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RHODODENDRON ASTROPHORUM (ERICACEAE, *RHODODENDRON* SECT. *SCHISTANTHE*), A NEW MICRO-ENDEMIC SPECIES FROM CENTRAL PALAWAN, PHILIPPINES

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A new micro-endemic species of *Rhododendron* is described and illustrated from botanical expeditions to the Victoria-Anepahan Mountain Range on the island of Palawan. It closely resembles *Rhododendron wilkiei* but differs in having leaves with laminae that are narrowly elliptic-oblanceolate, have adaxially indistinct venation, and are arranged in 4–8 active and mostly terminal pseudowhorls along the length of the stem; bracts without scales on the margin; yellow flowers with a red corolla tube interior that is densely hairy towards the base; and hairy anther filament bases. Morphological and geographical data place the species in *Rhododendron* sect. *Schistanthe*. The new species, together with a first record of *Rhododendron vidalii* on Palawan as part of this research, represent the tenth and eleventh members of this genus recorded from the island. A revised key to the Palawan species of *Rhododendron* is provided.

Keywords. *Euvireya*, Malesia, taxonomy, ultramafic, vireya.
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Introduction

Rhododendron L. is a genus of c.1070–1160 species worldwide (Khan *et al.*, 2021; POWO, 2022). It is considered the most species-rich genus within Ericaceae Juss. and has high levels of observed endemism across its range (Shrestha *et al.*, 2018). Within *Rhododendron*, c.340–400 species (Argent, 2016; Khan *et al.*, 2021) are found in *Rhododendron* sect. *Schistanthe* Schltr. *sensu* Craven *et al.* (2011), a group for which there is strong phylogenetic support for its monophyly (Craven *et al.*, 2011; Khan *et al.*, 2021). This group was formerly known as *Rhododendron* sect. *Vireya* (Sleumer, 1966; Argent, 2006; Craven *et al.*, 2008), and

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members of the group are still informally called vireya rhododendrons despite the priority of the section names of Schlechter (1917) now being recognised.

During a 2015 expedition led by Alastair Robinson to a peak in the Victoria-Anepahan Mountain Range (VAMR; in some publications called the Victoria Massif), Municipality of Narra, Central Palawan, a distinctive and undescribed vireya rhododendron was identified in the summit region by accompanying naturalist Dale Schubert. The plant was measured and documented photographically, and keyed (Argent, 2006) to *Rhododendron* subg. *Rhododendron* sect. *Schistanthe* subsect. *Euvireya*. However, in the absence of permits, no voucher material was taken.

A return expedition, led by Philippine Taxonomic Initiative, Inc., and Palawan State University (PSU) researchers, was made to the peak in June 2022. During that time, permitted collections were made and associated ecological data recorded, allowing formal recognition of the material as a species new to science.

Materials and methods

The species description is based on *in situ* observations, photographs, herbarium specimens, and spirit collections preserved in Copenhagen solution. Observations were carried out with a TM4000Plus II low-vacuum scanning electron microscope (Hitachi, Tokyo, Japan) using an accelerating voltage of 5 kV, a secondary electron detector and a 30 Pa vacuum. To prevent cell collapse under vacuum, wet samples were flash frozen to –20°C with a Deben Coolstage (Deben, Bury St Edmunds, UK). General measurements were made with a Leica M80 microscope (Leica Microsystems, Fremont, CA, USA) and a Mitutoyo vernier caliper (Mitutoyo, Kawasaki, Japan). Leaf-scale terminology follows Cowan (1950).

Species description

Rhododendron astrophorum M.N.Tamayo, Y.P.Ang & A.S.Rob., **sp. nov.**

Closely resembles *Rhododendron wilkiei* Argent but differs in having leaves with laminae narrowly elliptic-oblanceolate and c.5–7 times as long as wide (vs elliptic and c.2.5 times as long as wide), venation adaxially indistinct (vs prominent) with 4–8 active pseudowhorls of leaves along the length of the stem (vs 2–3(–4) mostly terminal pseudowhorls), bracts without scales on the margin (vs with scales), yellow corollas with the tube interior red (vs red throughout), the internal surface of the corolla tube densely hairy on the proximal 3/4 (vs glabrous), and filaments hairy at the base (vs glabrous).
– Type: Philippines, Palawan, Municipality of Narra, Victoria-Anepahan Mountain Range (VAMR), Mt Shumkat, ridge on east-facing slope, in moss on bark, 1100–1200 m elevation, 11 vi 2022, *AVAMR* 85 (Angiosperms of Victoria-Anepahan Mountain Range) (holotype PNH!; isotypes BRIT!, CAHUP!, PPC [accession no. 1783]!). **Figures 1–3, 4A.**

