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On the distribution and conservation of *Sievekingia hirtzii* Waldvogel (Orchidaceae, Stanhopeinae): first records from Colombia

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Abstract. We newly report two populations of the orchid *Sievekingia hirtzii* in the Andean–Amazonian foothills of Caquetá, Colombia. Following the B criterion of the International Union for the Conservation of Nature, we propose the categorization of this species as Endangered, due to its small Area of Occupancy and Extent of Occurrence, the limited number of populations, and habitat fragmentation and degradation caused by the expansion of agriculture. Additionally, we propose actions for *in situ* and *ex situ* conservation of this orchid, including habitat protection and cultivation in botanical gardens.

Keywords. Andes, Amazonia, Caquetá, foothills, risk of extinction

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Introduction

The Orchidaceae Juss. are epiphytic, lithophyte, terrestrial, and mycoheterotrophic plants and have a diversity of near 25,000 species worldwide (Chase et al. 2015; Phillips et al. 2020; Pérez-Escobar et al. 2022). Colombia harbors nearly 20% of this diversity, mainly in the Andes (Betancur et al. 2015). The tribe Stanhopeinae Benth. (subfamily Epidendroideae Kostel.) has Neotropical distribution and encompasses 21 genera, all of them producing short-duration flowers that emit a scent to attract euglosine male bees; when these bees enter upside down flowers, the pollinarium is attached to the trochanter of their legs (Dressler 1976; Rehman et al. 2016). The genera of the tribe Stanhopeinae—*Cirrhaea* Lindl., *Soterosanthus* F. Lehm. ex Jenny, *Sievekingia* Rchb. f., and *Trevoria* F. Lehm.—have a hook-shaped viscidium adapted to stick the pollinarium in the legs of the bees. In *Sievekingia* the stipe twists inward under the body of the pollinator (Dressler 1976; Whitten et al. 2000; Gerlach 2003).

Sievekingia is characterized by small to medium-sized plants with rounded to pyriform, sulcated pseudobulbs, one terminal leaf, and compact inflorescences with numerous flowers (Dressler 1976; Villegas 2007). The flowers of this genus are less specialized; the shallow pouch behind the callus contains the osmophores, and the labellum may be distinguished from the petals,

but is difficult to differentiate the hypochile, mesochile, and epichile (Curry et al. 1991; Rehman et al. 2016). This genus is composed of 14 species distributed in Central and South America, six of them known to occur in Colombia: *S. colombiana* Garay, *S. cristata* Garay, *S. fillifera* Dressler, *S. herklotziana* Jenny, *S. reichenbachiana* Rolfe, and *S. suavis* Rchb.f.. The first three species occur in the Andes at 600–1200 m a.s.l. and the last two species in the Chocó bioregion to elevations of 500 m (Betancur et al. 2015; Bernal et al. 2019, POWO 2023).

Extending from Amazonia to the Andes, the department of Caquetá harbours more than 9% (418 species from 98 genera) of the Orchidaceae of Colombia (Arias et al. 2023). Unfortunately, Caquetá is one of the departments with uncontrolled deforestation, mainly causes being illegal wood extraction and the expansion of the agricultural frontier for livestock and illicit crops (Myers et al. 2000; Armenteras et al. 2007; Malhi et al. 2008). This has led to the loss of more than 30% of the forest cover, which is habitat for many species, and the decline of biodiversity (Köster et al. 2009, 2011; Hoffmann et al. 2018; Sierra et al. 2022).

Local and national policies to ensure biodiversity conservation have a low impact in Caquetá. In consequence, deforestation, illegal extraction, and the trade of orchids, plus the lack of knowledge about species' diversity, are threats to the survival of wild orchid populations. To help improve knowledge of the orchid diversity in Colombia, we report the first records of *S. hirtzii* from Colombia, assess the risk of extinction of this species using IUCN criteria, and propose actions to protect and conserve this species.

Methods

We found two populations of *Sievekingia hirtzii* in the department of Caquetá, in the Colombian Amazon. One population is in Alto Fragua Indi-Wasi National Natural Park (municipality of Belén de Los Andaquíes; Fig. 1) and was found during in an expedition of the project "Taxonomy diversity of epiphytes in the Andean–Amazonian Foothills of the Caquetá department". The other population was found in the Caraño river basin (rural Florencia; Fig. 1), in an expedition supported by the project "Strategy for knowledge, study, and conservation of the orchid flora of the Andean–Amazonian foothills of Caquetá department". We compared individuals from these populations to the description of the species by Waldvogel (1977). We searched for geographical information in the Global Biodiversity Information Facility (GBIF), Distributed Information System for Biological Collections (SpeciesLink), Tropicos.org, and Plants of Colombia Catalogue. In addition, we searched online records in the databases of the COAH and COL herbaria (acronyms according to Thiers 2023), and we used Google Scholar to scientific literature on *S. hirtzii*.

