

## ***Saurauia decolorata* (Actinidiaceae), a new species from Mindanao, the Philippines**

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### **Abstract**

*Saurauia decolorata* from the Mt. Pantaron Range, Bukidnon and Mt. Balatukan Natural Park, Misamis Oriental, Mindanao Island, the Philippines, is illustrated and described as a new species. It closely resembles *S. avellana* and *S. elegans* in having branchlets, petioles, and abaxial surfaces of the leaves covered with tomentum and scales, densely clustered flowers, longitudinal anther dehiscence, and 3–4 styles. However, *S. decolorata* is distinguished from these species by its prominent rusty-colored tomentum and scales on branchlets and abaxial leaf surfaces, cordate leaf bases, crenate margin, 16–21 pairs of lateral veins, fascicled-cymose inflorescences that are both axillary and ramiflorous, and sparsely scaly pinkish green outer sepals. This discovery further emphasizes the unique biodiversity of the forests of the Pantaron Range and Mt. Balatukan which urgently need legislative protection and enhanced protected area management plans, respectively.

**Key words:** Actinidiaceae, *Saurauia*, Mindanao, biodiversity, tropical kiwi

### **Introduction**

Actinidiaceae is a small family of angiosperms consisting of ca. 355 species within three genera: *Actinidia* Lindley (1836: 439) (kiwi fruit), *Saurauia* Willdenow (1801: 407), and *Clematoclethra* (Franchet 1888: 53) Maximowicz (1889: 36). *Saurauia*, a genus of shrubs and small to medium-sized trees, is the largest among the three, having ca. 300 species (Dressler & Bayer 2004) distributed in Central and South America (60 species) (Hunter 1966; Soejarto 1980), Asia (ca. 240 species) (Briggs 2015; Löfstrand & Schönenberger 2015), and Australia (1 species) (Zich *et al.* 2020). The extant species have an amphi-Pacific tropical distribution; however, fossil records have shown that likely relatives of *Saurauia* existed during the late Cretaceous period of Central Europe and Eastern North America (Keller *et al.* 1996; Kubitzki 2004).

The presence of indumentum (stiff hairs or scales) is a consistent feature in most species of *Saurauia* (Briggs 2015). Variation in the types and density of trichomes found on the branches, leaves, sepals, and ovary have been useful for identifying Neotropical (Hunter 1966; Soejarto 1980), Bornean (Brunei, Malaysia, and Indonesia) (Wong 2017), and Papuan species (Diels 1922; Gilg & Werdermann 1925). Most *Saurauia* species have bisexual flowers (Dressler & Bayer 2004). Their corollas are gamopetalous and usually white (translucent or opaque), with overlapping lobes. The stamens are adnate to the base of the petals and usually fall with the corolla after anthesis (Soejarto 1980), leading many to erroneously describe the flowers as unisexual and female.

The Philippines is one of the most species-rich countries for *Saurauia*, with 57 accepted species (Pelser *et al.* 2011), all of which are endemic. They inhabit lowland rainforests to upper montane rainforests. A systematic review has never been conducted for the Philippine species and the extent of their character variation is poorly understood, making positive taxonomic determinations a challenge. The illustrated checklist available at Co's Digital Flora of the Philippines (Pelser *et al.* 2011), and the recently described species, *S. abbreviata* Mazo (2021: 205) from Zamboanga Peninsula (Mazo *et al.* 2021), represent important steps in reviving interest in the taxonomy of Philippine *Saurauia*.

During 2022 and 2023, the authors conducted fieldwork in the Provinces of Bukidnon and Misamis Oriental on the island of Mindanao as part of the project “Plant and Lichen Discovery in Southern Philippines”. During this fieldwork, we collected a *Saurauia* specimen with fascicled-cymose inflorescences and branches and abaxial leaves covered with rusty-colored tomentum. The specimen is phenotypically distinguishable from all other known *Saurauia* taxa and is thus described here under the morphological species concept. This discovery brings the total number of *Saurauia* species in the Philippines to 58.

