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VACCINIUM COARCTATUM (ERICACEAE), AN ULTRAMAFIC-OBLIGATE NEW SPECIES FROM THE DWARF FOREST OF MOUNT REDONDO, DINAGAT ISLAND, PHILIPPINES

M. N. Tamayo ¹, E. S. Fernando ² & P. W. Fritsch ³

A new species of blueberry, *Vaccinium coarctatum* M.N.Tamayo & Fernando, from the dwarf forest on ultramafic soil of Dinagat Island, Philippines, is described. It closely resembles *Vaccinium hamiguitanense* P.W.Fritsch but is distinct from that species in having a longer inflorescence, shorter pedicels, longer and persistent bracteoles, white-hirsutulous calyx lobes, and shorter anther spurs. This discovery brings the number of *Vaccinium* species known from the Philippines to 41. A key to the small-leaved *Vaccinium* in the Philippines is provided.

Keywords. Blueberry, Mindanao Island, mining, serpentine soil, Vaccinieae.

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Introduction

The Dinagat Islands are composed of an aggregate of various land formations on the northeastern edge of Mindanao Island in the Philippines. The islands constitute a province designated as a Key Conservation Site PH081 (Mallari *et al.*, 2001) and a Key Biodiversity Area spanning 28,524.31 ha of land (Philippine Clearing House Mechanism, 2022). This region served as passage for migrating species in Mindanao and the Eastern Visayas Islands during the Upper Pleistocene (Heaney, 1986). Thus, the Dinagat Islands are home to an array of microendemic species of animals and plants (e.g. Musser *et al.*, 1985; Mohagan *et al.*, 2013; Brown *et al.*, 2014; Sanguila *et al.*, 2016; Brown *et al.*, 2018; Fernando *et al.*, 2018; Robinson *et al.*, 2019; Fernando & Wilson, 2021). The high degree of biodiversity and endemism, especially on the large main island, strongly underscores the need for protection and conservation of their habitats. Like many other biodiverse areas in the Philippines, however, they are gravely threatened by anthropogenic disturbance, especially mining, which is detrimental to most species there (Villanueva, 2010; Fernando & Wilson, 2021).

The genus *Vaccinium* L. (Linnaeus, 1753: 349; Ericaceae: Vaccinieae; blueberries) comprises an estimated 450–500 species nearly cosmopolitan in distribution except in Antarctica and Australia (Sleumer, 1966–1967; Argent, 2014). New species discoveries of Philippine *Vaccinium* over the past three years (i.e. Fritsch *et al.*, 2020; Tamayo *et al.*, 2021; Tamayo & Fritsch, 2022a, 2022b; Tamayo *et al.*, 2022) have increased the species count

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of Philippine *Vaccinium* to 40 (Tamayo & Fritsch, 2022b). Of these, 22 are recorded from Mindanao Island (Pelser *et al.*, 2011 onwards). As part of an effort to produce a taxonomic revision of Philippine *Vaccinium*, ongoing botanical excursions to remote areas of the Philippines can be expected to lead to more new species discoveries in the country.

During fieldwork carried out as part of a floristic survey of the ultramafic dwarf forest of Mount Redondo, Dinagat Island, an unknown flowering *Vaccinium* shrub with small leaves was encountered and vouchered. A follow-up excursion at a higher elevation within the same locality led to discovery of a few additional flowering and fruiting individuals, which were also vouchered. The unknown *Vaccinium* was found only at the two sites, together covering the upper montane rain forest (Fernando *et al.*, 2008) of the ultramafic dwarf forest. Based on preliminary observations, we hypothesised that these plants represent an undescribed species.

Materials and methods

The new species was described from spirit collections preserved in 70% ethyl alcohol solution, dried herbarium specimens, and *in situ* photographs. The flowers were dissected and examined with a stereomicroscope ($\times 50$ magnification). Characters in the description were defined as in Beentje (2016). Relevant taxonomic literature on Philippine and Malesian *Vaccinium* was consulted (i.e. Copeland, 1930; Sleumer, 1966–1967; Co *et al.*, 2002; Argent, 2008; Salares *et al.*, 2018; Argent, 2019; Argent & Wilkie, 2020; Fritsch *et al.*, 2020; Tamayo *et al.*, 2021; Tamayo & Fritsch, 2022a, 2022b; Tamayo *et al.*, 2022). The area of occupancy and extent of occurrence of the new species were calculated with the aid of GeoCAT (Bachman *et al.*, 2011). Its conservation status was likewise assessed with IUCN guidelines (IUCN Standards and Petitions Committee, 2022).