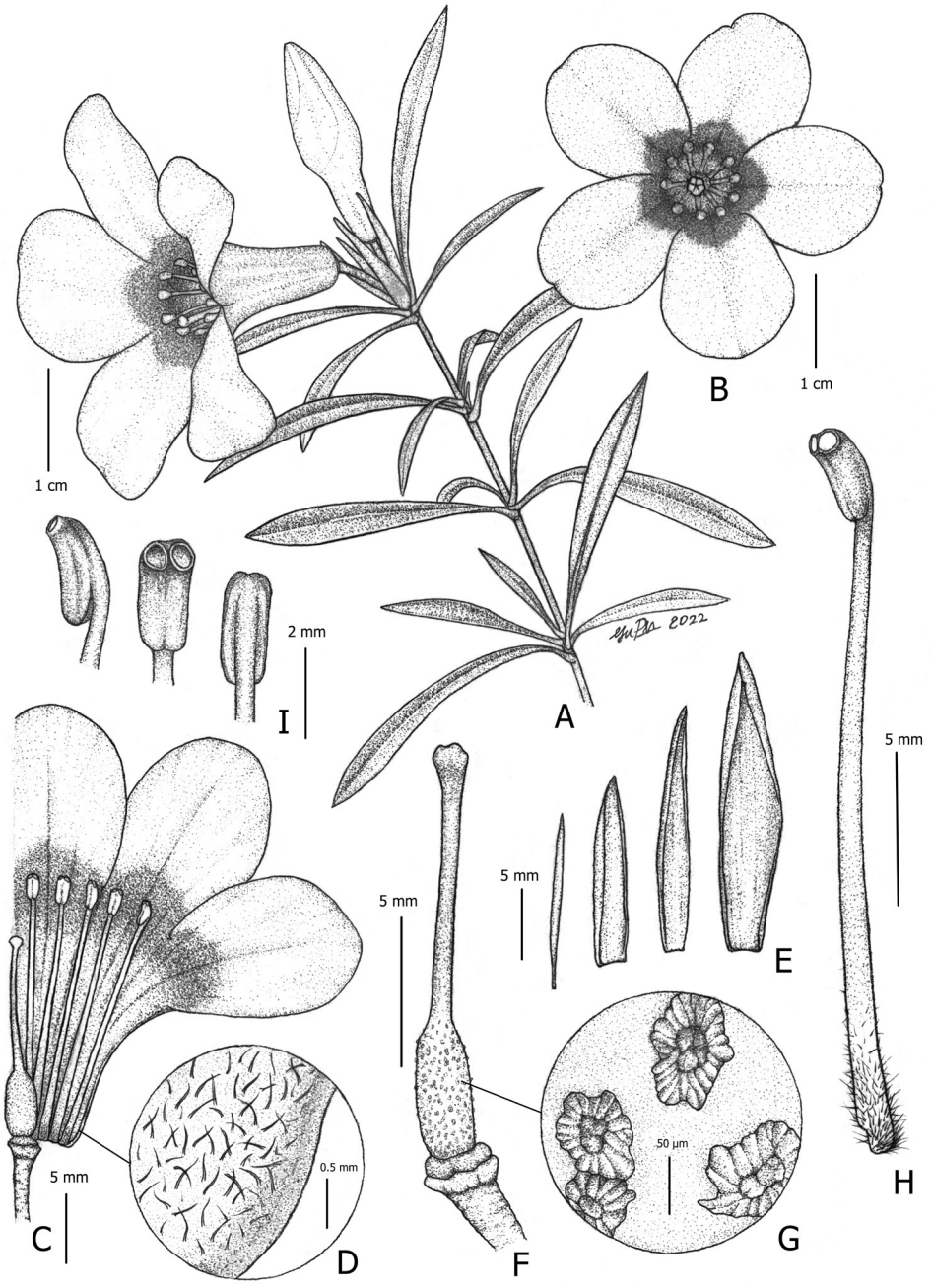

Figure 1. *Rhododendron astrophorum* M.N.Tamayo, Y.P.Ang & A.S.Rob., sp. nov. A, Flowering branch; B, flower (apical view); C, flower (dissected lateral internal view); D, base of corolla tube; E, bracts; F, pistil; G, scales on ovary; H, stamen; I, anther (lateral, ventral and dorsal views from left to right). Drawn by Y. P. Ang from the holotype (*AVAMR* 85), *in situ* photographs, and scanning electron microscopy images.

