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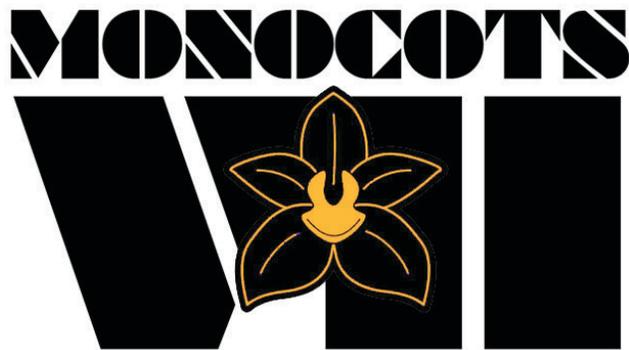
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EDITORIAL

A PAPERLESS JOURNAL, BUT STILL ON PAPER NEVERTHELESS

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Since immemorial time, humanity has expressed its desire to transmit ideas, emotions, concerns, and knowledge, in a manner that could be conserved through time. This legacy has been shaped in the form of documents, recorded on a wide range of media: stone, wood, bark, leaves, vegetable fibers, metal, clay, fabric, parchment, and paper. We are now witnessing the passage to the multi-media era, where information is output in the form of pictures, movies, sounds, texts or a combination of these, stored in a plethora of media such as flash drives, ZIP disks, diskettes of various kinds and sizes, CD and DVD ROM, internal and external hard disks, and others electronic media. Some of these media have already passed away, and no equipment is currently available to read and interpret the content stored in their memory.

Post-Linnean botany has been mostly perpetuated through books, journals, leaflets, and herbaria, and paper has proven to be a pretty effective medium for conserving the information. Libraries and plant museums have guaranteed unconditional access to this information. The validity of paper as the best storage medium, both from the point of view of efficiency and environmental impact, has however been put into question in the last two decades (Conway 1996). Let us discuss these two points separately.

Preservation is not a matter that applies to paper alone. The digital world poses significant challenges for the preservation of data as well, and the risk of loss is probably higher than in most other preservation functions (Conway 1999). Nevertheless, the principles of digital preservation are the same as those of the analog world and, essentially, aimed at extending the useful life of information resources. In some cases, however, the basic conservation

principles of longevity, choice, quality, integrity, and access, have shifted in priority and actors.

Traditionally, preservation of the information involved a complex, physical work aimed at perpetuating the integrity of the sources through the active control of external and internal factors of deterioration (stabilizing and maintaining temperature, humidity, light exposure, pollution, dirt, dust and mold, surveying handling techniques and security, adopting alkaline paper standards, deacidification, etc.). In the digital world, preservation is less concerned for the longevity of the storage media, but is much more dependent on the life expectancy of the access system to retrieve the data stored on them. For this reason, most libraries simply do not physically store electronic publications. Even though a study by Shipman *et al.* (2011) unequivocally shows that to destructively digitize documents in-house (disposing of the physical originals afterwards) is the most cost efficient method of preserving them over time, in the first instance it is several hundred percent more expensive than physical conservation. So, the libraries' e-journals, e-books, databases and so on, are linked to from their catalogues, but stored elsewhere. Where? Usually, on the publisher's own website.

In the past, the active role of the publisher ended when the book or journal or whatever kind of printed matter was released and dispatched. From this moment on, the responsibility of its conservation as a tangible item, and the preservation of the information stored in it, was passed on to the individuals, libraries, archives, museums and other subjects who owned copies of the publication. In the digital world, this responsibility remains mostly assigned to the publisher.

So, this poses a basic question to *Lankesteriana*. Are we ready, from the point of view of the knowledge,

the protocols, the human and IT resources needed, to be entrusted as the main conservators of the information stored in our journal, in an exclusively virtual, intangible, digital format? Last month, in only two consecutive days, we lost two of the three external disks (in addition to the two servers) where the history of *Lankesteriana* is preserved. None of us, as I fear is true for most editors of scientific journals, is a specialist in computer science, and even less in the theory that must undoubtedly exist on the best practices of preservation of digital information. We have already replaced the two damaged disks, but not our confidence in the efficiency of our conservation system. Simply said, we are not ready to go completely paperless and we do not know when we will be.

On the other side, the environmental issues associated with paper and digital media have occupied a large part of the debate on migration from traditional to electronic storage. They both do present common environmental issues including the extraction of materials, the use of huge amounts of energy and water for their production and transportation, and their transformation into waste throughout their life cycle. Whilst the use of paper seems to be more environmentally questionable during the production stages (but the organization representing the paper and print industry claims that the paper-making process is sustainable), digital media are particularly difficult to handle at the end of their useful life, as they contain toxic materials including lead, mercury, cadmium, brominated flame retardants, antimony trioxide, polyvinyl chloride, and phthalates. A study by Toffel and Horwath (2004), comparing the reading of newspaper content on a personal digital assistant vs. the traditional way of reading a newspaper, and the wireless teleconferencing vs. business travel, shows

that for both cases wireless technologies create lower environmental impacts. On the other side, Bull and Kozak (2014) argue that the context of the information and communication technology will continuously impede the ability of the the Life Cycle Assessment methodology to measure its products to be compared with the environmental footprint of paper media. Our assumption that digital is “greener” than paper could still be based on unsubstantiated claims.

As the main reason for physically distributing *Lankesteriana*, aside from improving its visibility, is to augment the probabilities of its “forever” conservation, we decided to remove from the mailing list of the journal all the individual subscribers, who obviously play no role for this purpose, including the authors themselves, who have so far received a physical copy of their publications. This also includes the numerous research libraries which, over the years, have shown their interest in essentially converting into repositories of digitized information, and therefore no longer require a physical copy of the journal to be placed on the shelves, and those organizations that the Costa Rican laws of printing assumed as obligatory recipients but were recently downgraded to “digital” users. Coherently, *Lankesteriana* will no longer accept individual subscriptions, which will be reserved exclusively for those public libraries that wish to offer a form of financial support for the management of the journal.

Cleaned of individual subscriptions and libraries no longer interested in receiving physical copies of the journal, from the first issue of the journal for 2019, the mailing list of *Lankesteriana* will be reduced to 280 copies, including the copies to be used for interchange and those printed for the journal’s physical archives and intended to replace any copies lost or damaged during shipment.

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THE EFFECT OF SMOKE DERIVATIVES AND CARBON UTILISATION ON SYMBIOTIC GERMINATION OF THE ENDANGERED *PTEROSTYLIS DESPECTANS* (ORCHIDACEAE)

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ABSTRACT. Orchids are highly dependent on exogenous nutritional sources and mycorrhizal associations to survive, particularly when challenged by extreme environmental stress such as bushfires that contribute significantly to its decline in nature. In this study, the effect of smoke derivatives and carbon utilisation was explored to improve germination and seedling establishment of an Australian endangered orchid, *Pterostylis despectans* (Lowly Greenhood) and its mycorrhizal fungi. Stored seeds were germinated *in vitro* with peloton-isolated fungal isolates with varying concentrations of smoke water (0–1.0 mL L⁻¹) to simulate fire and sucrose as the carbon source (10 g L⁻¹). Smoke water significantly increased germination, with advanced protocorms and robust seedlings produced. Sucrose inhibited germination such that protocorms and leafing was absent with sucrose inclusion. Fungal isolates were highly variable on its germination efficacy and tolerance to smoke water, highlighting the importance of fungal diversity and supports research-based conservation strategies to circumvent environmental challenges.

KEY WORDS: *in vitro* culture, mycorrhizae, smoke water, symbiotic germination

Introduction. Orchids form minute dust-like seeds that are ideal for wind dispersal. However, they are unable to store nutrients in the embryo and often rely on fungi (predominantly imperfect *Rhizoctonia* spp.) in order to germinate (Arditti & Ghani 2000, Brundrett *et al.* 2003, Rasmussen 1995). When fungi colonise orchid seeds, they grow as intracellular tightly coiled hyphal pelotons and a symbiotic relationship is established (Huynh *et al.* 2004). In this symbiotic relationship, fungi supply the orchid with nutrients including nitrogen (Girlanda *et al.* 2011) and phosphorus (Cameron *et al.* 2007) while the orchid supply carbon to the fungus (Cameron, Leake & Read 2006, Látalová & Baláž 2010). Carbon utilisation by mycorrhizal fungi vary with some clades from the same *Rhizoctonia* species inhibited by sucrose (Wright *et al.* 2011) resulting in suboptimal seed germination (Huynh *et al.* 2004, Nikabadi *et al.* 2014, Wright *et al.* 2009).

Some *in vitro* studies have successfully germinated orchid seeds asymbiotically (without fungi) using specific stimulants such as growth hormones to promote germination (Huynh *et al.* 2004, Nikabadi *et al.* 2014). Despite the germination success of asymbiotic plants, symbiotically germinated orchids established in soil better in the long term than those without fungi (Batty

et al. 2001, Rasmussen 1995) which suggests fungal superiority and importance to orchid conservation particularly for plants that reside in depleted nutrient habitats.

Fungal specificity of orchids is highly variable between species and different fungi are not equally effective in seed germination or growth (Phillips *et al.* 2011). Australian orchids generally have higher specificity for symbiotic fungi compared to species from other continents (Batty *et al.* 2001, Pandey *et al.* 2013, Phillips *et al.* 2011, Wright *et al.* 2009). Moreover, *Rhizoctonia* diversity in Australia is lower compared to other continents (Brundrett *et al.* 2003). Patchy fungal distribution in the soil, high fungal-host specificity and the preference for same-site specific fungal selections (Wright *et al.* 2011) can lead to orchid rarity (Phillips *et al.* 2011) and is a considerable barrier for the conservation of endangered species, for example *Caladenia huegelii* (Swarts *et al.* 2010) and some other *Caladenia* spp. (Wright *et al.* 2010) but not others (Bailarote, Lievens & Jacquemyn 2012).

Australian orchids reside in fire-prone regions and respond to fire differently ranging from destructive for some species whilst stimulatory for others (Brundrett 2007, Duncan & Coates 2010, Janes, Vaillancourt &

Steane 2008, Jasinge, Huynh & Lawrie 2018a,b). Smoke water is a byproduct of fire and has been investigated for its ability to increase the germination and development of some orchids (Papenfus *et al.* 2016, Mulgund *et al.* 2012, Malabadi *et al.* 2011) but not others (Teixeira da Silva 2013). Since smoke residues can be fungistatic (Jasinge *et al.* 2018a) or fungicidal (Jasinge 2014, Lin *et al.* 2012, Parmeter & Uhrenholdt 1975, Zagory & Parmeter 1984) due to compounds such as phenolics, imidazole (Chumpookam *et al.* 2012), karrikinolide and trimethylbutenolide (Papenfus *et al.* 2016), this could affect the ability for fungi to assist in seed germination and development and negate the benefits of smoke water.

Pterostylis R.Br has over 400 species that are spread across Australasia (Phillips *et al.* 2014). Many of these species were described only recently and their identification remains difficult due to repeated taxonomic revisions as well as rare flowering (Janes *et al.* 2008). One representative, *Pterostylis despectans* (Nicholls) M. A. Clem. & D. L. Jones (Lowly Greenhood) is critically endangered (Bickerton & Robertson 2000, Duncan, Pritchard & Coates 2005, Janes *et al.* 2008, Marsh 2011), restricted to south east Australia (NSW Government 2018) and conservation efforts are required to mitigate its decline. This study investigated factors to improve germination for reintroduction based on success from other orchid genera. The aim was to determine the usefulness of smoke water or sucrose utilisation on germination; the impact of fungal diversity and smoke water on protocorm development; and the effect of smoke water on fungal growth.

Materials and methods

Seed collection and preparation.— Germination was performed on 8 year old dried seeds of *P. despectans* collected in Talbot (Victoria) on January 2006 from seed capsules of six random plants. The seeds were surface sterilised for 1 min in 0.5% NaOCl with one drop of Tween 20 (Fisher BioReagents®). Seeds were spun at 13,000 rpm for 30 s and the supernatant was removed with a sterile glass pipette. Seeds were trice rinsed with sterile milliQ water and the supernatant removed.

Fungal isolation.— Three collars were collected *in situ* during the growing season in July 2013 from a population in Bung Bong state forest (Victoria). The collars were cleaned under running tap water, surface sterilized with

1% NaOCl for 3 minutes and rinsed trice with sterilized MilliQ water in a laminar flow cabinet. The collars were sliced into 1 mm longitudinal sections in sterile MilliQ water under sterile conditions. The pelotons were observed with a dissecting microscope, scraped out, dispensed in sterile MilliQ water and droplets containing pelotons were plated onto fungal isolation medium (FIM 0.3 g L⁻¹ sodium nitrate, 0.2 g L⁻¹ potassium dihydrogen orthophosphate, 0.1 g L⁻¹ magnesium sulphate, 0.1 g L⁻¹ potassium chloride, 0.1 g L⁻¹ yeast extract, 5 g L⁻¹ sucrose, 10 g L⁻¹ agar, prepared to 1 L with deionized (DI) water, pH adjusted to 6.8 before autoclaving (20 min at 121°C, 105 kg cm⁻²) (Clements 1981). Isolated pelotons were grown for 48 h at room temperature and scored as 1) *Rhizoctonia*-like fungi, 2) bacteria, 3) other fungi and 4) no growth (Huynh *et al.* 2009).

Fungal growth and smoke water.— *Rhizoctonia*-like fungi were transferred onto malt agar medium (MAM) with three smoke water concentrations (0, 0.1 and 1 mL L⁻¹) and labelled as collar number (1–3) and a letter representing separate fungal isolates from each collar. Each plate contained triplicate plugs from the same isolate. The fungi were incubated at 25°C in darkness and their growth was measured using a digital calliper at the same time point (five days) to test the effect of smoke water. When fungal colonies reached optimal growth on MAM plates, three agar blocks from control plates (no smoke water) were used to inoculate the symbiotic germination plates containing autoclaved oatmeal agar (OMA).

Symbiotic germination.— OMA (2.5 g L⁻¹ finely ground rolled oats, 0.1 g L⁻¹ yeast extract, 8 g L⁻¹ agar, pH adjusted to 5.3–6.0) (Nikabadi *et al.* 2014) was prepared in sterile petri dishes with three concentrations (0, 0.1 and 1 mL L⁻¹) of smoke water (Regen 2000® Smokemaster, Australia) in the absence or presence (10 g L⁻¹) of sucrose (Sigma Aldrich) before sterilization. One cm² squares of sterile Mira cloth (Calbiochem, USA) were placed onto set OMA. One droplet of surface sterilised seeds was released onto each Mira cloth square and a fungal square was placed in the middle of each plate. Nine fungal isolates were used for each of the six media types. One plate per treatment was not inoculated and was used as a control. The plates were sealed with Parafilm® (Sigma Aldrich) and incubated for six weeks at 25°C

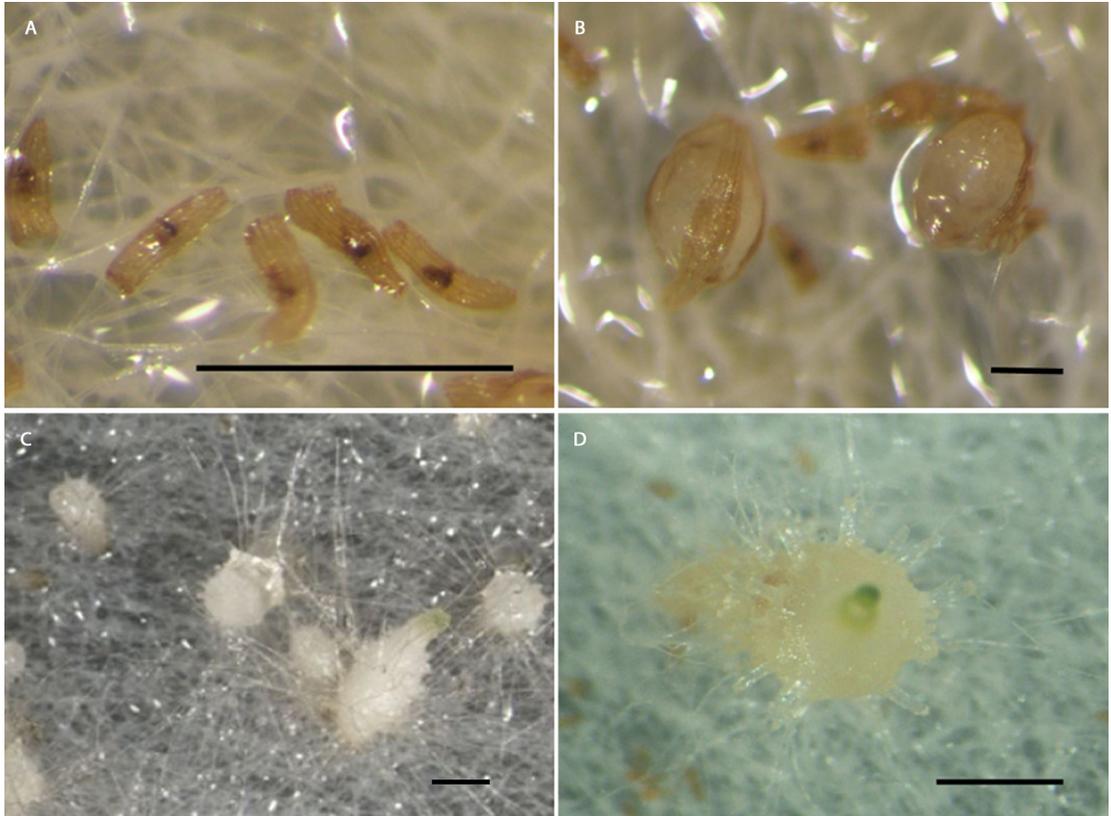


FIGURE 1. *Pterostylis despectans* seeds at different stages of germination. A. Dormant. B. Swollen. C. Protocorm. D. Protocorm with green leaf primordium. Bars (right bottom corner) = 1 mm.

in darkness and 1 week in a growth room under 16 h light cycles (NEC TRI-phosphor 30 watts fluorescent light FL). Seed changes were scored as 1) dormant - unchanged, 2) swollen, 3) protocorm and 4) protocorm with green leaf primordium (Fig. 1).

Data analysis.— Data was tested for normality and homogeneity. Normality was tested using Shapiro-Wilk analyses at $p \geq 0.05$. Homogeneity of data was tested using Levene's test for equality of variance and was considered homogeneous at $p \geq 0.05$. Data not meeting the above assumptions were transformed to normality. Normal data was analysed for statistical differences by ANOVA or t-test. Tukey HSD test was used as a post-hoc test for homogeneous data and Games-Howell post-hoc for non-homogeneous data. Abnormal data was tested using non-parametric Kruskal-Wallis test. All tests were performed at significance of $p \leq 0.05$ using IBM SPSS statistical software (version 23). Fisher's family error test was performed using Minitab (version 17).

Results

Effect of smoke water and sucrose on germination.— Symbiotic germination for *P. despectans* was low with the majority (94–99%) of seeds unchanged and categorised as dormant (Fig. 2). Smoke water had a positive effect on seed germination produced more than double the number of primordia stages. The highest germination was observed in media without sucrose and both smoke water concentrations (0.1 and 1.0 mL L⁻¹) significantly increased germination when compared to controls (without smoke water), particularly for protocorm and primordia stages. Although swollen seeds were noticeably changed from dormant seeds, they were not significantly affected by smoke water ($p \geq 0.05$, Tukey HSD test).

There were significant differences in protocorm numbers that increased for smoke water concentrations from 0.0 to 0.1 mL L⁻¹ but decreased from 0.1 to 1.0 mL L⁻¹ ($p \leq 0.05$, Games-Howell test) (Fig. 2). No

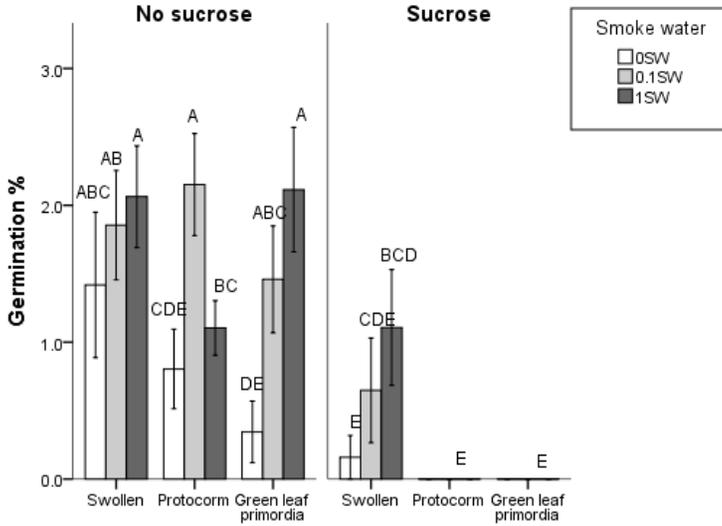


FIGURE 2. The effect of sucrose and smoke water on *Pterostylis despectans* symbiotic seed germination. Data are mean % (\pm 1SE) of germination stages reached (swollen, protocorms and leafing) in following treatments: \pm sucrose in three concentrations of smoke water 0SW=0.0 mL L⁻¹, 0.1SW=0.1 mL L⁻¹, 1SW=1.0 mL L⁻¹. Means that do not share a letter are significantly different using Fisher method grouping at $p \leq 0.05$ on arcsine transformed data. Dormancy scores (>95%) were excluded from the graph.

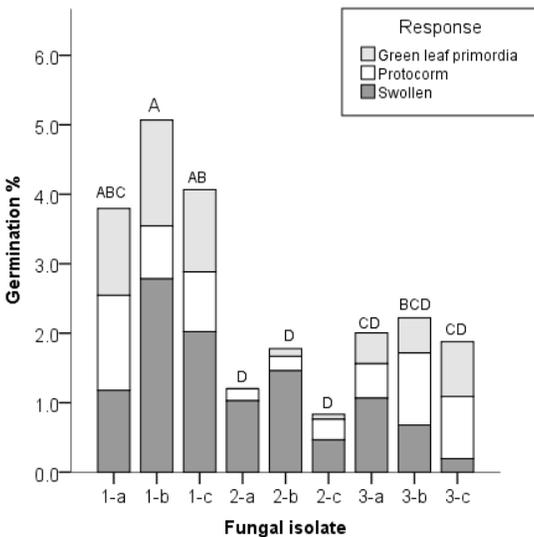


FIGURE 3. *Pterostylis despectans* fungal isolates' effectiveness (%) to germinate *P. despectans* seed (\pm 1SE). Fungal isolate abbreviations: numbers indicated a different *P. despectans* plant and letters indicated a different fungal isolate. Means that do not share a letter are significantly different using Fisher method grouping at $p \leq 0.05$ on arcsine transformed data. Dormancy scores (>95%) were excluded from the graph.

significant difference was found between smoke water concentrations of 0.0 and 1.0 mL L⁻¹ ($p > 0.05$, Games-Howell test). Smoke water significantly increased the number of seedlings with green leaf primordia ($p \leq 0.05$, Games-Howell test) and even though there was more leafing for the higher smoke water concentration, this was not significant ($p = 0.523$, Games-Howell test) (Fig. 2). Sucrose had a significantly negative effect on all seed development stages from swelling to germination and leafing ($p \leq 0.001$, t-test and Kolmogorov-Smirnov tests) (Fig. 2) such that no seed reached protocorm or leafing stages.

Effect of fungal variability and smoke water on germination stages reached.— Control (without fungal inoculum) was absent of germination. This was significantly different to symbiotic germination and the efficacy for each fungal isolate to promote germination to different stages of germination were significant ($p < 0.05$, Fisher's post-hoc test). There were significant differences in total germination between and within each replicate plant and isolate, with plant 1 isolate b initiating the highest overall and individual stages of germination. Even though there was a noticeable variation on all stages of germination, the efficacy was

not significantly different if the fungus was isolated from the same plant (Fig. 3). The effectiveness of fungal isolates from different plants was variable with the best isolates from plant 1 and the worst isolates from plant 2 with varying germination within.

Effect of smoke water on fungal growth.— Smoke water had a significant effect on fungal growth ($p < 0.05$, Fisher's post-hoc test) however the impact of smoke water presence and the concentration on fungal growth greatly varied between fungal isolates (Fig. 4). The greatest overall radial growth was in isolates from plant 3 and the least from plant 2. These patterns did not reflect germination, with the best germination from plant 1 that had middle range radial growth.

Discussion

Germination.— *Pterostylis despectans* seed in this study had very low germination success compared to other orchid genera. For example, other Australian orchids showed high germination that reached up to 100%, including more common *Pterostylis* species (Batty *et al.* 2006, Huynh *et al.* 2004, Nikabadi *et al.* 2014). This low germinability may indicate requirements for additional stimulants and be a contributing factor to its rarity and consequent endangered status of *P. despectans*. There are several other reasons that cause low germination numbers: seed age, post-harvest seed storage conditions and fungal specificity. *Pterostylis despectans* seed were collected 8 years prior to the experiment and may be too long for the optimum viability to be maintained. Studies on other plants have shown that time affects seed viability (Merritt *et al.* 2003) with high orchid seed germination achieved when seed material was obtained within a year before germination (Batty *et al.* 2001, Nikabadi *et al.* 2014). Seed viability of Australian plants was affected by relative humidity and temperature during storage (Merritt *et al.* 2003). *Pterostylis sanguinea* had higher germination in 15–20°C than in 25°C (Nikabadi *et al.* 2014), and the higher incubation temperature used in this experiment at 25°C may have restricted the full germination potential of the species.

Australian orchids are often colonised with more than one taxa of endophytic fungi (Dixon & Tremblay 2009, Rasmussen *et al.* 2015) which explains why fungi isolated from three different plants had significantly

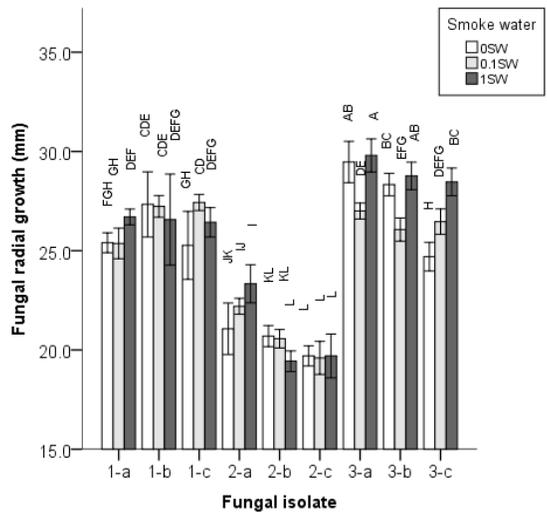


FIGURE 4. The effect of smoke water concentrations on fungal radial growth (mm) of nine isolates from *P. despectans* in three smoke water concentrations (0SW=0.0 mL L⁻¹, 0.1SW=0.1 mL L⁻¹, 1SW=1.0 mL L⁻¹). Data are means (\pm 1SE). Fungal isolate abbreviations: numbers indicated a different *P. despectans* plant and letters indicated a different fungal isolate. Means that do not share a letter are significantly different using Fisher method grouping at $p \leq 0.05$.

different effect on seeds (Fig. 3). Other studies found no correlation between fungal taxonomy with germination efficacy (Wright *et al.* 2010) and could indicate other factors contributing to varying seed responses. Our findings also imply that the fungal diversity in *Pterostylis* orchid species varies between the plants rather than within one plant despite morphological and genetic similarities (Huynh *et al.* 2009). Complex comparisons such as gene-environment interactions and metabolomic studies may provide more useful answers and direct future conservation efforts such as *in situ* inoculations to rejuvenate fungal diversity to improve germination and growth.

Symbiotic fungi were essential for *P. despectans* seed germination but highlighted that other factors may be important for improved germination and survivorship of this species. High and successful asymbiotic *in vitro* germination can be achieved to rival or exceed symbiotic germinations beyond 93% (Bustam, Dixon & Bunn 2014) and may be the only alternative for similar endangered orchids like *P. despectans* that have fastidious requirements for both the fungal partner and seed.

The effect of smoke water on germination.— Smoke water is beneficial for germination of Australian orchids' seeds. The presence of smoke water had a positive effect on *P. despectans* seed germination (Fig. 3). There are limited studies on smoke water effects on orchid seed germination (Jasinge 2014, Papenfus *et al.* 2016). Other studies have found that smoke released the dormancy of non-orchid Australian native plants (Bradshaw *et al.* 2011, Dixon *et al.* 2009, Flematti *et al.* 2004). On the other hand, heat was found to be more important in seed germination initiation of some plants in Western Australia than smoke (Tieu *et al.* 2001) and this is a possible research opportunity to investigate fire and smoke derivatives to improve major orchid life-cycle events particularly for recalcitrant species.

Even though smoke water significantly increased the germination of *P. despectans*, the results were still suboptimal with germination not exceeding 5%. This result translated into an ecological conservation context would mean that copious volumes of viable seed is required to replace existing populations and even more for the expansion of populations which is not sustainable for the longevity of the species without human intervention. The only other study to use smoke water as a stimulant also resulted in low germination rates on an African orchid, *Ansellia africana* (Papenfus *et al.* 2016) with <19% at stages 4–5 of development, equivalent to the leafing stages categorised in this study. The significance of smoke water on seed germination and the lack of published studies is an opportunity for future research, especially highly endangered species that have low germinability.

The effect of sucrose on germination.— Sucrose had an adverse negative effect on *P. despectans* seed germination. Similarly, the addition of sucrose decreased the germination of *Caladenia* species (Wright 2007, Wright *et al.* 2011) resulting in the omission of sucrose in other germination studies (Nikabadi *et al.* 2014). On the other hand, some other orchid species (*Microtis parviflora*, *Caladenia formosa*) grew better with the presence of sucrose (Huynh *al.* 2004, Wright *et al.* 2009) especially those germinated aseptically (Huh *et al.* 2016) so there is a need for individualised ingredients to cater for the preferences of both orchid and fungus.

In the presence of sucrose, fungi dominated and

outcompeted seeds for nutrients and thus negatively affected seed germination. The fungi in sucrose media were morphologically different with more vigorous dense growth and covered orchid seeds. Similarly, it was observed that high concentrations of sucrose encouraged parasitic fungal growth whereas lower concentrations of sucrose promoted symbiotic associations in *Dendrobium chrysanthum* (Hajong, Kumaria & Tandon 2013). In contrast, other studies on *C. tentaculata* found no changes in hyphal growth or dominance regardless of sucrose presence (Wright *et al.* 2011). They found that individual fungal isolates responded to different carbon sources differently, likely due to fungal isolates belonging to different taxa (Wright *et al.* 2011). Fungal isolates from *P. despectans* may also have different requirements and responses to carbon sources that reflect the complexity of fungal carbon utilisation and assimilation. This may also stimulate or exacerbate fungal functionality *in situ* under extreme environmental stress such as fire events.

The effect of smoke water on fungal growth.— These findings are contrary to previous studies, where smoke or smoke water had significantly inhibited fungal growth (Jasinge 2014, Zagory & Parmeter 1984). Smoke water contains phenolic compounds that are toxic to fungi and inhibit fungal growth by altering the fungal cell walls (Chumpookam *et al.* 2012) suggesting that fungi from *P. despectans* had higher tolerance to phenolic compounds. The varying fungal tolerance to phenolic compounds is thought to be due to the quantity or quality of enzymes (laccases) that metabolise these toxins (Jasinge 2014, Zagory & Parmeter 1984) and have significant consequences on plants that rely on symbiotic fungi.

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A NEW SPECIES OF *ANATHALLIS* (ORCHIDACEAE: PLEUROTHALLIDINAE) FROM BRAZIL

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ABSTRACT. *Anathallis luteola* is newly described and illustrated from the state of Bahia, northeast Brazil. It is similar to *A. guarujaensis* from which it can be distinguished by the smaller flowers, the successive two-flowered raceme, and shape of its floral segments. A note on the latter species is also provided.