Results

The vouchered specimens were studied and compared with other *Vaccinium* in the Malesian floristic region. Results show that the unknown species exhibited significant character differences warranting its status as undescribed. Thus, we here formally describe this species as new to science, under a morphological species concept (Cronquist, 1978). We also provide photographs, an illustration, and a key to the small-leaved species of *Vaccinium* (i.e. those with leaf blades < 2 cm long) in the Philippines.

Taxonomic treatment

Vaccinium coarctatum M.N.Tamayo & Fernando, sp. nov.

Vaccinium coarctatum resembles *V. hamiguitanense* P.W.Fritsch but differs in having longer inflorescences (c.4.5 cm vs c.1.6 cm), shorter pedicels (2–3 mm vs 3–4 mm), longer bracteoles (6–8 mm vs 0.14–0.54 mm) that are persistent (vs caducous),

hirsutulous calyx lobes (vs glabrous), and shorter anther spurs (0.2–0.3 mm vs 0.2–0.4 mm). – Type: Philippines, Dinagat Islands Province, Dinagat Island, Municipality of Loreto, Mt Redondo, dwarf forest on ultramafic soil, 10°21'6.91"N, 125°38'12.48"E, 878 m a.s.l., 1 ix 2016, E.S. Fernando 4202 (holotype PNH!; isotypes LBC 9623!, PUH 21855!) [acronyms follow Thiers ([continuously updated](#))]. **Figures 1, 2.**

Shrubs, terrestrial, evergreen, 1–2 m tall, densely branched. *Young branchlets* reddish, white-hirsutulous with simple erect trichomes 0.2–0.3 mm long. *Mature branchlets* greyish or greenish brown, 1.5–4 mm wide, often ridged, lenticellate, glabrescent; perennating buds compressed-ovoid, 0.5–0.9 mm long, with several obscurely overlapping scales. *Leaves* persistent on older branchlets, densely crowded, spirally and evenly arranged, ± imbricate; petiole dark green, occasionally with a tinge of red, in cross section abaxially rounded, adaxially nearly flat, 1–2.2 × 0.8–1 mm, white-hirsutulous; leaf blade oblong, obovate, or narrowly elliptical, larger leaves on each branchlet 5.2–17 × 3–5 mm, coriaceous, abaxial surface pale green, light brown *in sicco*, adaxial surface glossy green (dark brown *in sicco*), glabrous, base cuneate, margin faintly crenulate to entire, thinly revolute, apex emarginate, ± white hirsutulous, marginal glands 4 or 5(6) per side, sunken, scattered along length of margin, c.0.15 mm in diameter, midvein slightly raised abaxially, sunken adaxially or nearly so, secondary veins 2 to 3(4) on each side of midvein with basal pair arising from base and remainder along midvein, arc-ascending, obscure on both surfaces *in situ*, more evident abaxially *in sicco*, tertiary veins faintly evident or obscure. *Inflorescences* pseudoterminal or terminal, racemose, developing beyond confines of perennating bud, 1 per axil, c.4.5 cm long, ± densely 3- to 8-flowered; peduncle and rachis green, puberulent, slightly ridged with erect trichomes same as branchlets, peduncle 1.5–2 cm, rachis 2–2.5 cm, bracts borne at base of pedicels, light green, involute, ± imbricate, foliaceous, elliptic or lanceolate, planar or occasionally cucullate, 10–13 × 3–4.5 mm, coriaceous, glabrous except sparsely white-hirsutulous on midvein, margin entire, thinly revolute, with 3–5(6) impressed and gland-tipped crenations per side, base cuneate, sparsely white-hirsutulous, apex obtuse or rounded. *Flowers* articulated at junction with pedicel, 1–1.2 cm long. *Pedicel* slightly nodding, 2–3 × 0.7–0.8 mm at anthesis, white-hirsutulous; bracteoles 2, persistent until fruit ripening, borne at base or c.0.5 mm from pedicel, light green with a tinge of red, linear-lanceolate to oblong or nearly so, 6–8 × 1–1.5 mm long, glabrous except the puberulent base, margin entire with faint gland-tipped crenations and simple erect trichomes, apex acute or rounded with occasional simple erect trichomes. *Hypanthium* orange with a tinge of pink or light green, cupuliform, 1.6–1.8 × 1.8–2 mm, glossy, slightly ridged, white-hirsutulous with simple erect trichomes c.0.15 mm long; calyx limb 1–1.2 mm long, white-hirsutulous; calyx lobes broadly triangular, 0.8–1 × 1.5–1.7 mm, adaxially white-hirsutulous, margin entire, apex acute or obtuse, white-hirsutulous, with a ± sessile terminal gland. *Corolla* white with a tinge of pink, broadly urceolate, 6–7 × 5–5.5 mm, shallowly

