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FIRST RECORD OF A NATURAL HYBRID OF THE GENUS *GONGORA* (STANHOPEINAE) AND COMMENTS ON THE PARENT SPECIES

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Abstract. The first natural hybrid of the genus *Gongora* is described for the department of Copán, Honduras, between *Gongora truncata* and *Gongora batemanii* (=*Gongora cassidea*). The nothospecies described here presents intermediate characteristics between both species, such as setaceous projections on the lip, a large callus, spatulate epichile, and a cucullate hard dorsal sepal. The identity of a specimen from the Herbarium Jany Renz Botanical Institute, University of Basel, Switzerland, corresponds to the same hybrid described here. It was erroneously determined as *Gongora saccata* (=*Gongora seideliana*). The clarification of the synonymy of *Gongora saccata* and relevant aspects regarding the pollination mechanisms and reproductive barriers of both parent species are also discussed.

Resumen. Se describe el primer híbrido natural del género *Gongora*, entre *Gongora truncata* y *Gongora batemanii* (=*Gongora cassidea*). La notoespecie que aquí se describe presenta caracteres intermedios entre ambas especies, como las proyecciones setáceas en el labio, un callo grande, el epiquilo espatulado y el sépalo dorsal fuertemente cuculado. También se discute la identidad de un ejemplar del Herbarium Jany Renz Botanical Institute, University of Basel, Suiza, el cual corresponde al mismo híbrido aquí descrito. Fue erróneamente determinado como *Gongora saccata*, (=*Gongora seideliana*). Se discute también la sinonimia de *Gongora saccata*, y aspectos relevantes en cuanto a los mecanismos de polinización y barreras reproductivas de ambas especies parentales.

Keywords / Palabras clave: Copán, Cymbidieae, Euglossini, *Gongora cassidea*, *Gongora saccata*, Honduras, Orchidaceae

Introduction. Natural hybridization is a relatively common phenomenon, which has played an important role in plant evolution. Hybridization has been considered a great force in the speciation and diversity of angiosperm species (Grant 1981, Soltis & Soltis 2009). Within the Orchidaceae, the existence of natural hybrids is well known. They are capable of developing viable seeds through intra- and intergeneric crosses; this fact probably allows some gene exchange in nature to be added to the gene pool of the species (Pupulin 2007, Soltis & Soltis 2009). However, species also maintain reproductive isolation through different prezygotic mechanisms, such as phenology, fragrances, pollinators and geographic distribution (Pupulin 2007, Faegri & Van Der Pijl 2013).

About 10% of Neotropical orchids are pollinated exclusively by orchid bees (Apidae: Euglossini; Ramírez 2019), whose males visit flowers and other sources in search of aromatic substances, which are used to attract females (Eltz *et al.* 1999). The reproductive isolation barriers used by these groups of orchids, in addition to those already mentioned, can be

ORCID of the Author: AJV, HV, EM
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mechanical in function. For example, the area of the bee's body where each orchid species positions its pollinia is different, as is the shape of the pollinaria, and how it interacts with the stigma of the flower, through the size, form and behavior of the bee (Dressler 1968). Furthermore, these groups of orchids also employ chemical reproductive barriers; that is, the fragrance used by orchid species of the same genus usually have different compositions when they are sympatric (Dressler 1968, van der Pijl & Dodson 1966).

The subtribe Stanhopeinae are one of these groups of orchids pollinated exclusively by euglossine bees (Dressler 1968, 1993, Williams & Whitten 1983); with *Stanhopea* Frost ex Hook and *Gongora* Ruiz & Pavón being the largest genera. Although they are prone to hybridize, natural hybrids in the Stanhopeinae are very rare in nature (Gerlach 2003), and the few that have been found so far belong to *Stanhopea* (Dressler 1968, 1993, Jenny 1993a). *Gongora* comprises around 60–70 species, distributed from southern Mexico to South America, along the slopes of the Andes, as well as in regions of Venezuela, the Guianas, and Brazil (Hetherington-Rauth & Ramírez 2016, Jenny 1993b). Taxonomically, the genus is subdivided into three subgenera based on lip morphology: *Portentosa* Jenny, *Acropera* (Pfitzer) Jenny (which is subdivided into two sections: *Acropera* and *Armeniaca*), and *Gongora* (Pfitzer) Jenny (which is subdivided into five sections: *Aceras*, *Gratulabunda*, *Gongora*, *Grossa*, and *Truncata*) (Chase *et al* 2009). Jenny (1993b) considers a third section within the subgen. *Acropera* (sect. *Cassidea*), however, in this study, the most recent classification is used.

The objective of this work is to report a hybrid specimen collected in nature in the department of Copán, Honduras, found by chance during fieldwork carried out by some of the authors (HV, AA, EM). The discovered plant presents intermediate characters between species of *Gongora* belonging to two different subgenera, and we hypothesize that the probable parental species are *G. truncata* Lindl. and *G. batemanii* (Lindl. ex Rchb.f.) Henshall ex Mabb. & Jenny, both of which are found in the area of discovery. We also seek to clarify the identity of another specimen that likely corresponds to the same hybrid described here, and comment on some relevant aspects of the ecology and pollination mechanisms of the parent species.

Materials and methods.

Study area.— The discovery site is located north of the department of Copán, Honduras, a few kilometers from the archaeological reserve of the same name, at an elevation of 1650 m. The climate is classified as tropical rainy, with an average annual temperature of 26°C and an average annual rainfall of 1337 mm. Although, the vegetation is from the tropical humid forest, some parts of the discovery area are considered ecotones with pine forests, with large trees and abundant epiphytes, among which are: *Coelia densiflora* Rolfe, *Epidendrum cardiophorum* Schltr., *E. isthmi* Schltr., *E. laucheanum* Rolfe, *E. repens* Cogn., *Gongora truncata*, *G. batemanii*, *Maxillaria densa* Lindl., *Pleurothallis pansamalae* Schltr., *Prosthechea vitellina* (Lindl.) W.E.Higgins, *Scaphyglottis prolifera* (Sw.) Cogn., and *S. fasciculata* Hook. Among the most common tree species are: *Clethra occidentalis* (L.) Kuntze, *Liquidambar styraciflua* L., *Myrsine coriacea* (Sw.) R.Br., *Pinus maximinoi* H.E.Moore, and *Vochysia guatemalensis* Donn.Sm. The exact location of the plant is not revealed in the present paper to avoid illegal collection to which many orchids are subjected. However, exact details on the collecting locality can be found on the labels of the preserved specimen deposited at EAP.

Results.

Description of putative parental species.— *Gongora truncata* Lindl. belongs to the section *Truncata* of the subgenus *Gongora* and is distributed throughout Mexico (Veracruz, Oaxaca and Chiapas), Belize, Guatemala and Honduras. It is recognized for its showy flowers, reflexed lateral sepals that appear rectangular in natural position, and decurrent, small petals. The white or yellow lip, welded to the foot of the column, is cymbiform and laterally compressed, fleshy and waxy in appearance, concave, complex, hypochile unguiculate, with a very small transverse callus, with an inconspicuous lobe near the base on each side, and with a sharp rib ending in a retrorse bristle on each side. The epichile is oblong-ovate with a recurved apex (Salazar in Hágsater & Salazar 1990). Phenology: January to June (Beutelspacher 2014) (Fig. 1 A).

Gongora batemanii (Lindl. ex Rchb.f.) Henshall ex Mabb. & Jenny (synonym: *Gongora cassidea* Rchb.f.) belongs to the section *Acropera* of the sub-

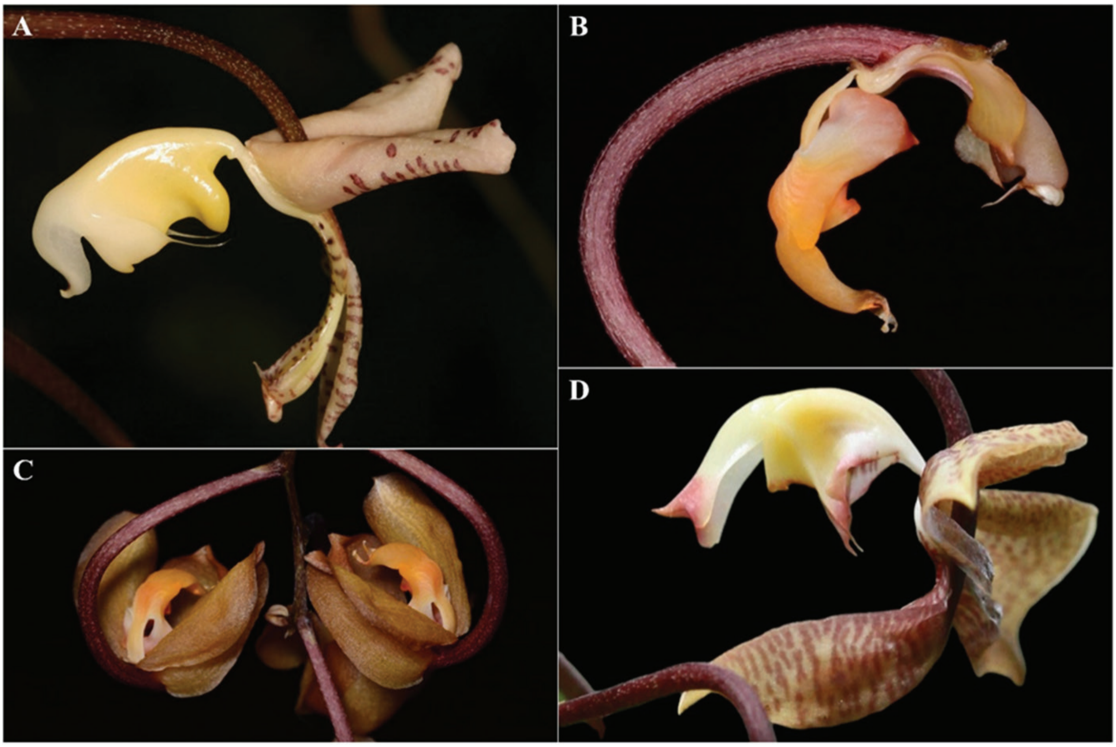

FIGURE 1. **A**. *Gongora truncata*. **B**. *G. batemanii*, sepals removed. **C**. *G. batemanii* with the sepals in place. **D**. Detail of the flower of *Gongora* × *copanensis*. Photographs by Rudolf Jenny (A), José Monzón Sierra (B–C), and Alexander Alvarado (D).

genus *Acropera* and it is distributed in Mexico (Chiapas), Guatemala, Honduras, and Nicaragua (Ames & Correll 1985). It can be recognized by the arcuate pedicellate ovaries, the broadly elliptic and cucullate dorsal sepal, the oblong to suborbicular-elliptic, obtuse and oblique lateral sepals inserted perpendicularly to the sides of the column. The lip is complex, articulated to the column foot, arched with the callus at the apex; lower portion of lip saccate, thickened and compressed in front of the sac, with a pair of erect parallel lobes arising from the margins of the sac (Ames & Correll 1953). Phenology: February to July (Damon *et al.* 2012). (Fig. 1B–C).

Gongora × ***copanensis*** Jiménez Axr, Vega, Alvarado & Mó., ***nothosp. nov.*** (Fig. 1D, 2, 3).

TYPE: Honduras. Santa Rita: Copán, tropical rain forest, May 15, 2019. UTM: 287236.24 m E, 1636948.11 m N, 1650 m above sea level, *A. Alvarado #001* (holotype, EAP).

DIAGNOSIS: Epiphytic plant, pendulous inflorescence, complex flowers. Intermediate between *G. truncata* and *G. batemanii*. It differs from *G. truncata* by a large callus, the spatulate epichile, cucullate hard dorsal sepal, and the lateral sepals perpendicular to the column. It also differs from *G. batemanii* by the slightly arched flower pedicel, the absence of the lip articulation, and setaceous projections on the lip.

Plant herbaceous, epiphytic, bifoliate. *Pseudobulbs* conical, elongate, sulcate. *Leaves* apical, elliptic, acuminate, three-veined, attached to the pseudobulb by a pedicel. *Inflorescence* a pendulous raceme, 19 flowers. *Ovary* pedicelate, incurved, terete, colored dark violet. *Flowers* 2.7 × 4.6 cm long, showy, not resupinate, fragrant, basically brown, with small purple dots, yolk-yellow lip with violet tips. *Dorsal sepal* 1.9 cm long, fused to the base of the column, strongly cucullate, ovate-acuminate with slightly retrorse tip. *Lateral sepals* 1.4 cm long, rolled, perpendicular to the column, obovate. *Petals* very small,

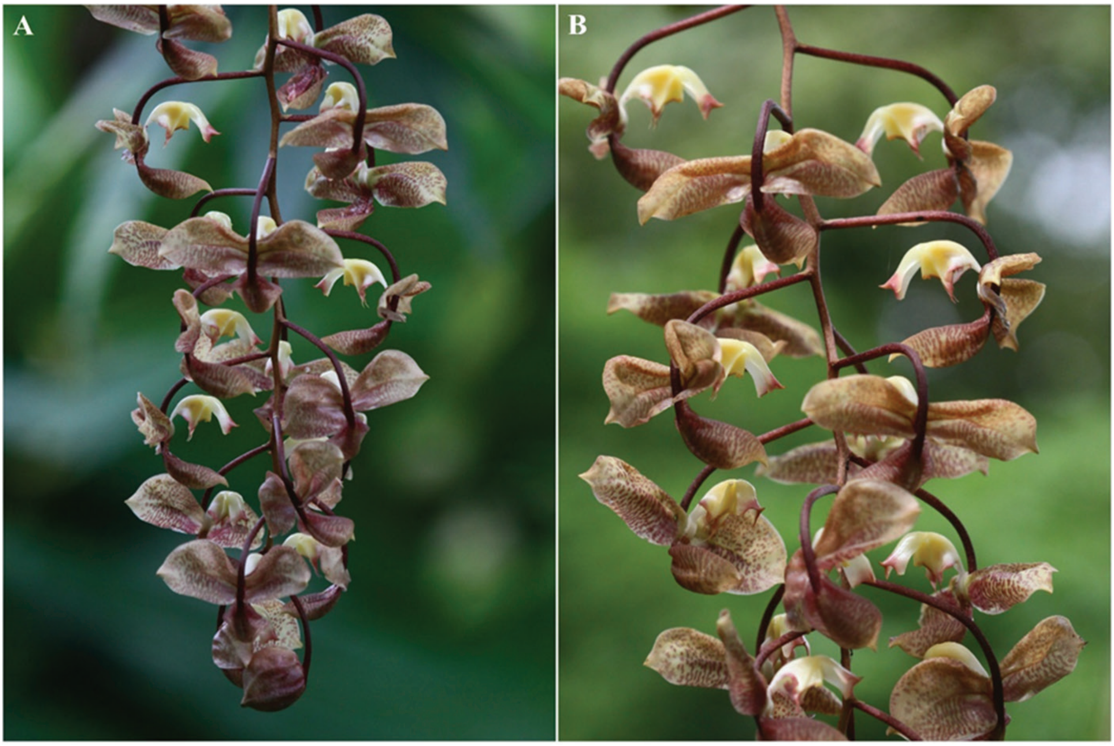

Figure 2. **A–B**. Inflorescence of *Gongora* × *copanensis in situ*. Photographs by Alexander Alvarado.

covered by the dorsal sepal, welded to the column, lanceolate, acuminate. *Lip* fleshy, waxy, complex, semitruncated, divided into hypochile, mesochile and epichile, laterally compressed, apex of epichile and apex of hypochile lobes purple. *Hypochile* 1 cm long, fused to the foot of the column, fleshy in texture, widening towards the base, grooved towards the apex, yellow, in lateral view saccate on the upper margin, rectangular on the lower, the laminae of the cavity unguiculate, slightly reflexed, with an inconspicuous lobe near the base of the epichile, the lamina conduplicate in its middle part, with two lobes on each side, the anterior large, strongly acuminate with a violet bristles termination, and the posterior small, completely reflexed, ovate-acuminate. *Mesochile* in lateral view very narrow, with a subquadrate, carinate, concave callus. *Epichile* 1.1 cm long, spatulate, longitudinally concave, cymbiform, trilobed, median lobe recurved, acuminate, the lateral ones oblong, the epichile separated from the mesochile by an angle of about 15° and a deep sinus. *Column* 1.5 cm long, covered by the dorsal sepal, semiclaviform, trigonous, arched, winged near the apex. *Capsule* not seen.

Phenology: flowering observed in May.

Etymology: the name refers to the area where it was discovered, in the department of Copán, Honduras. Copán was an astronomical center of the ancient great Mayan civilization.

Discussion. *Gongora* × *copanensis* presents a mixture of exclusive characteristics of members of subgen. *Acropera* sect. *Acropera*, and others of members of subgen. *Gongora* sect. *Truncata*. The only representatives of these groups in the discovery area where the putative hybrid was found are *G. truncata* and *G. batemanii*, which also correspond morphologically to the specimen described here, and whose flowering periods also overlap, for which it is considered as a hybrid between these species. The hybrid shares with *G. truncata* the shape of the pseudobulbs, the ovary not strongly arched (which positions the lip above the column horizontally and not vertically as in members of the sect. *Acropera*), and how the hypochile laminae fold, which is similar to *G. truncata*. Above all, it presents a pair of bristles on the anterior lobes of the

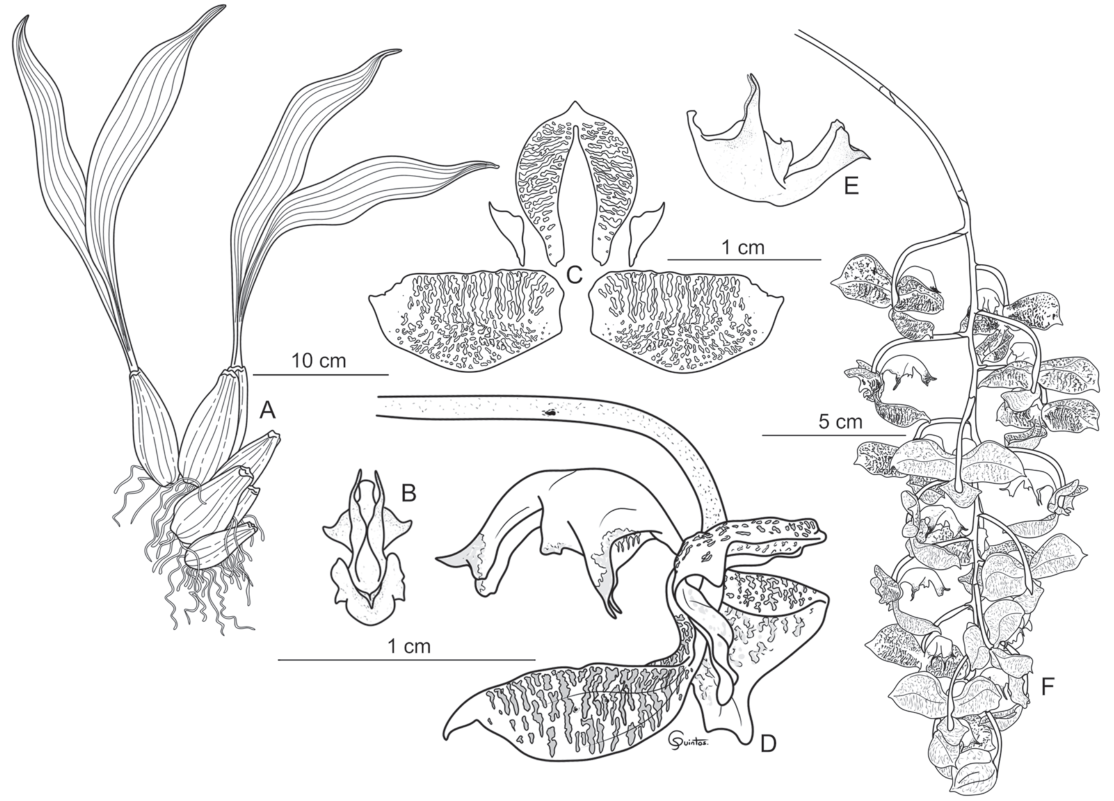

Figure 3. Illustration of *Gongora* × *copanensis*. **A**. Habit and size of the plant. **B**. Front view of the lip and view of the inconspicuous basal lobes in profile view. **C**. Petals and sepals. **D**. Flower, profile view. **E**. Profile view of the dissected lip. **F**. Inflorescence. Illustration by Gerardo Quintos Andrade, based on *A. Alvarado #001* (EAP).

hypochile, similar to the typical bristles of the subgen. *Gongora*, which are absent in all the species of subgen. *Acropera*. In addition, it shares with *G. batemanii* the cucullate dorsal sepal and the lateral sepals arranged perpendicular to the column, the callus and the first third of the hypochile exposed by the hypochile lobes, and the spatulate epichile; however, it lacks the joint that allows movement of the lip. Although numerous artificial hybrids have already been recorded for this genus, this is the first record of a natural hybrid for this popular but taxonomically difficult group of orchids.

A specimen with the same floral characteristics as the nothospecies described here, appeared without locality on the digital platform of the Swiss Orchid Foundation at the Herbarium Jany Renz, Botanical Institute, University of Basel, in Switzerland. It was registered under number 2065154 (Fig. 4A–B), and erroneously identified as *Gongora saccata* Rchb.f. (Fig. 5C). The latter is a synonym of *G. seideliana* Rchb.f. (Fig. 5A–B), since Reichenbach named the same plant twice (R. Jenny pers. comm. 2020), *G. seideliana* is a rare species from southern Mexico (García-Matínez & Jiménez-Machorro 2016). The photos and the identification of the specimen on the said platform, which have now been removed from the webpage, were erroneously attributed to Rudolf Jenny, but they do not belong to or were determined by him (R. Jenny pers. comm. 2020). This second plant has the basal lobes of the hypochile that are not markedly retrorse, so they are conspicuous in lateral view, unlike the specimen from Honduras, which has the same lobes retrorse, which makes them inconspicuous in lateral view. However, its shape basically corresponds tho the taxon described here. A third cultivated specimen is also known from a private collection in the same locality of Copán in Honduras, but we had no opportunity to voucher it. The presence of these plants, product of the crossing of the same parents, allows us to infer that sometimes

Figure 4. **A–B**. Specimen 2065154 from the Swiss Orchid Foundation at the Herbarium Jany Renz, Botanical Institute, University of Basel, Switzerland (SORA). Photographs by SORA.

the reproductive barriers between these species are broken, allowing with relative frequency the exchange of genetic material.

The species of euglossine bees pollinating *G. truncata* and *G. batemanii* have not been recorded. This prevents the possibility to glimpsing the probable cause of the breakdown of the reproductive barriers between both species, or to be able to infer the zones where this hybrid could appear based on the distribution overlapping of the involved plant spescies and their pollinators. However, some relevant aspects of the mechanical and chemical barriers of both parent species can be discussed.

Gongora truncata and *G. batemanii* have different pollination mechanisms. Hetherington-Rauth and Ramírez (2015) describes the hinge mechanism for the *Acropera* and *Cassidea* sections of the subgen. *Acropera*. In this mechanism, the species are pollinated by bees of the genus *Euglossa* Latreille, and position the pollinarium on the scutellum, with the help of a joint that allows the lip movement of the flowers. For subgen. *Gongora* sect. *Truncata*, and based on the observation of South American species, the same authors describe the header mechanism (Fig. 5E), in which the orchids of this group use large bees of the genus *Eulaema* Lepeletier, that receive the pollinarium behind head. This appears to hold true for the South American members of section *Truncata*, but not for the Mesoamerican species of this section, which have been observed using the genus *Euglossa* near their natural ranges (*G. truncata*: Winter pers. obs. 2022 (Fig. 5D), A. Jiménez pers. obs. 2022; *G. seideliana*: A. Mendez pers. obs. 2022). These are small bees to which the flowers adhere the pollinia to the scutellum, employing the slide mechanism (typical for the rest of the subgenus they belong to), in which the bees slip from the lip towards the column of the flower. Therefore, despite having different pollination mechanisms, both parent species place their pollinia on the same part of the bees' body.

As for the chemical barriers, the exact composition of the fragrance cocktail of the parent species is unknown. However, Hetherington-Rauth and Ramírez (2016) found that the terpene *a*-farnesene is part of the fragrance cocktail of both. Some authors have considered this terpene unattractive for Euglossini bees (Ackerman 1989, Williams & Dodson 1972, Williams & Whitten 1983). Nevertheless, the authors also found that this and other terpenes considered unattractive, appear in large quantities in some species of *Gongora* and related genera, representing up to 75% of the total fragrance. They comment that this percentage suggests a greater significance for these types of compounds in the function of the perfume due to the high cost that the synthesis of terpenes represents for the plant kingdom (Gershenzon 1994). Furthermore, substances considered unattractive are known to interact with attractive ones, with this chemical interaction having repercussions on bee behavior (Hetherington-Rauth & Ramírez 2016, Williams & Dodson 1972). How attractive and unattractive chemicals interact with bees, is a topic that needs much more research. This opens the possibility of a better understanding of natural hybridization in orchids.

Sharing one or more pollinator species is common in the Stanhopeinae (Hetherington-Rauth & Ramírez 2015, Roubik & Hanson 2004, van der Pijl & Dodson 1966). The barriers used by euglossine-pollinated orchids must be effective because natural hybrids are infrequent, but hybridization occurs when these barriers fall for some reason (Dressler 1968).

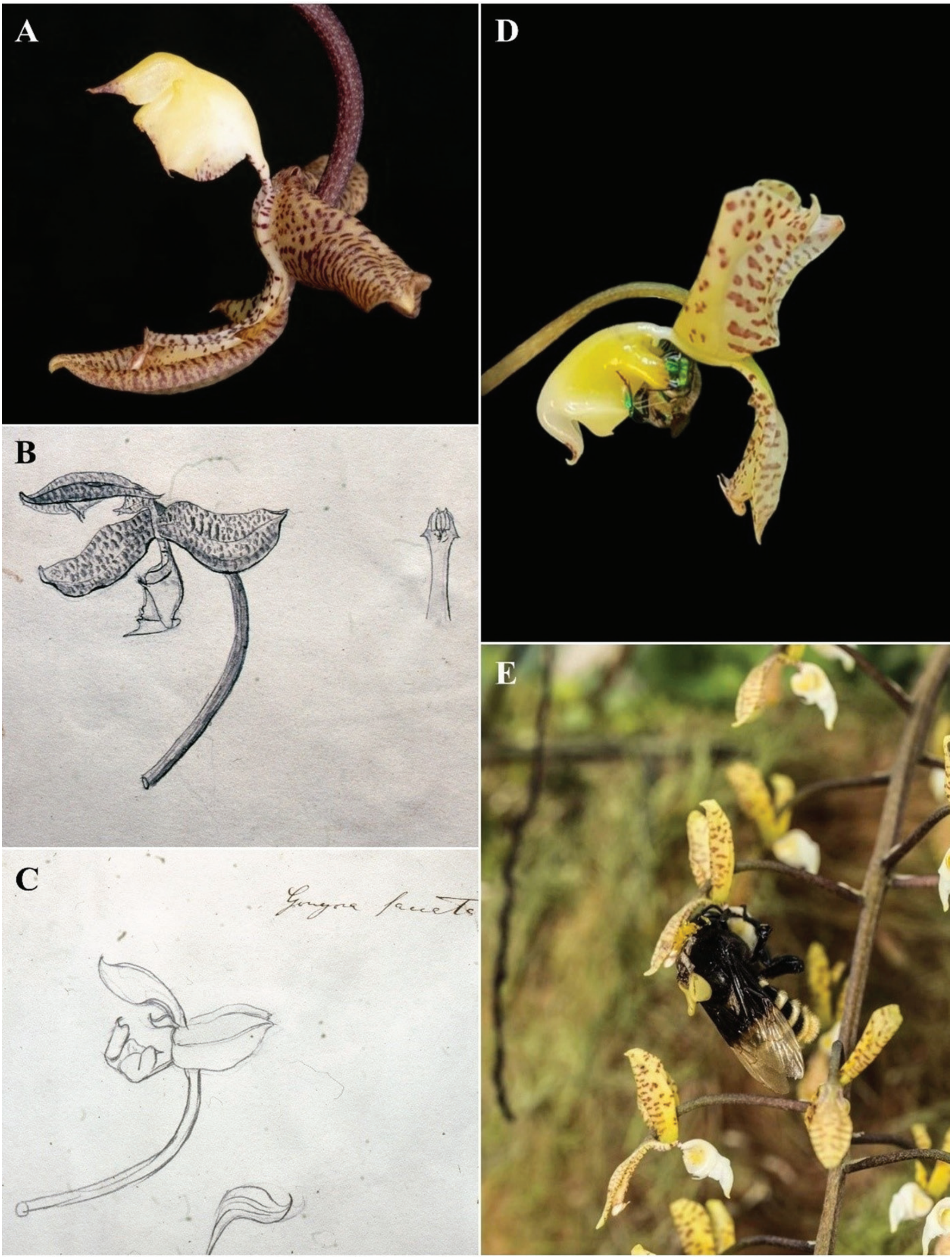

Figure 5. **A**. *Gongora seideliana*. **B**. Illustration of Reichenbach's *G. seideliana*. **C**. Illustration of *G. saccata* from Reichenbach, Herbarium of Natural History, Vienna (W). **D**. *Gongora truncata* and *Euglossa* sp. **E**. *Gongora tracyana* and *Eulaema bombiformis*. Photographs by Eduardo Pérez García (A), Rudolf Jenny (B–C), Diana Winter (D), and José Mesa Londoño (E).

Natural phenomena such as natural hybridization and its genetic consequences, are receiving enthusiastic attention from researchers (Soltis & Soltis 2009). Therefore, reporting phenomena like this is of great importance to understanding the way and frequency in which species interact and incorporate genetic characteristics among themselves. It is known that some natural hybrids sometimes manage to establish healthy populations, developing a new evolutionary route and, therefore, speciation (Dressler 1968, Soltis & Soltis 2009). Observing these changes help to understand the complexity of these interactions and the extraordinary plasticity of the chemical and evolutionary ecology in the subtribe Stanhopeinae and the tribe Euglossini. Furthermore, the role of ecotones and problems, such as deforestation and ecosystem fragmentation, could affect the frequency of these phenomena.

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ORCHIDS OF THE SOUTHERN CONE (1830–2000) – PART II. THE PHILIPPI DYNASTY: *PLANTARUM NOVARUM CHILENSIUM* AND *CATALOGUS PLANTARUM CHILENSIUM*

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ABSTRACT. Bernhard Eunom Philippi (1811–1852), his brother Rudolph Amandus Philippi (1808–1904), and the latter's son Federico Philippi (1836–1910) must be considered the main actors in the history of the natural sciences in Chile between 1840 and 1910. While Bernhard was responsible for convincing the rest of his family to emigrate to Chile (and in fact, became the initiator of German immigration to southern Chile), Rudolph became the leading Figure in Chile's scientific community, becoming the first director of the National Museum of Natural History, a post he held from 1853 to 1897. The description of many new orchid species in the series *Plantarum novarum Chilensium* (1856–1864) during this time is only one of his merits. His son Federico took over the direction of the Museum after his father's retirement until he died in 1910. *Catalogus plantarum Chilensium* (1881) stands out among his numerous publications.

KEYWORDS / PALABRAS CLAVE: Chile, German immigration to Chile, inmigración alemana a Chile, Museo Nacional de Historia Natural de Chile, Natural History Museum of Chile, orchids of Chile, orquídeas de Chile, R. F. Hohenacker

Bernhard Eunom Philippi (1811–1852) (Fig. 1) was born in Berlin and as a young boy, moved with his family to Switzerland in 1818. Together with his brother Rudolph, he attended the school of Heinrich Pestalozzi in Yverdon, where he studied natural sciences and languages. However, more inclined toward the exact sciences, he completed his studies at the School of Engineering in Berlin between 1822 and 1830. After learning the arts of navigation and seamanship in the harbor of Danzig, Philippi took part in two expeditions to Chile and Peru, between 1831 and 1837. In 1840, he was appointed as a traveling naturalist by the Zoological Museum in Berlin and established himself in the village of Ancud, on the Chilean island of Chiloé. In Ancud, he made the acquaintance of Captain John Williams, who in 1843, encouraged him to take part in the Chilean expedition that would take possession of the Strait of Magellan.

The schooner *Ancud* was built especially for this expedition. After securing the Strait of Magellan for Chile (just one day before the arrival of the French warship *Le Phaèton*, which sailed with similar intentions), Philippi played an important role in designing the fortifications that were built on the site of the future city of Punta Arenas (founded in 1848) (Fig. 2).

In 1848, Bernhard Philippi traveled to Germany with orders of the Chilean President Bulnes to recruit German settlers, a mission he completed successfully. Soon, the first German colonies began to flourish in Valdivia. In 1852, he was called back by the Chilean authorities and was appointed Governor of the province of Magallanes. Only a few months later, he disappeared during an excursion, presumably killed in an attack by the natives.

During his 1838 journey to Chile, Philippi had made the acquaintance of a collector of specimens of natural history, the German by the name of **Carlos Segeth** (1811–1890), who interested Philippi in forming a society to sell botanical and zoological collections in Europe. The society was short-lived, but a few botanical specimens were received by Heinrich Gustav Reichenbach (1823–1889), Germany's famous orchidologist of the 19th century, who, amongst Bernhard Philippi's collections, described four new orchid species: *Chloraea philippii* Rchb.f. (Fig. 3), *C. heteroglossa* Rchb.f. (Fig. 4), *C. unguis-cati* Rchb.f., and *Epidendrum philippii* Rchb.f. There is no possible confusion as to which of the brothers collected these orchids because they were described in 1849–1850, while Rudolph Philippi did not arrive in Chile until

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Figure 1. Bernhard Eunom Philippi (1811–1852). Unknown photographer.

1851. Furthermore, *E. philippii* is a native of Peru, where Rudolph Philippi, never collected.

Rudolph Amandus and Federico Philippi

"The second half of the nineteenth century was dominated by the work of **Rudolf Amandus Philippi** (1808–1904) (Fig. 5), in Chile from 1851 to 1897; he was effectively responsible, along with his son and successor **Federico**, for the establishment of the present national herbarium in Santiago" (Frodin 2001).

In 1858, Rudolph Philippi wrote to Guillermo Frick (1818–1905), a German friend in Valdivia, to recount a humorous comment that someone else had made about Philippi's dedication to natural history: "What is it that Philippi does? He hunts flies, and then he observes them through a large lens and captures them in a drawing. It's surprising the way in which some men can earn their bread" (Translated from German into English by Schell 2013).

Rudolph Amandus Philippi (1808–1904) was born just outside Berlin and studied, together with his brother Bernhard, natural history at Pestalozzi's institution in Switzerland. Until his last days, he spoke with great enthusiasm of his years in Yverdon. Later, he obtained a medical degree in Berlin, but never practiced, completely dedicating himself to the natural sciences (Fürstenberg 1905). As a young man, Rudolph traveled widely in Europe, mostly in Italy, where Federico (1836–1910), his first son, was born on the last day of his father's stay in Naples. After returning to Germany, Rudolph obtained a position as a professor at the Polytechnic School of Kassel, where he would spend 16 years. During this time, Philippi published numerous articles on the paleontology and geology of southern Italy and became widely known in Germany's scientific community. Political upheaval forced him to leave Kassel precipitously. His long conversations with Bernhard, who at that time was in Germany, the attraction of his brother's description of the Chilean wildlife, the political unrest in the Duchy of Hesse and his liberal convictions were the determining factors in Rudolph Amandus Philippi's decision to emigrate to Chile (Chaparral 2010).

After arriving in Valparaiso in late 1851, Rudolph went for a few weeks to Santiago (Fig. 6), where he was introduced to the President of the Republic and then, sailed south to the recently founded German colony of Valdivia. He made his first exploring expeditions inland and shortly after that, together with his brother, acquired the Fundo ("Estate"), San Juan, on Rio Bueno (Fig. 7).

Carl Christian Ochsenius (1830–1906) (Fig. 8), a German geology student of Philippi at the Polytechnic School in Kassel, accepted Philippi's invitation and joined him in his decision to emigrate to Chile. Ochsenius spent the following twenty years in Chile and became Rudolf Philippi's lifelong friend. He accompanied Philippi on many of his excursions and took over the administration of the "Fundo" San Juan from 1853 to 1856 after Philippi moved to Santiago following his appointment as university professor. In 1884, he published a book about his experiences in Chile, *Chile Land und Leute* ('Chile, the land and its people'), with a few illustrations by himself (Fig. 9). In 1906, shortly before his death, Ochsenius published what is probably known as the best biography of Rudolph Philippi (Ochsenius 1906). He made important contributions to

Figure 2. Monument to the sailors of the schooner *Ancud*, in Punta Arenas, Chile. Unknown photographer.

Figure 3. *Chloraea philippi* Rchb.f. Photograph by Gabriel Cartes.

Figure 4. *Chloraea heteroglossa* Rchb.f. Photograph by Jason Hollinger.

FIGURE 5. Rudolph Amandus Philippi (1808–1904), *ca.* 1870. Unknown photographer.

Chile's copper and saltpeter industries during his time in Chile. In 1871, Ochsenius left Chile and returned to his native Marburg, where he spent the rest of his life as professor at the local university.

After his brother's death, Rudolph Philippi became the sole proprietor of the San Juan estate. However, he maintained his scientific activities and, besides numerous excursions in the province of Valdivia, had the opportunity to climb the Osorno volcano. Philippi's reports to the university in Santiago awoke the interest of the government and he was named as first director of the high school in Valdivia, and then, in 1853, professor of natural sciences at the University of Chile and director of the Natural History Museum. The Museum had been housed in the (new) building of the University since 1863. In 1876, it was moved into a new building on the lands of the School of Agriculture (Fig. 10–11).

Rudolph Philippi served as professor of natural sciences until 1874, as director of the Botanical Garden until 1883, and continued as director of the Natural History Museum, until 1897. His successor at the Garden and the Museum was his son Federico, who was active until his death, in 1910.

Many of Philippi's herbarium specimens were distributed in Europe through **Rudolf Friedrich Hohenacker** (1798–1874), a member of the "Unio Itineraria" (in German "Botanischer Reiseverein"), a joint-stock company founded in 1827 exclusively responsible for sending botanists on travels to collect herbarium specimens. Thus, many of Philippi's specimens presently found at the Natural History Museum in Paris were labeled as *R. A. Philippi pl. chilens. Ed. R. F. Hohenacker* (Fig. 12).

During his 44 years of service, Philippi maintained his collecting activities in the field, and as an untiring publisher of scientific articles in all fields of the natural sciences he wrote over 300 articles about zoology, botany, geology, paleontology, mineralogy, geography, and ethnography. "Among his scientific endeavors, he contributed taxonomic descriptions to the biological diversity of Chile, encompassing organisms in three living kingdoms: plants, animals and fungi. We have examined his contribution to the knowledge of the biological wealth of Chile, quantifying the number and proportion of current valid species he described. Our findings indicate that Philippi described 1670 valid species, equivalent to 5.8% of the recognized biological diversity of Chile. His greatest contributions were in vascular plants with 1017 species descriptions, which represent 19% of the vascular flora of Chile." (Castro *et al.* 2006). As to his botanical excursions, those to the desert of Atacama and the islands of Juan Fernández stand out. During his scientific excursions, Rudolph Philippi prepared several highly interesting pencil drawings depicting the Chilean scenery and the life of its inhabitants (Fig. 13–14), later published by his grandson, Federico's son, Julio Philippi Izquierdo (1912–1997), as *Vistas de Chile* ('Views from Chile') (Philippi Izquierdo 1973). "However, some of those drawings were not Philippi's originals, but were copied from drawings made by Alexander Simon (1805–1852), a German artist who spent the last few years of his life in Chile with Bernhard Philippi before dying

Figure 6. Main square in Santiago in 1850. Oil on paper by Ernest Charton.

in unknown circumstances in Patagonia" (Kabat & Coan 2017).

Philippi´s contribution to Chile's national science can be summarized as follows: "his collecting expeditions in most of its territory; his theoretical contribution to the realm of superior education as a professor at the National Institute and later at the University of Chile; his work as director of the Natural History Museum and the Botanical Garden in Santiago; and his large collections of objects in all aspects of the country's natural history, which complemented those initiated by Claude Gay in 1830" (Saldivia 2015). Rudolph Philippi's last recorded collecting excursion took him in March 1896 to the city of Constitución, province of Maule, in Central Chile. At the time he was already 88 years of age.

Friedrich (Federico) Heinrich Eunom Philippi (1836–1910) (Fig. 15–16) began his studies of natural history in Kassel, during his father's direction of the natural history department of the local university. After Rudolph Philippi's appointment as director of the Natural History Museum and the Botanical Garden in Santiago, Federico and the rest of the family followed him to Chile, where they arrived in late 1853. They brought with them Rudolph's private library, an invaluable treasure for Chile´s scientific world.

Federico, a 17-year-old boy by then, worked at the family estate in Valdivia where he began collecting plants for his herbarium. From 1860 he accompanied his father on his botanical excursions. He was responsible for most of the collections, but it was his father who described most of the new species.

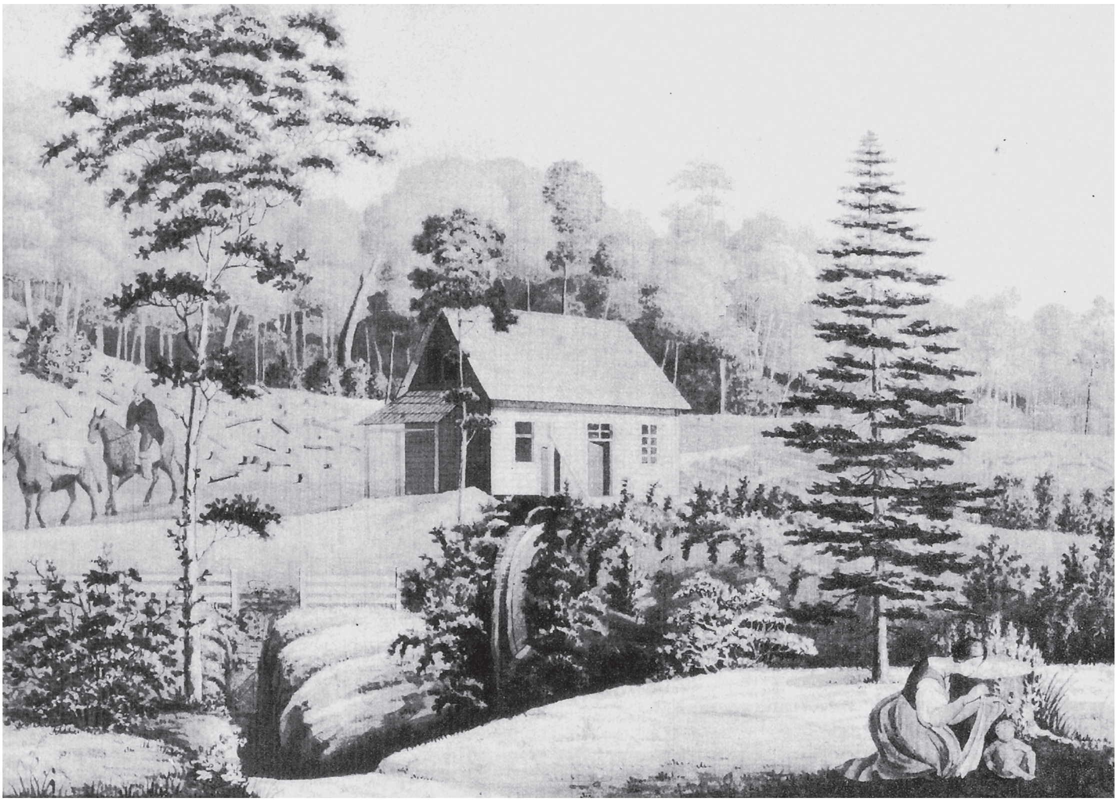


FIGURE 7. Watermill at the Fundo San Juan. By R.A. Philippi, 1856. In Phillipi Izquierdo, 1973: plate 97.

Federico Philippi returned to Germany and studied botany and zoology, from 1871 to 1874, at the University of Halle. After returning to Chile, he became the successor of his father as a professor of botany in Santiago and later as director of the Natural History Museum and the Botanical Garden. Until 1897, he also taught zoology at the Institute for Agriculture~~,~~ and botany at the Faculty of Medicine, until 1906.

The earthquake of August 1906 inflicted serious damage on the building of the Museum, and Federico, putting his life at risk, worked for days rescuing what was left of the collections, now buried under the rubble. Nevertheless, the Museum was his passion, and his work there was interrupted only by his death, in 1910.

The most important legacy of Federico Philippi was the continuation of Claude Gay's and his father's work, increasing and organizing the botanical and zoological collections of the Museum, which, at the turn of the century, made him the main scientific authority in Chile.

When Federico took over from his father as director of the Natural History Museum in 1897, he was already 61 years old. The longevity of Rudolph Philippi and his imposing authority as Chile's most important scientist in the second half of the 19th century made it inevitable that Federico lived for most of his life under the shadow of his father. In a photograph of father and son, taken in 1902, it is somewhat difficult to distinguish one from the other (Fig. 16).

An important contribution of Federico Philippi was the publication, in 1881, of his *Catalogus plantarum vascularium Chilensium*. In this treatise, he enumerated a total of 86 (!) orchid species, a list that is undoubtedly full of synonyms since the total in F. Philippi's *Catalogus* exceeds by far the present number of accepted Chilean species of orchids. Federico described a total of 33 new species in different plant families, a relatively small number when compared to that of his father.

Today, the types of species described by the Philippis are housed in a separate collection at the Natural

History Museum. This was established by Carlos Muñoz-Pizarro (1913–1976), when the specimens in the herbarium were mounted, a process that began in 1942 and continues today (Taylor & Muñoz-Schick 1994).