KEY WORDS: Bahia, Brazilian Atlantic forest, taxonomy

Introduction. The genus *Anathallis* Barb.Rodr. (Orchidaceae) comprises about 116 species (Karremans 2016) of epiphytic orchids, mostly South American in distribution. According to Brazilian Flora 2020 (in construction), 92 species of *Anathallis* are found in Brazil, of which 76 are endemic. However, these figures include a number of species recently transferred to *Stelis* Sw. (Chiron, Guiard & van den Berg 2012, Karremans 2014) and to *Lankesteriana* Karremans (Karremans 2014, 2015). Following this narrower concept and including the new species described herein, some recent additions not yet listed in Brazilian Flora 2020 (Chiron, Guiard & Bolsanello 2013, Krahl *et al.* 2016) and excluding a number of obscure names and synonyms, the current accepted *Anathallis* names for the Brazilian flora is approximately 72 species.

During recent fieldwork and visits to private and public collections in Brazil, aiming towards a taxonomic revision of the Brazilian *Anathallis*, an undescribed species has been discovered. It is herein described and illustrated.

Anathallis luteola Toscano, *sp. nov.*

TYPE: Brazil. Bahia: Without precise locality, obtained from a collector, cultivated by Maria Rita Cabral at her property in Paty do Alferes, state of Rio de Janeiro, fl. cult. 16 March 2015, *A. Toscano de Brito* 3352 (holotype: UPCB). Fig. 1–2.

DIAGNOSIS. This small, caespitose species is characterized by very short ramicauls, thickly coriaceous leaves, and two orange-yellow or greenish-yellow successive flowers; oblong-elliptical, obtuse petals; and the oblong-trilobed lip with minute lateral lobes. It is similar to *A. guarujaensis* (Hoehne) F. Barros from which it is distinguished by the smaller flowers, the successive 2-flowered raceme, 3-veined sepals, obtuse petals, and glabrous lateral lobules of the lip.

Plant to ca. 3 cm tall, epiphytic, caespitose. *Roots* thick. *Ramicaul* 2–5 mm long, erect, stout, short, enclosed by 2 evanescent sheaths. *Leaf* 10–25 × 5–7 mm, erect, thickly coriaceous, spathulate-elliptical, the base cuneate into a petiolate base, the apex obtuse to subacute, minutely tridenticulate. *Inflorescence* 1 to several successive racemes that emerge from an annulus below the abscission layer, shorter than the leaf, erect to suberect; peduncle 5–10 mm long; rachis inconspicuous. *Floral bract* 1.0–1.5 mm long, thin. *Flowers* 2, opening in succession, only one flower open at a time; pedicel 1.5–2.0 mm long; ovary 0.8–1.0 mm long; *sepals* translucent greenish-yellow or orange-yellow, glabrous, 3-veined, acute, the dorsal sepal 3.0–3.5 × 1.25–1.50 mm, oblong-lanceolate to slightly ovate-lanceolate, slightly concave and curved over the column, free from the lateral sepals, 3-veined, the lateral sepals 3.0–3.3 × 1.0–1.2, slightly oblique, oblong-lanceolate, shortly connate at base, forming a

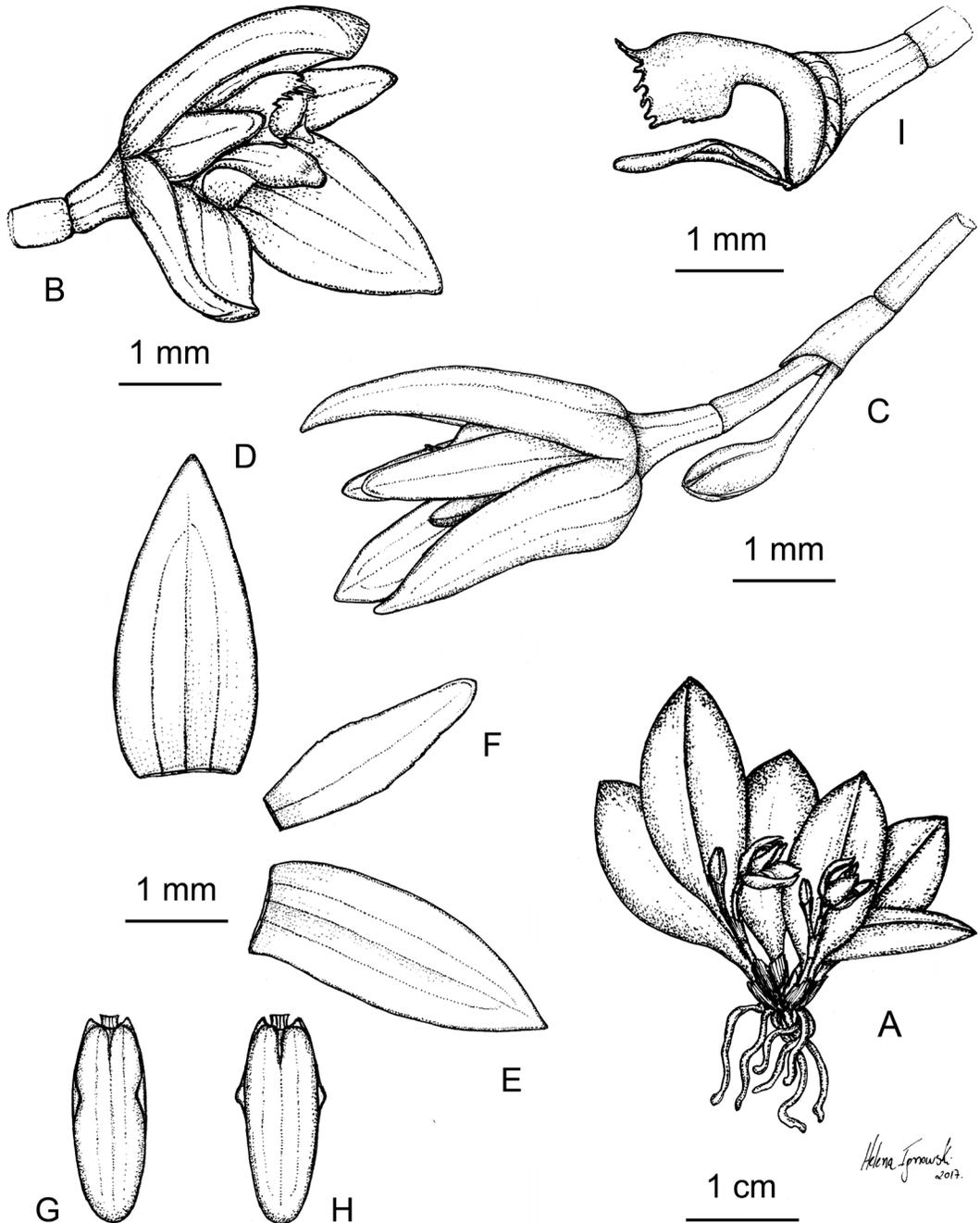


FIGURE 1. *Anathallis luteola*. A. Habit. B. Flower, $\frac{3}{4}$ view. C. Apical portion of inflorescence, showing bud and flower in side view. D. Dorsal sepal. E. Lateral sepal. F. Petal. G. Lip, from above. H. Lip, expanded. I. Ovary, column and lip, side view. Drawn by Helena Ignowski based on the holotype (A. Toscano de Brito 3352, UPCB).

shallow mentum with the column-foot; *petals* same color as sepals, $2.3\text{--}2.6 \times 0.60\text{--}0.75$ mm, oblong-elliptical, slightly convex and thickened at the apical

third, 3-veined, margins entire or microscopically erose, the apex obtuse; *lip* same color as sepals and petals, $1.75\text{--}2.00 \times 0.75\text{--}0.80$ mm, oblong-trilobed,



FIGURE 2. *Anathallis luteola*. A. Ramicaul, leaf and inflorescence, based on *A. Toscano de Brito* 3458. B. Habit, based on *A. Toscano de Brito* 3352. Photographs by W. Collier & A. Toscano de Brito.

slightly arcuate, the base minutely lobed at the angles, hinged to the column-foot, the disc unnoticeably channeled in the middle, the channel running from the base toward the apex of the lip, the lateral lobes below the middle, minute, glabrous, obtuse, erect, the apex of the lip rounded, the margins entire and shortly recurved; *column* 1.5–1.8 mm long, light-yellow with yellow-white anther, semiterete, concave abaxially, the base prolonged into a thick, 5.0–0.7 mm long column-foot, broadly winged above the middle, shortly lacerate and dentate at the apex, the anther, rostellum and stigma ventral.

DISTRIBUTION: So far known to occur in the state of Bahia, northeast Brazil.

ETYMOLOGY: The specific name derives from the Latin adjective *luteolus*, “pale yellow, yellowish,” and refers to the color of the flowers.

ADDITIONAL SPECIMENS EXAMINED: Brazil. Bahia: Without precise locality, obtained from a collector, cultivated by Maria Rita Cabral at her property in Paty do Alferes, state of Rio de Janeiro, fl. cult. 14 November 2015, *A. Toscano de Brito* 3458 (UPCB); same collection data, *A. Toscano de Brito* 3458-A (UPCB). Maracás, Pedra da Fazenda Canabrava, 977 m, 16 June 2018, *C. van den Berg* & *S. M. Oliveira* 2826 (HUEFS [not seen], photographs of the living plant).

Anathallis luteola resembles *A. guarujaensis* in habit, floral color and shape of floral segments, especially sepals and lip. In *A. luteola*, flowers are smaller, sometimes about half the size of those in *A. guarujaensis* (in the latter, sepals are 4.5–8.0 mm × 1.50–2.25 mm, and petals 3.5–4.0 mm × 1.00–1.25 mm). The inflorescence produces two flowers that open in succession, sepals are 3-veined, petals are



FIGURE 3. *Anathallis guarujaensis*. Isotype deposited at AMES. Courtesy of the Orchid Herbarium of Oakes Ames, Harvard University Herbaria.

obtuse, and the minute, lateral lobules of the lip are glabrous. In *A. guarujaensis*, inflorescence is single-flowered, sepals are 5-veined (the laterals sometimes are 4-veined), petals are acuminate, and lateral lobules of the lip are minutely pubescent or densely papillose and more prominent than in *A. luteola*. At the base of the lip of both species, a pair of minute lobules are found, a lobule on each angle. These are easily overlooked and were omitted in the illustration that appeared in the protologue of *A. guarujaensis*, whose isotype (*F. C. Hoehne s.n.*, AMES 54792) I examined (Fig. 3). An inaccuracy in the protologue of *A. guarujaensis* is the number of veins of the sepals, which are illustrated as 3-veined, but they were found to be 5-veined in the isotype at AMES. An additional collection examined of *A. guarujaensis* (*C. Luer 21146*, SEL) possesses 5-veined dorsal sepal and 4-veined lateral sepals. Petals are one-veined in both species. Recently, Miranda *et al.* (2014) published a photograph and a black and white illustration of a specimen of *A. guarujaensis* from the municipality of Caraguatubá, state of São Paulo, in southeast Brazil. This illustration agrees well with the isotype *A. guarujaensis* deposited at AMES.

Anathallis luteola was originally collected in the state of Bahia, northeast Brazil, but no precise locality was provided by the collector. More recently, it was collected again in Bahia, this time in the dry Atlantic forests of Maracás, southwest of the state.

Unfortunately, the specimen at HUEFS was not available for study and I only examined photographs of the living material. Despite the lack of precise origin of the specimens studied, this species is distinct and readily recognized from all others in the genus, and for this reason we do not hesitate to describe it as new.

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THE “FOUR FOOTED” *LEPANTHES* (PLEUROTHALLIDINAE), A NEW SPECIES FROM NORTH-WESTERN ECUADOR

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ABSTRACT. A new species of *Lepanthes*, closely resembling *L. hexapus* and *L. aguirrei*, is described and illustrated. The new species is characterized by bilobed, filiform and curved petals. Ecological and taxonomic notes are given. In addition, the first known locality for *L. bibarbullata* is presented herein.

RESUMEN. Se describe e ilustra una nueva especie de *Lepanthes*, cercanamente relacionada a *L. hexapus* y *L. aguirrei*. La especie nueva se caracteriza por tener pétalos bilobados, filiformes y curvados. Se proven notas ecológicas y taxonómicas. Además, se presenta por primera vez una localidad conocida para *L. bibarbullata*.

KEY WORDS: Ecuador, *Lepanthes hexapus*, new *Lepanthes*, Orchidaceae, petal lobe

Introduction. With more than 1,100 species, *Lepanthes* Sw. is one of the Neotropical genera in the Orchidaceae with most accepted species together with *Stelis* Sw. (Karremans 2016). New species are being discovered frequently (Jørgensen & Leon-Yanez 1999, Karremans 2016, Moreno *et al.* 2017, Pupulin & Bogarin 2012). Some species in the genus show a wide distribution range while others are endemic to restricted localities (Baquero 2018, Moreno *et al.* 2017). Species of *Lepanthes* are recognized by the ramicauls enclosed by commonly ciliated lepanthiform sheaths, the petals transversely bilobed or trilobed, and a complex lip that has a body which connects to a pair of blades which frequently cover the column (Luer 1996). At the base of the lip a small structure, present in most of the species in the genus, is called the appendix (Luer 1996). The shape, size, and position of the appendix has been traditionally used as a morphological trait which helps to distinguish among different species in the genus, and its importance in *Lepanthes* pollination has been confirmed by Blanco and Barboza (2005). Nevertheless, other characteristics, like the number of lobes in the petals and the shape of the lip, can also help to distinguish among species in *Lepanthes*.

Based on the number of petals and lip's lobes, some species of *Lepanthes* have received suggestive names, like *Lepanthes pentoxys* Luer, *Lepanthes hexapus* Luer & Escobar, *Lepanthes heptapus* Luer & Escobar and *Lepanthes octopus* Luer & Escobar with five, six, seven and eight filaments and lobes respectively (Dodson 2004, Luer & Thorerle 2012, Luer 1996).

A rich species area of *Lepanthes* is located in Carchi province, Ecuador, very close to the limit with Imbabura and Esmeraldas provinces. In this region, a new species has been discovered. It is described and compared here with an informal group of species within the genus, that shares similar morphological characteristics, both in the plants and flowers (Luer 1996).

Lepanthes tetrapus Baquero & J.S.Moreno, *sp. nov.* (Fig. 1–4).

TYPE: Ecuador. Carchi: north-west of Lita, 0°55' 24.42.0"N 78°30' 12.28"W, 754 m, 08.03.2017, *L. Baquero et al. LB 3112* (holotype, QCNE).

Diagnosis: *Lepanthes tetrapus* is vegetatively and florally similar to *L. hexapus*, from which it differs by

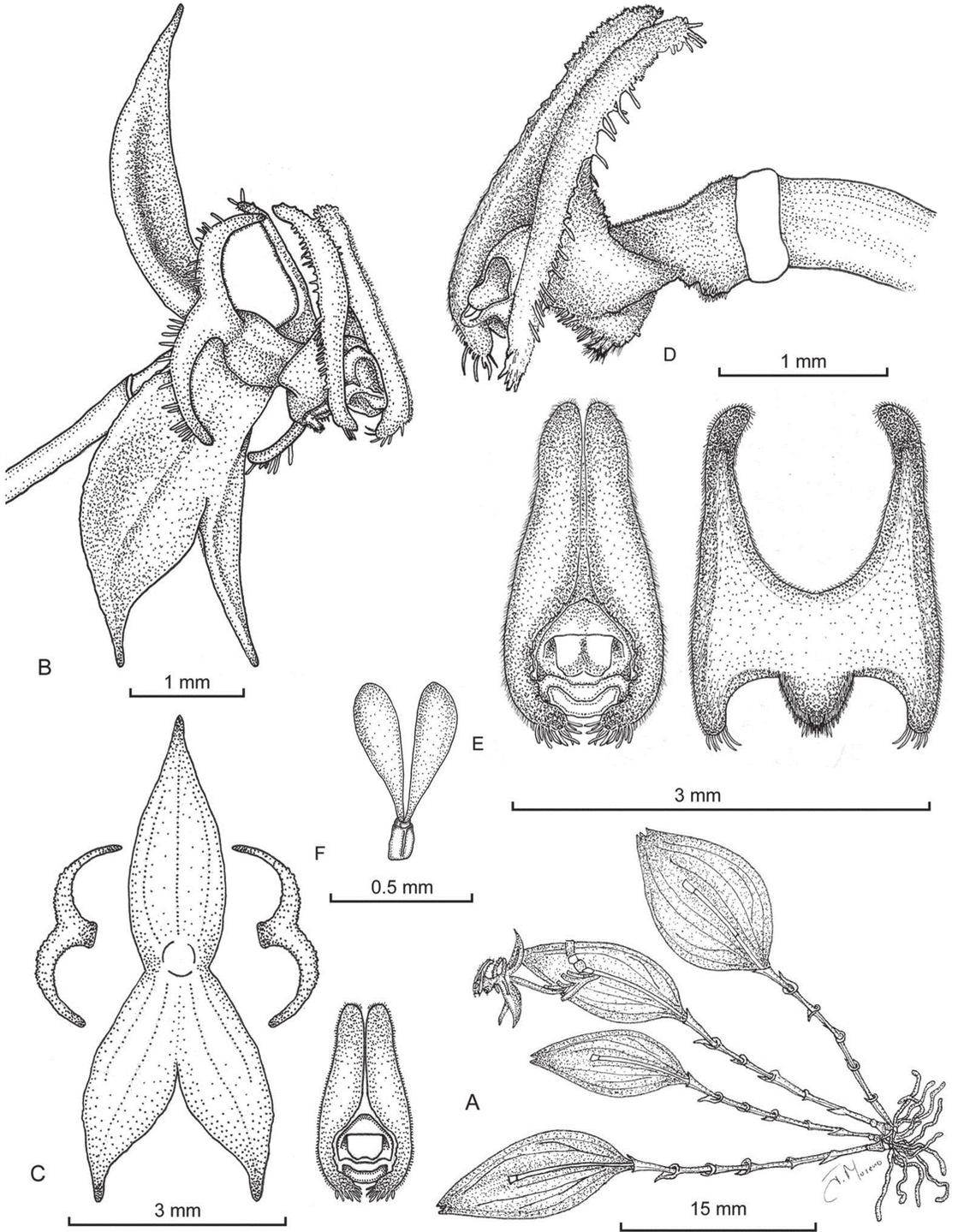


FIGURE 1. *Lepanthes tetrapus* Baquero & J.S. Moreno. A. Plant and Habit. B. Flower view in 3/4 position. C. Flower dissected. D. Column and lip detail. E. Lip detail. F. Pollinarium. Line-draw by Juan Sebastián Moreno.



FIGURE 2. *Lepanthes tetrapus* Baquero & J.S.Moreno. A. Plant with flower *in situ*. B. Frontal view of the flower and comparison with biohazard international symbol. C. Close-up of the Lip and petals. D. Lateral view of the flower. Photos by Luis E. Baquero.

the petals with two curved, filiform lobes instead of three.

Epiphytic, caespitose, erect to suberect *herb*. *Roots* flexuous, to 0.5 mm in diameter. *Ramicauls* erect, 4.0–9.0 mm long, enclosed by 3–5 minutely ciliate, keeled, lepanthiform sheaths, the ostia minutely ciliate, ovate, acuminate and slightly dilated. *Leaves* erect, coriaceous, elliptic-ovate, subacute, light green, prominently reticulated along the veins, veined in purple, 1.0–3.0 × 0.6–1.0 cm, the base cuneate into a petiole 1 mm long. *Inflorescence* a congested,

distichous, glabrous, successively flowered raceme, developed above the leaf, shorter or as long as the leaves, up to 1.8 cm long; peduncle terete, 0.6 cm long. *Floral bracts* acute, 0.8 mm long. *Pedicels* 1.5 mm long, persistent. *Ovary* to 1 mm long, glabrous. *Sepals* yellowish green suffused with brown-red towards the center, spiculate at the abaxial side of the veins. *Dorsal sepal* free, obovate, obtuse, acuminate, slightly concave, 3-veined, 3.0–3.3 × 1.5–1.7 mm, the margins minutely denticulate. *Lateral sepals* obovate, acuminate, slightly concave, 2-veined, 3.0–3.3 × 1.5–1.6 mm, connate for 0.5 mm. *Petals* yellow, darker



FIGURE 3. Comparison of *Lepanthes tetrapus* Baquero & J.S. Moreno and two similar species. A. *Lepanthes tetrapus* Baquero & J.S. Moreno. B. *Lepanthes hexapus* Luer & Escobar. C. *Lepanthes aguirrei* Luer. Photos by Luis E. Baquero (A–B) and Sebastián Vieira-Uribe (C).

towards the apex, transversely bilobed, filiform, 2.5 × 0.5 mm, the lobes equal in size and shape, falcate-oblong with the apex rounded, minutely pubescent, ciliate along the margins. *Lip* purple, orange towards the margin, bilaminate, the blades narrowly ovate to elliptic-oblong, the apex long pubescent, curved towards the column, 2.5–2.7 mm long, ciliate along the margins; the connectives cuneate, oblong, the body thick, densely pubescent, rounded, connate to the middle of the column; the appendix conspicuous, thick, pubescent, ovoid, bilobulate at the apex. *Column* cylindrical, to 1.5 mm long, the anther and the stigma apical. *Pollinia* two, ovoid, basally filiform. *Anther cap*, magenta, obovate.

ETYMOLOGY: From Greek “four-footed” due to the four filiform lobes of the petals.

Lepanthes tetrapus is very similar in habit and flowers to *L. hexapus* and *L. aguirrei* Luer (Fig. 3). Both species, *L. hexapus* and *L. aguirrei*, have erect leaves with purple reticulations, the inflorescence shorter than the leaf, flowers with essentially free sepals and trifurcate petals, and plants which are small for the genus. Nevertheless, the two species differ in the size of the plants (taller in *L. aguirrei*, with ramicauls reaching 4.5 cm vs. 2 cm long in *L. hexapus*) and the apex of the sepals, which is stoutly caudate in *L. aguirrei* and acute in *L. hexapus*. *Lepanthes tetrapus* is similar to both species, sharing all the characteristics mentioned above except for the two filiform lobes of each petal instead of three. Due to the characteristic shape of the petal lobes and the apex of the lip, this

species has been known so far as the “biohazard” *Lepanthes*, due to the remarkable similarity with the international alert symbol (Fig. 2). This similarity might visually help to immediately distinguish *L. tetrapus* from any other species in the genus.

DISTRIBUTION AND ECOLOGY: This species is known from a low elevation cloud-forest close to Lita, where it is fairly common. Another locality is known for the species in the province of Esmeraldas. It is found growing with several other species of *Lepanthes* including *L. filamentosa* Luer & Hirtz, *L. saltatrix* Luer & Hirtz, *L. tentaculata* Luer & Hirtz, *L. scrotifera* Luer & Hirtz and *L. bibarbullata* Luer. *Lepanthes tetrapus* grows significantly lower in elevation than *L. hexapus* and has not been observed at elevations higher than 800 m (Fig. 4).

A specific locality for *Lepanthes bibarbullata* Luer.

This species was originally described without a known locality from a specimen obtained from J&L Orchids (Luer 2002). It is here recorded for the first time with a known locality.

Lepanthes bibarbullata Luer, Monogr. Syst. Bot. Missouri Bot. Gard. 88: 87, f. 310. 2002.

TYPE: Ecuador. Without locality: cultivated by J&L Orchids 799-593, Easton, CT, Nov 2000, C. Luer 19440 (holotype, MO).

SPECIMEN STUDIED: Ecuador. Carchi: north-west of Lita, 0°55'24.42.0"N 78°30'12.28"W, 754 m, 08.03.2017, L. Baquero et al. LB 3113 (QCNE) (Fig. 4A).

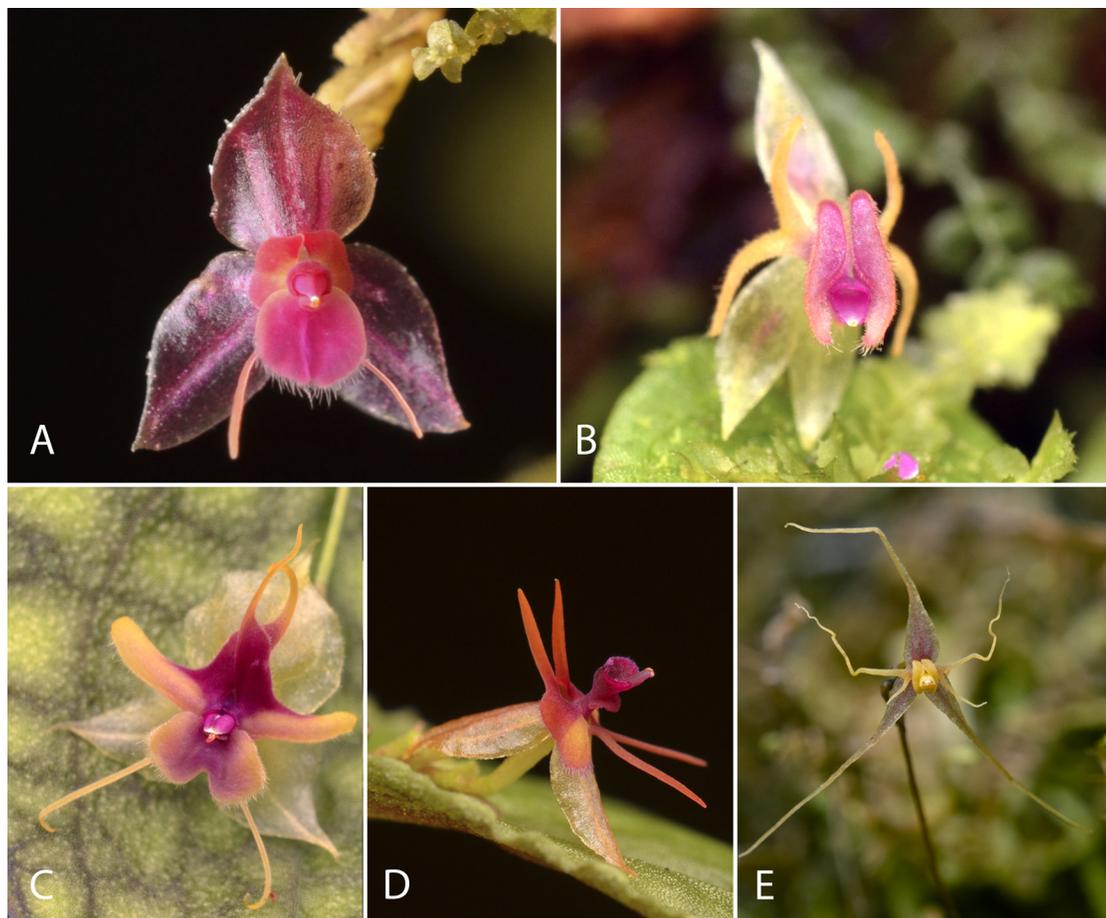


FIGURE 4. *Lepanthes bibarbullata* Luer and some sympatric species in the genus. A. *Lepanthes bibarbullata* Luer. B. *Lepanthes tetrapus* Baquero & J.S.Moreno. C. *Lepanthes saltatrix* Luer & Hirtz. D. *Lepanthes tentaculata* Luer & Hirtz. E. *Lepanthes filamentosa* Luer & Hirtz. Photos by Luis E. Baquero.

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in several trips made for obtaining plants and data from the new species *in situ* and his enthusiasm in the orchid world. The Ministerio del Ambiente del Ecuador is acknowledged for issuing the Environmental Research Permit No. 008-2016-IC-FLO-DNB/MA.

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**SPECIALIZED HERBIVORY ON INFLORESCENCE STALKS OF
TRICHOCENTRUM UNDULATUM (ORCHIDACEAE)
BY *MELANAGROMYZA* SP. (DIPTERA: AGROMYZIDAE) IN CUBA**

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ABSTRACT. Inflorescence stalk herbivory on the Mule Ear orchid (*Trichocentrum undulatum*) has been observed in Cuba, which resembles the specialized herbivory interaction seen in southern Florida between a specialized dipteran, *Melanagromyza miamensis* (Agromyzidae) and the Mule Ear orchid. We are able to identify the inflorescence herbivore to be the genus *Melanagromyza*. It is possibly the same species that can be found in southern Florida. The mule-ear orchid is endemic to the Caribbean region, i.e. Cuba, Jamaica and southern Florida. To our knowledge, this is the first report of an apparently specialized inflorescence stalk herbivory by Agromyzid flies on the Mule Ear orchid in Cuba. The herbivory can partially or completely destroy the flowering potential of the impacted plants.

KEY WORDS: Agromyzid, Cape-sable orchid, Florida endangered orchid, Oncidiinae, orchid herbivory

Introduction. *Trichocentrum undulatum* (Sw.) Ackerman & M.W.Chase is an epiphytic orchid whose distribution extends from Jamaica, Cuba and Bahamas to Florida (Ackerman 2014). The population in southern Florida is the northernmost limit of the species and is the only mainland North American population. In southern Florida, *T. undulatum* is rare and only found in a restricted area of coastal salt marsh found growing only on buttonwood trees (*Conocarpus erectus* L.). This Florida population is subject to specialized inflorescence stalk herbivory by *Melanagromyza miamensis* Spencer. Such herbivory has not previously been reported beyond southern Florida (Higgins & Gann 2007, Seavey & Seavey 2018, Spencer & Stegmaier 1973).

The dipteran genus *Melanagromyza* (Agromyzidae) consists of over 300 species and is distributed worldwide (Spencer & Steyskal 1986). Not much is known about host plants used by the majority of Agromyzids due to the difficulties in capturing or rearing adult flies or difficulties with locating puparia within plant tissues (Spencer 1990). Herein we report

inflorescence stalk herbivory of *T. undulatum* observed in four provinces within Cuba (Artemisa, Cienfuegos, Matanzas, and Sancti Spiritus).

Methodology. *Trichocentrum undulatum* can be found within every province of Cuba, in different habitats, and growing on a diversity of phorophyte hosts. Four populations of *T. undulatum* were visited in Cuba in the provinces of Artemisa, Cienfuegos, Matanzas, and Sancti Spiritus during the summers of 2016 and 2017. Transects were laid out within forest stands where the orchid was known to grow. A total of four transects were made at four wild populations in the Artemisa (one transect) and Matanzas (three transects) provinces. Inflorescence stalks were also evaluated and collected for herbivore presence at Macradenia Orchid Garden in Cienfuegos province and Comunidad 23 Orchid Garden in Sancti Spiritus province. For every *T. undulatum* plant encountered on the transect, a search for other plants was made within a five-meter radius. The length of the transects varied between 20 to 100 meters, depending on the forest

size and habitat topography. Inflorescence stalks were collected from every individual that had flowered in February/March (the flowering season for the species) and had failed to produce fruit. The inflorescence stalks were labelled and later dissected to determine the presence of an inflorescence stalk herbivore. Exit holes were examined and any pupal casings found were photographed.

Results. Although no adult fly exiting *T. undulatum* was captured, larval casing characteristics were used to determine that the herbivores affecting inflorescences of *T. undulatum* within Cuba are a *Melanagromyza* species. Pupal casings were extracted from inflorescence stalks from all of the transects sampled. The larvae found in the orchid samples fitted the description of the genus *Melanagromyza* by having two sclerotized plates with pronounced “bulbs” atop the plates with a protruding “horn” in the center (Fig. 1) (Spencer & Steyskal 1986). This identification had also been confirmed by an Agromyzidae specialist (Scheffer pers. comm. 2017). Exit holes found on the inflorescence stalks were similar to those found in the southern Florida population (Fig. 2). No other Diptera larvae were found within the flowering stalks, leaves, or fruits of *T. undulatum*.

A total of 391 plants were located in the transects between the 2016 and 2017 surveys. Of these, 149 (38%) produced inflorescences. The percentage of sampled flowering plants with *Melanagromyza* sp. presence was 48% (72 plants). The number of inflorescences produced by a plant generally varied between one to six stalks between the two surveys. A total of 198 inflorescence stalks were collected and examined. Of these, 87 inflorescences (44%) exhibited dipteran casing presence.