Our voucher specimens were deposited the CUVC herbarium (acronym according to Thiers 2023). We used the location of the populations and the B criterion of the International Union for Conservation of Nature categories and criteria (IUCN 2022) to risk of extinction for *S. hirtzii*. Forest-cover loss data from 2001 to 2022 (Hansen et al. 2013) were used in R (R Core Team 2022) to estimate deforestation in the Extent of Occurrence (EOO) of the species; this was used as a proxy for

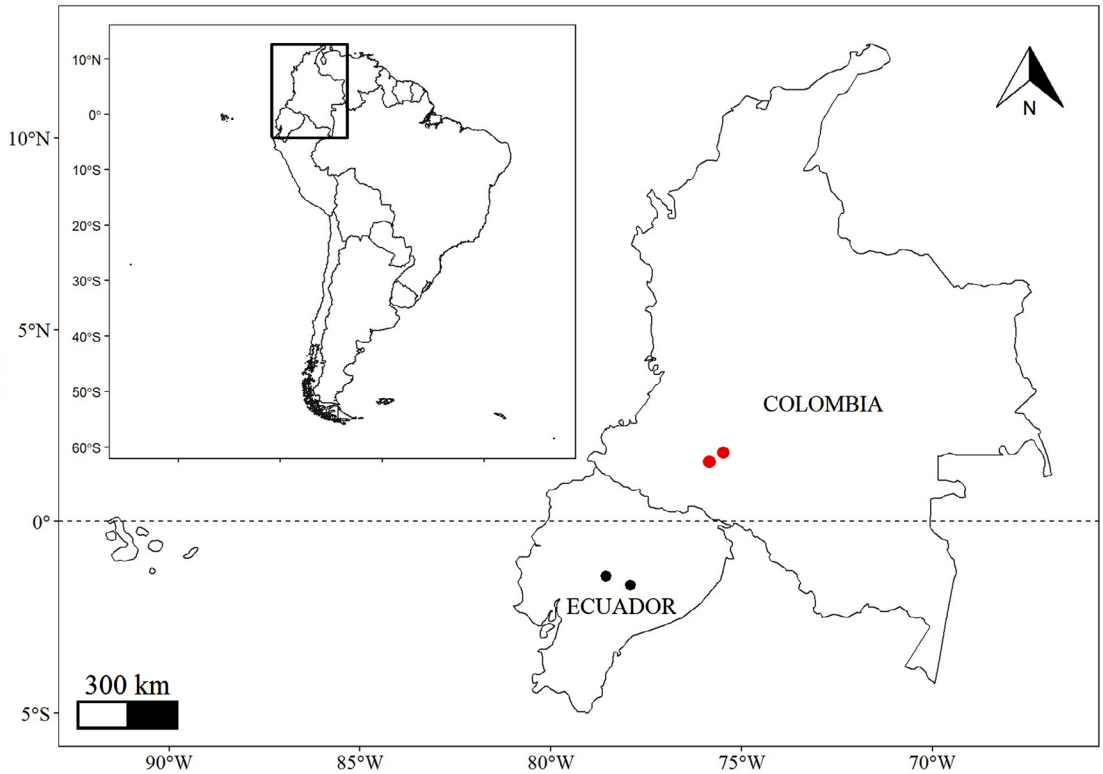

Figure 1. Populations of *Sievekingia hirtzii* recorded in Ecuador (black points) and the new records from Colombia (red points).

habitat loss. The map (Fig. 1) and bar plot (Fig. 3) were produced using RStudio (RStudio Team 2022).

Results

***Sievekingia hirtzii* Waldvogel**. Die Orchidee 28: 5–7 (Waldvogel 1977)

Figure 2

Previously known records (Fig. 1). ECUADOR – **Tunguragua** • Río Negro, 1200 m; 23.VI.1979, A. Hirtz 890; SEL. – **Pastaza** • Baños-Puyo way, 1000 m elev.; V.1985, A. Hirtz 2558; RPSC.

New records (Fig. 1). COLOMBIA – **Caquetá** • Belén de los Andaquíes, National Natural Park Alto Fragua Indi-Wasi, 01.5948, −075.9406, 643 m elev.; 03.X.2021, O. Perdomo, C. Núñez, & E. Trujillo; CUVC 82120 – **Caquetá** • Florencia, Vereda El Caraño, Camino real hacia la Finca Las Brisas; 01.7364, −075.6708, 1053 m elev.; 23.VIII.2021; O. Perdomo, A. Rojas, N. Rodríguez, & E. Trujillo; CUVC 82121.

