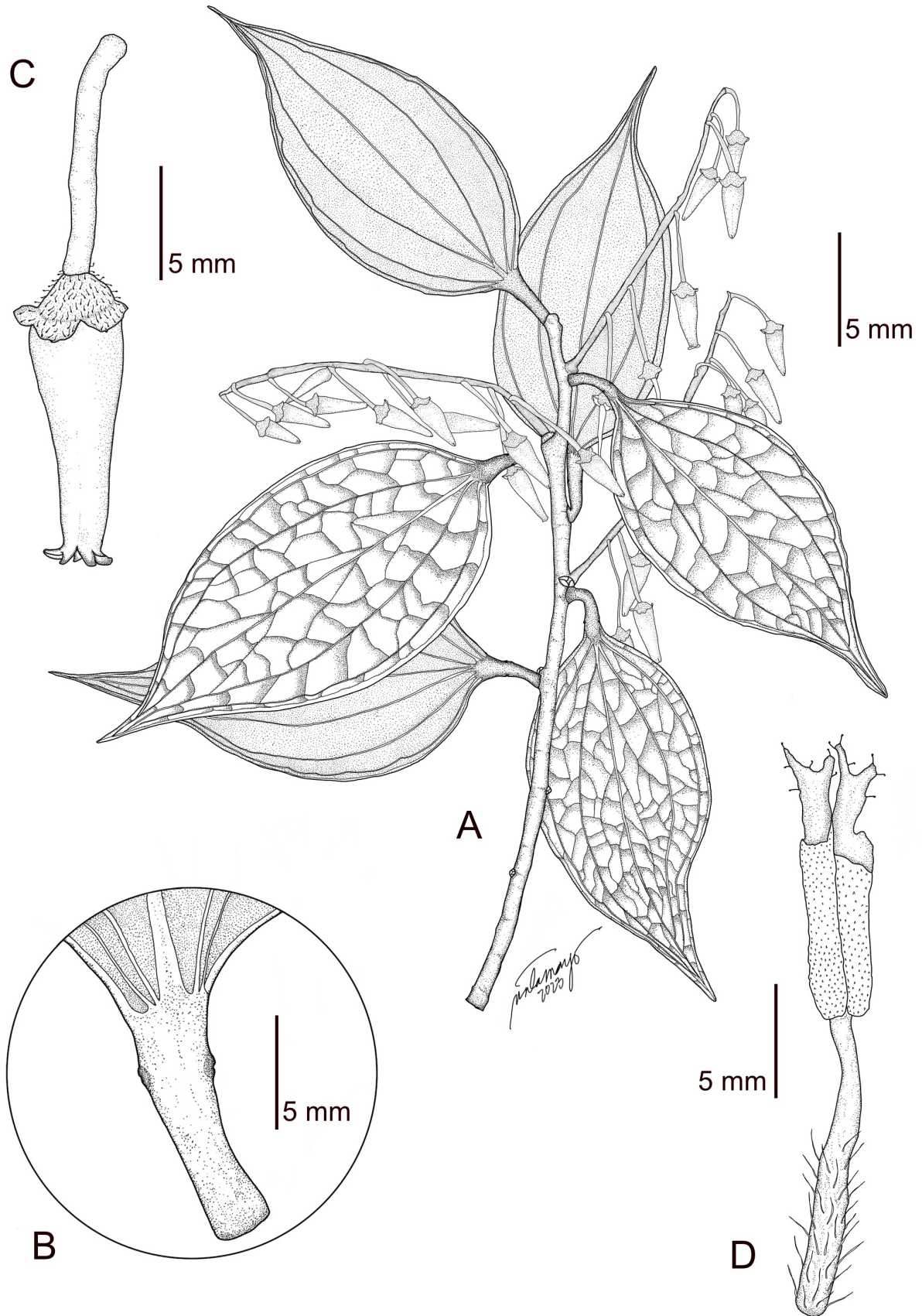


FIGURE 6. *Vaccinium vomicum*. **A.** Flowering branchlet. **B.** Petiole showing glands on the extreme end of the leaf blade base. **C.** Flower showing pedicel, hypanthium, calyx, and corolla. **D.** Ventral view of stamen. Illustration by M.N. Tamayo.