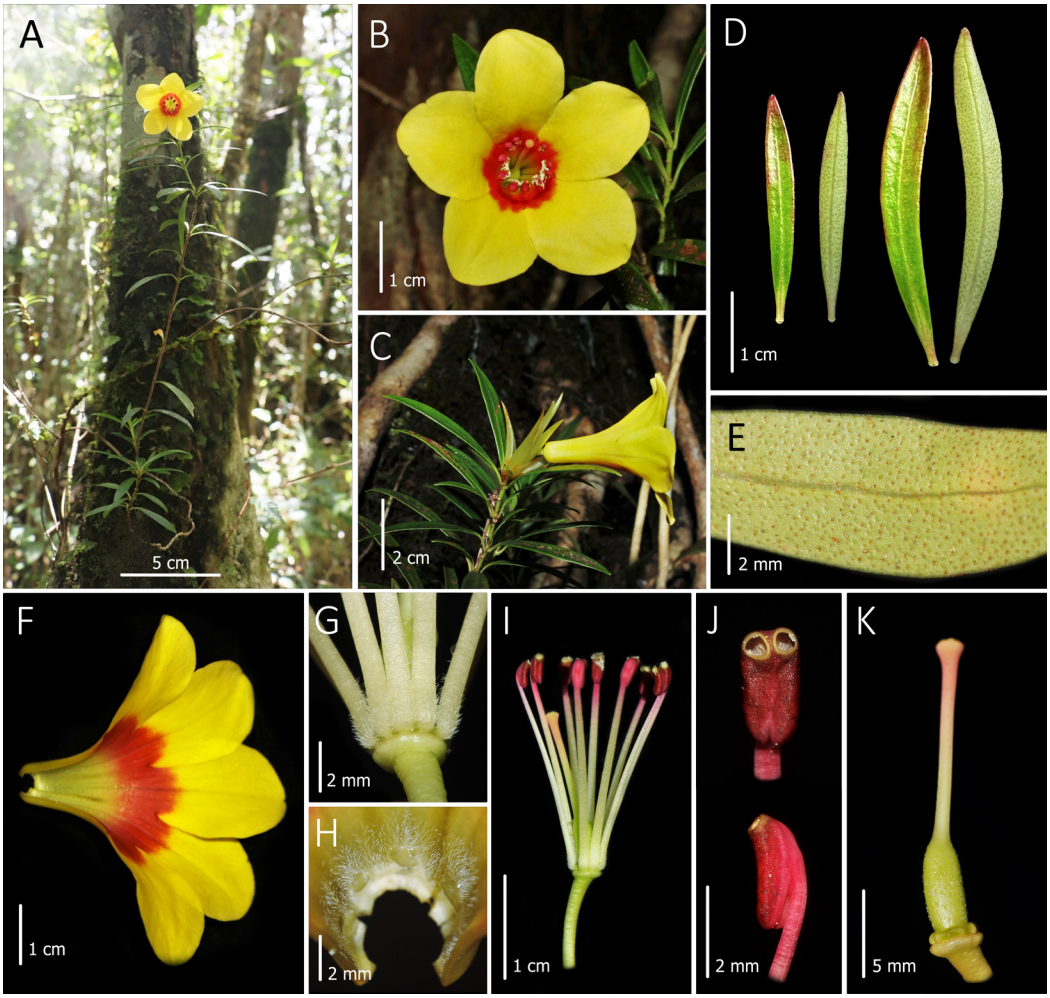

Figure 2. *Rhododendron astrophorum* M.N.Tamayo, Y.P.Ang & A.S.Rob., sp. nov. A, Flowering branch; B, flower (apical view); C, flower and growth point (lateral view, showing bracts); D, size and shape variation in larger pseudowhorl leaves; E, leaf (abaxial surface); F, corolla (internal surface); G, calyx and filament bases, showing trichomes; H, base of corolla tube, showing trichomes; I, flower (corolla removed); J, anther (ventral and lateral view); K, pistil. Photographs of the holotype (*AVAMR* 85): A, F and I, Y. P. Ang; B and C, M. Tamayo; D, A. Robinson; E, G, H, J and K, R. Bustamante.

Slender, sparingly branching epiphytic shrub up to c.70 cm tall. *Roots* fleshy, slightly swollen, multibranching, up to c.15 cm long, c.6 mm in diameter. *Stem* distally pale green, becoming rapidly woody below, terete, 1–1.8 mm in diameter, with an indumentum of pale brown scales at a density of 2–4 mm^{-2}. *Leaves* in tight pseudowhorls, generally 4–8 pseudowhorls per mature stem, each spread over c.2 mm of stem and 18–38 mm apart, and comprising