Global distribution. This species was previously considered endemic to Ecuador and known from only two herbarium collections. The new records extends the geographic distribution of *S. hirtii* to the Andean–Amazonian foothills of Colombia.

Identification. This species is easily distinguishable by the pale-yellow lip, orange at the base and the margins, concave, trilobate with nine orange keels in the base and five in the middle portion, the lateral lobes erect, subrectangular, and the mid lobe triangular, obtuse acuminate with two orange ornaments.

Description. *Plant* epiphytic, herbaceous, caespitose, to 35 cm tall. *Pseudobulbs* 4.0–5.0 × 2.5–3.0 cm, clumped, ovoid, sulcate, subtended by imbricated papyraceous sheaths, unifoliate. *Leaf* simple, elliptical, acuminate, plicate; petiole 7.5 cm long, 2.5 mm in diameter; blade 4.5 × 22 cm, coriaceous. *Inflorescence* racemose, to 20 cm long, pendular, arising from base of pseudobulb; peduncle 7 cm long, with ovate, papyraceous bracts 1.7 × 1.0 mm, 5–8 flowers. *Ovary* + pedicel 2.5 mm long, to 3 mm in diameter. *Sepals* creamy yellow, concave, elliptical, acute, acuminate; *dorsal sepal* obovate-elliptical, 22.6 × 9.6 mm; *lateral sepals* oblong, 19.3 × 10.8 mm. *Petals* orange, degrading to creamy yellow at base, oblong-linear, concave, obtusely acuminate, 18 × 6 mm; *lip* pale yellow, orange at base and margins, concave, 16 × 18 mm, trilobate with 9 keels at base and five at middle portion, orange; *lateral lobes* erect, subrectangular; *mid-lobe* triangular, obtusely acuminate, 2-ornate, with callus bilobate. *Column* semiterete, pale yellow, 17 mm long, claviform, obtusely alate, slightly arched; *rostellum* about 2 mm long. *Anther* orange, subquadrate, 4 mm long. *Pollinarium* viscidium circular, about 0.7 mm in diameter; stipe linear basally, rhombic above, 2.0 × 0.7 mm; *pollinia* oblong, cochleate, about 1.6 × 0.7 mm. *Capsule* 2.5–3.5 × 0.9–1.2 mm, 6-sulcate, with marcescent flower at apex.

Conservation status. We categorized *S. hirtzii* as globally Endangered under criteria B1 + B2ab(i, iii) because there are four populations, the AOO is only 16 km^2, and there is a continuing loss and degradation of habitat that has led to the loss of 12.6% (2,118 km^2) of the forest cover in the EOO (16,699 km^2).

Conservation strategies. We propose five strategies that may help in the conservation of *S. hirtzii* populations and their habitat. All strategies are from literature dealing with the conservation of epiphytic orchids.

1) *In situ* conservation—preserve species' habitat; consider life history traits; follow development of populations and their ecological relationships with mycorrhizal fungi, pollinators, dispersers, and predators (Orejuela-Gartner 2012; Zhou et al. 2021).

2) *Ex situ* conservation—cultivate plants in botanical gardens and institutions dedicated to plant conservation; collect and cryopreserve germplasm; conserve and reproduce associated mycorrhizal fungi (Seaton et al. 2010; Merritt et al. 2014; Zhou et al. 2021).

3) Sustainable use—implement through programs to develop trade of cultivated specimens obtained from vegetative and *in vitro* reproduction; implement orchid ecotourism; secure equitable distribution of social, economic, and environmental benefits of use (Orejuela-Gartner 2012; Fay 2018; Zhou et al. 2021; Longchar and Deb 2022; Mutum et al. 2023).

4) Research—study pollination biology and reproductive biology of species; identify pollinators, dispersers, and predators; determine the risk of extinction of the species; establish conservation priorities and policies (Orejuela-Gartner 2012; Wraith et al. 2020; Zhou et al. 2021)

5) Education—involve people in rural and urban areas and employees of institutions in conservation and surveillance of natural resource exploitation; expand knowledge on the importance of conservation of orchids, as well as on biology and ecology of orchid species; develop and understanding of the relationship between socio-economic development and orchid conservation (Swarts and Dixon 2009; Orejuela-Gartner 2012; Gale et al. 2018).

