



Boesenbergia igorota (Zingiberaceae), a new species from the Cordillera Central Range, Northern Philippines

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(Manuscript received 26 October 2021; Accepted 15 May 2022; Online published 23 May 2022)

ABSTRACT: Recent botanical explorations in the province of Benguet, Philippines have resulted in the discovery of a new ginger species, namely *Boesenbergia igorota* Tad-o & Napal., which is described and illustrated here, including the information on its phenology, ecology, conservation status, distribution, habitat, and surrounding floral species.

KEY WORDS: *Boesenbergia alba*, Cordillera Central Range, critically endangered, Igorot women, morphometrics, flora.

INTRODUCTION

Boesenbergia Kuntze (Zingiberaceae) is distinguished from other related genera in the tribe Zingibereae mainly by its distichous bracts, basipetalous flowering (flowers opening from the apex towards the base), and more or less saccate labellum (Smith, 1987; Larsen, 1997; Mood *et al.*, 2014; Docot *et al.*, 2020). The genus has approximately 93 species distributed mainly in the Indo-Malaysia, with few species occurring in China, the Western Ghats of India, Indonesia, Nepal, and the Philippines (POWO, 2019). In the Philippines, *Boesenbergia* is represented by four endemic species (Pelser *et al.*, 2011–). The first two species, *Boesenbergia longipetiolata* (Ridl.) Merr. and *B. macropoda* Merr., were discovered separately in the peninsula of Zamboanga and the islands of Jolo about a century ago. Recently, Docot *et al.* (2020) described two additional species both occurring in the province of Palawan but in different sites. These two new species can be easily differentiated by plant height and flower color: *B. eburnea* Docot has a smaller habit at 9–40 cm and white labellum with a yellow patch at the throat while *B. leonardocoi* Funak. & Docot has a taller habit at 20–60 cm and lavender labellum with a dark-violet patch at the throat. Notably, both species were found in semi-shaded to shaded part of the forest.

Before this report, *Boesenbergia* has never been reported in mainland Luzon, including the Cordillera Central Range (CCR). Situated in northern Luzon, the CCR harbors highly endemic flora and fauna and is one of the biogeographic zones in the country (Vallejo, 2014; Guron and Napaldet, 2020). During the American occupation of the Philippines, Merrill and his compatriots explored the vegetation of the CCR. On his several visits, Merrill described the flora of Mt. Pulag and the Mountain Province, wherein he noted unique species not found in other parts of the country (Merrill and Merrill, 1910;

Merrill, 1912; Merrill, 1926a). However, some parts of CCR were left unexplored, particularly the southwestern area. This includes the mountainous terrain of Bakun in the province of Benguet. Currently, forested areas of these localities are threatened by land-use changes and the continued expansion of lucrative commercial farms.

In 2020, an unknown species was accidentally spotted along a popular tourist trail in Bakun, Benguet (Fig. 1). Morphologically, the species was placed under the genus *Boesenbergia*. Further examination of the specimens concluded that the species is new to science and now presented as *Boesenbergia igorota* Tad-o & Napal. This new species is described and illustrated below. We also constructed a new key to the Philippine *Boesenbergia* species to accommodate this new taxon. Further, phenology, ecology, conservation status, distribution, habitat, and surrounding floral species are also presented.

MATERIALS AND METHODS

The study area, Mt. Kabunian, is one of the lesser known mountains in the CCR and falls under the ancestral domain of Bakun, Benguet. Thus, the municipality's and community's permissions were sought - culminating in the issuance of the Mayor's permit for the research project. The first author spotted the plant in 2020 as he hiked the mountains of Bakun to reach his students. Then he coordinated with the research team to conduct the proper field documentation of the species from June to September 2021. We compared our (living and mounted) collections mainly with the published reports on *Boesenbergia* by Docot *et al.* (2020) and Merrill (1926b). We also compared and examined it with the high-resolution images of specimens from the US, CAHUP, and PNH of most similar species occurring in the Philippines and neighbouring islands. The terminologies used in the description of the new species follow The Kew Plant Glossary (Beentje and Williamson, 2010). To