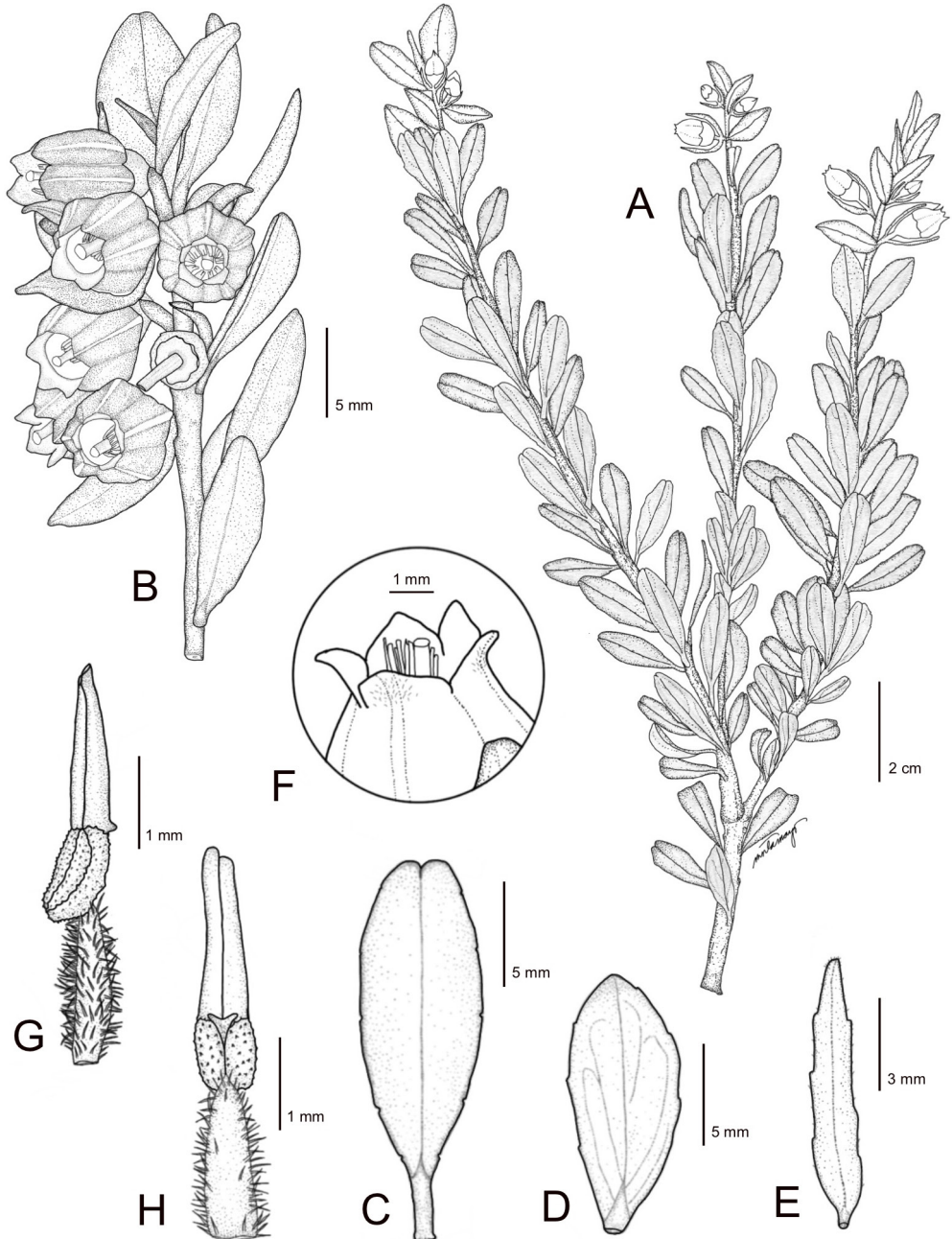


Figure 1. *Vaccinium coarctatum* M.N.Tamayo & Fernando, sp. nov. A, Flowering branchlets; B, inflorescence; C, leaf (adaxial view); D, bract (abaxial view); E, bracteole (adaxial view); F, corolla lobes; G, lateral view of stamen; H, dorsal view of stamen. Drawn from the holotype, *E.S. Fernando* 4202, by M. N. Tamayo.

