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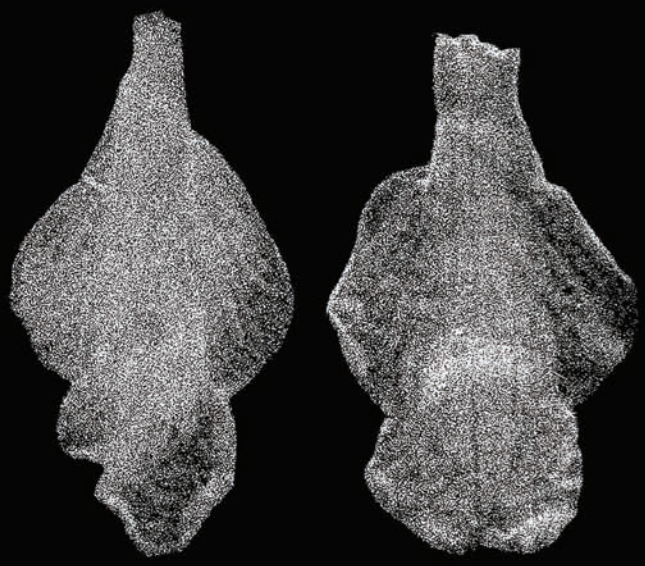

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A NEW ADDITION TO THE COSTA RICAN FLORA: *PALMORCHIS NITIDA* (ORCHIDACEAE: NEOTTIEAE) IS DOCUMENTED FROM THE OSA PENINSULA

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Abstract: *Palmorchis nitida*, previously known from seasonally wet forests of Panama, is reported from the Osa Peninsula in south-west Costa Rica. Notes and figures are provided regarding its natural history and phenology. The variable nature of this species is discussed on the basis of recently collected Costa Rican material.

Resumen: *Palmorchis nitida*, hasta ahora conocida solamente de bosques húmedos estacionales de Panamá, se reporta como una especie nueva para la flora de Costa Rica. Se presenta nueva información sobre su historia natural y se discute la naturaleza variable de esta especie con base a los nuevos especímenes colectados en Costa Rica.

Key word / Palabras clave: Orchidaceae, Neottieae, *Palmorchis, P. nitida*, Costa Rica, Osa Peninsula, Panama.

After years of botanical sampling of the species-rich forests of the Osa Peninsula, located in Costa Rica's south Pacific, one might assume that nothing new remained to be discovered. Just how wrong this is, can be clearly demonstrated by the fact that new registers and, indeed, new species, continue to issue from the region, including areas that have long served as choice collecting sites. One of the latest in a growing list of surprising plant discoveries to come out of the Osa Peninsula, is *Palmorchis nitida* Dressler (Orchidaceae: Neottieae).

Although a relatively small neotropical genus - 22 species are listed by the International Plant Names Index - as Dressler (1983, 1984) explains, spotting the genus in its natural environment and, subsequently, distinguishing between species, can be anything but a straightforward task, as plants look enough like palm seedlings or broad-leaved forest grasses that they are easily overlooked when not in flower. With the exception of *P. powellii*, which displays a much larger growth habit than that of any other species present in either Costa Rica or Panama, (reaching up to 1m or more), members of this genus are similar both in habit and vegetative appearance. Even in the case of *P. nitida,* where the specific epithet refers to the brilliance of the leaves, older leaves can appear dull due to the presence of small mosses growing on their upper surface. Thus, we depend on the presence of flowers to make anything more than a generic determination. But, as plants in a population all flower on the same day, and flowers last only a few hours, one needs to monitor plants over an extended time period in order to find flowers.

Dressler was surprised to discover that plants growing by a well-used trail on Panama's Barro Colorado Island that he had taken to be *P. powellii* were a distinctive new species, *P. nitida* (Dressler 1983, 1984). We were equally surprised to discover that plants we had taken to be *P. silvicola* L.O.Williams (1970) were *P. nitida*, a species from Panama.

We first observed plants on the Osa Peninsula in Costa Rica in November 2004, growing in secondary forest on the slopes of the property Los Charcos de Osa. However, it was not until July 2006, that we were lucky enough to finally observe, and photograph, the

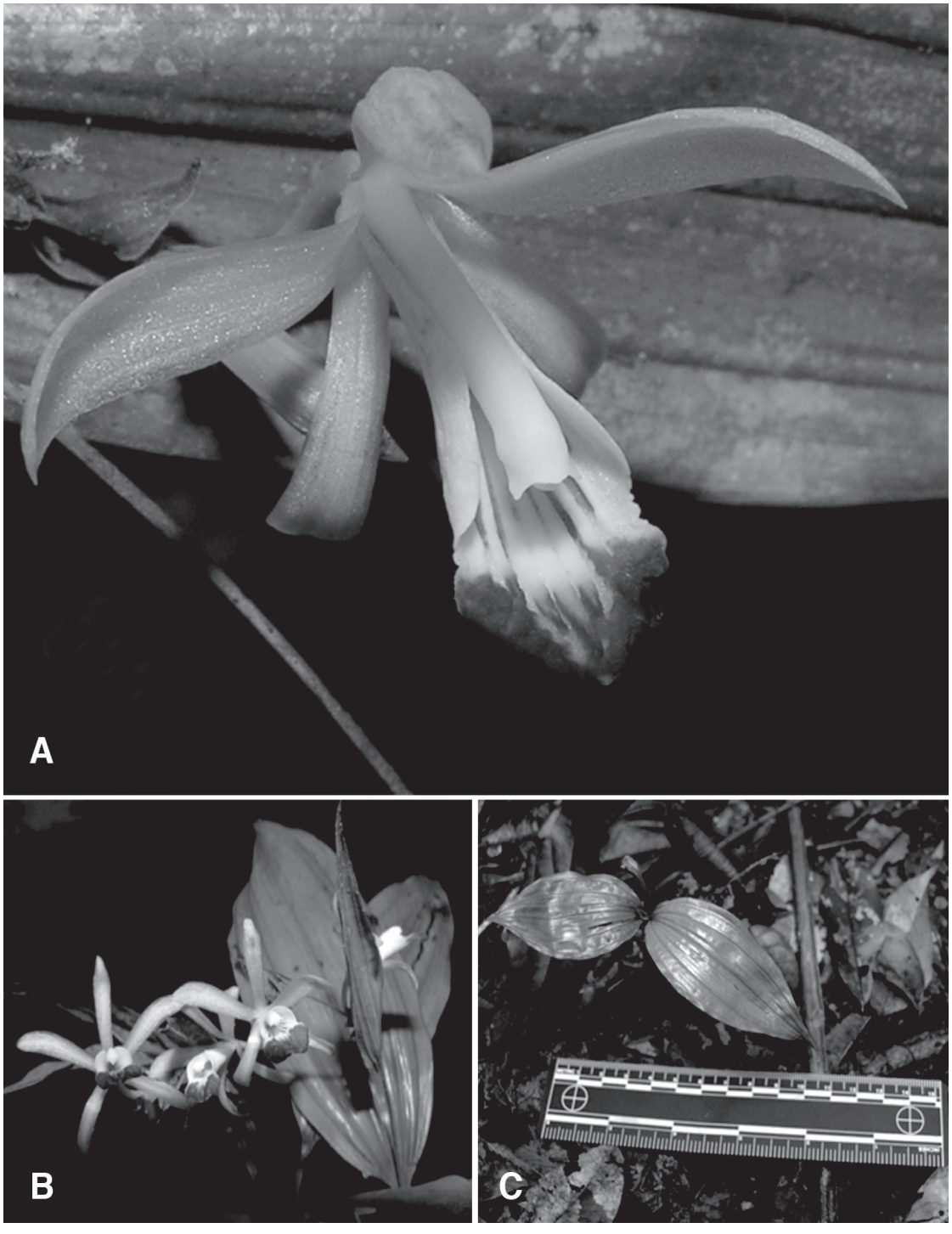

FIGURE 1. A – A single flower of *P. nitida.* B – Less commonly *P. nitida* produces several flowers simultaneously from more than one inflorescence. C – A juvenille plant amongst the leaf litter. Photographs by Reinaldo Aguilar, 2006.