lobes 5 or 6, broadly triangular or slightly rounded, glabrous on both sides, 0.7–0.8 mm long, margin entire, minutely ciliolate, with several scattered long clavate glands, with a sessile terminal gland. **Corolla** red, tubular-ampullaceous, gradually narrowed toward lobes, glabrous or occasionally with a few clavate glands outside, glabrous inside, 8.0–11.0 × 3.5–4.0 mm; lobes 5 or 6, narrowly triangular, ca. 0.8 × 0.7 mm, apex acute to rounded. **Stamens** 10 or 12, monomorphic, free from each other, 4.5–5.5 mm long; filaments straight, 3.5–3.8 mm long, sparsely white-pubescent, trichomes filamentous, 0.8–1.0 mm long, mainly at base and sparsely scattered distally; anthers opening by short introrse slits or terminal pores, 2.3–2.5 mm long, shorter than filaments, cells narrowly oblong, minutely echinulate, 1.2–1.5 mm long, tubules parallel, cylindrical, 1.5–1.7 mm long, slightly longer than cells, opening by oblique ventrally- to laterally-oriented apical pores, pores obliquely cut, apex serrate with a few scattered glandular trichomes ca. 0.2 mm long, spurs absent. **Ovary** 5- or 6-locular but appearing pseudo-10- to 12-locular with incomplete partitions extending ca. 0.20 mm from inner wall; ovules in two columns per locule; disk, slightly bulky, annular with obscure ridges on margin, 1.5–2.0 mm in diameter, glabrous; style not exerted from corolla, glabrous, 9–10 mm long, stigma truncate. **Fruits** not observed.

Distribution and Habitat:—This new species is restricted to the upper montane rain forest of Mt. Kitanglad range.

Etymology:—The epithet “vomicum” is Latin meaning abscess or sore. This is in reference to the conspicuous pair of glands on the extreme end of the leaf base of this species.

Phenology:—Flowering in September.

Proposed Conservation Status:—The species has been collected only once, during an inventory of flowering plants in 2007 at Mt. Kitanglad mountain range; a protected area and a designated ASEAN Heritage Park. The lack of population data hinders assessment of this species in accordance with IUCN guidelines. Thus, we provisionally assess this species as data deficient (DD) (IUCN Standards and Petitions Committee 2022).

Discussion:—*Vaccinium vomicum* is the only species of Philippine *Vaccinium* bearing glands on the extreme end of the leaf blade base. Normally, marginal glands on the leaves of Philippine *Vaccinium* are located some distance from the petiole along the margin, or spread throughout the length of the leaf margin, but never at the extreme end of the leaf blade base. These glands in *Vaccinium* and other species in the tribe Vaccinieae may serve as extrafloral nectaries to attract pollinators (Argent 2019). The clavate glands on the hypanthium of *V. vomicum* resemble those of *V. nitens* Sleumer (1961: 97), endemic to Mindoro Island, Philippines. *Vaccinium vomicum* differs from *V. nitens* by having larger leaves [5–9 × 1.8–5.2 cm vs. (4–)5–7 × 2.4–4 cm], an eglandular adaxial leaf surface (vs. bearing clavate glands), leaf marginal glands distributed along the length of the leaf margin (vs. bearing only a single pair of basal glands), longer pedicels [8–16 mm vs. 5–6(–7) mm], and a serrate anther tubule apex (vs. non-serrate).

The stipitate glands borne at the apex of the tubules of *Vaccinium vomicum* are usually not observed in Philippine *Vaccinium* but do occur in some other Malesian species (Sleumer, 1966–1967; Mustaqim *et al.* 2022; Argent & Wilkie 2020). The only Philippine *Vaccinium* known to have such glands on its anther tubules is *V. palawanense* Merrill (1908: 373) (Sleumer 1966–1967). *Vaccinium vomicum* differs from *V. palawanense* by having longer petioles [0.6–1 cm vs. 0.2–0.4(–0.6) cm], larger leaves [5–9 × 1.8–5.2 cm vs. (4–)5–7 × 1.5–2(–3) cm], a tubular-ampullaceous corolla (vs. urceolate), an absence of anther spurs (vs. presence), and a glabrous disk (vs. pubescent).

In the key to the Malesian species of *Vaccinium* sect. *Bracteata* sensu Sleumer (1966–1967), the new species best keys to *V. muriculatum* J.J. Smith (1914: 161) endemic to New Guinea but differs by having petiolar glands (vs. absent), longer petioles (0.6–1 cm vs. 0.2–0.5 cm), longer pedicels (8–16 mm vs. 3–6 mm), and a longer (8–11 mm vs. 6–7 mm) tubular-ampullaceous corolla (vs. urceolate).

