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Sarcoglottis neillii (Orchidaceae: Spiranthinae), a new species from the Andean Tepui Region of Ecuador and Peru

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Abstract

Recent exploration of the foothills of the Cordillera del Cóndor, southeastern Ecuador, led to the discovery of an unknown species of *Sarcoglottis*, and subsequent study in Peruvian herbaria permitted to record it in Peru. Here we describe it as *Sarcoglottis neillii* and provide a detailed drawing and color photographs taken from live plants. We compare its morphology with that of similar members of *Sarcoglottis* and conduct a preliminary assessment of its conservation status. *Sarcoglottis neillii* belongs to a small group of species including *S. metallica*, S. *maroaënsis* and *S. stergiosii*, differing from the former two species in leaf coloration and from the latter in flower size and labellum morphology. The single known Ecuadorian location of *S. neillii* was destroyed by extensive open pit-mining activities, but the several records from Peru suggest that the species is widespread; three locations occur within the Yanachaga-Chemillén National Park, but information on its actual range and potential threats is lacking and we suggest for it the category of Data Deficient (DD) until further field studies permit a better-informed assessment of its risk status.

Keywords: Amazon, Cordillera del Cóndor, *Sarcoglottis maroaënsis, Sarcoglottis metallica*, *Sarcoglottis stergiosii*, Yanachaga-Chemillén National Park

Introduction

The genus *Sarcoglottis* Presl (1827: 95, t. 15) is widespread in the Neotropics and consists of ca. 45 geophytic species with fasciculate, fleshy roots, flat broad leaves forming a rosette, and comparatively large, fleshy flowers for subtribe Spiranthinae Lindley (1840: 441) (Salazar 2003a, Salazar *et al.* 2018; Fig. 1A−D). The proximal portions of the lateral sepals are connate and decurrent along most of the ventral surface of the ovary to form a variously prominent nectary (Fig. 1F−H; see also Salazar *et al.* 2018: Fig. 2M−N, P). The labellum is channelled, mostly spatulate in outline but expanded into a recurved or deflexed apical lobe, and the labellum base bears two subulate, retrorse nectar glands (Fig. 1I−J). The column is clavate, with triangular or oblong-triangular rostellum, which is truncate or slightly emarginate after removal of the wishbone-shaped pollinarium (Fig. 1K−N; Salazar *et al.* 2018: Fig. 1S−T). The few available observations indicate pollination by long-tonged bees of tribe Euglossini (Apidae) that probably feed on the nectar present at the bottom of the floral tube (Singer & Sazima 1999, Salazar 2003a and pers. obs., Pérez-Escobar *et al.* 2017).

Three species of *Sarcoglottis* were recorded in Ecuador by Dodson (2004), namely *S. acaulis* (Smith 1806: 91, t. 105) Schlechter (1919: 53−54), *S. grandiflora* (Lindley 1826: t. 1043) Klotzsch (1842: 107) and *S. portillae* Christenson (2003: 243−244, Figs. 204, 205), and a fourth species, *S. turkeliae* Christenson (2004: 136−138), was described from a plant of Ecuadorian origin cultivated in the USA, but lacking information on its precise origin. However, during fieldwork conducted in 2017 at the Cordillera del Cóndor, southeastern Ecuador, we discovered several plants of a *Sarcoglottis* that did not match any of the species known for the country. A literature review and study of *Sarcoglottis* specimens in regional and foreign herbaria showed that our material shares the morphological

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features of a small group of species from the northern Amazon Region and the Guyana Shield, including *S. metallica* (Rolfe 1896: 46−47) Schlechter (1920: 417), S. *maroaënsis* Romero-González & Carnevali in Romero-González *et al.* (2010: 514−518, figs. 1C−D, 3) and *S. stergiosii* Carnevali & I.Ramírez (1993: 124, fig. 12). Subsequently, one of us (GAS) had the opportunity to study the orchid collections of two major Peruvian herbaria (HOXA and USM), where additional specimens of the unknown entity from the Cordillera del Cóndor were found. In the following we describe the Ecuadorian/Peruvian entity as a new species, provide a detailed drawing and color photographs, compare it with similar species of *Sarcoglottis* and carry out a preliminary assessment of its conservation status.