flowers of this species (Fig. 1). We then noted that our plants conformed with the description of *P. nitida* as presented in Dressler's (1993) dichotomous key and with an incomplete description from the Manual de Plantas de Costa Rica (Dressler, 2004) documented as *Palmorchis* Sp. B., which cites a collection made by Mike Grayum (*Grayum et al. 4027*, MO), as early as 1984. Probably, *P. nitida* is the "undescribed species in the south Pacific lowlands of Costa Rica" that Dressler (1997) referred to a decade ago.

The apparent leap in geographical distribution - from eastern Panama to the relatively isolated south west coast of Costa Rica – is perhaps an indication that *P. nitida* will prove to have a more continuous distribution through central Panama and northwards along the Pacific slopes. Dressler (1983, 1984) faced a similar geographical disjunct when considering the possible existance of *P. silvicola* – originally described from the Osa Peninsula - in central Panama. We anticipate that many more principally Panamanian species are likely to show up on the Osa Peninsula in the future.

We report here the first record of *P. nitida* for the flora of Costa Rica on the basis of the following voucher:

Costa Rica. Puntarenas: Osa Peninsula, Canton de Osa, District of Sierpe, Finca Los Charcos de Osa, 1km before the village of Banegas. 08º40'18"N83º30'17"W, 30 Nov 2006, *C. V. Bainbridge 263* (USJ).

On the basis of fresh material from Costa Rica, we have observed that the species can be variable. The more typical form we have observed being compact plants, of up to 30 cm tall. Less commonly encountered, is the larger to more elongate form, superficially more related to *P. trilobulata* (i.e., as can be seen in *A. Chacón 931*, INB), with a terminal leaf lamina of 25 x 8 cm and floral bracts which are well-spaced along the rachis (Fig. 2).

Prior to collection, two plants of *P. nitida* were monitored by us over a six month period and we recorded flowers opening on the following dates:

- *Bainbridge 263,* **Example A**: 23 Jul 2006, 13 Aug 2006, 27 Aug 2006, 17 Sept 2006, 20 Oct 2006, 18 Nov 2006.

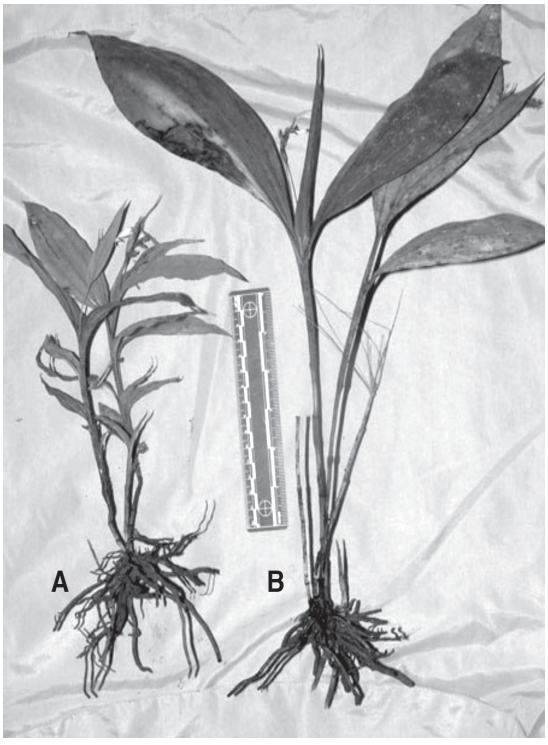

Figure 2. Variability in vegetative form in Costa Rican plants of *P. nitida.* A – The more common and compact form, similar to that of *P. silvicola.* B – The less common more elongated form, similar to that of *P. trilobulata*. Photograph by Reinaldo Aguilar. 2006.

- *Bainbridge 263*, **Example B**: 29 Jul. 2006, 7 Sept 2006, 21 Oct 2006, 29 Oct 2006, 21 Nov 2006.

Herbarium records show that flowers were produced in October (*Grayum et al. 4027*, MO) and in July (*A. Chacón 931*, INB) and buds were also recorded as present in wild individuals at Los Charcos on 27 Dec. 2006, 15 Feb. 2007, 15 Apr. 2007, and 15 May 2007. This information suggests that the species may have an extensive flowering period. A single mature fruit was collected on 20 Oct 2006. Cited material has been preserved in an alcohol and glycerine mixture.

The following presents a brief list of associated plants encountered in the habitat of *P. nitida* on the Osa Peninsula: *Cyclanthus bipartitus* (Cyclanthaceae), *Cryosophila guagara*, *Asterogyne martiana* (Arecaceae), *Heliconia irrasa, H. latispatha. H. imbricata* (Heliconiaceae), *Costus stenophyllus* (Costaceae),

Psychotria acuminata, P. elata (Rubiaceae), *Calathea crotalifera* (Marantaceae), *Miconia nervosa, M. osaensis* (Melastomataceae), *Sarcoglottis hunteriana, Stenorrynchos lanceolatum, Oeceoclades maculata* (Orchidaceae), *Bauhinia bahiachalensis, B. guianensis, Peltogyne purpurea* (Caesalpinaceae), *Williamodendron glaucophyllum* (Lauraceae), *Couratari scott-mori, C. guanensis* (Lecythidaceae), *Newtonia suaveolens, Acacia alleni* (Mimosaceae), *Coccoloba standleyana* (Polygonaceae), *Sloanea sulcata* (Elaeocarpaceae) and *Chaunochiton kappleri* (Olacaceae).

Acknowledgments: Our thanks to Jorge Lobo, Luis Diego Goméz, Franco Pupulin and Robert L. Dressler for their valuable comments during the preparation of this manuscript.