Despite approximately half of all flowering plants having been attacked by *Melanagromyza* sp., we observed fruit in both 2016 (two fruit out of 85 flowering plants) and 2017 (one fruit out of 64 flowering plants) (Fig. 3). Vouchers of the puparia casings and the inflorescence stalk tips exhibiting exit holes and boring architecture were deposited at the Onaney Muñiz National Herbarium from the Institute of Ecology and Systematics, Havana, Cuba.

Discussion. Our study is the first to report the presence of inflorescence herbivory of *T. undulatum* by an



FIGURE 1. Pupal casings of a *Melanagromyza* sp. found within an inflorescence stalk in Cuba, summer 2016. The sclerotized plate with the doubled “horns” are apparent and particular for the genus.

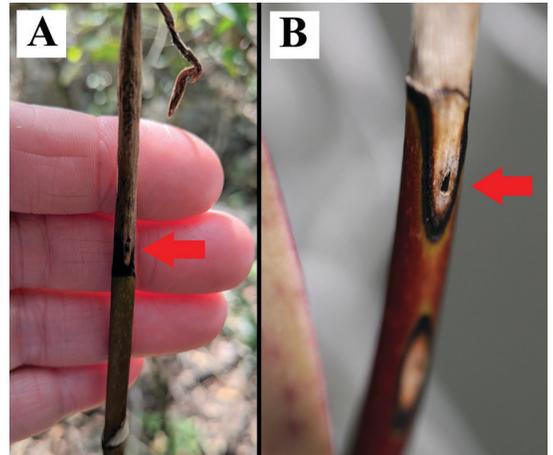


FIGURE 2. A. Exit holes made to accommodate the emergence of adult dipteran(s) from infested inflorescence stalks of *Trichocentrum undulatum* in Matanzas province, Cuba 2016. B. Exit holes made from emerging adult *Melanagromyza miamensis* from a *T. undulatum* inflorescence stalk in Florida, USA, 2013.

Agromyzid fly in Cuba. Due to the host specialization nature of the Agromyzidae family (Spencer 1990), it is possible that the observed *Melanagromyza* in Cuba is the same species as that found in southern Florida, but this requires further taxonomical study by a specialist. *Melanagromyza* sp. has only been observed in the inflorescence stalks of *T. undulatum* and not on any other orchid species in the surrounding areas assessed in Cuba and southern Florida (Borrero unpubl. 2017). In southern Florida, herbivory intensity by *M. miamensis* was 100% between 2014 and 2015 in the largest

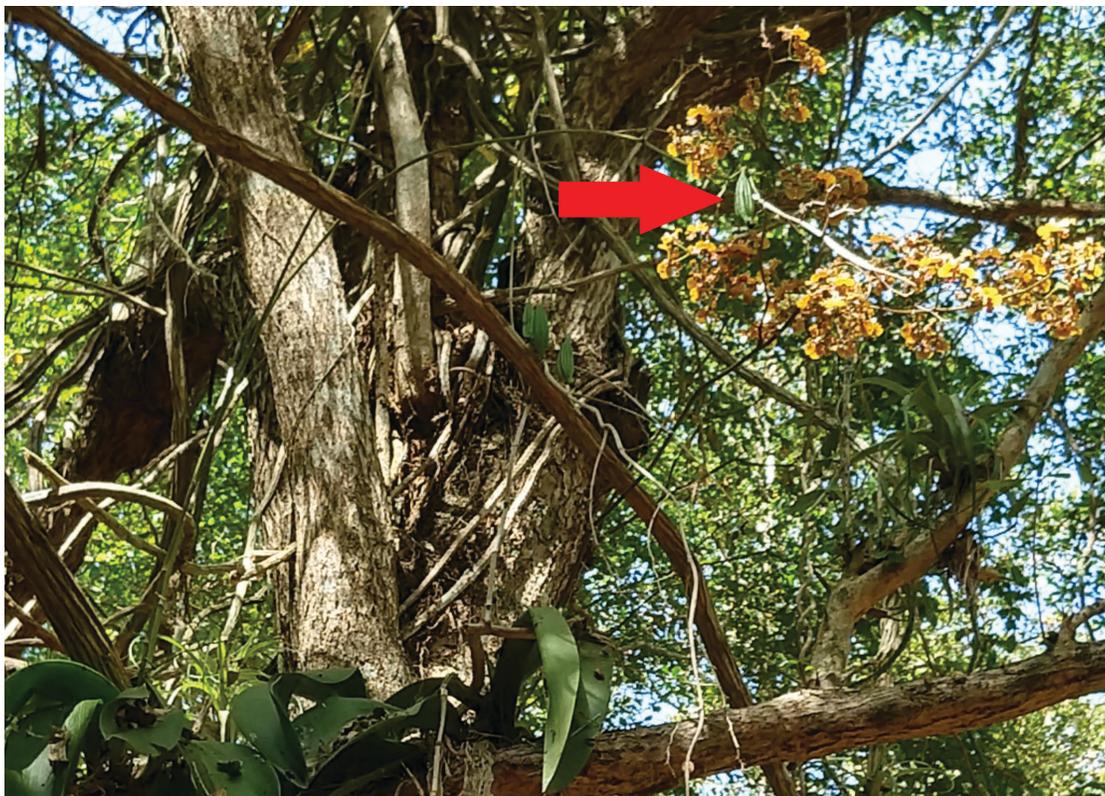


FIGURE 3. An uninfested fruiting inflorescence stalk found in Matanzas Province where no *Melanagromyza* sp. herbivory was evident.

known *T. undulatum* population within the Everglades National Park (n=155 at a 1 km long transect and a total of 53 inflorescence stalks evaluated), resulting in a very low to none pollination opportunities (loss of flowers) and subsequently, limited fruit/seed production (Gann *et al.* 2009, Borrero unpubl. 2017). In contrast, only 48% of flowering plants assessed in Cuba experienced *Melanagromyza* sp. herbivory between 2016 and 2017. The lower attack rate in Cuba versus that observed in Florida could indicate that different biological and ecological factors exist between populations. Study is on-going in comparing the demography and ecology between the orchid populations in South Florida and Cuba.

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THE GENUS *PALMORCHIS* (ORCHIDACEAE: NEOTTIAE) IN PERU: A TAXONOMIC SYNOPSIS INCLUDING FOUR NEW SPECIES AND A NEW RECORD

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ABSTRACT. A taxonomic synopsis of Peruvian *Palmorchis* with six accepted species is provided including four new species (*P. blancae*, *P. liberolabellata*, *P. loretana* and *P. yavarensis*) and a new record previously reported only for Ecuador (*P. imuyaensis*). This overview is the result of a review of local herbaria, taxonomic literature, and a field study of the genus. An artificial key for all Peruvian *Palmorchis* species is presented, as well as photographs and a map of known localities in Peru.

RESUMEN. Se presenta una sinopsis taxonómica de *Palmorchis* peruanas con seis especies aceptadas, incluyendo cuatro nuevas especies (*P. yavarensis*, *P. blancae*, *P. liberolabellata* y *P. loretana*) y un nuevo registro (*P. imuyaensis*) previamente reportado sólo para Ecuador. Este resumen es el resultado de la revisión de herbarios locales, literatura y el estudio de campo del género. Se presenta una clave artificial para todas las especies de *Palmorchis* peruanas, así como fotografías y un mapa de todas las localidades conocidas en Perú.

KEY WORDS: Amazonian lowlands, Neottieae, Orchidaceae, *Palmorchis*, Perú

Introduction. The genus *Palmorchis* Barb.Rodr. was proposed by Barbosa Rodrigues in 1877 to describe two Brazilian species, *Palmorchis pubescens* Barb.Rodr. and *Palmorchis sobralioides* Barb.Rodr., possessing a palm-like habit (fide Barbosa Rodrigues, “very similar to *Geonoma* palm [Arecaceae]”). Currently the genus encompasses 34 species found in Central and South America, including Trinidad (Pridgeon *et al.* 2005, Szlachetko *et al.* 2018). According to Dressler (1993a,b), *Palmorchis* species are terrestrial plants with slender, reed-like stems, several to many, 2-ranked or spiral, pleated leaves; inflorescence is terminal or lateral, of several flowers, usually produced one at a time; sepals and petals are similar, spreading; the slender column is enfolded by the lip and united with it basally along its mid-nerve; and four, soft pollinia.

Palmorchis is one of several poorly known orchid genera of the New World (Hágsater *et al.* 1996). Plants of this genus look like small palm seedlings or forest

grasses and can be easily overlooked when not in flower. Furthermore, the flowers last only a few hours; to find *Palmorchis* in flower, as Dressler (1984) noted, “you should be either lucky or persistent”. The taxonomic position of *Palmorchis* has been a subject of debate since its description (Hoehne 1945, Schweinfurth & Correll 1940, Szlachetko & Baranow 2014). Recent molecular phylogenetic studies reveal that *Palmorchis* is one of the most primitive Epidendroideae, sister to tribe *Neottieae* (Chase *et al.* 2003, Rothacker 2007). However, further studies and sampling are necessary to better assess this evidence.

In Peru, *Palmorchis* was first recorded in 1928 by Rudolf Mansfeld, who described *Neobartlettia lobulata* Mansf. [= *P. lobulata* (Mansf.) C. Schweinf. & Correll] (Fig. 1) based on a specimen collected in the eastern part of the country (Loreto). Since then, a few individuals have been recorded, mainly represented by sterile specimens from mixed lowland forest and

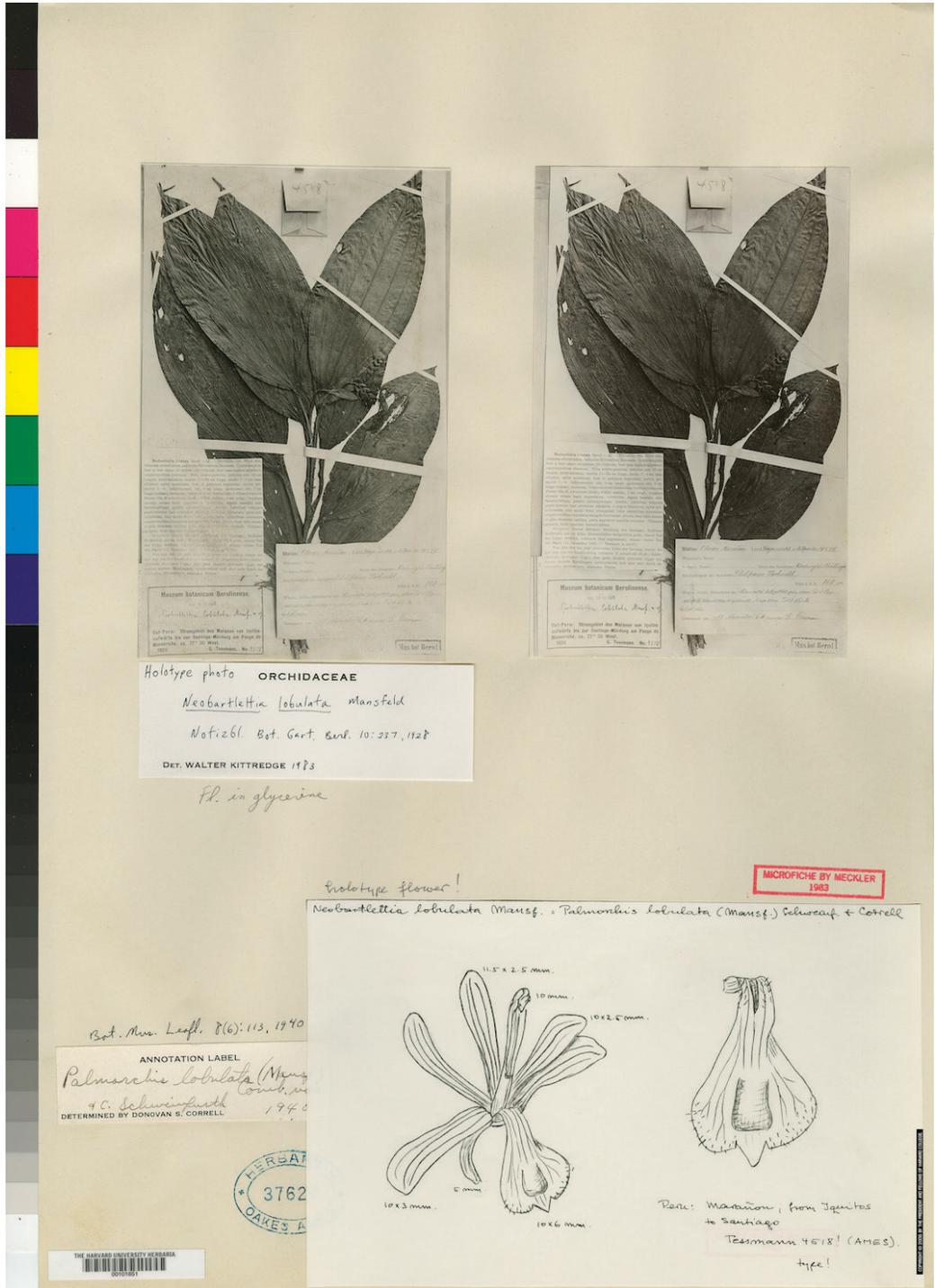


FIGURE 1. Photograph of the holotype of *Palmorchis lobulata* (Mansf.) C. Sweinf. & Correll held at AMES (00101851, 00083175). Reproduced with kind permission of the Director of Harvard University Herbarium.

palm-dominated wetlands (known as *aguajales*). Until this work, only *P. lobulata* was reported for the country (Brako & Zarucchi 1993). Nevertheless, a detailed study of available herbarium material reveals a higher diversity of *Palmorchis*. The present study recognizes six species of *Palmorchis* for Peru, including one new record and four new species (Fig. 2). A taxonomic synopsis, an artificial key, and a map of all known localities for Peruvian *Palmorchis* are provided in this work, as well as comparative notes with their close relatives.

Materials and methods. For the taxonomic treatment, protologues were obtained from Tropicos (2016), names were checked in the IPNI (2016) database, and

currently accepted scientific names and synonyms were based on Govaerts *et al.* (2016). Herbarium specimens deposited at USM and AMAZ were revised, as well as high-quality images of herbarium specimens at CUZ, FLAS, AMES, RB, F, US, P, and MO. In August 2016 the first author carried out field work in Peru's Amazon lowlands in the Department of Loreto. When available, specimens were photographed *in situ* using a Nikon D7100 with a Micro Nikkor 60-mm lens. Descriptions and measurements were carried out using a Euromex SB-1903 stereomicroscope. Line illustrations were prepared from alcohol-preserved available material, digital photos and rehydrated flowers, and processed with Adobe Photoshop CC v. 14.0.

Taxonomic treatment

KEY TO THE PERUVIAN SPECIES OF *PALMORCHIS*

- | | |
|---|---------------------------|
| 1. Plant small, up to 30 cm tall; leaves narrowly elliptic, 3-veined; flowers white | <i>P. imuyaensis</i> |
| 1a. Plant large, 40–60 cm tall; leaves broadly elliptic to obovate; 5–9 veined; flowers greenish to yellowish | 2 |
| 2. Flowers with tepals >2 cm long, narrowly lanceolate; lip with midlobe 9–10 mm long, densely pubescent | <i>P. yavarensis</i> |
| 2a. Flowers with tepals <2 cm long, oblong-elliptic to obovate; lip with midlobe <4 mm long, glabrous | 3 |
| 3. Inflorescence lateral; lip free from the column, midlobe bilobed; column overall glabrous | <i>P. liberolabellata</i> |
| 3a. Inflorescence terminal; lip united to the column by a membrane down the midline, midlobe simple; column densely pubescent | 4 |
| 4. Lip obovate, midlobe rounded, callus with 5 thickened keels | <i>P. blancae</i> |
| 4a. Lip obtriangular, midlobe oblong to ovate, callus without thickened keels | 5 |
| 5. Leaves 17–24 × 7–9 cm midlobe triangular, lateral lobes sparsely pilose, callus subquadrate, cushion-like | <i>P. lobulata</i> |
| 5a. Leaves 9–18 × 3–4.9 cm; midlobe oblong, lateral lobes glabrous, 2 fleshy ridges | <i>P. loreтана</i> |

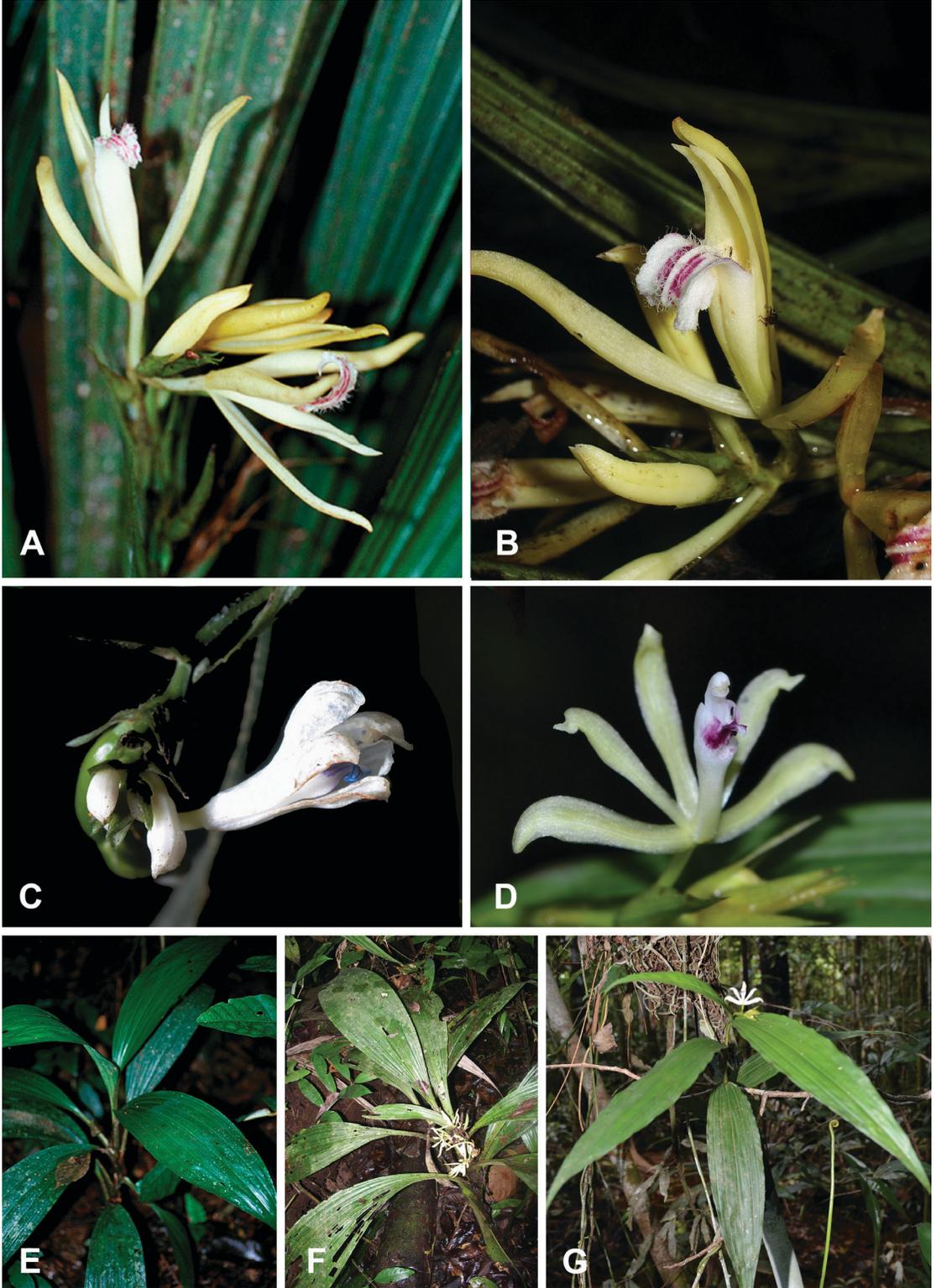
1. *Palmorchis blancae* Damián, *sp. nov.*

TYPE: PERU. Madre de Dios: Tambopata, 15 km E. de Puerto Maldonado, Albergue “Cusco Amazónico”. 5 April 1986. B. Leon & I. Bohorquez 895 (holotype: USM!). Fig. 3.

Most similar to *P. nitida* Dressler, from which it differs by the inflorescence bearing a long basal bract, 8.0 cm long (*vs.* 3.5–5.0 cm) and the lip distinctly 3-lobed ornamented by 5 prominent keels (*vs.* shallowly 3-lobed with 7 thickened keels), densely pubescent below the middle with ciliate margins (*vs.* glabrous lip with entire margins).

Herb up to 55 cm tall. *Roots* slender, 0.23 cm wide. *Stems* cane-like, up to 33 cm long, 0.5 cm in diameter, with 4 leaves. *Leaves* plicate, 5-veined, broadly elliptic, acuminate, cuneate at the base, 15.0–19.0 cm long, 6.0–8.0 cm wide; petiole up to 4 cm long. *Inflorescence* up to 5 cm long, terminal, few-flowered,

with 1 foliaceous bract at base, narrowly lanceolate, acuminate, 8 cm long. *Floral bracts* 6.0 mm long, 3.0 mm wide, broadly triangular, acute. *Peduncle* 24 mm long, pedicel and ovary 8 mm long. *Dorsal sepal* 11 mm long, 1.5–2.0 mm wide, linear-oblongate, acute, concave, 5-veined, thickened in the middle. *Lateral sepals* 10 mm long, 2 mm wide, oblanceolate, oblique, subfalcate, acute, 5-veined. *Petals* 10 mm long, 2 mm wide, obliquely ligulate-oblongate, acute, 7-veined, apical margin slightly erose, thickened on the outer margins. *Lip* 10 mm long, 4 mm wide when spread; united with the column for about 2 mm; densely pubescent below the middle with ciliate margins, constricted on the apical quarter with 5 main veins running from the base close to the apex, thickened in apical half; the middle lobe 2.5 mm long, 3.0 mm wide, transversely elliptic, rounded, margins crenulate; lateral lobes semicircular. *Column* pubescent, slender, terete, up to 8 mm long, densely pubescent on the ventral surface below the middle, *anther* conic, 1 mm



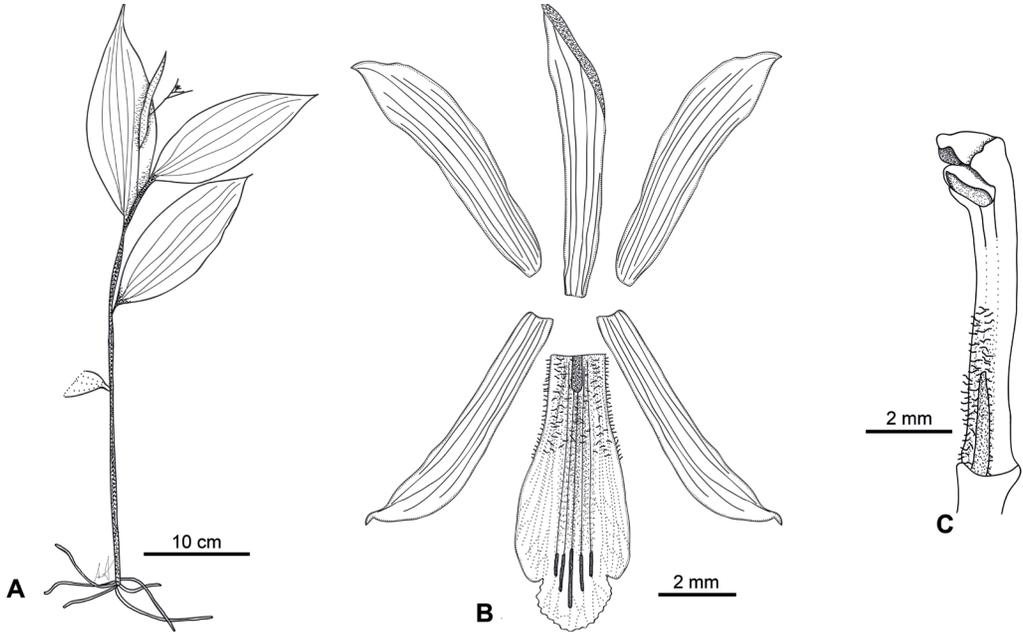


FIGURE 3. *Palmorchis blancae* Damián. A. Plant, B. Dissected perianth, C. Column. Drawn from the holotype (B. León & I. Bohorquez 895 USM!) by A. Damián.

long, *pollinia* ellipsoid, paired, 0.9 mm long, *stigma* oblong, emergent. *Fruit* not seen.

DISTRIBUTION: Endemic to Peru, where it is known from a single collection in the understory of mature lowland forest in easternmost Madre de Dios (Fig. 9). Given that the locality is close to the Peru-Bolivia border, it is likely that the species occurs in similar habitat in Pando, Bolivia.

ETYMOLOGY: Dedicated to Blanca León, who collected the plant that served as the holotype.

P. blancae belongs to a small group of *Palmorchis* species characterized by the inflorescence subtended by a basal bract, which resembles somewhat a spatha; and lip with 3 to 7 thickened keels (Table 1). Two species exhibit this combination of features: *P. nitida* and *P. fractiflexa* Szlach. & Baranow. The latter is easily distinguished by its overall glabrous lip with short pubescence close to the base and entire basal margins (vs. densely pubescent below the middle with conspicuous ciliate margins), constricted below the middle (vs. on the apical quarter), with 3 lamellae reaching the apex, much

higher in the midlobe (vs. 5 main veins not reaching the apex, thickened in apical half).

Another similar species is *Palmorchis puber* (Cogn.) Garay, which differs in the wide obtriangular lip with an obscure middle lobe, and with 2 inconspicuous lamellae below the apex (vs. obovate lip with 5 thickened veins).

2. *Palmorchis imuyaensis* Dodson & G.A.Romero, *Lindleyana* 8(4): 197. 1993

TYPE: ECUADOR. Sucumbios: Laguna de Imuya, October 1991, C.H. Dodson & G.A. Romero 18922 (Holotype: MO ex RPSC, Isotypes: AMES, SEL). Fig. 1–2,4.

Palmorchis imuyaensis is most similar to *P. puber*, but distinguished from the latter in the spathulate lip (vs. obtriangular to obovate-obtriangular) without lamellae on the disc (vs. 2 low lamellae below 3-lobed apex) and conspicuous triangular apex (vs. short, truncate apex).

DISTRIBUTION: Ecuador and Peru (Fig. 4).

Left, FIGURE 2. Representative species of Peruvian *Palmorchis*. A-B, E-F. *Palmorchis yavarensis* sp nov. Damián & Torres [H. Beltrán et al 5698 USM!; I. Huamantupa 14065 AMAZ!], C. *Palmorchis imuyaensis* Dodson & G.A. Romero [Damián & Mitidieri 4040 UFV!], D, G. *Palmorchis loreтана* sp nov. Damián & Torres [M. Ríos et al. 4268, AMAZ!]. Photographs: A, E: R. Foster; B, F: I. Huamantupa; C: A. Damián; D: T. Mori; G: L. Torres.

TABLE 1. Characters separating Peruvian *Palmorchis* species.

Character	<i>Palmorchis blancae</i>	<i>Palmorchis imuyaensis</i>	<i>Palmorchis liberolabellata</i>	<i>Palmorchis lobulata</i>	<i>Palmorchis loreтана</i>	<i>Palmorchis yavarensis</i>
Plant size (cm)	55	30	40	50	40–50	50
Leaf shape	broadly elliptic	narrowly elliptic	broadly elliptic	elliptic to ovate-elliptic	oblong-elliptic	broadly elliptic to obovate
Leaf size (cm)	15–19 × 6–8	13–17 × 1.5–3.0	37–48 × 7–9	24.0 × 9.0	9–18 × 3.0–4.9	65–70 × 10–11
Leaf veins	5	3	5	7–9	5	5–7
Inflorescence	terminal	terminal	lateral	terminal	terminal	terminal
Flowers	unknown	white with blue lip	green-yellowish	yellowish green	pale yellowish-green, purple lip	yellowish with red lines lip
Sepals size (mm)	10–11 × 1.5–2.0	8–10 × 2–3	8–10 × 2	13 × 2.5	6–8 × 1	27–30 × 2–3
Petals (mm)	10 × 2	9.5 × 2.5	8.0–8.5 × 2.0	11 × 2	5–8 × 1	22–25 × 2
Lip size (mm)	10 × 4	9.0 × 4.5	8 × 5	10 × 6	5–8 × 3	23–25 × 8
Lip shape	obovate, 3-lobed, midlobe rounded	spathulate, 3-lobed, midlobe ovate	obovate, 3-lobed, midlobe bilobulate	obtriangular, 3-lobed, midlobe triangular	obtriangular, 3-lobed, midlobe triangular	oblanceolate, 3-lobed, midlobe long
Lip callus	5 thickened veins	v-shaped	5 thickened veins	subquadrate cushion-like	2 parallel tall fleshy ridges	3 thickened veins, with a furrow in the midlobe
Column (mm)	8 mm, densely pubescent below the middle	10mm, densely pubescent	10 mm, shortly pubescent near the base	11 mm, densely pubescent	8 mm, densely pubescent	15 mm, densely pubescent

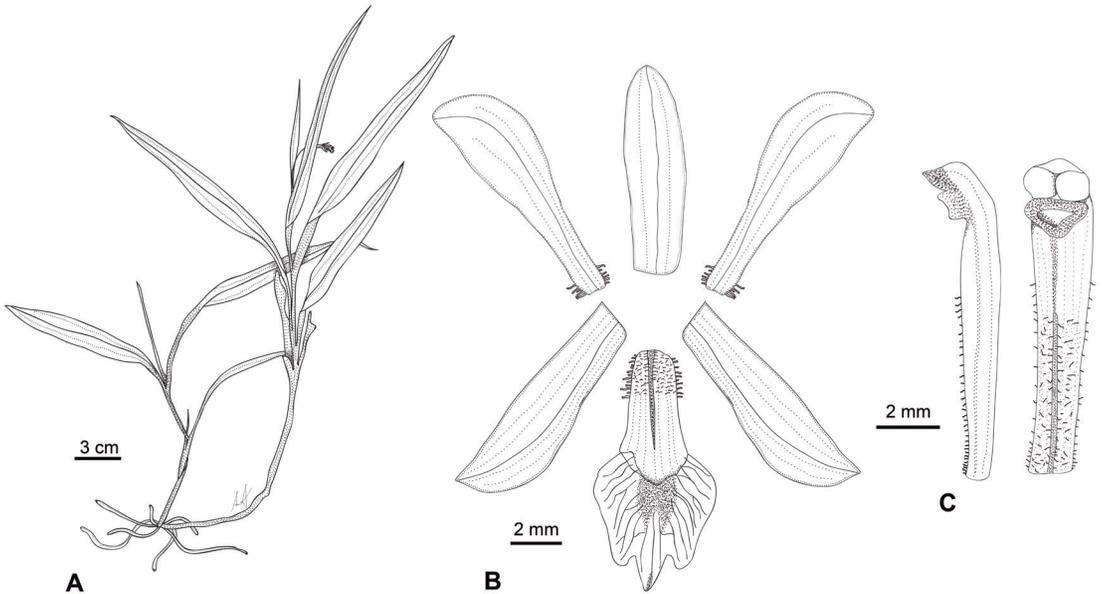


FIGURE 4. *Palmorchis imuyaensis* Dodson & G.A. Romero. A. Plant, B. Dissected perianth, C. Column on ventral and lateral view. Drawn from *Damián & Mitidieri 4040 UFV!* by A. Damián.

SPECIMENS EXAMINED: Perú. Loreto: Maynas, Dist. Las Amazonas, Yanayacu, 3°27'46.22"S 72°16'15.06"W, 100 m, 16 August, 2016, A. Damián, N. Mitidieri, R. Cahuachi & M. Segundo 4040 (UFV!).