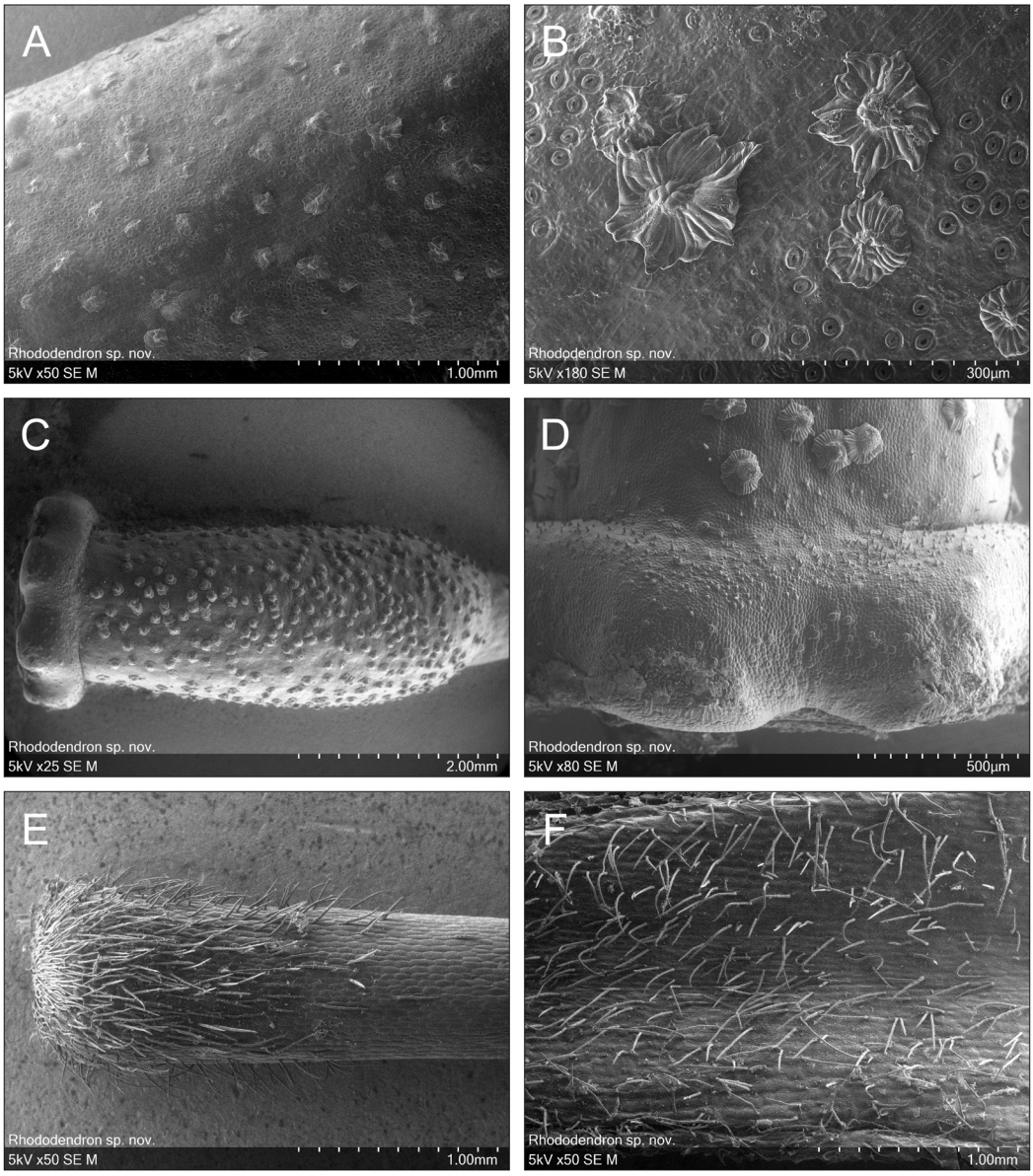

Figure 3. Scanning electron micrographs of selected characters of *Rhododendron astrophorum* M.N.Tamayo, Y.P.Ang & A.S.Rob., sp. nov. A, Abaxial leaf surface, showing scale density; B, scales on abaxial surface, showing ray cells and lacerate margins of annular zone; C, ovary and nectary with dense indumentum of ovary scales; D, detail of nectary, with simple aciculate hairs close to ovary base (note the convex-subconical ovary scales with a less irregular margin than that of the scales in panel B); E, base of anther, showing simple subulate trichomes; F, internal surface of corolla tube, showing dense indumentum of simple hairs. Micrographs of *AVAMR* 85: A. Robinson.

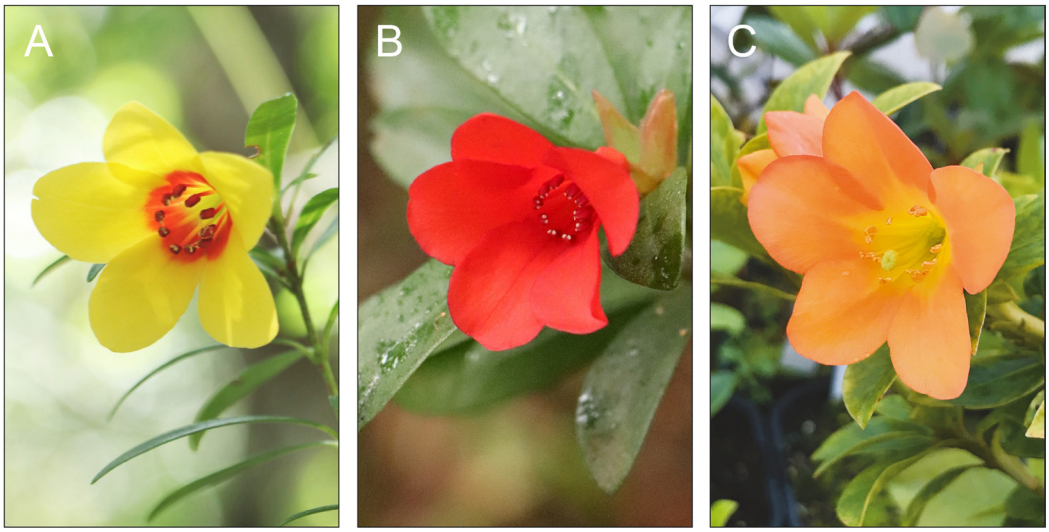

Figure 4. Comparison of the flowers of *Rhododendron astrophorum* (A) and its closest putative Palawan congeners, *R. wilkiei* (B) and *R. acrophilum* (C). Photographs of *AVAMR* 85 (A) and unvouchered field specimens (B, C): A and B, Y. P. Ang; C, Greg Bourke.