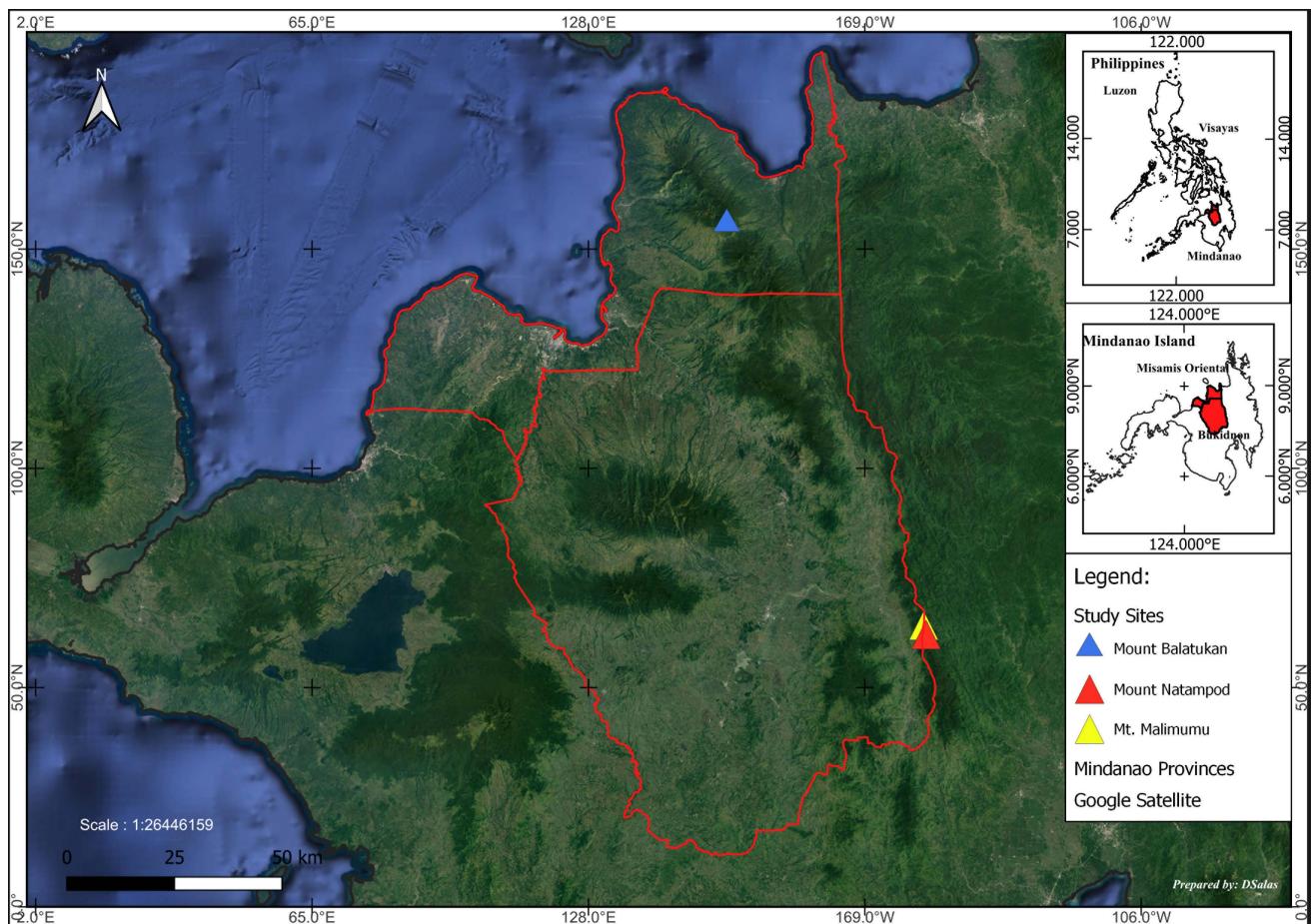
## Study sites

During 17–26 July 2022 and 18–21 January 2023, a team of botanists from the University of North Carolina Wilmington (UNCW), Botanical Research Institute of Texas (BRIT), Central Mindanao University (CMU), and other institutions conducted botanical explorations in Mt. Malimumu and Mt. Natampod of the Pantaron Range and Mt. Balatukan Natural Park, on the island of Mindanao. Mt. Pantaron Range, also known as the Central Cordillera of Mindanao, is a contiguous landscape that has an area cover of 1.26 million hectares, ca. 12% of Mindanao (Environment Science for Social Change Inc. 2018), and spans six provinces (Bukidnon, Agusan del Sur, Misamis Oriental, Davao del Norte, Davao del Sur, and Agusan del Norte). Its northern boundary is the south of Claveria, Misamis Oriental, stretching southward to the municipality of San Fernando, and it separates the provinces of Bukidnon in the west and Agusan del Sur in the east (Gronemeyer *et al.* 2014).