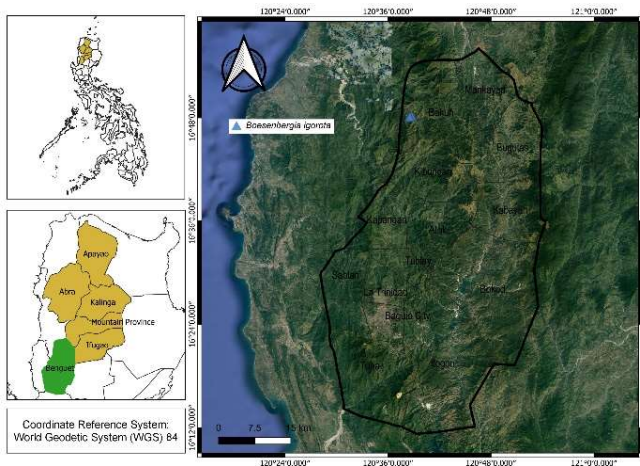


Fig. 1. Map of the Benguet showing the location of the taxon.

facilitate the assessment of the conservation status of the new taxon using the International Union for Conservation of Nature (IUCN) criteria (IUCN Standards and Petitions Subcommittee, 2019), the extent of occurrence (EOO) and area of occupancy (AOO) were calculated using the geospatial conservation assessment tool GeoCAT (Bachman *et al.*, 2011). Furthermore, the distribution map of the species was generated in QGIS version 2.18 (Quantum GIS Development Team, 2016).

The morphological characters and morphometrics of the new species were documented during the field documentation. The morphometrics or morphological measurements were analyzed statistically to present the extent of plasticity in the plant organs. We also documented the surrounding floral species in the habitat of *Boesenbergia igorota* Tad-o & Napal. with the use of 1 × 1 quadrat. Four subpopulations of the taxon were identified in its mountain habitat. In each subpopulation, three 1 × 1 quadrats were established and plants within the plots were inventoried for population counts.

TAXONOMIC TREATMENT

Key to *Boesenbergia* species in the Philippines

- 1a. Lamina smaller (10–60 × 6–29 mm), cordate to narrowly ovate, small habit (4–14 cm), ligule absent, veins arising from petiole or leaf sheath *B. igorota* sp. nov
- 1b. Lamina larger (65–300 × 13–130 mm), linear ovate to oblong-elliptic, larger habit (9–60 cm), ligule present, veins arising from midrib ... 2
- 2a. Lamina pubescent beneath, smooth, base rounded ... *B. longipetiolata*
- 2b. Lamina glabrous beneath, plicate, base obtuse 3
- 3a. Petiole 15–20 cm long; flower red and pink *B. macropoda*
- 3b. Petiole 2–9 cm long; flower white or lavender 4
- 4a. Pseudostem 3–25 cm; sheaths reddish brown; labellum and lateral staminodes white; throat of the labellum yellow; anther crest apex white *B. eburnea*
- 4b. Pseudostem 8–40 cm; sheaths mid-green; labellum and lateral staminodes lavender; throat of the labellum dark violet; anther crest apex purplish *B. leonardocoi*

Boesenbergia igorota Tad-o & Napal., *sp. nov.*

Figs. 2 & 3

This new species is similar to *Boesenbergia alba* (K. Larsen & R.M. Smith) Mood & L.M. Prince but differs by its smaller stature at 4–18 cm (vs. 30–60 cm tall), cordate to narrowly ovate lamina (vs. narrowly linear lamina), absence of ligule (vs. present bilobed ligule), lavender labellum with white patch tinged with light yellow at the throat (vs. white labellum with yellow patch at the throat), bidentate anther crest and lavender at both apices (vs. 4-dentate and yellowish).

Type: Philippines, Luzon, Benguet, Bakun, Barangay Bakun Central (Poblacion), Mount Kabunian, 16°48'08" N, 120°38'33"E, 1,304 masl, 01 ix 2021, *RVB Tad-o, JI Alafag, JT Napaldet 0091* (holo PNH: 258695; iso CAHUP, NLUH).