4 or 5 larger and (0–)3(–5) smaller leaves; *petiole* terete, 1–4.5 × 0.3–0.9 mm, with a deep, central adaxial groove to 0.1 mm wide, base densely covered with scales, mostly overlapping; *lamina* entire, narrowly elliptic-oblanceolate, larger leaves 12–55 × 2.5–8 mm, and smaller, narrower leaves 8–14 × 1–2 mm, length-to-width ratio c.7:1, base cuneate, apex acute or obtuse, midrib narrowly impressed above, below marked by weak keel close to base, becoming impressed from midpoint to apex, lateral veins indistinct, 4–6 pairs, abaxial and adaxial surfaces lepidote; *leaf scales* scurfy, minute, buff to pale, golden brown, 110–240 µm in diameter, slightly pitted, sessile, lacerate, convex, cells radially arranged, each cell (40–)70–90(–120) µm long, with umbo-like inner cap of appressed polyhedral cells projecting unequally outwards forming irregularly margined annular zone, abaxial density (7–)9(–12) mm^{-2} or c.3 diameters apart, adaxial density (2–)3(–4) mm^{-2} or c.7 diameters apart. *Inflorescence* terminal, congested, 1–2(–3)-flowered; *pedicels* 9–18 × 1.1–2 mm, green, trichomes absent, scales few to scattered, c.110 µm in diameter, annular zone ± round rather than lacerate, two pedicels ± fused along one side for their entire length, giving rise to two otherwise normal flowers; *flower buds* initially pale green, rapidly becoming bright yellow, narrowly conical above, swollen at midpoint and cylindrical below, abruptly contracting into pedicel, where buds develop in pairs often flattened on side facing other bud; *floral bracts* 3–5, linear to lanceolate, up to half as long as corolla, slightly to widely spreading, largest bract c.24 × c.3 mm, apex acute, lateral margins involute, entire, scales on abaxial surface only, and mostly distally situated towards apex; *flowers* 18–28 ×

19–34 mm, erect to slightly pendent, unscented, bright yellow throughout but with deep red flush on corolla tube interior; *calyx* annular inconspicuous, 0.3–0.8 mm long, 2.8–3.5 mm in diameter, with 10 lobes corresponding to stamens, upper part with numerous simple aciculate hairs 20–40 µm long, the same trichomes scattered at base of ovary; *corolla tube* 10–17 × 4–6 mm, internal surface densely hairy for proximal 3/4 tube length, hairs subulate, unicellular, (0.1–)0.3(–0.4) mm long; *corolla lobes* (8–)19 × 10.5–14 mm, obovate with a retuse apex, spreading widely up to c.70° from floral axis, overlapping in the lower 1/3 to 1/2; *stamens* 10, regularly arranged around ovary; *filaments* 13.5–22 mm long, terete, proximally yellow, becoming red distally, 0.8–1.1 mm wide at base, c.0.5 mm wide at anther, proximal c.1.8 mm with subulate hairs, densest at base, 8–30 µm long; *anthers* dorsifixed, poricidal, introrse, oblong, 2–2.2 × c.1 mm, dark brownish red, pores opening with yellow margins, pollen creamy white; *ovary* subcylindrical ellipsoid, 3.5–5 × 1.5–2.2 mm at anthesis, densely scaly, scales c.22–30 mm^{-2}, often clustered but not overlapping, similar to leaf scales but markedly convex-subconical, annular zone with more regular margins and straighter ray cells, simple hairs absent; *style* 13–15 mm long, c.0.8 mm in diameter, glabrous; *stigma* 5-lobed, 1–1.2 mm in diameter, pale orangish red to red; *fruits* narrowly ellipsoid, 24–27 × c.4 mm, valves spreading, straight or occasionally twisting slightly; *seeds* (4–)6(–7) mm, narrowly fusiform, winged, central portion c.900 × c.25 µm.

Distribution. Recorded only from the type locality.

Habitat and ecology. *Rhododendron astrophorum* is found as an epiphyte on the larger limbs of shrubs and small trees from mid-montane ultramafic forest at c.1100–1477 m elevation at the periphery of a swamp located close to the summit of Mount Shumkat, where the vegetation was notably lower in stature and more compact than at lower elevations. Other plant species recorded in the area are *Tristaniopsis oblongifolia* (Merr.) Peter G.Wilson & J.T.Waterh., *Vaccinium palawanense* Merr. and *Leptospermum* sp. in the immediate vicinity. Two other species of *Rhododendron* sect. *Schistanthe* were encountered, namely, *R. javanicum* (Blume) Benn. subsp. *palawanense* Argent (**Figure 5A–C**) and *R. vidalii* Rolfe (**Figure 5D,E**), the latter representing a new record for Palawan. *Rhododendron vidalii* was formerly known to occur only in Luzon and Mindoro Islands (Pelser *et al.*, 2011–).

Etymology. The specific epithet *astrophorum* is derived from the Greek *ἄστρον* (ástron = star), and the suffix *-φόρος* (*-phóros* = bearing) in reference to the bright yellow corolla, which resembles small clusters of stars in the forest canopy.

Phenology. The species was observed on 9 April 2015 mostly in bud, and in full anthesis in June 2022. This phenology suggests a tendency to flower following the dry season, which in Palawan occurs between January and April (Worldbank.org 2022).