One of Mindanao's few remaining intact tropical forests, the Mt. Pantaron Range supplies water to 82 rivers that serve as a lifeline to 42% of the Mindanao population (Environment Science for Social Change Inc. 2018). This massive mountain range is also essential to the survival of biological diversity, especially to the critically endangered national bird, the Philippine eagle (*Pithecophaga jefferyi* Ogilvie-Grant (1896:18)), endemic plants like pitcher plants (e.g., *Nepenthes malimumuensis* Lagunday, Acma, Cabana, Sabas, Amoroso (2017: 160)), and dipterocarps (e.g., *Shorea polysperma* Merrill (1918: 269)) (Coritico *et al.* 2022). It is also integral to the cultural identity of the region with ethnic and tribal groups, including the Manobo, Higaonon, and Bukidnon peoples who inhabit the mountains. Despite these crucial factors, the Mt. Pantaron Range does not hold any legislative protection and the remaining forests are being rapidly degraded.

Areas surveyed in the Mt. Pantaron Range included Mt. Malimumu in Barangay Magkalungay, and Mt. Natampod in Barangay Namnam, both within the Municipality of San Fernando, Province of Bukidnon (Fig. 1). Mt. Malimumu has four vegetation types: lowland forest with mixed dipterocarp species (820 m a.s.l.), lower and upper montane forest, and forest over ultramafic rock. Its highest peak is at 1,267 m a.s.l. Mt. Natampod has only lower and upper montane forest between 774–1,140 m a.s.l.

Mt. Balatukan is a massive compound stratovolcano that rises above the southwestern shore of Gingoog Bay, Misamis Oriental in north-central Mindanao, opposite Camiguin Island. Its terrain is steep, with several peaks reaching 2,000–2,442 m a.s.l. Classified as a protected area, Mt. Balatukan comprises 8,423 hectares of protected park area and ca. 6,500 hectares of old-growth forests. However, the extent of its primary lowland forest has been greatly reduced by logging and slash-and-burn agriculture, so by 1997 this forest type was reported to be almost eradicated (BirdLife International 2023). The park supports a significant population of the Philippine eagle and other threatened fauna like Philippine warty pigs (*Sus philippensis* Nehring (1886: 83)), Apo myna birds (*Goodfellowia miranda* Hartert (1903: 11)), and Philippine palm civet cats (*Paradoxurus philippinensis* Jourdan (1837: 523)), as well as economically important dipterocarp tree species such as the red lauan (*Shorea negrosensis* Foxworthy (1911: 274)), apitong (*Dipterocarpus grandiflorus* Blanco (1845: 314)), and almon (*Shorea almon* Foxworthy (1938: 313)) (Maanding 2021). Unlike the Mt. Pantaron Range, biodiversity data on Mt. Balatukan is scarce, and a recent search on Google Scholar yielded only three relevant publications. Mt. Balatukan may support many more Mindanao endemic species which occur at high elevations (BirdLife International 2023) and additional biodiversity surveys are needed. Mt. Balatukan was approached through Sitio San Isidro, Barangay Lunotan, Gingoog City from the lower to the upper montane forest at 880–1,800 m a.s.l. (Fig. 1).



**FIGURE 1.** Map of Mindanao Island showing Mt. Malimumu and Mt. Natampod of Mt. Pantaron Range and Mt. Balatukan. Map by Daryl Salas.

## Materials and Methods

Fertile specimens of the new *Saurauia* species were collected with eight duplicate vouchers (to be deposited at BRIT, CAS, CMUH, PNH, US, and other herbaria) and were field pressed. Because expeditions in each site spanned nearly one week and there was no access to a drying facility, 50% ethanol was applied to bagged bundles of pressed specimens to prevent molding. Flowers were placed in vials with 70% ethanol and later fixed in FAA solution (5 parts formalin, 5 parts glacial acetic acid, and 90 parts 70% ethanol) for several weeks, then transferred to a 70% ethanol solution for long-term anatomical preservation.

Every field collection of the unknown species of *Saurauia* was accompanied by detailed *in situ* photographs. Some structures (e.g., indumentum, style, ovary, and anthers) were measured with a Leica M60 stereomicroscope. A Moticam X5 camera was used to photograph and measure structures viewed with the stereomicroscope. Morphological comparisons were made with type specimens of closely related species accessed through herbarium loans (A, GH, HUH, MO, NY, and P) and digital images available on JSTOR Global Plants (<https://plants.jstor.org/>).

## Taxonomy

### *Saurauia decolorata* Olimpos & Penneys sp. nov. (Fig. 2)

Type:—PHILIPPINES, Mindanao, Province of Bukidnon, Municipality of San Fernando, Barangay Magkalungay, peak of Mt. Malimumu, mossy forest, 1,267 m a.s.l., 7.88388°N, 125.41967°E, 19 Jul 2022, *Plants and Lichens of the Southern Philippines Survey 2907* (holotype PNH!, isotypes BRIT!, CAHUP!, CAS!, CMUH!, US!)