Deciduous terrestrial herb, 4–14 cm tall. *Rhizome* subterranean, oblong, 3–9 mm in diameter, white to yellowish outer layer, white inside, faintly aromatic. *Pseudostem* 2–7 cm long, sheaths reticulate, glabrous, light green. *Leaves* 5–7; lamina cordate to narrowly ovate, 10–60 mm × 6–29 mm, smooth, glabrous on both sides, base subcordate to obtuse, apex acuminate, margin entire, mid-green upper surface, light-green lower surface, lower and upper leaves smaller, middle leaves largest; veins not prominent adaxially, arising from the petiole or leaf sheath, appear as curved lines in lamina as they spread toward the middle then tapered toward the apex; ligule absent; sessile to subsessile, petiole 1–8 mm long, canaliculate, glabrous, light green. *Inflorescence* terminal, 1–3 flowers blooming one at a time; peduncle sessile; floral bract ensiform, 16–36 mm × 3–9 mm, glabrous on both sides, upper half greenish white, basal half translucent white, apex acute; bracteole ensiform, 4–14 mm × 1.5–3 mm, glabrous, white, becoming light green towards the acute apex; calyx: 5–15 mm, glabrous, translucent white, apex bidentate; corolla tube 3.7–7 cm long, glabrous, white; dorsal corolla lobe narrowly ovate, 10–19 mm × 4–9 mm, glabrous, white, apex acuminate and cucullate; lateral corolla lobes narrowly linear, 12–17 mm × 3–6 mm, glabrous, white, apex acute; labellum orbicular, held flat, petaloid, 22–32 mm × 15–39 mm, glabrous apex with glandular hairs towards the throat, lavender, throat white with a tinge of light yellow, margin more or less repand, emarginate to bilobed; lateral staminodes ovate, petaloid, 15–27 mm × 6–12.5 mm, glabrous, white with tinge of light yellow at the base turning lavender towards the rounded apex; anther sessile, 4–5 mm × 2–3 mm, white; anther crest c. 1.5 mm long, white, apex bidentate and lavender at both apices; style 5.5–7.5 mm, glabrous, white; stigma orbicular, white, ciliated; epigynous glands two, linear, white, 3–5 mm; ovary 2–5 mm, elliptic-cylindrical, trilocular, placentation axile, glabrous, white. *Fruit* 12–16 mm × 6–8 mm subglobose, white covered with persistent bracts and bracteole and appended by the short persistent part of