Discussion

Caquetá department in Colombia harbours incredible biodiversity, mainly due to its location at the confluence of the Amazonia and Andes biomes (Gentry 1992; Bush et al. 2008). This region is classified into three altitudinal subregions: Amazonian lowlands below 250 m, Andean–Amazonian foothills at 250–800 m, and Andean Amazonia above 800 m (Hoekstra et al. 2010). Consequently, there are many niches for orchids, especially in the Andean region, which is considered the most species-rich in Colombia (Betancur et al. 2015). Our new records of *Sievekingia hirtzii* in two different areas in the Caquetá foothills indicates that there is a need for more botanical expeditions to explore and identify the whole orchid diversity of this department.

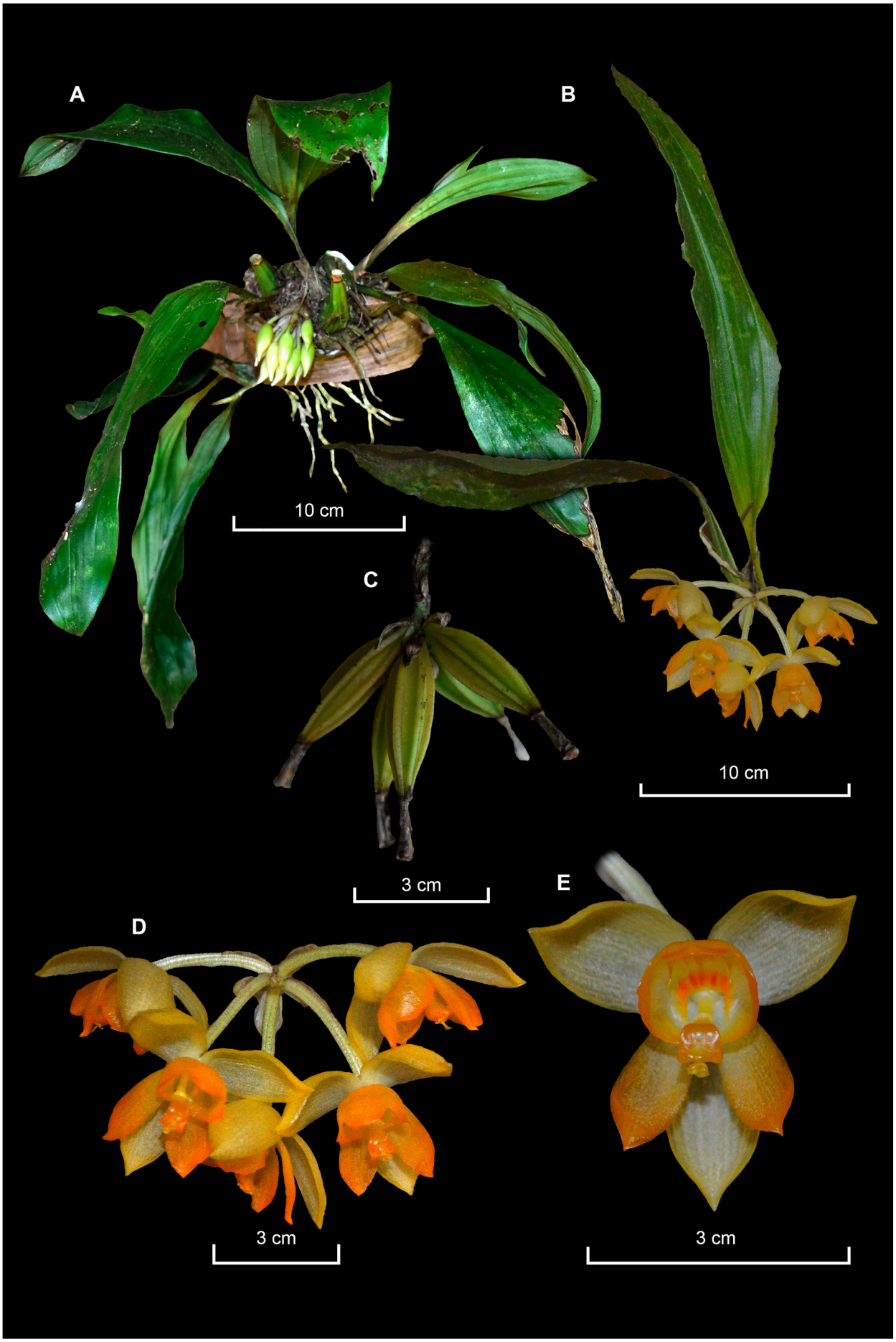

Figure 2. *Sievekingia hirtzii*. **A.** Plant with inflorescence. **B.** Plant with inflorescence in anthesis. **C.** Infructescence, **D.** Inflorescence in anthesis. **E.** Flower.