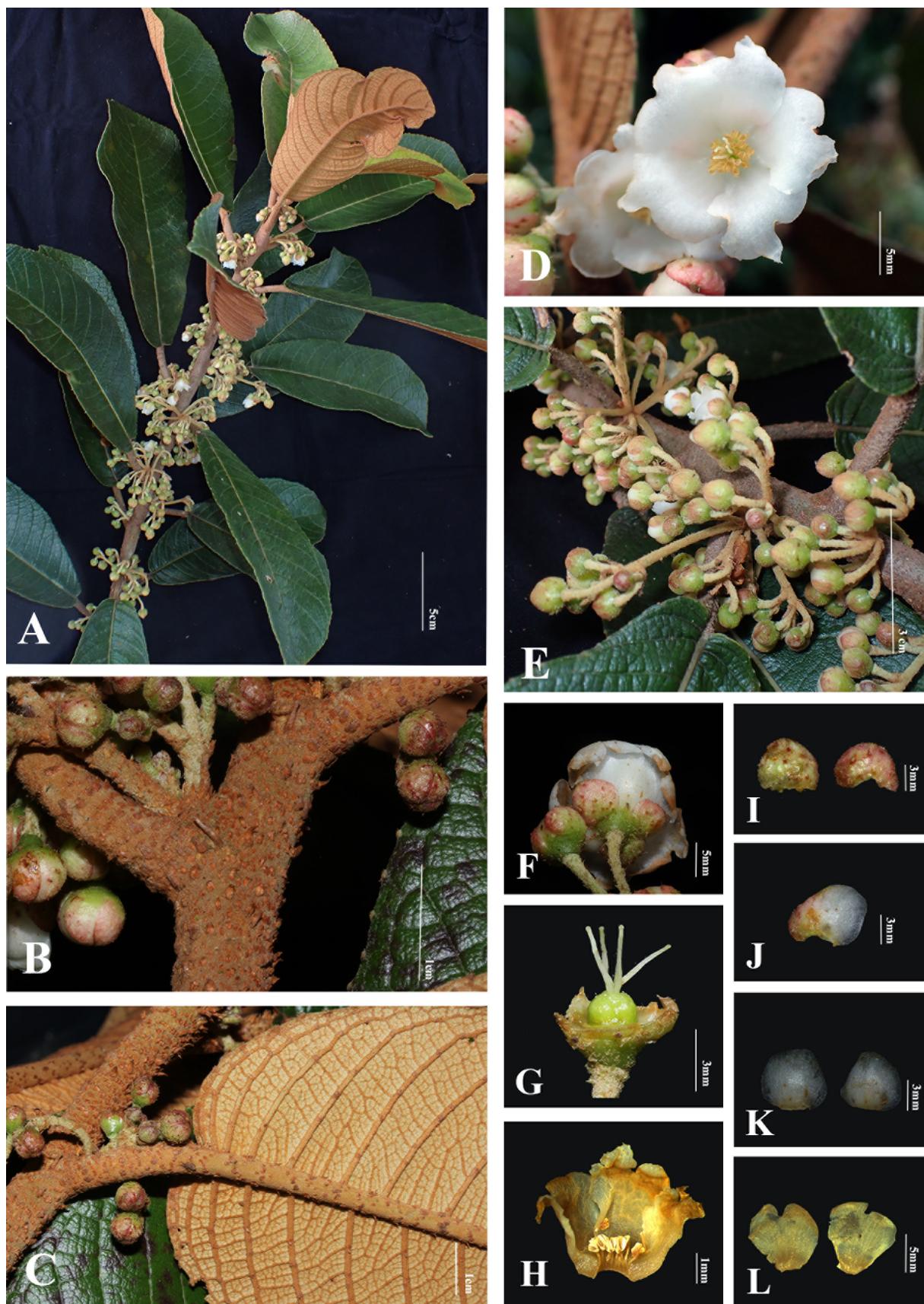
**Diagnosis:**—*Saurauia decolorata* closely resembles the Philippine species *S. avellana* Elmer (1908:498) (Fig. 3 A–C) in having branchlets and abaxial surface of the leaves that are densely tomentose and scaly, and flowers that are densely clustered, and have white corollas, longitudinal anther dehiscence, and 3–4 styles. *Saurauia decolorata* can be readily distinguished from *S. avellana* in having rusty-colored tomentum and scales (vs. reddish brown to yellowish brown), a cordate leaf base (vs. round to slightly obtuse), crenate leaf margins (vs. serrate), 16–21 pairs of secondary veins (vs. 13–17), a shiny and nearly glabrous adaxial leaf surface (vs. dull and sparsely tomentose), a fascicled cymose inflorescence (vs. fascicles of simple or compound umbels) with shorter peduncles (0.5–1.6 vs. 1.6–4.2 cm) and pinkish green outer sepals (vs. light green to yellowish green) that are sparsely scaly (vs. moderately scaly).