In the artificial key to Philippine *Vaccinium* of Copeland (1930), *V. vomicum* best keys to *V. tenuipes*. *Vaccinium vomicum* differs from *V. tenuipes* by having longer petioles (0.6–1 cm vs. ca. 0.3 cm), larger leaves (5–9 × 1.8–5.2 cm vs. 3–5 × 1–2.5 cm), an inflorescence and a hypanthium with clavate glands (vs. stipitate), and anthers with stipitate glands (vs. eglandular). In the key to Bornean *Vaccinium* (Argent 2019), *V. vomicum* best keys to *V. sarawakense* subsp. *montanum* Argent (2019: 108) but differs by having longer petioles (0.6–1 cm vs. 0.5–0.6 cm), fewer flowers per inflorescence (10–12 vs. 7–20), longer pedicels (8–16 mm vs. 2–3 mm), a long-tubular (ampullaceous) corolla (vs. ovoid-urceolate), and anthers without spurs (vs. with spurs).

Acknowledgments

We thank the Central Mindanao University through the Center for Biodiversity Research and Extension in Mindanao and the Plant Discovery in the Southern Philippines field team for logistical support in the field; the Department of Environment and Natural Resources and the indigenous people of Bagobo, Higaonon, and Talaandig for permits and field support; and the herbaria A, CAS, CMUH, NY, PNH, UC, and US for access to collections. We gratefully acknowledge the financial support of the U.S. National Science Foundation (grants DEB-1754697, DEB-1754667, DEB-1146409 to PWF and DSP). MNT thanks the Department of Biology, College of Science and Engineering at Texas Christian University, for a TCU SeRC grant, the International Association for Plant Taxonomy for a 2022 Research Grant, the American Society of Plant Taxonomists for a William R. Anderson Research Grant 2022, and the Botanical Research Institute of Texas for additional financial support.

References

- Argent, G. (2008) A checklist of Philippine Ericaceae. *Philippine Journal of Systematic Biology* 2: 40–46.
<https://doi.org/10.3860/pjsb.v2i1.900>
- Argent, G. (2014) *Vaccinium utteridgei* (Ericaceae), a new species (sect. *Bracteata*) from Indonesian New Guinea. *Edinburgh Journal of Botany* 71: 189–192.
<https://doi.org/10.1017/S0960428614000080>
- Argent, G. (2019) *Rigiolepis* and *Vaccinium* (Ericaceae) in Borneo. *Edinburgh Journal of Botany* 76: 55–172.
<https://doi.org/10.1017/S0960428618000276>
- Argent, G.P. & Wilkie, P. (2020) Six new species of *Vaccinium* (Ericaceae) from New Guinea. *Edinburgh Journal of Botany* 77: 439–453.
<https://doi.org/10.1017/S0960428620000104>
- Bachman, S., Moat, J., Hill, A.W., de la Torre, J. & Scott, B. (2011) Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. *ZooKeys* 150: 117–126.
<https://doi.org/10.3897/zookeys.150.2109>
- Beentje, H. (2016) *The Kew plant glossary*, Second Edition. Kew Publishing, Kew, Richmond, Surrey, pp. 1–200.
- Blume, C.L. (1826) *Bijdragen tot de flora van Nederlandsch Indië*. Lands Drukkerij, Batavia, 1169 pp.
<https://doi.org/10.5962/bhl.title.115427>
- Co, L.L., Madulid, D. & Argent, G. (2002) A new species of *Vaccinium* (Ericaceae) from the Philippines. *Edinburgh Journal of Botany* 59: 373–376.
<https://doi.org/10.1017/S0960428602000227>
- Copeland, H.F. (1930) Philippine Ericaceae, II: the species of *Vaccinium*. *Philippine Journal of Science* 42: 537–607.
- Cronquist, A. (1978) Once again, what is a species? In: Knutson, L.V. (Ed.) *Biosystematics in agriculture*. Allenheld Osmin, Montclair, New Jersey, pp. 3–20.
- Drude, O. (1889) Ericaceae. In: Engler, A. & Prantl, K. (Ed.) *Die natürlichen Pflanzenfamilien* 4, Leipzig, 1–310 pp.
- Elmer, A.D.E. (1912) Ericaceae. *Leaflets of Philippine Botany* 4: 1149–1532.
- Fernando, E.S., Suh, M.H., Lee, J. & Lee, D.K. (2008) *Forest formations of the Philippines*. ASEAN-Korea Environmental Cooperation Unit, Seoul National University, Korea, 232 pp.
- Fritsch, P.W., Amoroso, V.B., Coritico, F.P. & Penneys, D.S. (2020) *Vaccinium hamiguitanense* (Ericaceae), a new species from the Philippines. *Journal of the Botanical Research Institute of Texas* 14: 281–287.
<https://doi.org/10.17348/jbrit.v14.i2.1009>
- IUCN Standards and Petitions Committee. (2022) *Guidelines for using the IUCN Red List Categories and Criteria. Version 15*. Prepared by the Standards and Petitions Committee. Available from: <http://www.iucnredlist.org/documents/RedListGuidelines.pdf> <http://www.iucnredlist.org/documents/RedListGuidelines.pdf> (accessed 2 December 2022).
- Jussieu, A.L. de (1789) *Genera plantarum secundum ordines naturales disposita, juxta methodum in Horto Parisiensi exarata*. Paris, France, 498 pp.
<https://doi.org/10.5962/bhl.title.284>
- Linnaeus, C. (1753) *Species plantarum*, Vol. 1. Salvius, Stockholm, 1200 pp.
- Merrill, E.D. (1908) Philippine Ericaceae. *Philippine Journal of Science* 3, section C (Botany): 369–382.
- Miquel, F.A.W. (1859) *Flora van Nederlandsch Indië*, Vol. 2, C.G. van der Post, Amsterdam, 1103 pp.