The South American orchids of the Philippi dynasty

When we talk about the Philippis' Chilean orchids, we refer initially to the four species collected by Bernhard and described by Reichenbach (1849) (of which *Epidendrum philippii* was collected in Peru), and of those new species collected either by Rudolph or by Federico, but described solely by Rudolph Philippi in *Linnaea*, between 1856 and 1864, and in the *Anales de la Universidad de Chile* between 1861 and 1865 (Philippi 1856a, b, c, 1857–58a, b, c, 1859, 1861, 1864, 1865). In addition, Friedrich Kraenzlin (1847–1834) described twelve new species collected by the Philippis in his *Orchidacearum Genera et Species* in 1904.

Table 1 contains a list of South American orchids, described by Reichenbach and Rudolph Philippi. Reichenbach's descriptions were already mentioned. Philippi mentioned 46 different species in 3 genera, as follows: *Asarca* Lindl. (6 spp.), *Chloraea* Lindl. (36 spp.), *Habenaria* Willd. (3 spp.), and *Macrocentrum* Hook.f. (1 sp.). For currently accepted names of all Chilean orchids, the author, under the recommendation of reputed taxonomists, relied with few exceptions on the account of the Chilean orchids that Novoa prepared for the recent catalog of vascular plants of Chile by Rodríguez *et al.* (2018). Other reference works on the same subject are indicated in the literature section of this article, such as Novoa *et al.* (2006, 2015), Correa (1956, 1969a,b), Zuloaga *et al.* (2008), Batista *et al.* (2011) and the TROPICOS database (www.tropicos.org).

Rudolph Philippi also collected and described a new orchid genus from Argentina, *Macrocentrum*, with the type species *M. mendocinum* (Philippi 1865). (Fig. 17).

Philippi never left South America, but he was never isolated from the broader scientific community. In addition to continuing to publish in German serials (*Linnaea*, 1856–1859) and founding the *Anales del Museo Nacional* (1892–1910), which later continued as *Boletín del Museo Nacional de Historia Natural*, Philippi was visited by many European scientists traveling through Chile.

Dr. Carl Ochsenius

Figure 8. Carl Christian Ochsenius (1830–1906). Unknown photographer.

The Swiss naturalist Johann Jakob von Tschudi (1818–1889), who spent much of his life exploring South America, visited Philippi at the Museo in Santiago, in 1859, and particularly praised Philippi for his work: "I say that this is the most important and best-ordered natural history collection in South America, compared with the other institutions I had visited in Brazil, Montevideo and Buenos Aires" (Tschudi 1869).

When the *Comisión Científica del Pacífico*, the 1862–1866 Spanish scientific expedition that collected over 82,000 specimens in South America, landed at Valparaiso in 1863, the naturalists led by anthropologist Marco Jiménez de la Espada (1831–1898) and botanist José Isern Battló (1821–1866) made their way inland to Santiago. "Philippi introduced them to a number of other naturalists and collectors, and the naturalists admired Philippi's exhibits in the museum and the museum's fine library" (Kabat & Coan 2017).

FIGURE 9. Collecting *Araucaria* cones. Drawing by C. Ochsenius in *Chile, Land und Leute* (Ochsenius 1884: Figure 12).

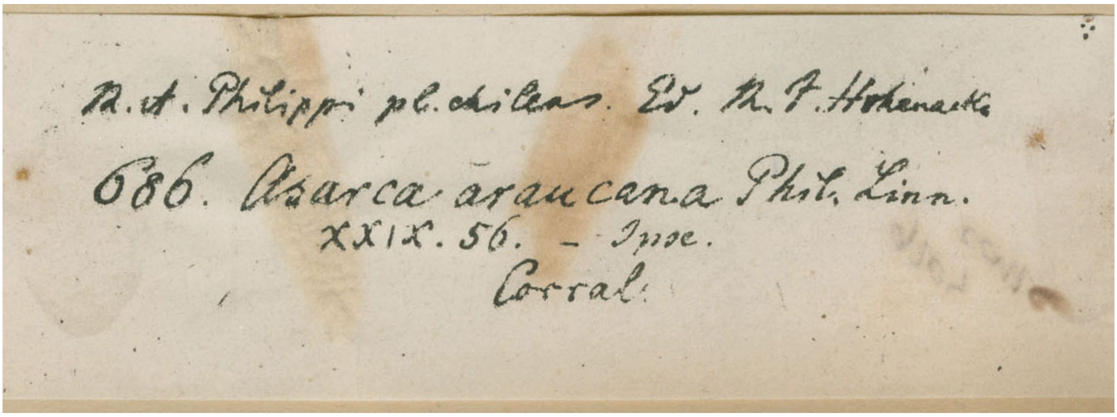
Isern wrote in his diary about his encounter with Dr. Rudolph Philippi with words of gratitude for an important number of herbarium specimens donated by Philippi to the expedition, which are housed today at the herbarium of the Royal Botanical Garden in Madrid (Blanco *et al.* 2006). Among them were specimens of four new orchid species described by Rudolf Philippi: *Asarca araucana*, *Chloraea fimbriata*, *Chloraea littoralis* and *Habenaria germainii* (Blanco & Puig-Samper 1995). In October 1864, when the Spanish Expedition departed from Chile, Philippi presented them with a letter in which he expressed his best wishes for the rest of the journey, also including a photograph of himself (Fig. 18).

Philippi's Chilean botanical type material is primarily located in the herbarium of the Museo Nacional de Historia Natural in Santiago. Although Claudio Gay (1800–1873) previously described a number of Chilean plants, Gay's locality information and descriptions left much to be desired, so Philippi's contributions did much to establish the foundation for systematic botany in Chile. "At the same time, however, Philippi's uncritical approach to describing new plant species was criticized by subsequent botanists (…) Chilean botanists were nevertheless grateful that Philippi's material remained in Chile for their study, in contrast to other European botanists whose Chilean specimens are a continent away" (Kabat & Coan 2017).

Philibert Germain (1827–1913) (Fig. 19–20) was a French entomologist born in Lyon, who arrived in Chile in 1850 and occupied the position of professor of natural history and interim curator, after Claude Gay at the Museo Nacional in Santiago. In 1853, after the appointment of Rudolph Amandus Phillipi as director of the Museum and Germain's demotion to the post

Figure 10. Main building of the University of Chile, home to the Natural History Museum from 1863 to 1876. Unknown author.

Figure 11. The new building of the Natural History Museum of Chile, inaugurated in 1876 on lands of the School of Agriculture in Santiago, the so-called “Quinta Normal de Agricultura”. Unknown photographer.



R. A. Philippi pl. chilens. Ed. R. F. Hohenacke

686. Asarca araucana Phil. Linn.
XX|X. 56. – Ipse.
Corral.

FIGURE 12. Herbarium label of *Asarca araucana* Phil. in the collection of R. F. Hohenacker. MNHN Paris.

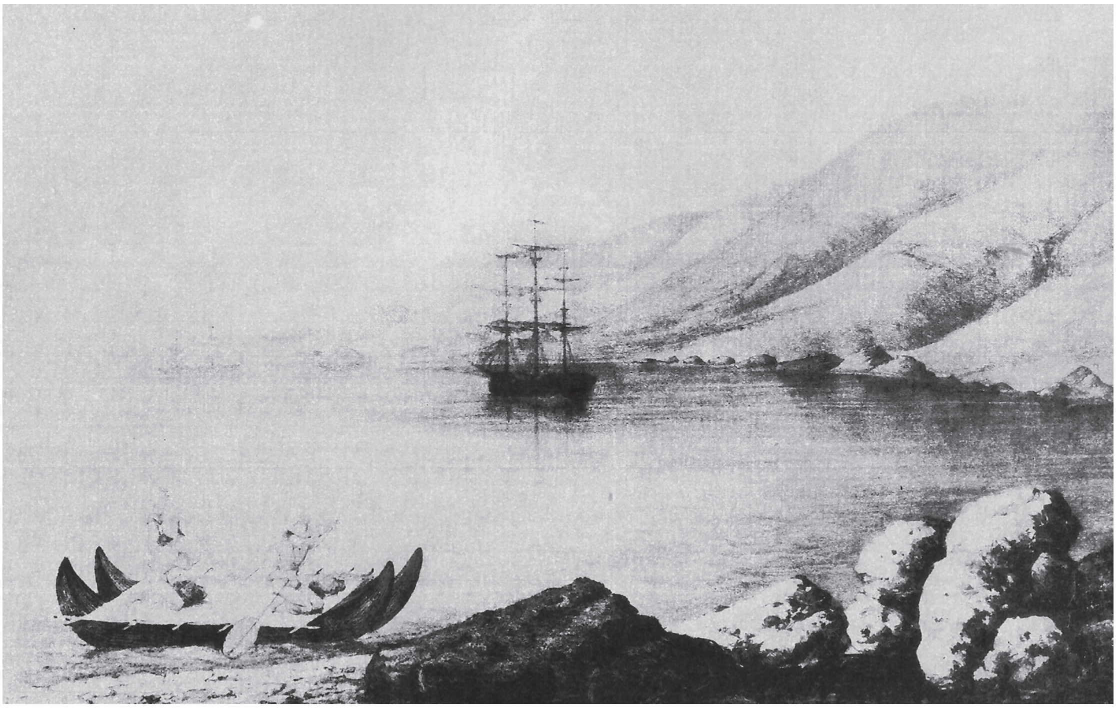


FIGURE 13. Harbor of El Cobre, province of Antofagasta, Philippi's arrival port on his expedition to the desert of Atacama. By R. A. Philippi. In Phillipi Izquierdo, 1973: plate 34.

of subdirector, Germain resigned from his position because of his cut in salary. Nevertheless, Germain, a Coleoptera specialist, continued to work for the museum as a collector and entomologist until 1910. He spent much of his time traveling and exploring other countries selling entomological and ornithological specimens, but also some plant specimens from Chile, Brazil and Bolivia. After a short interlude from 1889 to 1893 during which he accepted a teaching position at a secondary school in Quillota, Germain returned to the Natural History Museum.

During his years in Chile, Germain maintained close relations with Philippi and contributed ten orchid specimens to the flora of Chile (Table 1). One of them, *Habenaria germainii,* was named by Philippi in his honor. Germain collected mainly in Central Chile, in the Andean departments of Chillán and Linares (Fig. 20).

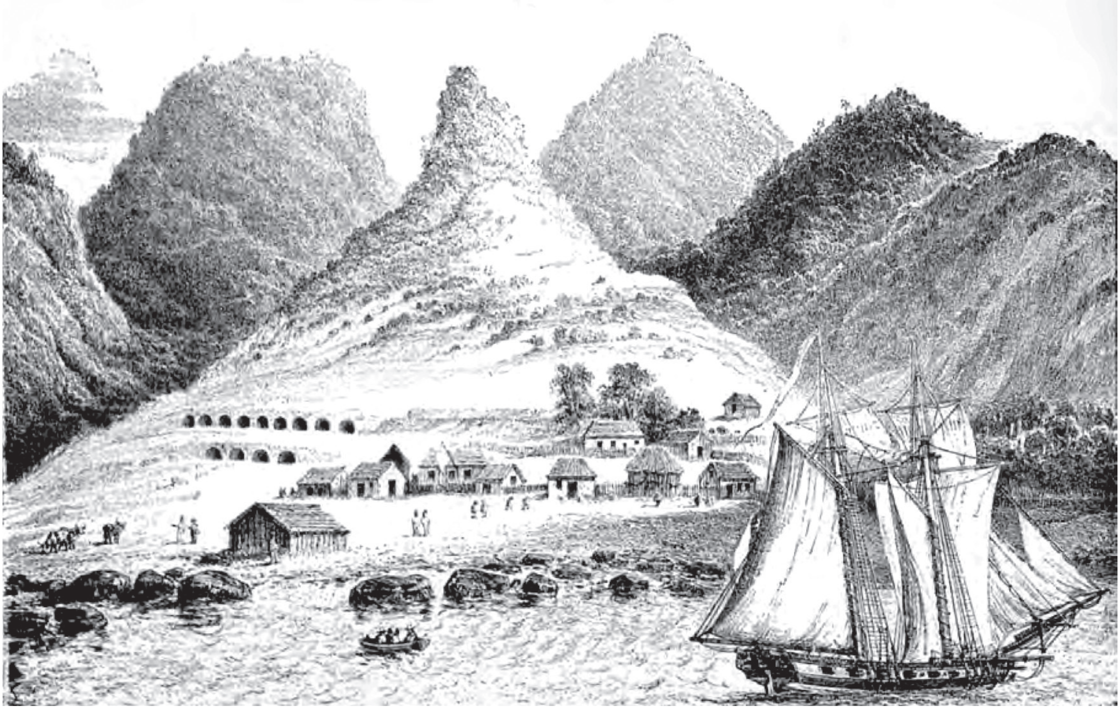


Figure 14. The island of Juan Fernández. By R. A. Philippi. In Phillipi Izquierdo, 1973: plate 27.

Acknowledgments. Special thanks go to Jimena E. Arriagada Torres, Curator of Botanical Collections at the Natural History Museum in Chile, for her kind help with information about the specimens of Phillipi held at the museum. Also, to Esther García Guillén of the Royal Botanical Garden and Rosa Villalón, of the Consejo Superior de Investigaciones Científicas, both in Madrid, for important information about the botanical collections donated by Rudolph Philippi to members of the Spanish Expedition to the Pacific (1862–1866).

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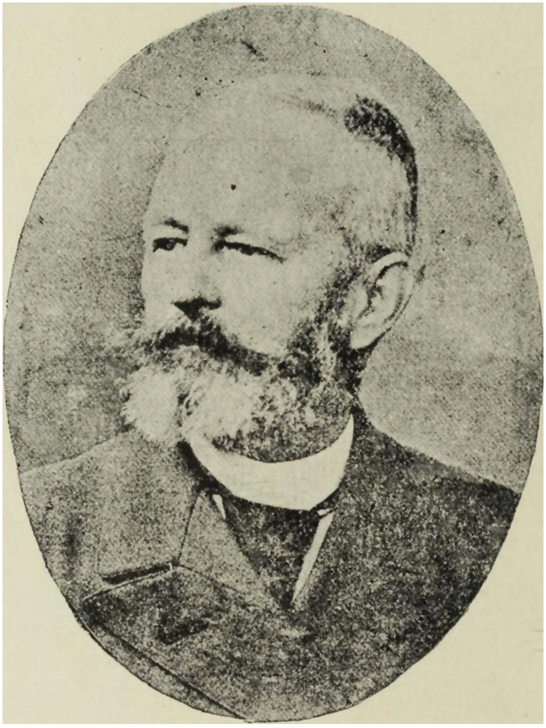

Figure 15. Friedrich Heinrich Eunom Philippi (1836–1910). In Barabino, 1910: 288.

FIGURE 16. Rudolph Philippi (right), and son Federico in 1902. Unknown photographer.

FIGURE 17. *Macrocentrum mendocinum* Phil. as *Habenaria gourlieana* Gilles ex Lindl. Photograph by Asociación Tucumana de Orquicultores.

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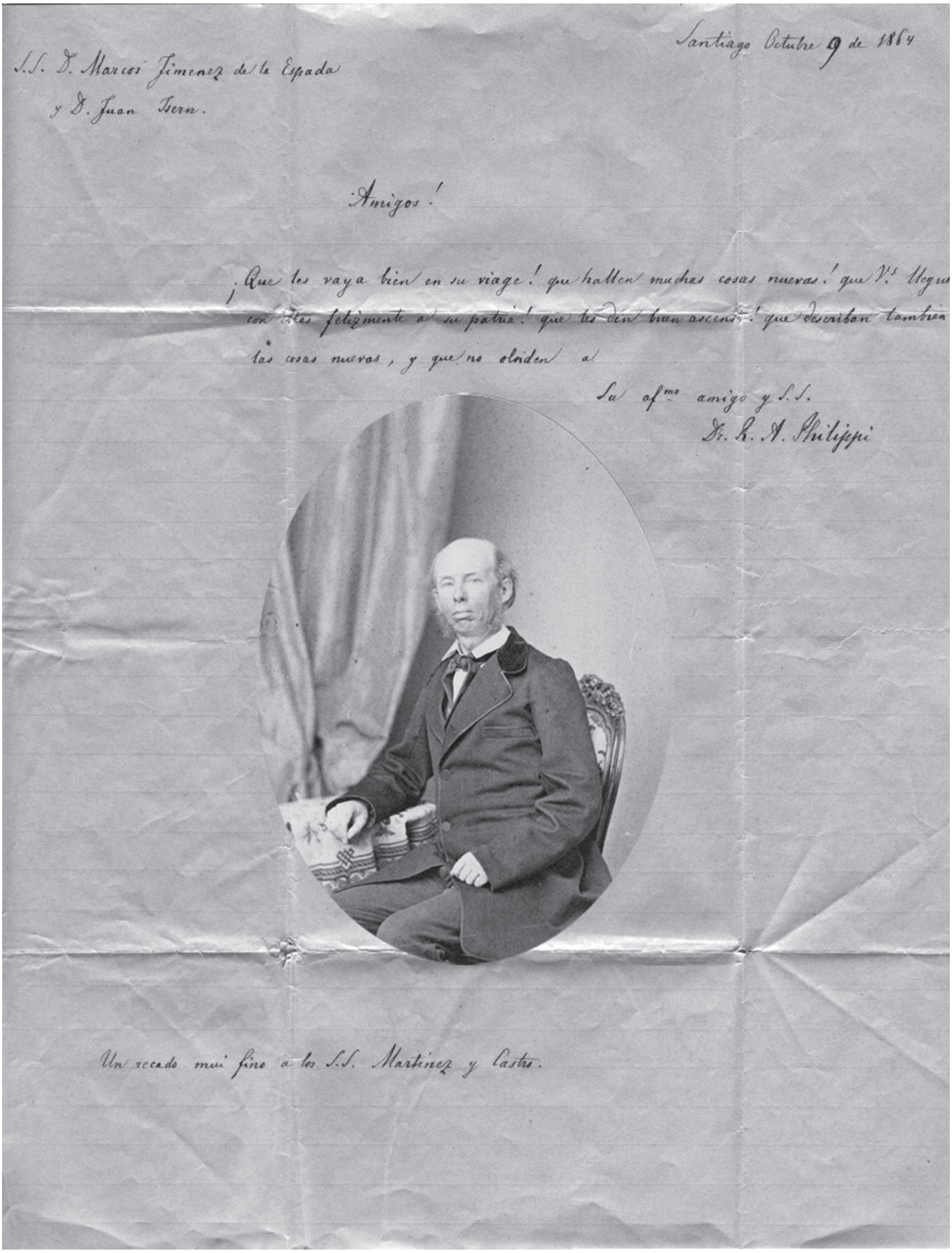


Santiago Octubre 9 de 1864

S.S. D. Marcos Jimenez de la Espada
y D. Juan Isern.

¡Amigos!

¡Que les vaya bien en su viage! que hallen muchas cosas nuevas! que V.^{s} llegu con ellas felizmente a su patria! que les dén buen ascensos! que describan tambien las cosas nuevas, y que no olviden a

Su af^{mo} amigo y S.S.
Dr. R. A. Philippi

Un recado mui fino a los S.S. Martinez y Castro.

Figure 18. Letter and photograph from R.A. Philippi to Marcos Jiménez and Juan Isern. 9 October 1864. Courtesy of the Royal Botanical Garden, Madrid, and the Spanish Consejo Superior de Investigaciones Científicas.

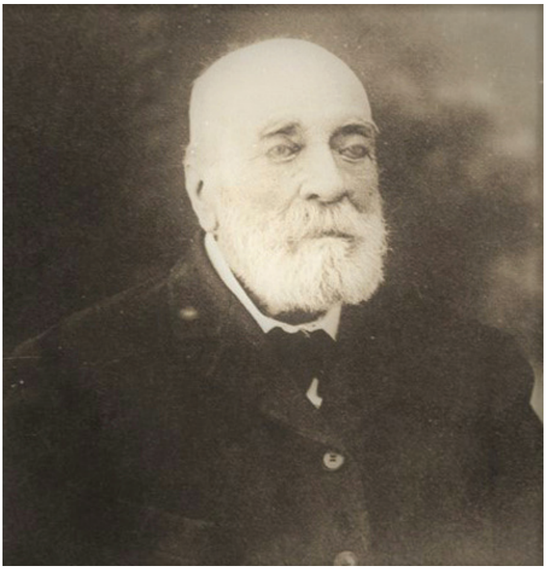


FIGURE 19. Philibert Germain (1827–1913). Unknown photographer.

FIGURE 21. *Asarca appendiculata* Phil. ex. Kraenzl. as *Gavilea glandulifera* (Poepp) M.N.Correa. Photograph by Marcela Andina.

PLANTES DU CHILI.

Chloræa rhypaloglossa Rich.
Cordilières de Chillan

Ann. 1855. Rec. Ph. Germain.

FIGURE 20. Herbarium label by Philibert Germain. MNHN Paris # P00363447.

FIGURE 22. *Asarca chrysostachya* Phil. or *A. sulphurea* Phil. as *Gavilea odoratissima* Poepp. Photograph by Hernán Tolosa.

reibung zur Arzeney dienlicher Pflanzen, welche in den Reichen des mittägigen America, in Peru und Chily vorzüglich im Gebrauch sind, in dem Land selbst auf königl. Befehl, in den Jahren von 1709. 1710. und 1711. aufgesezet, nebst verschiedenen andern aus eben desselben Tageregister physischer Beobachtungen gesammelten und zur natürlichen Historie gehörigen Anmerkungen. Nuernberg: Johann Michael Seeligmann. German edition.

Table 1. The Philippis' South American Orchids.

Orchids from Peru			
Basionym	**Original collector (date)**	**Currently accepted name By Rodríguez *et al.* (2018)**	**Notes**
I. *Epidendrum* L.	Type: *Epidendrum nocturnum* Jacq. (1760), Antilles	**I. *Epidendrum* L.**	
E. philippii Rchb.f.	B.E. Philippi (ca. 1837)	*E. philippii* Rchb.f.	*(1)
Orchids from Chile			
II. *Asarca* Lindl.	Type: *Asarca speciosa* Lindl. = *Chloraea pavonii* Pavón (1782–1783), Chile	***Gavilea* Poepp.**	
A. appendiculata Phil. ex Kraenzl.	R. and/or F. Philippi (?)	*G. glandulifera* (Poepp.) M.N.Correa	***(I)** (Fig. 21)
A. brachychila Phil.	Manuel Antonio de Solís Obando (ca. 1858)	*G. lutea* (Comm. ex Pers.) M.N.Correa	***(I)**
A. chrysostachya Phil.	R.A. Philippi (ca. 1856)	*G. odoratissima* Poepp.	(Fig. 22)
A. spectabilis Phil.	R.A. Philippi (ca. 1856)	*G.. longibracteata* (Lindl.) Sparre ex L.E.Navas	(Fig. 23)
A. sulphurea Phil.	Philibert Germain (ca. 1857)	*G. odoratissima* Poepp.	(Fig. 22)
A. thermarum Phil. ex Kraenzl.	R.A. Philippi (?)	*G. lutea* (Comm. ex Pers.) M.N.Correa	***(I)**
III. *Chloraea* Lindl.	Type: Feuillée (1712–1714), Chile (*Epipactis … vulgo piquichen*)	***Chloraea* Lindl.**	(Fig. 24)
C. aurea Phil.	R.A. Philippi (ca. 1856)	*C. barbata* Lindl.	(Fig. 25–26)
C. bicallosa Phil. ex Kraenzl.	R.A. Philippi (?)	*C. bidentata* (Poepp. & Endl.) M.N.Correa	***(I)** (Fig. 27)
C. calopogon Phil.	R.A. Philippi (?)	*C. prodigiosa* Rchb.f.	
C. chlorosticta Phil.	Philibert Germain (ca. 1857)	*C. virescens* (Willd.) Lindl.	(Fig. 26)
C. chrysochlora Phil.	R.A. Philippi (ca. 1857)	*C. chrysochlora* Phil.	(Fig. 28)
C. collina Phil.	Philibert Germain (ca. 1857)	*C. collina* Phil.	*(3)
C. crocata Phil.	Philibert Germain (ca. 1857)	*C. chrysantha* Poepp.	
C. cygnaea Phil.	R.A. Philippi (ca. 1863)	*C. crispa* Lindl.	*(4)
C. dasypogon Phil.	R.A. Philippi (ca. 1864)	*C. prodigiosa* Rchb.f.	(Fig. 29)
C. fimbriata Phil. nom. illeg.	R.A. Philippi (ca. 1857)	*C. virescens* (Willd.) Lindl.	
C. fonkii Phil.	Dr. Francisco Fonk (ca. 1857)	*C. gaudichaudii* Brongn.	*(5) (Fig. 30)
C. gymnoglossa Phil.	Dr. Francisco Fonk (ca. 1857)	*C. gaudichaudii* Brongn.	
C. heteroglossa Rchb.f.	B.E. Philippi (? – before 1848)	*C. heteroglossa* Rchb.f.	(Fig. 4)
C. homopetala Phil.	Philibert Germain (ca. 1856)	*C. nudilabia* Poepp.	
C. inconspicua Phil.	R.A. Philippi (ca. 1864)	*C. gaudichaudii* Brongn.	
C. kruegeri Phil. ex Kraenzl.	A. Selle, Reñihue Expedition (?)	*Gavilea chica* (Speg. & Kraenzl.) Chemisquy	(Fig. 31)
C. lineata Phil. ex Kraenzl.	R.A. Philippi (?)	*C. philippii* Rchb.f.	
C. littoralis Phil.	Anton Krause (?)	*Gavilea littoralis* (Phil.) M.N.Correa	*(I) (Fig. 32)
C. modesta Phil. ex Kraenzl.	R.A. Philippi (?)	*C. philippii* Rchb.f.	
C. multilamellata Phil. ex Kraenzl.	R.A. Philippi (?)	*C. longipetala* Lindl.	

C. nervosa Phil. ex Kraenzl.	R.A. Philippi (?)	*C. cuneata* Lindl.	
C. obovata Phil.	R.A. Philippi (?)	*C. cuneata* Lindl.	
C. panduriformis Phil. ex Kraenzl.	R.A. Philippi (?)	*C. longipetala* Lindl.	
C. papillosa Phil.	Philibert Germain (ca. 1856)	*Correorchis cylindrostachya* (Poepp.) Szlach.	(Fig. 33)
C. patagonica Phil.	J. Cox (?)	*C. virescens* (Willd.) Lindl.	
C. pearcei Phil.	R. W. Pearce (1859–1862)	*C. lamellata* Lindl.	
C. philippii Rchb.f.	B.E. Philippi (ca. 1840–1848)	*C. philippii* Rchb.f.	
C. picta Phil. ex Kraenzl.	Alfred Andeoud (?)	*C. disoides* Lindl.	(Fig. 34)
C. pogonata Phil.	C.L. Landbeck (ca. 1863)	*C. cristata* Lindl.	
C. reflexa Phil.	Philibert Germain (ca. 1856)	*Chloraea parviflora* (Poepp.) Mourgues & Novoa	(Fig. 35)
C. secunda Phil.	Philibert Germain (ca. 1856)	*C. galeata* Lindl.	
C. spectabilis Phil.	F. Philippi (ca. 1863)	*C. crispa* Lindl.	(Fig. 36)
C. semitensis Phil. ex Kraenzl.	Volkmann (?)	*C. gavilu* Lindl.	(Fig. 37)
C. suaveolens Phil.	C.L. Bertero (1831)	*C. galeata* Lindl.	
C. unguis-cati Rchb.f.	B.E. Philippi (ca. 1840–1848)	*C. virescens* (Willd.) Lindl.	
C. verrucosa Phil.	Philibert Germain (ca. 1856)	*C. viridiflora* Poepp.	
C. volkmannii Phil. ex Kraenzl.	Hermann Volckmann (ca. 1860–1869)	*C. volkmannii* Phil. ex Kraenzl.	*(6) (Fig. 38)
IV. *Habenaria* Willd.	Type: Swartz (1784–1786), Jamaica	***Habenaria* Willd.**	
H. brachyceras Phil. nom. illeg.	Hermann Volckmann (ca. 1860–1869)	*Habenaria pumila* Poepp.	(Fig. 39)
H. germainii Phil.	Philibert Germain (ca. 1856)	*H. pumila* Poepp.	
H. uliginosa Phil.	R.A. Philippi (ca. 1857)	*H. pumila* Poepp.	
Orchids from Argentina			
V. *Macrocentrum*	R.A. Philippi, province Mendoza, Argentina (1867)	***Habenaria* Willd.**	
M. mendocinum	R.A. Philippi	*Habenaria gourleiana* Gilles ex Lindl.	*(2) (Fig. 17)

*(1) Accepted by León et *al.* (2007).

*(2) Accepted by Zuloaga et *al.* (2008).

*(3) Not mentioned in Rodríguez et *al.* (2018). Mentioned by Novoa *et al.* (2015) as a valid species. Considered by Correa (1969) as doubtful.

*(4) Not mentioned in Rodríguez et *al.* (2018). Mentioned by Novoa *et al.* (2015) as a valid species.

*(5) Neither Rodríguez et *al.* nor Novoa *et al.* (2015) mention this species. The only mention is in Correa (1969) as a synonym of *C. gaudichaudii.*

*(6) Only mentioned by Novoa *et al.* (2006) and TROPICOS.

*(I): In these and many other cases the combination author is indicated in TROPICOS and HUH as M.D. Correa, while the correct name must be M.N. Correa. Mireya D. Correa (–1940), a reputed Panamanian botanist is seemingly confused with Maevia Noemí Correa (1914–2005), an Argentinian specialist in the terrestrial orchids of the Southern Cone.

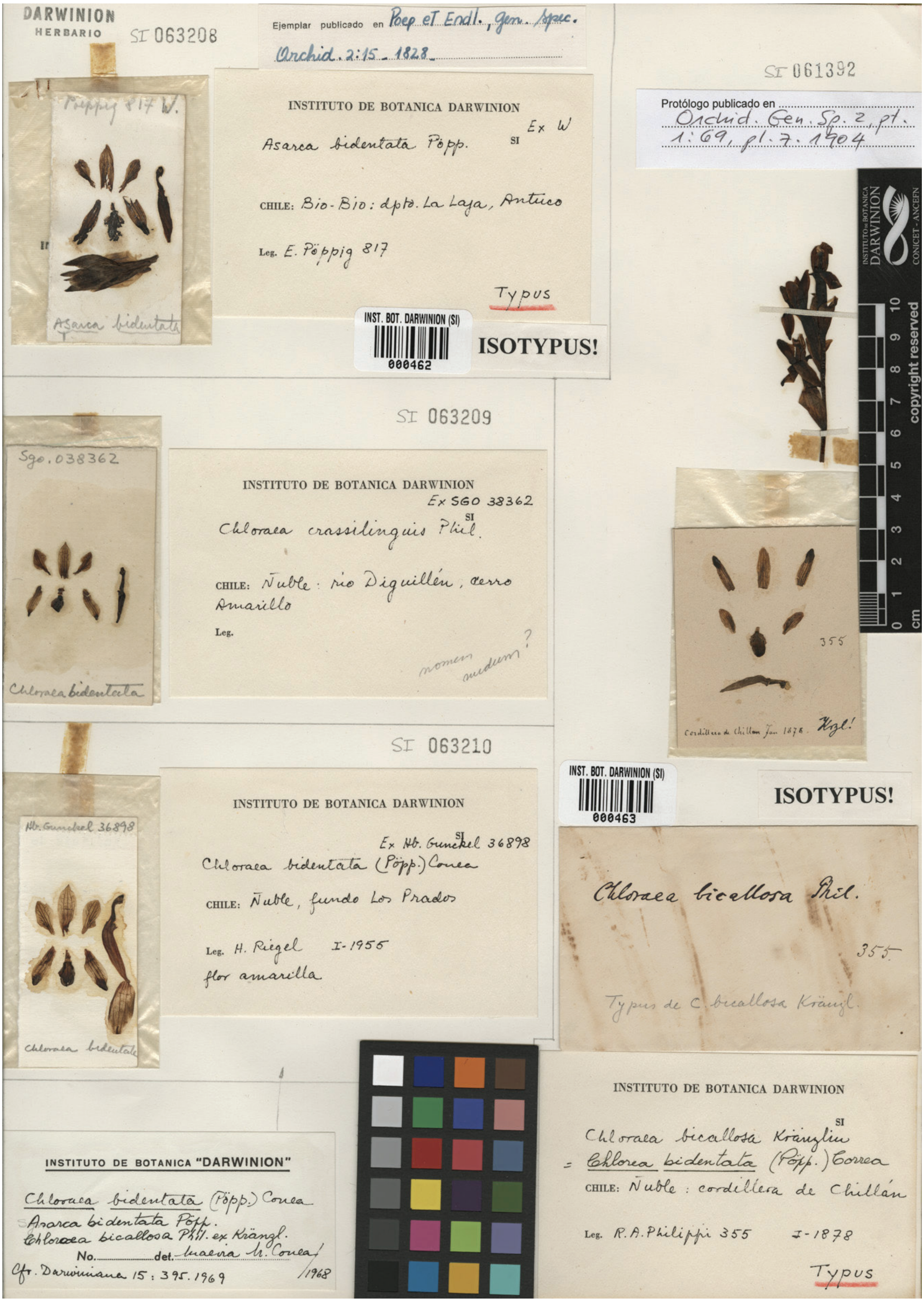
Figure 23. *Asarca spectabilis* Phil. as *Gavilea venosa* (Lam.) Garay & Ormerod. Photograph by Patricio Novoa.

Figure 24. *Epipactis flore virescente et variegatum vulgo Piquichen.* Type specimen for the genus *Chloraea* = *Chloraea piquichen.* In Feuillée, 1756: plate XIX.

Figure 25. *Chloraea aurea* Phil. as *C. barbata* Lindl. Photograph by José Montalva.

Fig. 8. — *Chloraea barbata* Lindley : A, planta : B, sépalo dorsal ; C, pétalo ; D, sépalo lateral ; E, labelo y detalle de uña, F, columna, F. Torres, (CONC 12294). Fig. 9. — *Chloraea virescens* (Willd.) Lindley A, planta ; B, labelo ; C, detalle de los apéndices del labelo ; D, sépalo dorsal ; E, pétalo ; F, sépalo lateral ; G, columna, R. A. Perez-Moreau, (BA 50278).

FIGURE 26. *Chloraea barbata* Lindl. & *C. virescens* (Willd.) Lindl. In Correa, 1969: plates 8, 9.



Ejemplar publicado en Poep eT Endl., gen. spec. Orchid. 2:15. 1828.

INSTITUTO DE BOTANICA DARWINION
Asarca bidentata Pöpp. SI Ex W
CHILE: Bio-Bio: dpto. La Laja, Antuco
Leg. E. Pöppig 817
Typus

INSTITUTO DE BOTANICA DARWINION
Ex SGO 38362
Chloraea crassilinguis Phil. SI
CHILE: Ñuble: rio Diguillén, cerro Amarillo
Leg.
nomen nudum?

INSTITUTO DE BOTANICA DARWINION
Ex Hb. Gunckel 36898 SI
Chloraea bidentata (Pöpp.) Correa
CHILE: Ñuble, fundo Los Prados
Leg. H. Riegel I-1955
flor amarilla

Protólogo publicado en Orchid. Gen. Sp. 2 pt. 1: 69, pl. 7. 1904

Chloraea bicallosa Phil.
355
Typus de C. bicallosa Kränzl.

INSTITUTO DE BOTANICA "DARWINION"
Chloraea bidentata (Pöpp.) Correa
Asarca bidentata Pöpp.
Chloraea bicallosa Phil. ex Kränzl.
No. det. Maevia N. Correa /1968
Cfr. Darwiniana 15: 395. 1969

INSTITUTO DE BOTANICA DARWINION
Chloraea bicallosa Kränzlin SI
= Chlorea bidentata (Pöpp.) Correa
CHILE: Ñuble: cordillera de Chillán
Leg. R.A. Philippi 355 I-1878
Typus

Figure 27. Type of *Chloraea bicallosa* Phil. Herbarium of the Instituto de Botánica Darwinion.

FIGURE 28. *Chloraea chrysochlora* Phil. as *C. lechleri* Lindl. ex Kraenzl. Photograph by E. Salazar.

FIGURE 29. *Chloraea dasypogon* Phil. as *C. cristata* Lindl. Photograph by Cristobal González.

FIGURE 30. *Chloraea fonkii* Phil. as *C. gaudichaudii* Brongn. Photograph by Víctor Sotelo.

FIGURE 31. *Chloraea kruegeri* Phil. ex Kraenzl. as *C. chica* Poepp. Photograph by Bastian Gygli.

Figure 32. *Chloraea litoralis* Phil. as *Gavilea littoralis* (Phil.) M.N.Correa. Photograph by "pabloendémico".

Figure 34. *Chloraea picta* Phil. ex Kraenzl. as *C. disoides* Lindl. Photograph by Eitel Thielemann.

Figure 33. *Chloraea papillosa* Phil. as *Correorchis cylindrostachya* (Poepp.) Szlach. Collected by P. Germain. Photograph by Patricio Novoa.

Figure 35. *Chloraea reflexa* Phil. as *C. galeata* Lindl. Photograph by Jan Thomas Johansson.

Figure 36. *Chloraea spectabilis* Phil. as *C. crispa* Lindl. Photograph by Erwin Domínguez.

Figure 37. *Chloraea semitensis* Phil. ex Kraenzl. as *C. gavilu* Lindl. Photograph by Lucía Abello.

Figure 38. *Chloraea volkmannii* Phil. ex Kraenzl. Photograph by Pablo Bravo Monasterio.

Figure 39. *Habenaria brachyceras* Phil. as *H. paucifolia* Lindl. Photograph by Patricio Novoa.

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TWO NEW SPECIES OF *PLEUROTHALLIS* (PLEUROTHALLIDINAE) SUBSECTION *MACROPHYLLAE-FASCICULATAE* FROM THE CENTRAL ANDES OF COLOMBIA

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Abstract. Two new species of *Pleurothallis* subsection *Macrophyllae-Fasciculatae* are described and illustrated. Both species were found in the central Andes of Colombia in the department of Tolima. The two species are compared and discussed with *Pleurothallis applanata*, *Pleurothallis ariana-dayanae*, *Pleurothallis paquishae*, and *Pleurothallis scabrilinguis*, which are the morphologically closest species. The two new species differ from their congeners mainly by lip morphology. *Pleurothallis franciana* is distinguished by having an oblong-lanceolate, acute, vesiculous lip with an obovate glenion, and *Pleurothallis petroana* is distinguished by the ovate-lanceolate, verrucose-papillose, slightly pilose lip, with a spathulate glenion.

Resumen. Se describen e ilustran dos nuevas especies de *Pleurothallis* subsección *Macrophyllae-Fasciculatae*, encontradas en los Andes centrales de Colombia en el departamento de Tolima. Las dos especies se comparan y discuten con *Pleurothallis applanata, Pleurothallis ariana-dayanae, Pleurothallis paquishae*, y *Pleurothallis scabrilinguis*, que son las especies morfológicamente más cercanas. Se diferencia de sus congéneres principalmente por la morfología del labelo, *Pleurothallis franciana* se distingue por tener el labelo oblongo-lanceolado, agudo, vesiculoso, con un glenion obovado y *Pleurothallis petroana* se distingue por el labelo ovado-lanceolado, verrucoso-papiloso, ligeramente piloso, con un glenion espatulado.

Keywords / Palabras clave: distribución, distribution, ecología, ecology, Ibagué, Orchidaceae, Tolima, Villahermosa

Introduction. *Pleurothallis* R.Br. is a neotropical genus distributed from southern Mexico to South America, with representation in the Antilles (Ackerman *et al*. 2014). According to Karremans & Vieira-Uribe (2020), 499 species are currently accepted; however, with the publication of new species during the last two years, the number increased to 528 species (Jiménez *et al*. 2021, Karremans *et al*. 2021, Moreno *et al.* 2022, Pupulin *et al*. 2020, 2021, Sierra-Ariza *et al.* 2022, Vélez-Abarca *et al*. 2022, Wilson *et al.* 2022). Colombia, with 236 species, comprises the largest number of species in the neotropics (Karremans *et al.* in prep.).

The *Pleurothallis* subsection *Macrophyllae-Fasciculatae* Lindl. was initially proposed as a section of *Pleurothallis* subgenus *Pleurothallis* by Lindley (1859). This group has undergone several nomenclatural changes over time. For example, Luer (1986) initially recognized the sectional status of the group, however, two years later, he classified the group under *P.* subsection *Macrophyllae-Fasciculatae* (Luer 1988). Finally, Luer (2005) recognized *Acronia* C.Presl, and he treated the members of *Macrophyllae-Fasciculatae* as a section of this genus (for a detailed taxonomic history of the group, see: Pupulin *et al*. 2020, 2021, Wilson *et al.* 2022). Nevertheless, phylogenetic studies suggest that *Acronia* and the *P.* subsection *Macrophyllae-Fasciculatae* belong to a well-supported clade within *Pleurothallis* (Pridgeon *et al*. 2001, Wilson *et al.* 2011, 2018).

Morphologically, the species within the *P.* subsection *Macrophyllae-Fasciculatae* can be recognized by having sessile leaves with a generally cordate base, solitary flowers grouped in a fascicle, lateral sepals connate into a synsepal more or less similar to the dorsal sepal, a bilobed stigma, and a lip lying on or slightly elevated above the synsepal (Lindley 1859, Luer 2005, Wilson *et al.* 2018).

Here, we describe and illustrate two new species of *P.* subsection *Macrophyllae-Fasciculatae* found in the department of Tolima, Colombia, belonging to the informal taxonomic group "*Pleurothallis scabrilinguis*".

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Members of this group are characterized by flowers with linear, falcate petals, large, flattened lip with irregular texture (cellular, verrucous, papillose, pilose, vesicular), and a conspicuous basal glenion (Vélez-Abarca *et al.* 2022).

Materials and methods. *Pleurothallis petroana* was found in July 2019 in one of the expeditions carried out in the research entitled "synthesis of the orchids of the Azufrado River, Tolima-Colombia", project where six new species of orchids have been discovered and described: *Acianthera villahermosae* Sierra-Ariza, Rinc.-González & Karremans, *Oncidium tolimense* Sierra-Ariza & A.Albino-Bohórquez, *Pleurothallis villahermosae* Sierra-Ariza, Rinc.-González & Villanueva, *Epidendrum villahermosaense* Sierra-Ariza & Hágsater and *Epidendrum rioazufrense* Sierra-Ariza, Hágsater & E.Santiago. In addition, *Pleurothallis franciana* was found in June 2022 on the road that connects the urban area of the city of Ibagué with the Municipalities of Ambalá and Carrizales in Tolima, Colombia.

The specimens were photographed with a Nikon D5300 camera and a NIKKOR AF 105 mm f/2.8 D Micro lens. Ecological data and phenology were recorded for *P. franciana* for three months and for *P. petroana* for two years. Type specimens were prepared by storing vegetative structures on newspaper soaked in 75% ethanol. The floral structures were preserved in a concentration of equal parts of glycerin and ethyl alcohol.

The collected material was dried at 75°C for 14 hours and subsequently deposited in the collection of the TOLI Herbarium. Literature on the genus was reviewed, such as monographs on the systematics of *Pleurothallis* section *Macrophyllae-Fasciculatae* (Luer 1988, 2005). In addition, specimens from AMES (www.huh.harvard.edu) and K herbaria (apps.kew.org/herbcat/gotoHomePage.do) were reviewed online. Finally, Lankester composite Digital plates (LCDP) were made with Adobe Photoshop® CS6.

Taxonomic treatment

Pleurothallis franciana Sierra-Ariza ***sp. nov.*** (Fig. 1–2).

TYPE: COLOMBIA. Tolima: Municipio de Ibagué, entre las veredas Ambala y Carrizales, 1976 m, 23 June 2022, *M. A. Sierra-Ariza & A. Albino Bohorquez 430* (holotype: TOLI).

Diagnosis: *Pleurothallis franciana* is similar to *Pleurothallis ariana-dayanae* Vélez-Abarca, M.M.Jiménez & D.Gut. del Pozo from which it differs by having a narrowly ovate-lanceolate dorsal sepal (*vs.* lanceolate), an ovate synsepal (*vs.* broadly ovate) and the lip oblong-lanceolate, acute, vesiculose (*vs.* ovate-elliptic, obtuse, verrucose-papillose), with an obovate glenion (*vs.* slightly bilobed).

Plant 4 to 12 cm tall, epiphytic, caespitose, erect to suberect. *Roots* slender, 1 mm in diameter. *Ramicauls* green, 3.5–11 cm long, with a tubular sheath on the lower third and two other sheaths at the base, papyraceous, light brown. *Leaf* light green, bright, coriaceous, ovate to ovate-lanceolate, acuminate, 3–5 × 2.4–3.5 cm, the base sessile, cordate. *Inflorescence* a fascicle of successive flowers, one flower, rarely with two simultaneous flowers, enclosed at the base by a spathaceous bract ca. 2.8 mm long; peduncle terete, green, 2.0–3.8 mm long; floral bract tubular, papyraceous, acute, 1.5–2.8 mm long. *Pedicel* terete, up to 3.2 mm long. *Ovary* yellow with red tones and some black dots, papillate, pedicellate, cylindrical, longitudinal sulcate, with some black dots, 2.5 mm long. *Sepals* membranaceous, glandular-papillate, margins irregular. *Dorsal sepal* reddish purple, margins slightly yellow, narrowly ovate-lanceolate, rounded, 3.9–4.4 × 1.5–1.9 mm, 3-veined. *Lateral sepals* yellow spotted with reddish-purple, connate into an ovate, acute to bifid synsepal, concave at base, 4.2–4.5 × 2.4–2.7 mm, 4-veined. *Petals* reddish purple, fleshy, linear, slightly glandular-papillose, acute, margins irregular, 2.3–2.6 × 0.3–0.4 mm, 1-veined. *Lip* reddish purple, fleshy, oblong-lanceolate, acute, vesiculose, margin erose, 2.2–2.5 × 1.2–1.4 mm, 3-veined, disc with a small, obovate glenion near the base, the base forming two rounded, pronounced lobes. *Column* reddish purple, short, broad, semiterete, margins irregular, 0.8 × 1.0 mm, with a short foot, thick; stigma apical, bilobed. *Anther cap* yellow, apical, obovate, minutely papillose, 0.6 × 0.4 mm *Pollinia* 2, yellow, obovoid. Capsule not seen.