**Description:**—Tree, ca. 6–15 m tall, 10 cm diameter, outer bark light brown, **lenticels** sparse. **Branchlets** terete, brown to greenish brown. **Distal portions of twigs** with dense rusty-colored or orangish brown tomentum and scales; longer scales (1.0–1.2 mm) appressed to slightly ascending, ovate or ovate-lanceolate, shorter scales (<1 mm) irregularly orbicular to elliptic-ovate. **Leaves** simple, alternate, chartaceous; **petiole** 2.5–3.0 cm long, indumentum similar to that of distal twigs; **lamina** narrowly oblong-elliptic, 19–26 × 6–9 cm, length width ratio 2.9–3.5:1; **adaxial** surface dark green, shiny, glabrous except for a few ovate or orbicular, rusty-colored scales on lower part of midrib; **abaxial** surface with dense rusty-colored tomentum and abundant to scattered, appressed to slightly patent, ovate, reddish orange scales on midrib and lateral veins; pairs of secondary veins 16–21, 8–11 mm distant from each other, curved and anastomosing at tips towards leaf margin, impressed and prominent abaxially; tertiary veins reticulate, impressed; base cordate, margin crenate with a red tinge at apex of each tooth and 2–3 mm distance between crenulations, apex obtuse. **Inflorescence** axillary, fasciculate-cymose (3–6 peduncles per axil), ramiflorous with first- to second-order branching, 2.5–4.0 cm long (peduncle base to distalmost petal apex); **flowers** 3–5(–9) per peduncle, cup-shaped, 15–19 × 13–17 mm, odorless, ca. 2–3 flowers anthetic at a time; **peduncle** 0.5–1.6 cm long, brownish green, with dense light green to brown tomentum and sparse, weak, ovate-lanceolate scales (ca. 0.5 mm long or less); **bracts** 2, subtending pedicel, linear, ca. 2–3 × 1.2–1.4 mm, greenish brown, indumentum similar to that of peduncle, persistent, inconspicuous; **pedicel** 0.9–1.0 cm long, brownish green, tomentose with scales similar to that of peduncle. **Sepals** 5, **outer sepals** 2, orbicular to widely ovate, 5–7 × 5–6 mm, pinkish green (basally green, becoming pinkish green apically), sometimes younger sepals (of buds) reddish green, with sparse, appressed, weak, ovate-lanceolate, green or pink scales; **intermediate sepal** that partially overlaps inner sepals present, partly scaly resembling outer sepals and partly glabrous similar to inner sepals; **inner sepals** 2, orbicular to broadly ovate, 5–6 × 6–7.5 mm, white, petaloid, glabrous. **Petals** 5, fan-shaped, 9.0–11.0 × 4.7–6.0 mm, white, opaque, each overlapping with adjacent petal for 40% of length, erect but apex slightly recurved, unequally retuse on apex and sides, apical sinus 1–2 mm long. **Stamens** 14–17, in two series, filaments 1–1.4 mm long, glabrous; anthers dorsifixed, longitudinally dehiscent, narrowly oblong, 0.6–0.8 × 0.5–0.7 mm, yellow, anther opening 0.5–0.8 × 0.2–0.4 mm. **Ovary** globose, 1.4–2.5 × 1.9–2.7 mm, green, glabrous, locules 4, placentation axile, ovules numerous, styles (3–)4, proximal 25% fused, pale greenish white, filiform, 2.9–3.2 mm long, apical portions erect, stigma capitate. Fruits not seen.