The Peruvian specimen shows some notable differences from the Ecuadorian type (Dodson & Romero-Gonzales 1993), especially in flower morphology. First, the leaves are shorter and narrower, 13.0 × 1.5 mm (vs. 16.0 × 3.0 mm). The flowers are slightly shorter as well, with sepal dimensions of 8.0–9.0 × 2.0–3.0 mm (vs. 10.0 × 2.5–3.0 mm). Moreover, the petals and lip are minutely ciliate at the base with a column densely pubescent on the lower part (vs. petals, lip and column glabrous). This species can be distinguished from other *Palmorchis* species by the small plants, narrower leaves which are 3-veined, flowers white with petals ciliate at the base, column densely pilose, lip margins glabrous and pilose at base (feature presented here), with a V-shaped cavity on the upper side just ahead of the keel, and iridescent blue broadly triangular midlobe (Table 1).

3. *Palmorchis liberolabellata* Damián, *sp. nov.*

TYPE: PERU. Cusco: La Convención, Dist. Echarati,

11°46'53.40»S; 72°42'6.00» W. Bosque colinoso disturbado, 400 m. H. Beltrán, W. Nauray, R. De la Colina, L. Acurio, J. Tenteyo 3204 (holotype USM!). Fig. 5.

Palmorchis liberolabellata is similar to *P. prospectorum*, from which it is easily distinguished by its glabrous floral bracts and flowers (vs. pubescent floral bracts, sepals, lip and column); smaller flowers with sepals 8.5–10.0 mm long (vs. >25.0 mm long); lip free from the column (vs. lip united with the column by a membrane down to the middle of its length), and callus formed by 5 main veins thickened in the upper part (vs. 3 main thickened veins).

Herb at least 40 cm tall. *Roots* not seen. *Stems* terete, 0.6 cm in diameter, with 5 leaves toward the apex. *Leaves* broadly elliptic, plicate, with 5 prominent veins on the underside, petiolate, not articulated to the sheath, oblong-elliptic, acuminate at the apex, cuneate at the base, 37–48 cm long including the petiole, 7–9 cm wide. *Inflorescence* axillar, 3–6 cm long, many flowered, congested. *Peduncle* 0.8–1.0 cm long, with 2 ovate bracts close to the base, 1.2–1.5 cm long. *Flowers* produced one to two at a time, green-yellowish; *flowers bracts* ovate, acute, glabrous, 1.0–1.5 cm long, 0.3–0.5 cm wide. *Pedicel* and *ovary*, 6–8 mm long. *Dorsal*

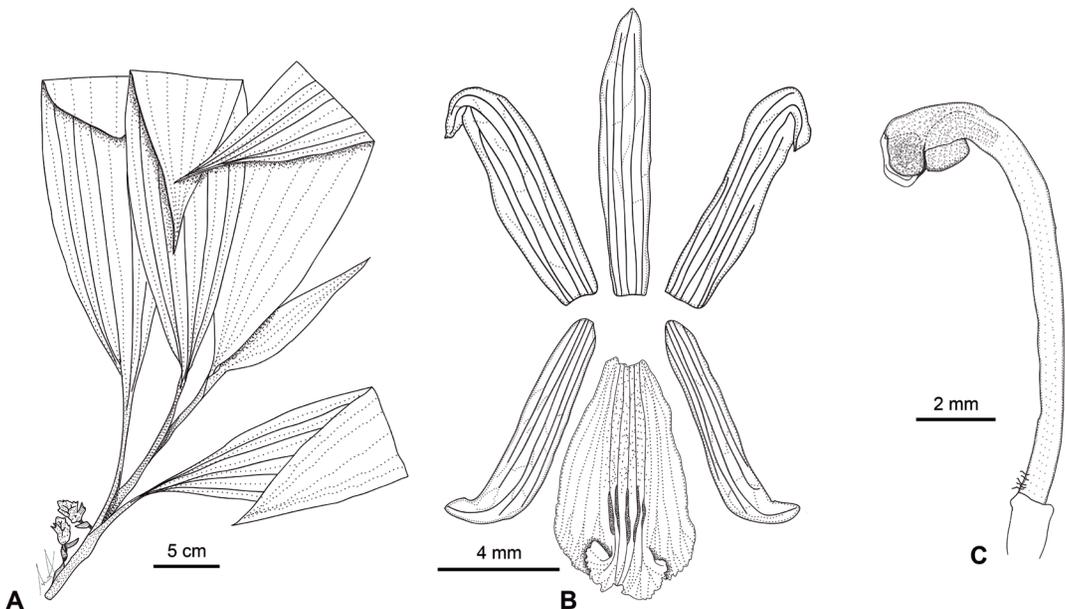


FIGURE 5. *Palmorchis liberolabellata* Damián. A. Plant, B. Dissected perianth, C. Column on ventral and lateral view. Drawn from the holotype (H. Beltrán 3204 USM!) by A. Damián.

sepal oblong-elliptic, acute at the apex, 5-veined, 10 mm long, 2 mm wide. *Lateral sepals*, oblong, obtuse, falcate, slightly erose at the apex, 5-veined, 8 mm long, 2 mm wide. *Petals* oblong, acute, 8.0–8.5 mm long, 2.0 mm wide, subacute, falcate at the apex, 5-veined. *Lip* 7.5 mm long, 4.5 mm wide, free from the column, obovate, distinctly 3-lobed near the apex, with 5 veins running from the base of the lamina towards the apex, distinctly thickened below the base of the midlobe, glabrous, midlobe bilobed, lobes broadly rounded, erose, lateral lobes semicircular. *Column* 10 cm long, terete, slightly arcuate, shortly pubescent on the ventral surface near the base, *anther* flattened conic, 1 mm long, *pollinia* ellipsoid, paired, acute, 0.6–0.8 mm long, *stigma* transversely oblong, emergent. *Fruit* not seen.

DISTRIBUTION: Endemic to Peru, where it is known only from the type locality in the understory of bamboo-dominated lowland forest in the department of Cusco (Fig. 9).

ETYMOLOGY: The epithet refers to the free lip from the column, an atypical feature among the genus.

Among the *Palmorchis* species with lateral inflorescences and bilobulate midlobe lips, *P. liberolabellata* is easily distinguished by its combination of glabrous floral bracts and lip, the latter also free from the column and bearing 5 thickened keels on the disk (Table 1).

Although *P. prospectorum* Veyret might be the closest relative to *P. liberolabellata*, it differs notably in its larger flowers and 3-veined thickened lip densely pubescent that is united to the column almost to its middle length. In addition, *P. prospectorum* is endemic to French Guiana and Surinam, where it grows as terrestrial herb in swamp forest, while *P. liberolabellata* has been reported from southeastern Peru, in the lowlands of Cusco, growing in a disturbed ‘paca’ forest dominated by the bamboo *Guadua sarcocarpa* (Poaceae).

Palmorchis deceptoris Veyret & Szlach. and *P. powellii* (Ames) C.Schweinf. & Correll also possess the main features of the informal group of *Palmorchis* species described above. However, both can be distinguished from *P. liberolabellata* by the densely pubescent subtrilobed lip with not well-defined lateral lobes. The disc of the lip of *P. powellii* is similar to

the one found on *P. liberolabellata*, bearing 5 long thickened veins. However, on *P. powellii* the middle vein extends to the apex of the midlobe, while in *P. liberolabellata* the main veins are only thickened close to the middle of the lamina, and none reach the midlobe. On the other hand, *P. deceptoris* presents 3 long thickened veins that are congested along the midvein, while *P. powellii* and *P. liberolabellata* bear 5 spreading thickened veins. *Palmorchis deceptoris* is believed to be endemic to Colombia, where it has been recorded near the Caunapi River, probably in swamp forest, while *P. powellii* is native to Mesoamerica (Costa Rica, Panama), where it grows in damp places with dense shade.

4. *Palmorchis lobulata* (Mansf.) C.Schweinf. & Correll, Botanical Museum Leaflets 8:113. (1940: 113). *Neobarlettia lobulata* Mansfeld (1928: 237).

TYPE: PERU. Loreto: Cuenca del Marañón, desde Iquitos hasta el Estuario Santiago en el Pongo de Manseriche, 160 m. 11 November 1924. *G. Tessmann 4518* (holotype: B, destroyed, lectotype AMES!, selected by Szlachetko *et al.* 2018). Fig. 6.

Palmorchis lobulata is most similar to *P. guianensis* (Schltr.) C.Schweinf. & Correll, from which it differs in having broader leaves, 4.7–9.0 cm wide (*vs.* 3.5–4.0 cm), lip with pilose margins in front (*vs.* glabrous, entire margins), lateral lobes rounded to truncate (*vs.* obtuse to rounded), subquadrate cushion-like callus and midlobe small, triangular (*vs.* narrower midlobe with an axial thickening and globose termination).

DISTRIBUTION: Colombia, Ecuador and Peru (Fig. 9).

ADDITIONAL SPECIMENS EXAMINED: Peru. Huanuco: Pachitea, Dpto. Honoria, Bosque Nacional de Iparia, 300–400 m, 21 February 1967, *J. Schunke 1652* F (photo!); Loreto: Dist. Alto Nanay, Santa María de Nanay, Trocha a piusco, 130 m, 9 March 1968, *J. Schunke 2517* F (photo!); Ucayali: Prov. Coronel Portillo, Dist. Iparia. Bosque nacional de Iparia: región de bosque seco tropical a lo largo del río Ucayali cerca del pueblo de Iparia (unos 80 km. arriba de la confluencia con el río Pachitea), 300 m, 26 agosto 1968, *J. Schunke 2693* F (photo!); Prov. Purús, Dist. Purús, cuenca del río Curanka, afluente del río Alto Purús, cerca de la comunidad Nativa Colombiana. 11

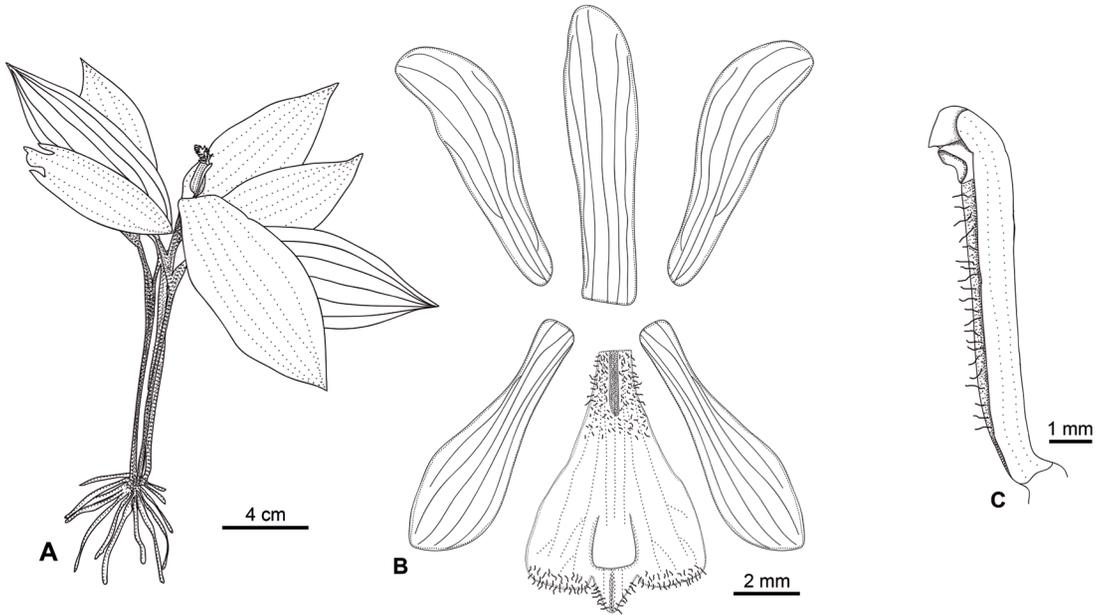


FIGURE 6. *Palmorchis lobulata* (Mansf.) Schweinfurth & Correll. A. Plant, B. Dissected perianth, C. Column on lateral view. Drawn from *Graham & Schunke 809 F!* by A. Damián.

February 2000, 10°04'00.0"S 71°06'00.0"W, 300–350 m, *Graham & Schunke 809 F!*.

According to the key presented by Szlachetko & Baranow (2014) and the description and illustration published by Dodson & Dodson (1980), the lip midlobe of *P. lobulata* is truncate. However, this disagrees with the original description (it states: “*lobo medio brevi triangulari*”), the detailed flower drawing of the holotype by L. Garay (AMES) and its treatment for Ecuador (Garay 1978), as well with the work of Schweinfurth & Correll (1940) which proved that the lip of this species is actually triangular.

Peruvian specimens of *P. lobulata* are scarce, usually infertile and with several misidentifications. We did our best to gather all the specimens available of this species and we include only those with flowers present. However, several specimens revised were fruiting or with immature buds, making them impossible to study rigorously. We managed to dissect a couple of flowers (*Graham & Schunke 809*) and some difference between the type and the latter specimen are noticeable. First, the leaves are shorter, 10.0–4.7 cm (vs. 24.0 × 9.0 cm). Moreover, the flowers are slighter smaller as well, 11.0–13.0 × 2.5–3.0 (vs. 8.0–9.0 × 2.5–3.0). Finally, the lateral lobes are distinctly truncate

with a small triangular midlobe which is pilose and has a low midvein that is thickened (vs. lateral lobes rounded, more or less truncate, midlobe glabrous without thickened veins) (Table 1).

5. *Palmorchis loretana* Damián & Torres, *sp. nov.*

TYPE: PERU: Loreto: Requena, Dist. Soplín, quebrada Yanayacu-Río Blanco. Campamento Wiswincho, 05°48'36.00"S 73°51'56.00"W, 10 October 2014. *M. Ríos, T. Mori, N. Pitman, L. Torres & C. Vriesendorp 4268* (holotype: AMAZ!). Fig. 7.

Palmorchis loretana is most similar to *P. sobralioides*, from which it differs in its smaller flowers, tepals 5–8 mm long (vs. tepals 20 mm long); densely pubescent lip below the middle (vs. glabrous); midlobe oblong, acute, with three low thickened keels (vs. triangular-ovate, obtuse, without keels) and callus with two fleshy tall ridges (vs. four elevated, small, protuberances).

Terrestrial herb, 40–50 cm tall. *Roots* not seen. *Stems* cane-like, up to 16 cm long, 0.25 cm in diameter, with 4 leaves towards the apex. *Leaves* light green, plicate, with 5 prominent veins on the underside, oblong-elliptic, acuminate at the apex, narrowing to the

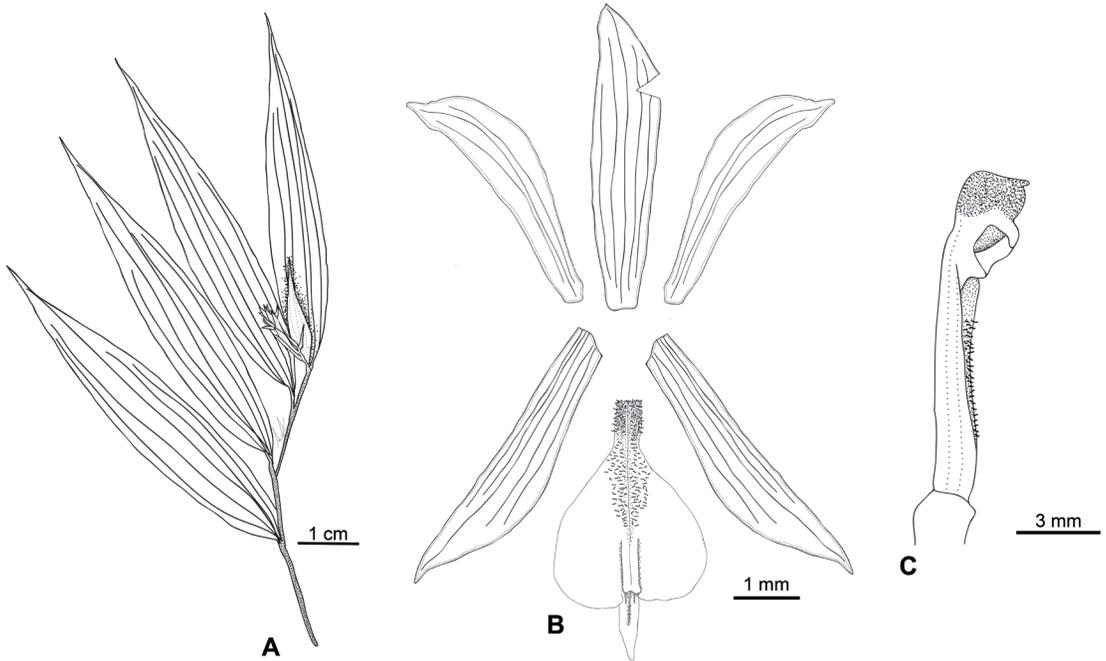


FIGURE 7. *Palmorchis loreтана* Damián & Torres. A. Plant, B. Dissected perianth, C. Column. Drawn from the holotype (*M. Ríos et al.* 4268, AMAZ!) by A. Damián.

junction with the petiole, 9.0–18.0 cm long and 3.0–4.9 cm wide; petiole up to 1.5 cm long. *Inflorescence* up to 4.5 cm long, terminal, few-flowered. *Floral bracts* 12–19 mm long, narrowly triangular, acuminate, pedicel and ovary 5 mm long. *Flowers* pale yellowish-green, small. *Dorsal sepal* 6–8 mm long, 1 mm wide, oblong-elliptic, acute, concave, 5-nerved. *Lateral sepals* 6–8 mm long, 1 mm wide, oblanceolate, oblique, subfalcate, acuminate, central nerved thickened externally, 5-nerved. *Petals* 5–8 mm long, 1 mm wide, obliquely oblanceolate to oblong-oblanceolate, acute, obscurely 5-nerved. *Lip* 5–8 mm long, 3 mm wide when spread, narrowly obtriangular, 3-lobed at the apex; united with the column at its base for about 1 mm; base of the lip densely pubescent and spread along the main axis up to the middle of the lip; callus with two parallel, approximate fleshy ridges, upcurved apically; midlobe of the lip with three conspicuous thickened keels. *Column* pubescent, slender, terete, up to 4.5–8.0 mm long; anther flattened subconic, 1.5 mm long, *pollinia* ellipsoid, subacute, 0.8–1.0 mm long, *stigma* transversely oblong, emergent. *Fruit* not seen.

PARATYPE: PERU. Loreto: Putumayo, Dist. Yaguas,

Inventario Rápido de la cuenca del río Yaguas. NE de Iquitos y Pebas en las esquinas del trapezoide de Colombia. Drenaje del bajo Putumayo. En la boca de la quebrada Cachimbo, tributario S del bajo Yaguas, a 44 km O de la unión Yaguas-Putumayo. 02°43'42.8"S 70°31'31.7"W. Bosque de planicie inundable. 94 m. 27 October 2010. I. Huamantupa, Z. Cordero, N. Pitman & R. García 14698B (AMAZ!)

ETYMOLOGY: In reference to the Peruvian Department of Loreto, where the type specimen was collected.

DISTRIBUTION: Endemic to Amazonian Peru, where it is known from two localities in the department of Loreto, at altitudes between 90–100 m in the Yaguas and Tapiche watersheds. At both localities the species was recorded growing in the understory of floodplain forest on relatively poor soils (Fig. 9; García Villacorta *et al.* 2011, Torres Montenegro *et al.* 2015). These sites are relatively close to the Colombian and Brazilian borders, and the species likely occurs in similar habitat in those countries.

ADDITIONAL SPECIMENS EXAMINED: ECUADOR. Napo: Yasuni river. 30 min. upstream from Garzacocha.

Primary rain forest. Terra firme. Alt. 200 m. 01°03'0.00"S 75°28'12.00"W, 11 April, 1983. *J. E. Lawesson, T.Lassoe & P. M. Jorgensen 43445* (AAU!). BRASIL, Est. do Pará, Mpio. Faro, 06/01/1920. *A. Ducke 14663 BR!*; Est. do Amazonas, Mpio. Manaus, Reserva Forestal Ducke, *Kinupp, V.F. & Pereira F.N. 2015* (210109 INPA!).

As the diagnosis states, *P. loretana* is quite similar to the poorly known *P. sobralioides*. Although minimal, the prologue of this latter species by Barbosa Rodrigues (1877) and later, the extended version of Cogniaux (1893) including Barbosa's drawings, are clear enough to differentiate it from *P. loretana*. Both authors indicate in their description of the early species a 3-lobed lip, with broad lateral lobes and a minute, ovate-triangular, acute midlobe, with four small protuberances. In contrast, *P. loretana* has a conspicuous oblong, acute midlobe with three low keels, and callus bearing two tall parallel ridges (Table 1). In addition, *P. sobralioides* is known to have a glabrous column while *P. loretana* is densely pubescent on the ventral surface.

Another important difference between these two species lies in their distribution. *Palmorchis* species are in the great majority restricted in range, with some notable exceptions like *P. silvicola* L.O. Williams and *P. powellii*, which disjunctions reported from Costa Rica to Ecuador and Colombia. A comprehensive study is needed in order to corroborate the South American populations. For example, we studied an Ecuadorian specimen cited as *P. sobralioides* (*Lawesson et al. 43445*, AAU!). A close look at the plant, which has the combination of narrower 3-veined leaves, (1.0–1.5 cm wide) and blue flower lip, pointed us to *P. imuyaensis*, whose holotype was found not far away (Imuya, Sucumbíos). Specimens of *P. sobralioides* are known from Pará and Manaus (Brazil), while *P. loretana* seems to be endemic to the northeastern lowland forest of the Peruvian Amazon (Loreto). We were able to compare photos of the flowers of our plant and *P. sobralioides* (Ribeiro *et al.* 1999, 210109 INPA). Flowers of the latter look robust, with a tiny midlobe lip bearing 4 obscure protuberances and some blue color at the midlobe of the lip, a feature not reported before (*vs.* slender flowers, long midlobe and purple colored midlobe of *P. loretana*).

6. *Palmorchis yavarensis* Damián & Torres, *sp. nov.*

TYPE: PERU. Loreto: Mariscal Ramón Castilla, Dist. Yavari, margen izquierda del río Yavari, entre Colonia Angamos y Lago Preto, Quebrada Limerá, 04°30'53.37"S, 71°54'2.77"W 9 April 2003, *H. Beltrán, R. Foster, N. Pitman, R. García, C. Vriesendorp & M. Ahuite 5698* (holotype: USM!, isotypes: F!, AMAZ!). Fig. 8.

Palmorchis yavarensis is most similar to *P. maguirrei* Szlach., S.Nowak & Baranow, from which it is distinguished by its glabrous bracts (*vs.* pubescent); linear-lanceolate glabrous sepals with acuminate apex, 27–30 × 2–3 mm, (*vs.* oblong, acute and pubescent along adaxial midvein, 21 × 4 mm); and distinctly 3-lobed lip, scarcely pubescent, with ciliate margins and 3 thickened main veins from the base to near the middle of the midlobe (*vs.* subtrilobed, with entire margins, pubescent along the midvein, and a single thick ridge along midvein).

Herb 60 cm tall. *Roots* not seen. *Stems* cane-like, 0.8 cm in diameter, with 8 leaves. *Leaves* plicate, 5–7-veined, broadly elliptic to obovate, acuminate, cuneate at the base, 65–70 cm long including the petiole, 10–11 cm wide. *Inflorescence* terminal, 8.0–9.7 cm long, many-flowered. *Peduncle* 6.0–7.5 cm long, with 1–2 lanceolate bracts. *Flowers* yellowish, simultaneous. *Floral bracts* 16.0–17.5 cm long, triangular, acuminate. *Pedicel* and *ovary* 9–12 mm long. *Sepals* similar, 27–30 mm long, 2–3 mm wide, linear-lanceolate, acuminate, obscurely 7-veined. *Petals* 22–25 mm long, 2 mm wide, linear-lanceolate, acuminate, 5-veined. *Lip* 23–25 mm long, 8 mm wide; distinctly 3-lobed; united to the column for 1.0–1.5 mm; sparsely pubescent all over, especially at the base and along the middle of the lamina, the margins ciliate, with 3 thickened main veins running from the base to near the middle of the midlobe; middle lobe 9–10 mm long, narrowly ligulate, acute, densely pubescent, recurved, margins undulate, upper part with a distinct longitudinal furrow; lateral lobes obliquely triangular-ovate, broadly obtuse. *Column* slender, terete, 15 mm long, densely pubescent below the stigma. *Anther* sub-conic, 1.5 mm long, *pollinia* ellipsoid, paired, 1 mm long, *stigma* transversely oblong; *fruit* not seen.

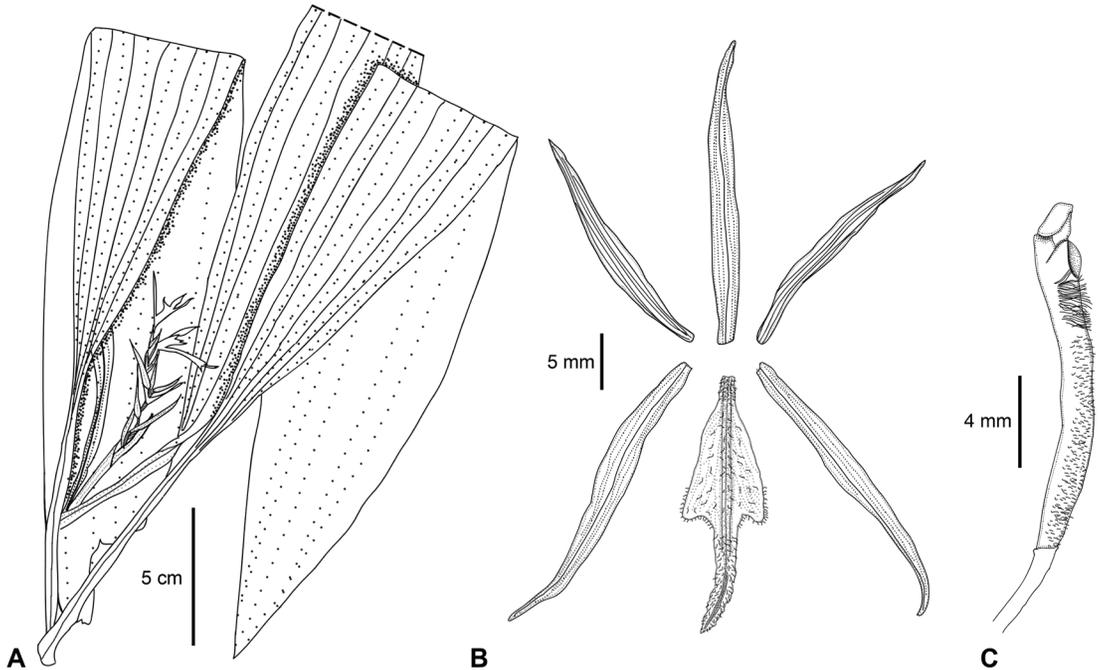


FIGURE 8. *Palmorchis yavarensis* Damián & Torres. A. Plant, B. Dissected perianth, C. Column. Drawn from the holotype (*H. Beltran et al.* 5698 USM!) by A. Damián.

PARATYPES: PERU. Loreto: Putumayo, Dist. Yaguas, NE de Iquitos y Pebas, en la esquina del trapezoide de Colombia. Drenaje del Bajo Putumayo. Quebrada Lupuna, tributario N del medio Yaguas, Bosque colinoso de tierra firme, 2°36'38.20"S 71°29'8.70"W. 161 m, 15 octubre 2010. *I. Huamantupa, Z. Cordero, N. Pitman & R. Garcia* 14065 (AMAZ); Ucayali: Padre Abad, Dist. Padre Abad, Carretera al caserío San Miguel y Mapuya, 12 a 17 km de la Aguaytía, 09°05'00.0"S 75°26'00.0"W, 350 m, 10 August 2004, *J. Schunke & J. G. Graham* 16290 F!

ETYMOLOGY: The new species was named after Yavarí, a proposed reserved Zone in Loreto, highlighting that the first records were made there.

DISTRIBUTION: Endemic to Peru, where it is known from two localities in Loreto (Yavarí and Yaguas watersheds) and one in Ucayali (Ucayali watershed). All known specimens were collected in the understory of mature lowland forest. The Loreto localities are very close to the Brazilian and Colombian borders; the species is likely to occur in similar habitat in those countries (Fig. 9).

Palmorchis yavarensis belongs to a small complex of species characterized by robust plants with large leaves and a distinct narrow acuminate lip (Table 1). Two members of the complex are *P. carlos-parrae* Szlach. & Baranow and *P. maguirrei*, from which *P. yavarensis* differs in its glabrous bracts and lip morphology. *Palmorchis carlos-parrae* from Colombia has the largest flowers of the genus with sepals 32 mm long and lip 26 mm long, entire and glabrous with a broad midlobe, 4 mm wide. *Palmorchis yavarensis*, on the other hand, has sepals and lip up to 30 and 25 mm long respectively, the lip is scarcely pubescent, especially along the middle of the lamina, and the midlobe is 1.5 mm wide. Moreover *P. yavarensis* has obliquely triangular-ovate lateral lobes with ciliate margins, while *P. carlos-parrae* presents falcate, acute entire lateral lobes.

This species was first reported as "*Palmorchis* sp." by Pitman *et al.* (2003) on a rapid biological inventory of the Yavarí river valley in the Amazonian lowlands of northeastern Peru (Loreto). Later that year, Foster *et al.* (2003) published a rapid color guide including a photograph of this species, in which its yellowish big flowers and large lip are clearly visible (Fig. 2A).

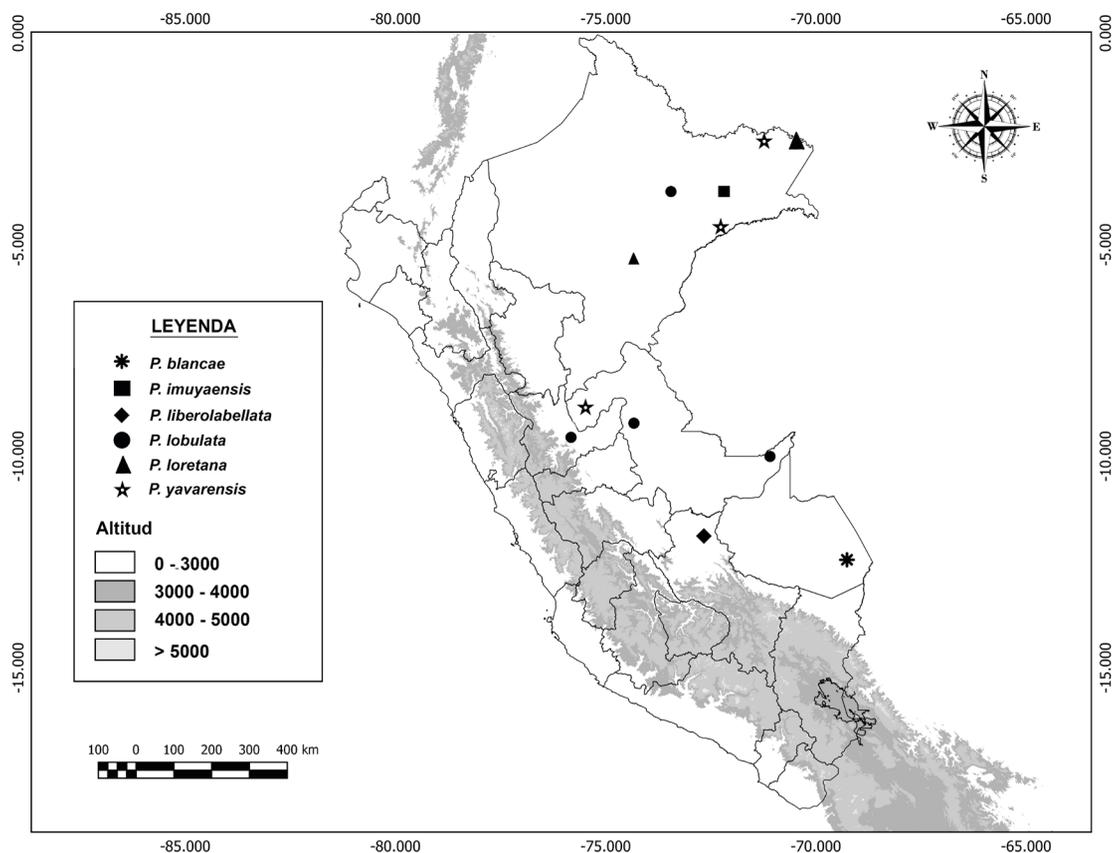


FIGURE 9. Map showing the known Peruvian localities for *Palmorchis*.