Proposed IUCN conservation category. Despite numerous expeditions to surrounding peaks in the VAMR, *Rhododendron astrophorum* has been formally only identified from its type

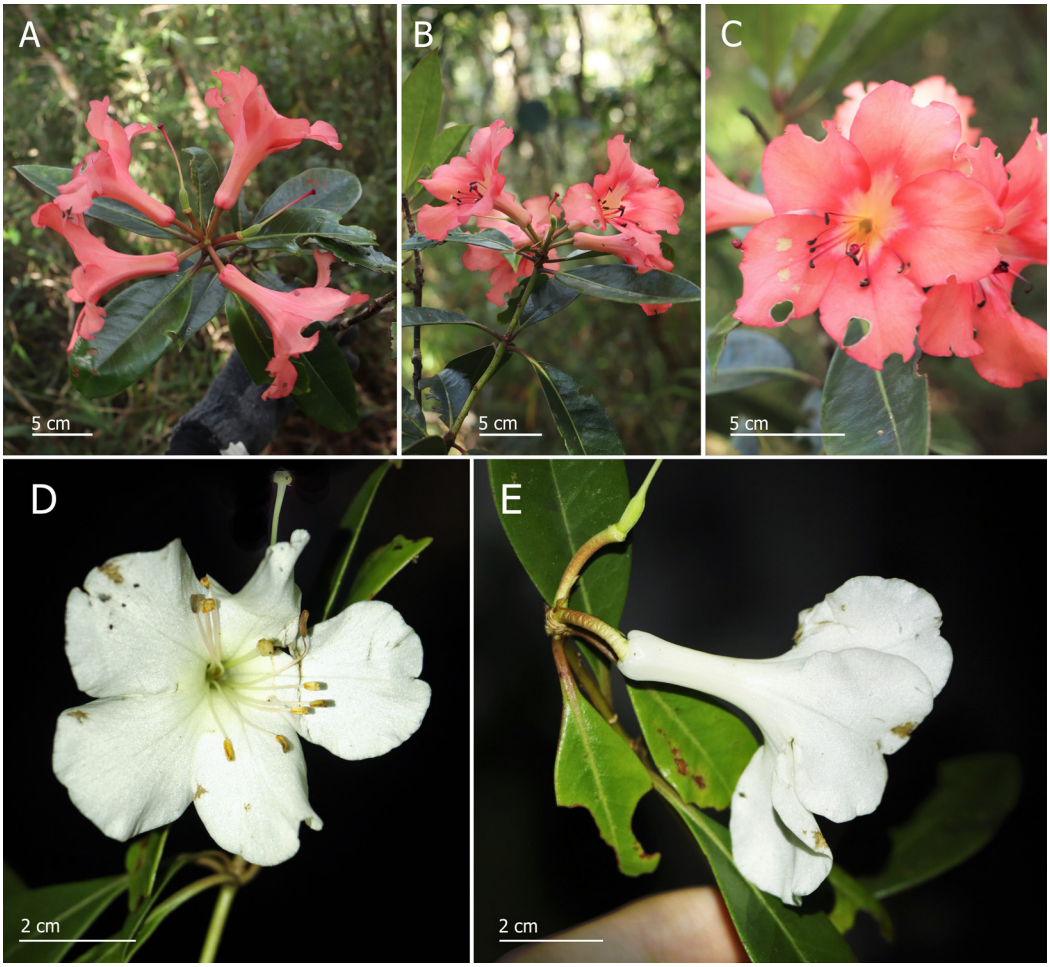

Figure 5. A–C, *Rhododendron javanicum* subsp. *palawanense* in a bamboo thicket at a similar elevation to *R. astrophorum*. The Palawan subspecies has a pink corolla flushed with orange around the tube inner surface. A, Apical view of inflorescence; B and C, lateral and ventral view of corollas from left to right; D and E, *Rhododendron vidalii* from the vicinity of *R. astrophorum*, representing a new record of this species for the island of Palawan: D, apical view of flower; E, lateral view of flower. Photographs of *AVAMR* 102 (A–C) and *AVAMR* 101 (D and E): Y. P. Ang.

locality, with just six mature individuals observed within an extent of occurrence (EOO) of c.3.4 km^2 (≤ 10 km^2). Direct observations of *Rhododendron astrophorum* made *in situ* satisfy the IUCN 3.1 Red List (2012) Critically Endangered (CR) Criteria B2ab (i, ii, v) (interpretation per IUCN Standards and Petitions Subcommittee, 2022). Plants believed to represent *Rhododendron astrophorum* occur on nearby Mount Victoria at c.1400 m elevation as epiphytes on tall trees; however, they have not been vouchered. The only evidence of

their presence is a single fallen flower. Should a formal determination of *Rhododendron astrophorum* be made for these plants, the conservation status must be reassessed.

Specimens of other taxa examined. *Rhododendron vidalii*. PHILIPPINES. **Palawan**: Municipality of Narra, Victoria-Anepahan Mountain Range, Mt Shumkat, ridge on east-facing slope, in moss on bark, 1100–1200 m elevation, 11 vi 2022, *AVAMR* 101 (Angiosperms of Victoria-Anepahan Mountain Range) (BRIT!; PPC [accession no. 2103]!); *Rhododendron javanicum* ssp. *palawanense*. PHILIPPINES. **Palawan**: Municipality of Narra, Victoria-Anepahan Mountain Range, Mt Shumkat, ridge on north-east to east-facing slope, in moss on bark, 1100–1200 m elevation, 11 vi 2022, *AVAMR* 102 (Angiosperms of Victoria-Anepahan Mountain Range) (BRIT!).