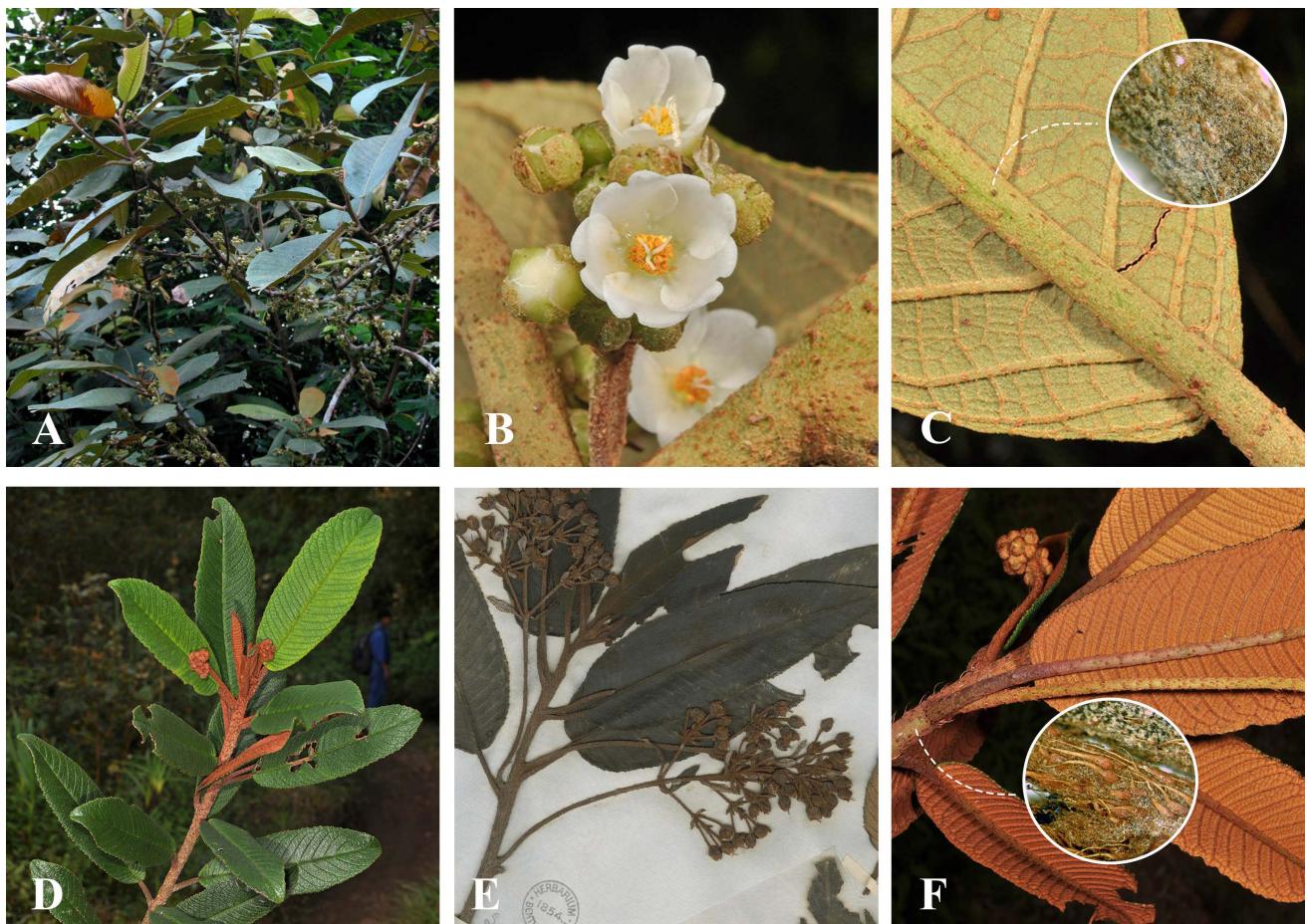
**Additional specimens examined:**—**PHILIPPINES. Mindanao:** Bukidnon, Municipality of San Fernando, Barangay Namnam, Mount Natampod, tropical lower montane forest, 1,087 m a.s.l., 7.86462°N, 125.42463°E, 22 Jul 2022, *Plants and Lichens of the Southern Philippines Survey 2969* (BRIT!, CAHUP!, CAS!, CMUH!, PNH!, US!); Misamis Oriental, Gingoog City, Barangay Lunotan, Sitio San Isidro, Mount Balatukan Natural Park, tropical lower montane forest, 1,387 m a.s.l., 8.72982°N, 125.00478°E, 19 Jan 2023, *Plants and Lichens of the Southern Philippines Survey 4251* (BRIT!, CAHUP!, CAS!, CMUH!, PNH!, US!).

**Distribution and habitat:**—*Saurauia decolorata* is known from two localities within the Municipality of San Fernando, Bukidnon Province, in the Mt. Pantaron Range. Five individuals were encountered at the summit of Mt. Malimumu, Barangay Namnam at 1,267 m a.s.l. which was a sloped open area with volcanic bedrock. In Mt. Natampod, two individuals of this species were seen at a partially shaded area of the lower montane forest at ca. 1,105 m a.s.l. and growing on loam substrate. In Mt. Balatukan Natural Park, three individuals were observed growing in lower montane forest at 1,387 m a.s.l. on volcanic substrate.