Materials & methods

Morphological observations and measurements were carried out on live plants and flowers, pressed specimens and flowers from herbarium specimens softened by immersion in hot soapy water. Photographs were taken with a digital camera (Nikon D7100, Nikon Corporation, Tokyo, Japan) provided with a 60 mm AF Micro Nikkor lens (Nikon).

The Ecuadorian and Peruvian specimens of the new species were compared with other specimens housed in the herbaria AMES, AMO, ANDES, ARIZ, ASU, BHCB, BHZB, BM, BR, CAS, CHAPA, COL, CORU, ECUAMZ, ENCB, F, FCME, GH, HB, HOXA, HUEFS, IBUG, IEB, JBSD, K, LL, M, MBM, MEXU, MG, MHES, MO, NY, P, PMA, QCA, QCNE, QMEX, R, RB, SEL, SERO, SLPM, SP, SPF, TEX, UAMIZ, US, USJ, USM, UVAL, VEN, W and XAL (acronyms according to Thiers 2017).

Conservation status was inferred using the World Conservation Union red list categories and criteria (IUCN 2012). Estimation of the extent of occurrence and area of occupancy was carried out using a beta version of GeoCAT (Bachman *et al.* 2011), as implemented in the Royal Botanic Gardens, Kew website (https://www.kew.org/science/our-science/projects/geocat-geospatial-conservation-assessment-tool), with the default setting of 2 km width cell.

Taxonomy

Sarcoglottis neillii Salazar & Tobar, *sp. nov.* (Figs. 1, 2).

Type:—ECUADOR. Zamora Chinchipe: cantón El Pangui, estribaciones de la Cordillera del Cóndor, 8 km en línea recta al E de Tundayme en la zona de construcción de la mina Cóndor Mirador, 1600 m, collected 10 April 2017, pressed in cultivation 12 February 2018, *Salazar et al. 9978* (holotype QCNE!).

Similar to *S. metallica* (Rolfe) Schltr. and *S. maroaënsis* G.A.Romero & Carnevali, differing from both in its bright green upper side of leaves densely streaked with silvery white and lower leaf surface homogeneously pale olive green (vs. upper surface of leaves reddish-, brownish-, or chocolate-purplish with irregular, bright green dots and spots and homogeneously purplish-red underside).