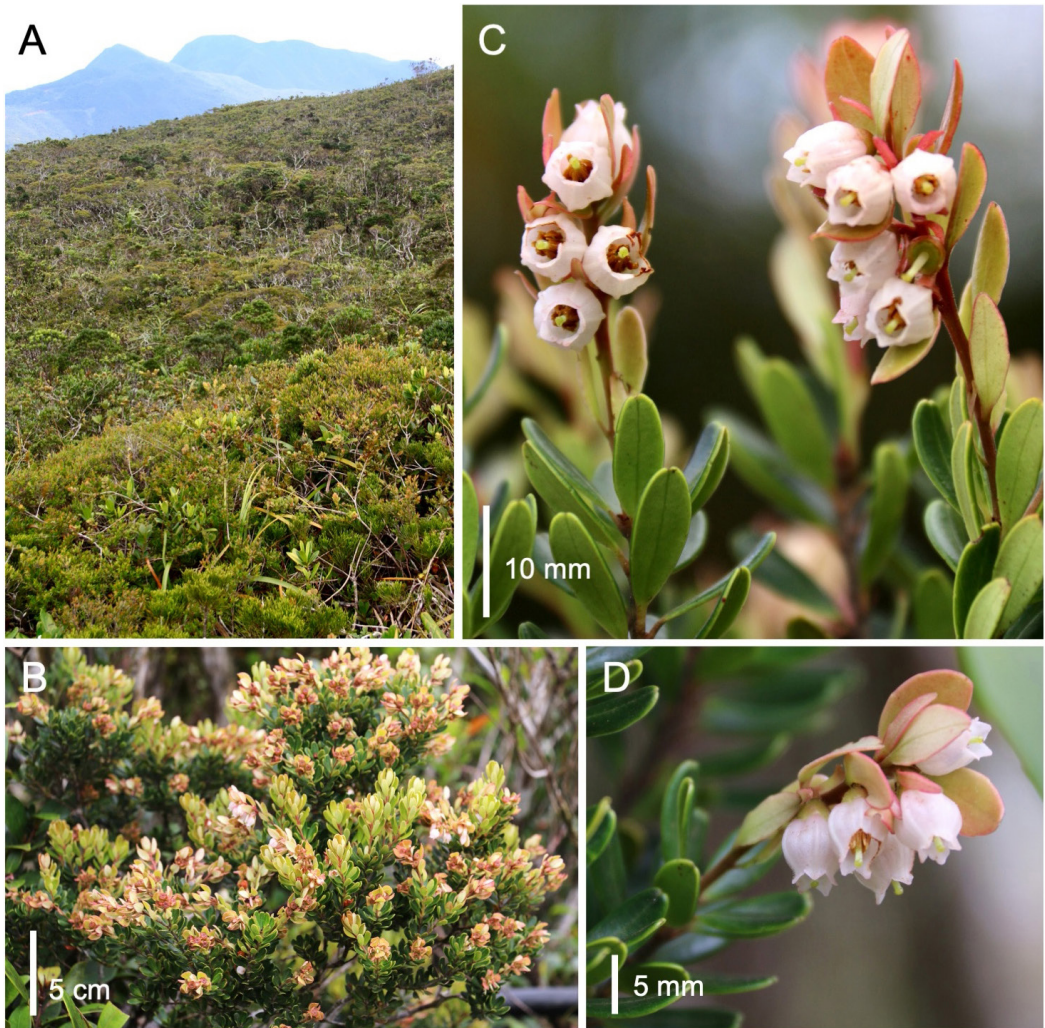


Figure 2. *Vaccinium coarctatum* M.N.Tamayo & Fernando, sp. nov. A, Upper montane rain forest of Mount Redondo, Dinagat Island, showing the dwarf vegetation in the habitat of the species; B, flowering branchlets; C, leaves and inflorescence (ventral view); D, lateral view of the inflorescence, showing corolla ridges and sulci. All photographs: E. S. Fernando.

5 to occasionally 6-sulcated, prominently ribbed along petal midveins, glabrous outside and inside, lobes 5 or occasionally 6, $1-1.2 \times 1-1.5$ mm, apex acute or obtuse. *Stamens* 8–10, monomorphic, distinct, 4.5–5.2 mm long; filaments straight or slightly curved, dorso-ventrally slightly flat, gradually dilated toward base, 1.7–2 mm long, white-hirsutulous with trichomes 0.2–0.3 mm long, anthers 2.7–3 mm long, slightly curved, opening by short introrse slits or terminal pores, cells 0.9–1.1 mm long, minutely echinulate, tubules parallel,

broadly cylindrical, 1.8–1.9 mm long, opening by oblique ventrally oriented apical pores, pore apex rounded or oblong, spurs present, borne \pm midway along anther, dorsally to slightly laterally oriented, 0.2–0.3 mm long. Ovary 5- or 6-locular but appearing pseudo-10- or 12-locular with false partitions extending 0.2–0.3 mm from inner wall; ovules in two columns per locule, each column separated by false partition; disk annular with ridges on margin, c.2 mm in diameter, glabrous; style tubular, not exerted from corolla, 5.5–6 mm long, glabrous, apex truncate. *Fruit* black at maturity, globose, 5–7 \times 5–6 mm, trichomes persistent.