- Mueller, B.F.V. (1890) *Descriptive notes on Papuan plants* 2 (9).
- Mustaqim, W.A. & Ardi, W.H. (2019) Ericaceae of Sulawesi: a new species of *Diplycosia*, a new variety of *Vaccinium paludicolum* and one rediscovery. *Telopea* 22: 193–204.
<https://doi.org/10.7751/telopea13168>
- Mustaqim, W.A., Fritsch, P.W., Ahmad, R.P.P., Lakiu, F.S., Pitopang, R. & Ardi, W.H. (2022) *Vaccinium* (Ericaceae) in Sulawesi: a new species and list of known taxa. *Telopea* 25: 301–307.
<https://doi.org/10.7751/telopea15774>
- Nakai, T. & Koidzumi, G. (1927) *Trees and shrubs indigenous in Japan proper* (revised Ed.), Vol. 1, Seibido Shoten, Tokyo, 714 pp.
- Pelser, P.B., Barcelona, J.F. & Nickrent, D.L. (Eds.) (2011) *Co's digital flora of the Philippines*. Available from: www.philippineplants.org (accessed 29 August 2022).
- Quinn, C.J., Brown, E.A., Heslewood, M.M. & Crayn, D.M. (2005) Generic concepts in Styphelieae (Ericaceae): the *Cyathodes* group. *Australian Systematic Botany* 18: 439–454.
<https://doi.org/10.1071/SB05005>
- Salares, V.B., Obico, J.J.A., Ormerod, P., Barcelona, J.F. & Pelsner, P.B. (2018) Taxonomic novelties from Cebu: a new species of *Vaccinium* (Ericaceae) and a new record of *Phaius* (Orchidaceae) for the Philippines. *Phytotaxa* 360 (3): 255–262.
<https://doi.org/10.11646/phytotaxa.360.3.5>
- Schlechter, R. (1919) Die Ericaceen von Deutsch-Neu-Guinea. *Botanische Jahrbücher* 55: 137–194.
- Schwery, O., Onstein, R.E., Bouchenak-Khelladi, Y., Xing, Y., Carter, R.J. & Linder, H.P. (2015) As old as the mountains: the radiations of the Ericaceae. *New Phytologist* 207: 355–367.
<https://doi.org/10.1111/nph.13234>
- Sleumer, H. (1961) Flora Malesianae precursores XXVIII, the genus *Vaccinium* in Malaysia. *Blumea* 11: 1–112.
- Sleumer, H. (1966–1967) Ericaceae: In: C.G.G.J. van Steenis (Ed.) *Flora Malesiana*. Ser. 1, Vol. 6, Parts 4, 5. Wolters-Noordhoff, Groningen, pp. 469–914.
- Smith, J.E. (1793–1795) *A Specimen of the botany of New Holland*, London, 54 pp.
- Smith, J.J. (1910) *Icones Bogorienses*, Vol. 4. Brill, Leiden, The Netherlands, 324 pp.
- Smith, J.J. (1914) Ericaceae. *Nova Guinea* 12: 18–168.
- Tamayo, M.N., Bustamante, R.A.A. & Fritsch, P.W. (2021) *Vaccinium exiguum* (Ericaceae, Vaccinieae), a new species from the ultramafic summit of Mt. Victoria, Palawan Island, Philippines. *PhytoKeys* 179: 145–154.
<https://doi.org/10.3897/phytokeys.179.68323>
- Tamayo, M.N., Coritico, F.P., Amoroso, V.B., Penneys, D.S., Tandang, D.N. & Fritsch, P.W. (2022) *Vaccinium carmesinum* (Ericaceae), a new species of blueberry from Mt. Tago Range, Mindanao Island, Philippines. *Phytotaxa* 533 (3): 173–180.
<https://doi.org/10.11646/phytotaxa.533.3.3>
- Tamayo, M.N. & Fritsch, P.W. (2022a) *Vaccinium paradoxum* (Vaccinieae, Ericaceae), an unusual new species from sea cliffs on ultrabasic forest of Luzon Island, Philippines. *Taiwania* 67 (3): 408–412.
<https://doi.org/10.6165/tai.2022.67.408>
- Tamayo, M.N. & Fritsch, P.W. (2022b) Two new endemic species of blueberry (*Vaccinium* L., Ericaceae) from Luzon and Mindanao Islands, Philippines. *Phytotaxa* 564 (2): 139–148.
<https://doi.org/10.11646/phytotaxa.564.2.1>
- Tamayo, M.N., Fernando, E.S. & Fritsch, P.W. (2023) *Vaccinium coarctatum* (Ericaceae), an ultramafic-obligate new species from the dwarf forest of Mount Redondo, Dinagat Island, Philippines. *Edinburgh Journal of Botany* 80: 1–12.
<https://doi.org/10.24823/EJB.2023.1960>
- Thiers, B. (2022) [continuously updated] Index Herbariorum. <https://sweetgum.nybg.org/science/ih/> (accessed 11 October 2022).
- Vander Kloet, S.P. (1988) The genus *Vaccinium* in North America. Research Branch Agriculture Canada Publication 1828, Ottawa, Canada, 258 pp.
- Vander Kloet, S.P. (1996) Floristics of Philippine *Vaccinium* (Ericaceae). *Proceedings of the first international symposium on floristic characteristics and diversity of East Asian plants*. China Higher Education Press, Beijing, pp. 114–119.
- Vander Kloet, S.P. & Dickinson, T.A. (2009) A subgeneric classification of the genus *Vaccinium* and the metamorphosis of *V.* section *Bracteata* Nakai: more terrestrial and less epiphytic in habit, more continental and less insular in distribution. *Journal of Plant Research* 122: 253–268.
<https://doi.org/10.1007/s10265-008-0211-7>
- Veldkamp, J.F. (1979) A new *Vaccinium* (Ericaceae) from Papua New Guinea. *Blumea* 25: 479–480.