Terrestrial, acaulescent herb 21−50 cm in height including the inflorescence. Roots fasciculate, terete, attenuating slightly towards the apex, long-pilose, pale dull yellowish, up to 8 × 5−6 mm. Leaves 3−6, forming a basal rosette, with ascending petioles and horizontal blades; petioles sublinear, channelled, white with pale green margins, 15−75 × 5−7 mm; blades bright green streaked adaxially with silvery-white, sometimes slightly oblique, homogeneously pale olive green abaxially, elliptic to ovate, base broadly cuneate to rounded, apex acute, 5−13 × 2.3−6.4 cm. Inflorescence racemose, erect, arising from the centre of the rosette of leaves; peduncle brownish-red, partially enclosed by 5 sheaths, glabrous below the middle, becoming increasingly villose above, with hairs simple, long and slender, translucent, sometimes slightly clavate, arising individually or entangled in groups; sheaths glabrous, pale greyish green with whitish margins, the uppermost 2 tinged with brownish-red, the lowermost one sometimes foliaceous, 3−7 cm long. Floral bracts lanceolate, concave, attenuate, slightly incurved, greenish-red, sparsely pilose at their bases, glabrous otherwise, margins irregularly ciliate but becoming minutely papillose near the apex, 1.3−2.5 cm long. Flowers 3−14, ascending, resupinate, without noticeable odor at day or night; sepals reddish-brown with greenish base, petals white with 3 brownish-pink veins, labellum pale green becoming white distally, with 7 faint, pinkish veins on the apical lobule. Ovary fusiform, obscurely 3-costate, gently attenuating towards the apex and abruptly so into the pedicel, ventricose, brownish-red and glabrous except for sparse pubescence near the apex and ventrally on the adnate portions of the lateral sepals, 20−23 × 4−5 mm; trichomes as in the peduncle. Dorsal sepal erect, concave, recurved at apex, sparsely pubescent as the ovary, especially so below the middle, lanceolate-elliptic, acute, cuneate at base, 3-veined, 10–13 × 2.3–3.2 mm. Lateral sepals decurrent over most of the length of the ovary, connate for about 1/3 of their length, free portion proximally oblong, distally falcate, acute and strongly recurved with their apices converging in natural position, usually 3-veined, occasionally with an additional lateral vein near the apex, sparsely pubescent externally, glabrous at apex, 20–21 × 3.1–3.9 mm; bottom of the synsepal glabrous and provided with nectar. Petals adherent internally to the dorsal sepal except at their free, recurved apices, obliquely oblanceolate-spatulate, apex obtuse and sometimes obscurely apiculate, external margin irregularly papillose above the middle, 3-veined, 10–11.5 ×1.8–1.9 mm. Labellum basally adnate to the sepals near the bottom of the nectary, spatulate in outline when spread out, except for the apical lobe, pandurate above the middle, with erect margins adherent to the sides of the column, apical lobe obreniform to broadly triangular, strongly revolute and bearing two basal, papillose convergent thickenings separated by a central groove, apex subtruncate to rounded overall but obscurely apiculate when fully spread out, looking slightly retuse in natural position; labellum 3-veined at base to 9-veined at its widest part; with a longitudinal, internal central groove that ends around the middle of the apical lobe; base provided at each side with a subulate, retrorse nectar gland 4.5–5 × 0.5 mm; total length of labellum 18−21 mm from the base of the nectar glands to the apex of the apical lobe, maximum width ca. 4−5.2 mm, spread out apical lobe 2.5−3 × 4.5−5.1 mm; narrow portion of labellum channel pilose on both surfaces, internally the trichomes digitiform and intercrossing, becoming papillae both towards the nectar glands and the expanded portion; expanded portion glabrous, apical lobe colliculate. Column subclavate, ventrally flat and glabrous, 5.7−7 × 2.1–2.3 mm, provided with a long column foot decurrent on most of the ventral length of the ovary; anther ellipsoid, ca. 4 mm long, ending at apex into a broad, rounded projection; rostellum somewhat deflexed, triangular, truncate after removal of the pollinarium, ca. 1.8 mm long; stigma slightly concave, somewhat bilobed transversely. Pollinarium wishbone-shaped, with two deeply cleft, creamy-white pollinia and a grey, rhomboid apical viscidium. Capsule ascending, ellipsoid, glabrous except for its ventral surface, pale brown with darker brown costae, 17–18 × 6 mm, plus an inconspicuous pedicel ca. 3 × 0.9 mm.

RECOGNITION. *Sarcoglottis neillii* is similar in floral structure to *S. metallica*, from the Guiana Shield and northwestern Amazonia—including its synonym, *S. maasorum* Pabst (1979: 21, *fide* Christenson 1999) and S. *maroaënsis*, from southern Venezuela (Romero-González *et al.* 2010). However, leaf coloration distinguishes *S. neillii* from the latter two species. In *S. neillii*, the upper surface of the leaves is bright green densely streaked with silvery white and its lower surface is homogeneously pale olive green. In contrast, the leaves of *S. metallica* and *S. maroaënsis* are reddish-, brownish-, or chocolate-purplish with irregular, bright green dots and spots on the upper surface and homogeneously purplish-red on the underside. Moreover, leaves of *S. maroaënsis* are ascending and proportionately narrower, elliptic-lanceolate to oblanceolate (vs. horizontal, elliptic to ovate). A further similar species is *S. stergiosii*, from southern Colombia and Venezuela, distinguished from *S. metallica*, *S. maroaënsis* and *S. neillii* by its much smaller plants and flowers, proportionately narrower perianth segments, and only slightly expanded apical lobe of the labellum (Carnevali & Ramírez 2003).