Eponymy: Named to honor Francia Elena Márquez Mina, Vice-president of the Republic of Colombia (2022–2026), social leader, environmental activist,

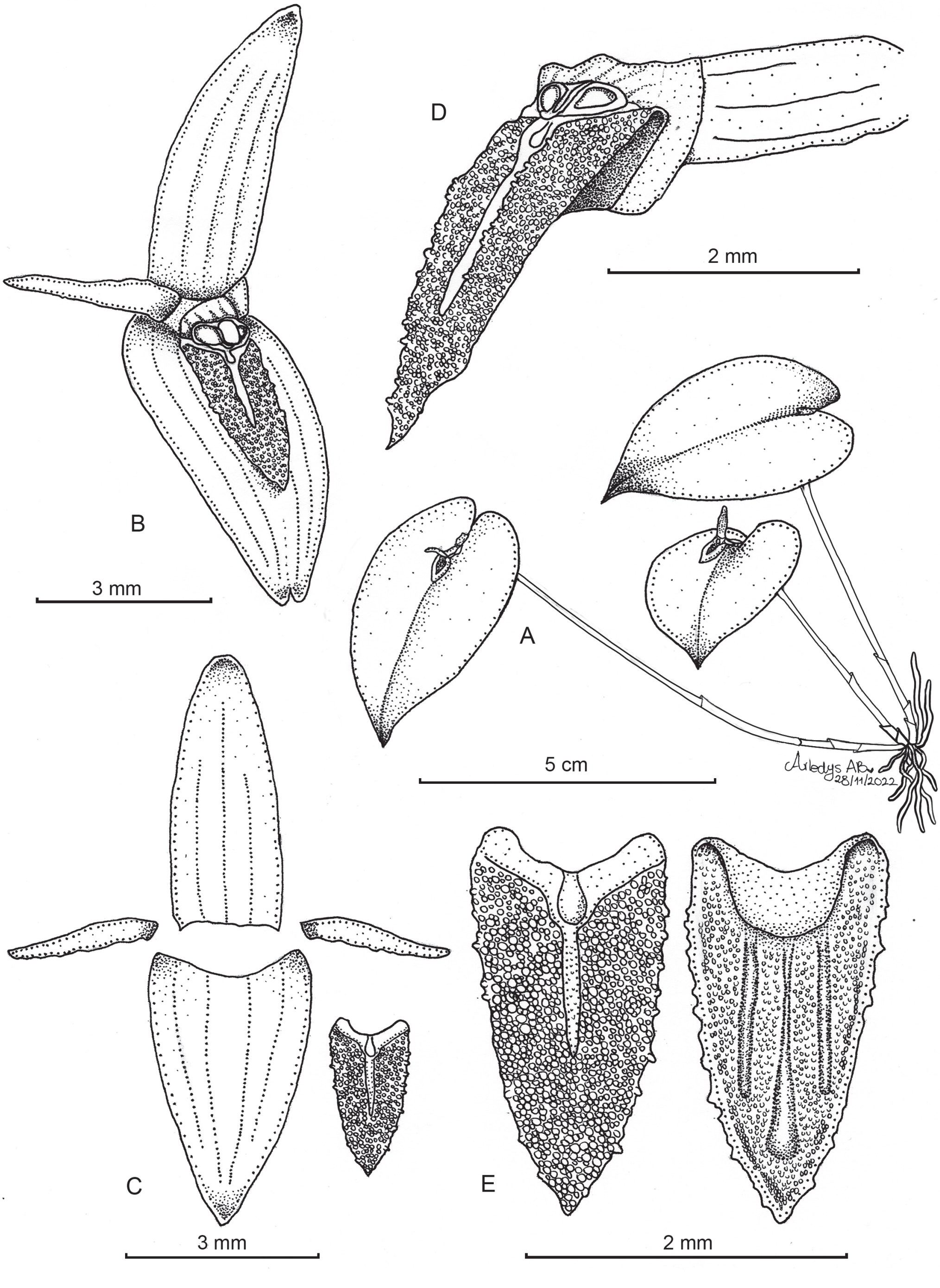

Figure 1. *Pleurothallis franciana* Sierra-Ariza. **A**. Habit. **B**. Flower. **C**. Dissected perianth. **D**. Lip and column, ¾ view. **E**. Lip, adaxial and abaxial views. Illustration by A. Albino Bohorquez, based on the plant that served as the holotype.

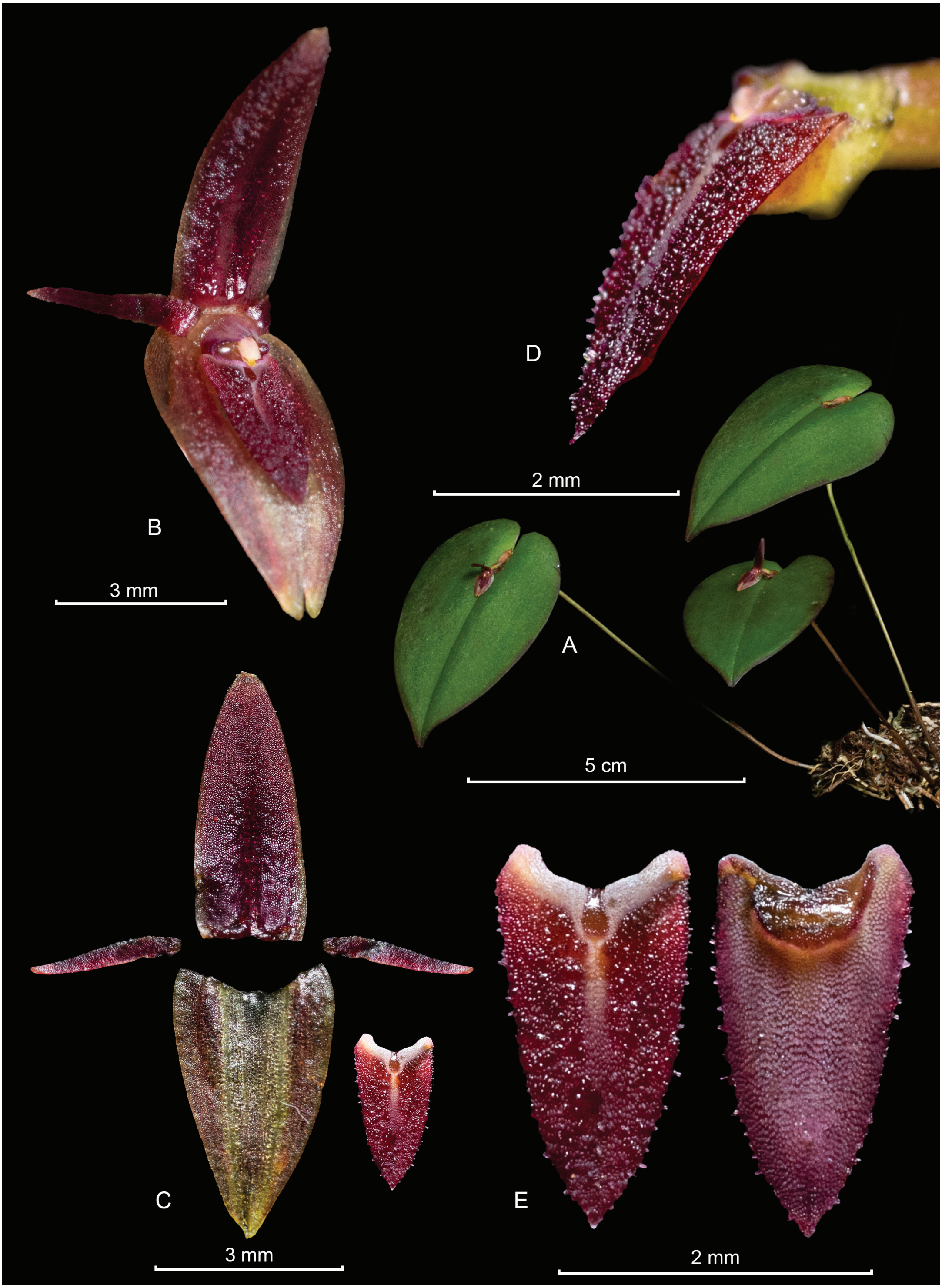

FIGURE 2. *Pleurothallis franciana* Sierra-Ariza. **A**. Habit. **B**. Flower. **C**. Dissected perianth. **D**. Lip and column, ¾ view. **E**. Lip, adaxial and abaxial views. LCDP by M. A. Sierra-Ariza, based on the plant that served as the holotype.

and Goldman Prize winner (2018), her work has been of vital importance in the social struggles in Colombia. She carried out activities supporting the conservation of rivers, customs, and the territory of the Afro-Colombian people. She is a tireless fighter against indiscriminate mining.

Distribution and ecology: *Pleurothallis franciana* was discovered in the Central Cordillera of Colombia, in a fragment of wet premontane forest, in the department of Tolima, at 1976 m of elevation.

This species was found on the edge of a public road near the urban center of Ibagué, in a relict of very degraded forest, surrounded by crops and pastures. It grows as an epiphytic on thin branches and among a sparse covering of bryophytes in dark and humid areas. It has been observed flowering in July.

Discussion. *Pleurothallis franciana* belongs to the morphological group "*P. scabrilinguis*" and it has probably the smallest flowers (less than 1 cm long) of the group. The most similar species is *P. ariana-dayanae* but differs from it by having the dorsal sepal narrowly ovate-lanceolate, rounded, 3.9–4.4 ×1.5–1.9 mm (*vs*. lanceolate, acute, 6.5–7.8 × 2.3–2.4 mm); the synsepal ovate, acute to bifid, 2.4–2.0 × 4.2–4.5 mm (*vs*. broadly ovate, acute, 5.8–6.5 × 4.3–4.5 mm); the lip oblong-lanceolate, acute, 2.2–2.5 × 1.2–1.4 mm, vesiculose (*vs*. ovate-elliptic, obtuse, 3.2 × 2.0–2.2 mm, verrucose-papillose) and the glenion obovate (*vs*. slightly bilobed).

This species is also similar to *Pleurothallis scabrilinguis* Lindl., which has larger flowers (1.5 to 2.0 cm long). However, the new species also differs by having the dorsal sepal dorsal narrowly ovate-lanceolate, rounded, 3.9–4.4 ×1.5–1.9 mm (*vs*. elliptic-ovate, subacute to obtuse, 6–10 × 2.5–7.0 mm); the synsepal ovate, acute to bifid, 2.4–2.7 × 4.2–4.5 mm (*vs*. broadly ovate, obtuse, shallowly concave, 5–10 × 4–8 mm); the petals linear, acute, 2.3–2.6 × 0.3–0.4 mm (*vs*. narrowly linear-triangular, acute, 3–7 × 0.50–1.25 mm); the lip oblong-lanceolate, acute, 2.2–2.5 × 1.2–1.4 mm, vesiculose (*vs*. triangular, oblong, subacute or rounded, 3–7 × 2–4 mm, papillose) and the glenion obovate (*vs*. obovate, slightly bilobed).

Another similar species is *Pleurothallis applanata* Luer & Dalström, but the new species differs mainly by having the dorsal sepal narrowly ovate-lanceolate, 3.9–4.4 × 1.5–1.9 mm (*vs*. narrowly elliptical-ovate, 10 × 3.6 mm); the petals linear, 2.3–2.6 × 0.3–0.4 mm (*vs*. narrowly linear-triangular, 6.75 × 1.00 mm); the lip oblong-lanceolate, acute, 2.2–2.5 ×1.2–1.4 mm, vesiculose (*vs*. oblong-ovate, obtuse, 4.5 × 2.2 mm cellular-verrucose) and the glenion obovate (*vs*. orbicular).

Pleurothallis petroana Sierra-Ariza, ***sp. nov.*** (Fig. 3–4).

TYPE: COLOMBIA. Tolima: municipio de Villahermosa, vereda Entrevalles, 3100 m, 25 July 2019, *M. A. Sierra-Ariza & A. Albino Bohorquez 194* (holotype: TOLI).

Diagnosis: *Pleurothallis petroana* is similar to *P. scabrilinguis*, but the new species differs by an oblong-lanceolate dorsal sepal (*vs*. oblong-ovate), an ovate synsepal (*vs*. broadly ovate), linear, acuminate petals (*vs*. narrowly linear-triangular, acute) and a lip ovate-lanceolate, verrucose-papillose, slightly pilose (*vs*. oblong-triangular, subacute or rounded, papillose), with a spathulate glenion (*vs*. obovate, slightly bilobed).

Plant 15 to 26 cm tall, epiphytic, occasionally terrestrial, caespitose, erect to suberect. *Roots* slender, 1.3 mm in diameter. *Ramicauls* yellow-green, 12–24 cm long, with a sheath located at the first basal third and two other sheaths at the base, tubular, broad, papyraceous, brown. *Leaf* light green, bright, coriaceous, minutely papillate, ovate-lanceolate, acuminate, 7–10 × 4.0–5.5 cm, the base sessile, cordate. *Inflorescence* a fascicle of successive single-flowers, rarely with two simultaneous flowers, enclosed at the base by a spathaceous bract ca. 12 mm long; peduncle terete, green, 9–11 mm long; floral bract tubular, papyraceous, acute, 9–11 mm long. *Pedicel* terete, up to 13 mm long. *Ovary* light green, papillate, pedicellate, cylindrical, longitudinal sulcate, covered with black dots, 6 mm long. *Sepals* membranaceous, glandular-papillate, margins irregular. *Dorsal sepal* dark red, margins pale yellow, oblong-lanceolate, acute, 14–16 × 3.0–4.2 mm, 3-veined. *Lateral sepals*, connate into an ovate, acute synsepal, dark red with a central yellow stripe and pale yellow margins, concave at the base, 13.5–15.0 × 8.5–9.2 mm, 4-veined. *Petals* dark red, margins pale

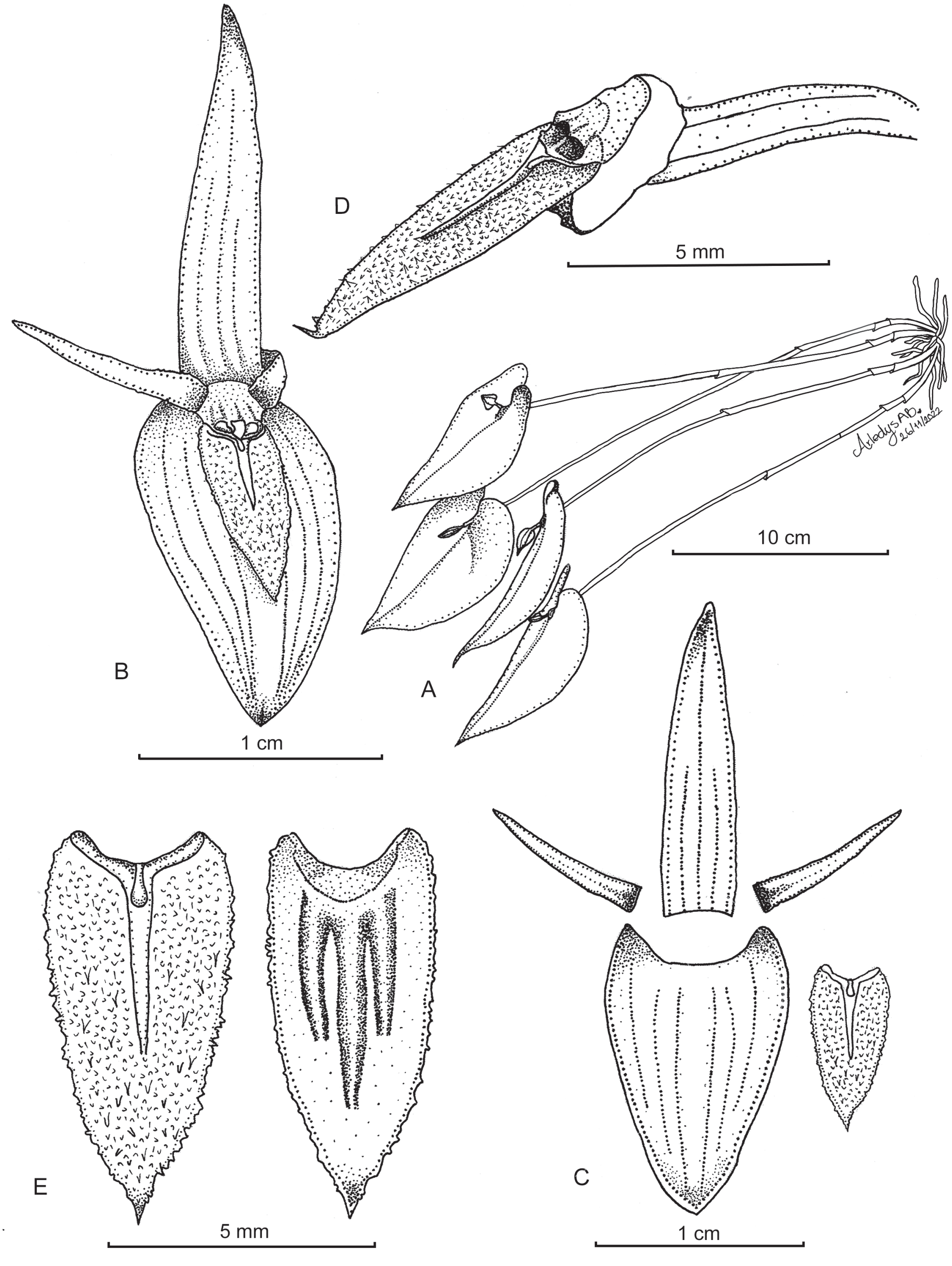

Figure 3. *Pleurothallis petroana* Sierra-Ariza. **A**. Habit. **B**. Flower. **C**. Dissected perianth. **D**. Lip and column, ¾ view. **E**. Lip, adaxial and abaxial views. Illustration by A. Albino Bohorquez, based on the plant that served as the holotype.

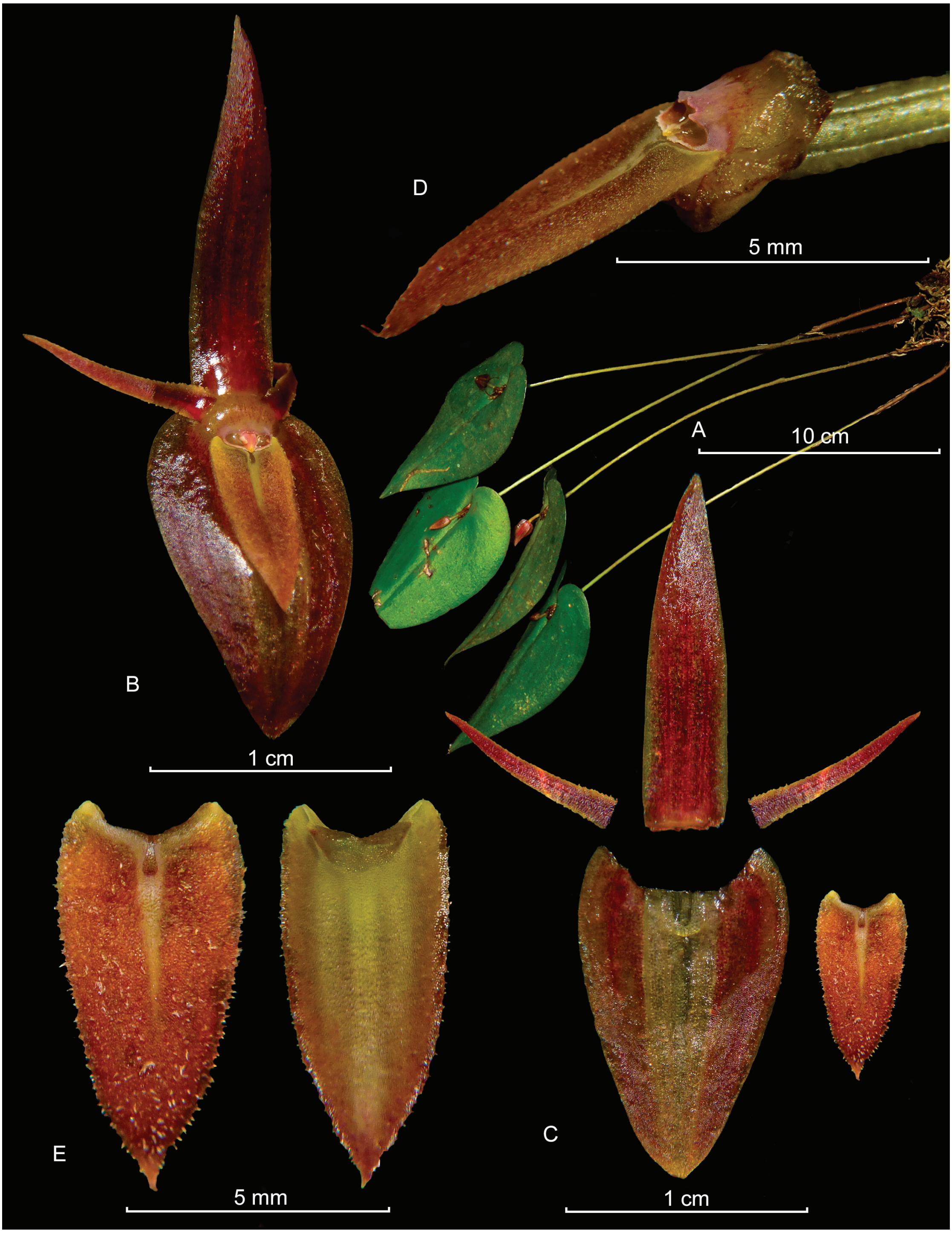

Figure 4. *Pleurothallis petroana* Sierra-Ariza. **A**. Habit. **B**. Flower. **C**. Dissected perianth. **D**. Lip and column, ¾ view. **E**. Lip, adaxial and abaxial views. LCDP by M. A. Sierra-Ariza, based on type.

FIGURE 5. Photographs of the new species *in situ*. **A**. *Pleurothallis franciana*. **B**. *Pleurothallis petroana.* by M. A. Sierra-Ariza.

yellows, fleshy, linear, acuminate, microscopically verrucose-papillose on the dorsal surface, margins irregular, minutely denticulate, 7.8–9.0 × 1.2–1.5 mm, 1-veined. *Lip* yellow-red, fleshy, oblong-lanceolate, acuminate, verrucose-papillose, slightly pilose abaxially, margins irregular, denticulate-ciliate, 7.5–8.6 × 3.4–4.2 mm, 3-veined, the disc with a small, spathulate glenion near the base, the base truncate forming two pronounced lobes, subacute. *Column* light red, short, broad, semiterete, margins irregular, 1.5 × 1.2 mm, with a short, thick; stigma apical, bilobed. *Anther cap* light red, apical, obovate, minutely papillose, 0.6 × 0.5 mm *Pollinia* 2, yellow, obovoid. *Capsule* not seen.

EPONYMY: In honor of Gustavo Francisco Petro Urrego, President of the Republic of Colombia (2022–2026), in commemoration of his political career; winner of the Letelier-Moffitt Human Rights Award (2007); tireless supporter of social causes and interest in caring for the environment and mitigating climate change.

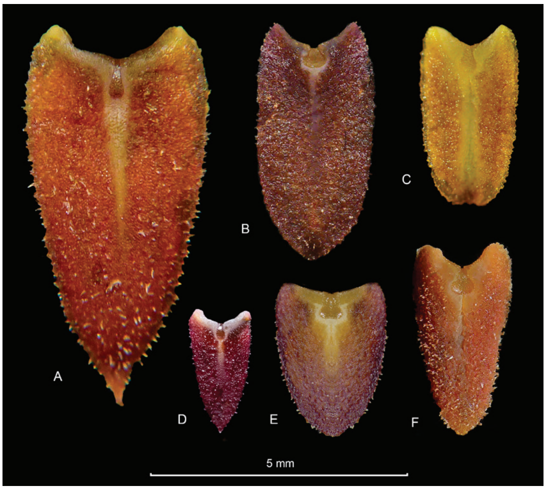

FIGURE 6. Adaxial view of the lip in morphologically similar species of *Pleurothallis*. **A**. *P. petroana*. **B**. *P.* aff *paquishae*. **C**. *P.* aff. *applanata*. **D**. *P. franciana*. **E**. *P. ariana-dayanae*. **F**. *P. scabrilinguis*. Photographs by M. M. Jiménez (B, C, E, F) and M. A. Sierra-Ariza (A, D). Prepared by M. A. Sierra-Ariza.

DISTRIBUTION AND ECOLOGY: *Pleurothallis petroana* was found in a fragment of montane rainforest in the municipality of Villahermosa, Tolima, between 3000 and 3200 m of elevation. It inhabits ecosystems that have been heavily disturbed by the expansion of the agricultural frontier. It grows as epiphytic in small forest fragments, on tree branches among bryophytes and constant shade. It is also a terrestrial on roadside ravines with high solar radiation. It flowered in June and July (Fig. 5).

Discussion. *Pleurothallis petroana* belongs to the "*P. scabrilinguis*" group showing big flowers, up to 3 cm long. It is similar to *P. scabrilinguis*, but it shows larger flowers (*vs*. 1.5 to 2.0 cm long). Also, *Pleurothallis petroana* differs from it by the dorsal sepal oblong-lanceolate, acute, 12–15 × 3.2–4.0 mm (*vs*. elliptic-ovate, subacute to obtuse, 6–10 × 2.5–7.0 mm); the ovate, rounded, synsepal 12.3–14.0 × 8.3–9.0 mm (*vs*. broadly ovate, obtuse, shallowly concave, 5–10 × 4–8 mm); the petals linear, acuminate, 7.2–8.3 × 1.2–1.4 mm (*vs*. narrowly linear-triangular, acute, 3–7 × 0.50–1.25 mm); the lip oblong-lanceolate, acuminate, 7.5–8.2 × 3.0–3.4 mm, verrucose-papillose, slightly pilose (*vs*. triangular, oblong, subacute or rounded, 3–7 × 2–4 mm, papillose) and the spathulate glenion (*vs*. obovate, slightly bilobed).

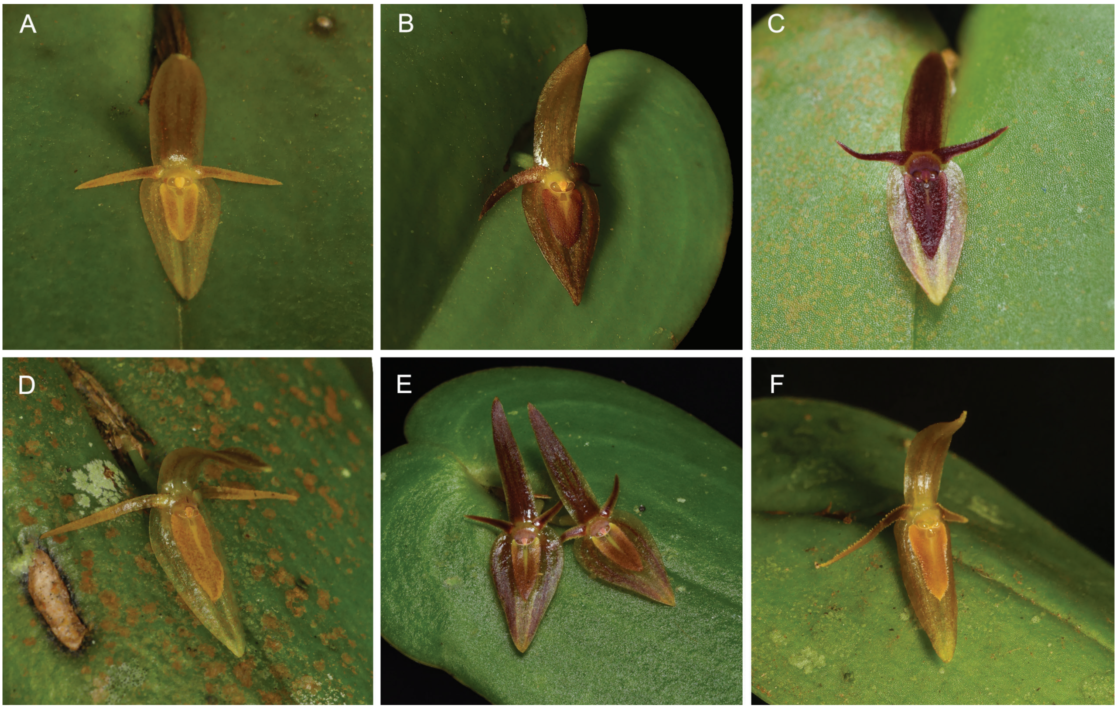

Figure 7. Flower morphology of similar species of *Pleurothallis*. **A**. *P.* aff. *applanata*. **B**. *P. ariana-dayanae*. **C**. *P. franciana*. **D**. *P.* aff. *paquishae*. **E**. *P. petroana*. **F**. *P. scabrilinguis*. Photographs by M. M. Jiménez (A, D, F), L. Vélez-Abarca (B), and M. A. Sierra-Ariza (C, E). Prepared by M. A. Sierra-Ariza.

This species is also similar to *Pleurothallis paquishae* Luer, but it differs in the oblong-lanceolate dorsal sepal, 12–15 × 3.2–4.0 mm (*vs*. narrowly elliptic, 9.5–3.3 mm); the synsepal elliptical, acute to acuminate, 13 × 6 mm (*vs*. ovate acute, 9.4 × 5.6 mm); the petals linear, acuminate, 7.2–8.3 × 1.2–1.4 mm (*vs*. narrowly linear-oblong, acute, 9 × 0.8 mm); the lip oblong-lanceolate, acuminate, 7.5–8.2 × 3.0–3.4 mm, verrucose-papillose, slightly pilose (*vs*. oblong, acute, 6.2 × 2.7 mm, verrucose-spiculated) and the glenion spathulate (*vs*. oblong, slightly bilobed).

Another similar species is *P. applanata*, but *P. petroana* differs by the dorsal sepal oblong-lanceolate, acute, 12–15 × 3.2–4.0 mm (*vs*. narrowly elliptical-ovate, 10.0 × 3.6 mm); the petals linear, acuminate, 7.2–8.3 × 1.2–1.4 mm (*vs*. narrowly linear-triangular, 6.75 × 1.00 mm); the lip oblong-lanceolate, acuminate, 7.5–8.2 × 3.0–3.4 mm, verrucose-papillose, slightly pilose (*vs*. oblong-ovate, obtuse, 4.5 × 2.2 mm cellular-verrucose) and the spathulate glenion (*vs*. orbicular) (Fig. 6–7).

Acknowledgements. I thank Arledys Albino Bohórquez for participating in the field trips where the new species were discovered and for the illustrations. I also thank Mark Wilson and Patricia Harding for their support in writing this manuscript, Leisberth Vélez-Abarca and Marco M. Jiménez for the loan of the photographs used in the comparison figure, and to the staff of TOLI herbarium, Dendrology section of the University of Tolima, for allowing to deposit the type specimens in their collection under the collection permit 2191 of 2018 by the Autoridad Nacional de Licencias Ambientales (ANLA).

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A CHECKLIST TO THE ORCHIDS OF BILIGIRI RANGASWAMY TEMPLE TIGER RESERVE, WESTERN GHATS, INDIA

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Abstract. This paper provides a comprehensive account of the orchid diversity in the Biligiri Rangaswamy Temple Tiger Reserve (BRTTR), Karnataka, India. A total of 97 orchid species belonging to 33 genera were documented. This includes 50 terrestrial and 47 epiphytic orchids, including one mycoheterotrophic orchid, *Epipogium roseum*, and a climbing leafless *Vanilla walkerae*. Additionally, 39 endemic orchids were documented during the study. The evergreen forests provide the most habitable conditions for the orchids in BRTTR. The present study adds 26 species to the orchid flora of BRTTR. About 49% of the orchid flora of Karnataka state and 32% of orchids of Western Ghats is found in BRTTR, making this area a microcenter for orchid diversity.

Keywords / Palabras clave: Biligirirangan, biodiversity hotspot, bosque siempreverde, checklist, diversidad, diversity, evergreen forest, Karnataka, listado, Orchidaceae, punto caliente de biodiversidad, santuario de vida silvestre, wildlife sanctuary

Introduction. During recent decades, the abundance and distribution of many species of plants and animals have declined dramatically, mainly because of habitat loss and fragmentation (Štípková & Kindlmann 2021). Orchids are among them and are considered one of the most threatened groups of plants despite their largest species diversity (Fay 2018). Orchidaceae is the second largest family among flowering plants, with more than 28,000 species worldwide (Christenhusz & Byng 2016), having more diversity in the tropics than in any other region. Orchids are indicators of ecosystem and climate health (Gale *et al.* 2018) because of their interactions with other organisms like fungi for seed germination and insects for pollination (Rasmussen 2002, Swarts & Dixon 2009, Sydes 1994). This makes orchid species highly sensitive to any disturbance in their environmental conditions and climate change. Many of the orchid species are now threatened and considered to be at risk of extinction due to habitat loss, habitat destruction, and indiscriminate collection from the wild for their fascinating flowers and medicinal use (Brummitt *et al*. 2015, Fay 2018, IUCN 2015). These disturbances highly impact their complex mutual ecological relationship with other organisms. Because of its high value, threatened status, and its significant ecological role in the ecosystem, the family is often considered a flagship group in biological conservation. All the wild orchid species are included under the Convention on International Trade in Endangered Species (CITES), and their trade is restricted between countries (Wraith & Pickering 2018).

India is one of the world's recognized mega-diverse countries and home to a rich diversity of orchids. A recent documentation by Botanical Survey of India estimates 1256 orchid species in 155 genera, of which 307 are endemic (Singh *et al*. 2019). These are mainly found in the biodiversity hotspots of India, viz. the Himalayas, Western Ghats, Indo-Burma region and the Sundaland. The present paper focus on the diversity of orchid flora in one of the protected areas in the Western Ghats hotspot. The Biligiri Rangaswamy Temple Tiger Reserve (BRTTR) has been selected for its unique geographic position with diverse climatic conditions that serves as a meeting point for the distinct floristic zones viz., the Western Ghats, the Eastern Ghats and the Tropical montane (Nilgiris) (Ramesh 2002). References to the botanical history of BRTTR hills began with the colonial botanical explorations carried out by C.E.C. Fischer, a forester who was in charge of the south Coimbatore division. Fischer's note on the floristic information covered part of these hills later published by Blatter in 1908 as "Contributions to the flora

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of North Coimbatore". A total of 23 orchid species were reported in that work and is the first document available on the orchids of BRTTR. Later, a chemistry Professor Edward Barnes who had a special interest in plants, visited these hills during 1938 and 1939 and published his findings as "Notes on the flowering plants of the Biligirirangan hills" in 1944. This report included 66 orchid species. While botanizing these hills Barnes stated that this area is remarkably rich in orchid diversity. Later on, R.V. Kammathy, A.S. Rao and R.S. Rao undertook botanical explorations in these hills in 1961 and 1962 which were later published as "A contribution towards a flora of Biligirirangan hills, Mysore state" in 1967. A total of 65 orchid species were documented in that study. Afterwards, R.R. Rao and B.A. Razi explored the flora of the Mysore district and also made collections in BRTTR during the period 1970 to 1972 and published "A synoptic flora of Mysore District" in 1981. This documentation included 56 orchids from BRTTR. B.R. Ramesh studied the Evergreen forests of the Biligirirangan hills from 1984 to 1987 and reported a few orchids, namely *Habenaria* sp., *Geodorum densiflorum* , and *Anoectochilus elatus* as the study was basically on trees and shrubs. Recently, Jayanthi (2017, 2018), while surveying the flora of BRTTR reported *Habenaria sahyadrica* K.M.P.Kumar, Nirmesh, V.B.Sreek & Kumar as a new record for Karnataka and *Vanilla walkeriae* Wight, a rediscovery after a lapse of 110 years from Karnataka. Documentation of species in a particular area provides the baseline information for setting conservation priorities. Hence, this paper aims to present an overview of all orchid species known from BRTTR to date, their identification, distribution within the reserve, and habitat and to facilitate their monitoring, and conservation within BRTTR. This is the first comprehensive documentation exclusively on the orchids of BRTTR.

Materials and methods.

Study area.— The BRTTR (also wildlife sanctuary) is located between 11-13° N and 77-78° E in the Chamarajanagar district of Karnataka state, India (Fig. 1A). It is spreading in five ranges viz., Yelandur, Kollegal, Kyathadevara Gudi (K.Gudi), Bylore, Punajur under three taluks such as Yelandur, Kollegal and Chamarajnagar covering an area of 574.82 sq. km. The BRTTR comprises two main hill ranges running in the north-south direction contiguous with the Sathyamangalam Tiger Reserve in the adjacent Tamil Nadu state. The entire Biligirirangan hill range belongs to one geomorphic unit. These are structurally controlled mountain ranges with steep slopes, valleys and narrow gorges (Basavarajappa & Srikantappa 1996). The elevation varies between 600 to 1825 m. The western hill range includes many hills with an average elevation of 1350 m. The eastern range consists of chain of hills with an average elevation of 1650 m. Kattaribetta is the highest peak reaching 1825 m elevation. The terrain is undulating with a network of valleys and west flowing streams. The hill ranges receive both the South-West monsoon and North-East monsoon rains with an average rainfall of 650 mm (range 600–3000 mm) in the low-lying plateaus, and 1990 mm in the higher elevations. The annual temperature ranges between 18-38° C. Due to its geographical location between western ghats and eastern ghats, and variation in topographical and climatic factors, BRTTR hosts a diversity of habitats within its boundaries including scrub forests, dry and moist deciduous forests, semi-evergreen and evergreen forests and the climax vegetation Sholas at higher elevation (Fig. 1–2). The valleys of hills provide ideal habitat for evergreen forests and few coffee plantations are located in this area. BRTTR is also known for its rich faunal diversity and the habitat for charismatic species like tigers and elephants. It was declared as Tiger Reserve in 2011. It is also home to the Soliga tribes, a forest dwelling indigenous communities of about 2900 families (~12,250 people) living in 63 hamlets in and around the reserve (Lingaraja *et al*. 2017).

Data collection.— Intensive botanical explorations were carried out from 2013 to 2017 across the tiger reserve. All five ranges were visited in every field tour covering all the seasons. Whenever the orchids were encountered in the field, all the macromorphological characters were noted and photographs were taken. Voucher specimens were collected, preserved, and deposited in BSI (Botanical Survey of India, Western Regional Centre, Pune) for future reference. The species found in vegetative condition were brought and grown in the conservatory in Botanical Survey of India, Pune for observation of flowering. The specimens were identified in the field and confirmed in laboratory using regional floras, relevant literature, protologues and

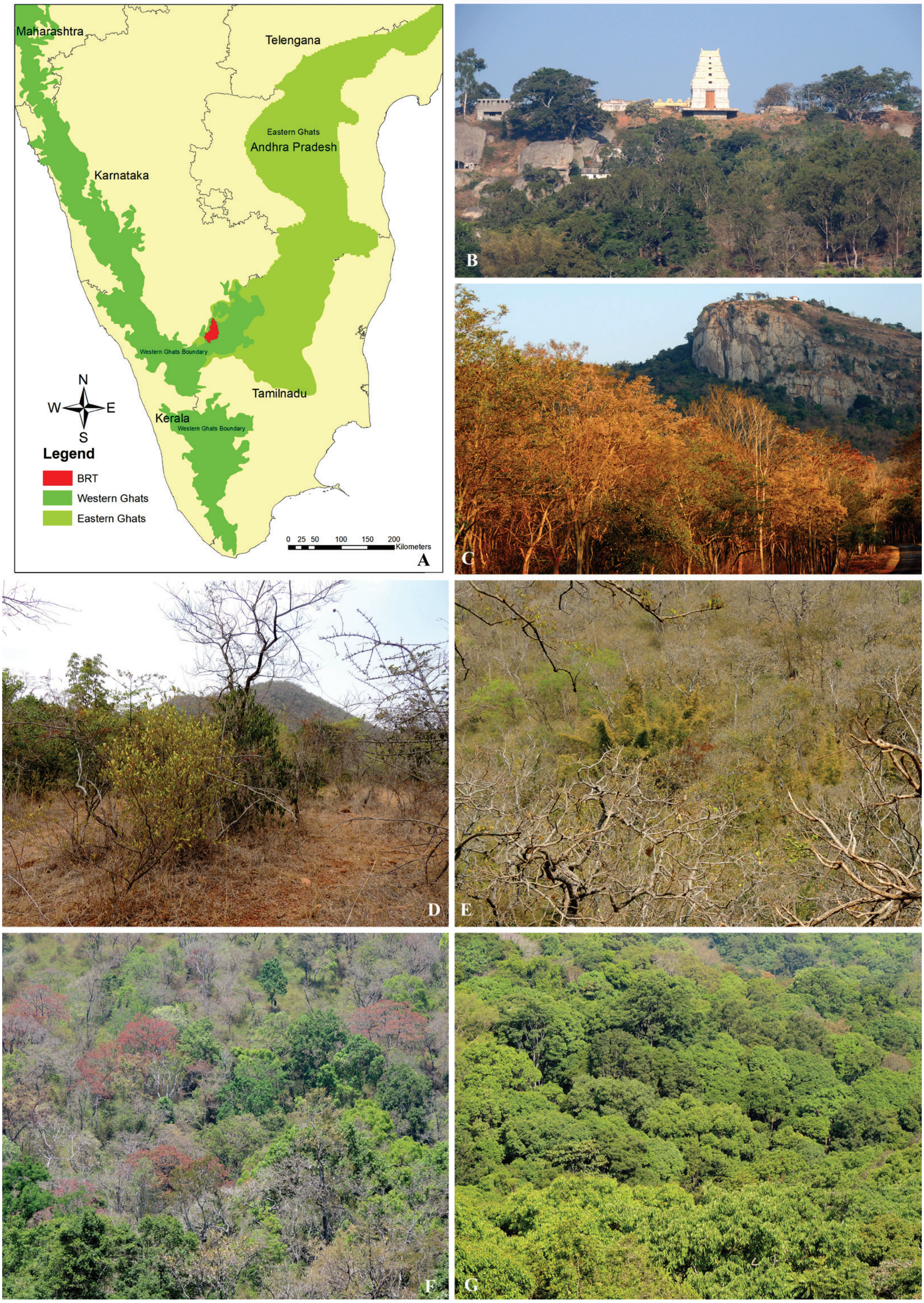

FIGURE 1. **A**. Location of BRTTR. Map by J.S.Jalal. **B–C**. View of Biligirirangan hill. **D**. Scrub Forest. **E**. Dry deciduous forest. **F**. Moist deciduous forest. **G**. Semi-evergreen forest. Photograph by J.Jayanthi.

FIGURE 2. **A**. Evergreen forest. **B, D**. Shola evergreen forest. **C**. Shola grassland. **E**. Luxuriant growth of epiphytic orchids (*Bulbophyllum fuscopurpureum* and *Coelogyne nervosa*). Photograph by J.Jayanthi.

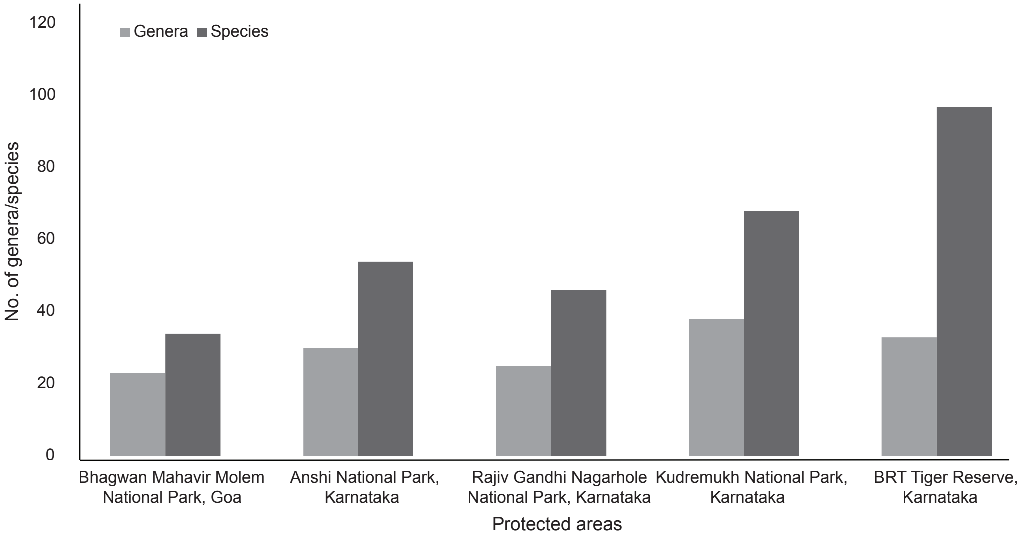

FIGURE 3. A comparison of orchid diversity in different protected areas.

compared with the herbarium specimens, including type specimens (Jalal 2018, Jalal *et al*. 2014, Rao 1998, Rao & Razi 1981, Saldanha 1976). The nomenclature is updated based on online databases such as IPNI (2023), POWO (2023) and the erstwhile World Checklist of Selected Plant Families (WCSP). However, the genus *Eria* Lindl. is followed *sensu lato* for easy identification in the field. Information on the orchid diversity of BRTTR was gathered through a comprehensive literature survey and review and consultation of herbaria (BSI, HIFP, Mysore University herbarium). This is substantiated by the field documentation and has resulted in the preparation of this current status on the orchid diversity of BRTTR. The data is presented in the following format: each genus and species are arranged alphabetically, under which flowering, habit, habitat, distribution within the BRTTR, elevation, specimen number and endemic information are provided. Photographs taken *in situ* as well as plants from there are separately provided. This checklist will be helpful to know the orchid flora of this region, to facilitate their monitoring, and conservation and further contribute to orchid research.