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AN ASIAN ORCHID, *EULOPHIA GRAMINEA* (ORCHIDACEAE: CYMBIDIEAE), NATURALIZES IN FLORIDA

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ABSTRACT. *Eulophia graminea*, a terrestrial orchid native to Asia, has naturalized in southern Florida. Orchids naturalize less often than other flowering plants or ferns, but *E. graminea* has also recently become naturalized in Australia. Plants were found growing in five neighborhoods in Miami-Dade County, spanning 35 km from the most northern to the most southern site, and growing only in woodchip mulch at four of the sites. Plants at four sites bore flowers, and fruit were observed at two sites. Hand pollination treatments determined that the flowers are self compatible but fewer fruit were set in selfed flowers (4/10) than in out-crossed flowers (10/10). No fruit set occurred in plants isolated from pollinators, indicating that *E. graminea* is not autogamous. Pollinia removal was not detected at one site, but was 24.3 % at the other site evaluated for reproductive success. A total of 26 and 92 fruit were found at these two sites, where an average of 6.5 and 3.4 fruit were produced per plant. These fruits ripened and dehisced rapidly; some dehiscing while their inflorescences still bore open flowers. Fruit set averaged 9.2 and 4.5 % at the two sites. No floral visitors were seen during limited (6.5 hr duration) timed watches of flowers. Individual flowers are open an average 11 days, and the inflorescences may bear flowers for at least one month. How *E. graminea* entered Florida is unknown, but capsules, bulbs and plantlets in flasks are available for sale and/or trade via the internet from Thailand and other places outside the U.S. The occurrence of the orchid at 900-1000 m elevation its native Sikkim (27-28°N) and in Kashmir (above 32°N), suggest that it can live well north of current area of naturalization in southern Florida, which is at sea level and 26°N latitude.

KEY WORDS: breeding system, *Eulophia*, orchid, mulch, naturalization, pollination

A terrestrial orchid, *Eulophia graminea* Lindl., native to subtropical and tropical Asia, has been detected in Miami-Dade County in southeastern Florida (Fig. 1-2). Its occurrence is noteworthy because relatively few orchids naturalize.

In the native region, *Eulophia graminea* occurs widely, from South Asia and Southeast Asia to eastern Asia to subtropical islands in the western Pacific. More specifically, it has been reported from Pakistan (Singapur), Kashmir, eastwards to Burma, Thailand, Malaysia, also Sri Lanka, Nikobar Isl., Philippines, Taiwan (Renz 1984). It also occurs in Singapore (Keng et al. 1989), the Himalayas (Nepal and Sikkim) from 900-l000 m (Singh 2001), Laos and Indonesia (GRIN 2008), China (Guangdong, Guangxi, Guizhou, Hainan, Yunnan; and Hong Kong) (http://mobot.mobot.org/W3T/Search/FOC/projsfoc.html), the Ryuku Islands (Japan) (Garay & Sweet 1974) and Guam (GRIN 2008).

Within its native range *Eulophia graminea* occurs in diverse habitats. In Singapore it is reported to be common on wasteland, sandy beaches, lawns, roadsides and other exposed areas (Keng et al. 1998), as well as open areas in secondary forests and parks (Tan 1993). In Taiwan, the orchid grows among shrubs in lowlands, on beaches, coastal grassland (Su 2000). In the Ryukus, it is uncommon in mountains and open low areas (Garay and Sweet 1974). The species is threatened in Sri Lanka (http://www.environmentlanka.com/biodiv/iucn_plant_list.htm).

Eulophia graminea was discovered to be naturalized in Australia in the Northern Territories in 2001 (http://www.daff.gov.au/animal-plant-health/pests-diseases-weeds/weeds/incursion). In the

Northern Territories the orchid is found in and around Darwin growing in woodchip mulched garden beds (Macrae 2002), and also "found pushing its way through bitumen and concrete" (Hussey & Lloyd 2002). It has also recently reported from Queensland, Australia (Pier 2008).

This study was undertaken to define and better understand the orchid's occurrence, its reproduction, potential to persist and spread in Florida and beyond.

Methods

Identification - The identity of *Eulophia graminea* was confirmed with technical descriptions in Flora of Taiwan (Editorial Committee of the Flora of Taiwan, 1993, Flora of Pakistan (Renz 1984), and Flora of the Ryuku Islands (Garay & Sweet 1974), and by Surangraj Indhamusika, of the Queen Sirikit Botanical Garden in Chiang Mai Thailand. To distinguish this orchid from related Florida orchids, published accounts of the morphological characteristics of *Eulophia graminea* and those orchids were compared. Herbarium specimens (*Pemberton 07-01, 07-02, 08-01, 08-02, 08-03*) have been placed in the herbaria of Fairchild Tropical Garden (FTG) in Coral Gables, the Florida Museum of Natural History (FLAS) in Gainesville, and the University of South Florida (USF) in Tampa.

Occurrence - After the orchid was first discovered in a residential garden in South Miami, its occurrence was determined by surveying the neighborhood to find plants and counting and describing the encountered plants. We interviewed people associated with yards where the plants were found to learn when the plants were first observed, and what other information they might have, pertaining to the possible origin of the orchids. We surveyed parks and mulched sites within a mile of the South Miami discovery site for additional plants. Interviews and discussions with colleagues led to the discovery of four additional sites with the orchid. Sites in western Kendall, Little River Miami, and North Miami were surveyed to confirm the occurrence and circumstance. Information about the eastern Kendall occurrence, including photographs of the plant and site, was provided by the reporting botanist Steve Woodmansee.

Breeding System and Pollination - *Eulophia graminea* plants and flowers were observed and manipulated to gain insights into the orchid's breeding system and pollination ecology. We examined flowers to detect rewards and inflorescences to discern odors. To assess male and female reproductive success, we measured fruit formation and pollinia removal in the South Miami and Little River Miami populations where multiple reproductive plants occurred. Pollinia removal was scored during single visits in October and November, 2007 in the South Miami population, and during one visit during April 2008 to the Little River Miami population. Fruit set in South Miami plants was determined by counting the number of fruit or fruit remnants, and the number of persistent bracts that subtended the flowers on old inflorescences on three plants during March, 2008, after the plants had flowered. Fruit set in the Little River Miami plants was determined by counting the number of fruit or fruit remnants, and the number of persistent bracts that subtended old or fallen flowers on 27 plants during April, 2008, near the end of flowering period for most of plants. Timed watches were made during October, November 2007, January and April 2008 to observe flower visitors. Flowers at the South Miami site were hand pollinated with self pollinia and crossed using pollinia from flowers of other plants at the same site and date to determine whether the plant is self compatible, and to compare self and outcross fruit set. Potted plants raised from bulbs dug at the South Miami site were placed inside a screen enclosure when their inflorescences appeared to determine the ability of the flowers to set fruit without pollinators, which would indicate either autogamous self pollination or apomixis. Selected flowers on these inflorescences were tagged as soon as they opened and followed until wilting to determine their longevity. Potted flowering plants were exposed in Ft. Lauderdale and Homestead gardens to increase observations of potential pollinators and to access the *Eulophia graminea*'s ability to set fruit at other locations other than the South Miami and Little River Miami naturalization sites.

Possible Routes of Introduction - Internet searches were made to find evidence of the plant's cultivation, presence in commerce, or other human aided movement. The importation of commodities or other

FIGURE 1. *Eulophia graminea* flowers (*ca.* 2.5 cm wide). Note the nearly horizontal position of the lateral sepals and the nectar spur.

FIGURE 2. Whole flowering plant of the naturalized *Eulophia graminea* growing in woodchip mulch in South Miami, Florida. Note the capsules.

bulk materials that may have carried propagules (bulbs and/or seed) of the orchid from the native region to the U.S. was investigated by examining U.S. Department of Agriculture importation data posted on the Foreign Agriculture Service website.