DISTRIBUTION. Know only from Ecuador and Peru, on the eastern (Amazonian) foothills of the Andes and on adjacent Andean tepuis, corresponding with the central and southern portions of the Andean Tepui Region proposed by Neill (2007) and Neill *et al.* (2014). The Andean Tepui Region consists a discontinuous series of mountain ranges located east of the main Andean cordillera and separated from it by low valleys. It includes, from north to south, the Serranía de la Macarena in Colombia, Cordilleras Galeras and Kutukú in Ecuador, Cordillera del Cóndor along the Ecuador-Peru border, Cerros de Kampankis in northern Peru (a southern extension of Kutukú), and Cordillera Escalera, Cordillera Azul and Cordillera de Yanachaga in Peru. This whole region holds an extraordinary biological diversity that has been only partially documented (Neill *et al.* 2014).

ADDITIONAL SPECIMENS EXAMINED. PERU. Pasco: provincia Oxapampa, distrito Palcazu, Parque Nacional Yanchaga-Chemillén, sector Ozuz, 750 m, 30 July 2012, *Durand et al. 405* (HOXA!); Pasco: provincia Oxapampa, Oxapampa, trocha hacia Río Venado, 550–600 m, 11 June 1995, *La Torre 1105* (USM!); Pasco: Pichis Valley, near Paujil, 10 km downriver from Puerto Bermúdez, 300 m, *Foster 8885* (USM!); Cusco: provincia La Convención, distrito Echárate, Pagoreni, 5 July 2004, *Baldeón & Beltrán 6041* (USM!); provincia La Convención, distrito Echárate, cerca de la plataforma de perforación de gas Cashiriari-1, 19 July 2005, *Baldeón et al. 6410* (USM!).

HABITAT. Terrestrial, in humus-rich dark brown soil with abundant leaf mould in primary lowland tropical forest and lower montane rain forest; alt. 300−1600 m. According to the system of classification of the ecosystems of continental Ecuador, the Ecuadorian forests were this species was collected correspond to evergreen pre-montane forest and low montane forest from the Cordilleras del Condor-Kutukú (Aguirre *et al.* 2013, Josse & Aguirre 2013). These are characterized by a canopy ~ 15 m in height, trees laden with bryophytes and other epiphytes, and understory with a great diversity of shrubs and herbs (Morales *et al.* 2013). The habitat of *S. neillii* in Peruvian lowland tropical forest sites may be represented by the Estación Biológica Paujil, at about 500 m elevation in the Parque Nacional

Yanachaga-Chemillén (INRENA 2005). Vegetation there consists of an evergreen forest with three or more strata, the highest of which is ~ 30 m in height, with emergent trees reaching up to 45 m. Floristic diversity is high and lianas and epiphytes are well represented.