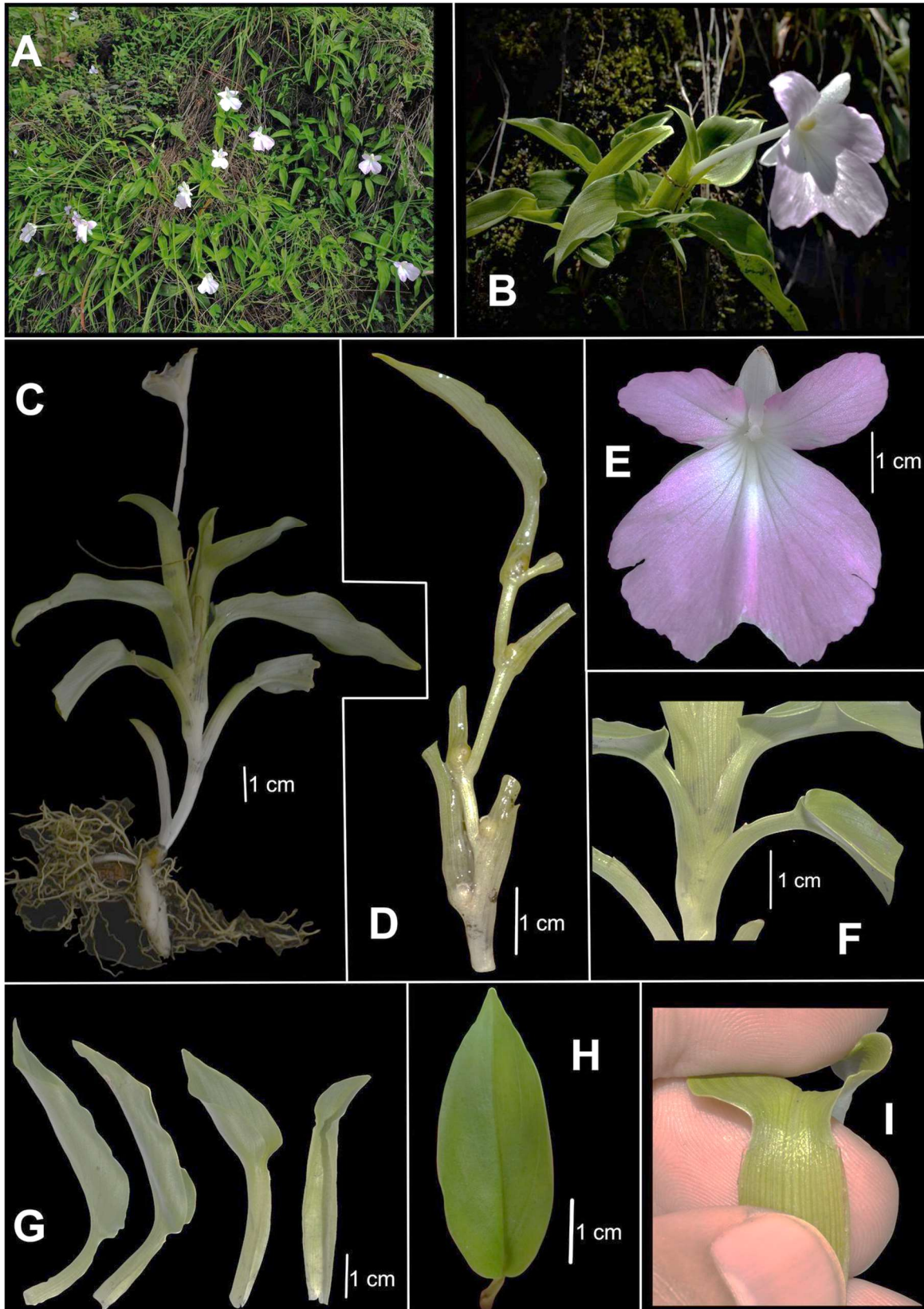


Fig. 2. *Boesenbergia igorota* Tad-o & Napal., sp. nov. **A, B, C**, Habit showing the habitat and rhizomes; **D**, bulbils arising from the leaf axil; **E**, flowers; **F**, pseudostem and petiole; **G, H**, leaf (lateral and ventral views); **I**, leaf sheath showing the absence of ligules. Scale bars, 1 cm. All photographs of the type, *R. V. Tad-o et al.* 0091 (PNH: 258695), taken by R. V. Tad-o and J.I. Alafag.