Discussion

With the discovery of *Rhododendron astrophorum*, the number of accepted species of *Rhododendron* recorded from the Philippines is now 27. Of that total, 11 are recognised from Palawan alone, namely, *Rhododendron acrophilum* Merr. & Quisumb. (Mount Mantalingahan), *R. astrophorum* (Mount Shumkat), *R. bagobonum* H.F.Copel. (Mount Mantalingahan), *R. edanoi* Merr. & Quisumb. (Mount Mantalingahan), *R. javanicum* subsp. *palawanense* (Mount Mantalingahan, Mount Shumkat), *R. kochii* Stein (Mount Victoria), *R. madulidii* Argent (Mount Mantalingahan), *R. mendumiae* Argent (Cleopatra's Needle), *R. reynosoi* Argent (Cleopatra's Needle), *R. wilkiei* (Thumb Peak, Mount Beaufort, Mount Mantalingahan [Tabayag, personal observation], Mount Shumkat and Cleopatra's Needle) and *R. vidalii* (Mount Shumkat) (Figure 6). The presence of *Rhododendron brookeanum* H.Low ex. Lindl. on Palawan was recorded by George Argent (Pelser *et al.*, 2011–). However, the taxon has not been further documented and the voucher *Argent* M270 has not been seen by the authors, thus preventing independent verification. This species has therefore been omitted from both the summary list and the revised key for Palawan *Rhododendron*.

Despite pronounced differences in foliage size and stature, similar floral and scale macromorphologies support our hypothesis that *Rhododendron astrophorum* is allied with two Palawan endemic species of *Rhododendron*, namely *R. wilkiei* and *R. acrophilum*. *Rhododendron astrophorum* is unique among Palawan *Rhododendron* in producing bright-yellow corollas with red centres, the closest colour equivalent being *R. acrophilum*, which produces orange corollas with yellow centres. Morphologically, the new species shares some scale and floral characteristics with both *Rhododendron acrophilum* and *R. wilkiei* but is readily distinguished in its sterile state by its distinctive, narrowly elliptic-oblanceolate leaves (Figure 2**D**). When in flower, *Rhododendron acrophilum* is distinguishable by corolla colour alone (Figure 4**C**). No obvious pollinators were observed during field studies of the species. Moreover, the styles have been observed to elongate towards the anthers within a matter of days post initiation of anthesis, potentially facilitating the transfer of pollen and possibly indicative of some capacity for self-pollination. However, it is not known at what point the stigma becomes receptive, nor for how long pollen is shed by the anthers.