After almost a decade, the species was found again in the same department, this time in the headwaters of the Yaguas River, close to the Peru-Colombia border (García-Villacorta *et al.* 2011). We were unable to dissect the flowers of this plant. However, the detailed photos provided by the collector are sufficient evidence to place this specimen in the concept of *P. yavarensis*.

ACKNOWLEDGEMENTS. We would like to express my gratitude to FONDECYT and UCSUR for their support of the project "Genetic and morphological characterization of species of *Vanilla* (Orchidaceae) in Peru" during which the specimen *P. imuyaensis* was collected. Thanks to Luis Sanches Saldaña (AMO) for help in obtaining literature; to personnel at USM, AMAZ and F for granting access to their collections, especially to James Graham, Nigel Pitman and Asunción Cano; to Nicole Mitidieri for her invaluable support and her useful comments on this paper; and to J. Janovec (BRIT) for his friendship and trust since the early days of the *Vanilla* project.

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FIRST WILD RECORD OF *DENDROCHILUM WARRENI* (ORCHIDACEAE: EPIDENDROIDEAE) CONFIRMS A PHILIPPINE PROVENANCE

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ABSTRACT. Recent explorations on one of the mountains of the Bukidnon province on the island of Mindanao in the Philippines resulted in a wild collection of *Dendrochilum warrenii*, an Orchidaceae species described in 2004 from a cultivated plant of unknown provenance. In this publication, an extended species description along with color photographs are provided to aid future identification. Information on the distribution, ecology and phenology of the species in the wild is also provided.

KEY WORDS: Coelogyninae, Mindanao, sect. *Platyclinis*, taxonomy, tropical botany

Introduction. Described by Blume in 1825, the genus *Dendrochilum* belonging to the subfamily Epidendroideae, is a largely Malesian orchid genus encompassing over 280 species (Sulistyo *et al.* 2015, Ormerod 2017). With approximately 120 known species, the Philippines are considered as a center of diversity for this genus (Cootes 2011, Pelsner *et al.* 2011). Given that most *Dendrochilum* species are restricted to cool, humid, and often exposed conditions in montane forests with an unusually high share of narrow endemism (Pedersen 2007a), it is believed that there are still a number species awaiting discovery and description, especially in Mindanao, as this island is composed of a number of high mountains which are relatively unexplored botanically (*e.g.* Cootes 2017, Naive *et al.* 2017).

Fresh materials of an interesting but unknown *Dendrochilum* plant identified as a member of the section *Platyclinis* because of the synanthous inflorescences, entire rostellum, presence of stelia and an apical wing on the column, was collected during the first author's excursion in the province of Bukidnon on the island of Mindanao in the Philippines in June 2017. After meticulous examination of its morphology and comparison with protologues and

digitized type specimens of *Dendrochilum* sect. *Platyclinis* species from the Philippines (JSTOR 2018) and neighbouring countries, we found the material matches with *Dendrochilum warrenii* H.A. Pedersen & Gravend. (2004: 358). This species was first exhibited at the European Orchid Conference in London by Blair Sibun (Pedersen *et al.* 2004). It was then described by Pedersen and Gravendeel in 2004 based on a specimen in cultivation provided by Richard C. Warren (after whom the species was named), with unknown provenance. Based on molecular phylogenetic analyses, these authors hypothesized that the species could be originating from the Philippines and/or Sulawesi (Pedersen *et al.* 2004, Sulistyo *et al.* 2015). The present publication reports the first collection of *D. warrenii* from the wild, confirming a Philippine origin. An extended species description based on this new collection in the field incorporating all current knowledge is provided together with color photographs to aid future identifications.

Materials and methods. Fresh plant material was collected during a botanical excursion in June 2017 in the Bukidnon province of the island of Mindanao in the Philippines. A spirit collection was deposited in the

University of Santo Tomas Herbarium (USTH). Our descriptions of vegetative and reproductive characters are based on living plants and the spirit collection. The species description follows the style of Pedersen (2011) using general plant terminology of Beentje (2016). Below, we provide a detailed description and colored photographs as well as notes on the distribution, phenology, and ecology in the wild.

TAXONOMIC TREATMENT

Dendrochilum warrenii H.A.Pedersen & Gravend., *Blumea* 49: 358–359. 2004.

TYPE: *Warren EQ 3066* (holotypus C), sine loco et coll./cult. Richard C. Warren anno 2003. Fig. 1.

Small, tufted, epiphytic *herb*. *Roots* arising from the rhizome, 1.0–1.5 mm in diameter, unbranched. *Pseudobulbs* clustered on a very short rhizome, fusiform, 1.0–2.1 cm long by 0.4–0.5 cm in diameter, unifoliate, covered with 1–4 tubular, attenuate to acuminate, papery cataphylls which soon disintegrate into persistent fibres. *Leaf* petiolate; *petiole* up to 1 cm long, distinctly canaliculate; *lamina* dorsiventrally complanate, coriaceous, narrowly linear, 10.0–10.2 cm long by 0.1–0.2 cm wide, with prominent midrib, margin entire, apex subacute. *Inflorescence* synanthous, racemose; *peduncle* straight to arching, up to 10.5 cm long, terete, very slender; *rachis* nodding to pendent with distichously alternating flowers, dense, up to 12-flowered with internodes of *ca.* 2 mm, slightly furrowed, 3.0–3.5 cm long, basally with 3–4 non-floriferous bracts. *Flowers* white to greenish white; *floral bracts* persistent, glumaceous, lanceolate to narrowly lanceolate, 5–6 mm long by 2.0–2.1 mm wide, papery, striate, many veined, margin entire, apex acuminate. *Dorsal sepal* 3-veined, linear, 6.0–6.1 mm long by 1 mm wide, incurved, margin entire, apex acute to attenuate. *Lateral sepals* 3-veined, linear, 6.5–6.6 mm long by 2.7–3.0 mm wide, glabrous on both sides, margin entire, apex acuminate. *Petals* 3-veined, narrowly lanceolate, 4.4–4.5 mm long by 0.8–0.9 mm wide, glabrous on both sides, finely erose, apex subacute. *Labellum* 3-veined, sessile, lanceolate, 2.0–2.2 mm long by 1.0–1.1 mm wide, glabrous on both sides, margin finely erose, apex acute. *Column* short, subclavate, slightly incurved, 1.0–1.1 mm long, glabrous, distally prolonged into a bidentate wing

exceeding the anther; *steldia* inconspicuous, two, erect, margin entire, apex obtuse. *Pollinia* four, subpyriform. *Rostellum* flat, triangular. *Ovary* (including pedicel) semiterete, *ca.* 2.2 mm long, glabrous. *Capsule* not seen.

DISTRIBUTION: The Philippines, Mindanao, province of Bukidnon.

ECOLOGY: The species grows as an epiphyte at elevations approximately between 1,000 to 1,200 m asl among mosses on the trunks and branches of trees under shaded to slightly lit conditions in montane broad leaf forest.

PHENOLOGY: Observed flowering in the wild in the months of June and July.

CONSERVATION STATUS: Following IUCN (2017), we propose this species to be treated as ‘Data Deficient’ (DD). Further field surveys are needed, as there is insufficient information to assess the status of this species with only limited distributional data and no information on population size, trends or threats to the species in the wild.

SPECIMEN EXAMINED: PHILIPPINES. Mindanao: Bukidnon, elevation 1,200 m asl, 25 June 2017, *M.A.K. Naive 101* (USTH, spirit material) – Full locality data are withheld to prevent potential exploitation of wild populations for commercial purposes; *Warren EQ 3066* (holotypus C), sine loco et coll./cult. Richard C. Warren anno 2003.

Following the publication of protologues based on cultivated material since 2000, *D. warrenii* is the sixth species of *Dendrochilum* located in the wild. Earlier on, wild plants of *D. coccineum* H.A.Pedersen & Gravend. (Pedersen *et al.* 2004), *D. croceum* H.A.Pedersen (Pedersen 2005), *D. quinquecallosum* H.A.Pedersen (Pedersen 2007b), *D. undulatum* H.A.Pedersen (Pedersen 2007b) and *D. hampeii* Sulistyo, Gravend., R.Boos & Cootes (Sulistyo *et al.* 2015) were discovered in the field after having been traded for several years under commercial names such as ‘Sherborne Star’ (*D. warrenii*) and ‘Big Pink’ (*D. hampeii*) before their formal taxonomic descriptions were published. Following recommendations by Pedersen (2011) and Sulistyo *et al.* (2015), we rechecked The International Orchid Register (accessed on 16 September 2018) to verify whether any new artificial hybrids had been



FIGURE 1. *In situ* photograph of *Dendrochilum warrenii* H.A. Pedersen & Gravend. showing its habit and flowers (inset). Photos made by M.A.K. Naive in the field in the Philippines.

described but the latest addition for *Dendrochilum* was from 2000. Finding this species in the wild in a remote and pristine montane rainforest, together with the congruent molecular phylogenetic positions provided by biparentally inherited nuclear genes and maternally inherited plastid genes and distinct single peaks in all chromatograms (Pedersen *et al.* 2004, Sulistyó *et al.* 2015, Pedersen *et al.* in prep.) convinces us that *D. warrenii* is not of human assisted hybrid origin.

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***SERTIFERA*, A NEW GENERIC RECORD FOR THE PERUVIAN ORCHID FLORA**

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ABSTRACT. An orchid species, previously known from Northern Andes, is reported for first time in Peru: *Sertifera purpurea*. A description, illustration, photographs, and comments about the species are provided.

RESUMEN. Una especie de orquídea, previamente conocida de los Andes del Norte, se reporta por primera vez para el Perú: *Sertifera purpurea*. Se presenta una descripción, ilustración, fotografías y comentarios sobre la especie.

KEY WORDS / PALABRAS CLAVE: Bosque de Protección Alto Mayo, Peru, Sobralieae

Introduction. There are currently four recognized genera in the Neotropical tribe Sobralieae: *Elleanthus* C. Presl, *Epilyna* Schltr., *Sertifera* Lindl. & Rchb.f. and *Sobralia* Ruiz & Pav. (including *Brasolia* (Rchb.f.) Baranow, Dudek & Szlach.) (Neubig *et al.* 2011, Chase *et al.* 2015, Baranow, Dudek & Szlachetko 2017).

Orchids of the genus *Sertifera* have relatively small flowers of bright colors, which resemble the flowers of *Elleanthus*. Vegetatively, *Sertifera*, like *Elleanthus* and *Sobralia*, are caespitose plants with slender, elongate cane-like stems and plicate leaves. However, *Sertifera* is easily distinguished from the other genera of the tribe by having leaf sheaths with tubercles, axillary and secund or subcapitate inflorescences, and flattened peduncle.

Lindley and Reichenbach (Reichenbach 1877) described *Sertifera* with two species: *S. purpurea* Lindl. & Rchb.f. from Ecuador (with “lateral corymbose” inflorescence) and *S. virgata* Rchb.f. from Peru (with terminal racemes inflorescence). However, the latter was transferred by Schweinfurth (1938) to *Elleanthus*. The second species of *Sertifera*, from Ecuador, was described by Kraenzlin (1899) but hiding under the

name of *Diothonea lehmanniana* Kraenzl. (transferred to *Sertifera* by Garay in 1978). Schlechter (1920, 1924) then described three species from Colombia: *Sertifera colombiana* Schltr., *S. major* Schltr. and *S. parviflora* Schltr. Subsequently, Williams (1939) and Schweinfurth (1946) described two more species from the same country: *S. grandifolia* L.O. Williams and *S. aurantiaca* C. Schweinf., respectively. Recently, another three species have been proposed for Colombia: *S. gracilis* Rchb.f. ex Szlach. & Baranow, *S. risaraldana* Szlach. & Baranow and *S. albiflora* Szlach., Kolan. & Medina Tr., (Szlachetko & Baranow 2014, Szlachetko, Kolanowska & Medina Trejo 2014). Thereby, at the moment ten species are referable to *Sertifera*.

Sertifera has been referred as a genus restricted to the northern Andes, species have been reported from Ecuador, Colombia, and Venezuela between 1,000 and 3,600 m of elevation (Schlechter 1924, Szlachetko & Baranow 2014).

Recent field work in the North of Peru revealed the presence of populations of *S. purpurea*; which represent the first record for this country. Previously,

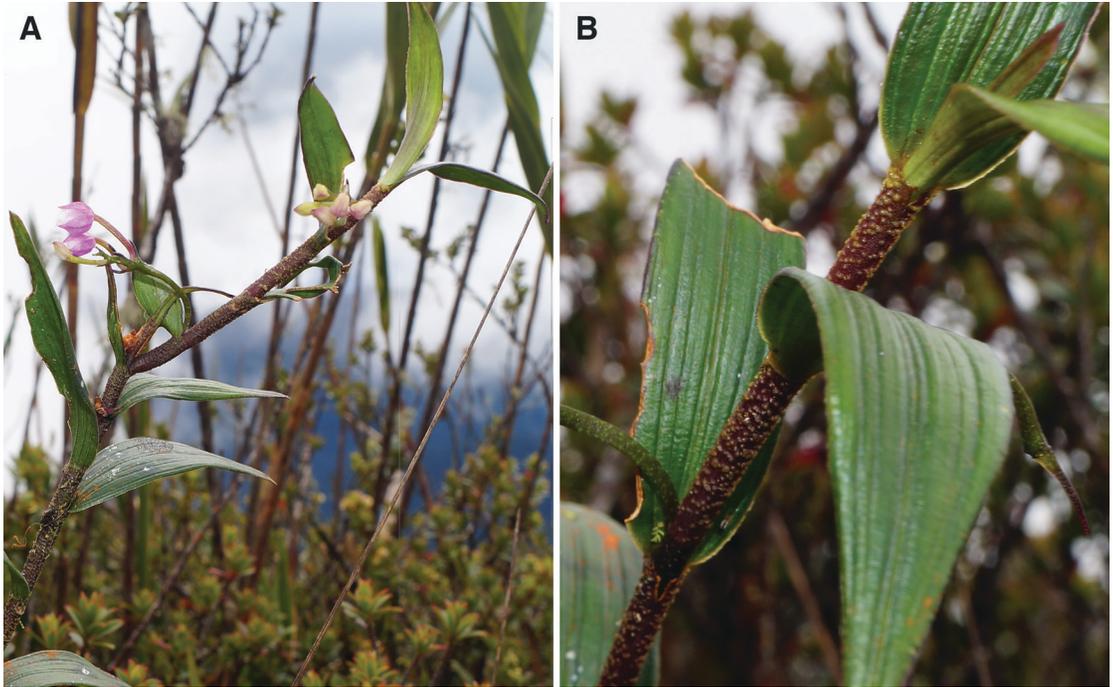


FIGURE 1. *Sertifera purpurea*. A. Plant in its natural habitat showing a branched stem. B. Verrucose leaf sheaths. Photographs by J. Edquén.

during a Rapid Assessment in The Cordillera del Cóndor, next to the Ecuadorian border, two specimens (one sterile) were collected and identified as *Sertifera* sp. (Schulenberg & Awbrey 1997). Those specimens are housed at MOL and were examined for this present study. Here, we formally record the genus *Sertifera* for Peru and provide a description of *Sertifera purpurea* based on the Peruvian specimens.

TAXONOMIC TREATMENT

Sertifera purpurea Lindl. & Rchb.f., *Linnaea* 41: 64. 1877.

TYPES: Ecuador, [Andes Quitensis], Tungurahua; *Spruce 5394* (syntype: W-76627, photo seen, designated as lectotype by Garay, 1978). Ecuador, [Quito], *Jameson s.n.* (syntype W-76625, photo seen). Ecuador, [Valley of Lloa, 1857], *Jameson s.n.* (syntype: K-501912, photo seen, (mixed), photo at AMES). Ecuador, [from the forest on the western slope of the Andes, 1854] *Jameson s.n.* (syntype: K-501912, photo seen, (mixed), photo at AMES).

Synonym: *Sertifera lehmanniana* (Kraenzl.) Garay,

Fl. Ecuador 9: 135. 1978. *Diothonea lehmanniana* Kraenzl., *Bot. Jahrb. Syst.* 26: 489. 1899. TYPE: Ecuador. Pichincha: Western declivity of Cerro Corazón, near Canchacoto on Río Pilatón, [2000 m, Jan 1881], *Lehmann 126* (G-422011, photo seen, lectotype, designated by Garay, 1978; isoelectotype G[x2], photos seen, HUH-82476 [flower at AMES ex G], photo seen).

Plant terrestrial, up to 1 m tall. *Stem* cane-like, erect to slightly arcuate, enclosed by reddish brown verrucose tubular leaf sheaths, unbranched (rarely branched), leafy above (Fig. 1A, B). *Leaves* somewhat coriaceous, blades ovate-lanceolate to elliptic-lanceolate, acuminate, plicate, margins minutely erose, sessile on tubular sheaths, $3.1\text{--}7.7 \times 0.7\text{--}1.8$ cm. *Inflorescence* axillary, arcuate, subcapitate, shorter than the subtending leaf; peduncle flattened, 1.0–2.5 cm long; rachis 0.7–1.0 cm long, 6 to 8 flowers. *Floral bracts* linear-lanceolate, acute to acuminate, green turning blackish purple, 2.0–4.5 mm long (decreasing in size towards the apex). *Flowers* globose, sepals and petals pink to purplish, lip and tip of petals white (Fig. 2A); ovary and pedicel green to red-violet. *Dorsal*

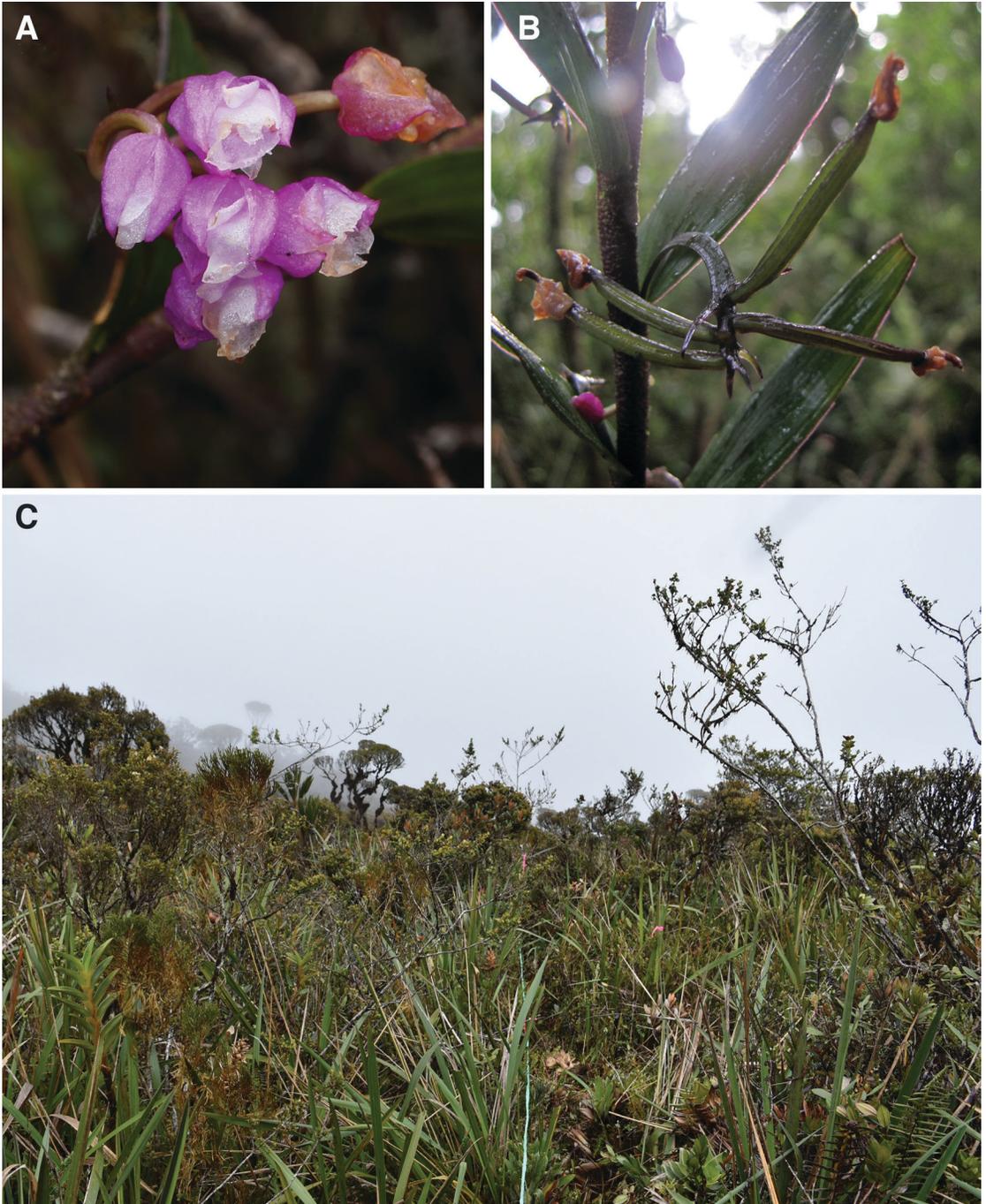


FIGURE 2. *Sertifera purpurea* A. Inflorescence B. Fruits, C. Habitat. Photographs A by J. Edquén; B, C by M. Acuña-Tarazona.

sepal elliptic, acute to obtuse, minutely mucronate at apex, 3-nerved, 5.5–6.5 × 3–4 mm. *Lateral sepals* slightly connate at base, oblique, elliptic, acute, mucronate, dorsally carinate, 3-nerved, 6–7 × 3–4 mm.

Petals ovate-elliptic to subrhombic, obtuse, somewhat undulate towards the apex, 1-nerved (sometimes with 1 or 2 short lateral nerves), 5–7 × 3.0–3.5 mm. *Lip* enfolding the column, basally saccate, conduplicate,

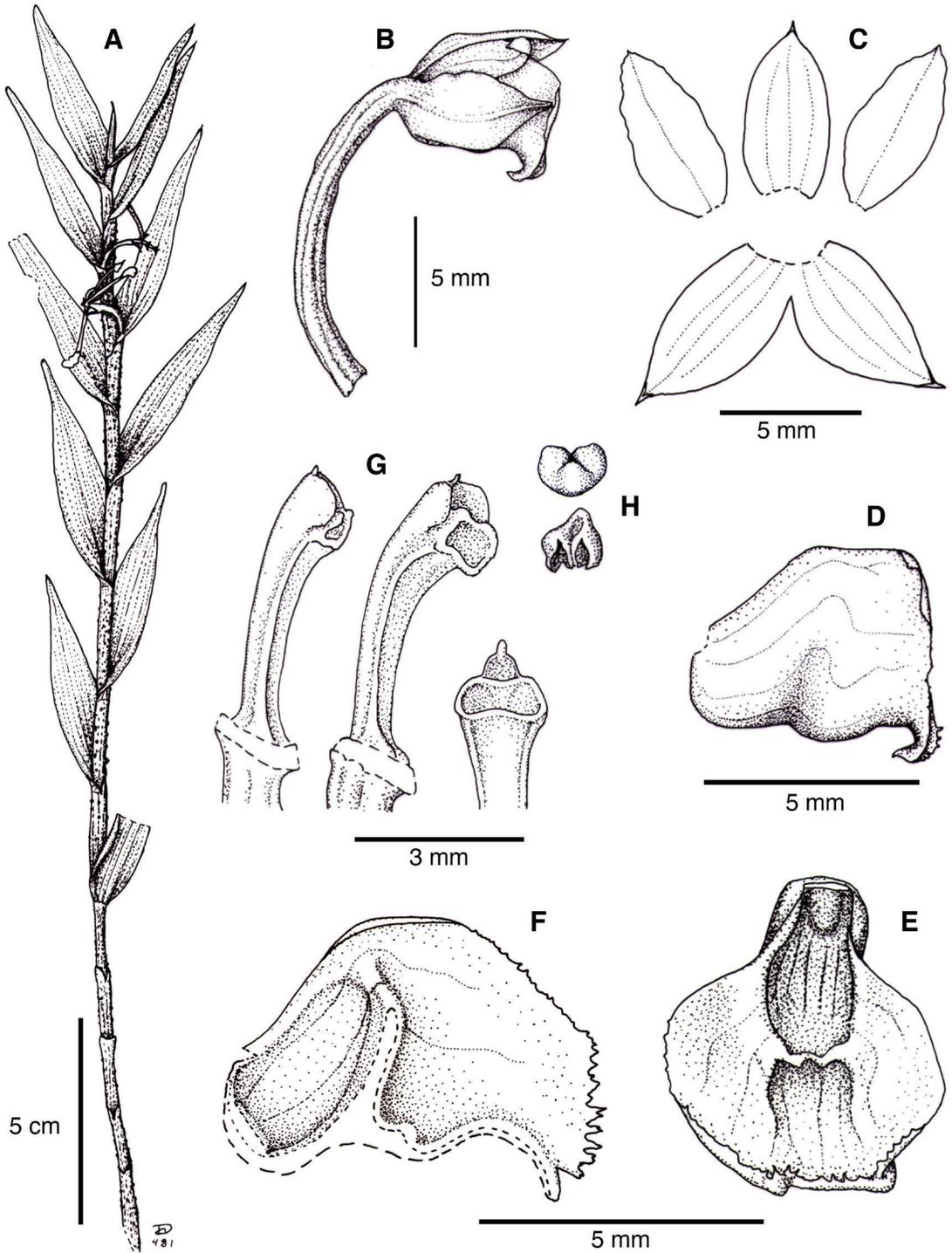


FIGURE 3. *Sertifera purpurea*. A. Habit. B. Flower. C. Dissected perianth. D. Lip, lateral view. E. Lip, ventral view, F. Lip, longitudinal section. G. Column (from two different flowers). H. Anther cap. Drawing by D. Trujillo based on *M. Acuña 1803* (USM).

flattened laterally, seen from the side subquadrate-obovate, when expanded transversely elliptic, base of the lip thickened, with a small callus, disc provided with a transverse, plate-like ridge which holds the two sides together, the upper margins involute and irregularly erose to shortly lacerate, 5.5–7.0 mm long. *Column* slender, slightly curved upward, auriculate at apex, 3.5–5.0 mm long. *Anther* reniform, 1 mm long. *Stigma* bilobed. *Ovary* cylindric, curved, glabrous, 7–14 mm long. *Fruit* narrowly ellipsoid, 13–17 × 2–5 mm (Figs. 2B, 3).

SPECIMEN EXAMINED: Peru. [Amazonas, Prov. Condorcanqui], Cordillera del Cóndor, [July -August 1994] *M. Cavero 1636* (MOL). San Martín, Prov. Rioja, Distrito Pardo Miguel Naranjos, Bosque de Protección Alto Mayo, 2500 m, 13 April 2017, *M. Acuña et al. 1803* (USM). Same locality, 3053 m, 23 May 2017, *M. Acuña et al. 1969* (USM).

OTHER SPECIMENS: Peru [Amazonas, Prov. Condorcanqui], Cordillera del Cóndor, [July -August 1994], *M. Cavero 1627* (MOL [sterile]).

DISTRIBUTION: Venezuela, Colombia, Ecuador, and Peru. In Peru, it is known in the Departments of Amazonas and San Martín, between 2,150 and 3,053 m elevation (Fig. 4).

HABITAT AND ECOLOGY: Plants of this species were found growing in shrub vegetation with small trees up to 5 m tall, dominated by *Podocarpus oleifolius* D. Don ex Lamb., *Clusia* sp., *Weinmannia* sp., *Miconia* sp., and *Myrcia* sp., and open areas with herbs and small shrubs (Fig. 2C). Individuals with flowers and fruits were recorded in April, May and October.

Sertifera purpurea and *S. lehmanniana* were described based on plants from the north-central Andes of the Ecuador. The type specimens of *S. purpurea* were collected in the Province of Tungurahua (*Spruce 5394*) and the Province of Pichincha: Quito (*Jameson s.n.*) and in the Valley of Lloa (*Jameson s.n.*). The type specimen of *S. lehmanniana* was collected in the Province of Pichincha: west of Cerro Corazon (south of Quito), near Canchacoto (*Lehman 126*). Both species display similar morphological features. Based on examination of the herbarium specimens (digital images) and a dissected flower of the lectotype

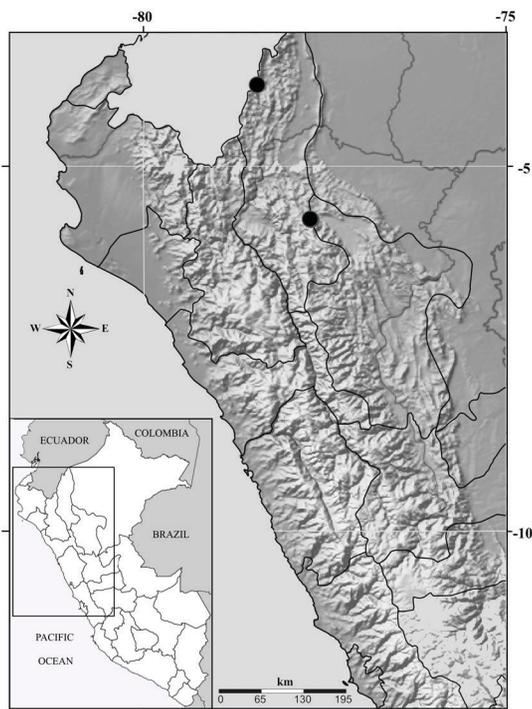


FIGURE 4. Distribution map of *Sertifera purpurea* (black circles) in Peru.

of *S. lehmanniana* (microscope slide prepared by Garay, HUH-82476), the feature that distinguishes *S. lehmanniana* from *S. purpurea* is that the first displays ovate-oblong to ovate-ligulate petals (vs. ovate-elliptic to subrhombic). Dunsterville and Garay (1966) considered that they both represent the same species and placed *S. lehmanniana* as synonym of *S. purpurea*; we agree with that assessment.

Sertifera colombiana is also similar to *S. purpurea* (Schlechter 1920, Mansfeld 1929, plate 13, nr. 46); however, additional research is necessary to state whether they are the same species.

ACKNOWLEDGEMENTS. We thank the staff and curators of AMES, K, G, and W for their help looking for the type material in their institutions. We also thank Stig Dalström and Günter Gerlach for their help with the bibliography; José Edquén for providing photographs of *Sertifera purpurea*. M. Acuña-Tarazona thanks to the Peruvian authorities for granting a permission for collecting plant specimens (research permit N° 007-2016-SERNANP-BPAM-JEF). M. Acuña-Tarazona also thanks Roner Espinar, Juan Cusi, Elluz Huamán, José Ramírez, José Edquén, and Elmer Mondragon for their invaluable help during the

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**A NEW SPECIES OF *PLEUROTHALLIS*
(ORCHIDACEAE: PLEUROTHALLIDINAE)
IN SUBSECTION *MACROPHYLLAE-FASCICULATAE* WITH A UNIQUE,
HIGHLY REDUCED, MORPHOLOGICALLY DISTINCT LABELLUM**

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ABSTRACT. *Pleurothallis minutilabia*, a species unique in subsection *Macrophyllae-Fasciculatae* because of the minute, highly reduced lip, is described and compared to the most similar species in the subsection. It is also compared morphologically to *Pleurothallis kaynagata* from section *Abortivae*, to which *P. minutilabia* is not related, but which also possesses a highly reduced lip. The morphology of the flower of *P. minutilabia* is discussed briefly in relation to possible pollination mechanisms. The distribution, restricted to Zamora Chinchipe, southern Ecuador, and the conservation status are addressed.