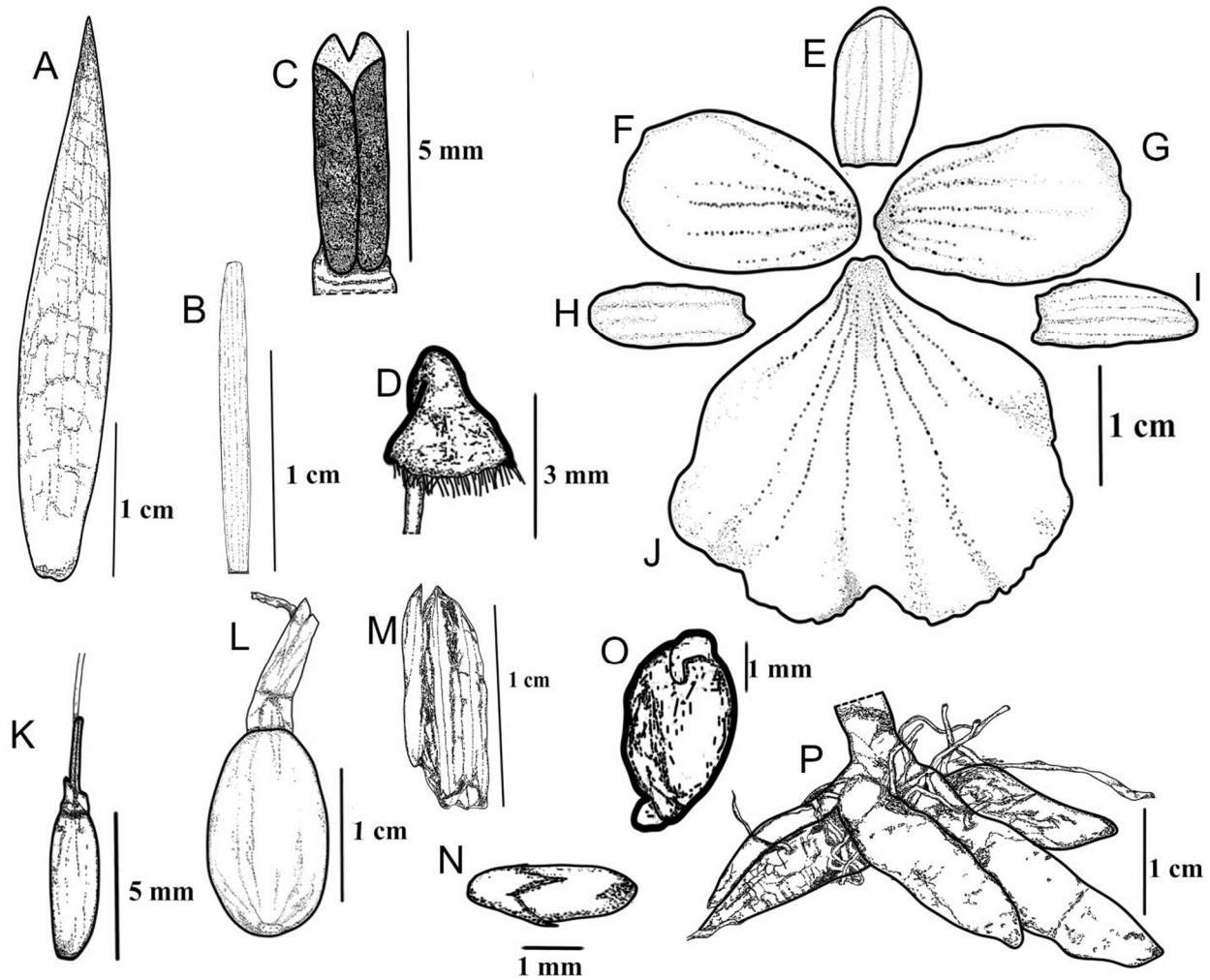


Fig. 2. *Boesenbergia igorota* Tad-o & Napal., sp. nov. A, bract; B, bracteole; C, anther; D, stigma; E, dorsal corolla lobe; F, G, lateral corolla lobes; H, I, lateral staminodes; J, labellum; K, ovary and epigynous gland; L, fruit; M, Calyx, N, seed; O, bulbil; P, rhizome. All drawn from the type, R.V. Tad-o et al. 0091 (PNH: 258695), by R.V. Tad-o

the corolla lobe. Seed numerous, c. 2.5×1.5 mm, fusiform, light brown with whitish arillode, white inside. *Bulbil* subglobose, arise in the axil, $2-5$ mm \times $2-3.5$ mm, brownish-yellow.

Note: The morphological measurements of the taxon are presented in Table 1. The table shows the greater variability of vegetative characteristics vis-a-vis the reproductive traits as shown in the standard deviation. Further, this taxon was compared with other related *Boesenbergia* spp. (Table 2).

Etymology. The species name *igorota* is used as an adjectival epithet to refer to Igorot women, thus it should conform to the gender of the genus *Boesenbergia*. Coincidentally, 'igorota' is the cultural term for Igorot women in the locality. Igorot refers collectively to the indigenous tribes living in the mountainous region of the Cordillera Central Range (CCR) and along its boundaries. This new *Boesenbergia* species possesses simple yet

elegant beauty and can thrive in a harsh environment. Such traits reflect Igorot women and their resourcefulness and resiliency to provide for their children and family amidst the harsh and physically demanding conditions of their mountain home. This species is a tribute to them:

Cordillera Central Range, majestic mountains towering to the skies

Endowed with unique flora and fauna, a naturalist paradise
And home of the Igorots, people both indigenous and courageous

Willing and daring to carve a living along the rugged slopes

Central to Igorot families are the women, affectionately called Igorota

Simply beautiful but much willing and industrious to toil the land

To care for their children and families, working from dawn to dusk

Allow us then, as a tribute, paint these good qualities in *Boesenbergia igorota*