**Proposed conservation status:**—*Saurauia decolorata* is only known from 10 individuals total among three localities on Mindanao Island (i.e., seven individuals in Mt. Pantaron Range and three individuals in Mt. Balatukan) with an estimated area of occupancy (AOO) of 12 km<sup>2</sup> (Bachman *et al.* 2011). All individuals were observed to inhabit lower montane forest where existing threats such as illegal logging, forest clearing, and over-collection of biological resources (e.g., rattan palm and timber) were observed. If these activities remain unregulated, especially in the case of Mt. Pantaron Range, which is not under legislative protection, the habitats and populations of this new species will be compromised. All these conditions satisfy IUCN criteria B2ab (IUCN Standards and Petitions Committee 2022) thus, we propose *S. decolorata* to be listed under the Endangered category.



**FIGURE 2.** A–L. *Saurauia decolorata*. A. Branchlets showing the fascicled inflorescence. B. Branchlets showing the rusty-colored tomentum and ovate to ovate-lanceolate scales and shorter orbicular to elliptic ovate scales. C. Leaf base and abaxial surface. D. Flower E. Fasciculate-cymose inflorescences. F. Calyx G. Ovary and styles H. Longitudinal anther dehiscence and dorsifixed filament insertion. I. Pinkish green outer sepals with sparse lanceolate scales. J. Intermediate sepal exhibiting the outer and inner sepal morph. K. Petaloid inner sepals L. Fan-shaped petals. Photos A and E by Darin Penneys, G by Daryl Salas, and B–J Shiella Mae Olimpos.



**FIGURE 3.** A–C. *Saurauia avellana*. A. Branchlets B. Flower C. Abaxial leaf surface covered with yellowish brown tomentum and lanceolate scales. D–F *Saurauia elegans* D. Branchlets E. Type specimen (H. Cumming 922) showing the paniculate inflorescence F. Branchlets and abaxial leaf surface covered with rusty-colored tomentum and bristle-like scales. Photos A–F by Pieter Pelser (Co's Digital Flora of the Philippines/PhytoImages) and E from JSTOR Global Plants.

**Etymology:**—The specific epithet *decolorata* refers to the rusty-colored tomentum and scales that densely cover the branchlets and the abaxial leaf surfaces imparting a distinct tarnished appearance to the plant. This feature stands out prominently and serves as the most distinctive characteristic of this taxon.

**Discussion:**—This taxonomic novelty brings the total number of Philippine *Saurauia* species to 58, making it the third most species-rich area for *Saurauia* (after Borneo and Papua New Guinea) in the Malesian phytogeographical region.

*Saurauia decolorata* also resembles *S. elegans* (Choisy 1855: 119) Fernández-Villar (1880:19) (Fig. 3 D–F) in sharing, e.g., tomentum color, crenate leaf margins, and shiny, glabrous upper leaf surfaces. However, *S. decolorata* has broader oblong-elliptic leaves (length/width ratio 2.9–3.5 vs. 3.2–5.9), a cordate leaf base (vs. round) and fewer pairs of secondary veins (16–21 vs. 25–35), a fascicled cymose inflorescence (vs. a panicle), and shorter peduncles (0.5–1.6 cm vs. 6–13 cm). Table 1 lists additional differences among *S. avellana*, *S. decolorata*, and *S. elegans*.

The addition of a new species from Mindanao suggests the urgent need for more taxonomic work in *Saurauia*, a genus that in the Philippines has never been revised. Species-level identifications in Philippine *Saurauia* have long been difficult because of the lack of revisionary studies and a clear understanding of species boundaries and morphological variation. Studies like this may revive interest in this genus, and information generated can contribute to narrowing the knowledge gap on its taxonomy and species conservation. Ongoing investigations by the first author on the phylogenetic systematics of *Saurauia* in the Philippines are expected to result in additional publications on evolutionary relationships, taxonomic revisions, and more new species.

The addition of *Saurauia decolorata* increases the number of *Saurauia* species in Mindanao to 28, 13 of which are endemic (Pelser *et al.* 2011). Mindanao is known for its extensive mountain ranges, where isolated peaks or “sky islands” function as barriers between the lowlands and neighboring mountains. This geographical setting fosters

reproductive isolation of species and formation of unique habitats, making these montane forests into crucibles of evolution with numerous endemic taxa (Amoroso 2000; Flantua *et al.* 2020). Moreover, the insular nature of Mindanao further isolates it geographically, thus restricting the exchange of genetic material with neighboring island ecosystems, intensifying the prevalence of unique plant species (Whittaker & Fernández-Palacios 2007; Kier *et al.* 2009). For these reasons, most *Saurauia* species in Mindanao are endemic there and apparently have little chance of dispersing, facts that have important conservation implications.