APPENDIX 1. Additional *Vaccinium* specimens examined for morphological comparison.

Vaccinium apiculatum Sleumer. PAPUA NEW GUINEA. Hagen Sub-district, W. Highlands, 8 July 1957, *R. G. Robbins* 296 (holotype CANB CANB41724-image!).

Vaccinium carmesinum M.N.Tamayo & P.W.Fritsch. PHILIPPINES. Mindanao Island, Bukidnon Province, Municipality [City] of Malaybalay, Barangay Kibalabag, Mt. Limbawon, [Mt. Tago Range,] accessory trail to peak 8.26217°N, 125.18055°E, 1546 m, 10 June 2019, *Plants and Lichens of the Southern Philippines Survey 611* (holotype PNH!, isotype BRIT BRIT572077!); *ibid.* open area with *Pandanus*, 8.27577°N, 125.18333°E, 1832 m, 30 June 2015, *P.W. Fritsch 2081* (BRIT BRIT554025!, CAS 490415!); *ibid.* Mt. Kiamo summit, [Mt. Tago Range,] on ridge of heathland scrub, 8.2563°N, 125.14799°E, 1760 m, 7 May 2014, *D.S. Penneys 2377* (BRIT BRIT554030!, CAS 490401!).

Vaccinium gitingense Elmer. PHILIPPINES. Sibuyan Island, Province of Capiz (currently Province of Romblon), May 1910, *Elmer 12555* (isotypes A 00016176-image!, BISH BISH1001436-image!, BM BM000996591-image!, HBG HBG-507691-image!, K K000780776-image!, MICH 1111147-image!, NY 00010730!, US 00116911!); *ibid.* Mindanao Island, Province of Surigao, April 1919, *Ramos and Pascasio 34577* (NY 04204565!, UC 413691!), *Ramos and Pascasio 34591* (A 02006682!); *ibid.* Mindanao Island, Province of Davao Oriental, 21 June 2015, *P.W. Fritsch 1971* (BRIT BRIT467364!); *ibid.* Mindanao Island, Province of Davao Oriental, 24 June 2015, *P.W. Fritsch 2043* (BRIT BRIT467365!).

Vaccinium hamiguitanense P.W.Fritsch. PHILIPPINES. Mindanao Island, Province of Davao Oriental, 23 June 2015, *P.W. Fritsch 2027* (isotypes BRIT BRIT554024!, CAS 490410!).

Vaccinium muriculatum J.J.Smith. PAPUA NEW GUINEA. Arfak Mountains, ca. 1900 m, 26 April 1912, *Gjellerup 1086* (isotype U 0042531-image!).

Vaccinium myrtooides (Blume) Miquel. PHILIPPINES. Luzon Island, Mountain Province, March 1948, *Celestino 4331* (A 02006736!); *ibid.* Province of Benguet, 24 January 1968, *Jacobs 7132* (L 2619536-image!); *ibid.* Province of Benguet, 30 January 1968, *Jacobs 7238* (A 02006740!); *ibid.* Province of Benguet, 27 March 1987, *Burley 28* (A 02006771!); *ibid.