Table 1. Morphological measurements for *Boesenbergia igorota* Tad-o & Napal., sp. nov. (N=40)

Plant Traits	Mini.	Max.	Mean±SD	
Leafy shoot height (cm)	4.30	13.60	8.16±3.36	
Number of leaf per plant	5.00	7.00	6.00±0.71	
Rhizome				
Length (cm)	1.60	1.80	1.7±0.14	
Diameter (cm)	0.30	0.90	0.61±0.28	
Lamina				
Length (cm)	1.00	6.00	3.78±0.85	
Width (cm)	0.60	2.90	1.57±0.50	
Leaf sheath	Length (cm)	1.70	3.10	2.37±0.46
Petiole	Length (cm)	0.00	0.80	0.40±0.32
Bract	Length (cm)	1.60	3.60	2.47±0.77
Bracteole	Length (cm)	0.40	1.40	0.81±0.34
Calyx	Length (cm)	0.50	1.50	0.97±0.46
Corolla tube	Length (cm)	3.70	7.00	5.22±0.95
	Diameter (cm)	0.20	0.25	0.23±0.03
Dorsal corolla lobe	Length (cm)	1.00	1.90	1.43±0.24
	Width (cm)	0.40	0.90	0.73±0.15
Lateral Corolla Lobes	Length (cm)	1.20	1.70	1.49±0.15
	Width (cm)	0.30	0.60	0.48±0.09
Lateral staminodes	Length (cm)	1.50	2.70	1.90±0.38
	Width (cm)	0.60	1.25	0.94±0.22
Labellum	Length (cm)	2.20	3.20	2.73±0.32
	Width (cm)	1.50	3.90	2.73±0.77
Anther	Length (cm)	0.40	0.50	0.46±0.05
	Width (cm)	0.20	0.30	0.27±0.06
Ovary	Length (cm)	0.20	0.50	0.39±0.11
	Diameter (cm)	0.15	0.25	0.20±0.03
Epigynous glands	Length (cm)	0.20	0.50	0.31±0.11
Fruits	Length (cm)	1.20	1.60	1.48±0.14
	Width (cm)	0.60	0.90	0.74±0.10
No. of seeds per fruit	30.00	38.00	35.20±3.90	
Bulbils				
Length (cm)	0.20	0.50	0.39±0.06	
Diameter at the base (cm)	0.20	0.35	0.25±0.05	

Phenology and ecology. The deciduous nature of *B. igorota* is highly adaptive to the area's type I climate - dry season from November to April and wet season during the rest of the year (PAGASA, 2021). It dies back to its rhizome as early as October and becomes dormant throughout the dry season. Then, it grows back as early as May when rainfall becomes heavy and frequent. It starts to flower by the end of June, mainly from July to August. By September, with less frequent rainfall, bulbils start to bud from the axillaries of late bloomers and mostly in individuals that failed to flower. During flowering, it takes three days from anthesis to full bloom, then another 3–4 days of bloom before the corolla starts to degrade.

Conservation status. Based on the IUCN Red List Categories and Criteria (IUCN, 2019), *B. igorota* is categorized as Critically Endangered [CN: B1, B2a]: B1: EOO is estimated to be <100 km² (total EOO is 0.20 km²); B2: AOO is estimated to be less than 10 km² (total AOO is 8 km²); a: severely fragmented or known from no more than one location (*B. igorota* is known only from Mount Kabunian). Extensive exploration of the nearby mountains did not register any *B. igorota*. The mountain site is within the ancestral domain of the Bakun Indigenous People thus falls within the jurisdiction of the

NCIP-CAR (National Commission on Indigenous People - Cordillera Administrative Region). Still, the practical implementation of domain protection laws is by the local government units. The local community actively promotes a no plant collection policy by tourists. We also interviewed some locals regarding the taxon. They are not aware of any use of the plant for either medical, ornamental, or ritual purposes — thus, it is protected from local harvesting.

Distribution, habitat, and surrounding floral species.