Distribution. Known only from two localities in the dwarf ultramafic forest of Mount Redondo, Dinagat Island (Figure 3).

Habitat and ecology. The upper montane rain forest of Mount Redondo is considered a dwarf forest because it is composed of shrubs and small trees up to 3 m in height (Lillo *et al.*, 2019; Fernando & Wilson, 2021). *Vaccinium coarctatum* was observed flowering in September and fruiting in November.

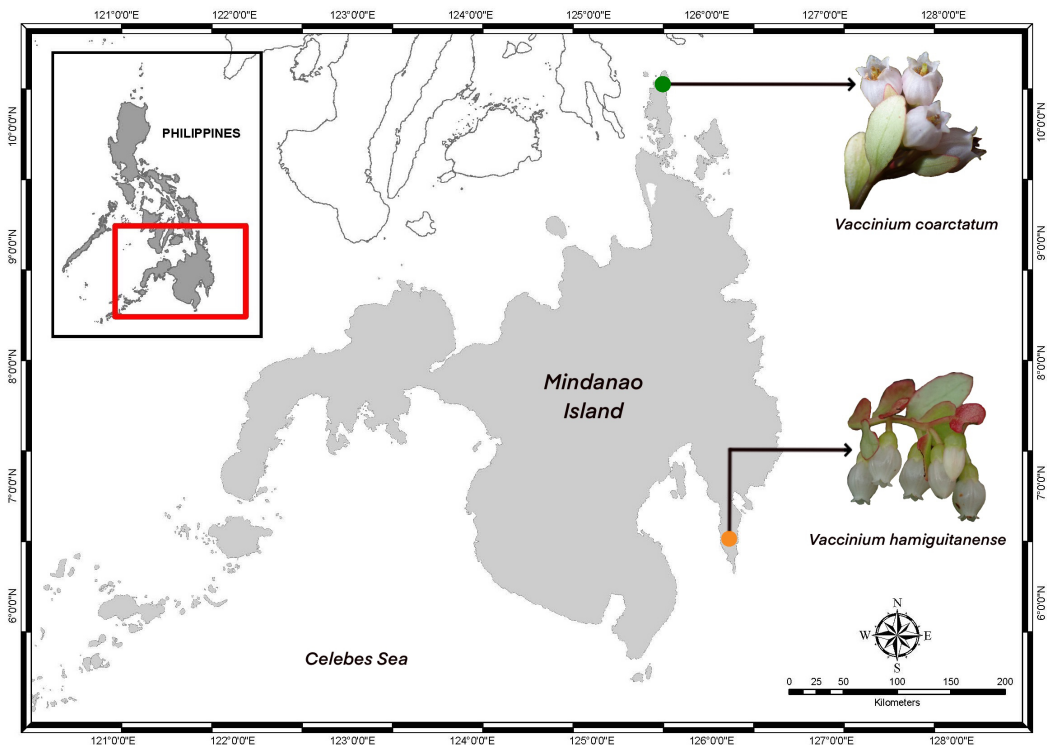


Figure 3. Distribution of *Vaccinium coarctatum* (green dot) and *V. hamiguitanense* (orange dot). Map created with ArcGIS version 10.5.

Etymology. The epithet *coarctatum* (neuter) is Latin for ‘crowded’ or ‘pressed together’. This is in reference to the growth habit and the slightly appressed flowers of the new species.

Proposed IUCN conservation category. From the two excursions conducted, only two flowering plants of the new species were found at the type locality. Although the vicinity of Mount Redondo consists of a dwarf forest, there were no other occurrences of *Vaccinium coarctatum* detected in the surrounding area. Therefore, its occurrence is rare (extent of occurrence, 0.046 km²; area of occupancy, 8.00 km²). Moreover, the eastern side of Mount Redondo is a chromium and nickel mining area. This anthropogenic disturbance adds to the pressure of possible extirpation. Therefore, in accordance with the criteria of the IUCN Standards and Petitions Committee (2022), we categorise the conservation status of *Vaccinium coarctatum* as Critically Endangered [CR: B1ab(i,ii,iii) + B2ab(i,ii,iii)].

Additional specimens examined (paratypes). PHILIPPINES. Dinagat Islands Province, Dinagat Island, Municipality of Loreto, Mt Redondo, dwarf forest on ultramafic soil, 820 m a.s.l., 9 ix 2015, E.S. Fernando 3821 (LBC!).