Results and discussion. In the present documentation, a total of 97 orchid species are recorded under 33 genera from BRTTR. Out of the total species, 47 are epiphytic, and 50 are terrestrial, including one mycoheterotrophic orchid; *Epipogium roseum*, and a climbing, leafless orchid; *Vanilla walkerae*. The genus *Habenaria* is the dominant genera with 20 species, followed by *Eria* (10 spp.), *Oberonia* (7 spp.), *Dendrobium* (6 spp.), *Peristylus* (6 spp.) and *Bulbophyllum* (5 spp.). The occurrence of 97 species of orchids in the present study area demonstrates the orchid diversity of this reserve, which contributes to almost 49% of the total orchid flora of Karnataka state. A comparison of orchid diversity in other protected areas based on published literature is also provided (Fig. 3).

Endemic orchids of BRTTR.— A total of 39 endemic orchid species under 13 genera are found in BRTTR. The genus *Habenaria* and *Eria* are the dominant genera having more endemic species. Almost 40% of the orchid species documented in BRTTR are endemic either to Western Ghats, Eastern Ghats, Peninsular India or India. 77% of the endemic orchids in BRTTR are endemic to Western Ghats (Fig. 4) mainly concentrated in high rainfall areas like evergreen and shola forests. In addition, 57% of endemic epiphytic orchids are also found in the high-altitude (above 1200 m) evergreen and shola forests, which makes them very important habitat for conservation. Table 1 provides the list of endemic species.

Orchids and their habitat within BRTTR.— In BRTTR, the orchids are found in different habitats ranging from dry scrub forests at lower elevations (600 m) up to Shola grasslands at higher elevation (1825 m). An

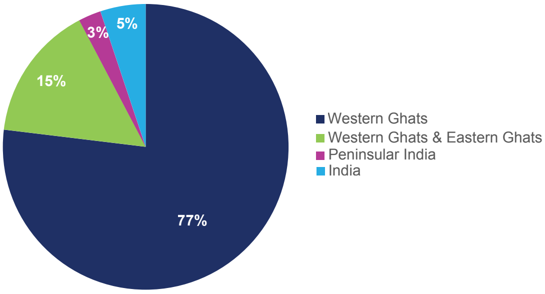

FIGURE 4. Phytogeographical distribution of endemic orchids in BRTTR.

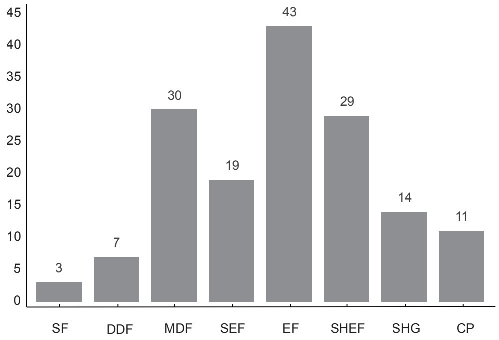

FIGURE 5. Diversity of orchids across various forest types in BRTTR. Scrub forests (SF), Dry deciduous forests (DDF), Moist deciduous forests (MDF), Semievergreen forests (SEF), Evergreen forests (EF), Shola evergreen (SHEF), Shola grassland (SHG), Coffee plantations (CP).

analysis based on the habitat preference shows that moist deciduous, semi-evergreen and evergreen forests provide suitable habitats for several terrestrial and epiphytic orchid assemblages due to the presence of moisture and humidity (Fig. 5). Table 1 provides the diversity of orchids across various habitat types.

Addition of orchids to BRTTR.— During the present study several orchids were reported as new additions to BRTTR. As many as 26 species were added to the orchid flora of BRTTR in the present documentation, including 15 endemic orchids. It is interesting to note that *Habenaria sahyadrica*, was described from Western Ghats of Kerala in 2016. The same was also collected in BRTTR in 2016 showing its extended distribution to Karnataka. Similarly, a climbing leafless orchid *Vanilla walkerae* was reported from the dry scrub thickets of BRTTR after a lapse of 110 years from Karnataka. These reports also emphasize the importance of intensive field explorations and taxonomic studies. Following are the new orchid records for BRTTR. *Coelogyne breviscapa* Lindl., *Dendrobium aqueum* Lindl., *Dendrobium nodosum* Dalzell, *Eria exilis* Hook.f., *Eria microchilos* (Dalzell) Lindl., *Eria mysorensis* Lindl., *Eria pseudoclavicaulis* Blatt., *Eria reticosa* Wight, *Eulophia graminea* Lindl., *Gastrochilus flabelliformis* (Blatt. & McCann) C.J.Saldanha, *Habenaria brachyphylla* (Lindl.) Aitch., *Habenaria crinifera* Lindl., *Habenaria elwesii* Hook.f., *Habenaria furcifera* Lindl., *Habenaria gibsonii* Hook.f., *Habenaria longicornu* Lindl., *Habenaria marginata* Colebr., *Habenaria multicaudata* Sedgw., *Habenaria roxburghii* Nicolson, *Habenaria sahyadrica* K.M.P.Kumar, Nirmesh, V.B.Sreek. & Kumar, *Lusia trichorhiza* (Hook.) Blume, *Oberonia brachystachys* Lindl., *Oberonia chandrasekharanii* V.J.Nair, V.S.Ramach. & R.Ansari, *Oberonia ensiformis* (Sm.) Lindl., *Peristylus plantagineus* (Lindl.) Lindl., and *Vanilla walkerae* Wight.

Diversity of orchid host species.— In BRTTR, several tree species are found to be good phorophytes for epiphytic orchids. Their trunk with rough bark, branches heavily laden with mosses, lichens, and crevices with thin layers of humus form suitable substrata for orchids. These epiphytic orchids are often associated with other epiphytes such as *Hoya pauciflora* Wight, *Aeschynanthus perrottetii* A.DC., ferns, mosses, lichens etc. Some common host trees and shrubs are, *Artocarpus heterophyllus* Lam., *Bischofia javanica* Blume, *Careya arborea* Roxb., *Catunaregam spinosa* (Thunb.) Tirveng., *Celtis tetrandra* Roxb., *Citrus medica* L., *Dalbergia lanceolaria* L.f., *Dalbergia latifolia* Roxb., *Elaeocarpus tuberculatus* Roxb., *Ficus racemosa* L., *Ficus virens* Aiton, *Garuga pinnata* Roxb., *Grevillea robusta* A.Cunn. ex R.Br., *Lagerstroemia parviflora* Roxb., *Machilus glaucescens* (Nees) Wight, *Mangifera indica* L., *Melia azedarach* L., *Meliosma simplicifolia* (Roxb.) Walp., *Meyna laxiflora* Robyns, *Neolitsea zeylanica* (Nees & T.Nees) Merr., *Olea paniculata* R.Br., *Phyllanthus emblica* L., *Platycladus orientalis* (L.) Franco, *Psydrax dicoccos* Gaertn., *Pterocarpus marsupium* Roxb., *Radermachera xylocarpa* (Roxb.) Roxb. ex K.Schum., *Symplocos acuminata* (Blume) Miq., *Syzygium cumini* (L.) Skeels, *Syzygium jambos* (L.) Alston, *Sterculia guttata* Roxb.

Table 1. Orchid diversity in different habitat type. Endemic species*, Scrub forests (SF), Dry deciduous forests (DDF), Moist deciduous forests (MDF), Semievergreen forests (SEF), Evergreen forests (EF), Shola evergreen (SHEF), Shola grassland (SHG), Coffee plantations (CP).

Species	**SF**	**DDF**	**MDF**	**SEF**	**EF**	**SHEF**	**SHG**	**CP**
Aerides ringens (Lindl.) C.E.C.Fisch.			×	×		×		
Anoectochilus elatus Lindl.*					×			
Bulbophyllum fimbriatum (Lindl.) Rchb.f.*			×		×	×		×
Bulbophyllum fischeri Seidenf.					×		×	×
Bulbophyllum fuscopurpureum Wight*					×	×		×
Bulbophyllum kaitiense Rchb.f.*					×	×		
Bulbophyllum proudlockii (King & Pantl.) J.J.Sm.*					×			
Calanthe sylvatica (Thouars) Lindl.					×			
Cheirostylis flabellata (A.Rich.) Wight			×					
Chiloschista fasciata (F.Muell.) Seidenf. & Ormerod				×	×			
Chrysoglossum ornatum Blume					×	×		
Coelogyne breviscapa Lindl.						×		×
Coelogyne nervosa A.Rich.*						×		×
Coelogyne odoratissima Lindl.						×		×
Crepidium intermedium (A.Rich.) Sushil K.Singh, Agrawala & Jalal*						×		
Crepidium versicolor (Lindl.) Sushil K.Singh, Agrawala & Jalal				×		×		
Cymbidium aloifolium (L.) Sw.		×	×		×			
Dendrobium aqueum Lindl.*						×		
Dendrobium heterocarpum Wall. ex Lindl.				×	×	×		
Dendrobium macrostachyum Lindl.		×	×					
Dendrobium nanum Hook.f.*				×	×			
Dendrobium nodosum Dalzell*					×	×		×
Dendrobium nutantiflorum A.D.Hawkes & A.H.Heller						×		
Diplocentrum recurvum Lindl.				×				
Disperis neilgherrensis Wight					×	×		
Epipogium roseum (D.Don) Lindl.				×	×			
Eria braccata (Lindl.) Lindl.					×	×		
Eria exilis Hook.f.*					×	×		
Eria filiformis (Wight) Rchb.f.*					×	×		
Eria microchilos (Dalzell) Lindl.*						×		×
Eria mysorensis Lindl.*				×	×			
Eria nana A.Rich.*					×	×		
Eria pauciflora Wight*					×			
Eria polystachya A.Rich.*				×	×			
Eria pseudoclavicaulis Blatt.*				×	×			×
Eria reticosa Wight*						×		×
Eulophia graminea Lindl.	×							
Eulophia nuda Lindl.			×		×			
Eulophia pratensis Lindl.*							×	

Gastrochilus acaulis (Lindl.) Kuntze						×		
Gastrochilus calceolaris (Buch.-Ham. ex Sm.) D.Don				×	×			
Gastrochilus flabelliformis (Blatt. & McCann) C.J.Saldanha*				×	×			
Geodorum densiflorum (Lam.) Schltr.			×		×			
Habenaria barbata Wight ex Hook.f.		×						
Habenaria brachyphylla (Lindl.) Aitch.*			×					
Habenaria crinifera Lindl.						×		
Habenaria elliptica Wight*					×		×	
Habenaria elwesii Hook.f.*							×	
Habenaria foliosa A.Rich.*					×		×	
Habenaria furcifera Lindl.			×					
Habenaria gibsonii Hook.f.			×					
Habenaria heyneana Lindl.*							×	
Habenaria hollandiana Santapau*		×						
Habenaria longicorniculata J.Graham							×	
Habenaria longicornu Lindl.*			×					
Habenaria marginata Colebr.			×					
Habenaria multicaudata Sedgw.*					×			
Habenaria ovalifolia Wight*			×					
Habenaria perrottetiana A.Rich.*							×	
Habenaria plantaginea Lindl.		×	×					
Habenaria rariflora A.Rich.*							×	
Habenaria roxburghii Nicolson, C.J.Saldanha & D.H.Nicolson	×	×						
Habenaria sahyadrica K.M.P.Kumar, Nirmesh, V.B.Sreek. & Kumar*					×			
Liparis atropurpurea Lindl.					×			
Liparis deflexa Hook.f.			×					
Liparis odorata (Willd.) Lindl.				×				
Liparis platyphylla Ridl.*			×					
Liparis wightiana Thwaites			×					
Luisia tenuifolia Blume			×					
Luisia trichorhiza (Hook.) Blume			×	×				
Luisia zeylanica Lindl.			×					
Nervilia concolor (Blume) Schltr.			×					
Nervilia plicata (Andrews) Schltr.			×					
Nervilia simplex (Thouars) Schltr.			×					
Oberonia brachystachys Lindl.					×			
Oberonia brunoniana Wight				×	×			
Oberonia chandrasekharanii V.J.Nair, V.S.Ramach. & R.Ansari*				×	×			
Oberonia ensiformis (Sm.) Lindl.			×	×	×			
Oberonia mucronata (D.Don) Ormerod & Seidenf.			×		×	×		
Oberonia verticillata Wight*				×	×			
Oberonia wightiana Lindl.					×			
Papilionanthe cylindrica (Lindl.) Seidenf.					×	×		

Pecteilis gigantea (Sm.) Raf.							×	
Peristylus aristatus Lindl.					×			
Peristylus caranjensis (Dalzell) Ormerod & C.S.Kumar*							×	
Peristylus densus (Lindl.) Santapau & Kapadia							×	
Peristylus goodyeroides (D.Don) Lindl.			×					
Peristylus plantagineus (Lindl.) Lindl.			×					
Peristylus spiralis A.Rich.							×	
Polystachya concreta (Jacq.) Garay & H.R.Sweet			×	×		×		
Satyrium nepalense D.Don							×	
Schoenorchis jerdoniana (Wight) Garay*					×	×		
Schoenorchis smeeana (Rchb.f.) Jalal, Jayanthi & Schuit.*					×	×		×
Trichoglottis tenera (Lindl.) Rchb.f.						×		
Vanda testacea (Lindl.) Rchb.f.		×	×					
Vanilla walkerae Wight	×							
Zeuxine longilabris (Lindl.) Trimen			×					

ex DC., *Sterculia urens* Roxb., *Terminalia anogeissiana* Gere & Boatwr, *Terminalia bellirica* (Gaertn.) Roxb., *Terminalia chebula* Retz., *Terminalia elliptica* Willd., *Tetrapilus dioicus* (Roxb.) L.A.S.Johnson and *Wendlandia thyrsoidea* (Roth) Steud.

Threats and conservation.— The flora of the BRTTR resembles the one of the Western Ghats. Barnes (1944) stated that the "valleys between the two ridges are largely filled by dense evergreen forests. Apart from the five not very large coffee plantations the hills are almost uninhabited and much of the area remains virgin". Coffee plantations in BRTTR was introduced by Morris in 1877. About 800 hectares of evergreen forests were converted into coffee plantations (Ramesh 2002). Apart from that, a considerable area of forests was cleared for the cultivation of *Eucalyptus* L'Hér and teak (Kammathy, 1967) before the notification of this area as BRT wildlife sanctuary in 1974. The area is in a state of delicate equilibrium with the climatic conditions, which makes it more vulnerable to any disturbance (Ramesh 2002). The semi-evergreen and evergreen and shola forests are severely restricted by the coffee plantations. Despite that, it has been observed that many of the coffee plantations harbour numerous orchids and the trees are fully laden with plants. When the trees are either pruned or felled by means of anthropogenic activities or fallen due to natural causes will result in a complete wipe out of the orchid population. Even removing a single tree will threaten the life of hundreds of plants and possibly an entire population. The lack of any rehabilitation program in such cases will endanger the habitat of those orchids. Hence, the cutting of trees in coffee plantations should be stopped or monitored critically. Those host trees with orchid populations should be geotagged for protection and long-term monitoring.

Dry deciduous forests are the predominant forest type found in BRTTR. Dry deciduous forests are prone to forest fires frequently (Verma *et al*. 2017). Hence, forest fires in some areas of BRTTR also cause damage to the trees as well as epiphytic orchid populations. In addition, routine activities such as repairing main roads and internal mud roads trample the orchids such as *Crepidium versicolor* (Lindl.) Sushil K.Singh, Agrawala & Jalal, *Disperis neilgherrensis* Wight, *Habenaria roxburghii* Nicolson, *Habenaria plantaginea* Lindl. and attempts should be made to rehabilitate them in the nearby undisturbed areas within the vicinity. Climate change is another alarm for the evergreen forests and orchids which are mainly dependent on the moisture as one of the factors. Any changes or decline in the rainfall pattern may increase the dry period, which will eventually affect the threshold of the evergreen forests and ultimately the orchid populations.
The diversity of orchids, including the endemic species is more in the high rainfall areas, higher elevations and valleys of evergreen forests such as Attikan, Honnemetti, Jodigere, Kattari betta, Bellaji betta, Akka thange betta, Devakere betta, Bedguli, Doddasampige and also in the coffee plantations. These areas have to be highly

protected and periodically monitored. This is because less than 10% of the total area of BRTTR comprises evergreen and shola forests. Hence, these forests should be given the top most priority within BRTTR. These are some of the orchid species which should be given immediate attention such as *Bulbophyllum fuscopurpureum*, *Bulbophyllum fischeri* Seidenf., *Coelogyne spp.*, *Dendrobium aqueum*, *Anoectochilus elatus*, *Schoenorchis smeeana*, *and Papilionanthe cylindrica* (Lindl.) Seidenf.. Unless strict measures are taken to prevent any threat to these species, the orchid species may gradually disappear. Some orchids documented earlier by Barnes could not be relocated in the present study which includes *Chiloschista fasciata* (F.Muell.) Seidenf. & Ormerod, *Chrysoglossum ornatum* Blume, *Crepidium intermedium* (A.Rich.) Sushil K.Singh, Agrawala & Jalal, *Dendrobium nutantiflorum* A.D. Hawkes & A.H.Heller, *Eulophia pratensis* Lindl., *Habenaria barbata* Wight ex Hook.f., *Liparis atropurpurea* Lindl., *Liparis platyphylla*, *Liparis wightiana* Thwaites, *Pecteilis gigantea* (Sm.) Raf., *Peristylus goodyeroides* (D.Don) Lindl., *Peristylus spiralis* A. Rich., *Peristylus caranjensis* (Dalzell) Ormerod & C.S.Kumar, *Schoenorchis jerdoniana*. Of these the habitats of terrestrial orchids are encroached upon by invasive alien species such as *Lantana camara* L. and *Ageratina adenophora* (Spreng.) R.M.King & H.Rob.

This study identifies BRTTR as an important region for orchid diversity as it is nestled between the Western Ghats, Eastern Ghats, and the Nilgiri Biosphere reserve. Due to its geomorphic features and monsoonal climate, the BRTTR offers macroclimatic and microclimatic conditions with varied habitats providing favorable niches for the orchids. About 49% of the orchid flora of Karnataka state and 32% of orchids of Western Ghats is found in BRTTR. Hence, BRTTR should be designated as one of the microcenters for orchid diversity along the Western Ghats hotspot for orchid conservation.

Checklist to the orchids of the Biligiri Rangaswamy Temple Tiger Reserve, India

Aerides Lour.

Aerides ringens (Lindl.) C.E.C.Fisch. in Gamble, Fl. Madras 1442. 1928; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967. BASIONYM: *Saccolabium ringens* Lindl., Gen. Sp. Orchid. Pl.: 220. 1833. Fig. 6A.

TYPE: India, Madras, *Wallich 7313* (leg. Wight s.n.) (holotype, K-WALL; isotype, IC-LINDL, icon.).

Flowering: July.

Habit and habitat: Epiphyte. On trunks and branches of trees, shrubs in moist deciduous forests to evergreen forests. Scatterdly occuring.

Distribution: Nellikathir, Avinmula, B.R. Hills, Attikan, K. Gudi.1000–1600 m.

Specimens examined: *J.Jayanthi 194449 & 194547* (BSI).

Anoectochilus Blume

Anoectochilus elatus Lindl., J. Proc. Linn. Soc., Bot. 1: 178. 1857; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967. Fig. 6B.

TYPE: India, Tamil Nadu, Otacamund, Wallaghaut, Jan.-May, *Mclvor 59* (holotype, K-LINDL; isotype, K).

Flowering: December.

Habit and habitat: Terrestrial. Along slopes and shady places of streamsides in evergreen forests. Often covered under the invasive plants such as *Ageratina adenophora* (Spreng.) R.M.King & H.Rob. which could be a potential threat to its habitat within the reserve.

Distribution: Honnemetti, Burude bungalow road. 1350–1500 m. Endemic.

Specimens examined: *J.Jayanthi 195959* (BSI), *B.R.Ramesh 1520* (HIFP).

Bulbophyllum Thouars

Bulbophyllum fimbriatum (Lindl.) Rchb.f., Ann. Bot. Syst. (Walpers) 6(2): 260. 1861. BASIONYM: *Cirrhopetalum fimbriatum* Lindl., Edwards's Bot. Reg. 25(Misc.): 72. 1839; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 591. 1981. Fig. 6C.

TYPE: India, Bombay, cult. *Loddiges s.n.* (holotype, K-LINDL).

Flowering: March–May.

Habit and habitat: Epiphyte. On the moss-covered tree trunks and branches of trees in moist deciduous forests, evergreen forests, coffee plantations and shola forests. Also found on the rocky boulders on the slopes of shola grassland.

Distribution: Devakere, Honnemetti, Moskal. 1200–1500 m. Endemic.

Specimens examined: *J.Jayanthi 197448* (BSI).

Bulbophyllum fischeri Seidenf., Dansk Bot. Ark. 29(1): 202. 1974. *Cirrhopetalum gamblei* Hook.f., Fl. Brit. India 5(16): 778. 1890; E. Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967. Fig. 6D.

TYPE: India, Nilgiri Hills, Conoor, alt. 6000 ft, Nov. 1883, *J. S. Gamble s.n.* (holotype, K; isotype, CAL).

Flowering: May–June.

Habit and habitat: Epiphyte. On the branches of trees in evergreen forests, coffee plantations and rocky boulders in shola grassland slopes.

Distribution: Attikan, Dupabare, Honnemetti, Moskal. 1400–1500 m

Specimens examined: *J.Jayanthi 195961 & 195744* (BSI).

Bulbophyllum fuscopurpureum Wight, Icon. Pl. Ind. Orient. 5: t. 1651. 1851; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 591. 1981. Fig. 6E.

SYNTYPES: India, Nilgiri Hills, on the banks of Kartairy river below Kaiti, Feb. 1850, also below Neddawuttim on the north-eastern slopes, *Wight s.n.* (syntypes, K [“Neelgherry Hill”].

Flowering: February–April.

Habit and habitat: Epiphyte. On the moss-covered tree trunks and branches in evergreen forests, coffee plantations and shola forests.

Distribution: Attikan, Bedguli, Bellaji, Honnemetti, Kattaribetta. 1400–1800 m. Endemic.

Specimens examined: *J.Jayanthi 197450* (BSI), *B.R.Ramesh 1564* (HIFP), *R.R.Rao 1792* (MU).

Bulbophyllum kaitiense Rchb.f., W.G.Walpers, Ann. Bot. Syst. 6: 262. 1861. *Cirrhopetalum nilgherrense* Wight, Icon. Pl. Ind. Orient. 6: t. 1654. 1853; R.R.Rao & Razi, Synop. Fl. Mysore District: 592. 1981. Fig. 12A.

TYPE: India, Kartairy [River] below Kaitie, *Wight s.n.* (holotype, K)

Flowering: June–October.

Habit and habitat: Epiphyte. On trees and branches of evergreen forests.

Distribution: Attikan. 1400–1600 m. Endemic.

Specimens examined: *R.R. Rao 1039* (MU).

Bulbophyllum proudlockii (King & Pantl.) J.J.Sm., Bull. Jard. Bot. Buitenzorg ser. 2, 8: 27. 1912.

BASIONYM: *Cirrhopetalum proudlockii* King & Pantl., J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 66: 588. 1897; E. Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R. Rao & Razi, Synop. Fl. Mysore District: 592. 1981.

TYPE: India, Tamil Nadu, Nilgiri Hills, Otacamund, Apr. 1897, *R. L. Proudlock s.n.* (holotype, CAL; isotype, K, L, W).

Flowering: April–May.

Habit and habitat: Epiphyte. On trees and branches of evergreen forests.

Distribution: Moskal, Bedguli. Endemic.

Specimens examined: *A.S.Rao 79899* (BSI). The specimen could not be traced.

Calanthe R.Br.

Calanthe sylvatica (Thouars) Lindl., Gen. Sp. Orchid. Pl.: 250. 1833. Fig. 6F.

BASIONYM: *Centrosis sylvatica* Thouars, Hist. Orchid.: t. 35. 1822.

TYPE: Mascarene Islands, *Thouars s.n.* [holotype, P] *Calanthe masuca* (D.Don) Lindl., Gen. Sp. Orchid. Pl.: 249. 1833; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967. *Bletia masuca* D.Don, Prodr. FI. Nepal.: 30. 1825.

TYPE: Nepal, Bagmati Zone, Narain-hetty, 21 Feb. 1803, *Buchanan-Hamilton s.n.* (holotype, BM; isotype, LINN).

Flowering: September–October.

Habit and habitat: Terrestrial. Along the streamsides and slopes of valleys in evergreen to shola forests with rich humus ground.

Distribution: Doddasampige, Honnemetti. 1300–1600 m.

Specimens examined: *J.Jayanthi 194736* (BSI).

Cheirostylis Blume

Cheirostylis flabellata (A.Rich.) Wight, Icon. Pl. Ind. Orient. 5: 16. 1851; R.R.Rao & Razi, Synop. Fl. Mysore District: 591. 1981. Fig. 6G.

BASIONYM: *Goodyera flabellata* A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 79. 1841.

TYPE: India, Nilgiri Hills, Kaity, May-June, *Perrottet s.n.* (holotype, P)

Flowering: December–March.

Habit and habitat: Terrestrial. Occurs in evergreen forests and degraded forests along grassy hill slopes, under shade of *Lantana camara* thickets.

Distribution: Attikan, Gummane betta. 1200–1300 m.

Specimens examined: *J.Jayanthi 206563* (BSI), *R.R.Rao 1202* (MU).

Chilochista Lindl.

Chiloschista fasciata (F.Muell.) Seidenf. & Ormerod, Opera Bot. 124: 64. 1995. BASIONYM: *Sarcochilus fasciatus* F.Muell., Fragm. 5: 202. 1866.

TYPE: Icon. PI. Ind. Orient. [Wight] 5(1): t. 1741. 1851 (right hand figure, iconotype).

sensu *Chilochista pusilla* (Willd.) Schltr., Repert. Spec. Nov. Regni Veg. Beih. 4: 275. 1919; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967.

Taeniophyllum pusillum auct. non (Willd.) Seidenf. & Ormerod in Seidenf., Descr. Epidendrorum J.G.König: 23. 1995.

Flowering: April–May.

Habit and habitat: Epiphyte. Occurs in Shola evergreen forests.

Distribution: Dupabare, Bedguli. 1300–1500 m.

Note: Included based on Barnes report.

Chrysoglossum Blume

Chrysoglossum ornatum Blume, Bijdr. Fl. Ned. Ind.: 338. 1825.

TYPE: Indonesia, Java, Mt. Salak, *Blume 295* (holotype, L).

Chrysoglossum maculatum (Thwaites) Hook.f., Fl. Brit. India 5: 784. 1890; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 591. 1981.

Tainia maculata (Thwaites) Hook, f., FI. Brit. India [J. D. Hooker] 5(16): 821. 1890.

TYPE: Sri Lanka, Hapootelle, *Thwaites s.n.* [Ceylon Plants 3515].

Flowering: May–June.

Habit and habitat: Terrestrial. Occurs in evergreen and shola forests.

Distribution: Honnemetti. 1600–1700 m.

Note: Included based on Barnes report.

Coelogyne Lindl.

Coelogyne breviscapa Lindl., Fol. Orchid. 5: 4. 1854.

TYPE: Sri Lanka, *Walker s.n.* (holotype, K-LINDL). Fig. 6H.

Flowering: March–April.

Habit and habitat: Epiphyte. Occurs in the trees of shola forests and coffee plantations.

Distribution: Honnemetti. 1600–1800 m.

Specimens examined: *J.Jayanthi 197478* (BSI).

Coelogyne nervosa A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 16. 1841; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 592. 1981. Fig. 6I.

SYNTYPES: India, Nilgiri Hills, Neddoubetta, July 1840, *Perrottet s.n*, [522 & 868] (syntypes, P)

Flowering: August–September.

Habit and habitat: Epiphyte. Occurs in the trees of shola forests and coffee plantations, also found in abundance in the rocky boulders and cliffs of grassy hill tops.

Distribution: Honnemetti, Doddamalki, K.Gudi. 1400–1700 m. Endemic.

Specimens examined: *J.Jayanthi 195769* (BSI), *R.R. Rao 1794*, *1592* (MU).

Coelogyne odoratissima Lindl., Gen. Sp. Orchid. Pl.: 41. 1830; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 592. 1981. Fig. 6J.

TYPE: Sri Lanka, Nuera Elba, *Wallich 1960* (leg. Macrae 14, 1829) (holotype, K-LINDL; isotype, K-WALL).

Flowering: March–April.

FIGURE 6. **A**. *Aerides ringens*. **B**. *Anoectochilus elatus*. **C**. *Bulbophyllum fimbriatum*. **D**. *Bulbophyllum fischeri*. **E**. *Bulbophyllum fuscopurpureum*. **F**. *Calanthe sylvatica*. **G**. *Cheirostylis flabellata*. **H**. *Coelogyne breviscapa*. **I**. *Coelogyne nervosa*. **J**. *Coelogyne odoratissima*. **K**. *Crepidium versicolor*. **L**. *Cymbidium aloifolium*. Photograph by J.Jayanthi.

HABIT AND HABITAT: Epiphyte. Occurs in the trees of shola forests and coffee plantations.

DISTRIBUTION: Dupabare, Honnemetti. 1600–1800 m.

SPECIMENS EXAMINED: *J.Jayanthi 197479* (BSI).

CREPIDIUM Blume

Crepidium intermedium (A.Rich.) Sushil K.Singh, Agrawala & Jalal, Orchids India: 172. 2019.

BASIONYM: *Liparis intermedia* A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 17. 1841.

Malaxis intermedia (A.Rich.) Seidenf., Bot. Tidsskr. 73: 99. 1978.

TYPE: India, Nilgiri Hills, Waterfall (“Water-Fat”) not far from Kaiti, *Perrottet s.n.* (lectotype, W, designated by Margoriska, 2012; isotype, G).

Microstylis stocksii Hook.f., Hooker’s Icon. Pl. 19: t. 1833. 1889; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967.

TYPE: India, Deccan Peninsula, Canara, Bababoodan [Baba Budan] Hills, *J. E. Stocks s.n.* (lectotype, K, designated by Margoriska, 2012; isotype, BM, C, FI, G, K, L, P, W).

FLOWERING: June–September.

HABIT AND HABITAT: Terrestrial. Occurs in shola forests.

DISTRIBUTION: Dupabare. 1600–1700 m. Endemic.

NOTE: Included based on Barnes (1994).

Crepidium versicolor (Lindl.) Sushil K.Singh, Agrawala & Jalal, Orchids Maharashtra: 57. 2018.

BASIONYM: *Microstylis versicolor* Lindl., Gen. Sp. Orchid. Pl.: 21. 1830; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944. Fig. 6K.

Malaxis versicolor (Lindl.) Abeyw., Ceylon J. Sci., Biol. Sci. 2: 83. 1959; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

TYPE: Sri Lanka, *Macrae s.n.* [2] (lectotype, K-LINDL, designated by Jayaweera, 1981; isotype, K, K-LINDL, LE, NY, SING).

FLOWERING: September–October.

HABIT AND HABITAT: Terrestrial. Occurs in semievergreen forests and shola forests.

DISTRIBUTION: Attikan, Bellaji. 1400–1700 m.

SPECIMENS EXAMINED: *J.Jayanthi 194748* (BSI), *R.R. Rao 1053* (MU).

CYMBIDIUM Sw.

Cymbidium aloifolium (L.) Sw., Nova Acta Regiae Soc. Sci. Upsal. 6: 73. 1799; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 592. 1981. Fig. 6L.

BASIONYM: *Epidendrum aloifolium* L., Sp. Pl.: 953. 1753.

TYPE: India, Malabar, icon. “Kansjiram-maravara” in Rheede, Hort. Malab. 12:17, t. 8.1692 (lectotype, designated by Seth, 1982).

FLOWERING: October–November.

HABIT AND HABITAT: Epiphyte. Occurs on trees of dry deciduous to moist deciduous and evergreen forests.

DISTRIBUTION: Burude. 1200–1600 m.

SPECIMENS EXAMINED: *J.Jayanthi 207146* (BSI).

DENDROBIUM Sw.

Dendrobium aqueum Lindl., Edwards‘s Bot. Reg. 29(Misc.): 5. 1843. Fig. 7A.

TYPE: India, Bombay, cult. Loddiges s.n, (not found).

FLOWERING: September–October.

HABIT AND HABITAT: Epiphyte. Occurs in the stunted trees of shola evergreen forests.

DISTRIBUTION: Attikan. 1400–1600 m. Endemic.

SPECIMENS EXAMINED: *J.Jayanthi 207149* (BSI).

Dendrobium heterocarpum Wall. ex Lindl., Gen. Sp. Orchid. Pl.: 78. 1830; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 592. 1981. Fig. 7B.

TYPE: Nepal, *Wallich s.n.* (holotype, K-LINDL).

FLOWERING: December–April.

HABIT AND HABITAT: Epiphyte. Occurs on the moss-covered trees of semievergreen, evergreen and shola forests.

DISTRIBUTION: Aneyeratha betta, Attikan, Devakere, Honnemetti, Kattari betta. 1400–1800 m.

SPECIMENS EXAMINED: *J.Jayanthi 197474* (BSI), *R.R. Rao 1233* (MU).

Dendrobium macrostachyum Lindl., Gen. Sp. Orchid. Pl.: 78. 1830; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 592. 1981. Fig. 7C.

TYPE: Sri Lanka, *Macrae s.n.* [17] (holotype, K-LINDL).

Flowering: May–June.

Habit and habitat: Epiphyte. Occurs in the trees of dry deciduous to moist deciduous forests.

Distribution: Burude, Dhumanegathe, K.Gudi, Moskal, MPCA, Seematti. 900–1300 m.

Specimens examined: *J.Jayanthi 195966 & 195730* (BSI).

Dendrobium nanum Hook.f., Hooker's Icon. Pl. 19: t. 1853. 1889; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 592. 1981. Fig. 7D.

TYPE: India, Malabar, Bababoodan [Baba Budan] Hills, *J. S. Law s.n.* (holotype, K; isotype, CAL)

Flowering: June–September.

Habit and habitat: Epiphyte. Occurs on the trees and branches of semievergreen and evergreen forests.

Distribution: Attikan, Bellaji, Nellikathir, Avinmula. 1100–1400 m. Endemic.

Specimens examined: *J.Jayanthi 194450* (BSI), *R.R.Rao 1269*.

Dendrobium nodosum Dalzell, Hooker's J. Bot. Kew Gard. Misc. 4: 292. 1852. *Desmotrichum nodosum* (Dalzell) Tang & F. T. Wang, Acta Phytotax. Sin. 1: 83. 1951. *Flickingeria nodosa* (Dalzell) Seidenf., Dansk Bot. Ark. 34(1): 41. 1980. Fig. 7E.

TYPE: India, Deccan, Ram Ghat, *J. E. Stocks 30* (holotype, K; isotype, K-LINDL).

Flowering: September.

Habit and habitat: Epiphyte. Occurs in the trees of evergreen, shola forests and coffee plantations.

Distribution: Akkatange betta, Attikan, Bellaji. 1400–1500 m. Endemic.

Specimens examined: *J.Jayanthi 207134* (BSI).

Dendrobium nutantiflorum A.D.Hawkes & A.H.Heller, Lloydia 20: 122. 1957. *Dendrobium nutans* Lindl., Gen. Sp. Orchid. Pl.: 90. 1830; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981.

TYPE: Sri Lanka, Peradeniya, *Macrae s.n.* (holotype, K-LINDL).

Flowering: April–May.

Habit and habitat: Epiphyte. Occurs in the trees of Shola evergreen forests.

Distribution: Dupabare. 1600–1700 m.

Note: Included based on Barnes report. Probably must have been eradicated with the clearing of forests in that region (Rao & Razi 1981). Could not be located during the present field study also.

Diplocentrum Lindl.

Diplocentrum recurvum Lindl., Edwards's Bot. Reg. 18: t. 1522. 1832; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981. Fig. 7F.

TYPE: India, *Wallich 7331* (leg. Heyne) (holotype, K-WALL).

Flowering: May–June (in fruits upto December).

Habit and habitat: Epiphyte or lithophyte. Occurs in the trees and large shrubs of semievergreen forests, at times in rocky boulders.

Distribution: Biligirirangan temple area, Ittuboodhi kanive, Devagiribetta, Jenumane ella, 1200–1400 m.

Specimens examined: *J.Jayanthi 195952 & 195767* (BSI), *R.S.Rao 73770* (BSI), *A.S.Rao 80436* (BSI).

Note: Population of this species around Biligirirangan temple area are not located in the present study. Probably could have been diminished due to anthropogenic activities.

Disperis Sw.

Disperis neilgherrensis Wight, Icon. Pl. Ind. Orient. 5: t. 1719. 1851; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981. Fig. 7G.

TYPE: India, Nilgiri Hills, July-Aug., *Wight s.n.* [173] (lectotype, K, designated by Kurzweil 2005 as Wight 3018).

Flowering: May–June & November–December.

Habit and habitat: Terrestrial. Occurs along the shady vertical slopes and near streamsides of evergreen forests and shola forests, completely covered by the ground vegetation and grasses.

Distribution: Doddasampige, Bellaji. 1200–1600 m.

Specimens examined: *J.Jayanthi 195979* (BSI).

Note: After Barnes, this species was collected during the present study after a lapse of 80 years in BRTTR.

Epipogium J.G.Gmel. ex Borkh.

Epipogium roseum (D.Don) Lindl., J. Proc. Linn. Soc., Bot. 1: 177. 1857; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981. BASIONYM: *Limodorum roseum* D.Don, Prodr. Fl. Nepal.: 30. 1825. Fig. 7H.

TYPE: Nepal, 1818, *Wallich s.n.* (holotype, BM).

Epipogium nutans (Blume) Rchb.f., Bonplandia (Hannover) 5: 36. 1857; E. Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944.

TYPE: Indonesia, Java, Mt. Salak, *Blume s.n.* (holotype,? L [Blume 723]).

Flowering: March–June.

Habit and habitat: Terrestrial. Occurs in the dense shady humus rich areas of semievergreen and evergreen forests.

Distribution: Ittuboodhikanive, Chikkasampige. 1200–1300 m.

Specimens examined: *J.Jayanthi 195737 & 197431* (BSI).

Note: After Barnes, this species was collected during the present study after a lapse of 80 years from BRTTR.

Eria Lindl.

Note: Morphologically the genus *Eria* is very heterogeneous group and divided into various genera by many workers. The morphological characters are overlapping and not well defined. So, for easy identification in the field, we are treating all the species under the genus *Eria* in the broad sense.

Eria braccata (Lindl.) Lindl., J. Proc. Linn. Soc., Bot. 3: 46. 1858; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981. Fig. 12B.

BASIONYM: *Dendrobium braccatum* Lindl., Gen. Sp. Orchid. Pl.: 75. 1830.

Porpax braccata (Lindl.) Schuit., Y.P.Ng & H.A.Pedersen, Bot. J. Linn. Soc. 186: 199. 2018.

TYPE: Sri Lanka, *Macrae 53* (holotype, K-LINDL)

Flowering: June–August.

Habit and habitat: Epiphyte. Occurs on the trunks and branches of trees of evergreen and shola forests.

Distribution: Attikan, Honnemetti.

Specimens examined: *Rao 1042* (MU).

Note: Once a common species, now become a rare sight.

Eria exilis Hook.f., Fl. Brit. India 5(16): 788. 1890. Fig. 7I.

Porpax exilis (Hook.f.) Schuit., Y.P.Ng & H.A.Pedersen, Bot. J. Linn. Soc. 186: 199. 2018.

TYPE: India, Travancore, *Johnson s.n.* (holotype, K).

Flowering: August–September.

Habit and habitat: Epiphyte. Occurs in the trees and branches of evergreen and shola forests.

Distribution: Gombegallu. 1200–1300 m. Endemic.

Specimens examined: *J.Jayanthi 202964* (BSI).

Eria filiformis (Wight) Rchb.f., W.G.Walpers, Ann. Bot. Syst. 6: 268. 1861. Fig. 7J.

BASIONYM: *Dendrobium filiforme* Wight, Icon. Pl. Ind. Orient. 5: t. 1642. 1851.

Eria dalzellii (Hook. ex Dalzell) Lindl., J. Proc. Linn. Soc., Bot. 3: 47. 1858; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981.

Porpax filiformis (Wight) Schuit., Y.P.Ng & H.A.Pedersen, Bot. J. Linn. Soc. 186: 199. 2018.

TYPE: India, Tamil Nadu, Nilgiri & Iyamally Hills near Coimbatore, *Wight s.n.* (syntype, IC); without locality, *J.S. Law s.n.* (syntype, K).

Flowering: August–October.

Habit and habitat: Epiphyte. Occurs in the moss-covered trunks and branches of trees in evergreen and shola forests.

Distribution: Attikan, Doddasampige. Endemic.

Specimens examined: *J.Jayanthi 207130* (BSI).

Note: After Barnes, this species was collected during the present study in BRTTR after a lapse of 80 years.

Eria microchilos (Dalzell) Lindl., J. Proc. Linn. Soc., Bot. 3: 47. 1858. Fig. 7K.

BASIONYM: *Dendrobium microchilos* Dalzell, Hooker‘s J. Bot. Kew Gard. Misc. 3: 345. 1851.

Porpax microchilos (Dalzell) Schuit., Y.P.Ng & H.A.Pedersen, Bot. J. Linn. Soc. 186: 200. 2018.

TYPE: India, Western Bengal, *Dalzell s.n.* (holotype, K).

Flowering: October.

Habit and habitat: Epiphyte. Occurs in the trees of Shola forests and coffee plantations.

Distribution: Honnemetti. 1600–1700 m. Endemic.

Specimens examined: *J.Jayanthi 194739* (BSI).

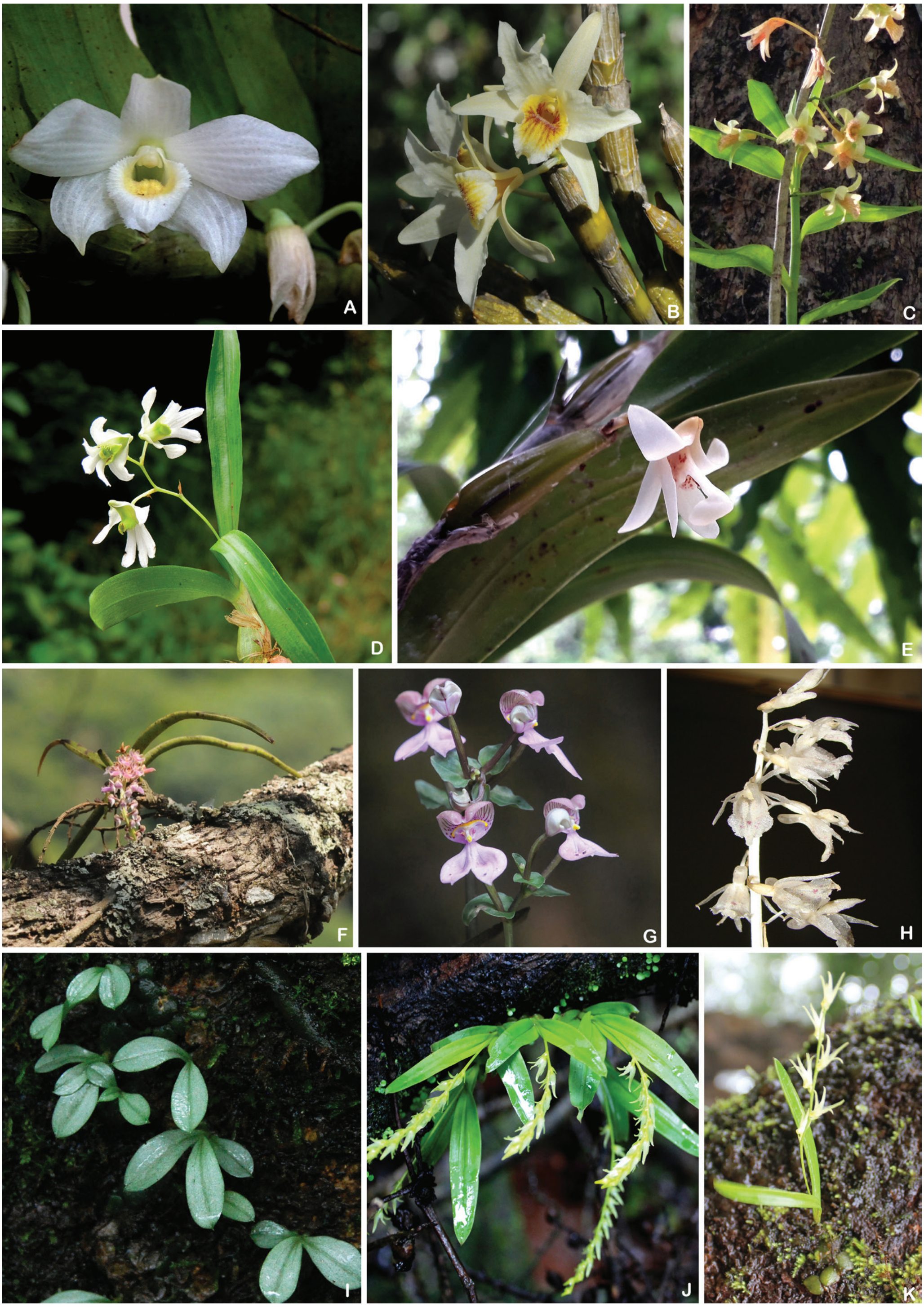

FIGURE 7. **A**. *Dendrobium aqueum*. **B**. *Dendrobium heterocarpum*. **C**. *Dendrobium macrostachyum*. **D**. *Dendrobium nanum*. **E**. *Dendrobium nodosum*. **F**. *Diplocentrum recurvum*. **G**. *Disperis neilgherrensis*. **H**. *Epipogium roseum*. **I**. *Eria exilis*. **J**. *Eria filiformis*. **K**. *Eria microchilos*. Photograph by J.Jayanthi.

Eria mysorensis Lindl., J. Proc. Linn. Soc., Bot. 3: 54. 1858.

Pinalia mysorensis (Lindl.) Kuntze, Revis. Gen. Pl. 2: 679. 1891.

TYPE: India. Mysore, *Law s.n.* (holotype, K-LINDL; isotype, K).

Flowering: September–October.