Results

Description and distinguishing characteristics – Plants terrestrial and autotrophic. Pseudobulbs ovoid with 4-5 concentric internodes, initially covered with many ovate scales, to 10 cm wide but usually 2.5-5.0 cm wide, occurring singly or in clusters, usually partly above the ground (Fig. 3). Leaves 2-5, grass-like, suberect. Flowers in or out of leaf. Inflorescences 30 to 150 cm tall bearing up to 60 flowers (Fig. 2). Flowers typically 2.5 cm wide (Fig. 1), with sepals and petals dull green with brownish purple netted veins; sepals spreading with lateral sepals held slightly above horizontal; petals pointing forward above the column; lip three lobed with two short lateral lobes green with purple striping and rolled inward to the column to form a short tube, median lobe white marked with rose-pink, elongate extending forward and downward, wavy-crisped along margin, and turning into white and rose papillae; spur at base of lip long, dilated at tip; Fruit a capsule ca. 3 cm long by 0.8 cm wide when fully grown (Fig. 4).

Only one other *Eulophia* species, the native *E. alta* (L.) Fawc. & Rendle, occurs in Florida and the United States (Romero-González 2007). Luer (1972) included *Eulophia ecristata* (Fernald) Ames in "The Native orchids of Florida", but this species is now *Pteroglossaspis ecristata* (Fernald) Rolfe. These three orchids are readily separated by the symmetry of both the inflorescences and the individual flowers, as well as flower color. *Pteroglossaspis ecristata* flowers are borne on a raceme and have yellow green petals and sepals converging over the brown purple lip. *Eulophia alta* flowers are in racemes and are green to purplish (but color can be quite variable), with lateral sepals held erect and spreading at 45 degree angles. *E. graminea* has green flowers with white lips marked with rose borne on racemes or panicles, with the lateral sepals spread widely and held almost horizontally. *Eulophia graminea* flowers are also smaller than those of *E. alta* (1.4 to 2.6 cm vs. 3.5 to 4.5 cm wide). Although the plants of all three species can be a meter or more in

FIGURE 3. *Eulophia graminea* plants pulled from a mulch bed. Note the distinctive nodes on the large primary pseudobulbs (*ca.* 3.5 cm in diameter), the uppermost nodes with paper sheaths, and the proliferation of small pseudobulbs from the bottom and side of the primary pseudobulbs.

FIGURE 4. Fruit of *Eulophia graminea*. The capsules (*ca.* 3 cm long x 0.8 cm wide) ripen and dehisce quickly, allowing the spread of seed while plant is still in flower.

height, *E. graminea* is more slender and has narrower leaves (1-1.5 cm vs. up to 10 cm wide in *E. alta* and 3.5 cm in *P. ecristata*) than the other two species.

Occurrence in Florida - *Eulophia graminea* plants were found in small numbers in five different areas of Miami-Dade County in southeastern Florida. The discovery occurred when three flowering plants of an unknown orchid growing in the yard of a neighbor were brought to one of us (SK) during September 2007. We investigated this South Miami yard on October 5 and found 17 bulbs of the orchid growing in woodchip mulch beneath shrubs and small trees. The property owner first observed a large flowering plant in the yard "a year or more earlier." He first observed a single large plant that flowered and produced fruit. Subsequently, he noticed many bulbs of the orchid, prompting him to remove "several dozen." He was alarmed at the proliferation of the plants and suspected that species could be invasive. Our survey of this South Miami neighborhood located bulbs in three other yards within the same block as the reporting neighbor. In the second yard with the orchid, a single bulb was growing in mulch beneath an avocado tree. The third yard had one plant with three bulbs in mulch beneath a coconut and two other plants in a mulched, partially shaded, flower bed. The fourth yard had four large flowering plants and two other plants with two large non-flowering bulbs. All were growing in mulch in partial shade of palms and other trees, except for one flowering plant in an open mulched bed. The four flowering plants bore tall (0.7 to 1. 5 m.), slender inflorescences in various stages of flowering and fruiting. On these four plants, the number of inflorescences, open flowers and fruits were as follows: 1) 4 inflorescences, 15 flowers, 8 fruits; 2) 10 inflorescences, 82 flowers, 18 fruit; 3) 1 inflorescence, 15 flowers, no fruit; 4) 1 inflorescence, 15 flowers, no fruit; and an average of 6.5 fruit per plant. This homeowner with the flowering plants was influenced by the reporting neighbor to pull and dispose of bulbs in the garbage, but decided to leave some flowering individuals. He also obtained mulch from the reporting neighbor, which could have contained bulbs or seed of the orchid. Pseudobulb size ranged from 1 to 10

cm; we also observed extensive vegetative production of small bulbs beneath, or adjacent to, the primary pseudobulbs. The large pseudobulb of one plant, which grew partly beneath a heavy concrete stepping stone, lifted the stone ca. 5 cm above the mulch, as it grew and expanded. Some large inflorescences had unopened buds on their upper portions and ripe dehiscing fruit on the lower sections. Surveys of parks and mulched areas within approximately one mile of this South Miami occurrence failed to locate additional plants.

The second occurrence of *E. graminea* was in a residential neighborhood in west Kendall, ca**.** 8.5 km southwest of the South Miami population. The brother of the homeowner (with flowering plants at the South Miami site) has a landscape maintenance business, and suggested that we check the yard of a client because he thought that the orchid might occur there. A single tight cluster of pseudobulbs was found in a mulched bed at the house. A survey of this neighborhood resulted in an additional large pseudobulb with leaves growing in mulch in a yard about two blocks to the west of the first house.

The third occurrence of *E. graminea* was reported to us by a botanist colleague Steve Woodmansee, who found a plant growing in mulch in his yard in eastern Kendall. This site is ca. 2.4 km west of the South Miami population, and between the South Miami population and the west Kendall occurrence. He first observed the plant in 2006. No flowers were observed until an inflorescence appeared in December, 2007. Flowers opened in mid January, 2008 on a single inflorescence, 0.38 m tall, and borne on a bulb 4 cm wide. About 30 flowers were produced but no fruits formed on the plant.

The fourth occurrence of *E. graminea* was reported to us by orchid grower Donald Wallstedt, who discovered a population of the orchid growing in the Little River area of Miami. This site is 19.4 km north of the South Miami population and 31.1 km north of the southern most site in western Kendall. Wallstedt first observed the plants during March 2008. The plants were found growing on adjacent vacant lots amidst grass and *Bidens pilosa* L. on shallow sandy limestone soil scattered with concrete, tile and other debris. The orchids occurred mostly in the open partly sunny central area of the two lots, where houses stood before being torn down during the summer of 2005 (Donald Wilson, pers. comm.). Because the site is due to be developed, Wallstedt removed 40 of the largest flowering plants to save them, planting most in his nearby garden and giving others away. Fifteen of the transplanted plants in pots in his garden had exposed pseudobulbs, and these averaged 5.2 cm (sd. = 1.8) in diameter. One unusually large plant had a mass of pseudobulbs 35 cm long by 11.3 cm wide, and bore 12 inflorescences. During a survey of the Little River Miami naturalization site on April 5, 2008, 29 additional plants including 27 reproductive (flowering and/or fruiting) plants were found. These plants had a mean of 1.26 (sd. = 0.447) inflorescences ranging from 0.3-0.9 m tall with a mean height of 0.45 m (sd. = 0.141). Twenty one plants had a total of 103 open flowers and a mean of 5.38 (sd.= 3.38) flowers per plant. Twenty seven reproductive plants had a total of 92 fruit on 23 different plants, ranging from 0-9 fruit, and an average of 3.41 (sd. = 2.63) fruit per plant.