* Province of Benguet, 9 June 1996, *PPI 26572* (BRIT BRIT26915!); *ibid.* Province of Laguna, April 1925, *Sulit 30077* (UC 291897!); *ibid.* Province of Tayabas (now part of Quezon Province), March 1907, *Foxworthy 2390* (NY 04204517!). *ibid.* Negros Island, 7 May 1953, *Rabor 16700* (A 02006754!); *ibid.* Province of Negros Occidental, SW facing slope of Mt. Kanlaon, near summit crater, above Guintubdan, 31 March 1992, *PPI 6486* ((BRIT BRIT26876!). *ibid.* Camiguin Island, Municipality of Mambajao, Barangay Esperanza, Sitio Tagdo, Mt. Hibok-hibok, trail to summit, low shady forest, 8 July 2015, *P.W. Fritsch 2116* (BRIT BRIT467366!). *ibid.* Mindanao Island, Todaya (Mt. Apo) District of Davao, August 1909, *Elmer 11767* (A 02006735!); *ibid.* Province of Davao, 13 November 1946, *Edaño 1458* (A 02006738!). INDONESIA. Celebes, Sulawesi Utara, Bolaang Mongondow, Gulung Ambang Nature Reserve, 19 April 1985, *de Vogel & Vermeulen 7276* (L 2619564-image!).

Vaccinium nitens Sleumer. PHILIPPINES. Mindoro Island, Mt. Yagaw (eastern Slope), 830 m, 7 June 1953, *Sulit & Conklin 17677* (isotype A 02006811!).

Vaccinium palawanense Merrill. PHILIPPINES. Palawan Island, Mt. Victoria, 23 March 1906, *Bur. Sci. 696 Foxworthy* (isotypes A 00016189!, K K000780764-image!, L 0008170-image!, NY 00010742!, NY 00010743!, US 00116932!).

Vaccinium sarawakense subsp. *montanum* Argent. MALAYSIA. Sabah, Keningau District, track from Keningau past Crocker Range, headquarters across range, 17 October 1999, *Davies et al. SJD99145* (isotype E E00106501-image!).

Vaccinium tenuipes Merrill. PHILIPPINES. Luzon Island, Benguet Province (Mt. Pulogloco), September 1921, *M. Ramos & G. Edaño 40404* (A 02006789!); *ibid.* Anilog, Rizal Province, March 1914, *A. Loher 14173* (UC 242975!); *ibid.* Mindoro Island, Barangay Lantuyan (Mt. Halcon), Oriental Mindoro Province, ca. 1200 m, 13 March 1997, *PPI 20045* (BRIT BRIT26879!; BRIT BRIT26909!); *ibid.* Negros Island, Dumaguete (Cuernos Mountains), Negros Oriental Province, May 1908, *A.D.E. Elmer 10108* (U 0111118!); *ibid.* Sibulan, Kabalanan (Lake Balinsasayao), Negros Oriental Province, 18 May 1991, *PPI 935* (BRIT BRIT26883!).