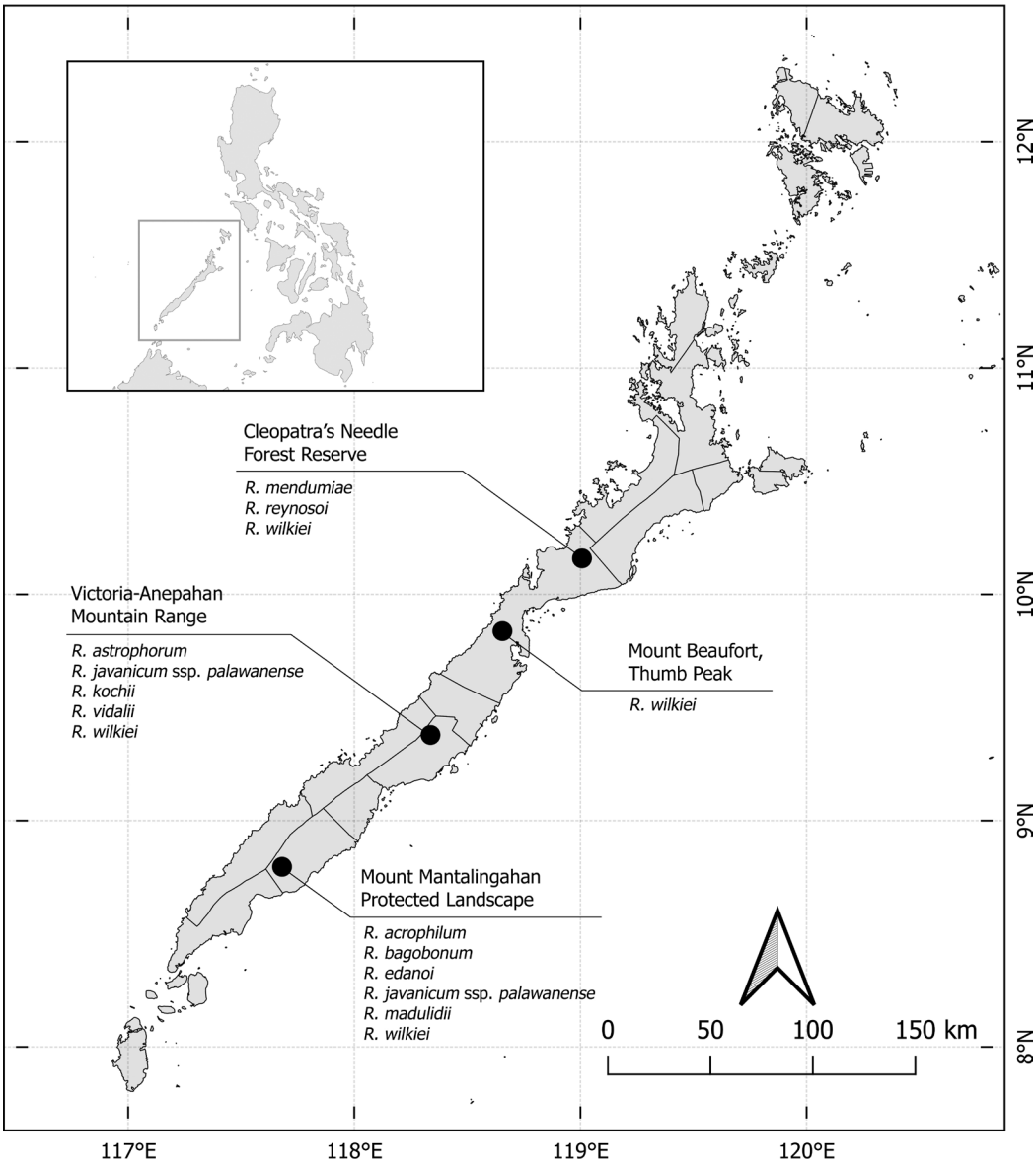

Figure 6. Map of Palawan, showing the distribution of *Rhododendron* species across the island by location. Map created by Y. P. Ang.

The cataloguing of new plant taxa from the VAMR has accelerated in recent years, with many taxa from a wide variety of families published (e.g. Robinson *et al.*, 2009, 2016; Quakenbush *et al.*, 2020; Tamayo *et al.*, 2021), including several vireya rhododendrons (Argent, 2004). The VAMR is the largest contiguous exposed area of the Mount Beaufort

Ultramafics geological terrane, a series of outcrops of Eocene origin (Okubo, 1989) that includes several mountains of > 1000 m elevation, including Brow Shoulder, Mount Shumkat, Sultan Peak, and the eponymous Mount Victoria and Anepahan. The highlands of this terrane, which arose in association with the geological events that gave rise to Mount Kinabalu in adjacent northern Borneo (Collenette, 1964; Hall, 2002), has recently seen a surge in exploration by botanists, giving rise to novel plant discoveries, including several edaphic specialists. Many of these newly described endemic species also demonstrate the close biological affinities between Palawan and Borneo, islands that have been connected in the past by land bridges (Hall, 1998; Voris, 2000; Sathiamurthy & Voris, 2006). These discoveries, of which *Rhododendron astrophorum* is the latest from a series we are preparing, underscore the highly endemic nature of the flora of Palawan. They also highlight the importance of further biodiversity research across the island, as well as the urgent need for conservation actions that safeguard this biologically diverse area.

Key to *Rhododendron* of Palawan (adapted from Argent 2006, 2016)

1a. Largest leaves ≥ 5 cm wide, petioles ≥ 1.5 cm long _____ 2
1b. Largest leaves ≤ 3 cm wide, petioles < 1.5 cm long _____ 3

2a. Leaves spirally arranged, leaf apex acute; corolla lobes orange, corolla tube yellow, flowers > 6 cm long _____ *R. javanicum* subsp. *palawanense*
2b. Leaves in pseudowhorls, leaf apex acuminate; corolla lobes and tube white, flowers ≤ 5 cm long _____ *R. kochii*

3a. Largest leaves < 1 cm wide _____ 4
3b. Largest leaves ≥ 1 cm wide _____ 5

4a. Leaves spathulate-elliptic, 2–3 times as long as wide, apex broadly acute to obtuse; corolla red throughout _____ *R. bagobonum*
4b. Leaves narrowly elliptic-oblanceolate, 5–7 times as long as wide, apex acute; corolla yellow with red throat _____ **R. astrophorum**

5a. Stems with minute hairs (also with scales) _____ 6
5b. Stems with scales only _____ 7

6a. Stems minutely puberulous (also with scales); corolla white with a greenish tinge on tube or flushed very pale pink, corolla lobes 5–6 cm long _____ *R. madulidii*
6b. Stems pubescent with short, fine hairs (laxly scaly); corolla white, corolla lobes ≤ 3 cm long _____ *R. vidalii*

7a. Leaf apex rounded (occasionally with a mucronate point); corolla infundibular, corolla tube narrowing from base to apex _____ *R. edanoi*

7b. Leaf apex obtusely or acutely pointed; corolla campanulate or infundibular, corolla tube broadening from base to apex _____ 8

8a. Leaves elliptic-obovate or narrowly obovate, mostly broadest in the distal half _____ 9
8b. Leaves elliptic-lanceolate, broadest in the middle and only rarely broader in the upper half _____ 10

9a. Leaves in pseudowhorls spread over c.6 mm of stem, leaf blades 2.5–4(–5) cm long; umbels 3- to 5-flowered; corolla orange with yellow throat _____ *R. acrophilum*
9b. Leaves in pseudowhorls spread over c.2 cm of stem, leaf blades > 5 cm long; umbels 1- or 2-flowered, corolla white with pale beige throat _____ *R. mendumiae*

10a. Largest leaves > 5 cm long, lateral veins more than 6 per side; corolla bright orange with red throat, inner surface of corolla tube and basal part of filaments pubescent *R. reynosoi*
10b. Largest leaves ≤ 4 cm long, lateral veins 3 or 4 per side; corolla red, inner surface of corolla tube and basal part of filaments glabrous _____ *R. wilkiei*

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