The fifth and last site where *Eulophia graminea* was detected is in North Miami, which is north of the Little River Miami site, and 24.3 km north of the South Miami site and 34.9 km north of the western Kendall site. Ronald Pereira found the plant and directed us to the site where we found a single plant growing in woodchip mulch in a Publix supermarket parking lot island. The inflorescence of the plant was 0.3 m tall and bore three old and three fresh flowers but no fruit.

Breeding system and pollination - *Eulophia graminea* flowers have a nectar spur containing nectar. We found the nectar to have >2% glucose as indicated by Diastix R (Bayer) glucose test strips used on three flowers. No fragrance could be detected in single flowers, but we were able to detect fragrance from inflorescences bearing many flowers during the morning. Flower longevity (determined with 15 flowers on two potted plants held inside a screen enclosure to exclude potential pollinators, and tagged the first day they opened and followed until they wilted) was 5-16 days, with a mean longevity of 10.9 (sd.= 3.4) days. None of these tagged 15 flowers, or the other ca. 15 untagged flowers on these potted plants in the enclosure, set fruit, indicating the orchid is probably not autogamous. Hand pollination treatments with self pollinia resulted in fruit formation in 4/10 flowers, indicating a degree of self-compatibility. All 10 flowers hand pollinated with out-cross pollinia set fruit.

Flowers on the two flowering plants scored at the South Miami site for pollinia removal on Oct. 14 had no pollinia missing (0/15 and 0/82). Two flowers had pollinia partly out of the anthers, and one of these almost touched the stigma. The three flowering plants examined for pollinia removal on Nov. 10 had no missing pollinia in a total of 28 flowers (0/4, 0/11, 0/13). Dissections of 20 wilted flowers from the site found two pollinia on the stigmatic surface and pollinia of many other flowers hanging from below the anther cap. One hundred thirteen flowers evaluated on 21 plants at the Little River Miami site on April 5, 2008, had an average pollinia removal of 24.3 % (sd. = 25.6). Three potted plants with 86 flowers exposed in a garden in Ft. Lauderdale failed to produce fruit, but two fruits were produced on a potted plant exposed in a garden in Homestead that had ca. 15 flowers. The percent fruit set of the flowers on the 13 inflorescences on the three plants growing at the South Miami site was: 4.9 % (4 fruit/81 flowers), 2.3% (3 fruit/133 flowers), and 6.0% (4 fruit/65 flowers), and a mean of 4.45% (sd. = 1.99). The mean fruit set for 27 reproductive plants growing at the Little River Miami site was 9.18 % (sd. = 7.14) per plant.

Aside from ants (*Brachymyrmex obscurior* Forel), encountered in some flowers at the South Miami site, no flower visitors were observed during limited timed watches (in periods between 8:45am and 4:20pm on Oct. 14, Nov. 4 and Nov. 10, 2007, Feb. 2, and April 5, 2008) totaling 390 minutes on 188 flowers on 12 plants.

Possible Introduction Routes - The means by which the orchid entered Florida and the U.S. is unknown. Although the flowers are not showy compared to most cultivated orchids, there is some cultivation of *Eulophia graminea* and commerce in the plants. Directions for its cultivation in Singapore are given by Tan and Sin (1993), but with the comment that the orchid is not very attractive. Several current postings on eBay (Feb.-March 2008) offered plants for sale. A Thai orchid grower (Kasorn Orchids in Bangkok) offered flasks containing 30-40 plantlets for $12/flask. Another Thai grower (LONUN~Thailand in Bankok) listed packets of five *E. graminea* bulbs for $8, and someone in Scotland offered bulbs for sale. There was a website posting on the Terrestrial Orchid forum from a man in Germany requesting advice for the cultivation of *E. graminea* bulbs that he acquired from Thailand. A garden website had a posting from someone in Singapore (part of the native range), offering to trade an *E. graminea* capsule (www. Gardenbanter.co.uk). Also of interest, because of the orchid's naturalization in Australia, was the selling of the *E. graminea* by the Australian eBay Australian store, by another Thai seller (Thai Tropicals), which currently offers 10 bulbs for ca. 2.14 Australian dollars.

Another possible introduction route could have been the importation of bulk raw materials from the orchid's native region in Asia containing its seed or bulbs. The bulk material that seemed to have the potential to carry the orchid material is woodchip component of the "Logs and woodchips" import category, and these were imported to the U.S. from *Eulophia graminea*'s native range (Malaysia, Indonesia, Singapore, China, Taiwan) (http://www.fas.usda.gov/scriptsw/bico/bico.asp?Entry=lout&doc=967). It is not known, however, what portion of this category woodchips represents, if the woodchips are treated prior to export or after import in a manner that would kill orchid propagules, or where these imported woodchips end up in the United States. No evidence for imported mulch was found except possibly the woodchips if used for mulch.

Discussion

Occurrence – It is highly likely that other undetected plants occur in Miami-Dade County and perhaps beyond. All five *Eulophia graminea* occurrences or populations were found with the assistance of other people. Our surveys to try to find new occurrences have been limited, and we have not investigated some of our local habitats of the same types the orchid occupies in its native area, such as beach, coastal grasslands, and secondary forest.

Possible routes of introduction - Although no evidence for cultivation or commerce of the orchid in the U.S. was discovered, we found that the orchid is cultivated overseas and is available as seed, bulbs, and plantlets in flasks by web-based businesses and private individuals. This suggests that importation to Florida could easily occur, although CITES restrictions on orchid importation might restrain and limit its legal importation. But both legal and illegal importation could

have occurred. The availability of *Eulophia graminea* is coupled with considerable enthusiasm for orchid growing in southern Florida. The American Orchid Society alone has ca. 25 affiliated chapters in the three highly populated counties (Broward, Miami-Dade, and Palm Beach) in southeastern Florida. The importation of bulk materials from the native area, which could introduce *E. graminea* seed or pseudobulbs, is another possible introduction route, but less plausible than purposeful importation for horticulture.

Breeding System and Pollination – Although we determined that *Eulophia graminea* needs a pollinator for pollination, we did not identify the pollinator(s). Fruit set was observed at the South Miami and Little River Miami naturalization sites, and in an exposed potted plant in Homestead. No fruit was seen in the flowering plants at the east Kendall and North Miami naturalization sites, or potted plants exposed in Ft. Lauderdale in Broward County, just to the north of Miami-Dade County. At the South Miami site, pollinia removal was not observed during the two scoring periods during October and November, but a low level of fruit was present during and after those assessments; with a 4.5 % fruit set detected after flowering finished. At the Little River Miami site, pollinia removal was documented (with a mean of 24 %), and a mean fruit set was 9%. Perhaps the greater number of flowering plants at the Little River Miami site, ca. 70 compared to 4 at the South Miami site, may have resulted in both more flower visitation and increased chances for reproductive success. In addition, the much greater presence of flowering weeds such as *B. pilosa* at the Little River Miami site could have also increased pollinator presence and activity. In other studies of tropical orchid pollination (Tremblay *et al.* 2005), pollinia removal rates were usually higher than fruit set rates. Pollinia removal rates were, however, higher in deceptive tropical orchids, but not in rewarding tropical orchids (Tremblay *et al.* 2005) such as *E. graminea*. Because our visits and observation periods were few, we could have missed the activity periods of pollinators responsible for the fruit set. It might also be possible, despite the absence of fruit set in enclosed plants or in exposed plants in Ft Lauderdale, that some low level autogamy occurs. The presence of nectar and fragrance in the daytime, the prominent lip with coloration contrasting coloration, papillae, and a gullet (formed by the lateral lobes of the lip) suggest pollination by bees. More observations are needed to detect the pollinator(s) and additional treatments to determine whether a limited amount autogamy might be possible in plants in the field.