Habit and habitat: Epiphyte. Occurs on trees of evergreen and semievergreen forests.

Distribution: Bellaji. 1500–1600 m. Endemic.

Specimens examined: *J.Jayanthi 202976* (BSI).

Eria nana A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 19. 1841; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981. Fig. 12C.

Porpax nana (A.Rich.) Schuit., Y.P.Ng & H.A.Pedersen, Bot. J. Linn. Soc. 186: 200. 2018.

TYPE: India, Nilgiri Hills, Condas, Oct., *Perrottet s.n.* (holotype, P; isotype, K, L).

Flowering: September–October.

Habit and habitat: Epiphyte. Occurs in evergreen and shola forests.

Distribution: Attikan, Devagiribetta, Dodasarihalla. Endemic.

Specimens examined: *R.S.Rao 73721 & 73770* (BSI), *R.R.Rao 1046* (MU).

Eria pauciflora Wight, Icon. Pl. Ind. Orient. 5(1): 4, t. 1636. 1851; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981. Fig. 8A.

Cylindrolobus pauciflorus (Wight) Schuit., Y.P.Ng & H.A.Pedersen, Bot. J. Linn. Soc. 186: 195. 2018.

TYPE: India, Nilgiri Hills, Kaitie Falls, Aug.-Sep., *Wight s.n.* (holotype, K).

Flowering: September–October.

Habit and habitat: Epiphyte. Occurs in evergreen forests.

Distribution: Attikan, Bellaji. 1500–1700 m. Endemic.

Specimens examined: *J.Jayanthi 202978* (BSI), *R.R.Rao 1049* (MU).

Eria polystachya A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 20. 1841; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967. Fig. 8B.

Pinalia polystachya (A.Rich.) Kuntze, Revis. Gen. Pl. 2: 679. 1891.

TYPE: India, Nilgiri Hills near Neddoubetta, Sep. 1840, *Perrottet s.n.* (holotype, P).

Flowering: September.

Habit and habitat: Epiphyte. Occurs in semievergreen forests and evergreen forests.

Distribution: Honnemetti. 1600–1700 m. Endemic.

Specimens examined: *J.Jayanthi 207139* (BSI).

Eria pseudoclavicaulis Blatt., J. Bombay Nat. Hist. Soc. 32: 519. 1928. Fig. 8C.

Cylindrolobus pseudoclavicaulis (Blatt.) Schuit., Y.P.Ng & H.A.Pedersen, Bot. J. Linn. Soc. 186: 195. 2018.

TYPE: India, Bombay, cultivated, Sep. 1917, *Blatter 554* (holotype, St. Xavier's College, Bombay, kept in formalin).

Flowering: September.

Habit and habitat: Epiphyte. Occurs in semievergreen, evergreen forests and coffee plantations.

Distribution: Honnemetti. 1500–1600 m. Endemic.

Specimens examined: *J.Jayanthi 203499* (BSI).

Eria reticosa Wight, Icon. Pl. Ind. Orient. 5(1): 4, t. 1637. 1851. Fig. 8D.

Pinalia reticosa (Wight) Kuntze, Revis. Gen. Pl. 2: 679. 1891.

Conchidium reticosum (Wight) Ormerod, Taiwania 57: 119. 2012.

Porpax reticosa (Wight) Schuit., Malesian Orchid J. 24: 107. 2020.

TYPE: India, Pycarrah, May-June, *Wight s.n.* (holotype, K).

Flowering: June–July.

Habit and habitat: Epiphyte. Occurs on trees of shola evergreen forests and coffee plantations.

Distribution: Hatthubarebetta, Doddasampige. 1500–1700 m. Endemic.

Specimens examined: *J.Jayanthi 207152* (BSI), *B.R.Ramesh 1490* (HIFP).

Eulophia R.Br.

Eulophia graminea Lindl., Gen. Sp. Orchid. Pl.: 182. 1833. Fig. 8E.

TYPE: Singapore, 1822, *Wallich 7372.C* (leg. T. Lobb) (syntypes, BM, CAL, K-LINDL, K-WALL).

Flowering: April–May.

Habit and habitat: Terrestrial. Occurs in the dry open scrub forests and thickets.

DISTRIBUTION: Punajur. 700 m.

SPECIMENS EXAMINED: *J.Jayanthi 207144* (BSI).

Eulophia nuda Lindl., Gen. Sp. Orchid. Pl.: 180. 1833; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 593. 1981. Fig. 8F.

TYPE: Nepal, Morung [Morang] Hills, 27 Apr. 1810, *Wallich 7371* (leg. Buchanan-Hamilton) (holotype, K-WALL).

FLOWERING: April–August.

HABIT AND HABITAT: Terrestrial. Occurs in humus rich soil in moist deciduous forests to evergreen forests.

DISTRIBUTION: Gombegallu betta, K. Gudi. 1200–1300 m.

SPECIMENS EXAMINED: *J.Jayanthi 207141* (BSI), *A.S.Rao 80089* (BSI).

Eulophia pratensis Lindl., J. Proc. Linn. Soc., Bot. 3: 25. 1858; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 453. 1944.

TYPE: India, Deccan, *Stocks 22 bis* (holotype, K-LINDL).

Eulophia ramentacea Wight, Icon. Pl. Ind. Orient. 5: t. 1666. 1851; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967.

FLOWERING: April–June.

HABIT AND HABITAT: Terrestrial. Occurs in marshy areas near shola grasslands.

DISTRIBUTION: Dupabare. 1500–1600 m. Endemic.

NOTE: Included based on Barnes.

GASTROCHILUS D.Don

Gastrochilus acaulis (Lindl.) Kuntze, Revis. Gen. Pl. 2: 661. 1891. Fig. 8G.

BASIONYM: *Cleisostoma acaule* Lindl., Gen. Sp. Orchid. Pl.: 227. 1833.

TYPE: Sri Lanka, *Macrae s.n.* (not found).

Saccolabium pulchellum (Wight) C.E.C.Fisch. in J.S.Gamble, Fl. Madras: 1446. 1928; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967.

TYPE: India, Nilgiri Hills, on the banks of the Kaitairy River, *Wight s.n.* (holotype, K).

FLOWERING: March–April.

HABIT AND HABITAT: Epiphyte. Occurs on the trunks of trees in semievergreen to evergreen forests.

DISTRIBUTION: Attikan, Bedguli, Gombegallu, Kattari betta. 1200–1700 m.

SPECIMENS EXAMINED: *J.Jayanthi 207105* (BSI).

Gastrochilus calceolaris (Buch.-Ham. ex Sm.) D.Don, Prodr. Fl. Nepal.: 32. 1825; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981. Fig. 8H.

BASIONYM: *Aerides calceolaris* Buch.-Ham. ex Sm. in A.Rees, Cycl. 39(1): no. 11. 1818.

TYPE: Nepal, Bagmati Zone, Kathmandu, Narainhetty, *Buchanan-Hamilton s.n.*

FLOWERING: March–April.

HABIT AND HABITAT: Epiphyte. Occurs on the trunks of trees in semievergreen to evergreen forests.

DISTRIBUTION: Attikan, Bedguli, Gombegallu. 1200–1300 m.

SPECIMENS EXAMINED: *J.Jayanthi 197454* (BSI), *A.S.Rao 79856* (BSI), *R.R.Rao 1267* (MU).

Gastrochilus flabelliformis (Blatt. & McCann) C.J.Saldanha in C.J.Saldanha & D.H. Nicolson, Fl. Hassan Distr.: 830. 1976. Fig. 8I.

BASIONYM: *Saccolabium flabelliforme* Blatt. & McCann, J. Bombay Nat. Hist. Soc. 35: 722. 1932.

TYPE: India, North Kanara, Devimane Ghat, *Sedgwick & T. R. Bell 6975* (holotype, BLATT)

FLOWERING: March.

HABIT AND HABITAT: Epiphyte. Occurs on the trunks of trees in semievergreen to shola evergreen forests. Endemic.

DISTRIBUTION: Doddasampige, Jodigere. 1300–1400 m.

SPECIMENS EXAMINED: *J.Jayanthi 207138* (BSI).

GEODORUM Andrews

NOTE: Chase *et al*. (2021a) reduced *Geodorum* under *Eulophia* R.Br. based on phylogenetic study and subsequently proposed (Chase *et al*., 2021b) to conserve *Eulophia* over *Geodorum*. However, treating *Eulophia* as a conserved name over *Geodorum* is subject to acceptance the proposal in the XX International Botanical Congress to be held in Madrid, Spain in 2024 and therefore, *Geodorum* must be treated as correct name at present due to priority.

Geodorum densiflorum (Lam.) Schltr., Repert. Spec. Nov. Regni Veg. Beih. 4: 259. 1919; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981. Fig. 8J.

BASIONYM: *Limodorum densiflorum* Lam., Encycl. 3: 516. 1792.

Eulophia cernua (Willd.) M.W.Chase, Kumar & Schuit., Phytotaxa 491: 51. 2021.

TYPE: India, Malabar, Rheede, icon. Hort. Malab. 2: 69, t. 35. 1692.

Flowering: June–October. (Fruiting in December).

Habit and habitat: Terrestrial. Occurs in the moist deciduous forest floors under *Lantana* thickets, in Bamboo brakes and in evergreen forests.

Distribution: B.R. Hills, Bedguli, Burude bungalow road, Bylore, K. Gudi, Honnemetti. 1000–1400 m.

Specimens examined: *J.Jayanthi 194442* (BSI), *B.R.Ramesh 1504* (HIFP).

Habenaria Willd.

Habenaria barbata Wight ex Hook.f., Fl. Brit. India 6: 133. 1890; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967.

TYPE: India, Travancore, Pulney and Dindygal Mountains, *Wallich 7034* (leg. Wight) (missing).

Habenaria virens (Lindl.) Abeyw., Ceylon J. Sci., Biol. Sci. 2: 83. 1959 *nom. inval. et illeg*., non A. Rich. & Galeotti, 1845; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

TYPE: India, Dindigul, alt. 4000 ft, *Wight s.n.* [2084] (holotype, K-LINDL; isotype, K)

Flowering: September.

Habit and habitat: Terrestrial. Occurs in moist shaded places of dry deciduous forests.

Distribution: Moskal.

Note: Included based on Barnes report.

Habenaria brachyphylla (Lindl.) Aitch., J. Linn. Soc., Bot. 19: 188. 1882. Fig. 8K.

BASIONYM: *Platanthera brachyphylla* Lindl., Gen. Sp. Orchid. Pl.: 293. 1835.

TYPE: India, *Wight s.n.* (holotype, K-LINDL; isotype, P).

Flowering: August–September.

Habit and habitat: Terrestrial. Occurs in moist deciduous forests.

Distribution: Burude. 1100–1200 m. Endemic.

Specimens examined: *J.Jayanthi 207148* (BSI).

Habenaria crinifera Lindl., Gen. Sp. Orchid. Pl.: 323. 1835. Fig. 8L.

TYPE: Sri Lanka, *Macrae s.n.* (holotype, K-LINDL).

Flowering: August–September.

Habit and habitat: Epiphytic. Occurs in the shola evergreen forests.

Distribution: Kattaribetta. 1600–1800 m.

Specimens examined: *J.Jayanthi 207145* (BSI).

Habenaria elliptica Wight, Icon. Pl. Ind. Orient. 5: t. 1706. 1851; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981.

TYPE: India, Pulney Hills, Sep., *Wight s.n.* (holotype, K).

Flowering: August–September.

Habit and habitat: Terrestrial. Occurs in the evergreen and shola grasslands.

Distribution: Devagiribetta. 1500–1600 m. Endemic.

Specimens examined: *R.S.Rao 73789* (BSI).

Habenaria elwesii Hook.f., Bot. Mag. 122: t. 7478. 1896. Fig. 9A.

TYPE: India, Nilgiri Mountains, *Proudlock s.n.* (holotype, K).

Flowering: August–September.

Habit and habitat: Terrestrial. Occurs in the shola grasslands.

Distribution: Kattaribetta. 1700–1800 m. Endemic.

Specimens examined: *J.Jayanthi 207140* (BSI).

Habenaria foliosa A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 71. 1841. Fig. 9B.

Habenaria digitata var. *foliosa* (A. Rich) Hook.f., Fl. Brit. India 6: 135. 1890; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981.

TYPE: India, Nilgiri Hills near Avalanchy and Otacamund, July-Aug., *Perrottet s.n.* (holotype, P).

Flowering: June–September.

Habit and habitat: Terrestrial. Occurs in grassy slopes in evergreen forests and shola grasslands.

Distribution: Ittuboodhikanive. 1400–1700 m. Endemic.

Specimens examined: *J.Jayanthi 203500* (BSI).

Habenaria furcifera Lindl., Gen. Sp. Orchid. Pl.: 319. 1835. Fig. 9C.

TYPE: India, Mussoorie, *Royle s.n.* (holotype, K-LINDL).

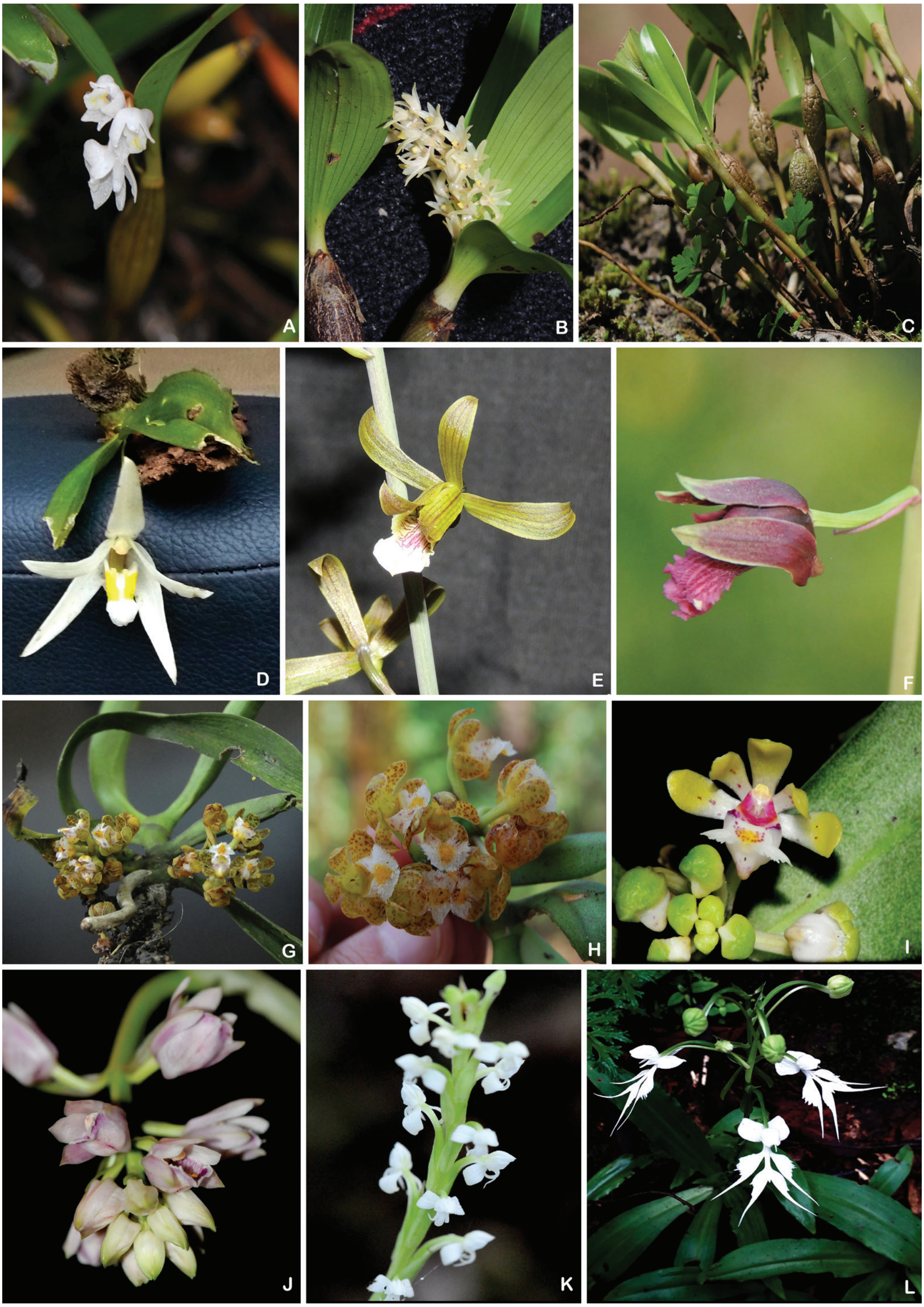

FIGURE 8. **A**. *Eria pauciflora*. **B**. *Eria polystachya*. **C**. *Eria pseudoclavicaulis*. **D**. *Eria reticosa*. **E**. *Eulophia graminea*. **F**. *Eulophia nuda*. **G**. *Gastrochilus acaulis*. **H**. *Gastrochilus calceolaris*. **I**. *Gastrochilus flabelliformis*. **J**. *Geodorum densiflorum*. **K**. *Habenaria brachyphylla*. **L**. *Habenaria crinifera*. Photograph by J.Jayanthi.

Flowering: September–October.

Habit and habitat: Terrestrial. Occurs in moist deciduous forests, amidst grasses in moist places.

Distribution: K. Gudi, Manjikere, Bylore. 1000–1100 m.

Specimens examined: *J.Jayanthi 207124* (BSI).

Habenaria gibsonii Hook.f., Fl. Brit. India 6: 135. 1890. Fig. 9D.

TYPE: India, the Concan, Kyreswur and Kandalla [Khandala], *Gibson s.n.* (holotype (syntype?), K).

Flowering: August–September.

Habit and habitat: Terrestrial. Occurs in moist deciduous forests.

Distribution: Bylore. 1100–1200 m.

Specimens examined: *J.Jayanthi 207131* (BSI).

Habenaria heyneana Lindl., Gen. Sp. Orchid. Pl.: 320. 1835; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981. Fig. 9E.

TYPE: India, locality not recorded, 23 Sep. 1826, *Wallich 7044* (leg. Heyne s.n.) (holotype, K-LINDL; isotype, K-WALL).

Flowering: August–November.

Habit and habitat: Terrestrial. Occurs in marshy and swampy places in shola grasslands.

Distribution: Honnemetti, Kattaribetta. 1700–1800 m and above. Endemic.

Specimens examined: *J.Jayanthi 203482 & 203485* (BSI), *R.R. Rao 1043* (MU).

Habenaria hollandiana Santapau, Fl. Purandhar: 126. 1957; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981. *Habenaria affinis* Wight, Icon. Pl. Ind. Orient. 5: t. 1707. 1851; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944.

TYPE: India, ?Belgaum, ?]. *S. Law s.n.* (?holotype, K [without collector or locality]

Flowering: August–September.

Habit and habitat: Terrestrial. Occurs in open tall grassy areas of dry deciduous forests.

Distribution: Moskal. Endemic.

Specimens examined: *R.S. Rao 73746* (BSI).

Habenaria longicorniculata J.Graham, Cat. Pl. Bombay: 202. 1839; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981. Fig. 9F. SYNTYPES: India, South Concan, Kandalla [Khandala], Sir Herbert Compton's Bungalow, *J. S. Law s.n.* (syntypes, K, P); Pulney Hills, *Wight s.n.* (syntypes, K, P).

Habenaria longecalcarata A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 71. 1841; E. Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944.

TYPE: India, Nilgiri Hills, Konoor, Otacamund, July-Aug., *Perrottet s.n.* (holotype, P).

Flowering: August–October.

Habit and habitat: Terrestrial. Occurs in grassy slopes in semievergreen forests and shola grasslands.

Distribution: Ittuboodhikanive, Honnemetti. 1300–1700 m.

Specimens examined: *J.Jayanthi 194732 & 202967* (BSI), *R.R.Rao 1040* (MU).

Habenaria longicornu Lindl., Gen. Sp. Orchid. Pl.: 322. 1835. Fig. 9G.

TYPE: India, locality not recorded, 17 Aug. 1818, *Wallich 7027* (leg. Heyne s.n.) (holotype, K-LINDL; isotype, K-WALL).

Flowering: August–September.

Habit and habitat: Terrestrial. Along the open rocky slopes of moist deciduous forests.

Distribution: On the way to Bedguli. 1100–1200 m. Endemic.

Specimens examined: *J.Jayanthi 203440* (BSI).

Habenaria marginata Colebr., W.J.Hooker, Exot. Fl.: t. 136. 1824. Fig. 9H.

TYPE: India, July 1814, cult. Calcutta s.n. (probably not preserved and hence the illustration in Exot. FI. 2 :1.136, 1824, considered as the type).

Flowering: August–September.

Habit and habitat: Terrestrial. Occurs in open rocky, grassy slopes in moist deciduous forests.

Distribution: Bedguli. 1100–1200 m.

Specimens examined: *J.Jayanthi 207137* (BSI).

Habenaria multicaudata Sedgw., Rec. Bot. Surv. India 6: 352. 1919. Fig. 9I.

TYPE: India, North Kanara, Near Kaswar, Gudihalli, Sep. 1917, *T. R. D. Bell s.n.*

Flowering: September–October.

Habit and habitat: Terrestrial. Occurs in the shady places of evergreen forests.

Distribution: Bedguli. 1300–1400 m. Endemic.

Specimens examined: *J.Jayanthi 207135* (BSI).

Habenaria ovalifolia Wight, Icon. Pl. Ind. Orient. 5: t. 1708. 1851; E.Barnes, J. Bombay Nat. Hist. Soc.

44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981. Fig. 9J.

TYPE: India, Malabar and Anamally Hills, July-Aug., *Wight 3017* (syntype, K).

Flowering: September–October.

Habit and habitat: Terrestrial. Occurs in moist deciduous forests, amidst grasses in moist places.

Distribution: K. Gudi, Manjikere, Bylore. 1000–1100 m. Endemic.

Specimens examined: *J.Jayanthi 195934* (BSI), *R.S. Rao 73597* (BSI).

Habenaria perrottetiana A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 74. 1841; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 594. 1981.

TYPE: India, Nilgiri Hills, Otacamund to Avalanchy, Aug. 1840, *Perrottet s.n.* [1129 in G] (holotype, P; isotype, G).

Flowering: September–October.

Habit and habitat: Terrestrial. Occurs in shola grasslands.

Distribution: Bedguli, Dupabare, Honnemetti. 1500–1600 m. Endemic.

Specimens examined: *R.S.Rao 73786* (BSI), *R.R.Rao 1041* (MU).

Habenaria plantaginea Lindl., Gen. Sp. Orchid. Pl.: 323. 1835; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

SYNTYPES: India, betw. Tenevelly & Travancore, Oct. 1814, *Wallich 7053A* (leg. Rattler) (syntypes, K-LINDL, K-WALL)

Flowering: September–November.

Habit and habitat: Terrestrial. Occurs in scrub, dry deciduous to moist deciduous forest slopes and bamboo brakes.

Distribution: Bodipadaga, Burude, B.R. Hills, K.Gudi, Nellikathir, Punajur-Bedguli, Yelandur. 700–1100 m.

Specimens examined: *J.Jayanthi 194679*, *194680*, *194683*, *195914*, *195785*, *197250 & 202916* (BSI).

Notes: After Barnes, this species is collected in the present study after a lapse of 80 years.

Habenaria rariflora A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 70. 1841; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

TYPE: India, Nilgiri Hills near Konoor, July, *Perrottet s.n.* (holotype, P).

Flowering: September–October.

Habit and habitat: Terrestrial. Occurs in shola grasslands.

Distribution: Devagiribetta, Honnemetti, Kattaribetta. 1600–1800 m. Endemic.

Specimens examined: *J.Jayanthi 207150* (BSI), *R.S.Rao 73788* (BSI).

Habenaria roxburghii Nicolson, C.J.Saldanha & D.H.Nicolson, Fl. Hassan Distr.: 834. 1976. Fig. 9M.

TYPE: India, Coromandel coast, icon. *Roxburgh s.n.*, Pl. Coromandel 1: 32, t. 37. 1795.

Flowering: July–November.

Habit and habitat: Terrestrial. Occurs in scrub thickets and dry deciduous forests.

Distribution: Bodipadaga, Bellatha, Yelandur. 800–900 m.

Specimens examined: *J.Jayanthi 194441*, *202957 & 203472* (BSI).

Habenaria sahyadrica K.M.P.Kumar, Nirmesh, V.B.Sreek. & Kumar, Phytotaxa 244: 196. 2016. Fig. 9N.

TYPE: India, Kerala: Palakkad district, Muthikulam, way to Elival hills, 1700 m, 22 Nov. 2013, *Nirmesh & Prabhukumar 28501* (holotype, KFRI; isotype, CMPR, CALI).

Flowering: December–January.

Habit and habitat: Terrestrial. Occurs along the slopes of evergreen forests.

Distribution: Gombegallu, Ittuboodhikanive. 1400–1500 m. Endemic.

Specimens examined: *J.Jayanthi 206559* (BSI).

Liparis Rich.

Liparis atropurpurea Lindl., Gen. Sp. Orchid. Pl.: 28. 1830; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

TYPE: Sri Lanka, *Macrae s.n.* (holotype, K-LINDL).

Flowering: July–September.

Habit and habitat: Terrestrial. Occurs in evergreen forests.

Distribution: Attikan, Bellaji. 1200–1600 m.

Note: Included based on Barnes report.

Liparis deflexa Hook.f., Fl. Brit. India 5: 697. 1890. Fig. 9O.

Liparis flavoviridis Blatt. & McCann, J. Bombay Nat. Hist. Soc. 35: 260. 1931.

TYPE: India, Sikkim Himalaya, Darjeeling, 1844, *Griffith's collector 5367* (holotype, K; isotype, K-LINDL).

Flowering: July–September.

Habit and habitat: Terrestrial. Occurs in slopes of moist deciduous forests.

Distribution: K. Gudi, Burude. 1100–1300 m.

Specimens examined: *J.Jayanthi 202915* (BSI).

Liparis odorata (Willd.) Lindl., Gen. Sp. Orchid. Pl.: 26. 1830; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967. Fig. 9P.

BASIONYM: *Malaxis odorata* Willd., Sp. Pl., ed. 4, 4: 91. 1805.

TYPE: India, Malabar, icon, of "la-Poulou-Mararava" in Rheede, Hort. Malabar. 12: 53, t. 27.

Flowering: July–September.

Habit and habitat: Terrestrial. Occurs in semievergreen forests.

Distribution: Bellaji. 1400–1500 m.

Specimens examined: *J.Jayanthi 207122* (BSI).

Liparis platyphylla Ridl., J. Linn. Soc., Bot. 22: 264. 1886; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

TYPE: India, Anamallays, alt. 3000 ft, *Beddome s.n.* (holotype, BM).

Flowering: September.

Habit and habitat: Terrestrial. Occurs in slopes of moist deciduous forests.

Distribution: Western slopes. 1100–1300 m. Endemic.

Note: Included based on Barnes report.

Liparis wightiana Thwaites, Enum. Pl. Zeyl.: 295. 1861; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 452. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

TYPE: Sri Lanka, Central Province, alt. 3000–5000 ft, *Thwaites s.n.* [Ceylon Plants 3 1 79] (holotype, BM; isotype, K, P).

Flowering: August–September.

Habit and habitat: Terrestrial. Occurs in rocky crevices of hill top forests.

Distribution: Pokkibetta. 1400–1600 m.

Note: Included based on Barnes report.

Luisia Gaudich.

Luisia tenuifolia Blume, Rumphia 4: 50. 1849; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981. Fig. 10A.

TYPE: Sri Lanka, Peradenia, *Macrae s.n.* [67] (holotype, K-LINDL).

Flowering: July–September.

Habit and habitat: Epiphyte. Occurs on trees of moist deciduous forests.

Distribution: Doddasampige, K.Gudi. 1100–1300 m.

Specimens examined: *J.Jayanthi 194546* (BSI).

Note: After Barnes, this species is collected from BRT after a lapse of 80 years. Rao & Razi 1981 stated that this species has been completely eradicated from the area along with the deforestation programme. However, during the present study some moderately good population observed due to protection measures.

Luisia trichorhiza (Hook.) Blume, Rumphia 4: 50. 1849. Fig. 10B.

Vanda trichorhiza Hook., Exot. Fl. 1: t. 72. 1823.

TYPE: Nepal, cult. Liverpool (leg. *Wallich s.n.*) (not found).

Flowering: March–April.

Habit and habitat: Epiphyte. Occurs on trees of moist deciduous forests and disturbed semievergreen forests.

Distribution: Seegevadibetta. 1100–1300 m.

Specimens examined: *J.Jayanthi 207147* (BSI).

Luisia zeylanica Lindl., Fol. Orchid. 4: 3. 1853. Fig. 10C.

TYPE: Sri Lanka, *Macrae 50* (holotype, K-LINDL).

Luisia teretifolia auct. non Gaudich. 1829; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

Flowering: March–April & October–February.

Habit and habitat: Epiphyte. Occurs on trees of moist deciduous forests.

FIGURE 9. **A**. *Habenaria elwesii.* **B**. *Habenaria foliosa.* **C**. *Habenaria furcifera.* **D**. *Habenaria gibsonii.* **E**. *Habenaria heyneana.* **F**. *Habenaria longicorniculata.* **G**. *Habenaria longicornu.* **H**. *Habenaria marginata*. **I**. *Habenaria multicaudata*. **J**. *Habenaria ovalifolia*. **K**. *Habenaria plantaginea*. **L**. *Habenaria rariflora*. **M**. *Habenaria roxburghii.* **N**. *Habenaria sahyadrica*. **O**. *Liparis deflexa*. **P**. *Liparis odorata.* Photograph by J.Jayanthi.

Distribution: B.R. Hills, Devakere, K.Gudi, Punajur ghat. 1100–1300 m.

Specimens examined: *J.Jayanthi 207123* (BSI), *R.R.Rao 1793* (MU).

Nervilia Comm. ex Gaudich.

Nervilia concolor (Blume) Schltr., Bot. Jahrb. Syst. 45: 404. 1911. Fig. 10D–E.

BASIONYM: *Cordyla concolor* Blume, Bijdr. Fl. Ned. Ind.: 416. 1825.

TYPE: Indonesia, Java, Mt. Salak, *Blume s.n.* (?holotype, L).

Nervilia aragoana Gaudich., Voy. Uranie: 422. 1829; E. Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R. Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

TYPE: Mariana Islands (Gaum), *Gaudichaud s.n.* (holotype, P).

Flowering: April–May. (Leaves appear in June onwards).

Habit and habitat: Terrestrial. Occurs in moist deciduous forest floors.

Distribution: Dhumanegathe, K.Gudi, Minchiguli. 1100–1200 m.

Specimens examined: *J.Jayanthi 194530* (BSI), *A.S. Rao 80089* (BSI).

Nervilia plicata (Andrews) Schltr., Bot. Jahrb. Syst. 45: 403. 1911. Fig. 10F–G.

Arethusa plicata Andrews, Bot. Repos. 5: 321. 1803. Lectotype (designated by Atthanagoda *et al*., 2021): Andrews, Bot. Repos. 5: t. 321. 1803. (plate 321 is based on the collection, *A.B. Lambert s.n*., from East India in 1803).

Nervilia biflora (Wight) Schltr., Bot. Jahrb. Syst. 39: 48. 1906; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 595. 1981.

TYPE: India, Wynad, *Jerdon s.n.* (not found).

Flowering: April–May. (Leaves variegated, appear in June onwards).

Habit and habitat: Terrestrial. Occurs in moist deciduous forest floors.

Distribution: Cubbongundi, Dhumanegathe. 1100–1200 m.

Specimens examined: *J.Jayanthi 194592* (BSI).

Note: After Barnes, this has been collected from BRTTR after a lapse of 80 years.

Nervilia simplex (Thouars) Schltr., Bot. Jahrb. Syst. 45: 401. 1911. Fig. 10H–I.

BASIONYM: *Arethusa simplex* Thouars, Hist. Orchid.: t. 24. 1822.

TYPE: icon. Thouars, Hist. Orchid.: t. 24. 1822 (lectotype, designated by Pettersson, 1990). *Nervilia crispata* (Blume) Schltr. ex K. Schum. & Lauterb., Fl. Schutzgeb. Südsee: 240. 1900; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967.

TYPE: Indonesia, Java, Bantam Prov., Mt. Batuauwel, *van Hasselt s.n.* (holotype,? L, not found, painting W).

Nervilia monantha Blatt. & McCann, J. Bombay Nat. Hist. Soc. 35: 724. 1932; E. Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944.

TYPE: India, North Kanara, Yellapur, June 1911, *T. R. Bell 5428a* (holotype, BLAT). *Nervilia crociformis* (Zoll. & Moritzi) Seidenf., Dansk Bot. Ark. 32: 151. 1978.

TYPE: Indonesia, Java, Tjikoya, 11 Oct. 1812, *Zollinger 762*.

Flowering: May. (Leaves appear in July).

Habit and habitat: Terrestrial. Occurs in moist deciduous forest floors.

Distribution: B.R. Hills. 1100–1200 m.

Specimens examined: *J.Jayanthi 194534* (BSI).

Oberonia Lindl.

Oberonia brachystachys Lindl., Sert. Orchid.: t. 8 B. 1838. Fig. 10J. SYNTYPES: “Burmese Empire,” Griffith 697 (not found); *Griffith 778* (syntypes, K-LINDL, P); Griffith s.n. (possible syntype, K).

Oberonia recurva Lindl., Edwards’s Bot. Reg. 25(Misc.): 14. 1839.

TYPE: India, Bombay, Messrs. *Loddiges s.n.* (holotype, K-LINDL).

Flowering: December.

Habit and habitat: Epiphyte. Occurs on trees of evergreen forests.

Distribution: Kattaribetta. 1600–1700 m.

Specimens examined: *J.Jayanthi 207143* (BSI).

Oberonia brunoniana Wight, Icon. Pl. Ind. Orient. 5: t. 1622. 1851; E.Barnes, J. Bombay Nat. Hist. Soc.

44: 451. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981. Fig. 10K.

TYPE: India, Tamil Nadu, Iyamally Hills near Coimbatore, Mt. Agamullu, June-July, *Wight s.n.* (lectotype, K, designated by Geiger, 2019).

Oberonia lindleyana Wight, Icon. Pl. Ind. Orient. 5: t. 1624. 1851; E. Barnes, J. Bombay Nat. Hist. Soc. 44: 451. 1944.

TYPE: India, Tamil Nadu, Iyamally Hills, near Coimbatore, Aug.-Sep., *Wight s.n.* (holotype, K).

Oberonia santapaui Kapadia, J. Bombay Nat. Hist. Soc. 57: 265. 1960; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981. TYPE: India, Iyamally hilla, Coimbatore (holotype, K?).

Flowering: December–February.

Habit and habitat: Epiphyte. Occurs on trees of riparian forests, semievergreen to shola evergreen forests. Also found on the crevices of rocky boulders amidst shola grasslands.

Distribution: Attikan, Bellaji, Bedguli, Devagiribetta, Dupabarebetta, K.Gudi. 1400–1550 m.

Specimens examined: *J.Jayanthi 194755 & 206598* (BSI), *R.R. Rao 1051*, *1596 & 1786* (MU), *B.R.Ramesh & M.Deshayes 626* (HIFP).

Oberonia chandrasekharanii V.J.Nair, V.S.Ramach. & R.Ansari, Blumea 28: 361. 1983. Fig. 10L.

TYPE: India, Kerala State, Cannanore District, Chandanathode, 2500 ft, 15 Aug. 1980, *Ramachandran 66948* (holotype, CAL; isotype, K, MH).

Flowering: December.

Habit and habitat: Epiphyte. Occurs on trees of semievergreen and evergreen forests.

Distribution: Bellaji. 1400–1500 m. Endemic.

Specimens examined: *J.Jayanthi 207133* (BSI).

Oberonia ensiformis (Sm.) Lindl., Fol. Orchid. 8: 4. 1859. Fig. 10M.

Malaxis ensiformis Sm., A.Rees, Cycl. 22: n.° 14. 1812.

Oberonia iridifolia Lindl., Gen. Sp. Orchid. Pl.: 15. 1830.

TYPE: Nepal, Bagmati Zone, Kathmandu, Narayanhetty, on trees, 12 Nov. 1802, *Buchanan-Hamilton s.n.* (lectotype, LINN sheet L1NN-HS 1396.11.1-2, designated by Ansari & Balakrishnan, 1990 and Geiger, 2020; isolectotype, K).

Flowering: September–December.

Habit and habitat: Epiphyte. Occurs on trees of moist deciduous to evergreen forests.

Distribution: Seematti, Dodduveetha Kadavu, Honnemetti. 1100–1700 m.

Specimens examined: *J.Jayanthi 194738 & 202954* (BSI).

Oberonia mucronata (D.Don) Ormerod & Seidenf. in G. Seidenfaden, Contrib. Orchid Fl. Thailand 13: 20. 1997. Fig. 10N.

Stelis mucronata D.Don, Prodr. Fl. Nepal.: 32. 1825.

TYPE: Nepal, *Buchanan-Hamilton s.n.* (holotype, BM).

Oberonia iridifolia var. *denticulata* (Wight) Hook.f., Fl. Brit. India 5: 676. 1890; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 451. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981.

TYPE: India, Tamil Nadu, Coimbatore, Iyamally Hills, July-Aug. [December 1847], *Wight s.n.* [2939] (syntypes, CAL, K).

Flowering: September-December.

Habit and habitat: Epiphyte. Occurs in shaded areas, on the trunks and branches of trees in moist deciduous forests, evergreen forests and along streams in shola forests.

Distribution: Attikan, Bedguli, K.Gudi, Seerindi. 1200–1400 m.

Specimens examined: *J.Jayanthi 202955* (BSI), *R.S. Rao 73593* (BSI), *R.R.Rao 1052* (MU).

Oberonia verticillata Wight, Icon. Pl. Ind. Orient. 5: t. 1626. 1851; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 451. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967. Fig. 10O.

TYPE: India, Nilgiri Hills, July-Oct., *Wight s.n.* (lectotype, BM, designated by Ansari & Balakrishnan, 1990.

Flowering: September–December.

Habit and habitat: Epiphyte. Occurs on trees of semievergreen and evergreen forests.

Distribution: Bellaji, Devabetta. 1500–1600 m. Endemic.

Specimens examined: *J.Jayanthi 202977* (BSI).

Oberonia wightiana Lindl., Edwards's Bot. Reg. 25(Misc.): 14. 1839; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981.

TYPE: India, Nilgiri & Pulney Hills, Aug.-Sep., *Wight 181* (lectotype, K-LINDL, designated by Ansari & Balakrishnan, 1990; isotype, MH).
Flowering: December–February.
Habit and habitat: Epiphyte. Occurs on trees of evergreen forests.
Distribution: Bedguli.
Specimens examined: *R.R. Rao 1785* (MU).

Papilionanthe Schltr.

Papilionanthe cylindrica (Lindl.) Seidenf., Descr. Epidendrorum J.G.König: 33. 1995. Fig. 11A. BASIONYM: *Aerides cylindrica* Lindl., Gen. Sp. Orchid. Pl.: 240. 1833; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 228. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 591. 1981.
TYPE: India, without locality, *Wallich 7317B* (leg. Wight s.n.) (syntype, K-WALL), *Wallich 7317A* (leg. Heyne s.n., 21 Mar. 1817) (syntypes, K-LINDL, K-WALL).
Flowering: March–May.
Habit and habitat: Epiphyte. Occurs on trees of evergreen and shola forests. Most of the time found loosely hanging from the trees of *Elaeocarpus* sp.
Distribution: Bedguli, Bellaji, Honnemetti. 1400–1700 m.
Specimens examined: *J.Jayanthi 195706 & 197449* (BSI).

Pecteilis Raf.

Pecteilis gigantea (Sm.) Raf., Fl. Tellur. 2: 38. 1837.
Orchis gigantea Sm., Exot. Bot. 2: 79. 1806.
TYPE: Nepal, *Buchanan-Hamilton s.n.*
Platanthera susannae auct. non (L.) Lindl., 1835; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981.
Flowering: September.
Habit and habitat: Terrestrial. Occurs in slopes of shola grasslands.
Distribution: Attikan, Dupabare. 1400–1600 m.
Note: Included based on Barnes report.

Peristylus Blume

Peristylus aristatus Lindl., Gen. Sp. Orchid. Pl.: 300. 1835; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 229. 1967. Fig. 11B.
TYPE: Sri Lanka, *Macrae s.n.* (holotype, K-LINDL).
Flowering: September.
Habit and habitat: Terrestrial. Occurs in slopes of evergreen forests.
Distribution: Attikan. 1400–1500 m.
Specimens examined: *J.Jayanthi 207136* (BSI).

Peristylus caranjensis (Dalzell) Ormerod & C. S. Kumar, Harvard Pap. Bot. 23 (2): 283. 2018. BASIONYM: *Habenaria caranjensis* Dalzell, Hooker's J. Bot. Kew Gard. Misc. 2: 262. 1850 (as "caraujensis").
TYPE: India, Bombay, Caranja ("Carauja") Island, *Dalzell s.n.* NEOTYPE: India, Dronagheree, July 1848, *J. E. Stocks(?) s.n.* (holotype, K, designated by Ormerod & Kumar, 2018). *Habenaria stocksii* Hook.f., Fl. Brit. India 6: 158. 1890.
Peristylus stocksii (Hook.f.) Kraenzl., Orchid. Gen. Sp. 1: 513. 1898; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981.
TYPE: India, Mysore, *J. E. Stocks 173* (lectotype, K, designated by Ormerod & Kumar, 2018).
Flowering: September.
Habit and habitat: Terrestrial. Occurs in shola grassland.
Distribution: Attikan. 1500–1600 m.
Note: Included based on Barnes report.

Peristylus densus (Lindl.) Santapau & Kapadia, J. Bombay Nat. Hist. Soc. 57: 128. 1960; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981. Fig. 11C.
BASIONYM: *Coeloglossum densum* Lindl., Gen. Sp. Orchid. Pl.: 302. 1835.
TYPE: India, Sylhet, Pundua, July 1820, *Wallich 7057* (leg. De Silva 115) (holotype, K-LINDL; isotype, K-WALL).
Flowering: October–December.
Habit and habitat: Terrestrial. Occurs in slopes of shola grasslands.
Distribution: Attikan, Honnemetti. 1400–1500 m.
Specimens examined: *J.Jayanthi 207151* (BSI), *R.R. Rao 1038* (MU).

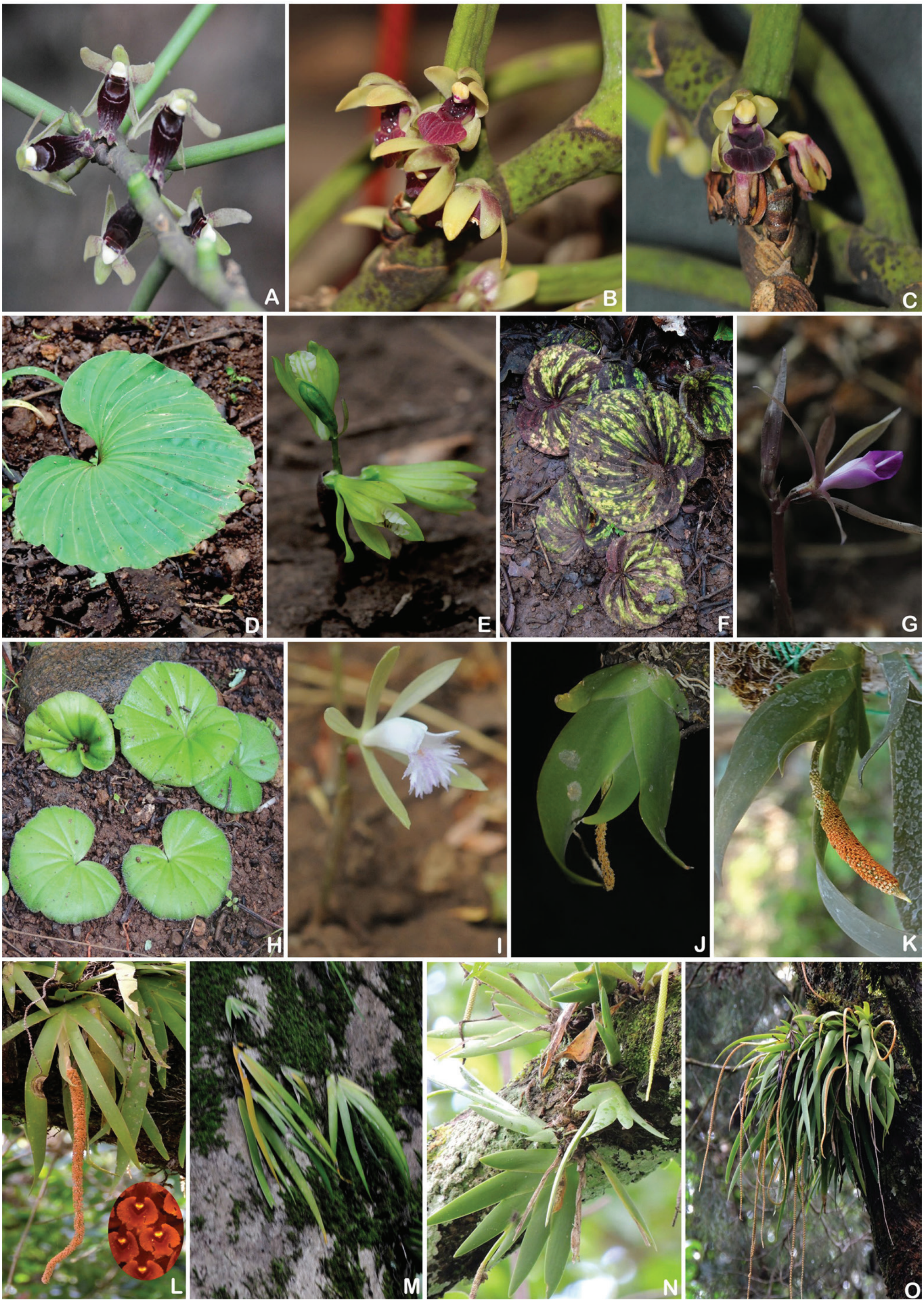

Figure 10. **A**. *Luisia tenuifolia*. **B**. *Luisia trichorhiza*. **C**. *Luisia zeylanica*. **D**. *Nervilia concolor* (leaf). **E**. *Nervilia concolor* (flower) **F**. *Nervilia plicata* (leaf). **G**. *Nervilia plicata* (flower). **H**. *Nervilia simplex* (leaf). **I**. *Nervilia simplex* (flower). **J**. *Oberonia brachystachys*. **K**. *Oberonia brunoniana*. **L**. *Oberonia chandrasekharanii*. **M**. *Oberonia ensiformis*. **N**. *Oberonia mucronata*. **O**. *Oberonia verticillata*. Photograph by J.Jayanthi.