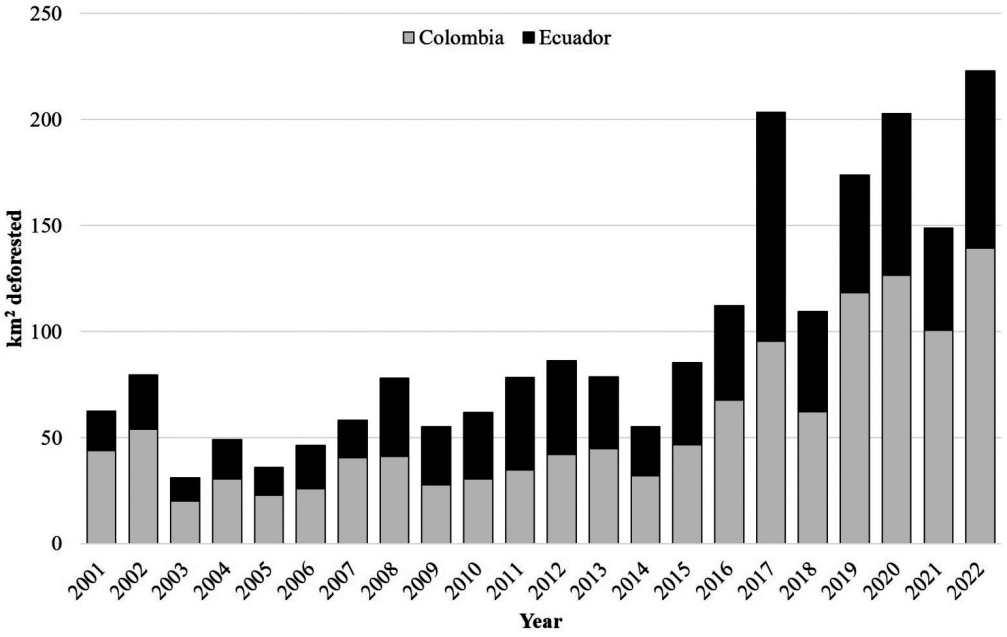

Figure 3. Forest cover loss, 2001–2022, in the Extent of Occurrence of *Sievekingia hirtzii* in Colombia and Ecuador. Sources: older locations SEL 890 (Waldvogel 1977) and RPSC 2558 (Tropicos.org), new locations from our fieldwork CUVC 82120 and CUVC 82121.

Our assessment of *S. hirtzii* as Endangered highlights the threats that this species faces, mainly the loss of the habitat in the cloud forests as a consequence of deforestation and agricultural expansion (Viña and Cavelier 1999; Dixon and Phillips 2015; Hoffmann et al. 2018; Sierra et al. 2022). The loss of phorophytes is a driver of habitat loss for this species and numerous other orchid species (Califa and Bravo 2020; Montibeller-Silva et al. 2020). One *S. hirtzii* population that we found was in Indi-Wasi National Natural Park, a protected area of 72,600 ha. This park is in eastern Caquetá department, on the eastern slopes of the Andes and a portion of Andean–Amazonian foothills (Rebolledo 2019). The park implies that the habitat of this population is protected, but the other population, in the Caraño river basin, is in a forest fragment of less than 1 ha, is threatened by the expansion of surrounding pastures (Fig. 3). Other orchid species from this area, like *Epidendrum porphyreonocturnum* Hágsater & R. Jiménez, *E. whittenii* Hágsater & Dodson, and the recently described *Masdevallia leonor-baeziana* Os.Perd., Edwin Trujillo & Karremans, were categorized as at risk of extinction because of deforestation, habitat fragmentation, and an expanding agricultural frontier (Perdomo et al. 2020, 2023).

Although the illegal commercialization of orchids does not affect the area of occurrence of *S. hirtzii*, we point out the need for strategies to protect this species from this largely unnoticed threat, which is currently categorized as an urgent, global priority for orchid conservation (Cooney et al. 2017; Margulies et al. 2019). We highlight the lack of conservation policies and efforts to conserve orchids in the Caraño river basin and the scarcity of government presence in environmental control and protection. Although *S. hirtzii* is in Appendix II of the CITES (https://www.speciesplus.net/), the restriction for the trade needs to be declared and applied by local authorities. Finally, another threat to the orchid flora is climate change, which has now been said to be the most critical threat to all the biodiversity on Earth (Dixon and Phillips 2015).