Potential to persist - The underground (or partially underground) pseudobulbs, particularly those buried in mulch, probably provide a means to survive the dry season and drought. Mulch is widely utilized in southern Florida, in part, to conserve moisture for garden plantings. Part of the plant's native range (South and Southeast Asia) experiences an intense dry season with higher temperatures than occur in Florida's dry season. During these times the leaves dry and the plant become dormant (Tan & Sin 1993). The pseudobulb, particularly those that are underground, may be better able to survive the rare freeze events southern Florida experiences, and may allow it to persist farther north in Florida, and perhaps beyond.

Potential to spread - *Eulophia graminea* has capsules which ripen and dehisce quickly, suggesting that its spread by seed is likely. The occurrence of multiple plants in relatively small areas of three neighborhoods also suggests local spread by air-borne seed. The occurrence in five separated areas of Miami-Dade County might also be due to wind blown seed, but spread by the movement of seeds or pseudobulbs in mulch is also possible. We know that mulch was shared from the first yard in the South Miami (where the orchid was found) with another neighbor where we also found the plants. The ability of the orchid to persist as dormant pseudobulbs can probably facilitate their survival during movement with mulch.

Eulophia graminea occurs beyond the tropics in some parts of its native range. The northeast part of its range in Okinawa (Garay & Sweet 1974) is just above 26°N, which is the same latitude as Miami-Dade County. The orchid lives in the Himalayas between 900-l000 m in Nepal and Sikkim) (Singh 2001). Nepal lies between 26-32°N, but areas at or below 1000 m lie in the lower latitudes of the country. Sikkim lies between 27 and 28°N. The orchid's occurrence in Kashmir (Renz 1984), an elevated region, whose southern border lies above 32°N, is the region with the most temperate climate in the plant's native range.

One inland Chinese location for the plant is in Anhui province is ca. 32°N (Chinese distribution map for the species, Tropicos, Missouri Botanical Garden), but this locality is unconfirmed. The occurrence of the *E. graminea* at higher latitudes and higher elevations than the 26°N and near sea level occurrence in southern Florida, suggests that the plant could survive well north of its current area of naturalization. If the orchid is able to live at 32°N in the southeastern U.S., it could occur from southern Georgia to eastern Texas. The source area of the plants that have naturalized in southern Florida is, however, unknown, and the naturalized plants may not necessarily have the cold tolerance of plants occurring in the more northern parts of the native range. The large native geographic range, including its occurrence on isolated islands, suggests an ability to disperse and to spread widely. *Eulophia graminea* was one of the first orchids to colonize Krakatau Islands after the 1883 massive eruption, being detected in 1908 (Partomihardjo 2003).

This combination of the orchid's more northern occurrence in its native range, its ability to seed quickly and disperse over great distances, vegetative proliferation of its pseudobulbs, and terrestrial pseudobulbs which can be dormant, all suggest that *Eulophia graminea* will probably spread in Florida and possibly north of Florida to Georgia the Carolinas. The orchid could spread to the West Indies by windborne seed. It could also be moved accidentally (as pseudobulbs or seed) as contaminants of horticultural potted plants exported from Florida to warmer parts of the US and to the West Indies. *Eulophia graminea* could also be moved intentionally by people for cultivation.

We found the orchid growing in mulch at four of the five sites in southern Florida; it has also naturalized in mulch in Australia**.** All of the detected plants in mulch were found in woodchip mulch, although the roots of some plants may have been growing into soil beneath the mulch. Mulch might have the mycorrhizae needed by the orchid for seed germination and establishment. Mulch harbors many fungi, and alien fungi have been first detected in ornamental woodchip mulch (Shaw *et al.* 2004). The orchid is reported to have a wide tolerance of environmental conditions (Tan & Sin 1993), and its occurrence on sandy beaches, grasslands, and other shrubby, open areas, and secondary forests in its native area, indicate that it could colonize these habitat types in Florida. The habitats the orchid colonizes will probably depend on whether suitable mycorrhizae occur in them.

Orchid naturalization - Only 11 species of orchids are naturalized in Florida (Wunderlin and Hansen 2004). With the addition of *Eulophia graminea,* this is around 10% of the total orchid species in the state. This indicates that naturalization of orchids in Florida occurs less frequently than either other flowering plants (ca. 33% naturalization) or ferns (ca. 33%) (Pemberton 2003). Lower naturalization rates in orchids appears to be a general occurrence (Daehler 1998). Eleven of 12 of the orchids naturalized in Florida are terrestrial species, suggesting that terrestrial species may naturalize more easily than epiphytes. This is noteworthy because epiphytic orchids dominate horticulture and home cultivation in Florida, although a couple of terrestrial species, *Spathoglottis plicata* Blume and *Phaius tancarvilleae* (Banks ex L'Hér.) Blume, are commonly sold. Both orchids are naturalized in Florida to a limited extent (Wunderlin & Hansen 2008). The lack of specialist pollinators and appropriate mycorrhizae are thought to limit orchid naturalization (Daehler 1998). Terrestrial environments, particularly mulch, may provide more potential mycorrhizae needed by orchid seed to germinate than do the arboreal habitats of epiphytic orchids. An invasive orchid, *Disa bracteata* Sw., and a weedy native orchid, *Microtis media* R.Br**.,** in Australia form associations with a greater array of mycorrhizal fungi of more world-wide occurrence than do non-weedy native orchids (Bonnardeaux *et al.* 2007).

While the breeding system of colonizing orchids may be diverse (Sun 1997), the only wide-spread naturalized orchids in Florida, *Oeceoclades maculata* (Lindl.) Lindl. and *Zeuxine strateumatica* (L.) Schltr.), are thought to be autogamous (Sun 1997, González-Díaz & Ackerman 1988). This supports, in part, the idea that pollination limitation may be a barrier to orchid naturalization. The recent naturalization of two tropical bees in southern Florida, an orchid bee (Pemberton & Wheeler 2006), and an oil-collecting bee (Pemberton & Liu 2008), may reduce this pollinator limitation and both promote some already naturalized orchids and facilitate the naturalization of some ornamental

orchids. The orchid bee, *Euglossa viridissima* Friese, visits many different ornamental orchids (Pemberton 2007a), and is pollinating and causing considerable fruit set in *Guarianthe skinneri* (Bateman) Dressler & W.E. Higgins (Pemberton 2007b). The oil-collecting bee, *Centris nitida* Smith, is pollinating and inducing fruit set in the ornamental *Oncidium sphacelatum* Lindl. (Pemberton, in press), and is the only known pollinator of the invasive cowhorn orchid, *Cyrtopodium polyphyllum* (Vell.) Pabst ex F. Barrios, (Liu and Pemberton, unpubl. data). It is doubtful that either of these naturalized bees visits the flowers of *Eulophia graminea* because they are quite unlike the flowers used by them.