**TABLE 1.** Comparison of *Saurauia decolorata*, *S. avellana*, and *S. elegans* morphology.

	<i>S. decolorata</i>	<i>S. avellana</i>	<i>S. elegans</i>
Branchlet, petiole, and abaxial leaf indumentum	Rusty-colored tomentum with a combination of long (1–1.2 mm) ovate or ovate-lanceolate scales, and shorter (< 1 mm) irregularly orbicular to elliptic-ovate scales	Reddish brown to yellowish brown tomentum with lanceolate or narrowly ovate (0.5–1.5 mm) scales	Rusty-colored to reddish brown with long (1–3 mm) bristle-like scales (possessing lanceolate base and seta-like apex)
Leaf length/width ratio	2.9–3.5	1.7–2.8	3.2–5.9
Leaf base	Cordate	Round to slightly obtuse	Round
Leaf margin	Crenate	Serrate	Crenate
Number of leaf secondary veins per side	16–21	13–17	25–35
Adaxial leaf surface	Shiny and glabrous except for very few scales on base of midrib	Dull and sparsely tomentose on midrib and secondary veins	Shiny and glabrous
Inflorescence position	Axillary and ramiflorous	Axillary and ramiflorous	Axillary
Inflorescence type	Fasciculate cyme	Fasciculate simple or compound umbel	Panicle
Peduncle length (cm)	0.5–1.6	1.6–4.2	6.0–13.0
Outer sepals: shape	Orbicular to widely ovate	Oblong-ovate	Oblong-ovate
Outer sepals: color	Pinkish green (basally green, becoming pinkish green apically)	Light green to yellowish green	Light green or orangish brown
Outer sepals: indumentum	Sparse, appressed, weak, green or pink ovate-lanceolate scales	Dense reddish brown to yellowish brown tomentum and with abundant, appressed, lanceolate scales	Dense to moderate orangish brown tomentum and appressed, bristle-like scales
Inner sepal shape	Orbicular to widely ovate	Oblong to widely obovate	Elliptic-obovate
Petal shape	Flambellate	Widely oblong to widely obovate	Oblong to obovate
Petals: apex	Erect but apex slightly recurved	Erect	Erect

The Pantaron Mountain Range has still no legislation for its protection despite the number of threatened, endemic, and unique vascular plant species it harbors (Gronemeyer *et al.* 2014; Lagunday *et al.* 2017; Amoroso *et al.* 2020; Coritico *et al.* 2022). In addition, the cordillera of Central Mindanao is also experiencing significant forest cover loss due to development, mining, and the unsustainable harvest of biological resources (ESSC 2018; Coritico *et al.* 2022). If this continues and no conservation programs are initiated, Mindanao will not only lose a biodiversity hub in the Mt. Pantaron Range but also its ancient cultural identity, as the mountains are considered sacred places for the indigenous Manobo, Higaonon, and Bukidnon tribes who continue to coexist with their ancestral forests.

Mt. Balatukan presents a different challenge because it was already declared a protected area (Proclamation no. 1249, s. 2007), but forest clearing and poaching are abundantly evident within the area. Moreover, paramilitary insurgencies, i.e., the New People's Army, have made parts of it inaccessible, hampering implementation of conservation programs. There is a need for better enforcement of protection laws to ensure that the remaining forest of Mt. Balatukan Natural Park can recover from past disturbance. As scientific data on the protected area's floristic biodiversity is scarce, botanical surveys should be prioritized to support the enhancement of conservation management. The discovery of

*Saurauia decolorata* will hopefully spark interest in conducting more taxonomic studies and create awareness of the noteworthy, unique, and threatened plants of the protected area.

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**Appendix I.** Additional *Saurauia* specimens examined for morphological comparisons.

*Saurauia avellana* Elmer. PHILIPPINES. Negros Island: Province of Negros Oriental, Dumaguete City, Cuernos Negros, ca. 914 m a.s.l., May 1908, *A.D.E. Elmer 10055* (isotypes MO!, NY!); Mindanao Island: Bukidnon Province, Mt. Candon, June-July 1920, *M. Ramos and G. Edaño 38845* (P!).

*Saurauia elegans* (Choisy) Fern-Vill. PHILIPPINES. Luzon: Province of Benguet, Baguio, March 1904, *A.D.E. Elmer 5796* (NY!), Bokod Road between Baguio and Binga Dam, 1,463 m a.s.l., 25 November 1963, *W. Stern & B.A. Lomibao 2220* (ILL!).