Both populations require monitoring for growth, reproduction, and ecological interactions to ensure their survival (Orejuela-Gartner 2012; Zhou et al. 2021). *Ex situ* conservation actions, like inclusion of specimens in botanical gardens, reproduction by institutions dedicated to plant conservation, and preservation of germplasm and pollen, are required to secure genetic material for future research (Seaton et al. 2010; Merritt et al. 2014). *In vitro* propagation should be done to obtain vegetative materials of *S. hirtzii* to reproduce and cultivate in nursery gardens (Longchar and Deb 2022; Mutum et al. 2023). The beautiful, colorful flowers of this species, characteristics sought after in orchids, suggest potential trade in this species.

Although knowledge of the diversity of Orchidaceae in Colombia has improved in recent decades, biology, ecology, and risk of extinction remain unassessed for most species (Orejuela-Gartner 2012; Alba et al. 2021). For *S. hirtzii*, no studies have been developed, and there is only its original description (Waldvogel 1977) and a host–epiphyte analysis (Paredes et al. 2021). Thus, additional research is needed to improve our understanding of this species and better develop conservation strategies. Finally, environmental education on this species, including its biology, ecology, risk of extinction, and trade restriction under CITES, is needed to highlight the importance of this and other orchid species to the ecosystem and socio-economic development of the region (Orejuela-Gartner 2012; Dixon and Phillips 2015; Gale et al. 2018). Education will lead to the valuation of orchids and their habitat from a sustainable

perspective, where the environment and plants are at the center of local socio-economic development.

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Author Contributions

Conceptualization: NR, OP. Data curation: AL, ETT. Formal analysis: NR, AR, OP. Funding acquisition: ETT, OP. Investigation: NR, AR, AL, ETT, OP. Methodology: NR, AR, OP. Visualization: NR, OP. Writing – original draft: NR, OP. Writing – review and editing: NR, AR, AL, OP.

References

Alba D, Martínez F, Mota J (2021) Determination of sites of special importance for the conservation of threatened orchid species in Colombia. Mediterranean Botany 42: e67589. https://doi.org/10.5209/mbot.67589

Arias T, Chaux-Varela J, Camero M, Calderón-Álvarez RA, Trujillo A, Correa-Munera MA, Zuluaga A, Perdomo O, Pérez-Escobar OA, Trujillo-Trujillo E, Valencia-D J (2023) Checklist of Orchidaceae from Caquetá, Colombia. PhytoKeys 229: 21–46 https://doi.org/10.3897/phytokeys.229.102737

Armenteras D, Cadena-V C, Moreno R (2007) Evaluación del estado de los bosques de niebla y de la meta 2010 en Colombia. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Bogotá, D.C., Colombia, 72 pp.

Bernal R, Gradstein SR, Celis M (2019) Catálogo de plantas y líquenes de Colombia. Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá. http://catalogoplantasdecolombia.unal.edu.co. Accessed on: 2022-10-03.

Betancur J, Sarmiento H, Toro L, Valencia J (2015) Plan para el estudio y la conservación de las orquídeas en Colombia. Dirección de Bosques, Biodiversidad y Servicios Ecosistémicos, Ministerio de Ambiente y Desarrollo Sostenible & Universidad Nacional de Colombia, Bogotá D.C., Colombia, 336 pp.

Bush M, Silman M, McMichael C, Saatchi S (2008) Fire, climate change and biodiversity in Amazonia a late-Holocene perspective. Philosophical Transactions of the Royal Society B: Biological Sciences 363 (1948): 1795–1802. https://doi.org/10.1098/rstb.2007.0014

Califa SD, Bravo LH (2020) Patrones de distribución de orquídeas en un relicto de bosque altoandino, Cundinamarca-Colombia. Colombia Forestal 23 (1): 5–19. https://doi.org/10.14483/2256201x.14816

Chase MW, Cameron KM, Freudenstein JV, Pridgeon AM, Salazar G, van den Berg C, Schuiteman A (2015) An updated classification of Orchidaceae. Botanical Journal of the Linnean Society 177 (2): 151–174. https://doi.org/10.1111/boj.12234

Cooney R, Roe D, Dublin H, Phelps J, Wilkie D, Keane A, Travers H, Skinner D, Challender D, Allan R, Biggs D (2017) From poachers to protectors: engaging local communities in solutions to illegal wildlife trade. Conservation Letters 10 (3): 367–374. https://doi.org/10.1111/conl.12294

Curry J, McDowell LM, Judd WS, Stern WL (1991) Osmophores, floral features, and systematics of *Stanhopea* (Orchidaceae). American Journal of Botany 78 (5): 610–623. https://doi.org/10.1002/j.1537-2197.1991.tb12585.x

Dixon K, Phillips R (2015) The orchid conservation challenge. Lankesteriana 7 (1–2): 11–12. https://doi.org/10.15517/lank.v7i1-2.18384

Dressler R (1976) Una *Sievekingia* nueva de Colombia. Orquideologia 11: 215–221.