Eulophia graminea is probably destined to be a permanent part of Florida's flora, given its multi-site and relatively wide occurrence during the early phase of its colonization, as well as its ability to produce ample fruit and persist during the dry season via its dormant pseudobulbs. It will be interesting to observe the extent of this alien orchid's colonization and spread in the New World and to try to understand the reasons for its successful naturalization.

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GENERIC REALIGNMENTS IN MAXILLARIINAE (ORCHIDACEAE): CORRIGENDA ET ADDENDA

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1) Two new combinations for the basionym *Maxillaria bomboizensis* Dodson were made in Blanco *et al*., (2007), one in *Camaridium* (page 519) and another in *Sauvetrea* (page 535). The first was accidentally left undeleted after we confirmed the correct placement of this taxon in *Sauvetrea*, and therefore should be considered a synonym:

Sauvetrea bomboizensis (Dodson) M. A. Blanco, Lankesteriana 7: 535. 2007. *Camaridium bomboizense* (Dodson) M. A. Blanco, Lankesteriana 7: 519. 2007, ***syn. nov.***

2) The wrong year (1964) was given for the basionym *Ponera adendrobium* Rchb.f. [*Ornithidium adendrobium* (Rchb.f.) M. A. Blanco & Ojeda] (page 532). The correct year of publication for *Ponera adendrobium* is 1865. The rest of the citation is correct and therefore the transfer is valid (see article 33.4 of the Code; McNeill *et al*., 2006).

3) The following combinations were not included in the article, and are thus validated here:

Camaridium carinulatum (Rchb.f.) M. A. Blanco, ***comb. nov.***

Basionym: *Maxillaria carinulata* Rchb.f., Flora 41: 6. 1877.

Ornithidium fasciculatum (C. Schweinf.) M. A. Blanco & Ojeda, ***comb. nov***.

Basionym: *Maxillaria fasciculata* C. Schweinf., Bot. Mus. Leafl. 15: 162. 1952.

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A NEW SPECIES OF *MASDEVALLIA* (ORCHIDACEAE: PLEUROTHALLIDINAE) FROM PERU

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Abstract. *Masdevallia vilcabambensis*, a new species from the department of Cuzco in Peru, is described and illustrated. It is similar to *M. minuta*, but it has much smaller plants and flowers, the flowers are yellowish and blotched with purple, and the sepals abruptly reflexed at the middle. Also, *M. vilcabambensis* is exclusively know from around 2500 meters elevation, whilst *M. minuta* is restricted to warm regions below 350 meters of altitude.

Key words : Orchidaceae, Pleurothallidinae, *Masdevallia vilcabambensis*, Peru, new species

Introduction. The cloud forest of the region of Vilcabamba in Peru hosts an astonishing variety in plant species, and the efforts by botanists and concerned institutions to enlighten this floristic mega diversity promote the continue discovery of taxa new to the science. The characteristic climate of the cloud forest, with its high humidity and the constant presence of fog, favors the establishment of a rich epiphytic flora, among which the family Orchidaceae is outstanding for the great number of species (Schweinfurth 1944, 1951, 1958—1961, 1970, Bennett & Christenson 1993, 1995, 1998, 1999, 2001, Rodríguez 1999).

The orchids of the subtribe Pleurothallidinae (Tribu Epidendreae) account for approximately 3000 species, which means more o less 10% of the world orchids. Among them, *Masdevallia* Ruiz & Pav. has nearly 500 species, 150 of which are endemic to Peru, but it is easy to estimate that this number will quickly increase as new difficult-to-reach areas still covered with pristine vegetation will be explored.

The genus *Masdevallia* is distributed from southern Mexico to the South of Brazil, with the greatest species diversity in the central mountain ranges of Colombia, Ecuador, Peru, and Bolivia. It is characterized by terrestrial, epiphytic or lithophytic plants provided with non-pseudobulbous stems and a single leaf, fleshy to coriaceous, cuneate at the base. The basal inflorescences can be single- or many-flowered, with the peduncle usually cylindrical. The flowers are showy and frequently with brilliant colors. The sepals are always adnate, with the free apexes ending in more or less elongate tails. Species of *Masdevallia* are most commonly found in wet and cold climates, with some taxa spanning toward more temperate regions.

Taxonomic treatment. During one of the explorations done by the team of the Missouri Botanical Garden to collect material from the Vilcanota River basin, Efraín Mountañés Suclli, one of the team members, discovered a tiny orchid that is described here as new:

Masdevallia vilcabambensis L. Valenzuela & E. Suclli, *sp. nov.*

TYPE: Perú. Convención: Vilcabamba, Oyara, 2500 m, 13º01'29"S 72º50'08"W, 22 Febrero 2007, *L. Valenzuela 8896, E. Suclli, I. Huamantupa, G. Calatayud, F. Zamora & N. Suárez* (holotype, CUZ; isotype MO). Fig. 1.

Species *Masdevallia minuta* Lindl. similis, sed statura multo minore, floribus minoribus, sepalis reflexis, habitat diverso recedit.

Herb epiphytic, small, up to 25 mm tall. *Ramicaul* to 23 mm long. *Leaves* obovate-elliptic, glabrous, 10-25 x 5-8 mm, narrowed toward the base into a conduplicate petiole 8-12 mm long. *Inflorescences* single-flowered, emerging from the basal sheaths, 2 -3 per ramicaul, to 20 mm long, green. *Flowers*