KEY WORDS: cloud forest, Ecuador, labellar morphology, *Pleurothallis*, pollination

Introduction. Within *Pleurothallis* R.Br. as circumscribed by Pridgeon *et al.* (2005), subsection *Macrophyllae-Fasciculatae* Luer represents the largest taxonomic group with between 236 and 305 described species, depending on synonymy (Wilson, unpubl.). A consistent characteristic among all the species of *Pleurothallis* subsection *Macrophyllae-Fasciculatae* described to date, without exception, is a prominent and conspicuous labellum or “lip” laying flat upon the synsepal or elevated slightly above it (Fig. 1), which was illustrated in detail for *Pleurothallis castanea* Mark Wilson, G.Merino & J.D.Werner, *Pleurothallis nangaritzae* M.M.Jiménez, Tobar & Mark Wilson and *Pleurothallis rubrifolia* Mark Wilson, Tobar & Salas Guerr. by Wilson *et al.* (2016). While the dimensions, morphology, texture and positioning of this lip vary among the species, the presence of such a visible lip is constant (Fig. 1). There are currently no described species of *Pleurothallis* in

subsection *Macrophyllae-Fasciculatae* with a highly reduced or apparently “vestigial” lip.

The first species of *Pleurothallis* to be described with a minute and apparently vestigial lip was *Pleurothallis abortiva* Luer (Fig. 2a; Luer 1980). Not fitting well morphologically within any other section or subsection within subgenus *Pleurothallis*, Luer (1986) created section *Abortivae* to include *P. abortiva* and a few other species. Subsequently, Luer (1988) removed all but *P. abortiva* from the section, rendering it monotypic. Luer (1998) retained the monotypic section and stated that *P. abortiva* “is distinguished from all other species of the subgenus by the small, vestigial lip”. The section remained monotypic until Doucette *et al.* (2016) described *Pleurothallis kaynagata* A.Doucette, Mark Wilson & J.Portilla which has a similar lip (Fig. 2b, 3, 4).

Until recently, *P. abortiva* (Fig. 2a) and *P. kaynagata* (Fig. 2b, 3, 4) of section *Abortivae*



FIGURE 1. Flowers of various species of *Pleurothallis* subsection *Macrophyllae-Fasciculatae* demonstrating the prominent, clearly visible lip of the group. A. *P. arctata*. B. *P. baudoensis*. C. *P. calamifolia*. D. *P. calceolaris*. E. *P. conicostigma*. F. *P. crucifera*. G. *P. depressa*. H. *P. latipetala*. I. *P. octavioi*. J. *P. ortegae*. K. *P. pansamalae*. L. *P. platysepala*. M. *P. scurrula*. N. *P. titan*. O. *P. tridentata*. P. *P. volans*. Prepared from floral scans of plants in the Living Collection at Colorado College by M. Wilson. (Lips presented at the bottom, although some of these species are non-resupinate. Flowers not to the same scale.)

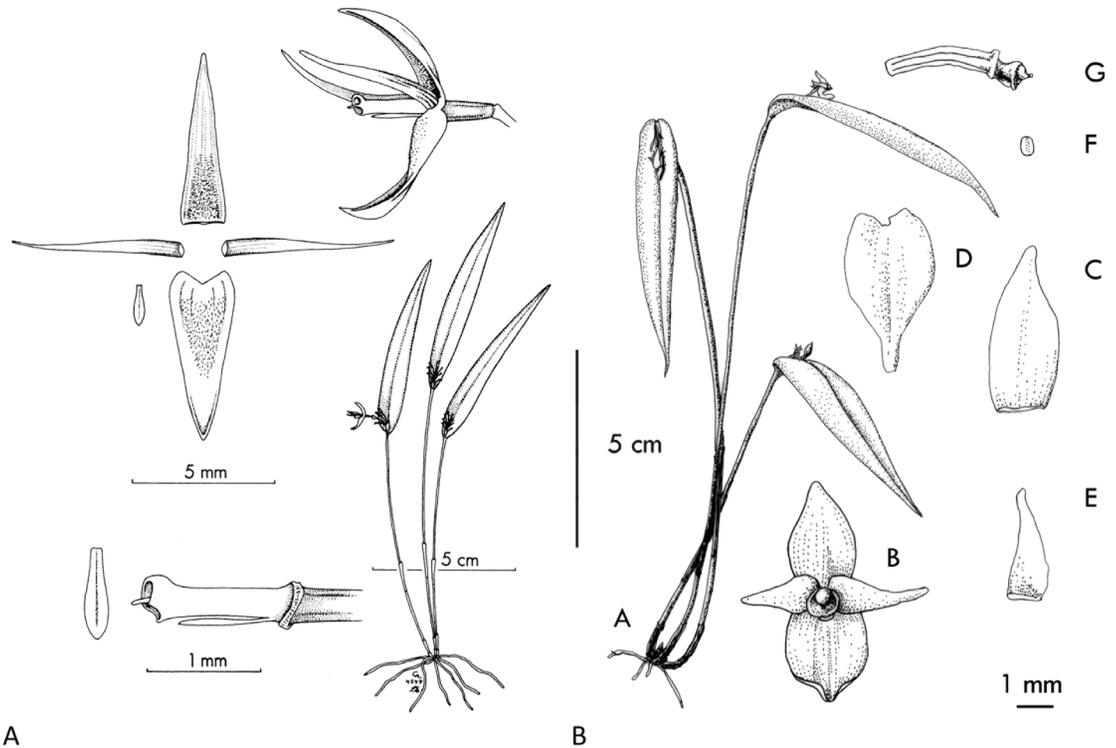


FIGURE 2. Drawings of A. *Pleurothallis abortiva* (drawing reproduced from Luer 1980, courtesy of Missouri Botanical Garden Press); and B. *Pleurothallis kaynagata* (drawing reproduced from Doucette *et al.* 2016, courtesy of Sociedad Colombiana de Orquideología and the journal *Orquideología*).

remained the only known *Pleurothallis* species with a minute, highly reduced and apparently vestigial lip, none existing in any of the other taxonomic groups within *Pleurothallis sensu* Pridgeon *et al.* (2005). The only thing remotely comparable being the very small, highly modified lips of the *P. crocodileiceps* species complex of subgenus *Ancipitia* (Wilson *et al.* 2017a, 2017b, 2018). However, in 2015 an undescribed species of *Pleurothallis* was collected from Podocarpus National Park during an intensive survey of poorly collected areas of Ecuador (Muchhala & Pérez 2015, Pérez *et al.* 2016, Orozco *et al.* 2017). The species was brought to the attention of Wilson because of the minute lip and the remarkable, though superficial, resemblance to *P. kaynagata*; the difference being that, based on the cordate leaves and bilobed stigma, the new species was most likely attributable to subsection *Macrophyllae-Fasciculatae*, not section *Abortivae*.

As stated above, all species of subsection

Macrophyllae-Fasciculatae described to date possess a prominent lip. The vast majority of these exhibit a “glenion” on the hypochile below and slightly in front of the anther/rostellum, which is hypothesized to provide a reward, though this has yet to be conclusively demonstrated. Further, many species in the subsection have been observed *in vivo* with a liquid substance on the lip (Wilson, unpubl.). These observations suggest the probable importance of the glenion and the nectar-like liquid in pollinator attraction and positioning during pollination (Luer 1986, Wilson *et al.* 2016). Therefore, any species with a highly reduced and apparently vestigial lip are of interest because they may exhibit a very different pollination syndrome from other members of the subsection. In this paper, the new species is described and illustrated and we present an hypothesis regarding the possible role of the unique labellar morphology in the reproductive ecology of the species.



FIGURE 3. *Pleurothallis kaynagata*. A. Whole flower – lateral view. B. Column and lip – lateral view. C. Column and lip – ventral view. Prepared by M. Wilson from material in Ecuagenera collection.

Materials and Methods

Plant material. — Living material of the putative new species was examined *in situ* in Ecuador by Tobar, Pérez, Romoleroux and Jiménez and in a private collection in The Netherlands by Wilson.

Morphological and taxonomic comparisons. — Since the new species was believed to be a member of subsection *Macrophyllae-Fasciculatae*, in order to determine taxonomic novelty the material was compared with all described species in that subsection. The new species was also compared in detail with *Pleurothallis kaynagata* from section *Abortivae* using material from the living collection at Colorado College (Wilson PL0734 and PL0735) and *Pleurothallis abortiva* from the type, drawings and description since no living material or photographs are known. Finally, the new species was compared with those described in subsection *Acroniae*, in case the species had mistakenly been published in that group.

Scanning electron microscopy. — For scanning electron microscopy (SEM) fresh-harvested flowers were preserved in Kew Mix (5% formalin [37.6% formaldehyde], 53% methanol, 5% glycerol, 37% deionized water). Flowers were dehydrated in successively higher concentrations of ethanol (80%, 95%, 100%, 100%) for 15 min each before being placed in freshly-opened 100% ethanol. Specimens were dried in a critical point dryer (model EMS 850, Electron Microscopy Sciences, Hatfield, PA, USA) prior to mounting on aluminum stubs and sputter coating (model Pelco SC-6, Ted Pella, Redding, CA, USA). Specimens were imaged using a scanning electron microscope (model JSM-6390LV, Jeol, Peabody, MA, USA) with an accelerating voltage of 10–15 kV.

Results

Morphological and taxonomic comparisons. — Exhaustive examination of all the published taxonomic literature for subsection *Macrophyllae-Fasciculatae*, section *Abortivae* and subsection *Acroniae* confirmed the novelty of the species. While attributable to subsection *Macrophyllae-Fasciculatae* based upon the cordate leaves spreading horizontally from the ramicaul and the bilobed stigma, the floral morphology

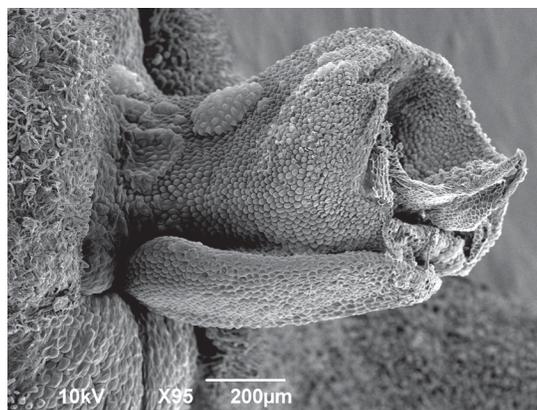


FIGURE 4. Scanning electron micrograph of *Pleurothallis kaynagata* column and lip. Prepared by G. Frank and M. Wilson from *P. kaynagata* PL0734 from living collection at Colorado College.

with the highly reduced and apparently vestigial lip indicates that the new species, to date, is unique in the subsection. The lip initially appears to be absent when the flower is viewed from the dorsal surface. Indeed, at first glance it resembles a flower in which the lip has been removed by a slug or snail, as occurs somewhat frequently. The lip becomes visible beneath the column only when the flower is tilted backwards (Fig. 5) or the flower is viewed from the side. Interestingly, the lip was observed to be loosely hinged and partially motile, though the point of articulation on the column was not visible. A flat, triangular flange projecting from the base of the lip appeared to limit the range of motility by resting against the synsepal.

Scanning electron microscopy. — Considering the uniqueness of the floral morphology, a detailed SEM examination was warranted (Figs. 6–9). When imaged from above, the lip is completely obscured by the column and projecting anther (Fig. 6a), but is exposed, nestled beneath the column, when the flower is tilted (Fig. 6b). The lip approximates an equilateral triangle, ~538 μm wide at the base and ~520 μm long, and is ~285 μm deep at the base, assuming minimal shrinkage during critical point drying (Figs. 7 and 8). The lip is subtended at its base by a downward projecting triangular extension, or flange, ~436 μm long (from point of attachment to the tip) or ~560 μm (from dorsal surface of lip to tip of flange) (Figs. 7 and 8). The most prominent feature is a papilla-lined cavity at the apex of the lip, ~78 μm

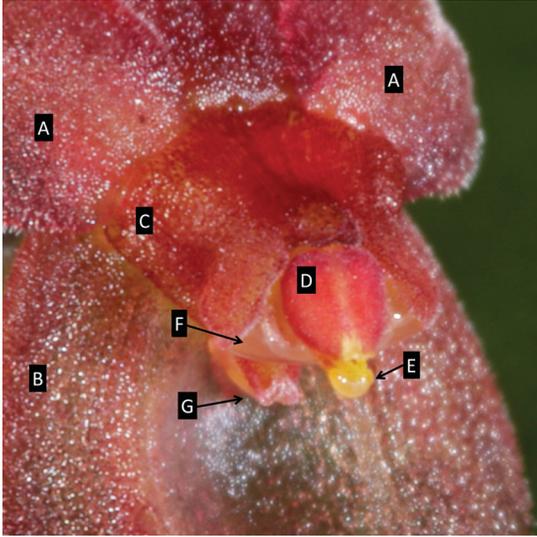


FIGURE 5. *Pleurothallis minutilabia* column and lip. A. Petals. B. Synsepal. C. Column. D. Anther cap. E. Viscidium. F. Stigma. G. Lip. Photograph by M. Wilson from *Wilson PL0996*.

wide, which appears to project backwards into the lip, creating a ridge along the dorsal surface (Figs. 7 and 8). While the dorsal surface was not completely visible, no glenion or other morphologically-distinct possibly secretory tissue was visible.

The pollinarium is typical for subsection *Macrophyllae-Fasciculatae*, consisting of two clavate pollinia, $522 \times 264 \mu\text{m}$, subtended by caudicles, with a spherical viscidium at the apex (Fig. 9).

TAXONOMY

Pleurothallis minutilabia Mark Wilson, F.Tobar, A.J.Pérez, *sp. nov.* (Figs. 5–11).

TYPE: Ecuador. Zamora-Chinchipe. Podocarpus National Park, Bombuscaro River sector, collected on the trail to the outlook, 1000–1400 m, $04^{\circ}06'38.9''\text{S}$, $78^{\circ}58'11.9''\text{W}$, 31 Mar 2015 (fl, flower in alcohol), A. J. Pérez, F. Tobar, N. Zapata, W. Santillán, H. Namcela 8539 (holotype QCA - 237066).

In subsection *Macrophyllae-Fasciculatae*, the most morphologically similar species is *Pleurothallis erythrium* Luer. The new species is easily distinguished from *P. erythrium* by the lip (ovate-triangular, approximately 50% the length of the synsepal, with

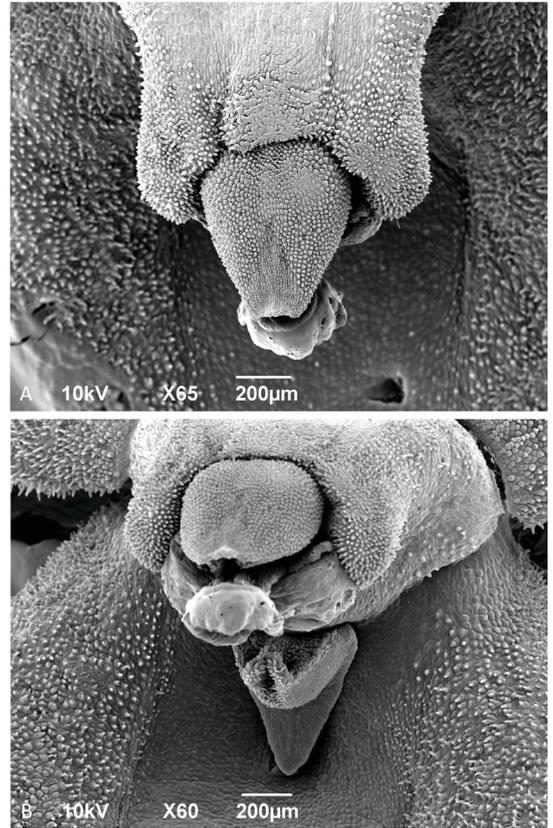


FIGURE 6. *Pleurothallis minutilabia* scanning electron micrographs. A. Column, anther cap, viscidium and synsepal (dorsal view). B. Column, lip and synsepal (tilted front view). Micrographs by M. Wilson from *Wilson PL0996*.

distinct glenion in *P. erythrium* versus highly reduced, not projecting beyond the column, glenion apparently absent and apical, papilla-lined cavity in *P. minutilabia*) and the surface of the petals and sepals (hirsute in *P. minutilabia* versus glabrous in *P. erythrium*).

Plant epiphytic, caespitose, to ~8–10 cm tall. *Roots* fibrous, slender. *Ramicauls* slender, terete, suberect-spreading, 5.4–11.6 cm long, enclosed by thin, papery, tubular sheaths, basal sheath 3.2–5.8 mm long, mid-ramicaul sheath 13–17 mm long. *Leaves* horizontal, ovate, acute, $2.0\text{--}3.8 \times 1.2\text{--}2.8$ cm, base sessile, shallowly cordate, coriaceous. *Inflorescence* fascicle of successive, single flowers, $6.0\text{--}7.8 \times 4.3\text{--}4.9$ mm, resupinate, borne from reclining spathaceous bract 3.8–6.0 mm long, pedicel 2.5–2.9 mm long, ovary 1.8–2.2 mm long. *Dorsal sepal* beige suffused with

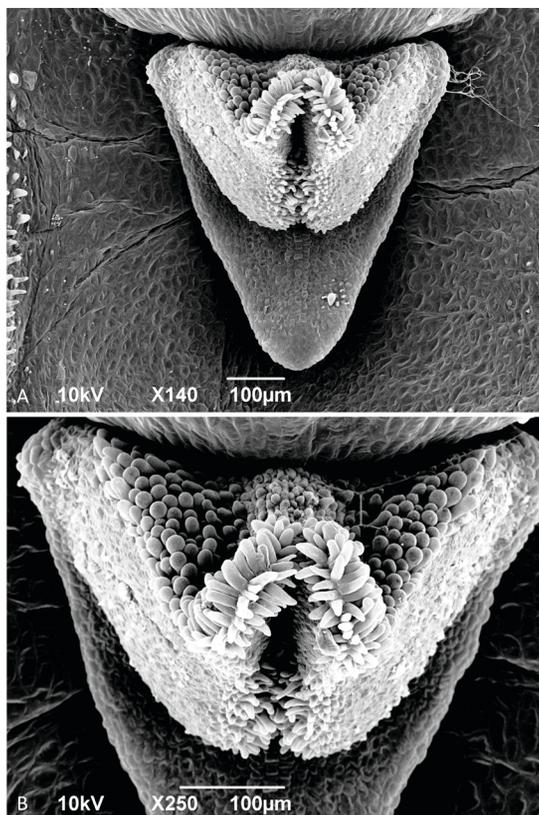


FIGURE 7. *Pleurothallis minutilabia* scanning electron micrographs. A. Lip with flange (front view). B. Lip (front view). Micrographs by K. Zhao and M. Wilson from *Wilson PL0996*.

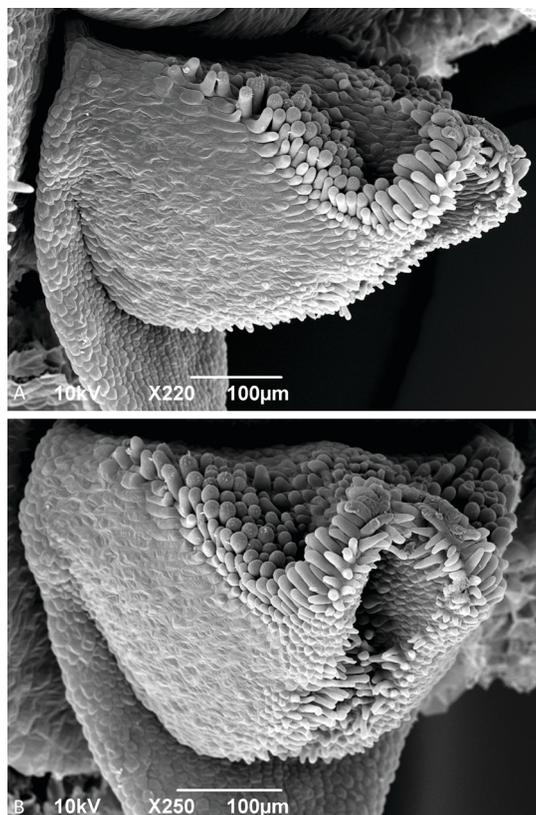


FIGURE 8. *Pleurothallis minutilabia* scanning electron micrographs. A. Lip (lateral 3/4 view). B. Lip (lateral 2/3 view). Micrographs by H. Hampson from *Wilson PL0996*.

red-purple, ovate, subacute, 3.4–4.0 × 2.2–2.9 mm, 3-veined, pubescent. *Synsepal* beige suffused with red-purple, ovate, subacute, 2.9–3.5 × 2.7–3.0 mm, concave centrally, 2-veined, pubescent. *Petals* beige suffused with red-purple, ovate-lanceolate, acute 3.1–3.3 × 1.0–1.1 mm, one-veined, pubescent. *Labellum* rufous, triangular, slightly wider than long, 520 × 538 µm, stout, 285 µm thick, concave dorsally, involute (“hooked”) apex, keeled ventrally, flat flange projecting downwards from underside of base, 436 µm (from point of attachment on underside to tip). *Column* rufous, stout, 1.0–2.0 × 1.2–1.4 mm, papillose, anther apical, stigma bilobed, ventral. *Pollinarium* two clavate pollinia 522 × 264 µm, short caudicle, spherical viscidium.

ADDITIONAL MATERIAL STUDIED: The Netherlands. Heijningen, flowered in cultivation without collection data, December 2017, *Wilson PL0996* (paratype: COCO).

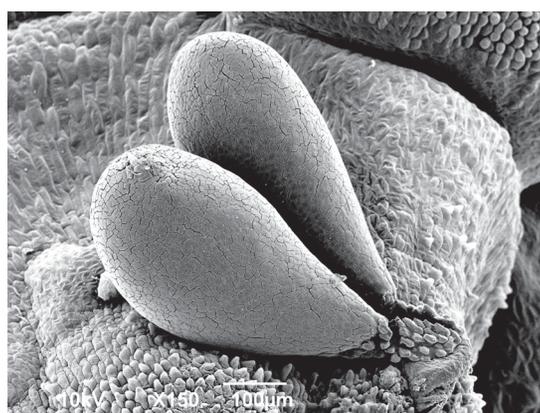


FIGURE 9. Scanning electron micrographs of *Pleurothallis minutilabia* pollinarium. Micrograph by K. Zhao and M. Wilson from *Wilson PL0996*.

ETYMOLOGY: Named for the minuscule size of the lip.

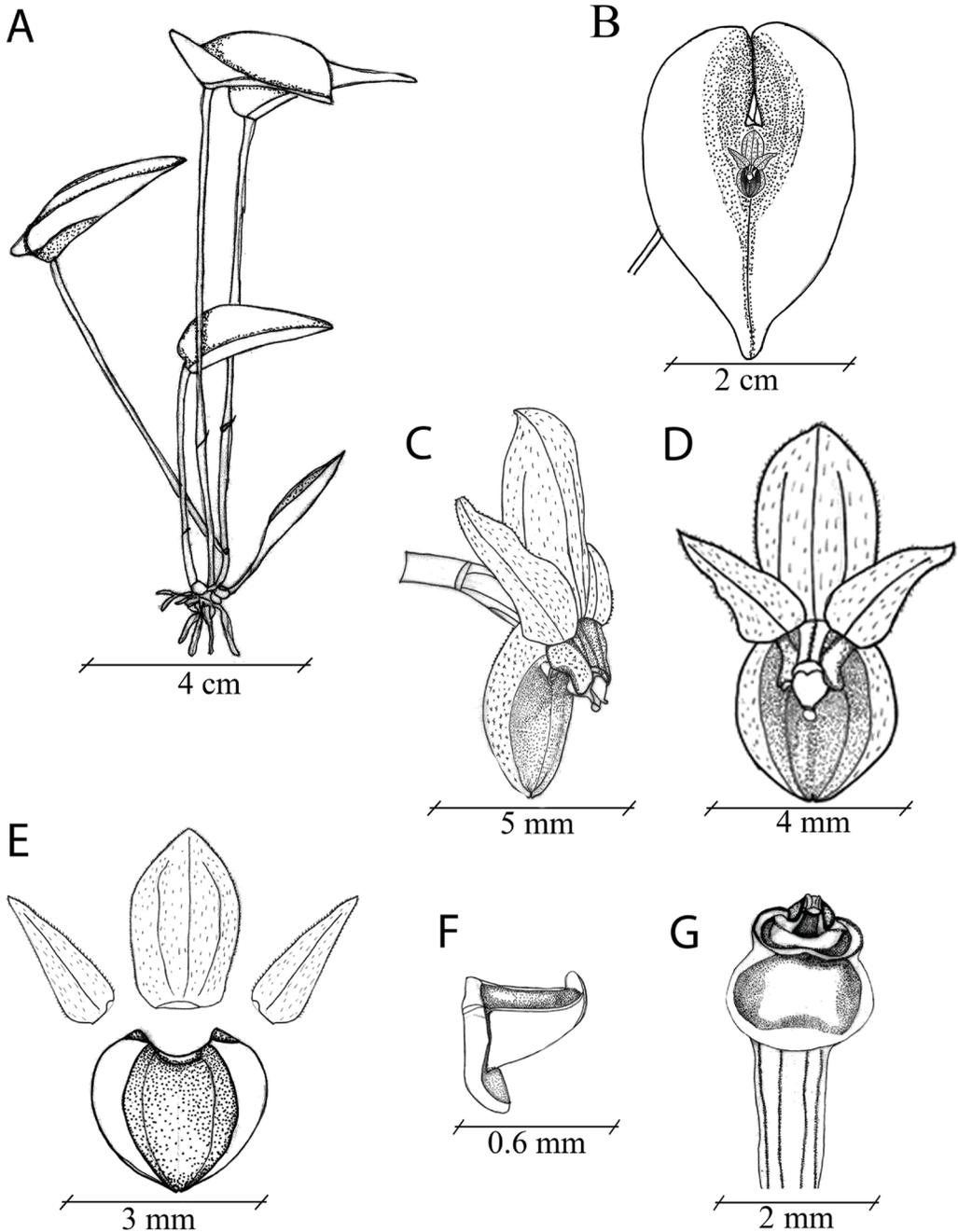


FIGURE 10. Drawing of *Pleurothallis minutilabia*: A. Whole plant. B. Leaf with flower. C. Flower (3/4 view). D. Flower (front view). E. Floral dissection. F. Labellum. G. Column and ovary (ventral surface). Illustration by F. Tobar and K. Romoleroux, from material used to prepare the type specimen.

Pleurothallis minutilabia is placed in the group *Macrophyllae-Fasciculatae* (Luer 1986, 1988, 2005) based on morphological attributes: spreading-to-erect,

well-developed ramicauls; sessile, cordate leaves, not in same plane as ramicaul; single-flowered inflorescence emerging from the apex of the ramicaul at the base

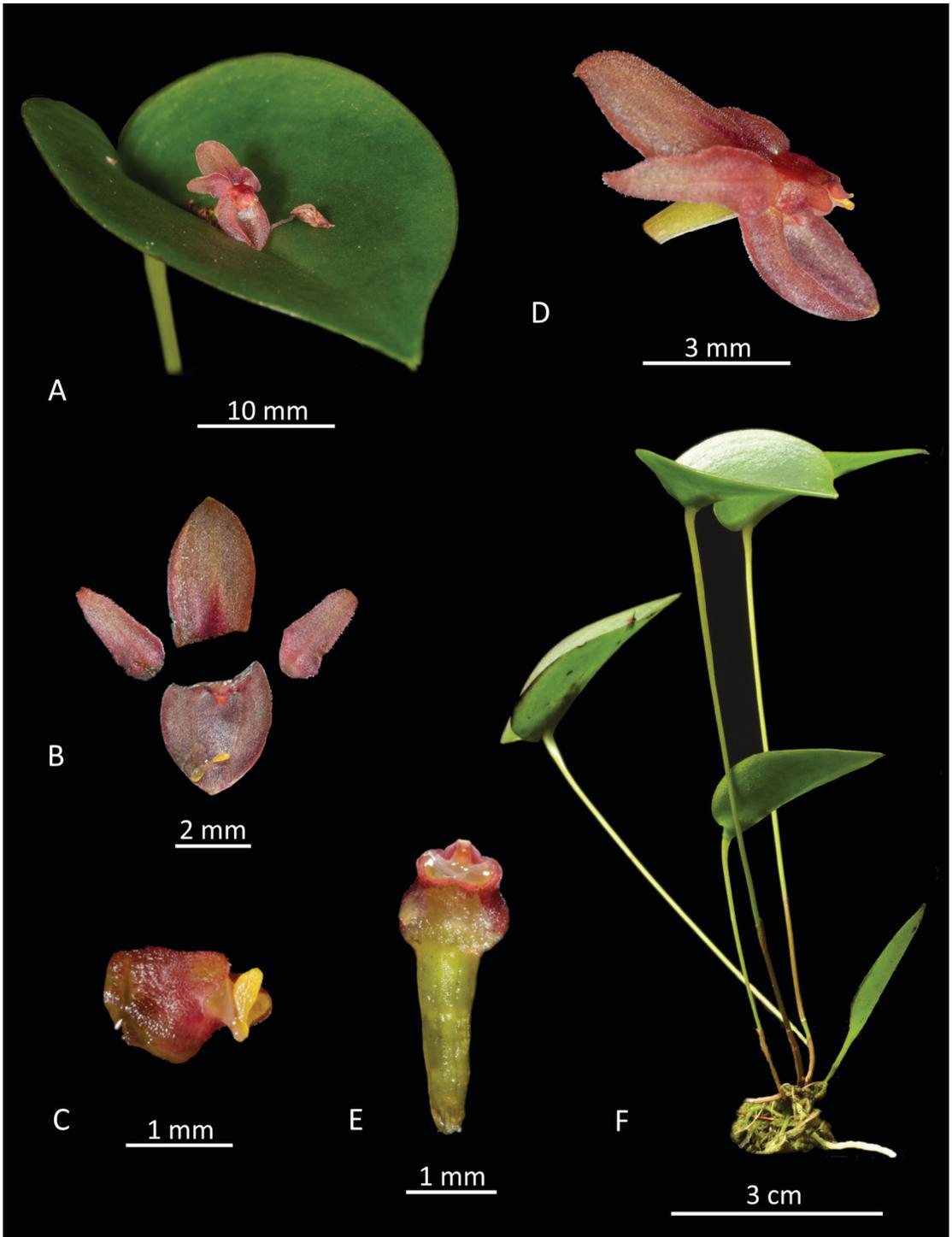


FIGURE 11. *Pleurothallis minutilabia* Lankester composite dissection plate. A. Leaf and flower. B. Floral dissection – sepals and petals. C. Column. D. Whole flower – lateral view. E. Column and ovary – ventral view. F. Whole plant. LCDP prepared by M. Wilson from *Wilson PL0996*.

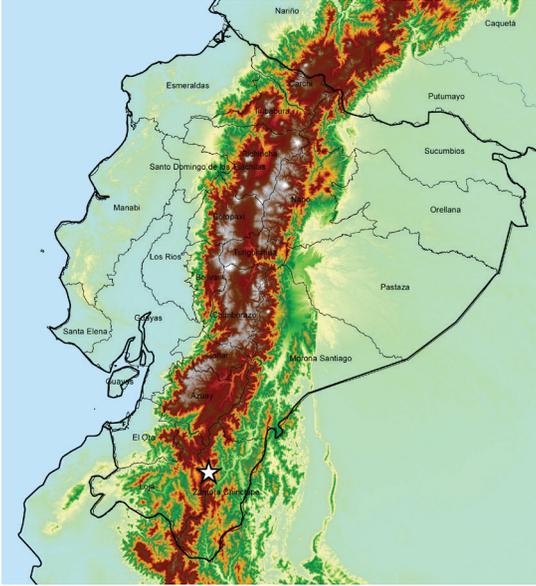


FIGURE 12. *Pleurothallis minutilabia* distribution map indicating type locality (white star). Map prepared by H. Hampson.