Discussion

Based on photographs from Co’s *Digital Flora of the Philippines* (Pelser et al., 2011 onwards) (digital photograph identifiers: DOL105337, DOL105346, DOL105374, DOL105420, DOL105427, DOL105475, DOL105501, DOL107583, DOL107596, DOL107602, DOL107612, DOL107623 and DOL107639, all at 10°21’10.188”N, 125°38’2.076”E), Fritsch et al. (2020) suggested that an undescribed species of *Vaccinium* allied to *V. hamiguitanense* occurs in the Redondo dwarf forest on Dinagat Island. The plant in these photographs, labelled ‘*Vaccinium* plant 3’, undoubtedly represents *V. coarctatum*, as is evident from its compact habit, elliptic to oblong leaves with emarginate apex, persistent bracts and bracteoles, and few-fruited infructescence. In addition to the characters mentioned in the diagnosis, *Vaccinium coarctatum* can be further distinguished from *V. hamiguitanense* by having more compressed branchlets (vs slightly compressed), leaf blades with a higher number of marginal glands per side (4 or 5(6) vs 2–4), and larger bracts (10–13 × 3–4.5 mm vs 5.9–8.3 × 3.5–4 mm). Furthermore, the geographical distributions of the two species are distant from each other (see Figure 3). The densely branched habit of *Vaccinium coarctatum* is a plausible adaptation to crowding in its habitat because most plants in the locality tend to compete for space and sunlight.

In the key to the Malesian species of *Vaccinium* sect. *Bracteata sensu* Sleumer (1966–1967), the new species best keys to *V. gitingense* Elmer, which can also be found at the type locality (E. S. Fernando, personal observation). *Vaccinium coarctatum* can be distinguished from *V. gitingense* by having faintly crenulate to entire leaf blade margins (vs subserrate-crenulate), an emarginate leaf blade apex (vs acuminate), fewer flowers per inflorescence

(3–8 vs 5–10), shorter pedicels (2–3 mm vs (7–)10–15 mm) that are white-hirsutulous (vs glabrous), and a glabrous disk (vs pubescent).

In the artificial key to Philippine *Vaccinium* (Copeland, 1930), *V. coarctatum* best keys to *V. myrtoides* (Blume) Miq., a species widely distributed across the Philippine Archipelago. *Vaccinium coarctatum* can be distinguished from *V. myrtoides* by having leaf blade marginal glands 4 or 5(–6) per side (vs 1 or 2, near leaf blade base), an emarginate leaf blade apex (vs acute to obtuse), shorter pedicels (2–3 mm vs 3–10 mm) that are pubescent (vs glabrous), a pubescent hypanthium (vs glabrous), and corolla with sulci (vs no sulci). In the key to Bornean *Vaccinium* (Argent, 2019), *V. coarctatum* best keys to *V. coriaceum* (var. *coriaceum sensu* Argent, 2019). The new species is distinct from *Vaccinium coriaceum* var. *coriaceum* by having longer (6–8 mm vs c.1 mm) and persistent (vs caducous) bracteoles, larger corollas (6–7 mm vs 3–6 mm) that are glabrous inside (vs pubescent proximally), gradually dilated filaments at base (vs terete), and a glabrous disk (vs pubescent).

The characters of *Vaccinium coarctatum* allow placement in *Vaccinium* sect. *Bracteata sensu* Sleumer (Sleumer, 1966–1967), i.e., racemose multiflowered inflorescences, hypanthium distinctly larger than calyx lobes, absence of a membranaceous wing at the sinuses of the corolla, and anthers that open by terminal pores. However, in accordance with the key in the revised sectional treatment by Vander Kloet and Dickinson (2009), *Vaccinium coarctatum* can be accommodated as a member of *Vaccinium* sect. *Euepigynium* Schlechter by its evergreen habit, monomorphic perennating buds, a single perennating bud per leaf axil, plinerved leaf blade venation, a peduncle that is longer than the pedicels, the calyx tube (hypanthium) completely fused to the ovary, and a pseudo–10-locular ovary.