Peristylus goodyeroides (D.Don) Lindl., Gen. Sp. Orchid. Pl. 299. 1835; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981.

Habenaria goodyeroides D.Don, Prodr. Fl. Nepal.: 25. 1825.

TYPE: Nepal, Toka, July 1821, *Wallich s.n.* [7066A] (lectotype, K-LINDL; isotype, K-WALL).

Flowering: September.

Habit and habitat: Terrestrial. Occurs in moist deciduous forests.

Distribution: Burude.

Note: Included based on Barnes report.

Peristylus plantagineus (Lindl.) Lindl., Gen. Sp. Orchid. Pl.: 300. 1835. Fig. 11D.

BASIONYM: *Herminium plantagineum* Lindl., Edwards's Bot. Reg. 18: t. 1499. 1832. TYPE: Sri Lanka, *Macrae s.n.* (holotype, K-LINDL).

Flowering: July–September.

Habit and habitat: Terrestrial. Occurs in moist deciduous forests.

Distribution: Doddasampige road. 1100–1200 m.

Specimens examined: *J.Jayanthi 194591* (BSI).

Peristylus spiralis A.Rich., Ann. Sci. Nat., Bot., sér. 2, 15: 69. 1841; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 596. 1981.

TYPE: India, Nilgiri Hills, Avalanchy, Aug.-Sep., *Perrottet s.n.* (holotype, P).

Flowering: September.

Habit and habitat: Terrestrial. Occurs in moist shola grassland.

Distribution: Honnemetti. 1500–1600 m.

Note: Included based on Barnes report.

Polystachya Hook.

Polystachya concreta (Jacq.) Garay & H.R.Sweet, Orquideologia 9(3): 206. 1974. Fig. 11E. BASIONYM: *Epidendrum concretum* Jacq., Enum. Syst. Pl.: 30. 1760.

TYPE: Martinique, *Privault 136* (neotype, P, designated by Mytnik-Ejsmont & Raranow, 2010).

Polystachya purpurea Wight, Icon. Pl. Ind. Orient. 5: t. 1679. 1851; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944.

TYPE: India, Tamil Nadu, top of Iyamally Hill, alt. 3000 ft, June, *Wight s.n.* (holotype, K).

Polystachya flavescens (Blume) J.J.Sm., Orch. Java: 284. 1905; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 597. 1981.

SYNTYPES: Indonesia, Java, Mt. Salak & Mt. Seribu, *Kuhl & van Hasselt s.n.* (syntypes, L).

Flowering: June–September.

Habit and habitat: Epiphyte. Occurs in moist deciduous forests to semievergreen forests and shola forests, at times in crevices of rocks.

Distribution: Attikan, Kuraji Kadavu, K.Gudi. 1100–1500 m.

Specimens examined: *J.Jayanthi 194491* (BSI), *R.R. Rao 1044* (MU).

Satyrium L.

Satyrium nepalense D.Don, Prodr. Fl. Nepal.: 26. 1825; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 456. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 597. 1981. Fig. 11F.

TYPE: Nepal, Bagmati Zone, Rashuwa District, Gosainthan [Shishapangma], *Wallich s.n.* (holotype, BM).

Flowering: September–December.

Habit and habitat: Terrestrial. Occurs in slopes of shola grassland.

Distribution: Anebetta, Honnemetti. 1600–1700 m.

Specimens examined: *J.Jayanthi 194737 & 203429* (BSI), *R.R. Rao 1045* (MU), *B.R.Ramesh 1531* (HIFP).

Schoenorchis Reinw. ex Blume

Schoenorchis jerdoniana (Wight) Garay, Bot. Mus. Leafl. 23: 202. 1972.

BASIONYM: *Taeniophyllum jerdonianum* Wight, Icon. Pl. Ind. Orient. 5: t. 1756. 1851. *Saccolabium jerdonianum* (Wight) Rchb.f., W.G.Walpers, Ann. Bot. Syst. 6: 886. 1864; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 597. 1981.

TYPE: India, Malabar, *Jerdon s.n.* (holotype, K).

Flowering: September.

Habit and habitat: Epiphyte. Occurs on trees of evergreen and shola forests.

Distribution: Honnemetti. 1400–1600 m. Endemic.

Note: Included based on Barnes report.

Schoenorchis smeeana (Rchb.f.) Jalal, Jayanthi & Schuit., Kew Bull. 69(2)-9508: 4. 2014. Fig. 11G.

BASIONYM: *Saccolabium smeeanum* Rchb.f., Gard. Chron., ser. 3, 2: 214. 1887. *Xenikophyton smeeanum* (Rchb.f.) Garay, Bot. Mus. Leafl. 23: 375. 1974.

TYPE: Origin unknown, cult. *Smee s.n.* (holotype, K).

Schoenorchis latifolia (C.E.C.Fisch.) C.J.Saldanha, J. Bombay Nat. Hist. Soc. 70: 415. 1973; R.R.Rao & Razi, Synop. Fl. Mysore District: 597. 1981.

Rhynchostylis latifolia C.E.C. Fisch., Bull. Misc. Inform. Kew 1927: 358. 1927; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967. TYPE: India, Cardamonai, Mysore, Sep. 1903, *C. A. Barber 6093* (holotype, K). *Xenikophyton seidenfadenianum* M.Kumar, Sequiera & J.J.Wood, Kew Bull. 57: 227. 2002. TYPE: India, Kerala, Palghat District, Siruvani Forest Reserve, Dam Site, *Stephen 0020621* (holotype, KFRI).

Flowering: June–October.

Habit and habitat: Epiphyte. Occurs on trees of semievergreen and shola forests. Endemic.

Distribution: Attikan, Doddasampige, Honnemetti. 1100–1600 m.

Specimens examined: *J.Jayanthi 195738 & 195943* (BSI), *R.R. Rao 1050* (MU).

Trichoglottis Blume

Trichoglottis tenera (Lindl.) Rchb.f., Gard. Chron. 1872: 699. 1872; R.R.Rao & Razi, Synop. Fl. Mysore District: 597. 1981. Fig. 11H.

BASIONYM: *Oeceoclades tenera* Lindl., Gen. Sp. Orchid. Pl.: 236. 1833.

TYPE: Sri Lanka, *Macrae s.n*, [66] (holotype, K-LINDL; isotype, K).

Flowering: March–April & September–December.

Habit and habitat: Terrestrial. Occurs on trees of Shola forests.

Distribution: Honnemetti. 1600–1800 m.

Specimens examined: *J.Jayanthi 197480* (BSI), *R.R. Rao 1626* (MU).

Vanda R.Br.

Vanda testacea (Lindl.) Rchb.f., Gard. Chron., n.s., 8: 166. 1877; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967; R.R.Rao & Razi, Synop. Fl. Mysore District: 597. 1981. Fig. 11I.

BASIONYM: *Aerides testacea* Lindl., Gen. Sp. Orchid. Pl.: 238. 1833.

TYPE: Sri Lanka, *Macrae s.n.* (not found).

Vanda parviflora Lindl., Edwards's Bot. Reg. 30(Misc.): 45. 1844; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 454. 1944.

TYPE: India, Bombay, Messrs. *Loddiges s.n.* (holotype, K-LINDL).

Flowering: March–April.

Habit and habitat: Epiphyte. Occurs in moist deciduous and dry deciduous forests.

Distribution: Basavnalla kere, Kathekallane kere, K.Gudi, Manjikere, Navodhaya gate. 700–1300 m.

Specimens examined: *J.Jayanthi 202854* (BSI), *R.S Rao 73664* (MU).

Vanilla Plum. ex Mill.

Vanilla walkerae Wight, Icon. Pl. Ind. Orient. 3: t. 932. 1845. Fig. 11J–K.

TYPE: Sri Lanka, icon. *Walker s.n.* (not found).

Flowering: March (Fruiting upto December).

Habit and habitat: Terrestrial. Occurs in scrub forests.

Distribution: Gumballi. 700–800 m.

Specimens examined: *J.Jayanthi 207115* (BSI).

Zeuxine Lindl.

Zeuxine longilabris (Lindl.) Trimen, Syst. Cat. Fl. Pl. Ceylon 90. 1885; E.Barnes, J. Bombay Nat. Hist. Soc. 44: 455. 1944; Kammathy *et al*., Bull. Bot. Surv. India 9: 230. 1967. *Monochilus longilabris* Lindl., Gen. Sp. Orchid. Pl.: 487. 1840. Fig. 11L.

TYPE: Sri Lanka. 1829, *Macrae s.n.* [4] (holotype, K-LINDL).

Flowering: December.

Habit and habitat: Terrestrial. Occurs in moist deciduous forests.

Distribution: Bedguli. 1100–1200 m.

Specimens examined: *J.Jayanthi 207142* (BSI).

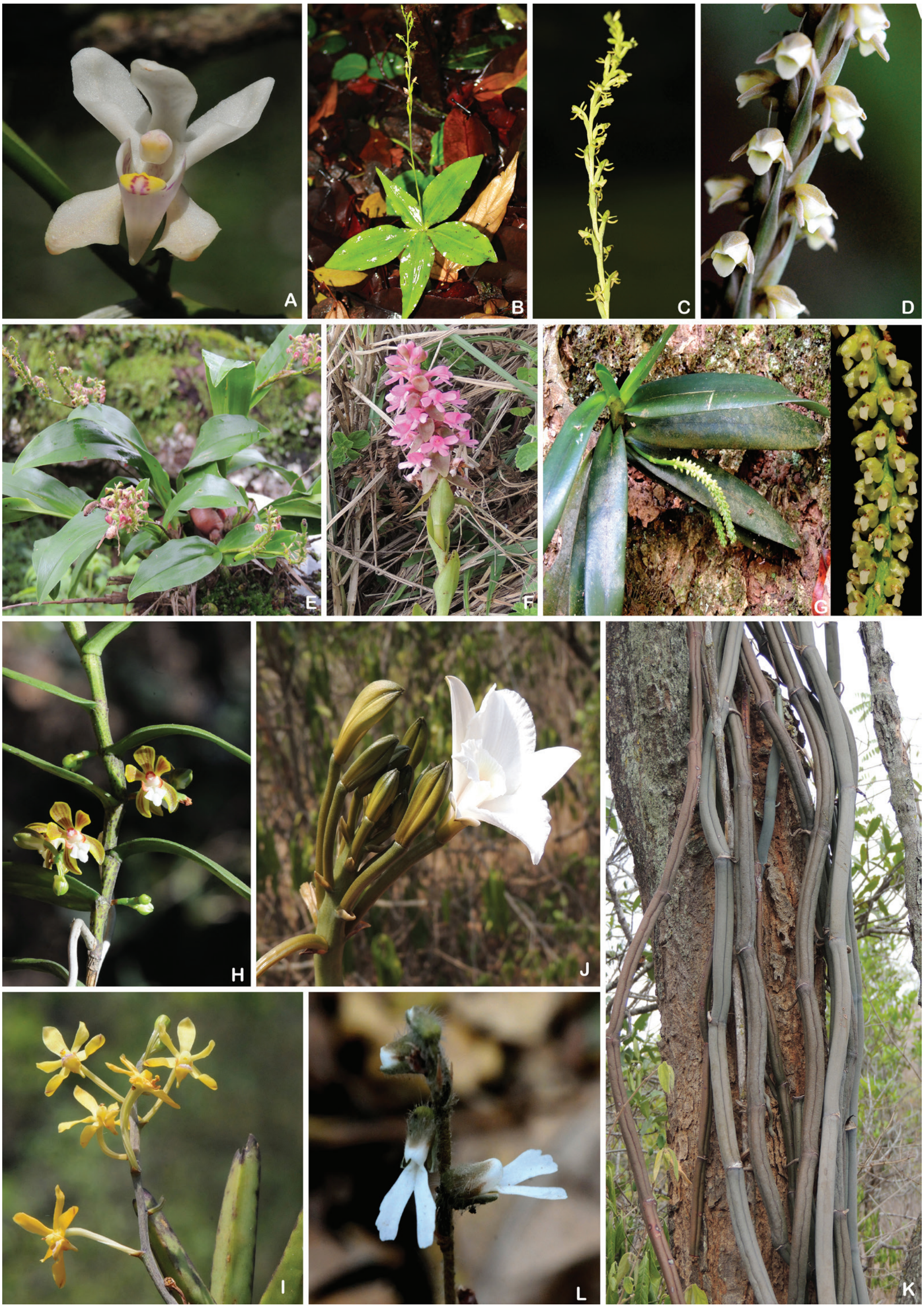

FIGURE 11. **A**. *Papilionanthe cylindrica*. **B**. *Peristylus aristatus*. **C**. *Peristylus densus*. **D**. *Peristylus plantagineus*. **E**. *Polystachya concreta*. **F**. *Satyrium nepalense*. **G**. *Schoenorchis smeeana*. **H**. *Trichoglottis tenera*. **I**. *Vanda testacea*. **J**. *Vanilla walkerae* (flower). **K**. *Vanilla walkerae* (Habit). **L**. *Zeuxine longilabris*. Photograph by J.Jayanthi.

HERBARIUM UNIVERSITY OF MYSORE
Date 4. 10. 1970. Herb. No. 3400
Loc. Attikan. District Mysore.
Bot. name Cirrhopetalum neilgherrense W.
Local name
Family Orchidaceae.
Collector R. Raghavendra Rao.
Coll. No. 1039.

HERBARIUM UNIVERSITY OF MYSORE
Date 4. 10. 70 Herb. No. 4956
Loc. Attikan, District Mysore.
Bot. name Eria braccata Lindl.
Local name
Family Orchidaceae
Collector R. Raghavendra Rao
Coll. No. 1042.

HERBARIUM UNIVERSITY OF MYSORE
Date 4. 10. 70. Herb. No. 5075
Loc. Atti Kan. (B.R. Hills) District Mysore.
Bot. name Eria dalzellii Lindl.
Local name
Family Orchidaceae.
Collector R. Raghavendra Rao.
Coll. No. 1046.

HERBARIUM UNIVERSITY OF MYSORE
Date 4. 10. 70. Herb. No. 3402
Loc. Honnametti District Mysore.
Bot. name Habenaria perrottetiana A. Rich
Local name
Family Orchidaceae.
Collector R. Raghavendra Rao.
Coll. No. 1041.

FIGURE 12. **A**. *Bulbophyllum kaitiense*. **B**. *Eria braccata*. **C**. *Eria nana*. **D**. *Habenaria perrottetiana*. Herbarium image taken from Mysore University.

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POTENTIAL DRIVERS OF SPATIAL DISTRIBUTION OF THE GHOST ORCHID, *DENDROPHYLAX LINDENII*, IN A SOUTH FLORIDA CYPRESS STRAND: A PRELIMINARY STUDY

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Abstract. This study examined a population of ghost orchids (*Dendrophylax lindenii*) in Fakahatchee Strand Preserve State Park in Collier County, Florida, to determine if they exhibit host species preference, vertical stratification, substrate diameter stratification, or a distribution pattern similar to their host plants. Twenty-five ghost orchids were found on three host plant species: 20 (80%) were on pop ash (*Fraxinus caroliniana*), four (16%) on arthritis vine (*Hippocratea volubilis*), and one (4%) on pond apple (*Annona glabra*). Our analysis indicated a statistically significant occurrence of ghost orchids on pop ash relative to other woody plant species in the study area. Although most orchids were found below 3 m from the forest floor, this was not statistically significant when compared to orchids above 3 m. A weak trend (p=0.06) for increasing occurrence was observed in the next to largest (14.1 cm to 17.2 cm diameter at breast height) size class among the five size classes of pop ash in this study. The spatial analyses indicated that both the stems of pop ash and ghost orchids demonstrate non-random clumping on the landscape. In addition, the presence of an individual orchid increases the probability of multiple ghost orchids on a stem. These results further emphasize the importance of pop ash as a host species in Florida's ghost orchid populations and add to the list of hosts (arthritis vine) in the literature. Continuing to study the vertical position of ghost orchids will be important as climate change has the potential to alter humidity patterns and the occurrence of both low temperature events and hurricanes. Improved understanding of host plant preference, microhabitat requirements, spatial distribution, and continued long-term monitoring of population dynamics are critical for the conservation of the ghost orchid.

Keywords / Palabras clave: conservación de plantas, ecología de epífitas, ecología espacial, epiphyte ecology, leafless orchid, Orchidaceae, orquídea áfila, plant conservation, spatial ecology

Introduction. The ghost orchid, *Dendrophylax lindenii* (Lindl.) Benth. ex Rolfe, is a rare epiphytic leafless orchid found in the warm, humid climate of southwest Florida and Cuba (GBIF 2023). In Florida, where it is state listed as endangered, the ghost orchid grows naturally in Lee, Collier, and Hendry Counties (http://florida.plantatlas.usf.edu) where it inhabits cypress swamps and wet hammocks (Wunderlin & Hansen 2011). In Florida, a diversity of tree species has been documented as hosts to ghost orchids including red maple (*Acer rubrum* L.), pond apple (*Annona glabra* L.), pop ash (*Fraxinus caroliniana* Mill.), oaks (*Quercus* species), royal palm (*Roystonea regia* (Kunth) O.F.Cook), and bald cypress (*Taxodium distichum* (L.) Rich.) (Brown & Folsum 2002). In Florida, despite a diversity of substrate availability, the orchids are reported to be found primarily on pop ash, and typically less than 3 m from the soil surface on trunks and main branches of all host species (Mújica *et al*. 2018).

Seed dispersal and subsequent establishment of mature individuals are important contributors to orchid distribution within habitats. Orchid seeds are typically small, produced in large numbers, and wind-dispersed (Arditti & Ghani 2000, Yoder *et al*. 2010). Fruit production by the ghost orchid is variable, including some years when no fruit is produced, and has been reported to be negatively impacted by hurricanes (Mújica *et al*. 2013, Raventós *et al*.

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2015a). The number of seeds per fruit in orchids can be quite high (Arditti & Ghani 2000); however, ghost orchid seed production has not been quantified. Orchid seeds typically lack endosperm (Arditti & Ghani 2000), enabling long-distance dispersal but necessitating an external nutrient source for germination (Yoder *et al.* 2010). Seeds of epiphytic orchids require a physical surface that prevents subsequent dislodging of the seed, retains sufficient moisture, and a substrate containing suitable mycorrhizal fungal species capable of providing carbon, nutrients and water (Callaway *et al.* 2002, Hoang *et al.*2017, Mújica *et al.* 2018). Different tree species likely have differing amounts of suitable microhabitat that meet the criteria for successful colonization and establishment by epiphytic orchids. Such variation in suitable microhabitat among potential host species (Mújica *et al.* 2018), along with variability in the distribution of those species on the landscape would influence and correlate with the distribution of specific epiphytic orchid species.

Compared to animals, plants receive relatively little attention when it comes to conservation and protection. This is likely a function of several factors, such as plant blindness, and conservation efforts focused on charismatic megafauna species (Balding & Williams 2016). Orchids are a plant group analogous to charismatic megafauna and one could argue that ghost orchids could be the “charismatic megaflora” poster child. All plants, including orchids, perform important ecosystem functions and services that are often ignored, such as serving as an energy source for pollinators, and in the case of ghost orchids, serving as recreational and tourism resources. Human activities have significantly impacted orchid populations such as ghost orchids (Wraith & Pickering 2018). Historically, this species has been heavily affected due to poaching by orchid enthusiasts, logging of old growth cypress forests, land use change, and altered hydrology and fire regimes in southern Florida. Looking into the future, it will be further impacted by changes resulting from anthropogenic climate change. Ghost orchids will unlikely be able to sustain their populations given all these pressures from human activities. If they are to remain on the landscape, there is a strong need for conservation efforts focused on protecting and enhancing their populations.

To promote successful conservation and/or recovery of this and other orchid species, the integration of multiple areas of research - genetic diversity, propagation science, pollination biology, mycology, ecology and distribution, and reintroduction - are required (Stewart 2007). While work has been done on the biology of the ghost orchid - exodermis structure and its relationship to mycorrhizal fungi (Chomicki *et al.* 2014), desiccation tolerance (Coopman & Kane 2019), greenhouse acclimatization methods (Coopman & Kane 2018), and germination and seedling development (Hoang *et al.* 2017) - until recently little was known about its ecology (but see Mújica *et al.* 2018, Ray *et al.* 2012, Zettler *et al.* 2011, 2019). Recent ecological studies have primarily focused on the orchid’s population biology and pollinator ecology (Danaher *et al.* 2020, Houlihan *et al.* 2019, Mújica *et al.* 2021, Sadler *et al.* 2011, Zettler *et al.* 2019). This work examined a population of ghost orchids in Fakahatchee Strand Preserve State Park (FSPSP) in Collier County in southwest Florida to determine if ghost orchids in FSPSP exhibit host preference, vertical stratification, substrate diameter stratification, and a distribution pattern similar to that of their host plants. The data presented here will aid in the long-term quantification of both spatial and temporal changes in this orchid population (Zotz *et al.* 1999) and afford a better understanding of this orchid’s population ecology, providing valuable information to those making management and conservation decisions.

Materials and methods

Study site.— Fakahatchee Strand Preserve State Park (FSPSP), located in Collier County in southwest Florida (Fig. 1), experiences a humid, subtropical climate with a mild winter dry season and hot summer rainy season. Mean annual temperature is 23°C, ranging from a mean January temperature of 14°C to a mean August temperature of 28°C (Duever 1986). Most of the region’s mean annual rainfall of 136 cm falls during the summer (Duever 1986).

FSPSP comprises a complex mosaic of ecosystems, including a cypress strand that runs north to south through the center of the Preserve. The strand, regrown after extensive logging in the mid-20th century and characterized by a 6 to 9-month hydroperiod (Ewel 1990), is dotted with deep sloughs with a second growth bald cypress canopy and an understory dominated by pond apple and pop ash. Humidity from the deep waters of the central strand and the ponds within provide insulation for tropical epiphytic orchids during the infrequent cold events that occur in south Florida (Lodge 2016, Mújica *et al.* 2018).

Data collection.— A line-transect of 90 m was established in a mixed bald cypress/pond apple/pop ash slough within FSPSP with a known population of ghost orchids. The geographic coordinates of this population are not described here due to the risk of poaching associated with the study species. Woody plant species within 15 m of the transect and with a dbh (diameter at breast height or 1.3 m) greater than 4 cm were identified, dbh recorded, and their locations mapped. The vertical stems of multi-stemmed trees, such as pond apple and pop ash were mapped individually, to provide a better indicator of habitat availability (Bennett 1986). All ghost orchids were recorded, and orchid heights were quantified as above or below 3 m, based on a previous study (unpublished data) indicating the slough's standing water provided thermal protection up to 3 m above the ground during irregular frost events. Ghost orchids co-occur with the leafless ribbon orchid, *Campylocentrum pachyrrhizum* (Rchb.f.) Rolfe, at this study site but were distinguishable by their significantly less compressed roots which have short white dashes that parallel the direction of growth.

Data analysis.— Likelihood Ratio χ^2 tests were conducted to determine if ghost orchids were randomly distributed among tree species, or at different heights, and on host plant stems of varying dbh. Pearson χ^2 tests were used when data were sparse (Sall *et al.* 2017). We limited our diameter preference analysis to pop ash because most individual ghost orchids in this study were found on this host tree species. Because of its increased power compared to other indices (Goodall & West 1979), the Hopkins Index of Aggregation (A) was computed for pop ash trees, individual pop ash vertical stems, and ghost orchids to determine whether their distributions on the landscape were significantly clumped (A greater than 1) compared to random (A equal to 1) and whether the dispersion pattern of the two species was different (Hopkins & Skellam 1954). The Hopkins Index of Aggregation was computed in Microsoft Excel. All other statistics were conducted in R using package "RVAideMemoire" (Hervé 2019) and in SAS-JMP® Version *14.0* (SAS Institute Inc., Cary, NC).

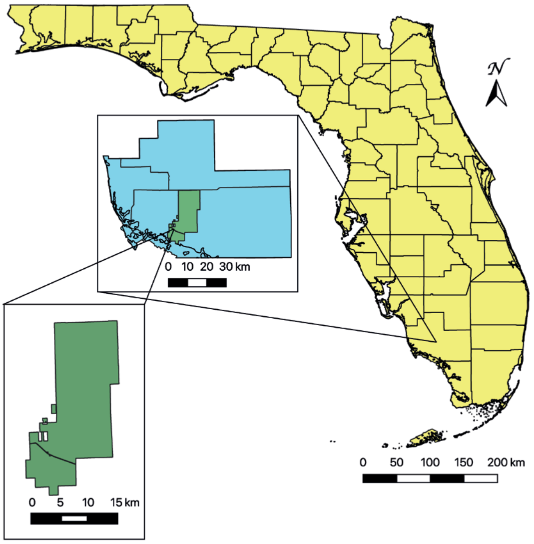

Figure 1. Location of Fakahatchee Strand Preserve State Park in Collier County, Florida (Thomas 2009). The state of Florida is in yellow with county boundaries in black. The insets are of Collier County, Florida in blue and the Fakahatchee Strand Preserve State Park in green.

Results. A total of 695 stems were recorded among 13 woody plant species. *Fraxinus caroliniana* stems totaled 33.5% of all stems measured, bald cypress totaled 25.6%, and pond apple totaled 20.3% (Table 1). Laurel oak exhibited the highest mean dbh (28.7 cm) of all woody plant species while arthritis vine (*Hippocratea volubilis* L.), a woody vine, had the lowest (4.6 cm) (Table 1).

Host species preference.— Twenty-five ghost orchids were found on three host plant species - 20 (80%) on pop ash, four (16%) on arthritis vine, and one (4%) on pond apple (Table 2). Although the sample size is small, by some estimates, it could represent over 1% of the entire Florida population (Zettler *et al*. 2019). Given that most ghost orchids occurred on pop ash (20), we used a likelihood ratio χ^2 to determine whether this frequency was statistically greater on pop ash than other species based upon the host plant species com-

Table 1. Composition of the forested study site, including the number of stems, percentage of all stems, and mean dbh for all woody plant species greater than 4 cm dbh.

Species	**Number of stems**	**% of all stems**	**Mean dbh (cm)**
Pop ash (*Fraxinus caroliniana)*	233	33.5	13.6
Bald cypress (*Taxodium distichum*)	178	25.6	27.7
Pond apple (*Annona glabra*)	141	20.3	7.9
Arthritis vine (*Hippocratea volubilis*)	60	8.6	4.6
Strangler fig (*Ficus aurea*)	29	4.2	9
Dahoon holly (*Ilex cassine*)	22	3.2	8.5
Myrsine (*Myrsine cubana*)	10	1.4	4.9
Red Maple (*Acer rubrum*)	9	1.3	26.1
Sabal palm (*Sabal palmetto*)	7	1.0	*
Gumbo limbo (*Bursera simaruba*)	2	0.3	7
Laurel oak (*Quercus laurifolia*)	2	0.3	28.7
Marlberry (*Ardisia escallonioides*)	1	0.1	5.1
Royal palm (*Roystonea regia*)	1	0.1	*

Table 2. Woody plant species hosting ghost orchids, including stem dbh and the number of orchids found 3 m above and below ground level.

Species	**dbh**	**<3m**	**>3m**
Pond apple	7.7	0	1
Pop ash	5.0	1	0
Pop ash	8.2	1	0
Pop ash	8.4	1	0
Pop ash	8.6	0	1
Pop ash	9.6	1	0
Pop ash	12.1	1	0
Pop ash	13.5	1	1
Pop ash	14.0	0	1
Pop ash	14.3	1	0
Pop ash	14.6	3	0
Pop ash	16.5	0	1
Pop ash	17.2	0	3
Pop ash	23.0	0	1
Pop ash	27.1	1	0
Pop ash	31.9	1	0
Arthritis vine	2.8	0	1
Arthritis vine	2.9	1	0
Arthritis vine	4.0	1	0
Arthritis vine	6.0	1	0

position of the forest (Fig. 2). This analysis indicated a statistically significant occurrence of ghost orchids on pop ash relative to all of the other species in the study area ($\chi^2 = 30.3$, $p<0.01$).

To determine if the distribution on pop ash was greater than expected for just the species it occurred on in this study, the frequencies of *D. lindenii* were compared against the relative frequencies of only pond apple, pop ash, and arthritis vine. The Pearson χ^2 test indicated significantly more ghost orchids on pop ash and less on pond apple compared to what would be expected given their relative frequencies in the study area ($\chi^2 =9.9$, $p<0.01$). However, comparing the frequencies of ghost orchids against the relative basal areas of the host plant species on which it occurred, arthritis vine, representing only 2% of the relative basal area of host species, accounted for significantly more of the ghost orchid occurrences (16%) than would be expected ($\chi^2 =14.6$, $p<0.001$). Pond apple accounted for fewer than expected ghost orchids compared to its relative basal area contribution of 17.5% and pop ash accounted for 80% of the ghost orchids, matching its 80% contribution to the relative basal area of the species upon which ghost orchids were growing.

Vertical stratification.— Fifteen ghost orchids (60%) were found growing below 3 m and 10 (40%) were growing above 3 m (Table 2). A likelihood ratio χ^2 was used to determine if this differed significantly from a

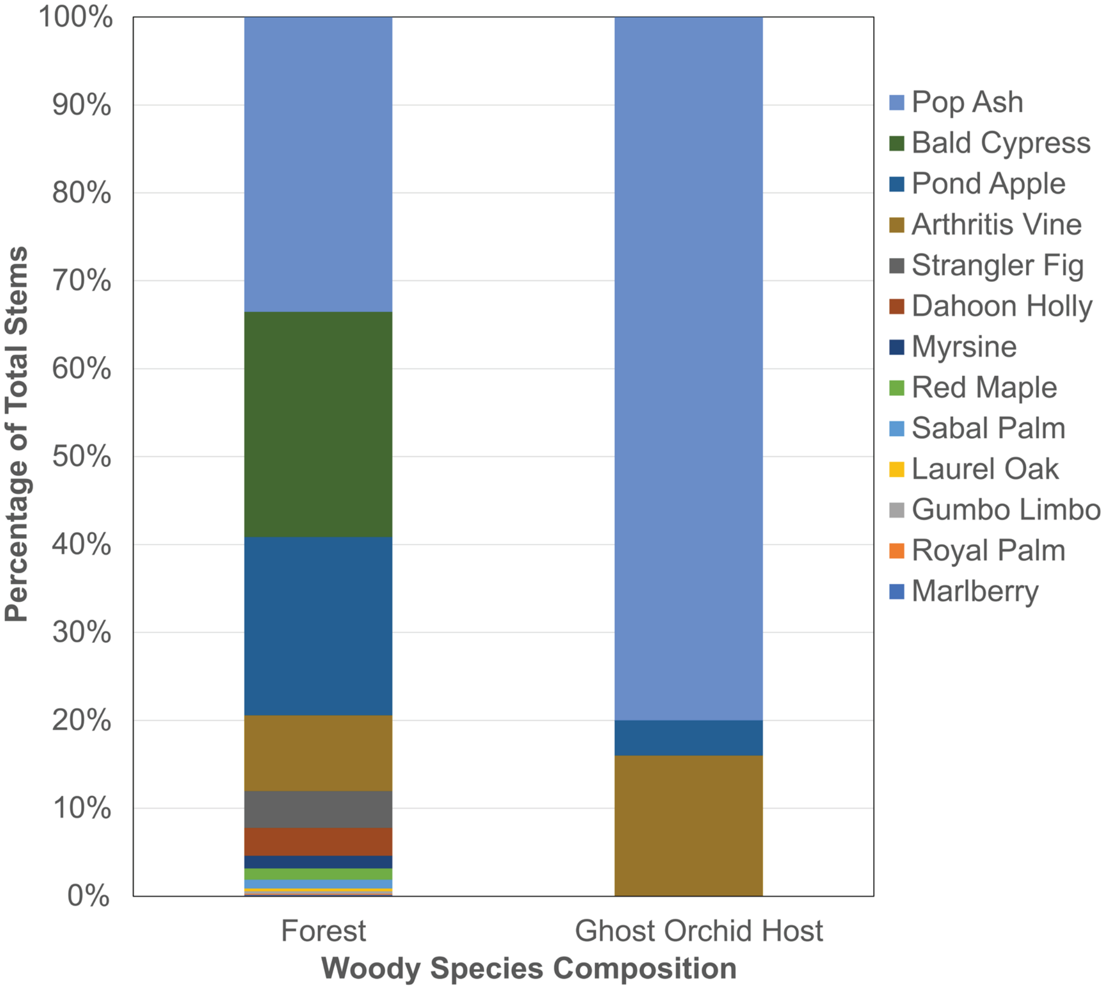

FIGURE 2. Woody plant species composition of the forested study site and the composition of the ghost orchid host species, calculated as a percentage of all stems.

50:50 ratio. The data in this study do not indicate a statistically greater number of ghost orchids occurring <3m from the forest floor compared to above that height (χ^2=1.0, p=0.32).

Substrate diameter stratification.— To assess host plant diameter preference, we divided all pop ash stems into five dbh classes, each containing approximately equal numbers of stems (Table 3). Most ghost orchids growing on pop ash were found on stems between 14.1 cm and 17.2 cm dbh (Table 3). The χ^2 test indicated a weakly significant deviation from a random distribution of ghost orchids across the five dbh categories (χ^2 =9.07, p=0.06).

Dispersal.— The spatial distribution of individuals of both ghost orchids and pop ash were assessed in two separate ways. First, the Hopkins Index of Aggregation (A') was computed for the locations of the pop ash trees, the individual pop ash stems, and the ghost orchids. The data in this study indicate the trees and stems of pop ash and the epiphytic ghost orchids demonstrate departures from random dispersal on the landscape (Table 4) with all of them being significantly clumped (p<0.01). The pop ash trees showed the lowest Index of Aggregation (3.0), and ghost orchids had the highest (9.0).

Additionally, we tested whether the presence of ghost orchids on a host plant significantly increased the

TABLE 3. Number of ghost orchids per dbh class of pop ash used to assess host diameter preference. All stems greater than 4 cm dbh were categorized into the classes below so that each class contains nearly equal numbers of stems.

F. caroliniana dbh class (cm)	Number of stems per class	Number of *D. lindenii* per class
<9.2	49	4
9.2–11.8	49	1
11.9–14.0	50	3
14.1–17.2	49	9
>17.2	49	3

probability of having multiple ghost orchids (13.0%) present on the same host compared to the probability of any stem in the study being host to at least one ghost orchids (2.9%) or not (97.1%). The Pearson χ^2 test on these data indicates a significantly increased probability of multiple individuals of ghost orchids occurring on a host plant if there is at least one individual present (p=0.004). This test is further evidence of increased clumping in ghost orchids compared to its host plants.

Discussion

Host species preference.— Pop ash served as the primary host for ghost orchids growing in a mixed cypress strand in FSPSP, as has been reported in nearby Florida Panther National Wildlife Refuge (Coopman & Kane 2019, Mújica *et al*. 2018). Alternatively, Sadler *et al.* (2011) reported pond apple as the predominant host species in another ghost orchid population in Collier County. This work documents a greater utilization of pop ash than previously reported (Mújica *et al.* 2018) and describes arthritis vine, a woody vine, as a new host species for ghost orchids in south Florida. Further, this work examined the distribution of ghost orchids in relation to the relative proportion of the woody plant species in the forested transect.

Although there were more pop ash stems within the transect than the other woody species, ghost orchids were not randomly distributed among all species, or randomly distributed among the stems of host species at the site. For example, pond apple made up 20.3% of all stems, but only one ghost orchid (4% of total individuals) was found on this species. In contrast, bald cypress made up 25.6% of all stems, but hosted no ghost orchids. The orchid's distribution is likely explained by the synergy of several factors influencing host preference in epiphytes. However, as suggested by Zettler *et al.* (2019) this preference for pop ash by the ghost orchid must also be considered in the context of the invasion of the exotic emerald ash borer as a threat to this preferred host.

TABLE 4. Hopkins index of aggregation A' and associated t-statistics and p-values for pop ash and ghost orchids observed in this study. A random dispersion pattern on the landscape is indicated if A'=1, A'<1 indicates a uniform or regular pattern and A'>1 signifies clumping.

Species	A'	t-statistic	p-value
Pop ash trees	3.0	5.04	<0.01
Pop ash stems	4.2	6.21	<0.01
Ghost orchids	9.0	8.03	<0.01

Pop ash and pond apple are similar in architecture, often producing multiple stems per tree, while the other woody species in the study site tend to produce one main stem per tree. Multiple stems from the same root system would create proximal suitable habitat for wind-dispersed orchid seeds from parent plants. Although similar numbers of stems existed for pop ash and pond apple (Table 1), pond apple only served as host to one ghost orchid.

Age of the host tree may also influence host preference (Benzing 1980). Successful pollination of ghost orchids is rare (Luer 1972) as is successful seed germination (Zettler *et al*. 2011). In addition, epiphytic orchids are slow-growing due to the resource-limited environments in which they live (Laube & Zotz 2006). Therefore, an older substrate may have an increased probability of hosting ghost orchids than a younger substrate. For example, Thomas (2009) found that pop ash growing in another slough in FSPSP were older than bald cypress in the same slough by 30-40 years, likely due to successional processes during recovery following logging in the 1940s and 1950s.

No data were collected on bark roughness for this work, although bark texture is known to affect host preference in epiphytes (Benzing 1990) and is suggested as critical to ghost orchids (Zettler *et al*. 2019). A rough surface creates cracks and fissures where moisture can potentially be retained and seeds lodge until conditions are right for germination (Callaway *et al*. 2002, Hoang *et al*. 2017, Mújica *et al*. 2018). Zarate-García *et al.* (2020) more specifically suggest bark water storage linked to microrelief characteristics influences phorophyte preferences of orchids. Mújica *et al.* (2018) characterize pop ash and pond apple bark as corrugated, with crevices between 0.5 and 2.0 cm deep, and suggest bald cypress has "smoother bark" than these species. Brown (1984, p.18) describes bald cypress bark as "…an interwoven pattern of narrow flat ridges and narrow furrows," which may suggest bald cypress as a suitable substrate for ghost orchid seeds. However, unlike pop ash and pond apple, bald cypress sheds its bark, perhaps explaining why no ghost orchids were found on this potential host species.

Recent research emphasizes the role of mycorrhizal fungi in the life cycle of epiphytic orchids. Orchids require these fungi to stimulate germination (Yoder 2000). Rasmussen (2002) and Gowland *et al*. (2011) suggest host preference may be related to the mycobiont found on a host species. A strain of *Ceratobasidium* grows symbiotically with adult ghost orchids in Florida (Mújica *et al*. 2018) and improves germination and seedling development (Hoang *et al.* 2017). The presence of this strain or other fungal symbionts may be necessary for establishment of ghost orchids (Mújica *et al.* 2018, Hoang *et al*. 2017). Suitability of host plants for ghost orchid establishment therefore may be determined partially by the fungal species present on the hosts. The endophytic fungal strains studied by Hoang *et al*. (2017) were collected from a ghost orchid population in the Florida Panther National Wildlife Refuge in Southwest Florida. Hoang *et al*. (2017) did not specify the host plants supporting the individual ghost orchids that they sampled but reported that most epiphytic orchids in their study area grew on pop ash and pond apple. While explored to some extent by Johnson (2019), the importance of fungal symbionts to the establishment of ghost orchids and other epiphytic orchids warrants further investigation into the spatial distribution and potential host plant preference of these fungal species.

Vertical stratification.— We anticipated a significant tendency for the orchid to occur below 3 m, as has been reported (Mújica *et al*. 2018). Although most of the individuals we located were below 3 m (15 of 25), the trend was not significantly different from a random distribution above and below 3 m. Canopy height was not assessed in this study but may significantly impact vertical stratification of ghost orchids because of differences in solar radiation and vapor pressure deficit. Future investigation of the role of canopy height on orchid vertical stratification across populations from different locations would provide valuable insights into the observed differences across studies. It is difficult to quantify the available space for potential colonization, given the variable stem diameter and height of potential host species and the complex surfaces of these stems at greater height with numerous branches. It is possible that ghost orchid occurrence at higher positions in the canopy may be underreported as seeing this leafless orchid in upper canopy levels would be difficult when not in flower. Alternatively, many epiphytes are sensitive to higher light levels found in higher positions in the canopy (Laube & Zotz 2006). In addition, a pilot study indicated standing water in the swamp provides thermal protection of up to 2^{o}C as high as 3 m above the ground surface from irregular frost events (unpublished data). It may be that historical vertical distributions were driven in part by cold events, but these events are likely to decrease in the future due to climate change. Mújica *et al*. (2013) found no differences in the mean height of surviving and non-surviving ghost orchid individuals following Hurricane Ivan in Cuba, suggesting that hurricane damage may not differentially affect individuals based on vertical position on the host plant. However, continuing to study the vertical position of ghost orchids in the canopy will be important as climate change can alter the occurrence of both low temperature events and hurricanes, particularly in landscapes impacted by human activities that alter hydrology.

Substrate diameter stratification.— The distribution of ghost orchids among pop ash stems of varying diameter was not random. Rather, ghost orchids exhibited a weak preference for larger stems, specifically those between 14.1 and 17.2 cm dbh. Abe *et al*. (2018) found a similar trend among the Okinawa dendrobium (*Dendrobium okinawense*)*,* an epiphytic orchid from Japan. Larger, and hence older, trees often have rougher bark, creating crevices for orchid seeds, symbiotic fungi, and sufficient moisture to support them both. In addition, older trees would give the slow-growing orchids a longer opportunity to establish and grow.

We did not collect data on the size of the ghost orchid individuals. However, individuals were found on the smallest size class of pop ash (<9.2 cm dbh) suggesting relatively recent establishment, possibly indicating this population is not 'senile' (Zettler *et al*. 2019) but may be actively recruiting.

Dispersal.— In terms of aggregation of ghost orchids, the data from this study indicated individuals of their primary host species, pop ash, have a clumped spatial arrangement on the landscape. As would be expected, the stems of pop ash with ghost orchids appear to be even more clumped. Such a spatial arrangement on the landscape may be a function of dispersal (e.g. Trapnell *et al*. 2013) or appropriate microhabitat conditions during establishment. The clumped arrangement of pop ash likely is contributing to the clumping observed in ghost orchids. However, our analysis suggests additional dispersal and/or microhabitat limitations on ghost orchids may be further influencing its dispersion pattern. Many variables determine the suitability of a host plant species, including bark stability and texture, age and architecture, and bark chemistry (Migenis & Ackerman 1993, Zettler *et al*. 2019). In addition, abiotic and biotic factors including fungal associations, temperature, irradiance, relative humidity, water availability, wind speed and direction during seed dispersal events, may collectively contribute to the clumping patterns observed in this species, and all warrant further investigation.

Establishment of new populations may be driven primarily by a few founding individuals who later reproduce, with nearby establishment of offspring, or by the concurrent arrival and establishment of many founding individuals. Trapnell *et al*. (2013) inferred the former pattern in the epiphytic Lady of the Night orchid, *Brassavola nodosa* (L.) Lindl. It is not known which pattern is typical of ghost orchid populations. However, the population dynamics of ghost orchids suggest that recruitment of new individuals, along with reproductive success, is especially important in maintaining a stable population (Raventós *et al.* 2015b). Population decline has been reported in ghost orchid populations affected by hurricanes (Mújica *et al*. 2013, Raventós *et al*. 2015a), which are predicted to become more intense under climate change projections (Knutson *et al*. 2010). Hurricane events may negatively impact host plants, and they can influence orchid-pollinator species interactions (Ackerman & Moya 1996, Mújica *et al*., 2018, Zettler *et al*. 2019). However, unpublished data from Fakahatchee Strand Preserve State Park suggests increased seed capsule production following hurricane disturbance. This dichotomy may suggest the response of this species varies according to hurricane intensity and ecosystem structure. Therefore, an improved understanding of host plant preference, microhabitat requirements, disturbance impacts and distribution of ghost orchids is crucial for the conservation of this charismatic epiphytic orchid.

Conclusion. Conservation of the ghost orchid in southern Florida must include both protection and additional research to better understand its ecology. This work adds to the understanding of ghost orchid spatial distribution and suggests potential drivers of that distribution. Long-term monitoring of this population should be continued to quantify spatial and temporal changes, particularly in a time of changing climate. However, due to the risk of poaching, this should be done with the utmost of discretion. At the time of this writing, several of the orchids within this population have been removed by humans since the fieldwork was completed.

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A NEW *MASDEVALLIA* (PLEUROTHALLIDINAE) FROM THE HUANUCO REGION IN PERU

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Abstract. A new *Masdevallia* from the cloud forests of Huanuco, Peru, is described and illustrated. It is morphologically similar to what is considered to be its closest relatives, the sympatric *Masdevallia fenestralis* and *Masdevallia fenestrellata*, but differs from both by the lack of translucent fenestrations ("window-like" areas) near the base of the sepals, and by the presence of distinct external ridges of the sepals.

Resumen. Una nueva *Masdevallia* de los bosques nublados de Huánuco, Perú, es descrita e ilustrada. Se compara con las que son consideradas sus parientes más cercanas, las simpátricas *Masdevallia fenestralis* y *Masdevallia fenestrellata*, pero difiere de ambas por la falta de áreas transparentes cerca de la base de los sépalos, y por la presencia de distintivas crestas externas en los sépalos.