FIGURE 13. *Pleurothallis minutilabia* habitat in Podocarpus National Park. Photograph by Á. J. Pérez.

of the leaf; short peduncle and pedicel mostly hidden within the reclining spathaceous bract; apical anther; and transversely bilobed stigma. Morphologically *P. minutilabia* does not fit within section *Abortivae* (Luer 1980, 1998) or within the single-flowered subsection *Acroniae* series *Amphigyae* Luer (Luer 1998), because these species typically have less well developed ramicauls; sessile, but rarely cordate leaves, usually in the sample plane as the ramicaul; a longer, terete column; longer peduncles and pedicels emerging some distance from the spathaceous bract; and an oval,

rather than bilobed, stigmatic surface.

While not closely related, the flowers of *Pleurothallis minutilabia* (*Macrophyllae-Fasciculatae*) and *Pleurothallis kaynagata* (*Abortivae*) are superficially similar and could be confused. *Pleurothallis minutilabia* is, however, easily distinguished by the leaves (ovate, acute, sessile, cordate in *P. minutilabia* versus lanceolate, acute, tridenticulate apex, sessile, cuneate in *P. kaynagata*) and the stigma (bilobed in *P. minutilabia* versus oval in *P. kaynagata*).

DISTRIBUTION AND HABITAT: *Pleurothallis minutilabia* is an endemic species from Zamora Chinchipe in the southeast of Ecuador, on the eastern slope of the Andes, only known from two collections in the vicinity of Zamora (Fig. 12). It grows in cloud forest (Fig. 13), between 1000–1400 m, which, according to the Ministerio del Ambiente de Ecuador (2013), lies within a much larger zone dominated by evergreen forest in the foothills of the southern Cordillera Oriental of the Andes (“bosque siempreverde piemontano del sur de la cordillera oriental de los Andes” (BsPn04)). This species is sympatric with *Pleurothallis* aff. *undulata* Poepp. & Endl. and *Pleurothallis cardiostola* Rchb.f. from subsection *Macrophyllae-Fasciculatae* and the tree species *Centronia laurifolia* D. Don (Melastomataceae), *Ocotea longifolia* Kunth (Lauraceae) and *Guatteria pastazae* R.E.Fr. (Annonaceae).

CONSERVATION STATUS: *Pleurothallis minutilabia* appears to have a very restricted distribution and may be endemic to the province of Zamora Chinchipe. The type locality is in the Parque Nacional Podocarpus, an area of ca. 1500 km² protected since 1982. The second locality, however, somewhat to the west of Zamora, is not in a protected area. Further data are required on the distribution and abundance of this species before a valid conservation assessment can be made. Hence, the species should be listed as Data Deficient according to IUCN (2012) criteria until such an assessment can be made.

Discussion. Vegetative and floral morphological characters place *Pleurothallis minutilabia* within section *Pleurothallis* subsection *Macrophyllae-Fasciculatae* (Luer 1988) and not within section *Abortivae* (Luer 1980, 1998) or subsection *Acroniae*

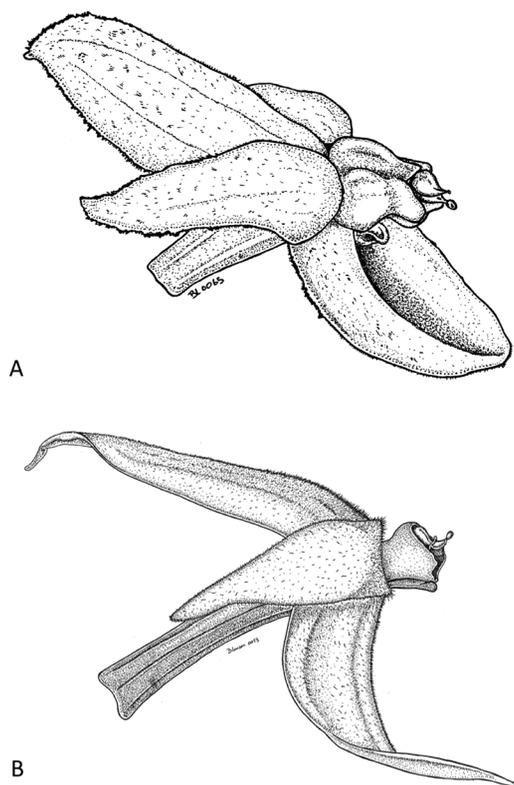


FIGURE 14. A. *Pleurothallis minutilabia* flower (lateral view). B. *Pleurothallis kaynagata* flower (lateral view). Illustrations by B. Larsen from Wilson PL0996 and Wilson PL0734, respectively.

series *Amphigyae* (Luer 1998), the only two other possible groups. The labellar morphology of *P. minutilabia* is completely unique within the subsection. Of the 236+ species described to date, all possess a small-to-large lip which projects beyond the column (Fig. 1); of those examined so far, the vast majority possess a glenion on the lip; and many have been observed with a liquid substance somewhere on the lip (Wilson *et al.*, unpubl.). In *P. minutilabia*, however, the lip is completely obscured until the flower is tilted backwards or sideways to reveal the minute, highly reduced structure beneath the column. The only parallel is in the apparently vestigial lips of *P. abortiva* and *P. kaynagata* (Figs. 2–4).

Following the taxonomy of Luer, *Pleurothallis kaynagata* would be attributable to section *Abortivae*. However, Doucette *et al.* (2016) hypothesized that the closest relative is *Pleurothallis neossa* (Luer & Hirtz) J.M.H. Shaw of subsection *Acroniae*, which

has been borne out by recent phylogenetic analysis (Wilson, unpubl.). Although Luer (2005) chose to combine subsections *Macrophyllae-Fasciculatae* and *Acroniae* under the resurrected name *Acronia* C. Presl., preliminary phylogenetic analyses indicate that the two groups are phylogenetically distinct (Wilson *et al.* 2011, 2013).

Although not closely related, flowers of *P. minutilabia* and *P. kaynagata* are morphologically similar (Fig. 14): both flowers are beige, lightly suffused with burgundy; both flowers are hirsute, uniformly covered in short hairs (a characteristic rare within *Macrophyllae-Fasciculatae*); both flowers are relatively open, with reflexed petals; and, both have a short column with a highly reduced lip. The lip of *P. minutilabia* at $\sim 520 \times 538 \mu\text{m}$ (or $\sim 0.5 \times 0.5 \text{ mm}$), however, is significantly smaller than that of *P. abortiva* $1.6 \times 0.5 \text{ mm}$ (Luer 1980) or that of *P. kaynagata* $1.0 \times 0.7 \text{ mm}$ (Doucette *et al.* 2016). And, the lip of *P. minutilabia* is very different in morphology from those of the other two species. While the lips of *P. abortiva* and *P. kaynagata* are ovate, membranous and adpressed to the ventral surface of the column (Luer 1980, Doucette *et al.* 2016) (Figs. 2–4), the lip of *P. minutilabia* is stout, triangular, concave dorsally, with a papilla-lined cavity at the apex (Figs. 6–8). Further, the lip has a flat, triangular flange at the base of the lip which lies against the synsepal and appears to maintain the position of the lip in the vertical plane.

Luer (1998) referred to the lip of *Pleurothallis abortiva* as “vestigial”. According to the Oxford Living Dictionary vestigial can be defined as: “*degenerate, rudimentary, or atrophied, having become functionless in the course of evolution*” and according to the Merriam-Webster dictionary the definition is: “*remaining in a form that is small or imperfectly developed and not able to function*”. In both definitions, loss of function is a central concept. We hypothesize that, at least in *Pleurothallis minutilabia*, the highly reduced, but morphologically unique and structurally complex lip is not vestigial according to these definitions. The micromorphology of the lip revealed by SEM, including the papilla-lined, apical labellar cavity and the supporting flange seem far too elaborate to comprise a vestigial structure. We hypothesize, therefore, that the lip of *P. minutilabia* performs a very specific function during the reproductive ecology of the species.

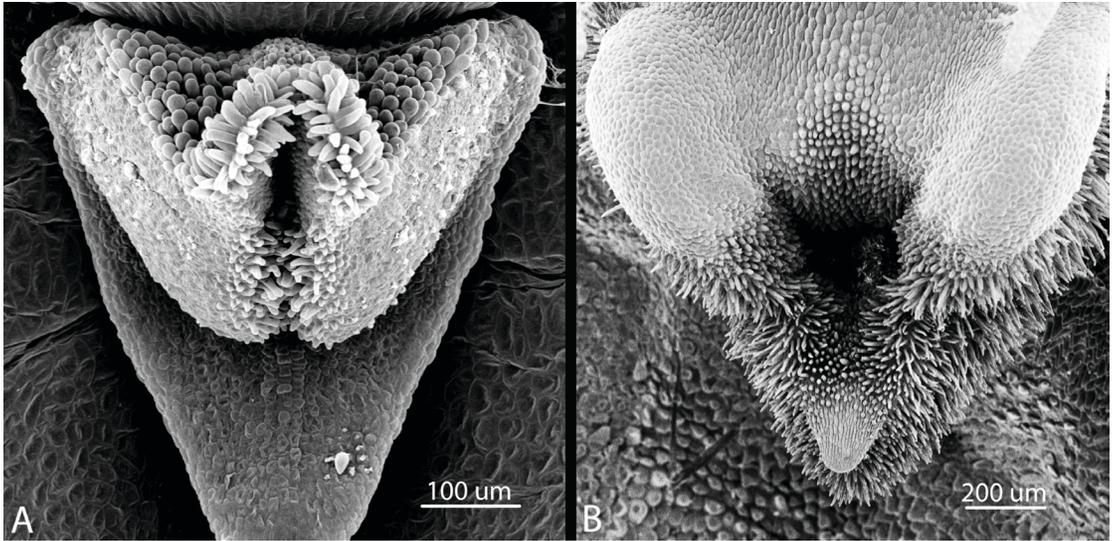


FIGURE 15. Papilla-lined, apical labellar cavities. A. *Pleurothallis minutilabia*. B. *Pleurothallis wielii*. Scanning electron micrographs by K. Zhao, K. Dupree and M. Wilson.

The last two decades have seen substantial progress in the study of pollination strategies in Pleurothallidinae, including in the genera *Acianthera* Scheidw. (Borba & Semir 2001); *Andinia* (Luer) Luer (Álvarez 2011); *Dracula* Luer (Endara *et al.* 2010, Policha *et al.* 2016); *Lepanthes* Sw. (Blanco & Barboza 2005, Blanco & Vieira 2011, Calderón-Sáenz 2012); *Restrepia* Kunth (Millner & Baldwin 2016); *Specklinia* Lindl. (Karremans *et al.* 2015); and *Trichosalpinx* Luer (Bogarín *et al.* 2018). In comparison to these other Pleurothallidinae much less is known about pollination strategies in *Pleurothallis*, with only a few careful studies having been published (Calderón-Sáenz 2011, Damon & Salas-Roblero 2007, Díaz-Morales & Karremans 2015, Duque-Buitrago *et al.* 2014) and only one of these being of a species in subsection *Macrophyllae-Fasciculatae* (Duque-Buitrago *et al.* 2014). Nevertheless, we can observe that in almost all species of *Pleurothallis* subsection *Macrophyllae-Fasciculatae*, there is a distinct lip projecting beyond the column; typically with a glenion on the hypochile; and a liquid substance, a probable pollinator reward, is often observed on the lip (Wilson *et al.* unpubl.). The lip of *P. minutilabia* is unique among the 236+ species of the subsection and, therefore, one might conclude, functions differently than the other lips.

We hypothesize that *Pleurothallis minutilabia* is deceit-pollinated through pseudocopulation by a

male insect and that the lip plays a specific, important role in the process. To date, among Pleurothallidinae, pseudocopulation has been observed only in *Andinia* (Álvarez 2011) and *Lepanthes* (Blanco & Barboza 2005, Blanco & Vieira 2011, Calderón-Sáenz 2012) and, admittedly, apart from reduced size, there are no morphological similarities between the lips of these species and that of *P. minutilabia* that would support this hypothesis. However, the extreme reduction in size despite morphological complexity; the apical papilla-lined cavity into which the abdomen of an insect could be inserted; and the labellar motility modulated by the subtending flange all suggest to us a possible pseudocopulatory role for the lip. Interestingly, the papilla-lined cavity of *P. minutilabia* strongly resembles the cavity in the lips of the *P. crocodiliceps* complex (Fig. 15) (Wilson *et al.* 2017a, 2017b, 2018), which are also hypothesized to involve deceit-pollination by pseudocopulation. Acknowledging that only *in situ* observations of the pollination process can conclusively demonstrate deceit-pollination by pseudocopulation in *P. minutilabia*, given the difficulty of performing such studies in a sparsely distributed, tropical montane species, in the meantime additional studies are planned to address the hypothesis. These include light microscopy of labellar sections with staining for possible reward chemicals; transmission electron microscopy of labellar sections

to further examine the apical labellar cavity; and gas chromatography-mass spectroscopy (GC-MS) to examine floral volatiles.

We further hypothesize that the phylogenetically unrelated *Pleurothallis kaynagata* is also deceit-pollinated through pseudocopulation and that floral morphological similarities between *P. kaynagata* and *P. minutilabia* represent convergent evolution due to similar pollination syndromes. The reproductive ecology of *P. minutilabia*, *P. kaynagata* and the *P. crocodileiceps* species complex and the hypothesized involvement of deceit pollination via pseudocopulation is one area of ongoing research in the Wilson lab.

ACKNOWLEDGEMENTS. MW, KZ, HH and GF thank Colorado College and Robert Hevey for research funding and Colorado College for provision of greenhouse, herbarium, electron microscopy and GIS facilities; Dr. Ron Hathaway for assistance with scanning electron microscopy; and Matt Cooney for GIS instruction. AP, KR, MJ and FT thank the curators from QCA and QCNE herbaria and Secretaría de Educación Superior, Ciencia, Tecnología e Innovación de la República del Ecuador (SENESCYT, Arca de Noé Initiative; S. R. Ron and O. Torres-Carvajal, main researchers) and the Ecuadorian Ministerio del Ambiente for granting permits MAE-DNB-ARRGG-CM-2014-0002 and MAE-DNB-CM-2016-0045. The authors are grateful to the Editors of *Lankesteriana* and the anonymous reviewers for suggestions to improve the manuscript.

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***SCAPHOSEPALUM TARANTULA* (ORCHIDACEAE: PLEUROTHALLIDINAE), A NEW SPECIES FROM ECUADOR**

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ABSTRACT. A new species, *Scaphosepalum tarantula*, is described. It is recognized by the medium-sized plants with grey-green leaves suffused with red-brown to purple stains at the petioles; densely fimbriated, red-brown to sanguine flowers, spiky tails of the lateral sepals and a dark sanguine, wingless lip. It is here compared to *Scaphosepalum fimbriatum* with which it shares similarities.

RESUMEN. Se describe aquí *Scaphosepalum tarantula*, una nueva especie. Se reconoce por las plantas de tamaño mediano con hojas verde-gris salpicadas por manchas rojo-café en los peciolos; las flores densamente fimbriadas, café-rojizo a color sangre, con las caudas de los sépalos laterales con púas y el labelo sin alas. Se lo compara con *Scaphosepalum fimbriatum*, con el que comparte rasgos similares.

KEY WORDS: new species, Pichincha, *Scaphosepalum fimbriatum*, sympatric species

Introduction. There are more than 50 species of *Scaphosepalum* Pfitzer (Luer 1988, 1991, 1992, 1993, 1998a, 1998b, 2000, 2009, Pridgeon *et al.* 2001, Endara *et al.* 2011, Chase *et al.* 2015, Valenzuela Gamarrá 2015, Karremans 2016, Karremans *et al.* 2016, Baquero 2017). *Scaphosepalum* species are recognized from other members in the Pleurothallidinae mainly by the osmophores at the apex of the lateral sepals, sepaline tails of variable length, and the non-resupinate flowers (Luer 1988, Pridgeon *et al.* 2001, Endara *et al.* 2011, Karremans *et al.* 2016). The known species with long, fimbriate, spiculate, sepaline tails are *Scaphosepalum fimbriatum* Luer & Hirtz, *S. zieglerae* Baquero and *S. beluosum* Luer (Luer 1988, Baquero 2017). A species that shares these characteristics but is much smaller in size compared with *S. zieglerae* and *S. beluosum*, and differs from *S. fimbriatum* in lip morphology, was discovered close to Quito and is described here.

DIAGNOSIS: Species similar to *Scaphosepalum fimbriatum*, from which it differs by triangular osmophores of the lateral sepals instead of quadrilateral osmophores; the pandurate, dark sanguine lip, with a rhomboid epichile instead of an elliptical-subpandurate, three-lobed, purple lip; and the rhomboid petals versus the subquadrate, oblique petals of *S. fimbriatum* (Fig. 3).

Plant epiphytic, densely caespitose, 15–20 cm tall. *Roots* slender. *Ramicauls* erect, slender, 1.5–2.0 cm long, enclosed by 2–3 sheaths. *Leaf* erect, green suffused with red-brown to purple stains at the petioles, thinly coriaceous, conduplicate, long-petiolate, 8–12 cm long including the petiole 1.8–3.0 cm long, leaf apex acute, the blade narrowly elliptical 1.0–1.5 cm wide, attenuate below into a slender, channeled petiole. *Inflorescence* a loose, distichous, successively several flowered raceme, 5–10 cm long, each flower borne by a slender, glabrous to faintly verrucose, descending peduncle 4–7 cm long, originating from low to medially on the ramicaul; *floral bracts* thin, acuminate, conduplicate, 2 mm long; *pedicel* slightly recurved, 3–5 mm long; *ovary* ribbed, 2 mm long. *Sepals* cream colored, densely spotted with dark-purple dots, the margins ciliate, with spiculate carinae. *Dorsal sepal* tricarinate,

TAXONOMIC TREATMENT

***Scaphosepalum tarantula* Baquero & Hirtz, sp. nov.** (Fig. 1–3).

TYPE: Ecuador. Pichincha: Las Tolas, 0°04'14.1"N 78°13'46.3"W, October 28, 2016, 1884 m. *Luis Baquero 3092* (holotype, QCNE).

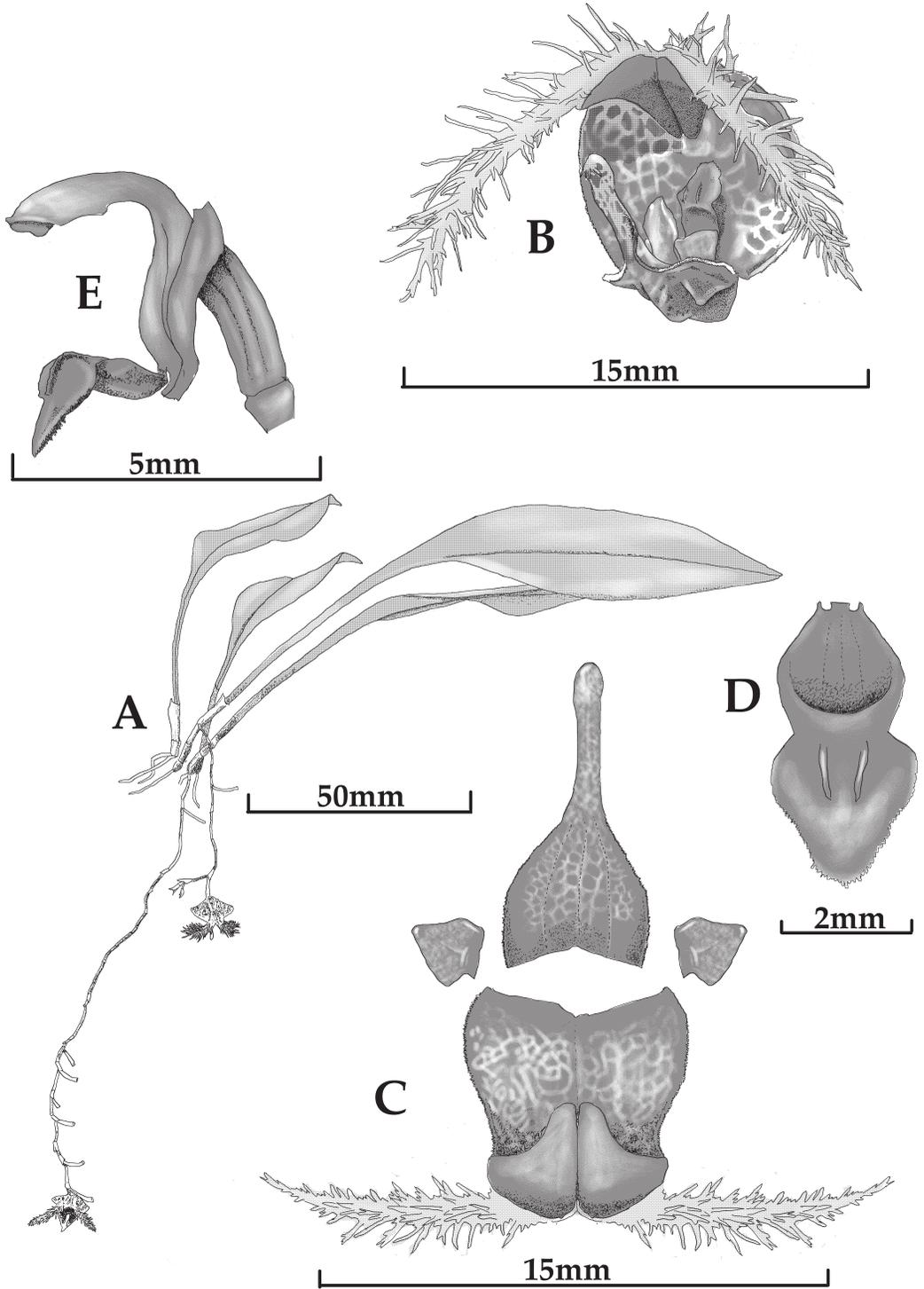


FIGURE 1. *Scaphosepalum tarantula*. A. Habit. B. Flower. C. Dissected perianth. D. Lip extended. E. Lip and column. Drawn by L. E. Baquero from the holotype.

not spiculated, ovate and concave, 7.5×4.0 mm unexpanded, concave below the middle and narrowly linear above the middle with revolute margins and a swollen apex. *Lateral sepals* connate 7 mm into a bifid, oblong, concave lamina 3.4×7.0 mm unexpanded, the apical portion of each lateral sepal occupied by a thick, triangular, diverging, glabrous cushion 3.0×2.5 mm, continuous with the acute, oblique, diverging apex terminating in a decurved, yellowish-green, densely fimbriate tail, each lateral sepal 14 mm long including the tail. *Petals* orange suffused with red, solid red at the base, spotted with red towards the apex, rhomboid, acute, 2×2 mm, provided with a longitudinal callus medially, the labellar margins obtusely angled. *Lip* dark blood-red, pandurate, reflexed near the middle, 3.0×2.1 mm wide, the epichile rhomboid, fringed at the edge, the disc with a pair of tall, erect lamellae above the middle; the hypochile rectangular, slightly concave, the base truncate, minutely bilobulate. *Column* dark-purple at the base, fading whitish towards the apex, semi terete, slender, 2.7 mm long, slightly winged above the middle, with a thick foot 2.6 mm long. *Pollinia* 2, yellow. *Fruits* and *seeds* not observed.

EPONYMY: Named for the large, hairy spiders of which this orchid flower is reminiscent because of the spiky tails of the sepals and dark color.

DISTRIBUTION: *Scaphosepalum tarantula* is known from a few remaining forests near Las Tolas, not far from Quito, Ecuador, north-west of the city.

HABITAT AND ECOLOGY: The first plants of *S. tarantula* were seen growing in a cloud forest, not far from Las Tolas, about fifteen years ago and they still remain in the diminishing forests at the same location. It grows at an elevation of ~1800 m a.s.l. as an epiphyte and is sympatric with other orchids of subtribe Pleurothallidinae such as *Scaphosepalum ophidion* Luer, *Dracula felix* (Luer) Luer, *Dracula dodsonii* (Luer) Luer, *Dracula marsupialis* Luer & Hirtz, *Lepanthes kujitii* Luer & Hirtz and *Platystele microscopica* Luer. As with many other species in the genus, it grows in a very moist, low light environment, mainly directly in the trunk of big, remaining trees of the zone.

CONSERVATION STATUS: Even though a population of *S.*

tarantula is still growing in the same area where it was first spotted about fifteen years ago, this area is being cut down and about 80% of the original forest is now gone. Urgent actions are required to preserve this remaining forest since not only to protect this new species, but also *Dracula dodsonii*, a very rare species. Most of the plants of *D. dodsonii* grow in an embankment with few epiphytic plants growing nearby. Not far from where *S. tarantula* grows, some protected forest such as Bellavista, Mindo Nambillo or even Pahuma are being protected, nevertheless, in about ten years of searching for a new locality of *S. tarantula* by the authors, we were unsuccessful at finding it elsewhere.

Scaphosepalum tarantula is unique among the species of *Scaphosepalum* because of a particular combination of characters. The leaves suffused with red-brown to dark purple stains at the petioles, the slender, shortly spiked- apex of the central sepal, the rhomboid petals and the pandurate lip with a shovel-shaped epichile distinguishes it from any other species in the genus (Fig. 1–4). This species has been mistaken as a color variation of *S. fimbriatum* mainly because of the long densely fimbriated-spiked tails of the lateral sepals (Fig. 3–4). Nevertheless, the different shape of the lip and petals distinguishes both species. The rhomboid versus subquadrate petals and the pandurate lip with the epichile shovel-shaped versus the elliptical-subpandurate, trilobed lip, separates *S. tarantula* from *S. fimbriatum*. In *S. tarantula* some other features are different from any of the forms of *S. fimbriatum* including the slenderer peduncle and pedicels, the much slender, spiked apex of the dorsal sepal, and the tails of the lateral sepals more densely fimbriated and commonly projecting to the front instead of projecting to the sides of the flower which is seen frequently in *S. fimbriatum* (Figs. 1–4). Although *S. zieglerae* and *S. beluosum* also have fimbriated or speculated sepaline tails as well, the plants (to 35 and 25 cm respectively) and the flowers are larger than those of *S. tarantula*. *Scaphosepalum beluosum* have a pair of lobes near the middle of the lip that are not present in *S. tarantula*. The lip on *S. ziegleriae* has an obtuse epichile against the rhomboid epichile in *S. tarantula*. In *S. zieglerae* the flower bracts are conspicuous and larger than

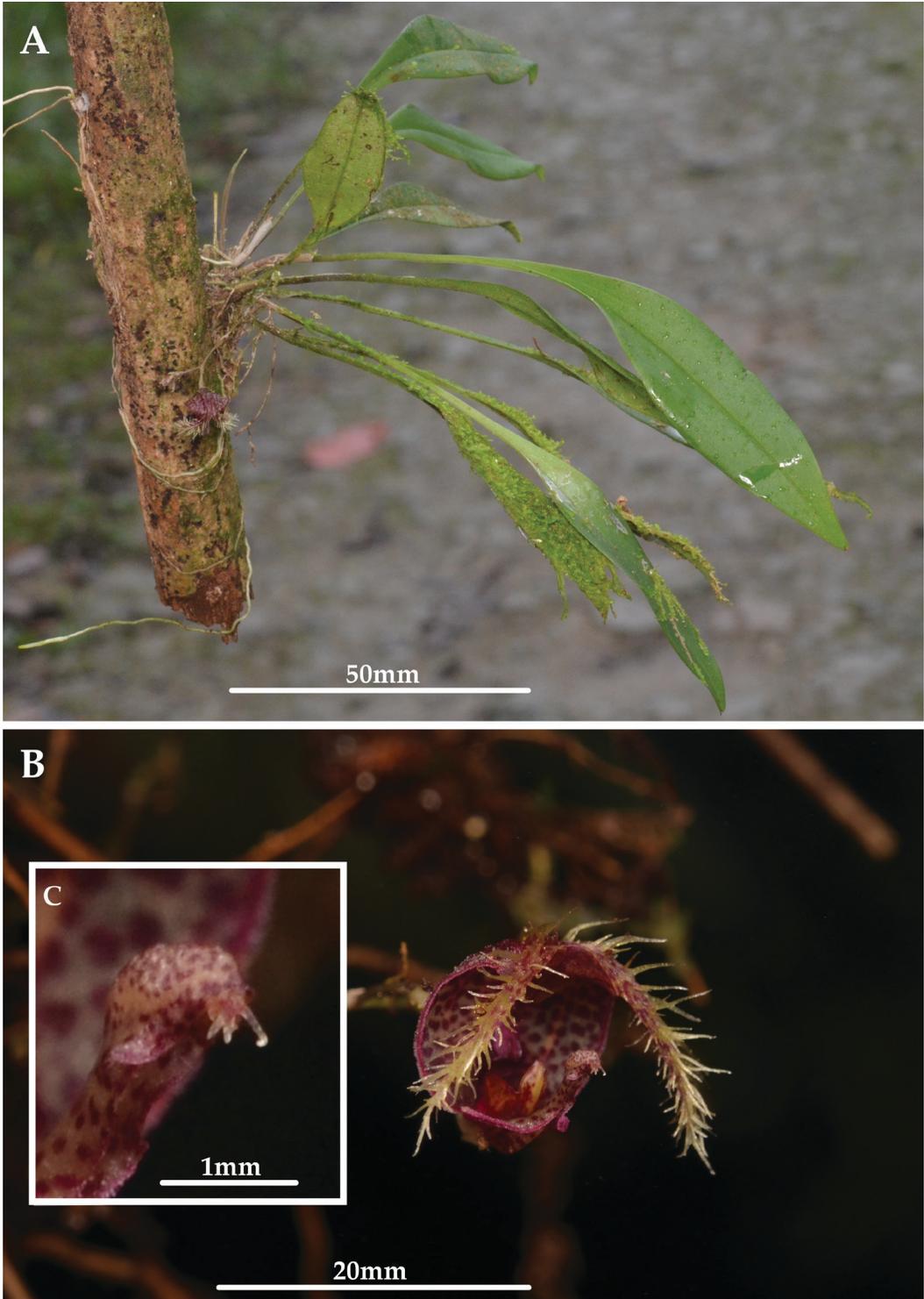


FIGURE 2. *Scaphosepalum tarantula* in situ. A. Plant and habit. B. Flower in situ. C. Close-up of the apiculate apex of the dorsal sepal. Photos by L. E. Baquero.