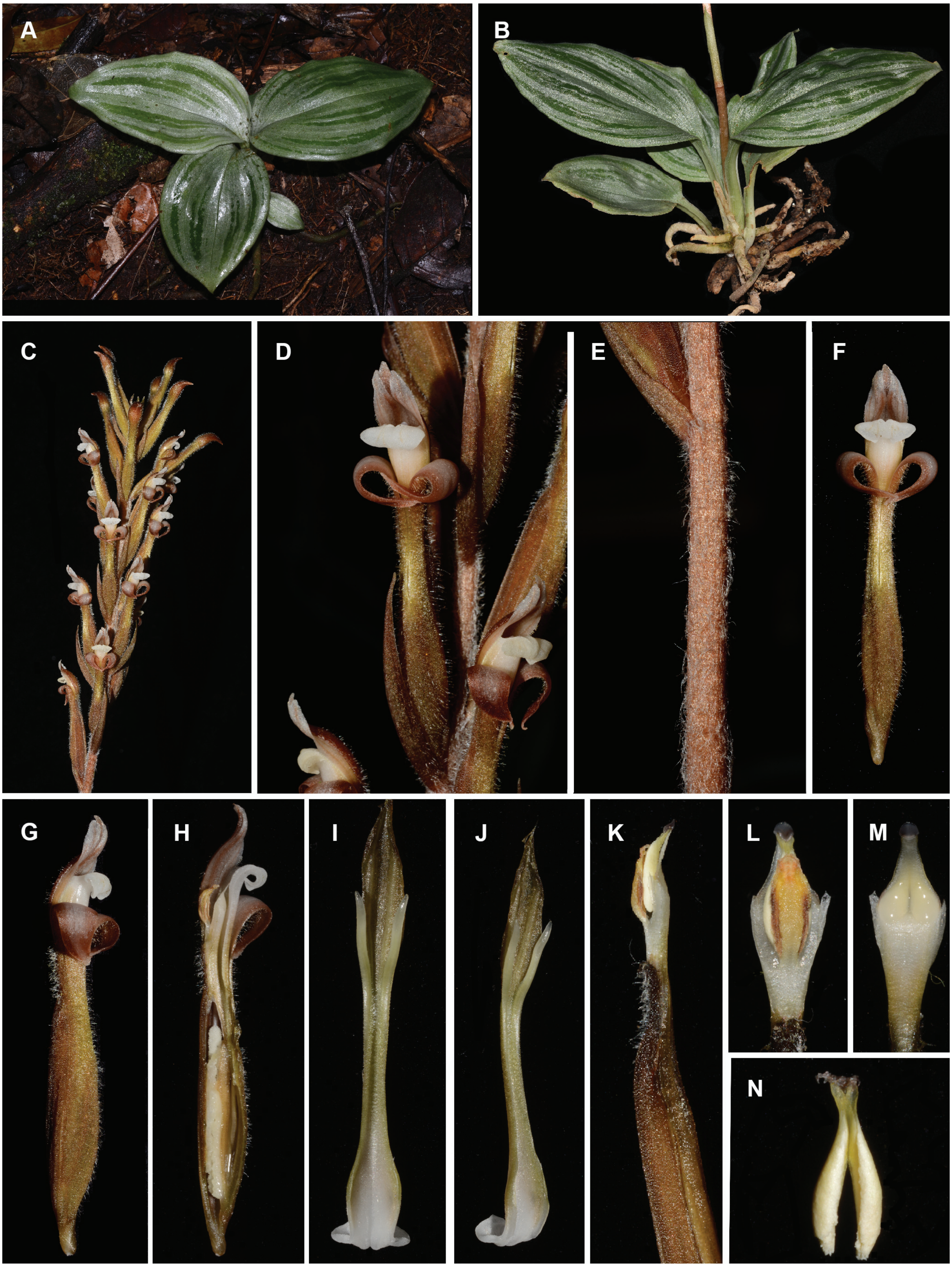

FIGURE 1. *Sarcoglottis neillii* (Ecuador, *Salazar et al. 9978*). A. Rosette of leaves *in situ*. B. Flowering plant removed from soil. C. Inflorescence. D. Close-up of flowers. E. Upper part of peduncle showing pubescence. F. Flower from front. G. Flower from side. H. Longitudinal section of flower from side. I. Labellum from above. J. Labellum from side. K. Column and upper part of ovary from side. L. Column from above. M. Column from below. N. Pollinarium from above. Photographer: Gerardo A. Salazar.