The presence of sulci and ridges in the corolla of Philippine *Vaccinium* is a character that has not been consistently reported or described in previous treatments. The corolla sulci create angles of the flower in cross section at the united portion of the petals, whereas the ridges appear as troughs on the petal midveins. Only four species of *Vaccinium* in the Philippines are documented to have pronounced corolla sulci and/or ridges, namely *V. coarctatum*, *V. exiguum* M.N.Tamayo, R.Bustam. & P.W.Fritsch, *V. gitingense* and *V. hamiguitanense*. This character is taxonomically diagnostic because most of the Philippine species possess a smooth corolla. Additionally, the results of previous botanical excursions to document the Philippine species of *Vaccinium in situ* show that some species may have faint sulci and/or ridges on their corolla (e.g. *V. indutum* S.Vidal, *V. jagori* Warb. and *V. philippinense* Warb.) (M. N. Tamayo, personal observation). These sulci are not easily observable in open flowers from dried herbarium material (although occasionally they can be visible on the dried floral buds). Therefore, documenting *Vaccinium* species *in situ* is vital for recording the presence of this character.

Key to the small-leaved Vaccinium in the Philippines

- 1a. Leaf margin entire; leaf marginal glands one or two pairs confined near leaf base ___ 2
- 1b. Leaf margin crenulate; leaf marginal glands more than two pairs distributed along the length of leaf margin _____ 3
- 2a. Inflorescence terminal, or pseudoterminal; flowers in racemes
V. myrtoides (Blume) Miq.
- 2b. Inflorescence axillary; flowers solitary _____ *V. microphyllum* Reinw. ex Blume
- 3a. Corolla long-conical (ampullaceous), without pronounced sulci and/or ridges
V. whitfordii Merr.
- 3b. Corolla urceolate, with pronounced sulci and/or ridges _____ 4
- 4a. Bracteoles caducous before anthesis, ≤ 1 mm long; pedicels 6–7 mm long
V. hamiguitanense P.W.Fritsch
- 4b. Bracteoles persistent until anthesis, > 1 mm long; pedicels 2–5 mm long _____ 5
- 5a. Leaves with raised glands on each crenation; hypanthium glabrous
V. exiguum M.N.Tamayo, R.Bustam. & P.W.Fritsch
- 5b. Leaves with sunken glands on each crenation; hypanthium white-hirsutulous
V. coarctatum M.N.Tamayo & Fernando

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References

- Argent G. 2008. A checklist of Philippine Ericaceae. *Philippine Journal of Systematic Biology*. 2(1):40–46. <https://asbp.org.ph/wp-content/uploads/2016/09/900-3008-1-PB.pdf>.
- Argent G. 2014. *Vaccinium utteridgei* (Ericaceae), a new species (sect. *Bracteata*) from Indonesian New Guinea. *Edinburgh Journal of Botany*. 71(2):189–192. <https://doi.org/10.1017/S0960428614000080>.
- Argent G. 2019. *Rigiolepis* and *Vaccinium* (Ericaceae) in Borneo. *Edinburgh Journal of Botany*. 76(1):55–172. <https://doi.org/10.1017/S0960428618000276>.
- Argent GP, Wilkie P. 2020. Six new species of *Vaccinium* (Ericaceae) from New Guinea. *Edinburgh Journal of Botany*. 77(3):439–453. <https://doi.org/10.1017/S0960428620000104>.
- Bachman S, Moat J, Hill AW, 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*, 2nd edition. Richmond: Kew Publishing. pp. 1–200.
- Brown RM, Weghorst JA, Olson KV, Duya MRM, Barley AJ, Duya MV, Shekelle M, Neri-Arboleda I, Esselstyn JA, Dominy NJ, Ong PS, Moritz GL, Luczon A, Diesmos MLL, Diesmos AC, Siler CD. 2014. Conservation genetics of the Philippine Tarsier: cryptic genetic variation restructures conservation priorities for an island archipelago primate. *PLoS ONE*. 9(8):e104340. <https://doi.org/10.1371/journal.pone.0104340>.
- Brown RM, Smart U, Leviton AE, Smith EN. 2018. A new species of Long-glanded Coralsnake of the genus *Calliophis* (Squamata: Elapidae) from Dinagat Island, with notes on the biogeography and species diversity of Philippine *Calliophis* and *Hemibungarus*. *Herpetologica*. 74(1):89–104. <https://doi.org/10.1655/Herpetologica-D-17-00008>.
- Co LL, Madulid D, Argent G. 2002. A new species of *Vaccinium* (Ericaceae) from the Philippines. *Edinburgh Journal of Botany*. 59(3):373–376. <https://doi.org/10.1017/S0960428602000227>.
- Copeland HF. 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 LV, editor. *Biosystematics in Agriculture*. Montclair, New Jersey: Allenheld Osmin. pp. 3–20.
- Fernando ES, Wilson PG. 2021. *Tristaniopsis flexuosa* (Myrtaceae), a new species from ultramafic soils in the Philippines. *Telopea*. 24:345–349. <https://doi.org/10.7751/telopea15588>.
- Fernando ES, Suh MN, Lee J, Lee DK. 2008. *Forest formations of the Philippines*. ASEAN–Korea Environmental Cooperation Unit (AKECU). Seoul: GeoBook Publishing Co. 232 pp.
- Fernando ES, Quakenbush JP, Lillo EP, Ong PS. 2018. *Medinilla theresae* (Melastomataceae), a new species from ultramafic soils in the Philippines. *PhytoKeys*. 113:145–155. <https://doi.org/10.3897/phytokeys.113.30027>.