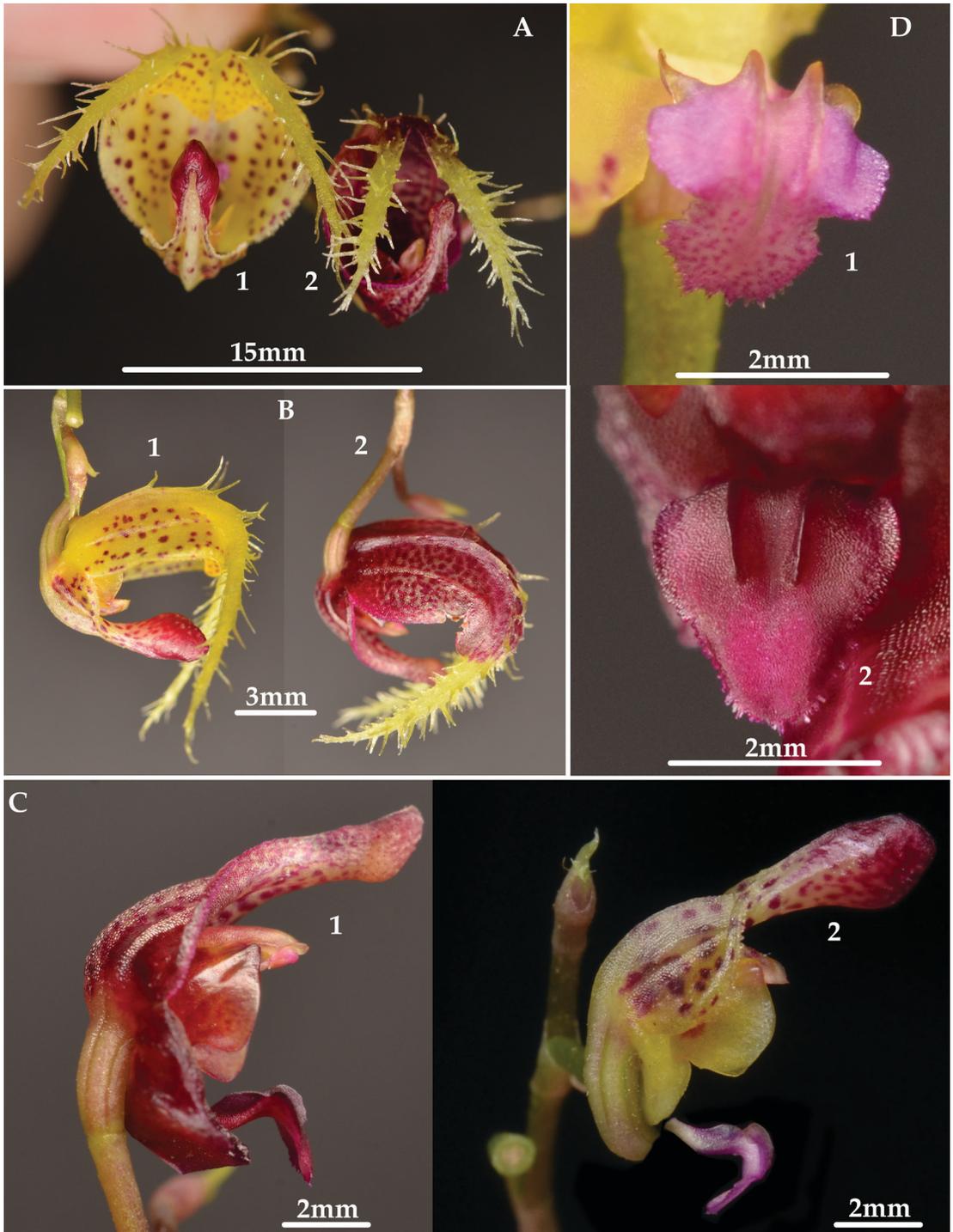


FIGURE 3. Comparison between *Scaphosepalum tarantula* and *S. fimbriatum*. A. Frontal view of the flowers: 1. *S. fimbriatum*, 2. *S. tarantula*. B. Lateral view of the flowers: 1. *S. fimbriatum*, 2. *S. tarantula*. C. Lateral view of dorsal sepals, column, petals and lip: 1. *S. tarantula*, 2. *S. fimbriatum*. D. Frontal view of the epichile of the lip: 1. *S. fimbriatum*, 2. *S. tarantula*. Photos by L. E. Baquero.

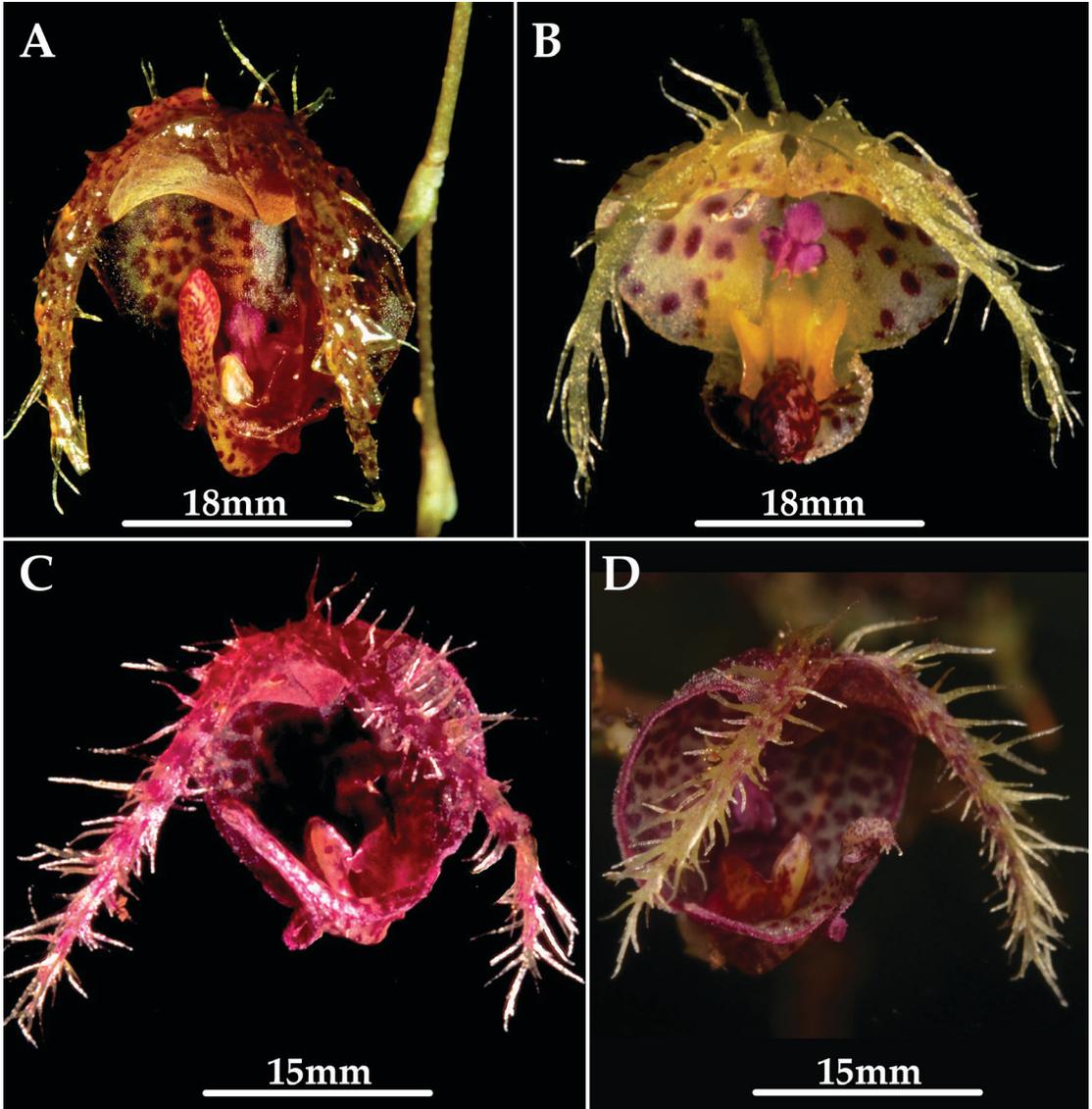


FIGURE 4. Comparison of the flowers of *Scaphosepalum fimbriatum* and *S. tarantula*. A. *S. fimbriatum* form from Esmeraldas province. B. *S. fimbriatum* form from Imbabura province. C–D. *S. tarantula*. Photos by A. Hirtz (A–C) and L. E. Baquero (D).

the pedicel, while in *S. tarantula* are shorter than the pedicel. *Scaphosepalum fimbriatum* was found growing in Imbabura and Esmeraldas provinces, north from where *S. tarantula* is found, in the province of Pichincha. The forms from Esmeraldas are darker in color than those from Imbabura, nevertheless, the color and shape of the lip, the petals, the dorsal tail and the rest of the morphology are the same in the two populations (Fig. 4).

ACKNOWLEDGEMENTS. The author acknowledges the Universidad de Las Americas (UDLA) for funding research on orchids in Ecuador. The Quito Botanical Garden is also acknowledged for cultivating *S. tarantula* and *S. fimbriatum* and making material available for the comparison of species. The Ministerio del Ambiente de Ecuador is acknowledged for issuing the Environmental Research Permit No. 008-2016-IC-FLO-DNB/MA.

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THE ORCHIDACEAE OF *PRIMITIAE FLORAE ESSEQUEBOENSIS* (1818)

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ABSTRACT. The German botanist and Professor at the University of Göttingen, Georg Friedrich Wilhelm Meyer (1782–1856), studied the plants collected in the Dutch colony of Essequibo by Ernst Carl Rodschied and those kept in the herbarium of Professor Franz Karl Mertens, which he had received from a Dutch colonist during the early 1800s. On that basis, he published in 1818 his work *Primitiae Florae Essequiboensis*, describing 344 species of plants. Among them there are five species of orchids, two of which were new to science.

KEY WORDS: Essequibo, Georg Friedrich Wilhelm Meyer, Guiana, Orchidaceae

Essequibo (or *Essequibo* in Dutch) was a Dutch colony on the northern coast of South America from 1616 to 1814 (Fig. 1). It was founded between the Essequibo River on the west and the Demerara River on the east, on the eastern border of the Spanish General Captaincy of Venezuela in the Guiana region. It formed a part of the settlements that are known under the collective name of Dutch Guiana. Essequibo's

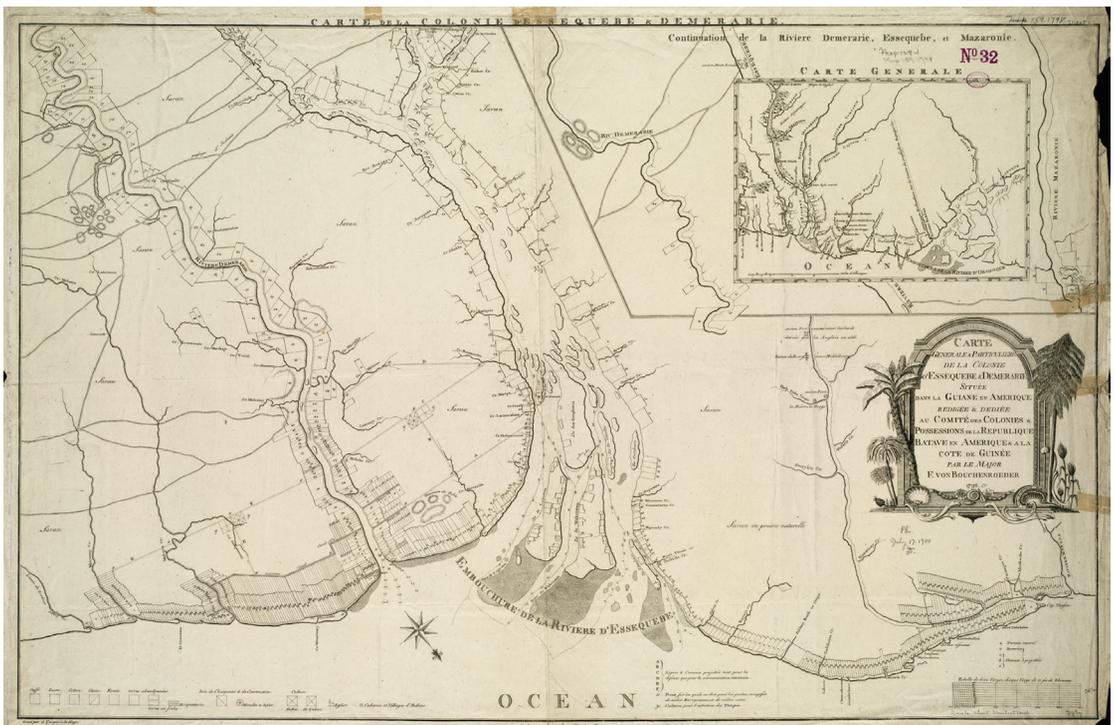


FIGURE 1. *Carte generale et particuliere de la colonie d'Essequibe & Demerarie située dans la Guiane en Amérique*. Brave & Wouter (1798).

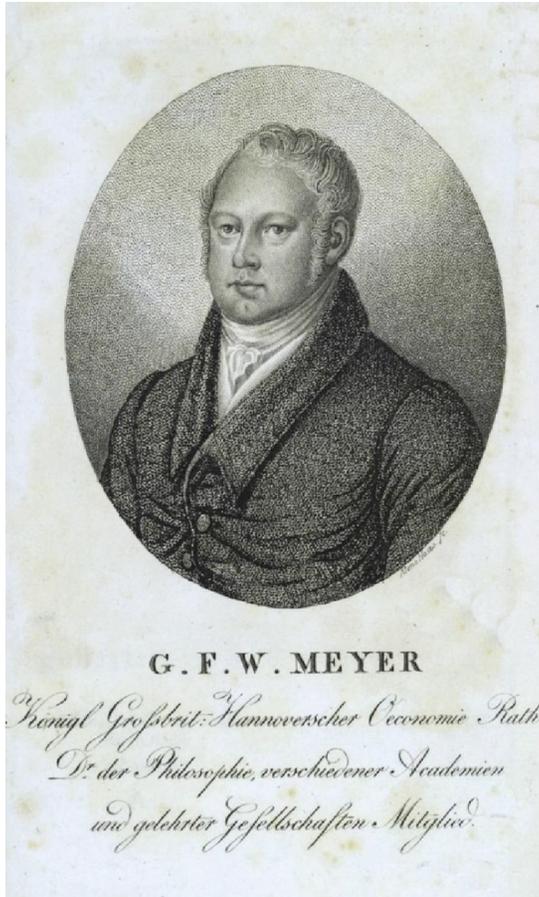


FIGURE 2. Georg Friedrich Wilhelm Meyer (1782–1856). Engraving by Meno Haas.

main town was the small city of Starbroek.

Essequibo and Demerara were captured by the British in 1781, then the colonies were occupied by the French until in 1783 the Peace of Paris restored the territories to the Dutch. The British occupied Essequibo again in 1796 and gave it back for a short time to the Netherlands as a consequence of the Peace of Amiens, from 1802 to 1803. After that it was again taken by the British during the Napoleonic wars. The British never left again and Essequibo became officially British territory in 1814 as part of the Treaty of London. Starbroek was renamed as Georgetown. The colonies of Essequibo and Demerara were merged into British Guiana.

Georg Friedrich Wilhelm Meyer (1782–1856) was a German botanist and Professor for Forestry at the University of Göttingen (Fig. 2). He had studied

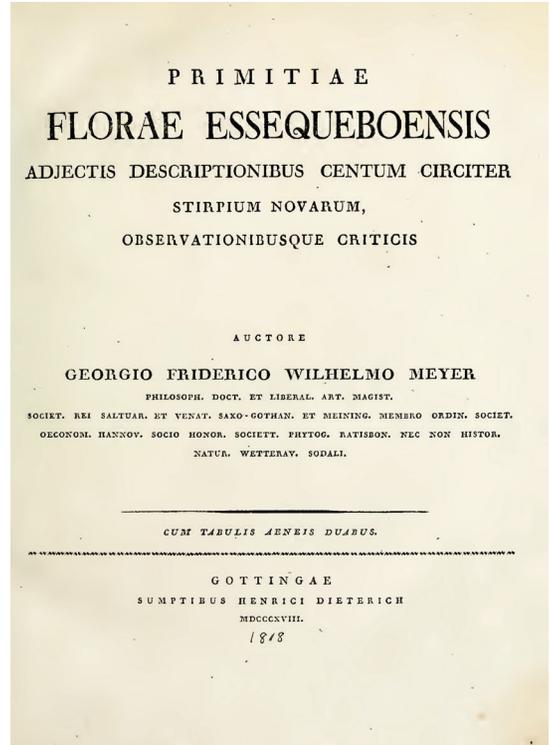


FIGURE 3. Title page of *Primitiae Florae Essequiboensis*.

Forestry and Natural History between 1801 and 1805 in Göttingen and Dillingen and came in 1813 under employ of the Prussian Government as Forestry Inspector and then Director of Forests in Paderborn, Corvey and Höxter. He continued his studies in Göttingen and received in 1818 his Ph.D.

It was at that time that Meyer became interested in tropical botany, especially after he had the opportunity to purchase the herbarium of Ernst Carl Rodschied (?–1796). Rodschied was a German physician and botanist who had emigrated to Essequibo in 1790 in the service of the Dutch West-India Company and had lived there until his death in 1796. Rodschied wrote several small works about climate, social circumstances, and health problems of the population of the colony, and made frequent botanical excursions along the rivers Demerara and Essequibo (Baldinger 1796).

Meyer was also fortunate to make the acquaintance of Professor Franz Karl Mertens (1764–1831), a botanist from the city of Bremen, who had a second collection of plants from Essequibo, which he

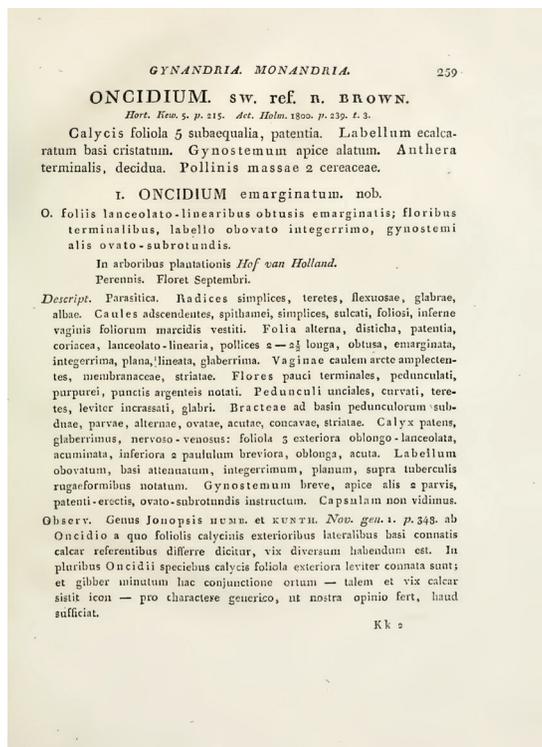


FIGURE 4. Protologue of *Oncidium emarginatum*, from *Primitiae Florae Essequeboensis*.

had received from a Dutch colonist during the early 1800s. These he gave to Meyer on loan.

Based on both Rodschied's and Mertens' collections, Meyer published in 1818 an important work, under the title *Primitiae Florae Essequeboensis adjectis descriptionibus centum circiter stirpium novarum, observationibusque criticis* (Fig. 3), in short words a precursor to a flora of the colony in which 344 species of plants were described, of which 118 turned out to be new to science (Anonymous 1819a, 1819b, 1820).

Five species of orchids are mentioned in Meyer's Flora, among them two that were new to science: *Cymbidium trinerve* G.Mey. [= *Cyrtopodium andersonii* (L.) Lindl.], *Oncidium emarginatum* G.Mey. [= *Dimerandra emarginata* (G.Mey) Hoehne], new to science (Fig. 4), *Epidendrum ciliare* L., *Epidendrum flexuosum* G.Mey, yet again a new orchid species, and *Vanilla aromatica* Sw. *Oncidium emarginatum* was collected by Rodschied on trees in the sugar plantation *Hof van Holland*.

The type specimen of *Oncidium emarginatum*

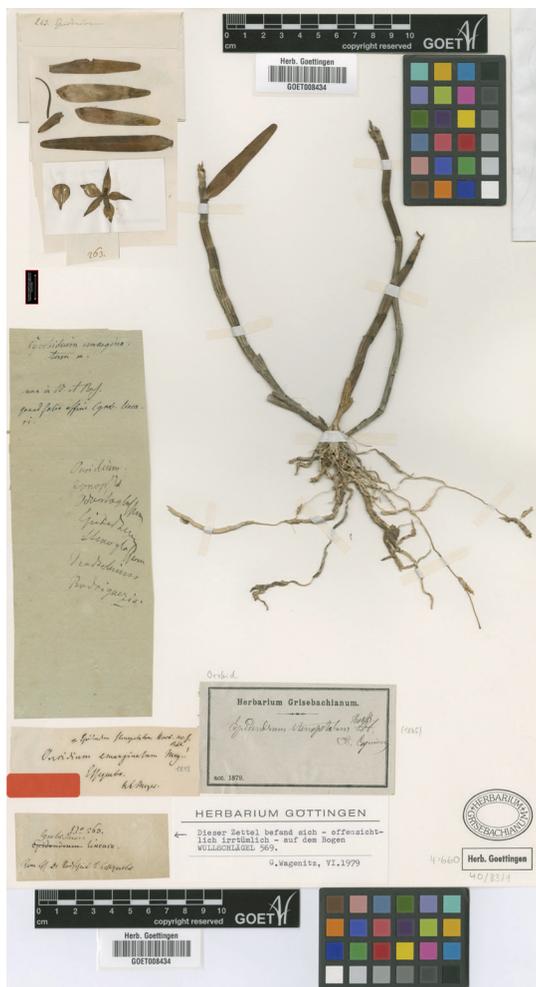


FIGURE 5. Type specimen of *Oncidium emarginatum* G.Mey. Herbarium of Göttingen University, Germany (GOET008434). Courtesy of the curator, Dr. Marc Appelhans.

together with a flower analysis by Leslie A. Garay can be found at the herbarium of the University of Göttingen, Germany (Fig. 5–6).

ACKNOWLEDGEMENTS. Special thanks to Dr. Marc Appelhans, Curator of the Herbarium of the University of Göttingen, for valuable copies of the type specimen of *Oncidium emarginatum*.

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FIGURE 6. *Oncidium emarginatum*. Flower analysis by Leslie A. Garay from the type specimen.

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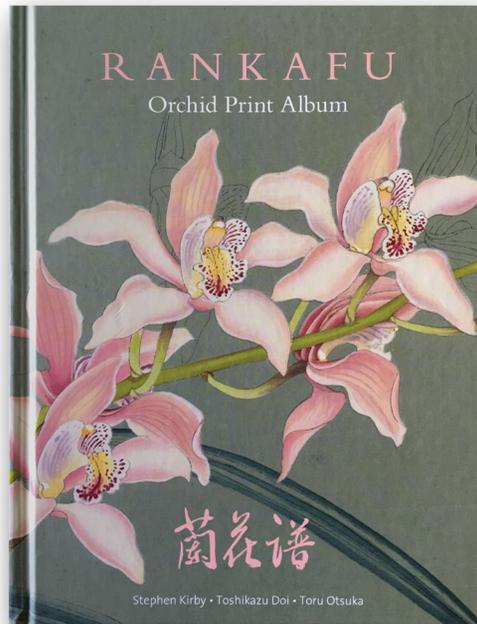
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BOOKS

Rankafu. Orchid Print Album, by Stephen Kirby, Toshikazu Doi & Toru Otsuka. Richmond, Surrey, UK, the Royal Botanic Gardens, Kew, 2018. Volume in octavo (19.5×25.3 cm), x, 289 pages, 250 illustrations in color, 31 black and white photographs. Hardbound. Special price at Kew Gardens, £25.00.



Rankafu is a remarkable book, which tells the story of a remarkable set of Japanese orchid woodblock prints from the early 20th century, and through them the story of three remarkable men.

Shotaro Kaga (1888–1954), the eldest son of a wealthy family, was a banker and a pioneer horticulturist, whose work and collection helped to start an orchid craze in Japan that continues to this day. He built what probably was the best Japanese nursery of its times, taking advantage of the direct experience he had acquired through the acquaintance with renowned collections like that of the Royal Botanic Gardens, Kew, and with famous British growers like Sander in St. Albans, who he visited in 1910 and from whom he would buy hundreds of plants over the next decades.

To ensure his plants were cultivated to their best, Kaga had them grown under the care of Kenkichi Goto (1895–1981), who had been in charge of the Imperial Nursery of the Shinjuku Garden as a specialist

orchid grower and had acquired direct experience on the natural life of orchids through collecting trips in the Philippines, Indonesia, Malaysia, Myanmar and India. In the greenhouses of Kaga's Oyamazaki Villa, where some ten thousand orchids were grown, he made more than 1,100 crosses and germinated hundreds of hybrids, some of which were portrayed for the Rankafu collection. He retired from his position shortly before Kaga's death in 1954.

Finally, Zuigetsu Ikeda (1877–1944) was hired in the early 1930's, and for the next twelve years he was the main artist at the Oyamazaki Villa, where he sketched and portrayed in watercolor thousands of plants. Of these, 83 found the way to be immortalized into the Rankafu woodblock prints. Another series of 60 water colors, intended for a second volume of the work, were never printed. Ikeda painted his last orchid from Kaga's collection in 1942.

Faced with the difficult choice about the best botanical art printing available at the time, "no

matter how expensive and costly” (Kaga 1946), Shotaro Kaga asked help from the authorities on art printing in Japan, but the results failed to fulfill his expectations. Then, Kaga directed his attention to an old Japanese printing technique, that of wood engraving. This technique had began in Japan in the mid XVIII century and reached its highest standards during the XIX century.

I guess that, until Kirby and his colleagues decided to publish their meticulous research on *Rankafu*, just a handful of westerners had any knowledge of traditional Japanese wood engraving. Their work was instrumental not only to disclose the refined beauty of *Rankafu* to a larger audience, but also to the organization of an exhibition of the same name, held since last October at the Shirley Sherwood Gallery of Botanical Art, Kew Gardens, which will run until March 2019.

Woodblock prints represent a spectacular art form, and a technical challenge but, as the used inks are water-based, it is particularly adapted to reproduce watercolour paintings. Highly specialized woodblock carvers transform the painting into prints, carving away the areas that are not to be printed on individual blocks of cherry tree (*Prunus serrulata*) for any of the colors of the painting, and leaving raised areas that may be as small as a fraction of a millimeter. Such fine details must then be perfectly aligned from one block to another. In the process, the original watercolor is usually lost, and no original *Rankafu* painting that corresponds to woodblock prints remains. The book is very instructive in describing the technique and the materials of woodblock printing in great detail.

Eventually, by the end of 1944, during the difficult years of the war, 83 sets of *Rankafu* were printed at two different workshops and by at least six famous printers. Apart from the printings prepared from Ikeda's watercolors, Kaga wanted to have printed in the *Rankafu* also a few black and white photographs taken by Toyo Okamoto, and nine conventional color print copies of colour oil paintings done by one of Kaga's classmates, Seitaro Nakamura. Also five conventional copies (not woodblocks) of Ikeda's painting are included into the prints collection. All these images are duly reproduced in the book together

with the core section of woodblock printings. The superbly printed book showcases in full color the set owned by the senior author. Particularly well featured are species and hybrids of the *Cattleya* alliance, *Cymbidium*, *Dendrobium*, and slipper orchids, plus a number of orchid species from different groups, which were among the preferred orchids by Shotaro Kaga. The quality of the prints, and the delicacy of the compositions prepared by Ikeda, are simply stunning.

In 1954, Shotaro Kaga died, and by 1958 the greenhouses were in disrepair. In 1967 Kaga's heirs sold the Oyamazaki Villa, and by the 1970s the greenhouses had been demolished. It was the end of an era. The villa was fortunately brought back to its splendor during the 1990s, when the Asahi Beer Corporation acquired it and expanded it into the Oyamazaki Museum of Art, an important regional museum.

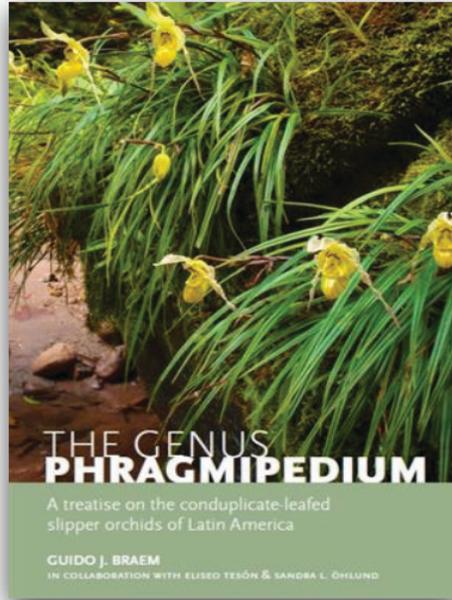
As to the woodblocks, a series of originals for twelve woodblock printings were discovered in 2003 in Kyoto, in the warehouse of the Muira Printing Company. A set was reprinted with traditional woodblock printing methods, and was sold in 2005.

Fortunately, the book by Kirby, Doi and Otsuka has now made available the complete set of these spectacular prints, which for their level of accuracy and artistic expression are justly considered masterworks of botanical art.

I just want to echo the words by Phil Cribb, who introduced the book, warmly recommending this extraordinary work on a single collection of orchid prints, not only as a great introduction to a less known and highly decorative form of art, but also to the history of early modern Japanese orchid culture and some of its greatest progenitors. It is an informative, varied, and really entertaining lecture.

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The Genus *Phragmipedium*. A treatise on the conduplicate-leafed slipper orchids of Latin America. by Guido J. Braem, Eliseo Tesón and Sandra L. Öhlund. Atlanta - Belgium, privately printed by the author, 2018. ISBN 978-3-00-056249-5. Volume in small octavo (17×23 cm), 305 pages, 208 figures. Hardcover with dust jacket. \$110.00.



If you are interested in slipper orchids, *The Genus Phragmipedium* is a must have. The richly illustrated and colorfully executed book by Braem and collaborators is an essential guide.

The book starts off with a short chapter on general considerations provided by the first author. This is followed by a very practical and detailed chapter on the cultivation of *Phragmipedium* species written by Eric Sauer. The main body of the book is composed of the treatment of individual taxa. Each is accompanied by a wealth of useful information from someone who clearly knows these plants first hand. Personal experience is transmitted throughout the book. Every accepted species includes a synonym list, type information, etymology, a discussion on history and a morphological description. Each of them is appropriately adorned with watercolors, photographs and plates. The rich illustrative material presented in the book includes photographs of the flowers of every species and also of varieties, subspecies and forms. How species are found in nature is well exemplified by the many plants that are photographed *in situ*.

Plates with floral details are provided for several species as well, allowing easy comparison among closely related taxa. A few “orchid people” are also featured, including Henry Oakley and Cassio van den Berg.

The book is full of short stories and side notes which make it very entertaining. An example is the story about the discovery of *Phragmipedium lindenii*. Three slightly different versions are provided, starting with that of Linden himself. The discoverer of this notable species is famously quoted to have encountered the orchid when escaping from a bear. His account reads “It was a bear that made me discover it, and this circumstance, coupled with my astonishment at the sight of this flower, hitherto unknown, with such a strange form, will always prevent me from forgetting such an encounter”. I will not further spoil the story and encourage the reader to procure their copy of the book. Historical information is provided for several species. Especially interesting are the extensive commentaries surrounding the controversial discoveries and introduction into cultivation of the

beautifully flowered *Phragmipedium bessae* and *Phragmipedium kovachii*.

The taxonomic treatment of each species is meticulously carried out. The reader is given all the elements that the authors use for each particular decision. They are extremely precise in arguing each detail in favor or against the recognition of taxa. Ample explanation of which morphological features are useful in species recognition is given throughout, this is extremely helpful to understand some of the lesser known names in the group. This objectivity is unfortunately lost when the taxa that have been described by the authors are involved. One example is the use of *P. popowii* Braem, Ohlund & Quéné over *P. humboldtii* (Warsz.) J.T. Atwood & Dressler. The discussion as to the correct name of this species, which has already been the subject of at least five articles in recent years, takes up several pages in this book. I am no expert on slipper orchids, nor on Germanic languages, but the code is clear. Article 46.2 explicitly states that a name can be ascribed to someone other than the author of an article it appears in. As Reichenbach filius clearly cites Warszewicz as author and provides a, albeit brief, description, the taxon is for all effects validly published regardless of Reichenbach's own opinion. Another is perhaps the interpretation of "good" species within the *Phragmipedium schlimii* complex. *Phragmipedium anguloi* and *P. fischerii*, both described by the senior author are accepted, whereas *P. manzurii* and *P.*

ramiroi, which are not, are regarded as synonyms. The arguments used to recognize these taxa are similar in each case, and not particularly strong.

Nevertheless, taxonomic interpretation is always up for debate and the book loses no merit for what is an understandable defense of the authors' own work. At the end it is far more important to document orchid diversity well and that is the biggest success of this magnificent compendium. Perhaps the only serious drawback of *The Genus Phragmipedium* are the recurrent personal attacks on fellow botanists that appear on several instances throughout the otherwise highly entertaining read. Rather than give the book, or any argument therein, additional strength, the unnecessary critiques become tiring. The book would be much better without them. Besides these minor details, Braem, Tesón and Öhlund present a wonderful treatment of the genus *Phragmipedium*. The book should be in the hands of every orchid enthusiast, especially those interested in slipper orchids. It should not be missed by anyone looking to know more about the historical details behind the controversial discovery and description of orchids with potential commercial value. The beauty, diversity and intrigue of *Phragmipedium* is uniquely represented in this outstanding work.

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