Keywords/ Palabras clave: los Andes, new orchid, nueva orquídea, Peruflora, redescubierta, rediscovered, the Andes

Introduction. The taxonomic classification of *Masdevallia* Ruiz & Pav. has been and still is complicated. Before molecular research was available to taxonomists, the classification was based on morphological features. But once the "secrets" of the DNA molecule were revealed, multiple options how to split large orchid genera into smaller entities became available. But regardless how "correct" this remarkable scientific development is, it still leaves plenty of room for subjective preferences in taxonomic treatments. In 2006, the genus *Masdevallia* had grown to include more than 500 species (Luer 2006), classified into numerous subdivisions (Luer 2000a,b, 2001, 2002, 2003). This vast number of species, in combination with newly available molecular evidence (Pridgeon & Chase 2001), encouraged Luer to split the genus into 16 new genera, in addition to the remaining *Masdevallia* (Luer 2006). However, the taxonomic advantages of this division of *Masdevallia* (Luer 2006) are questionable and not recognized by the present and other authors, mainly due to the difficulties in separating the new genera from each other in consistent ways, and difficulties in identifying to which genus many species belong. Therefore, we favor the previous and more conservative taxonomic treatment of the genus as circumscribed by Luer (2000a,b, 2001, 2002, 2003), for scientific, user-friendly and practical reasons.

The genus *Masdevallia* is currently represented in Peru by approximately 198 recognized species, excluding the one described here (POWO 2023). The origin of the cultivated type specimen of this latter species is from a collecting trip in 2010, to the rich cloud forest east of Monopampa, Huanuco (Fig. 1). Several plants were collected in this area on that occasion and were introduced into cultivation and propagation by Peruflora, an officially authorized plant nursery established for the conservation and commercial utilization of native Peruvian plants, including orchids. When the cultivated *Masdevallia* plant flowered, it was compared to flowering plants recently observed and photographed by the authors along the new road between Monopampa and Pozuzo (Fig. 2–4). The conclusion is that they are the same and represent a new species to science, which is described here.

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Figure 1. The habitat of *Masdevallia emieliana* in the rich cloud forests of eastern Huanuco. Photo by Stig Dalström.

Taxonomic treatment

Masdevallia emieliana Dalström, Deburghgr. & Ruíz Pérez, ***sp. nov.*** (Fig. 2, 3, 4, 5).

TYPE: Peru. Region of Huanuco: Province of Pachitea, District of Chaglia, Location: Millpo, along the ancient trail between Monopampa and Pozuzo, exact GPS coordinates for the original collection uncertain, flowered in cultivation 16 Nov, 2022 by Peruflora, *S. Dalström 3942* (holotype: USM, accession N° 331222).

Diagnosis: *Masdevallia emieliana* appears to belong to the subgenus *Pygmaeia*, section *Amaluzae*, and seems to be most morphologically similar to *M. fenestralis* Dalström & Ruíz Pérez, and *M. fenestrellata* Dalström & Ruíz Pérez (Dalström & Ruíz Pérez 2015) which are sympatric. The new species differs from both by lacking the basal sepaline translucent fenestrations (“window-like” structures) and by the presence of external sepaline ridges. Although the basic general floral features of this new species are similar to many other *Masdevallia* species in other subgenera, the vegetative habit and the production of a second flower on the threadlike inflorescence, however, are very similar to the above-mentioned sympatric species, which suggests a close relationship.

Epiphytic *herb*. *Plant* medium sized for the subgenus, with a creeping rhizome with distant ramicauls *ca*. 2 cm apart, partially enclosed by one 5–6 mm long sheath. *Ramicauls* erect and rather thin, *ca*. 1.2–1.5 mm in diameter, *ca*. 30–35 mm long, enclosed basally by one to three 7–22 mm long tubular sheaths. *Leaf* erect to arching, petiolate, slender, longitudinally furrowed, *ca* 1.5 mm in diameter and *ca*. 60 mm long, blade basally conduplicate and cuneate, elliptic, with a broad and slightly folded apicule, 35–45 × 14–17 mm. *Inflorescence* erect, very thin and thread-like, *ca*. 1 mm in diameter, with a

Figure 2. Author Deburghgraeve inspects a blooming plant of what became *Masdevallia emieliana*. Photo by Stig Dalström.

Figure 3. Side view of the flower of *Masdevallia emieliana*. Photo by Stig Dalström.

Figure 4. Front view of the flower of *Masdevallia emieliana*. Photo by Stig Dalström.

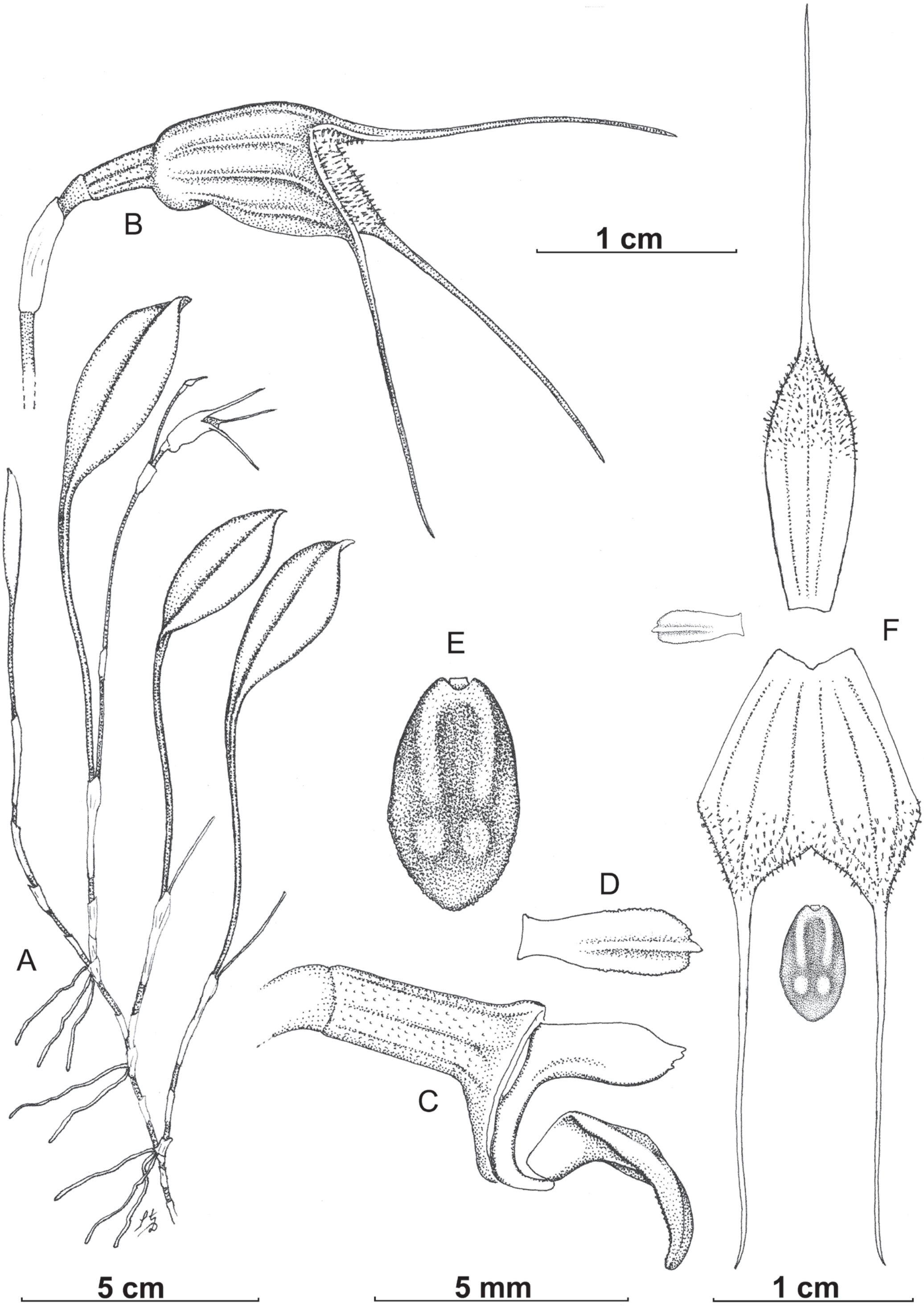

FIGURE 5. *Masdevallia emieliana* Dalström, Deburgh. & Ruíz Pérez. **A**. Plant habit. **B**. Flower lateral view. **C**. Lip, column, and ovary, lateral view. **D**. Petal, abaxial side. **E**. Lip, adaxial side. **F**. Flower dissected. Drawn from the holotype by Stig Dalström.

second successive flower on larger plants (like for the type), with an up to *ca*. 7 cm long peduncle; *peduncular bract* 1, tubular, *ca*. 6–7 mm long; *floral bract* appressed, tubular, 6–7 mm long; *pedicel* excluding the ovary *ca*. 8 mm long; *ovary* shallowly sulcate, smooth, with scattered tiny "fungal pits" (Dalström & Ruíz Pérez 2016), 2.4–2.5 mm long. *Flower* cupulate, forming a *ca.* 10 mm long sepaline cup; *dorsal sepal* whitish with purple irregular stripes along raised fleshy ridges, which follow the veins, internally similarly colored, but without furrows along the veins, apically covered with fine white hairs, *ca.* 13 × 5 mm, connate to the lateral sepals for 7–8 mm, then obtuse and terminated in a whitish, basally purple spotted *ca*. 18 mm long tail; *lateral sepals* similar in texture, hairiness and coloration, connate to the dorsal sepal, then obliquely acute, fused to each other for *ca.* 9–10 mm, and *ca*. 12 × 10 mm when measured combined, with apical, slender, whitish *ca*. 18–19 mm long tails; *petals* whitish, cartilaginous, indistinctly unguiculate with a distinct, longitudinal, central, fleshy ridge emerging from the middle of the petal and ending in a fleshy protruding apicule, *ca*. 3.5 × 0.9–1.0 mm; *lip* whitish with purple center furrow and purplish hue apically, attached to the column foot by a short, strap-like "hinge", lip lamina basally u-shaped then angled into an elliptic, flat, fleshy lamina, with two parallel longitudinal ridges, emerging from the base and ending near the middle of the lamina, then with a pair of low, fleshy knobs between the end of the ridges and the obtuse apex of the lamina, *ca*. 4.5 × 2.5 mm; *column* whitish, straight, *ca*. 2.7 mm long, apically indistinctly serrate, with an equally long, curved and apically hook-shaped foot; *antercap* and *pollinia* not seen.

Other specimens examined: Peru. Huanuco: Millpo, in wet cloud forest along the road between Monopampa and Pozuzo, S 09°48.123'; W 75°42.589', alt. 2622 m, 16 Nov. 2022. Digital images only; Fig. 1–3 (Dalström archives). A few flowering plants were observed and photographed growing epiphytically on mossy branches. No other populations are known.

Distribution: *Masdevallia emieliana* is only known in the wild from the wet forests east of Monopampa, Huanuco, Peru.

Eponymy: This species is named in honor of Emiel Coppens of Nieuwerkerken near Aalst, Belgium, for being a great source of inspiration to the second author.

Acknowledgments. The authors acknowledge the Ministerio de Agricultura, Dirección General, Forestal y de Fauna Silvestre, for issuing the collection permit No 0283-2010-AG-DGFFS-DGEFFS. The authors thank Manolo Arias and his family for invaluable assistance, support and hospitality. The authors also thank Wesley Higgins and anonymous reviewers for viewing and improving the manuscript.

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PACHYGENIUM MUYSCARUM (SPIRANTHINAE), A NEW OVERLOOKED SPECIES FROM THE SUBXEROPHYTIC ENCLAVES FROM THE EASTERN RANGE OF COLOMBIA

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Abstract. *Pachygenium muyscarum*, a new species from Colombia, is described, illustrated, and aspects related to its distribution, ecology, conservation status, and relationships with morphologically similar species are discussed. This species is characterized by flowering without leaves, labellum 1.4–1.6 cm long, with the apex trilobulate and labellum nectar glands 0.2–0.4 cm long, subulate and uncinate. To date, this is the only species of the genus present in Colombia, being endemic to the subxerophytic enclaves of Cundinamarca.

Resumen. *Pachygenium muyscarum*, una especie nueva de Colombia, es descrita, ilustrada y se discuten aspectos relacionados con su ecología, estado de conservación y relaciones con especies morfológicamente similares. Esta especie se caracteriza por florecer sin hojas, labelo de 1.4–1.6 cm de longitud, de ápice trilobulado y glándulas de néctar del labelo de 0.2–0.4 cm de longitud, subuladas y uncinadas. A la fecha, esta especie es la única representante del género en Colombia y es endémica de los enclaves subxerofíticos de Cundinamarca.

Keywords / Palabras clave: flora de Bogotá, flora de Cundinamarca, flora of Bogotá, flora of Cundinamarca, high-Andean terrestrial orchids, orquídeas terrestres altoandinas, *Pelexia*

Introduction. Subtribe Spiranthinae is the most species-rich clade of terrestrial orchids in the New World, with *ca*. 40 genera and 500 species (Salazar *et al*. 2018). One of the largest genera in this subtribe is *Pelexia* Poit. ex Lindl. (Lindley 1826), which in its broad sense includes about 77 species (Chase *et al.* 2015). Schlechter (1920a) recognized five sections within *Pelexia*: *Cogniauxocharis* Schltr., *Centropelexia* Schltr., *Pachygenium* Schltr., *Pelexia*, and *Potosia* Schltr. The monotypic *Potosia* and one of the species of *Cogniauxocharis* have been shown to belong to *Sarcoglottis* C.Presl (Presl 1827) and *Pteroglossa* Schltr. (Schlechter 1920a), respectively (Salazar *et al.* 2018). In turn, the two species assigned by Schlechter to the section *Centropelexia* shared many features with the type species of *Pelexia*, *P. adnata* (Sw.) Spreng. (Sprengel 1826), and therefore, there is no way to distinguish this section from the section *Pelexia* (Salazar *et al*. 2018). The remaining two sections [“Eu-”] *Pelexia* and *Pachygenium*, have received different treatments in recent classifications, either as congeneric (Balogh 1982, Garay 1982, Salazar 2003) or as two separate genera (Rutkowski *et al*. 2008, Szlachetko *et al*. 2001, Szlachetko *et al*. 2005).

Salazar *et al*. (2018) assessed the phylogenetic relationships in Spiranthinae, analyzing nuclear and

ORCID of the Author: AFC, MRG, JLL, GAS
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plastid DNA markers of a nearly complete generic sample and about one-third of the species of the subtribe. Their results recovered two strongly supported clades corresponding to sections *Pelexia* and *Pachygenium*. Nevertheless, the low bootstrap support prevents knowing with certainty the relationships of these groups with *Brachystele* Schltr. (Schlechter 1920b). The authors of that article suggested a possible closer relationship between the *P.* sect. *Pachygenium* and *Brachystele*, based on their richness centered in eastern South America, their preference for open grassy habitats, and the pollination by bumblebees (*Bombus* spp.). In contrast, the diversity of *Pelexia* s.s. is widespread from the Andean region to Mexico and the Caribbean, its species inhabit forests, and the pollination is carried out by euglossine bees (G. Gerlach pers. comm.). All the above is consistent with the recognition of the sections *Pelexia* and *Pachygenium* (Schltr.) Szlach., R.González & Rutk. (Szlachetko *et al*. 2001) as distinct genera.

Morphologically, *Pachygenium* is distinguished from *Pelexia* by the presence of leaves gradually attenuating (vs. abruptly contracted into a pseudopetiole in *Pelexia*), the proportionately broad and wide lateral sepals, and the saccate nectary spur (vs. proportionately narrow, long lateral sepals and rounded or sharp spur). Other floral morphological differences indicated by Szlachetko *et al*. (2001) as distinctive, such as details of the rostellum and stigma, do not hold true as distinctive characters upon close examination (Salazar *et al*. 2018).

In their synopsis of the "spiranthoid" orchids of Colombia, Dueñas & Fernández-Alonso (2009) recorded 14 species of *Pelexia* s.l., including two assignable to *Pachygenium* sensu Szlachetko *et al*. (2001), namely *P. hirta* (Lindl.) Schltr. (Schlechter 1920b) and *P. orobanchoides* (Kraenzl.) Schltr. (Schlechter 1920b). The specimen quoted by Dueñas & Fernández-Alonso (2009) as *P. orobanchoides* (*M. Schneider 679/1*, COL!) had been designated by Szlachetko as the type of his new species, *Pelexia cundinamarcae* Szlach. (Szlachetko 1993), which appears to have been overlooked by Dueñas & Fernández-Alonso (2009). On the other hand, the specimen determined as *P. hirta* (*R. Schnetter 494*, COL!) corresponds to the new species here described as *Pachygenium muyscarum*.

Here, we propose a new species of *Pachygenium* which is described and illustrated. Its possible relationships to other species are discussed on morphological grounds, and information about its distribution, ecology, and conservation status is provided.

Materials and methods. We conducted fieldwork at the Parque Ecológico Cerro Seco, Ciudad Bolívar locality, Bogotá D.C., in May–June 2019, May–June 2021, December 2021, and January–February 2022. The vouchers were deposited at JBB. To determine the generic identity of the species, we consulted the pertinent literature on the taxonomy of the subtribe Spiranthinae (Szlachetko *et al*. 2001, Dueñas Gómez & Fernández-Alonso 2007, 2009, Salazar *et al*. 2018). For the circumscription of *Pachygenium*, we followed Salazar *et al*. (2018). We followed the terminology of Balogh (1982), and for the seed coat morphology that of Molvray & Kores (1995); we measured the organs with a digital caliper and observed the specimens under a stereomicroscope Motic SMZ 168. We examined the protologues of the types deposited in JSTOR PLANTS website (http://plants.jstor.org), the collections of COL, HUA, HUQ, HUAZ, JBB, JAUM, MEDEL, MEXU, and the virtual collections (digital photographs) of A, BHBC, F, HBG, K, MBM, NY, RB, and U (acronyms follow Thiers 2022). We followed the morphological species concept (McDade 1995, Wiens & Servedio 2000, De Queiroz 2007). The Geospatial Conservation Assessment Tool (GeoCAT) application (http://geocat.kew.org/) was used to establish the conservation status, according to the categories and criteria of IUCN (2019).

TAXONOMIC TREATMENT

Pachygenium muyscarum Rinc.-González, Fonseca-Cortés & Salazar, ***sp. nov.*** Fig. 1–4.

TYPE: Colombia. Cundinamarca: Bogotá D.C., Ciudad Bolívar, Arborizadora Alta, Cerro Seco, 2800 m, 15 July 2021, *M. Rincón-González, A.I. Díaz & M. Pinzón 1842* (holotype: JBB!).

DIAGNOSIS: *Pachygenium muyscarum* is morphologically similar to *P. tamanduense* (Kraenzl.) Szlach., R.González & Rutk., from which it differs by flowering without leaves (vs. flowering with leaves), labellum 1.4–1.6 cm long (vs. 1.2–1.4 cm long), apical labellum lobe trilobate (vs. entire, rounded) and labellum nectar glands 0.2–0.4 cm long (vs. up to 0.1 cm long).

Terrestrial *herb*, 3–5 cm in height without the inflorescence and 15–30 cm in height, including the inflorescence. *Roots* 10–20 × 0.5–0.8 cm, fasciculate, terete, attenuating slightly towards the apex, pale dull yellowish. *Leaves* 6–16 × 1–2 cm, 4–6 when present, elliptic-lanceolate, 5–6 parallel nerved, base attenuate, margin entire, apex acute, dark green adaxially, pale green abaxially, forming a rosette, with the leaves ascending; pseudopetioles sublinear, channeled, white adaxially, tawny abaxially. Inflorescence 15–25 cm long, racemose, erect, glabrous below the middle, becoming increasingly villose towards the apex, hairs multicellular and clavate; peduncle 12–20 cm long; sheaths 3.7–5.0 × 0.7–1.0 cm, 5–12, lanceolate, chartaceous, yellowish green at the base, green on the rest, glabrous; *floral bracts* 1.8–2.5 × 0.6–0.8 cm, elliptic-lanceolate, concave, cuneate, 3–4 veined, olive green, tomentose with multicellular, clavate, caducous hairs, margins irregularly ciliate and becoming papillose near the apex. *Flowers* 0.8–1.4 cm long, ascending, resupinate, dorsal sepal green, lateral sepals green with the margins white, tomentose abaxially, glabrous adaxially, petals green with the apex white, labellum green at the base, white in the middle at the apex, with greenish dorsal vein. *Dorsal sepal* 8–1.2 × 0.4–0.6 cm, ovate-lanceolate, concave, 3–5 veined. *Lateral sepals* 1.2–1.4 × 0.3–0.5 cm, lanceolate-falcate, concave, 3–5 veined, base fused into a saccate nectary. *Petals* 1.0–1.2 × 0.2–0.3 cm, oblong, spatulate, 3–5 veined, fused internally at the base with the dorsal sepal, apex acute, external margin irregularly papillose above the middle. *Labellum* 1.4–1.6 × 0.4–0.6 cm, panduriform, with 3–9 veins, base provided at each side with one subulate, uncinate nectar gland, 0.2–0.4 × to 0.1 cm, apical lobe 0.4–0.6 × 0.4–0.6 cm, rounded. *Column* 0.8–1.2 × 0.1–0.2 cm, terete, papillose, canaliculate; anther 0.2–0.4 cm long, ellipsoid; rostellum 0.1–0.3 cm long, triangular; ovary 1.3–1.6 × 0.3–0.5 cm, fusiform, cylindrical, green, tomentose; stigma concave, slightly bilobed. *Pollinarium* 4.0–4.1 × 1.9–2.0 mm, wishbone-shaped, with two creamy-white pollinia; pollinia 3.0–3.2 × 0.8–1.0 mm, ellipsoid, creamy-white, viscidium 0.3–0.5 × to 0.1 cm, rhomboid, grey. *Capsule* 1.6–1.7 cm long × 0.6–0.7 cm wide, elliptic, tomentose, with 3 longitudinal keels, perianth persistent, brown. *Seeds* 0.5–0.8 × 0.15–0.20 mm, seed coat spiranthoid type, with 12–15 cells in length and 5–7 in width, cells rectangular with one of both ends arched and prominent, embryo 0.25–0.30 mm, ovoid.

Etymology: The specific epithet "muyscarum" commemorates the indigenous ethnic group Muysca, who inhabit the Cundinamarca-Boyacá highlands where this species grows.

Distribution and habitat: To the date, *P. muyscarum* only has been found in four localities of Cundinamarca, located in subxerophytic enclaves between 2600–2800 m a.s.l. (Fig. 6). This species grows on hills with slopes with an inclination of 15–20° and well-drained soils, with an A or A/E horizon formed from the root activity within a well-drained, silty sand, thick eluviated horizon (originally formed from altered volcanic ash), which became enriched in quartz (>70%), feldspars, hornblende, and cristobalite, with some remnant (about 10%) of halloysite clay. It exhibits a pH close to 6, about 2% organic carbon, base saturation close to 60%, and low K and P contents. Below this horizon, a sequence of intercalated clayey and silty horizons with variable thickness follows, which are richer in K and P (León Linares *et al.* unpubl. data). *Pachygenium muyscarum* grows under the shadow of *Dodonaea viscosa* Jacq. (Jacquin 1760) or exposed to the sun besides *Anthoxanthum odoratum* L. (Linnaeus 1753), *Bidens andicola* Kunth (Kunth 1818), *Cuphea ciliata* Ruiz & Pav. (Ruiz & Pavón 1794), *Desmodium molliculum* (Kunth) DC. (De Candolle 1825), *Echeandia flavescens* (Schult. & Schult.f.) Cruden (Cruden 1981), *Euphorbia orbiculata* Kunth (Kunth 1817), *Evolvulus bogotensis* Ooststr. (Ooststroom 1934), *Hypericum brevistylum* Choisy (Choisy 1821), *Jarava ichu* Ruiz & Pav. (Ruiz & Pavon 1798), *Laennecia gnaphalioides* (Kunth) Cass. (Cassini 1822), *Myriopteris myriophylla* (Desv.) J.Sm. (Smith 1854), *Nassella mucronata* (Kunth) R.W.Pohl (Pohl 1990), *Pombalia parviflora* (L.f.) Paula-Souza (Paula-Souza & Ballard 2014), *Rhynchospora nervosa* (Vahl) Boeckeler (Boeckeler 1869), *Selaginella sellowii* Hieron. (Hieronymus 1900), and *Stenandrium dulce* (Cav.) Nees (De Candolle 1847).

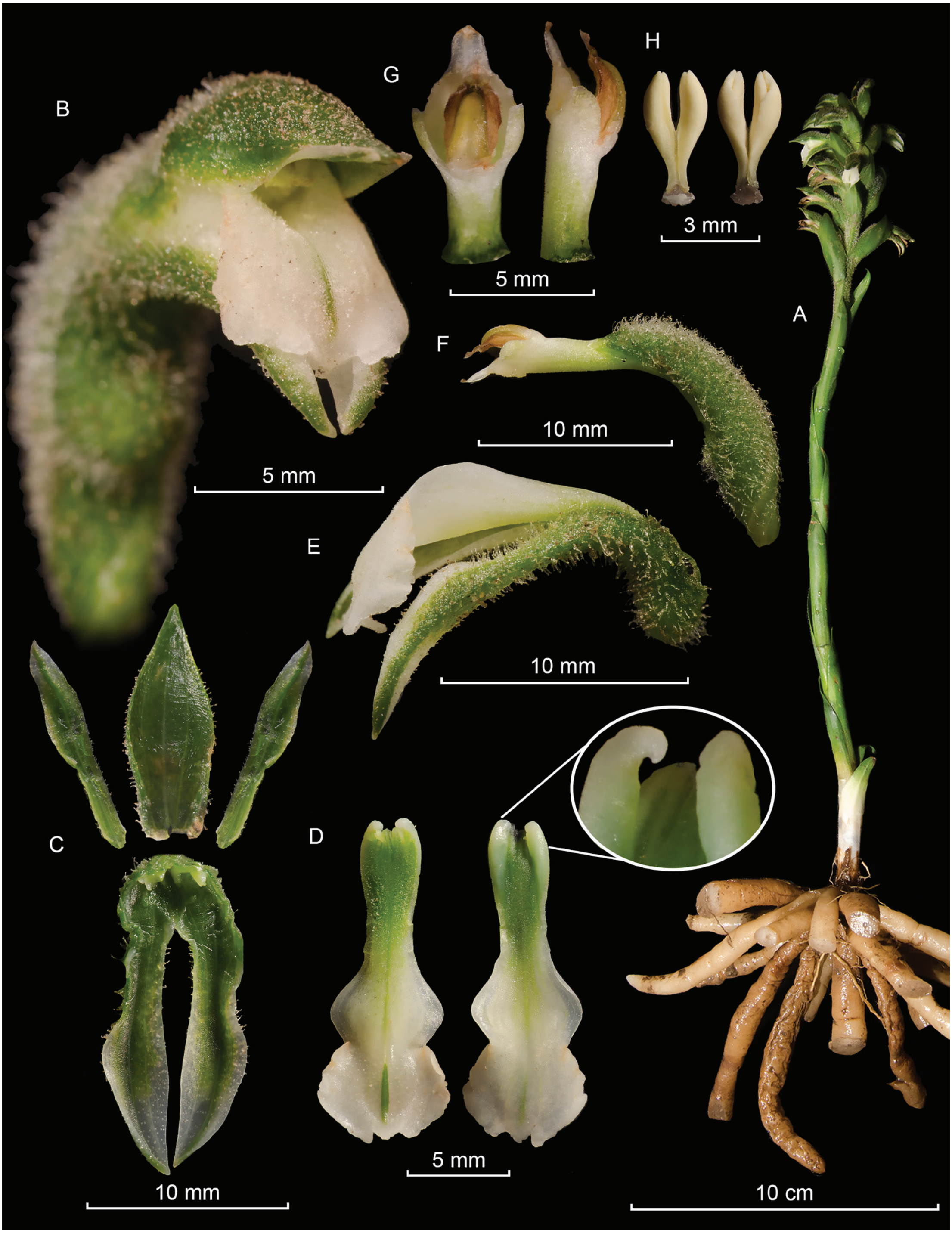

FIGURE 1. Lankester Composite Dissection Plate (LCDP) of *P. muyscarum*. **A**. Habit when flowering. **B**. Detail of the flower. **C**. Sepals and petals. **D**. Abaxial and adaxial view of the labellum, showing the falcate subulate nectary spurs. **E**. Labellum and sepal in lateral view. **F**. Column and ovary. **G**. Column in dorsal and lateral view. **H**. Pollinarium. Photographs and elaboration by Milton Rincón-González.

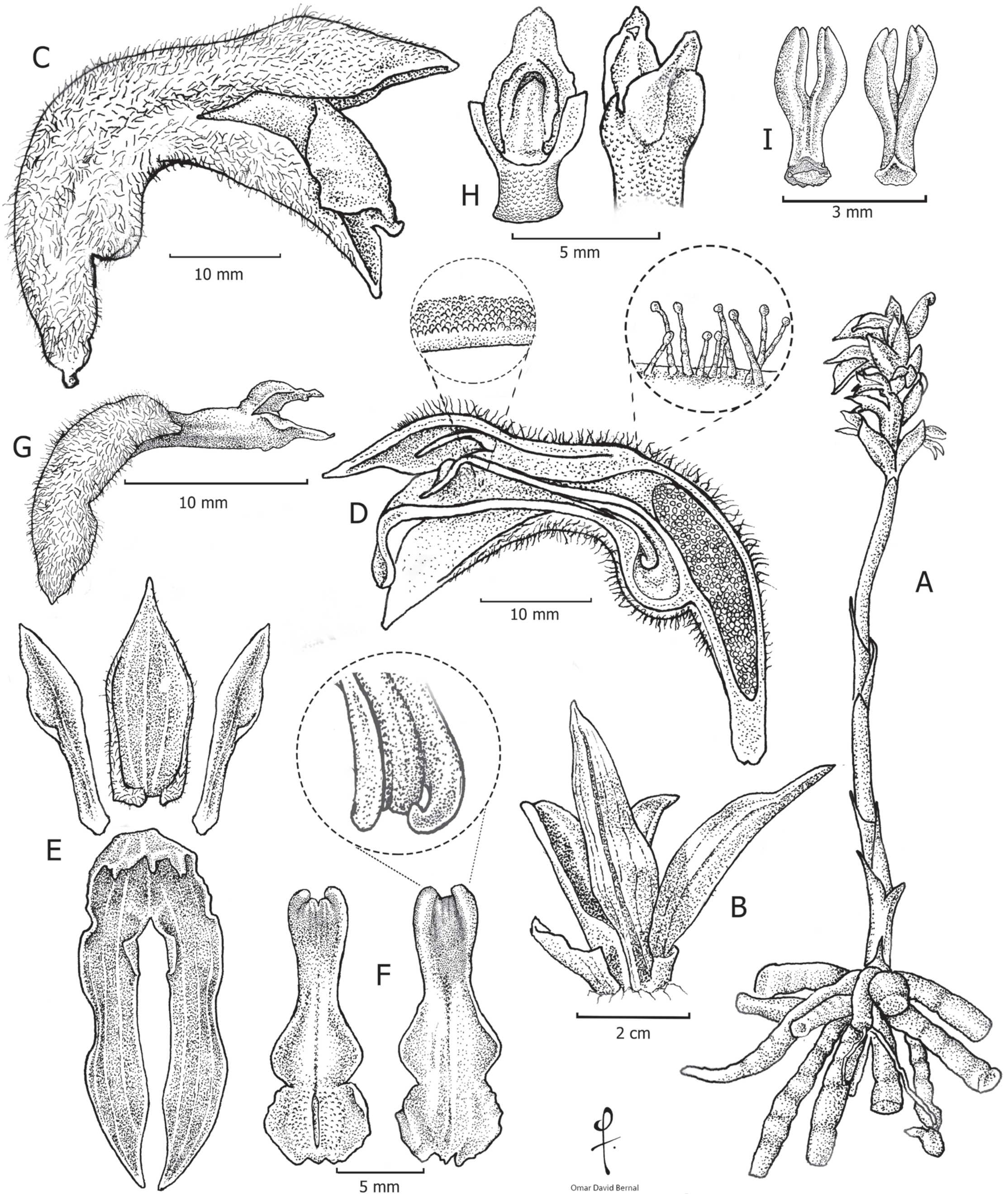

Figure 2. Illustration of *P. muyscarum*. **A**. Plant with inflorescence. **B**. Leaf rosette. **C**. Flower in lateral view. **D**. Longitudinal view of flower with details in the surface and trichomes. **E**. Sepals and superior petals. **F**. Abaxial and adaxial view of the labellum showing the falcate subulate nectary spurs. **G**. Column and ovary. **H**. Column in dorsal and lateral view. **I**. Pollinarium. Illustration based on *Milton Rincón-González et al. 1842* (JBB). Elaborated by Omar David Bernal.

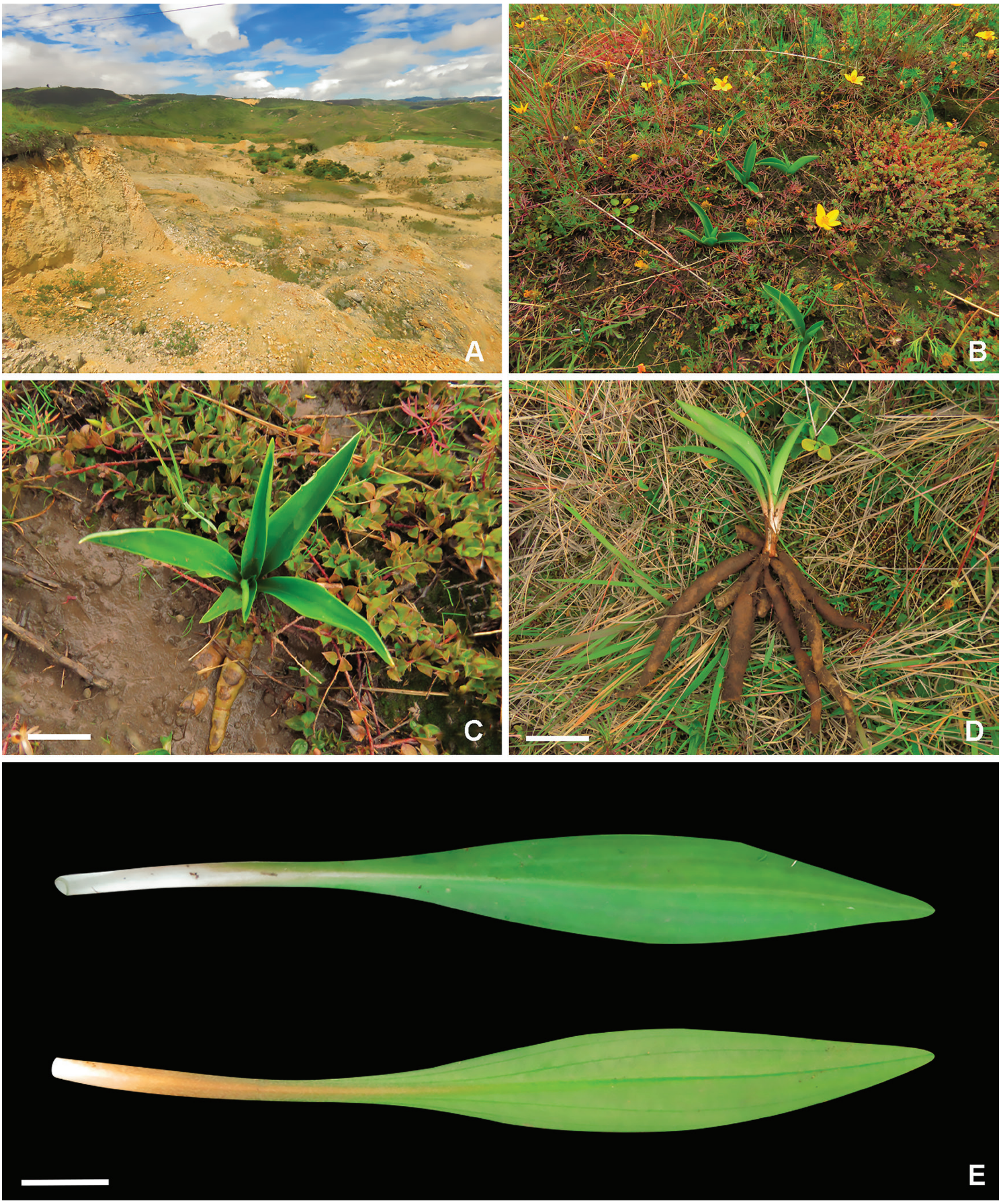

FIGURE 3. Habitat and vegetative parts of *P. muyscarum*. **A**. Habitat degraded by quarry extraction. **B**. Conserved habitat. **C**. Habit. **D**. Roots. **E**. Leaves, upper one on the adaxial surface, lower one on the abaxial surface. Scales: C-D: 2 cm, E: 1 cm. Photographs and elaboration: Andrés Fonseca-Cortés.

CONSERVATION STATUS: The extent of occurrence (EOO) is 916.306 km^2, and the area of occupancy (AOO) is 20 km^2; hence, *P. muyscarum* meets the requirements under criterion B for threatened species (AOO < 2000

Figure 4. Reproductive parts of *P. muyscarum*. **A**. Inflorescence. **B**. Bracts. **D**. Flower in front view. **E**. Flower in lateral view. **F**. Longitudinal cut of the flower showing the ovary, the subulate nectary spur, and the nectary chamber. Scales: A=1 cm, B=1.5 cm, D–E=0.5 cm. Photographs by: Andrés Fonseca-Cortés.

km). Additionally, it is only known from four localities, the populations are declining due to the presence of goats, cattle, and horses, quarrying, adventure sports (ATV and motorcycle tracks), and establishment of invasive neighborhoods. In this sense, the Endangered (EN) category is proposed (B2aiii) (IUCN 2019).

Additional specimens examined: Colombia. Cundinamarca: Bogotá D.C. Ciudad Bolívar, Parque Ecológico Cerro Seco, 2800 m, 26 V 2021, *B. Villanueva et al. 6022*, JBB! municipio Nemocón, vereda Moguá, 2650 m, 31 July 2007, *S.P. Cortés 4970* (JBB!); municipio Madrid, Hacienda Casa Blanca, cúspide del cerro, fr-

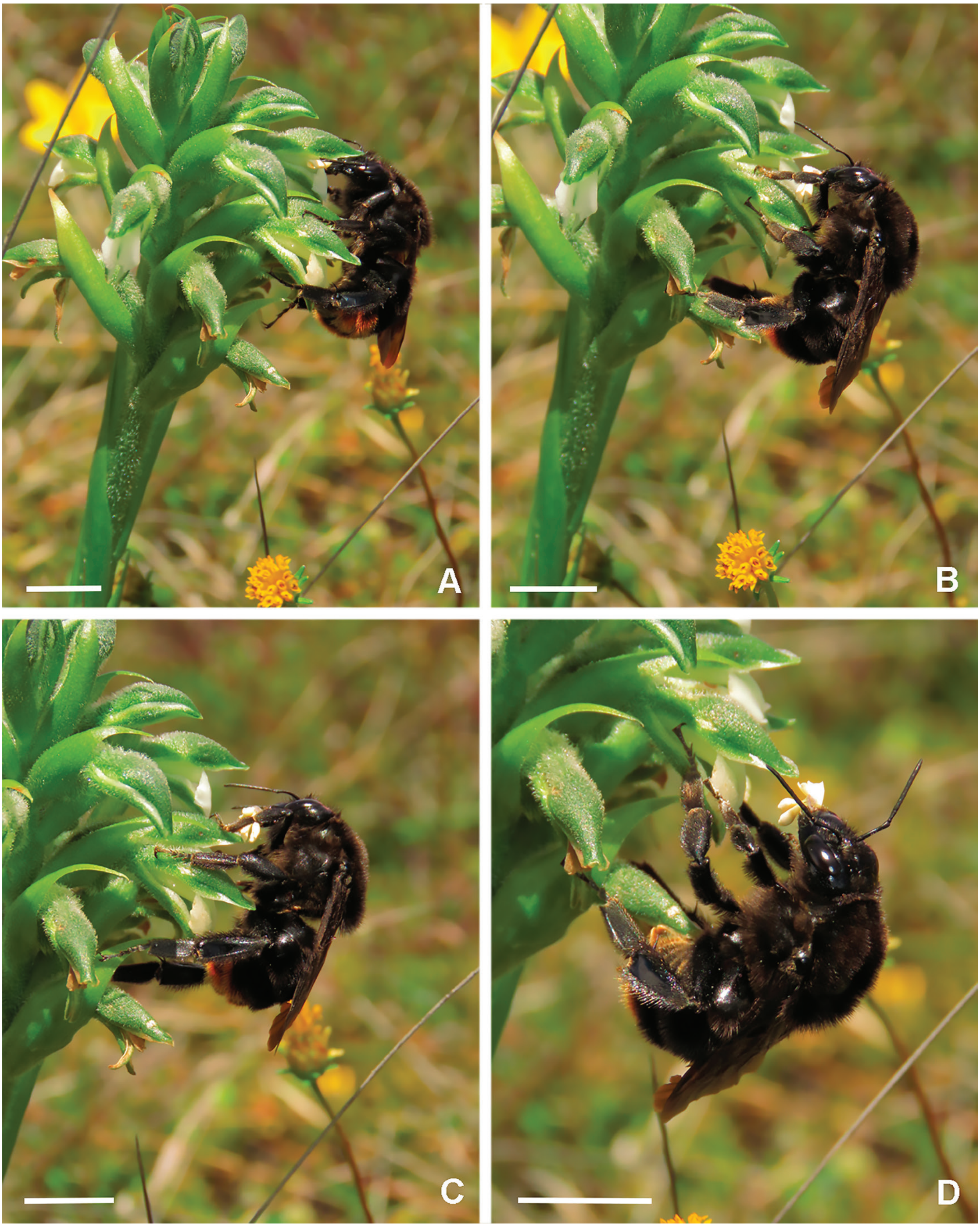

FIGURE 5. *Bombus atratus* visiting *P. muyscarum*. **A–D**. sequence of visiting for nectar and consequent pollinarium removal. Scales: A–C: 1 cm, D: 2 cm. Photographs and elaboration by Andrés Fonseca-Cortés.

ente a la casa principal, 11 July 1999, *Y.A. Mora & R. Sánchez 155* (COL!); municipio de Mosquera, zona xerofítica de la laguna de la Herrera, 22 June 1972, *R. Schnetter 494* (COL!).

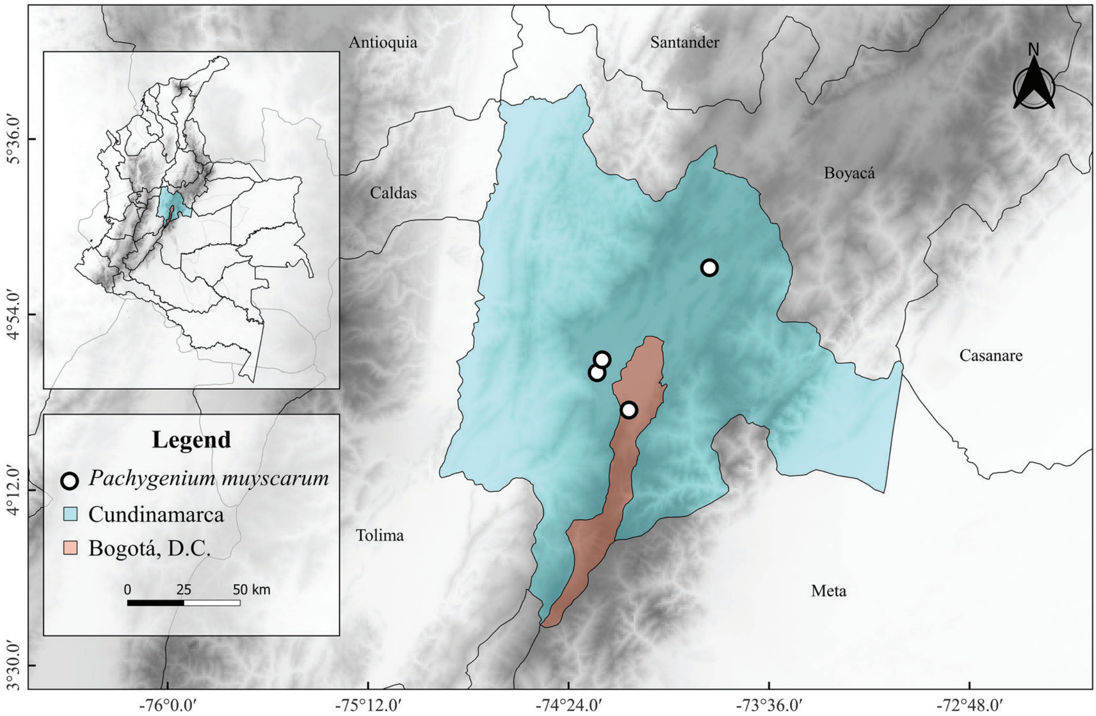

Figure 6. Distribution map of *Pachygenium muyscarum*. Elaborated by Camila Castellanos.

Ecology: The places in which this species grows have a bimodal precipitation pattern, with the dry seasons usually occurring in December–March and July–September and the humid seasons in October–November and April–June. *Pachygenium muyscarum* produces leaves and flowers in the humid seasons, whereas during the dry seasons most individuals lose the leaves. The plants have a strong radicular system (Fig. 1D) which probably stores starch and allows this species to survive the dry season. We recorded *Bombus atratus* Franklin (1913) pollinating the flowers of *P. muyscarum* (Fig 3); when the bee visits the flower, it introduces its mouth parts deeply into the flower to reach the nectar, and the pollinarium attaches to the bee's labrum (Fig. 5D). This bumblebee species has been reported as a pollinator of *Pachygenium oestriferum* (Rchb.f. & Warm.) Szlach., R.González & Rutk. in a similar manner to *P. muyscarum* (Singer & Sazima 1999).

Discussion. *Pachygenium muyscarum* is similar to *P. ekmanni* (Kraenzl.) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001), *P. longibracteatum* (Pabst) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001)., *P. tamanduense* (Kraenzl.) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001) and *P. ventricosum* (Cogn.) Szlach., R.González & Rutk. (Szlachetko *et al.* 2001), but it is clearly distinguished from them by the characters listed in Table 1.