-
- Fritsch PW, Amoroso VB, Coritico FP, Penneys DS. 2020. *Vaccinium hamiguitanense* (Ericaceae), a new species from the Philippines. *Journal of the Botanical Research Institute of Texas*. 14(2):281–287. <https://doi.org/10.17348/jbrit.v14.i2.1009>.
- Heaney LR. 1986. Biogeography of mammals in SE Asia: estimates of rates of colonization, extinction, and speciation. *Biological Journal of the Linnean Society*. 28(1–2):127–165. <https://doi.org/10.1111/j.1095-8312.1986.tb01752.x>.
- IUCN Standards and Petitions Committee. 2022. Guidelines for Using the IUCN Red List Categories and Criteria, version 15.1. Prepared by the Standards and Petitions Committee. Downloadable from https://nc.iucnredlist.org/redlist/content/attachment_files/RedListGuidelines.pdf. [Accessed 20 April 2022.]
- Lillo EP, Fernando ES, Lillo MJR. 2019. Plant diversity and structure of forest habitat types on Dinagat Island, Philippines. *Journal of Asia-Pacific Biodiversity*. 12(1):83–105. <https://doi.org/10.1016/j.japb.2018.07.003>.
- Linnaeus C. 1753. *Species plantarum, exhibentes plantas rite cognitatas, ad genera relatas, cum differentiis specificis, nominibus trivialibus, synonymis selectis, locis natalibus, secundum systema sexuale digestas*, vol. 1. Stockholm: Laurentius Salvius. 1200 pp.
- Mallari NAD, Tabaranza BR Jr, Crosby MJ. 2001. *Key Conservation Sites in the Philippines*. Makati City, Philippines: Bookmark. 485 pp.
- Mohagan AB, Mohagan DP, Libor R. 2013. Diversity and status of butterflies in Dinagat Island, Philippines. *SDSSU Multidisciplinary Research Journal*. 1(1):34–40.
- Musser GG, Heaney LR, Rabor DS. 1985. Philippine rats: a new species of *Crateromys* from Dinagat Island. *American Museum Novitates*. 2821:1–25. <http://hdl.handle.net/2246/5231>.
- Pelser PB, Barcelona JF, Nickrent DL, editors. 2011 onwards. *Co's Digital Flora of the Philippines*. <https://www.philippineplants.org>. [Accessed 29 August 2022.]
- Philippine Clearing House Mechanism. 2022. <http://www.philchm.ph/database/kba-database/>. [Accessed 2 September 2022.]
- Robinson AS, Zamudio SG, Caballero RB. 2019. *Nepenthes erucooides* (Nepenthaceae), an ultramaficolous micro-endemic from Dinagat Islands Province, northern Mindanao, Philippines. *Phytotaxa*. 423(1):21–32. <https://doi.org/10.11646/phytotaxa.423.1.3>.
- Salares VB, Obico JJA, Ormerod P, Barcelona JF, Pelser PB. 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>.
- Sanguila MB, Cobb KA, Siler CD, Diesmos AC, Alcalá AC, Brown RM. 2016. The amphibians and reptiles of Mindanao Island, southern Philippines, II: the herpetofauna of northeast Mindanao and adjacent islands. *ZooKeys*. 624:1–132. <https://doi.org/10.3897/zookeys.624.9814>.
- Sleumer H. 1966–1967. Ericaceae. In: Van Steenis CGGJ, editor. *Flora Malesiana, Series 1: Spermatophyta (Seed Plants)*, vol. 6, parts 4 and 5. Groningen: Wolters-Noordhoff. pp. 469–914.
- Tamayo MN, Fritsch PW. 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 MN, Fritsch PW. 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 MN, Bustamante RAA, Fritsch PW. 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 MN, Coritico FP, Amoroso VB, Penneys DS, Tandang DN, Fritsch PW. 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>.
- 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/> [Accessed 16 November 2022.]
- Vander Kloet SP, Dickinson TA. 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>.
- Villanueva RJT. 2010. Adult *Odonata* community in Dinagat Island, the Philippines: impact of chromium ore mining on density and species composition. *Odonatologica*. 39(2):33–150. <https://natuurtijdschriften.nl/pub/592692>.