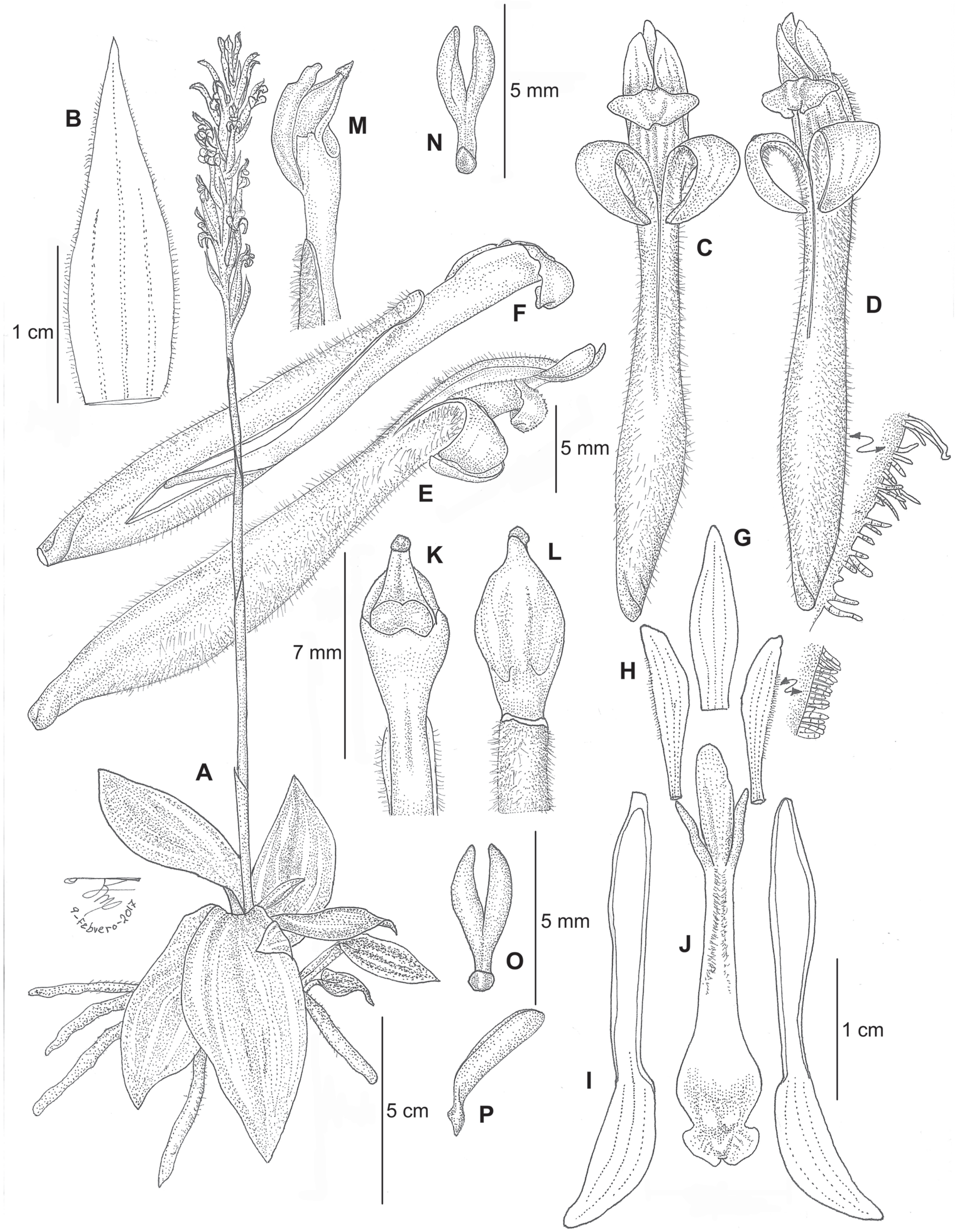

FIGURE 2. *Sarcoglottis neillii* (Ecuador, *Salazar et al. 9978*). A. Habit. B. Floral bract spread out. C. Flower from front. D. Flower in oblique view. E. Flower from side. F. Flower from side with sepals and petals excised to show the labellum. G. Dorsal sepal. H. Petal. I. Lateral sepal. J. Labellum. K. Column from below. L. Column from above. M. Column from side. N. Pollinarium from above. O. Pollinarium from below. P. Pollinarium from side. Drawn with camera lucida by Rolando Jiménez-Machorro.

CONSERVATION STATUS. Data deficient (DD). The single population of *S. neillii* recorded by us in Ecuador consisted of eight groups of plants scattered over 2−3 ha, each including 3−7 individuals. That population was destroyed by extensive open-pit mining activities (F. Tobar, pers. obs. 2018). Two of the Peruvian locations (Pagoreni and Cashiriari) occur within the extensive Camisea Project, the major natural gas production field in the Peruvian Amazon (http://gasnatural.osinerg.gob.pe/contenidos/consumidores_gnv/alcance_labores-actividad_exploracion_explotacion_lote56.html; see also Chabaneix 2010), but we do not have information about the extent of disturbance that this may imply. Based on the six known locations, the extent of occurrence estimated by GeoCat amounts to 70,034 km^2, but the area of occupancy is estimated at only 24 km^2. However, there are vast expanses of seemingly suitable habitat available for this species in Ecuador and Peru, most of which have not been explored botanically. We suspect that the paucity of specimens of this species available in herbaria is an artefact of under-collecting, and we do not foresee immediate threats to the species. Three of the Peruvian locations are found within the limits of the Yanachaga-Chemillén National Park. Further fieldwork is required to verify the presence of other populations in Ecuador.