The taxon occurs along Mount Kabunian, a popular trekking site in the province. Two types of vegetation occur along its slopes - the westward slope covered with montane and pine forest; and, the bare eastward face characterized by rocky outcrops, and grassland slope sparse with pine trees (*Pinus kesiya* Royle ex Gordon). *B. igorota* grows in the eastward slope where local livestock such as cows, carabaos, and goats graze. This mountainside is burned annually during the dry season, allowing new and palatable grasses to grow for the grazers in the rainy season. The fire does not eradicate the *B. igorota* as it lays dormant in the soil or rock crevices. Also, the annual fire maintains the low-lying vegetation by burning the taller grasses and preventing them from totally outrunning the taxon's population when it emerges during the start of the rainy season. In addition, the burnt vegetation from the dry season enriches the shallow soil where the taxon grows. During the rainy season, the area receives continuous rainfall that creates a lot of intermittent streams, which sustain the taxon's population in an otherwise dry ground. The shallow soil on rocky outcrops and crevices are usually collected and held together by bryophytes, generally moss, and these shallow soils are enough to support the taxon. Notably, *B. igorota* grows under full exposure to sunlight.

B. igorota is clustered at different altitudes with at least four subpopulations identified along Mt. Kabunian. When trekking towards the mountain, the 1st subpopulation to be encountered is located in a rocky outcrop near a stream at 1006 masl (therefore, the lowest-slope population) and is the smallest population with approximately 10–20 individuals. Afterward is an expanse of grassland with sparse pine trees before reaching the 2nd subpopulation at 1301 masl (hence, the mid-slope population). Similarly, after the 2nd subpopulation, there is another grassland with sparse pine trees before the 3rd subpopulation at 1563 masl near the mountain's summit (hence, the summit population). The mid-slope and summit subpopulations have larger populations with approximately 100–200 individuals each. And lastly, the 4th subpopulation is found along the summit in a hanging outcrop cliff that is dangerously out of reach. The 4th subpopulation was not included in the documentation.

A total of 22 floral species were documented to be surrounding *B. igorota* in its immediate environment

**Table 2.** Comparison of the morphological characters of *Boesenbergia igorota* with other related *Boesenbergia* spp.

Morphology	<i>B. igorota</i>	<i>B. eburnea</i>	<i>B. leonardocoi</i>	<i>B. alba</i>	<i>B. longipetiolata</i>	<i>B. macropoda</i>
Leafy shoot	4–14 cm	9–25 cm	20–40 cm	30–60 cm	–	c. 60 cm
Sheath	light green	reddish brown	mid-green	mid-green	–	–
Ligule	absent	bilobed, the lobes subulate	bilobed, the lobes subulate	bilobed, the lobes ovate	–	–
Lamina attachment	sessile to petiolate (1–8 mm long)	petiolate (20–60 mm long)	petiolate (20–60 mm long)	sessile to petiolate (5–30 mm long)	petiolate (50–90 mm long)	petiolate (150–200 mm)
Lamina Size	10–60 x 6–29 mm	90–250 x 40–90 mm	100–250 x 50–130 mm	65–130 x 13–20 mm	140 x 20 mm	200–300 x 90–110 mm
Lamina Shape	narrowly ovate	narrowly ovate	narrowly ovate	narrowly linear	linear-lanceolate	oblong-elliptic
Base	subcordate to obtuse	obtuse	obtuse	rounded	obtuse	decurrent
Texture	smooth	plicate	plicate	smooth	membranaceous	membranaceous
Calyx	2-dentate	1-dentate	1-dentate	2-dentate	–	–
Corolla tube	white	white	lavender	white	–	–
Labellum Orientation	flat	flat	flat	flat	–	–
Shape	orbicular	orbicular	orbicular	orbicular	obovate	orbicular
Apex	emarginate to bilobed	entire	entire	entire to bilobed	crisped	acuminate
Colour	lavender	white	lavender	white	–	red or pink
Colour of throat	white with tinge of light yellow	yellow	dark violet	yellow	–	–
Lateral staminodes	base whitish-yellow, lavender towards apex	white	lavender	lavender	–	red or pink
Anther crest Length	c. 1.5 mm	c.3 mm	c. 1.5 mm	c.4mm	–	c. 7 mm
Colour	white	white	white	yellow	–	–
Apex Shape and colour	bidentate and lavender	rounded and white	rounded and purplish	4-dentate and yellowish	rounded	Oblong
Reference		Docot <i>et al.</i> , 2020	Docot <i>et al.</i> , 2020	Docot <i>et al.</i> , 2020	Ridley, 1909 & Merrill, 1926b	Merrill, 1926b

* Docot *et al.* (2020);** Ridley (1909) and Merrill (1926b); *** Merrill (1926b)

(Table 3). The area was dominated by *Themeda triandra* and other grass species. Most of these floral species are weeds and hardy plants that tolerate the annual grass fire during the dry season.