Fay MF (2018) Orchid conservation: how can we meet the challenges in the twenty-first century? Botanical Studies 59: 16. https://doi.org/10.1186/s40529-018-0232-z

Gale SW, Fischer GA, Cribb PJ, Fay MF (2018) Orchid conservation: bridging the gap between science and practice. Botanical Journal of the Linnean Society 186 (4): 425–434. https://doi.org/10.1093/botlinnean/boy003

Gerlach G (2003) La subtribu Stanhopeinae: sus notables mecanismos de polinización, la química de sus aromas florales e implicaciones en sistemática y taxonomía. Lankesteriana 3 (2): 104–106. https://doi.org/10.15517/lank.v3i2.23029

Gentry AH (1992) Tropical forest biodiversity: distributional patterns and their conservational significance. Oikos 63 (1): 19–28. https://doi.org/10.2307/3545512

Hansen MC, Potapov PV, Moore R, Hancher M, Turubanova SA, Tyukavina D, Thau D, Stehman SV, Goetz SJ, Loveland R, Kommareddy A, Egorov A, Chini L, Justice CO, and Townshend JR (2013) High-resolution global maps of 21st-century forest cover change. Science 342 (6160): 850–53. https://doi.org/10.1126/science.1244693 (data available from https://glad.earthengine.app/view/global-forest-change).

Hoekstra J, Molnar J, Jennings M, Revenga C, Spalding M, Boucher T, Robertson JT, Ellison K (2010) The atlas of global conservation: changes, challenges, and opportunities to make a difference. University of California Press, Berkeley, USA, 250 pp.

Hoffmann C, García JR, Krueger T (2018) A local perspective on drivers and measures to slow deforestation in the Andean–Amazonian foothills of Colombia. Land Use Policy 77: 379–391. https://doi.org/10.1016/j.landusepol.2018.04.043

IUCN (2022) IUCN Red List categories and criteria, version 15.1. International Union for the Conservation of Nature, Cham, Switzerland. https://www.iucnredlist.org/resources/redlistguidelines. Accessed on: 22-07-2023.

Köster N, Nieder J, Barthlott W (2011) Effect of host tree traits on epiphyte diversity in natural and anthropogenic habitats in Ecuador. Biotropica 43 (6): 685–694. https://doi.org/10.1111/j.1744-7429.2011.00759.x

Köster N, Friedrich K, Nieder J, Barthlott W (2009) Conservation of epiphyte diversity in an Andean landscape

transformed by human land use. Biological Conservation 23 (4): 911–919. https://doi.org/10.1111/j.1523-1739.2008.01164.x

Longchar TB, Deb CR (2022) Optimization of *in vitro* propagation protocol of *Dendrobium heterocarpum* Wall. ex. Lindl. and clonal genetic fidelity assessment of the regenerates: an orchid of horticultural and medicinal importance. South African Journal of Botany 149: 67–78. https://doi.org/10.1016/j.sajb.2022.05.058

Malhi Y, Roberts JT, Betts RA, Killeen TJ, Li W, Nobre CA (2008) Climate change, deforestation, and the fate of the Amazon. Science 319 (5860): 169–172. https://doi.org/10.1126/science.1146961

Margulies JD, Bullough L, Hinsley A, Ingram D J, Cowell C, Goettsch B, Klitgård B, Lavorgna A, Sinovas P, Phelps J (2019) Illegal wildlife trade and the persistence of "plant blindness" Plants People Planet 1: 173–182. https://doi.org/10.1002/ppp3.10053

Merritt DJ, Hay FR, Swarts ND, Sommerville KD, Dixon KW (2014) *Ex situ* conservation and cryopreservation of orchid germplasm. International Journal of Plant Sciences 175 (1): 46–58. https://doi.org/10.1086/673370

Montibeller-Silva K, Gomes JP, Mantovani A, Bortoluzzi R (2020) Ecological relationships between orchids and phorophytes in Upper-Montane Araucaria Forest with cloud influence, Southern Plateau, Santa Catarina. Rodriguésia 71: e01252018. https://doi.org/10.1590/2175-7860202071139

Mutum R, Chanu N, Khanganba T, Thongam B, Das S (2023) In vitro conservation and propagation of endangered ethno-medicinal orchids from the Northeast Region of India. In Sumita J, Mihir H (Eds.) Medicinal plants: biodiversity, biotechnology and conservation. Springer Nature, Singapore, 541–579.

Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403: 853–858. https://doi.org/10.1038/35002501

Orejuela-Gartner JE (2012) Orchids of the cloud forests of southwestern Colombia and opportunities for their conservation. European Journal of Environmental Sciences 2 (1): 19–32. https://doi.org/10.14712/23361964.2015.84

Paredes C, Ferro-Díaz J, Lozano P (2021) Effect of forest successional stage on the host–epiphyte orchid relationship in the Pindo Mirador biological station, Ecuador. Revista Cubana de Ciencias Forestales 9 (1): 53–71.

Pérez-Escobar OA, Zizka A, Bermúdez MA, Meseguer AS, Condamine FL, Hoorn C, Hooghiemstra H, Pu Y, Bogarín D, Boschman LM, Pennington RT, Antonelli A, Chomicki G (2022) The Andes through time: evolution and distribution of Andean floras. Trends in Plant Science 27 (4): 364–378. https://doi.org/10.1016/j.tplants.2021.09.010

Perdomo O, Coca LF, Trujillo E (2020) Nuevos registros de *Epidendrum* (Orchidaceae) para Colombia: *Epidendrum porphyreonocturnum* Hágsater & R. Jiménez y *Epidendrum whittenii* Hágsater & Dodson. Revista Peruana de Bilogía 27 (3): 411–416. https://doi.org/10.15381/rpb.v27i3.17901

Perdomo O, Trujillo E, Karremans A (2023) *Masdevallia leonor-baeziana* (Pleurothallidinae): a new species from the Andean–Amazonian foothills of Caquetá, Colombia. Lankesteriana 23 (2): 139–144. https://doi.org/10.15517/lank.v23i2.54019

Phillips RD, Reiter N, Peakall R (2020) Orchid conservation: from theory to practice. Annals of Botany 126 (3): 345–362. https://doi.org/10.1111/jipb.13462

POWO (Plants of the world online) (2023) *Sievekingia* Rchb.f. https://powo.science.kew.org/. Accessed on: 2023-07-22.

R Core Team (2022) A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/. Accessed on: 2022-10-03.

RStudio Team (2022) RStudio: integrated development for R. RStudio, PBC, Boston, USA. http://www.rstudio.com/. Accessed on: 2022-10-03.

Rebolledo J (2019) ¿Para qué sirven los parques naturales? Legibilidad estatal en el Parque Alto Fragua Indi Wasi, Colombia. Colombia Internacional 100: 121–145. https://doi.org/10.7440/colombiaint100.2019.06

Rehman R, Hanif MA, Mushtaq Z, Mochona B, Qi Xin (2016) Biosynthetic factories of essential oils: the aromatic plants. Natural Products Chemistry and Research 4 (4): 1000227. https://doi.org/10.4172/2329-6836.1000227

Seaton PT, Hu H, Perner H, Pritchard HW (2010) Ex situ conservation of orchids in a warming world. Botanical Review 76: 193–203. https://doi.org/10.1007/s12229-010-9048-6

Sierra JP, Junquas C, Espinoza JC, Segura H, Condom T, Andrade M, Molina-Carpio J, Ticona L, Mardoñez V, Blacutt L, Polcher J, Rabatel A, Sicart JE (2022) Deforestation impacts on Amazon–Andes hydroclimatic connectivity. Climate Dynamics 58: 2609–2636. https://doi.org/10.1007/s00382-021-06025-y

Swarts ND, Dixon KW (2009) Perspectives on orchid conservation in botanic gardens. Trends in Plant Science 14 (11): 590–598. https://doi.org/10.1016/j.tplants.2009.07.008

Thiers B (2023) Index herbariorum: a global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/science/ih/. Accessed on: 2023-05-03.

Villegas F (2007) El género *Sievekingia* en Colombia y *Sievekingia fimbriata* una especie reportada por primera vez para Colombia. Orquideología 25 (1): 97–102.

Viña A, Cavelier J (1999) Deforestation rates (1938–1988) of tropical lowland forests on the Andean Foothills of Colombia 1. Biotropica 31 (1): 31–36.

Waldvogel E (1977) Eine neue *Sievekingia* aus Ekuador. Die Orchidee 28: 5–7.

Whitten T, Soeriaatmadja RE, Afiff SA (2000) The ecology of Java and Bali. Periplus Editions, Hong Kong, China, 960 pp.

Wraith J, Norman P, Pickering C (2020) Orchid conservation and research: an analysis of gaps and priorities for globally Red Listed species. Ambio 49: 1601–1611. https://doi.org/10.1007/s13280-019-01306-7

Zhou Z, Shi R, Zhang Y, Xing X, Jin X (2021) Orchid conservation in China from 2000 to 2020: Achievements and perspectives. Plant Diversity 43 (5): 343–349. https://doi.org/10.1016/j.pld.2021.06.003