PHENOLOGY. Flowering occurs in the field in June and July, and in cultivation in January and February. Well-developed, but still not dehiscing capsules were recorded in late July.

ETYMOLOGY. We name this species after Dr. David Neill, born in the USA but for many years living and working in Ecuador. He is Director of Conservation and Wildlife Management at the Universidad Estatal Amazónica, Puyo, and founder and Curator of the Herbario Amazónico (ECUAMZ). Dr. Neill has discovered and named many new plant species and several genera, and is a leading researcher of the flora and vegetation of the Andean Tepui Region, one of the less-known biodiversity hotspots of South America.

NOTES. Many species of *Sarcoglottis*, such as *S. grandiflora*, *S. richardiana* (Schlechter 1918: 435) Salazar & Soto Arenas (2003: t. 664), *S. sceptrodes* (Reichenbach 1855: 214) Schlechter (1920: 421) and *S. schaffneri* (Reichenbach 1857: 352) Ames in Donnell Smith (1905: 50) show variation in leaf color, but such variation merely involves whether the upper leaf surface is of a homogeneous green color or if it has silvery white dots, spots or stripes. No other instance is known in *Sarcoglottis* of such a striking difference in ground leaf coloration as it exists between *S. neillii* and both *S. metallica* and *S. maroaënsis*. It is likely that their contrasting leaf ground color reflects differences in the type and abundance of leaf pigments, e.g. anthocyanins, but no information on the secondary chemistry of *Sarcoglottis* is available.

Leaf coloration permits to distinguish *S. neillii* from *S. metallica* and *S. maroaënsis* at a glance, even in herbarium specimens, in spite of the three species being florally indistinguishable. Floral homogeneity contrasting with distinctive vegetative features that easily allow for species distinction is known to occur in other genera of Spiranthinae, such as *Stenorrhynchos* Richard ex Sprengel (1826: 677) (Salazar 2003b; Christenson 2005; Salazar *et al.* 2011, 2018) and *Cyclopogon* Presl (1827: 93, pl. 13) (Salazar *et al.* 2018). The biological significance of such floral conservatism has not been investigated, but a possibility is that interspecific differentiation occurs in geographical isolation and does not necessarily imply displacement in floral morphospace. However, very little is known on the pollination biology of *Sarcoglottis*, and Spiranthinae in general, and it is not clear at present whether morphospecies such as the one described here are reproductively isolated from their congeners other than by geographical distance.

Szlachetko and Rutkowski (in Rutkowski *et al.* 2008) assigned *S. metallica* (and *S. maasorum*, considered here as its synonym following Christenson 2009) to their newly created *Sarcoglottis* sect. *Longipetiolatae* Szlach., Mytnik & Rutk. Although the infrageneric relationships and classification of *Sarcoglottis* are beyond the scope of the present work, a perusal of the species' assignations to the five sections recognised in *Sarcoglottis* by Szlachetko & Rutkoswki (in Rutkowski *et al.* 2008) reveals conflicts between their system and the relationships among species of *Sarcoglottis* recovered in the molecular phylogenetic analysis of Salazar *et al.* (2018). However, neither *S. neillii* nor any other species morphologically similar to it has been available for molecular study and their relationships to other members of *Sarcoglottis* are unclear at present.

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MO, NY, P, PMA, QCA, QCNE, QMEX, R, RB, SEL, SERO, SLPM, SP, SPF, TEX, UAMIZ, US, USJ, USM, UVAL, VEN, W and XAL for courtesies extended during our study of the collections in their charge; and Germán Carnevali and an anonymous reviewer for useful suggestions that improved the manuscript. GAS also thanks Federico Rizo Patrón (Centro de Capacitación en Conservación y Desarrollo Sostenible, Oxapampa), Luis Valenzuela and Rodolfo Vázquez (HOXA) and Ricardo Fernández (USM) for their hospitality and assistance while studying Peruvian herbaria. Financial support from PAPIIT/DGAPA/UNAM (project IG200316) to conduct fieldwork in Ecuador is gratefully acknowledged.

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