ACKNOWLEDGMENTS

The discovery of this species was done under the research project titled “Documentation and Re-description of Floral Diversity in Cordillera Central Range, Northern Philippines” funded by SEARCA (Southeast Asian Regional Center for Graduate Study and Research in Agriculture) through the Seed Fund for Research and Training. The study was also provided with travel fund support from Benguet State University through the Office of the Vice President for Research and Extension headed by Romeo A. Gomez Jr. Further, the authors are indebted to Ingrid P. Lin of US, Jeremy Carlo B. Naredo of CAHUP, and Dany Tandang of PNH for providing high-resolution images of *Boesenbergia* spp. from their collections; Pearlyn Gambulao of DOST-CAR and Yolanda C. Ruperto and Jeanette P. Pagaran of DENR-CAR for technical assistance; the indigenous people and LGU officials of Bakun for allowing us to conduct the study; Eugene Logatoc for the helpful insights;

and the reviewers for their valuable comments and suggestions for the improvement of the manuscript. Thanks to all and to God be the glory!

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Table 3. Surrounding floral species with *Boesenbergia igorota* Tad-o & Napal., sp. nov. in Mt. Kabunian, Benguet, Philippines

Plant Species	Density Frequency		Relative		Importance Value (IV)
	(Di)	(Fi)	Density (RD)	Frequency (RF)	
<i>Ageratina riparia</i> (Regel) R.M.King & H.Rob.	0.75	25	3.45	2.94	3.19
<i>Alloterosia semialata</i> (R.Br.) Hitchc.	0.25	25	1.15	2.94	2.05
<i>Bidens pilosa</i> L.	0.25	25	1.15	2.94	2.05
<i>Boesenbergia igorota</i> Tad-o & Napal., sp. nov.	3	100	13.79	11.76	12.78
<i>Bulbophyllum catenulatum</i> Kraenzl.	0.5	25	2.30	2.94	2.62
<i>Carex indica</i> L.	0.25	25	1.15	2.94	2.05
<i>Chamaecrista mimosoides</i> (L.) Greene	1.5	75	6.90	8.82	7.86
<i>Drynaria rigidula</i> (Sw.) Bedd.	0.25	25	1.15	2.94	2.05
<i>Fimbristylis littoralis</i> Gaudich.	1.25	25	5.75	2.94	4.34
<i>Gonostegia triandra</i> (Blume) Miq.	0.5	25	2.30	2.94	2.62
<i>Peristylus</i> sp.	0.75	25	3.45	2.94	3.19
<i>Hackelochloa granularis</i> (L.) Kuntze	0.25	25	1.15	2.94	2.05
<i>Imperata cylindrica</i> (L.) P.Beauv.	0.25	25	1.15	2.94	2.05
<i>Ixeridium laevigatum</i> (Blume) Pak & Kawano	1.25	75	5.75	8.82	7.29
<i>Lantana camara</i> L.	0.25	25	1.15	2.94	2.05
<i>Murdannia loriformis</i> (Hassk.) R.S.Rao & Kammathy	1	25	4.60	2.94	3.77
<i>Odontosoria chinensis</i> (L.) J.Sm.	2	50	9.20	5.88	7.54
<i>Oplismenus hirtellus</i> (L.) P.Beauv.	0.75	25	3.45	2.94	3.19
<i>Pteridium aquilinum</i> (L.) Kuhn	0.5	25	2.30	2.94	2.62
<i>Selaginella</i> sp.	0.25	25	1.15	2.94	2.05
<i>Themeda triandra</i> Forssk.	4.5	100	20.69	11.76	16.23
<i>Utricularia aurea</i> Lour.	1	25	4.60	2.94	3.77
<i>Utricularia striatula</i> Sm.	0.5	25	2.30	2.94	2.62