Table 1. Differences among *P. muyscarum* and morphologically similar species.

Characters	*P. ekmanni*	*P. longibracteatum*	*P. muyscarum*	*P. tamanduense*	*P. ventricosum*
Leaves present at flowering	Yes	Yes	No	Yes	No
Length of labellum (cm)	1.4–1.6	1.0–1.2	1.4–1.6	1.2–1.4	1.2–1.4
Apex of the labellum apical lobe	Entire	Entire	Trilobate	Entire	Entire
Length of the labellum spur (cm)	0.2–0.3	0.1–0.2	0.2–0.4	to 0.1	to 0.1
Distribution	Brazil	Brazil	Colombia	Brazil	Paraguay

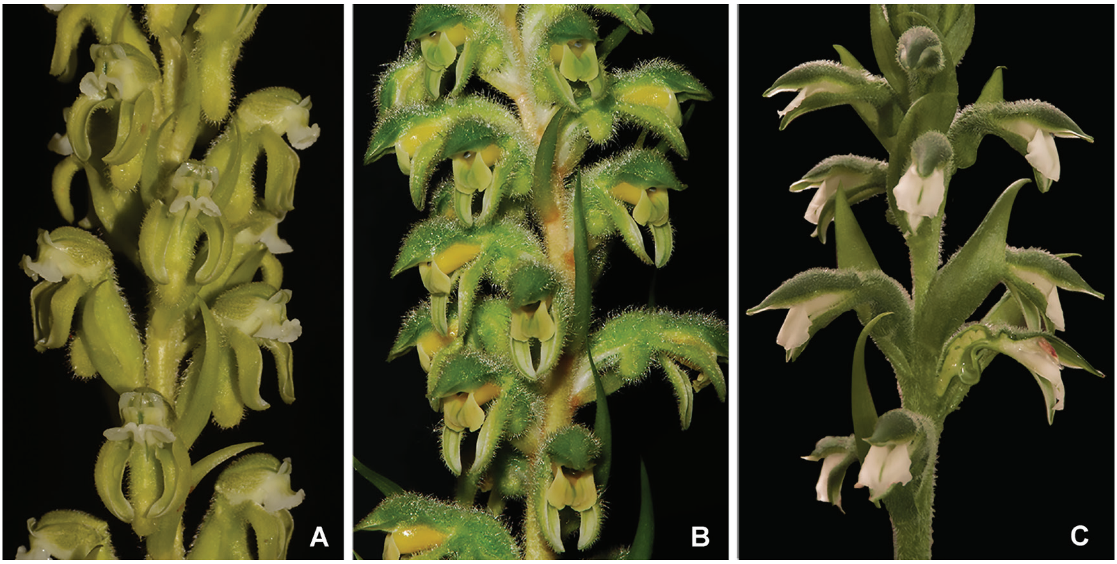

Figure 7. Comparison between the flowers of *P. orobanchoides* (A; Brazil, *J.A.N Batista 2403*), *P. hirtum* (B; Ecuador, *F. Tobar s.n.*) and P. *muyscarum* (C; Colombia, *M. Rincón-González 1842*). Photographs by João Aguiar Nogueira Batista (A), Francisco Tobar (B), and Andrés Fonseca-Cortés (C). Plate preparation: Andrés Fonseca-Cortés.

In their synopsis of the Colombian Spiranthoideae, Dueñas Gómez and Fernández-Alonso (2009) recorded 14 species of *Pelexia*, without considering the combinations in *Pachygenium* done by Szlachetko *et al.* (2001). Of those species, only two are now included in *Pachygenium*, *P. hirtum*, and *P. orobanchoides*. *Pachygenium hirtum* was recorded based on the specimen *Mora & Sánchez 155* (COL!) and *P. orobanchoides* on the specimen *Schneider 679/1* (COL!). Close study of those specimens allowed us to determine that *Mora & Sánchez 155* corresponds to the species described here as *P. muyscarum*. At the same time, *Schneider 679/1* is the holotype of *Pelexia cundinamarcae*, a species described in 1993 by Szlachetko but not reported by Dueñas Gómez and Fernández-Alonso (2007). Therefore, the only species of *Pachygenium* present in Colombia is *P. muyscarum*. Photographs of flowers of the three species are presented above (Fig. 7) because *P. hirtum*, *P. orobanchoides*, and *P. muyscarum* could be confused, and the former two were attributed to Colombia by Dueñas and Fernández-Alonso (2009).

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TWO NEW SPECIES OF *BULBOPHYLLUM* FROM BHUTAN

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Abstract. Two new species of *Bulbophyllum*, namely, *B. gurungianum* (sect. *Biseta*) and *B. punakhaense* (sect. *Brachyrantha*) are described and illustrated. *Bulbophyllum gurungianum* is similar to *B. brevispicatum* and *B. sonii* but differs strikingly by having pseudobulbs placed distantly on the rhizome, a shorter peduncle, and oblong petals with a ciliated margin. *Bulbophyllum punakhaense* is morphologically similar to *B. farreri, B. thaiorum,* and *B. mamillatum*, but can be easily distinguished by its larger leaves, pseudobulbs distantly placed on the rhizome, longer peduncle, and oblong-lanceolate petals with shortly papillate margin towards the apex. We provide a detailed description of each species, and information on their distribution, ecology, and conservation status.

Keywords / Palabras clave: Bhutan, *Bulbophyllum* sect. *Biseta*, *Bulbophyllum* sect. *Brachyrantha*, conservation status, ecología ecology, estado de conservación, taxonomía, taxonomy

Introduction. *Bulbophyllum* Thouars is one of the largest genera in Orchidaceae, comprising around 2147 accepted species (POWO 2023) distributed in the tropical and subtropical regions of the world (Chase *et al*. 2015, Gyeltshen *et al*. 2020, POWO 2023, Pridgeon *et al*. 2014, Vermeulen *et al*. 2014). In Bhutan, 62 species have been documented (Dalström *et al*. 2017, Gurung 2006, Gyeltshen *et al*. 2020, 2021, Pearce & Cribb 2002, Rabgay *et al*. 2021, Zangpo *et al.* 2021). However, the diversity of this genus in the country is poorly surveyed and documented compared to the neighboring countries. This is particularly true for miniature orchids that grow on tall trees (Averyanov *et al*. 2019) and in thick grassland, which are easily overlooked and rarely collected by researchers. Moreover, the taxonomic complexity of *Bulbophyllum*, with its large number of species, minuscule morphological differences, and wide distribution range, requires thorough examination and in-depth studies for accurate identification and documentation.

In 2006, Prof. Dhan Bahadur Gurung collected an interesting species of *Bulbophyllum* from the broadleaved forest in Punakha district while documenting the orchids of Bhutan. However, it remained unidentified in his book ‘An Illustrated Guide to the Orchids of Bhutan’ (Gurung 2006). During botanical exploration in the different parts of the district in 2022, the first two authors (PG and KR) spotted the same species growing on the main tree trunk of dead-standing *Alnus nepalensis* D.Don and the rotten stump of *Juglans regia* L. Furthermore, during a survey in Menchuna in 2020, PG observed and collected another interesting *Bulbophyllum* species similar to *Bulbophyllum retusiusculum* Rchb.f. growing on the main trunk and branches of *Alnus nepalensis*, *Torricellia tiliifolia* DC., and *Symplocos ramosissima* Wall. ex G.Don. After a critical examination of the specimens and consultation of available literature and related species described from the Eastern Himalayan and Southeast Asian region, we identified both the species as new to science, one belonging to the section *Biseta* J.J.Verm. and the other to the section *Brachyantha* Rchb.f. (Averyanov *et al*. 2018, Chen & Vermeulen 2009, Lucksom 2007, Nguyen *et al*. 2022, Pearce & Cribb 2002, Pridgeon *et al*. 2014, Seidenfaden 1973, 1979, Seidenfaden & Arora 1982, Tsi & Chen 1994, Vermeulen *et al.* 2014).

ORCID of the Author: PG , KT , CG , P , PK
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According to Vermeulen *et al.* (2014), members of *Bulbophyllum* sect. *Biseta* are characterized by one-leaved pseudobulbs along a creeping rhizome, a contracted or elongated racemose inflorescence that arises from the base of the pseudobulb, a pedicel with the basal node positioned above the attachment of the floral bract, a free dorsal sepal, lateral sepals that are 1 to 1.6 times longer than the dorsal sepal, 5-veined, with midvein abaxially keeled, with the apices thickened, globular to ellipsoid to almost cylindrical. The labellum is undivided, without auricles and the column foot often has lateral wings near the apex. Stellidia ca. ½ the length of the column, and the upper margin with or without a tooth, while the lower margin has a tooth. Members of *Bulbophyllum* sect. *Brachyanta* are also characterized by several morphological features that distinguish them from other species. They show one-leaved pseudobulbs along a creeping rhizome, a sub-umbellate inflorescence that arises from the base of the pseudobulb, and the lateral sepals that are 2 to 6 times longer than median sepal. The lateral sepals are twisted at the base with the upper margin turned inward and adnate to each other. The lip simple and connate to the column foot apex, and the column is simple or winged with or without stelidia at the apex.

Materials and methods. Morphological comparisons and assessments were performed using specimens from herbaria: PE, E, K, and THIM, as well as illustrations and taxonomic literature. Living floral parts and vegetative structures of the specimens were photographed in situ with a Nikon D3400 camera, and 18–55 mm f/3.5–5.6 lens. Microscopic structures were photographed with a Z-Stack microscope at the National Biodiversity Centre. The colored plates were prepared and edited in Adobe Photoshop software. Measurements and descriptions were based on the freshly collected material, and the collected specimens were deposited at the National herbarium THIM. In addition, living plants were collected and transplanted in the Royal Botanical Garden at Serbithang in Thimphu, Bhutan.

Taxonomic treatment

Bulbophyllum gurungianum P.Gyeltshen, K.Rabgay & Kumar, ***sp. nov.*** (Fig. 1–3).

TYPE: Bhutan. Punakha District: Rimchu, 20 October 2022, *P.Gyeltshen & K.Rabgay 69* (holotype THIM; isotypes: THIM).

Diagnosis: *Bulbophyllum gurungianum* shows morphological similarities with *B. brevispicatum* Z.H.Tsi & S.C.Chen and *B. sonii* Aver. & Duy in terms of habit and general floral morphology. However, *B. gurungianum* can be differentiated from *B. brevispicatum* based on the narrowly ovoid to ovoid pseudobulbs placed distantly (3–7 cm apart), shorter (13–16 × 1–2 cm) oblong to broadly oblong leaves, shorter peduncle (up to 1 cm long), sepals with sparse hairs on the outer surface, oblong petals with ciliate margin and labellum lacking keels in the former versus subcylindric pseudobulbs that are closely (2 cm apart) placed on the rhizome, longer (17 × 2.8 cm) leaves, longer (2 cm long) peduncle, sepals with dense papillose hairs, petals ovate with irregularly denticulate margin and labellum glabrous with 2 keels in latter. On the other hand, *B. sonii* has dense papillose hairs on the sepals, petals are ovate-oblong with erose to ciliate margin, and labellum glabrous without any keels (Table 1).

Plant epiphytic with creeping rhizomes and spreading roots. *Rhizome* terete, 1.4–1.8 mm diam., brown, sections between two pseudobulbs 3–7 cm long, arising from the basal node of the pseudobulb; rhizome scales thick, weathering to woolly fibers, persistent. *Pseudobulbs* 1-leaved, narrowly ovoid to ovoid, 1–3 × 0.6–1.5 cm, green to yellowish green, with numerous light green to almost white terete roots densely clustering at base; young pseudobulbs smooth, with partially disintegrated papyraceous or membranous sheaths, longitudinally ridged when mature. *Leaf* subsessile; petiole narrowing into short conduplicate petiole-like base 3.5–4 mm long; blade oblong, narrowly oblanceolate, 13–16 × 1–2 cm, leathery, apex acute or shortly acuminate, adaxially dark green, abaxially light green with a prominent dark green median vein. *Inflorescences* pendent, short dense-flowered raceme, 7–9 flowered; peduncle stout, slightly arched, ca. 1 cm long, green, glabrous, with 2–4 bracts, young light green and turning into brown with maturity, spirally arranged flowers. *Floral bracts* lanceolate, 4.5–5.0 × 1–2 mm, concave, light green or almost white, coriaceous, glabrous. *Pedicel* and *ovary* 1.8–2.1 mm long,

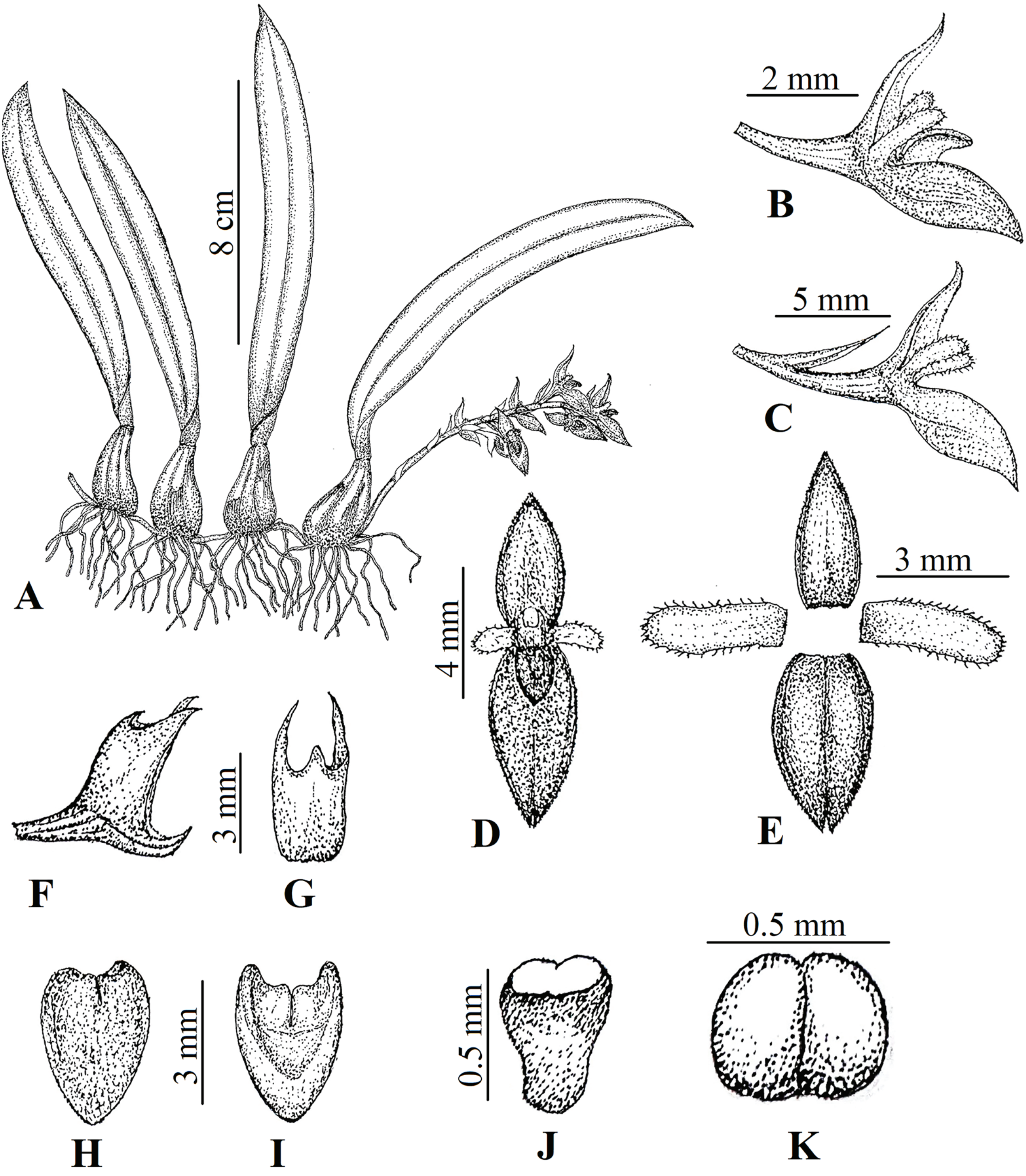

FIGURE 1. *Bulbophyllum gurungianum* P.Gyeltshen, K.Rabgay & Kumar. **A**. Habit. **B**. Flower with labellum and perianth (side view). **C**. Flower with floral bract and perianth (side view). **D**. Flower (front view). **E**. Dissected perianth. **F**. Ovary and pedicel with column and column-foot (lateral view). **G**. Column (abaxial view). **H**. Labellum (adaxial view). **I**. Labellum (abaxial view). **J**. Operculum (adaxial view). **K**. Pollinia. Drawn from holotype by Kezang Tobgay, edited by Phub Gyeltshen.

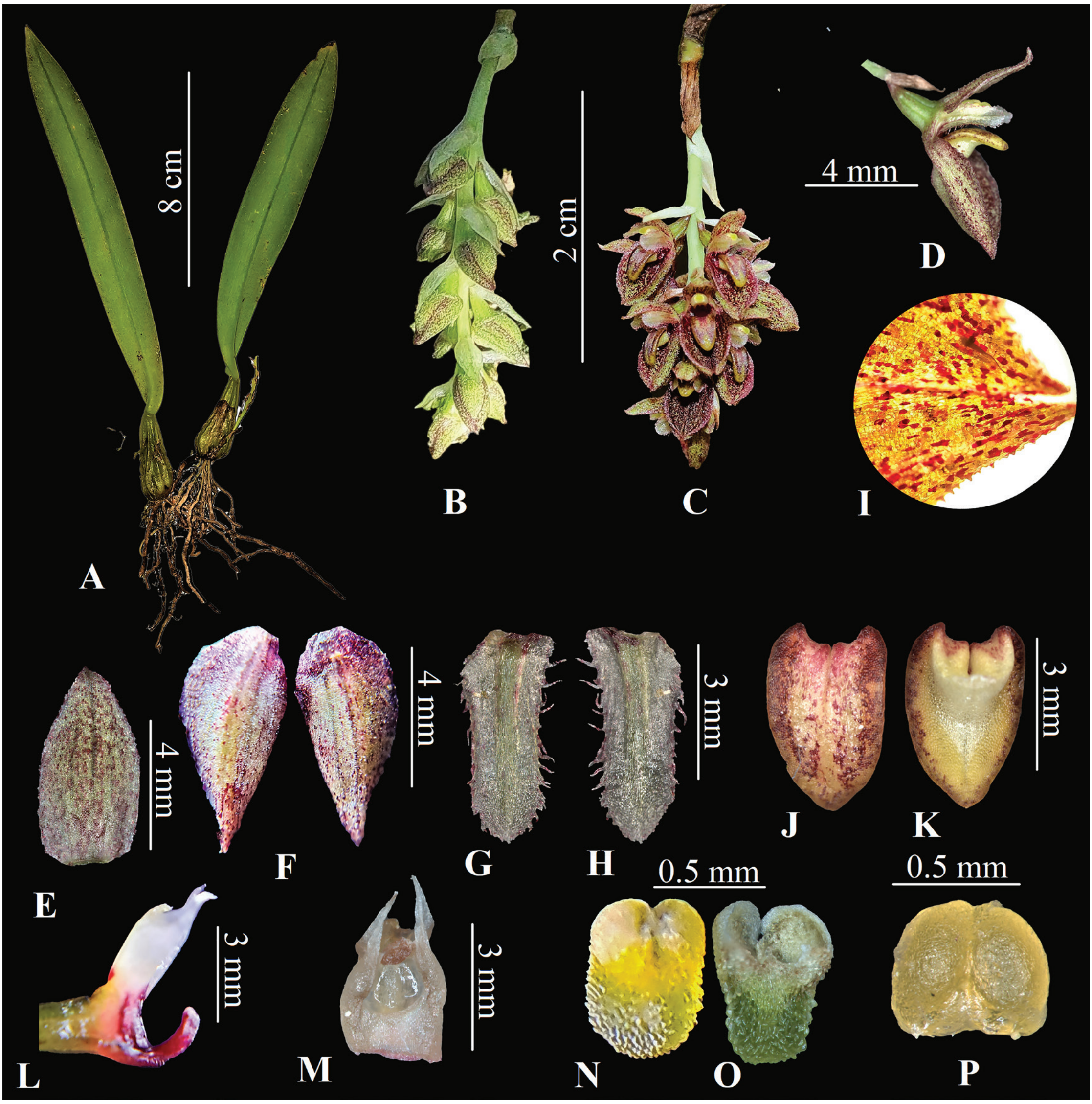

FIGURE 2. *Bulbophyllum gurungianum* P.Gyeltshen, K.Rabgay & Kumar. **A**. Habit. **B**. Immature inflorescence. **C**. Matured inflorescence. **D**. Flower (lateral view). **E**. Dorsal sepal (adaxial view). **F**. Lateral sepals (abaxial view). **G–H**. Petals (abaxial and adaxial view). **I**. Lateral sepal apex (Close up view). **J–K**. Labellum (adaxial and abaxial view). **L**. Column and column-foot (lateral view). **M**. Column (adaxial view). **N–O**. Operculum (abaxial and abaxial view). **P**. Pollinia. Photographs by Phub Gyeltshen (A, B, D–P) and Kinley Rabgay (C). Illustration assembled by Phub Gyeltshen.

greenish yellow to pale brown-purple, ovary distinctly broader than pedicel, longitudinally grooved. *Flowers* non-resupinate, not widely opening, sepals and petals purple, labellum pale yellowish with purple tint on the disc; sepals concave, apex acute or narrowly acute; petals flat, abaxially with sparse short and maroon papillous hairs. *Dorsal sepal* ovate, 4.8–5.0 × 2.3–2.6 mm, with recurved acute apex, shortly setose-ciliated margin towards the apex, 3-nerved. *Lateral sepals* obliquely ovate, 5–6 × 2.8–3.0 mm (when flattened), connate along lower edges completely or partly free at base and apex, 3-nerved. *Petals* oblong, 2.8–3.0 × 1.0–1.5 mm, rounded to obtuse apex, margin ciliated, with 1 prominent median vein. *Labellum* ovate 2.5–3.0

FIGURE 3. *Bulbophyllum gurungianum* P.Gyeltshen, K.Rabgay & Kumar. **A**. Plant in the habitat. **B–C**. Inflorescences. **D**. Pseudobulbs showing rhizome, roots and leaf base. Photographs by Kinley Rabgay (A–B) and Phub Gyeltshen (D–C). Illustration assembled by Phub Gyeltshen.

× 1.8–2.1 mm, fleshy, recurved and slightly grooved near the base, simple, sparsely verruculose in apical half adaxially, apex rounded to obtuse, with short setose hairs, side lobes absent. *Column* terete, 2.8–3.0 × 1–2 mm, white, with distinct down and forward directed foot ca. 1.5 mm long. *Stelidia* triangular, 0.5–1.0 mm long, pointing forward, exceeding operculum; *operculum* oblong, ca. 1.0 × 0.5 mm, yellow, surface densely verruculose, apex obtuse. *Pollinia* 4, ovoid, ca. 0.5 mm long, yellow. *Fruits* unknown.

Table 1. Morphological comparison of *Bulbophyllum gurungianum* and its closely allied species.

Characters	*B. brevispicatum*	*B. gurungianum*	*B. sonii*
Pseudobulb	subcylindric, 3–3.5 cm tall, distant at 2 cm on rhizome	narrowly ovoid to ovoid, 1–3 cm tall, distant at 3–7 cm on rhizome	narrowly ovoid to ovoid, 0.8–2 × 0.4–1.0 cm, distant at 0.5–2.2 cm
Leaves	oblong, 17 × 2.8 cm	oblong broadly oblanceolate, 13–16 × 1–2 cm	oblong broadly lanceolate, 8–13 × 0.8–1.8 cm
Inflorescence	peduncle, ca. 2 cm long, 6–7 flowered	peduncle ca. 1 cm long, 7–9 flowered	peduncle, 0.8–2.0 cm long, densely flowered (> 20)
Sepals	dense papillose hairs	short sparse and maroon papillose hairs	white dense papillose hairs
Petals	ovate, margin irregularly denticulate	oblong, margin ciliated	oblong ovate, margin erose-ciliated
Labellum	glabrous, with 2 cornute keels on both basal sides	short papillose hairs, keels absent	glabrous, keels lacking

Etymology: The species is named in honor of Prof. Dhan Bahadur Gurung, who first observed the orchid and for his immense contribution to orchid taxonomy in Bhutan.

Phenology: Flowering in October and November and fruiting from November to December *in situ*.

Habitat and ecology: In Bhutan, the orchid grows epiphytically on the main tree trunk of *Alnus nepalensis*, *Castanopsis tribuloides* (Sm.) A.DC., and the rotten stump of *Juglans regia* of the warm broadleaved forest at around 1400–2000 m in elevation. The associated plants are *Goodyera vittata* (Lindl.) Benth. ex Hook.f. and *Ficus* sp.

Distribution: Bhutan (Punakha, Rimchu, Type) (Fig. 7).

Conservation status: *Bulbophyllum gurungianum* is known from three sites, with around 60 mature individuals. Based on GeoCat (Moat, 2007), the Extent of Occurrence (EOO) and Area of Occupancy (AOO) of the species is estimated as 32.9 km^2 and 16 km^2, respectively. Since the species grows on the dead tree trunk and rotten stumps, the collapse of the dead tree and further rotting of the stump is likely to threaten the existing population. However, this is a natural process. Although similar habitats are available, the new species was not encountered in adjoining areas. Therefore, based on available information, currently, the species can be assessed as Data Deficient (DD) until further studies have been conducted exclusively (IUCN 2022).

Notes: *Bulbophyllum sonii*, which is used for comparison with *B. gurungianum*, belongs to the *B*. sect. *Biseta*, as it shows a simple lip without auricles. Interestingly, *B. sonii* reported from Tibet Autonomous region of China by Lei *et al.* (2022) deserved to be a distinct species, and it should be *B. gurungianum* described in this study because inflorescence is raceme, with less dense flowers, 8–12 flowered (vs. more dense, *ca*.>20 flowers per inflorescence in *B. sonii*), petals oblong (vs. oblong-ovate), margin ciliate (vs. finely erose-ciliate).

Bulbophyllum punakhaense P.Gyeltshen, K.Rabgay & Kumar, ***sp.nov.*** (Fig. 4–6).

TYPE: Bhutan. Punakha District: Menchuna, 15 October 2022, *P.Gyeltshen & K.Rabgay 070* (holotype THIM; isotypes: THIM).

Diagnosis: *Bulbophyllum punakhaense* shares morphological similarities with *B. farreri* (W.W.Sm.) Seidenf., *B. thaiorum* J.J.Sm., and *B. mamillatum* Vuong, Aver. & V.S.Dang in having coarsely papillose lateral sepals but differs in having laxly placed and longer (2.5–4.5 cm) pseudobulbs, dorsal sepal ovate-oblong, obtuse and densely papillose on the outer surface towards the base and margin shortly papillose towards the apex, lateral sepals together forming ca. elliptic structure (widest point approximately halfway along its length), petals oblong, obtuse and shortly papillose towards the apex, labellum shortly papillose on margin and apex (Table 2).

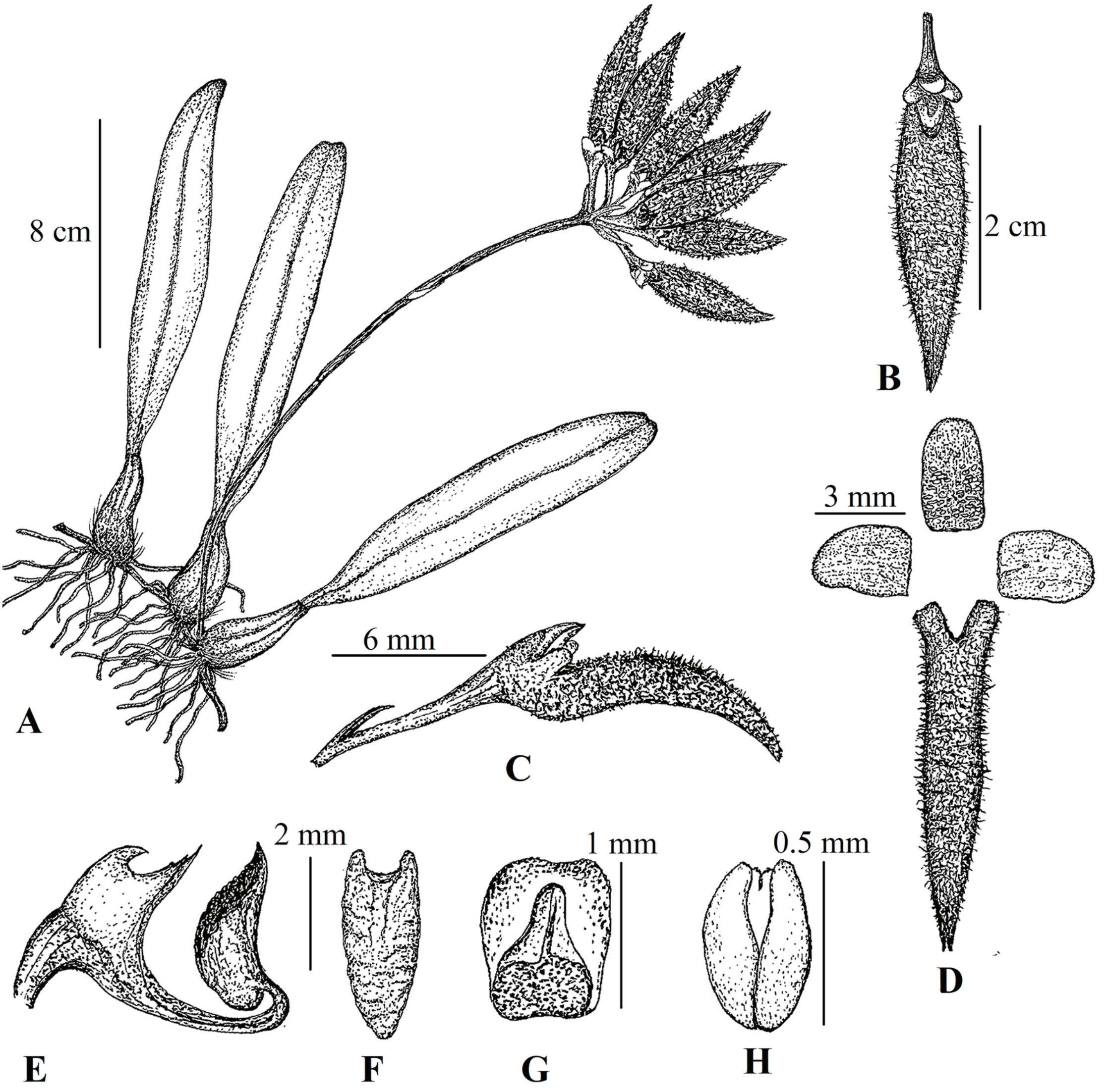

FIGURE 4. *Bulbophyllum punakhaense* P.Gyeltshen, K.Rabgay & Kumar. **A**. Habit. **B**. Flower (front view). **C**. Flower with floral bract (lateral view). **D**. Dissected perianth. **E**. Column and labellum (lateral view). **F**. Labellum (adaxial view). **G**. Operculum (adaxial view). **H**. Pollinia. Drawn from holotype by Kezang Tobgay, edited by Phub Gyeltshen.

Plant epiphytic with creeping rhizomes and spreading roots. *Rhizome* 0.4–1.8 mm diam., brown, arising from the base of the pseudobulb, pseudobulbs placed at 1.5–6 cm long intervals, rhizome covered with thick scales that weather to woolly fibers, persistent. *Pseudobulbs* 1-leaved, narrowly ovoid to ovoid, 2.5–4.5 × 1.0–1.5 cm, green to yellowish-green with numerous light-green to almost white cylindrical roots densely clustering at the base, covered with partially disintegrated membranous sheaths, longitudinally ridged, with many numerous white roots densely clustering at base. *Leaf* 1, oblong-lanceolate, 6–16 × 1.0–2.3 cm, apex acute or shortly acuminate, coriaceous, adaxially dark green, abaxially light green with prominent dark green median vein, margin entire, apex rounded, slightly retuse. Petiole short conduplicate, 3.5–5.0 mm long. *Inflorescence* a subumbellate raceme, 5–12-flowered, arising from the base

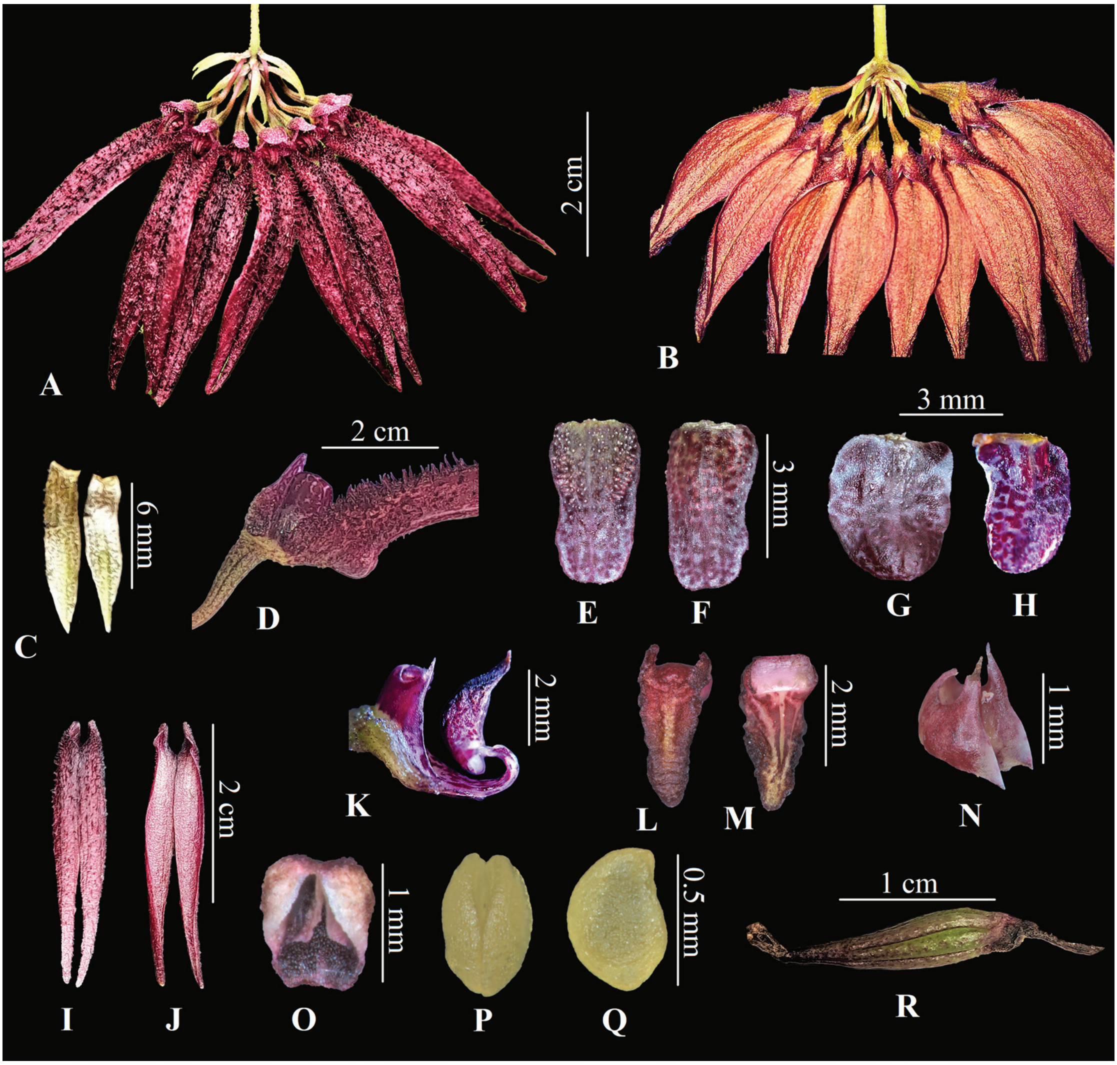

FIGURE 5. *Bulbophyllum punakhaense* P.Gyeltshen, K.Rabgay & Kumar. **A–B**. Portion of inflorescence (Adaxial and abaxial view). **C**. Flora bracts. **D**. Portion of flower with pedicel and ovary (lateral view). **E–F**. Dorsal sepals (abaxial and adaxial view). **G–H**. Petals (abaxial and adaxial view). **I–J**. Lateral sepals (adaxial and abaxial view). **K**. Column and column-foot with labellum (Lateral view). **L–M**. Labellum (adaxial and abaxial view). **N**. Column showing stelidias (lateral view). **O**. Operculum (adaxial view). **P–Q**. Pollinia (front and lateral view). **R**. Fruit. Photographs by Kinley Rabgay (A), Phuentsho (B) and Phub Gyeltshen (C–R). Illustration assembled by Phub Gyeltshen.

of the pseudobulb; peduncle horizontal or pendulous, 10–18 cm long, with 3 to 4 brown tubular overlapping bracts at base and 1–3 distant bracts in middle part, green, glabrous, young bracts are light green when young and turning brown with maturity. *Floral bracts* narrowly lanceolate, 5–8 × 1–2 mm, concave, white, herbaceous, glabrous, apex acuminate. *Pedicel and ovary* 0.8–1.0 cm long, pedicel pink, slender, slightly curved, ovary golden green with maroon stripes, thicker, glabrous, longitudinally grooved. *Flowers* resupinate, not widely open, lateral sepals maroon; median sepal, petals and labellum white with purple patches. *Dorsal sepal* oblong-ovate, 3.8–4.1 × 2–3 mm, apex obtuse, with short papillose margin abaxially densely papillose on basal concave part, sparsely papillose towards apex, 3-nerved. *Lateral sepals*

FIGURE 6. *Bulbophyllum punakhaense* P.Gyeltshen, K.Rabgay & Kumar. **A–B**. Plant in the habitat. **C**. Portion of inflorescence. **D**. Pseudobulbs showing rhizome, roots and leaf petiole. Photos taken Phub Gyeltshen (A & D) and Phuentsho (B–C). Illustration assembled by Phub Gyeltshen.

narrowly lanceolate, 1.5–3.2 × 0.3–0.4 cm, obtuse, twisted at base, upper margin incurved and connate along the margin, free at lower margin, adaxially glabrous, abaxially densely papillose at base, sparsely papillose above base. *Petals* oblong-lanceolate, 3–4 × 2–3 mm, obtuse, slightly convex, adaxial surface glabrous, slightly oblique sparsely papillose on abaxial surface apex obtuse, shortly ciliate, with 1 prominent median vein. *Labellum* simple, narrowly ovate in outline, 3 × 1.5 mm, recurved, with rounded apex, with short papillate hairs on margin and apex, base with transverse callus and small appendage joining to column foot. *Column* broadly ovoid, ca. 1.5 mm tall, maroon, with forwarded and strongly incurved foot ca. 3 mm long, strongly incurved. *Stelidia* broadly subulate, ca. 0.5 mm long, sometimes with a small branch near the apex; *operculum* helmet-shaped, ca. 1 mm tall, maroon; *pollinia* 2, flat, ovoid, 0.5 mm long, yellow. *Capsule* clavate, 2 × 0.5 cm, glabrous, longitudinally grooved.

TABLE 2. Morphological comparison of *Bulbophyllum punakhaense* and its closely allied species.

Characters	***B. farreri***	***B. mamillatum***	***B. punakhaense***	***B. thaiorum***
Pseudobulb	clustered, ovoid-globose, 0.9–1.2 cm tall	close, narrowly ovoid to ovoid, erect, 1.6–2 cm tall	distantly placed, narrowly ovoid to ovoid, 2.5–4.5 cm tall	clustered, narrowly ovoid, ca.2 cm tall
Leaves	oblong, 2–7 × 0.8–2.2 cm	narrowly oblong, 7.5–8 × 0.7–0.8 cm	oblong-lanceolate, 6–16 × 1.0–2.3 cm	narrowly oblong, ca. 4 × 0.7–0.8 cm
Peduncle length	ca. 7 cm	11.5–12 cm	10–18 cm long	ca. 5 cm
Petals	obliquely elliptic, margin entire	narrowly ovate, margin entire	oblong, shortly papillose margins towards apex	broadly oblong or elliptic-oblong, margin entire
Labellum	glabrous	finely hairy along margin and deeply keeled longitudinally with raised sides	shortly papillose hairs on margin and apex	glabrous

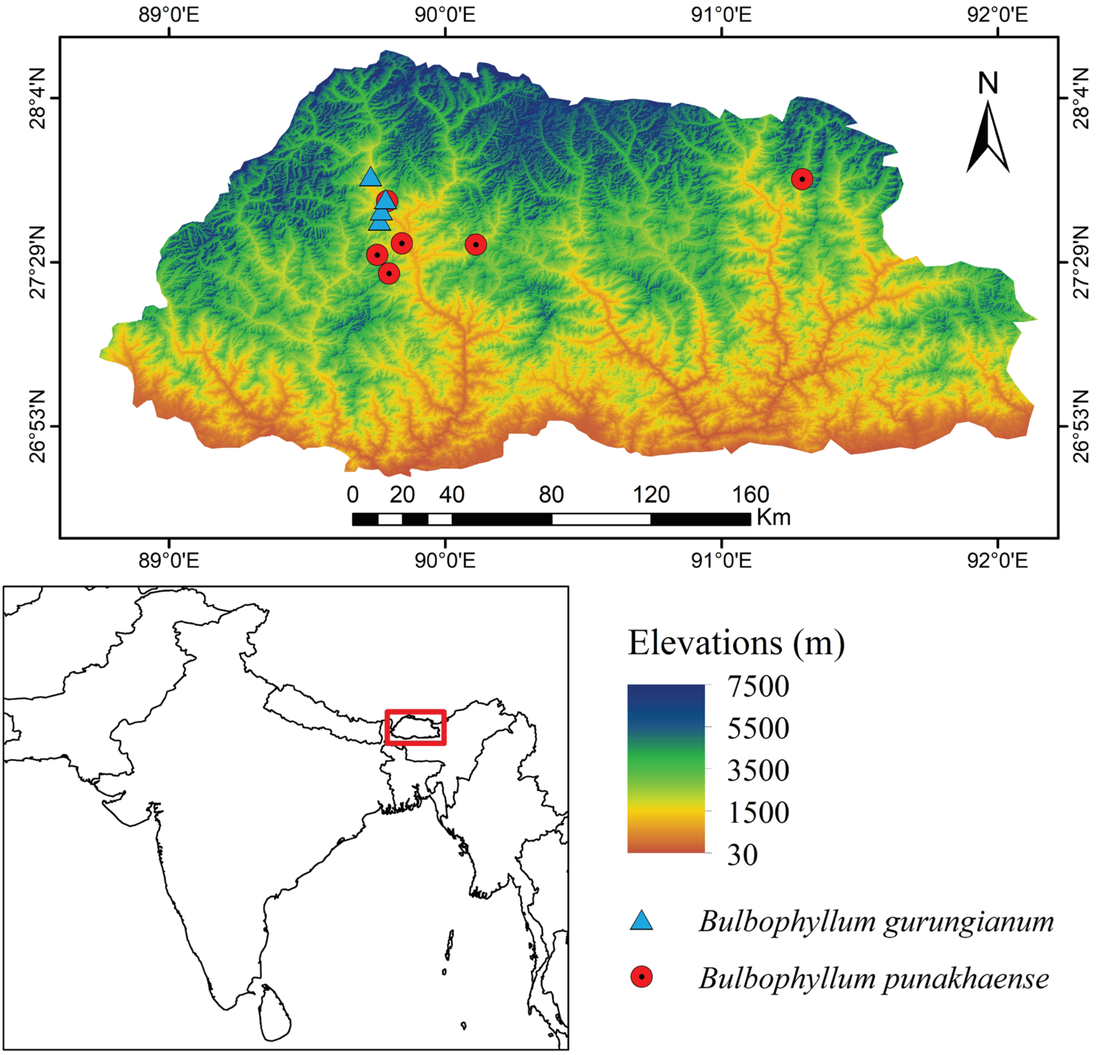

FIGURE 7. Distribution map of *Bulbophyllum gurungianum* and *Bulbophyllum punakhaense* in Bhutan. Illustration by Phub Gyeltshen.

Phenology: Flowering *in situ* from October to November and fruiting from November to December.

Etymology: The specific epithet of the new species refers to the type locality *i.e.*, Punakha in Bhutan.

Habitat and ecology: In Bhutan, it is epiphytic on the primary and secondary branches of *Alnus nepalensis*, *Juglans regia*, *Symplocos ramosissima*, *Torricellia tiliifolia,* and *Quercus griffithii* Hook.f. & Thomson ex Miq., of the cool broadleaved forest at an elevation ranging from 2000–2700 m. The associated plants are *Pholidota protracta* Hook.f., *Dendrobium longicornu* Lindl., and *Hedera nepalensis* K.Koch.

Distribution: Bhutan (Punakha, Menchuna, Type) and Lhuentse (Fig. 7).

Conservation status: *Bulbophyllum punakhaense* is only known from four sites in Punakha and one site in Lhuentse Districts. The total population is estimated to be around 200 matured individuals, and according to the GeoCAT (Moat 2007), the Extent of Occurrence (EOO) and Area of Occupancy (AOO) is estimated as 2222.5 km^2 and 24 km^2, respectively. It is expected that this species may occur in intermediate areas and similar habitats in other districts of the country, but so far, no more populations have been observed. Some subpopulations are located within road buffer and at the periphery of human settlement; an extension of the road and anthropogenic activities may cause habitat degradation and population decline in the future. Based on current information, this species can be assessed as a Data Deficient (DD) until further studies have been conducted exclusively (IUCN 2022).

Notes: *Bulbophyllum punakhaense* is also similar to *B. tigridum* Hance*,* but it differs in having the lateral sepals elliptic-lanceolate, abaxially densely papillose (vs. lanceolate or linear, abaxially glabrous).

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