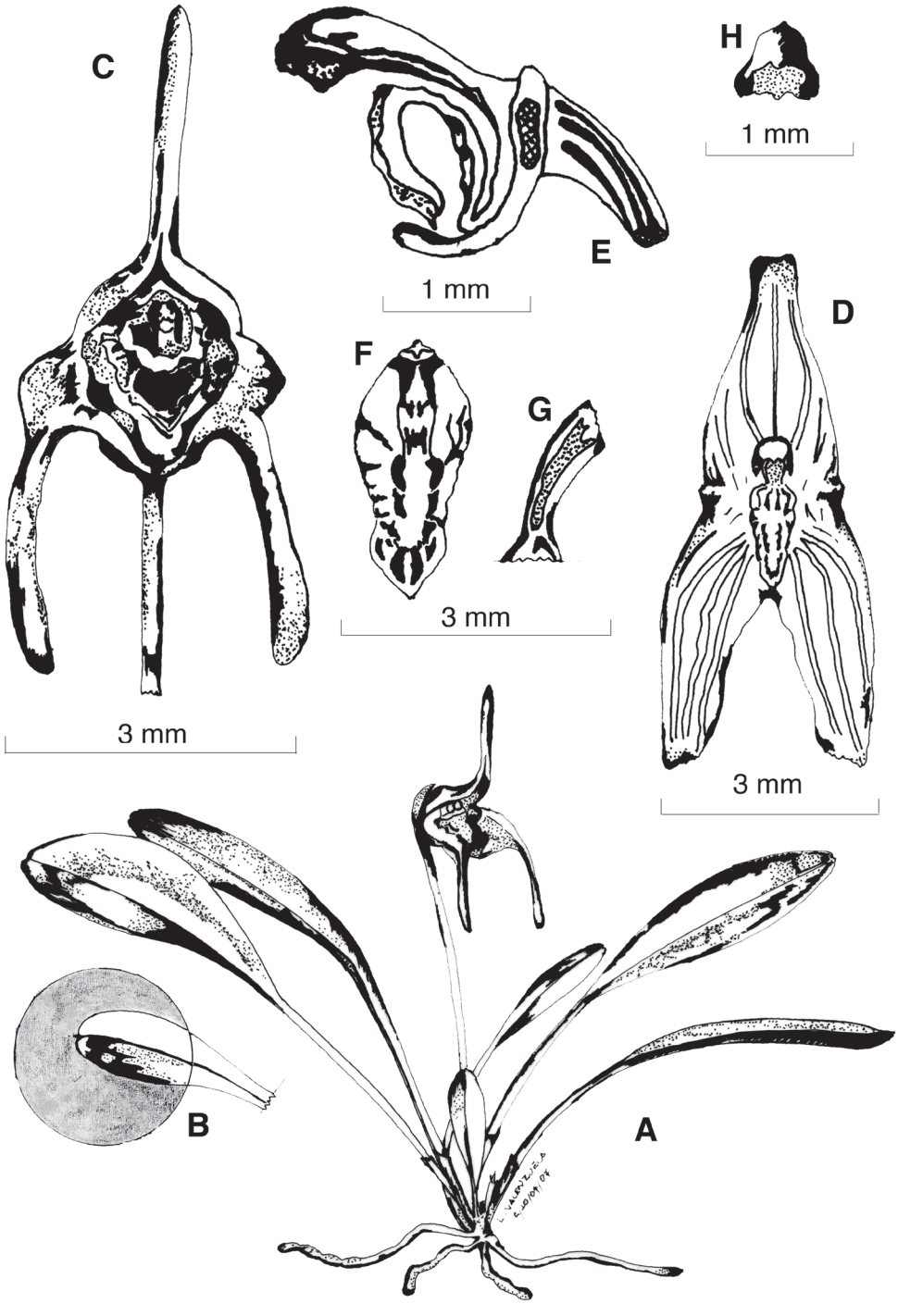

FIGURE 1. *Masdevallia vilcabambensis* L. Valenzuela & E. Suclli. A - Habit. B - Apex of the leaf, abaxial view. C - Flower. D - Flower, spread (the petals removed), the reflexed tails not visible. E - Column and lip, lateral view. F - Lip. G - Petal. H - Anther cap. Drawn by L. Valenzuela from the holotype.

with yellowish sepals, blotched vivid purple at the base, the tails yellow; petals and lip purple; column green with the apex cream-hyaline. *Sepals* narrowly triangular-ovate, connate at the base ca. 1 mm, ending into reflexed, conduplicate tails, 3 x 1 mm excluding the tail. *Petals* obcuneate-subfalcate, truncate, 1.5 x 1 mm. *Lip* narrowly ovate-subpandurate, abruptly reflexed-folded at the middle, acute, 2 x 1.5 mm. *Column* terete, slender, subclavate, with shallow clinandrium, 1.6 mm long. *Anther cap* cucullate, helmet-shaped, cream.

Distribution and Ecology: Epiphytic in cloud forest at an altitude of between 2400-2500 m. The plants grow in shady places, on the stems of vines (up to 2 cm in diameter) covered with mosses, at medium height (up to 3 meters from the ground), forming small populations usually of 4-8 individuals.

Etymology: Named from the district to which belongs the locality where the species was found, in the district of Vilcabamba, the historical place where the Incas directed by Manco Inca offered their last resistance to the Spanish invasion in 1532.

The only species similar to *M. vilcabambensis* is *M. minuta* Luer, but the former has much smaller plants and flowers, the flowers are yellowish, blotched with purple (vs. white in *M. minuta*), the disposition of the column and the shape of the sepals, and sepals abruptly reflexed at the middle (vs. straight). Furthermore, *M. minuta* is restricted to warm regions below 350 meters, while *M. vilcabambensis* is exclusively know from a cold region at around 2500 meters elevation.

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BOOK REVIEW

Luer, C.A. 2007. **Icones Pleurothallidinarum XXIX. A third century of *Stelis* of Ecuador. Systematics of *Apoda-Prorepentia*. Systematics of miscellaneous small genera. Addenda: new genera, species, and combinations**. Monogr. Syst. Bot. Missouri Bot. Gard. 112: 1-130.

With this recent delivery of a third century of new species of *Stelis* Sw. from Ecuador (pp. 1--82), Carlyle A. Luer raised to three hundreds the number of *Stelis* species he and his co-workers (notably Alex Hirtz and Lorena Endara) revealed to science in the last five years (Luer 2002, 2004). Taking in account a forthcoming lot of 130 previously known and new species (announced in the Introduction), plus some 50 names among those recorded by Schlechter (1921), the total number of accepted species known from Ecuador is close to 500, or over the half of the number of species presently known in the genus. However, according to Luer's estimate, Ecuadorean leadership in *Stelis* diversity is destined to fade as soon as a similar amount of time and effort in studying this genus will be expanded to the neighboring regions of Colombia and Peru, both of which are more than four times larger in geographic area. This let us easily envision a genus *Stelis* in the strict sense (as it is treated by Luer in his series) encompassing more than 1500 valid species, which will convert it into the largest Neotropical orchid genus and perhaps into the largest natural genus of the Orchidaceae as a whole.

As it is usual in Luer's "green books" series, each species is fully described, and paragraphs are provided on etymology and a short discussion for each taxon. With the exceptions of *S. lynniana* and *S. paulula*, which are known only from cultivated specimens without exact provenience, locality data are provided for all the species. All the new species are illustrated in composite ink plates by the well-trained hands by Luer himself and Stig Dalström, and it is unfortunate that, for editorial reasons, the 101 plates had to be strongly reduced in size from the original full-page format, someway impeding a clearer view of the often-intricate floral details of *Stelis*.

Unlike the two previous parts of the treatment of *Stelis* of Ecuador (Luer 2002, 2004), section *Labiatae* is combined here with sect. *Stelis*, the diagnostic character of sect. *Labiatae* (the degree of connation of lateral sepals) proving to be inconsistent. The species of the new century are accordingly arranged into three Sections, namely *Nexipous* (8 species), *Humboldtia* (8 species) and *Stelis* (87 species), the latter including sect. *Labiatae*. Because of the comparatively stable flower morphology and the mostly stereotyped vegetative architecture of *Stelis*, which makes difficult to manage such a large group for identification purposes, a key to the Ecuadorian species will be a welcome addition to part four of the series, where a systematic treatment is promised.

Following the third century of new *Stelis* from Ecuador, the fascicle includes, systematic monographs of *Apoda-Prorepentia* (Luer) Luer, and other miscellaneous pleurothallid genera not previously treated in the "green" series.

Apoda-Prorepentia, based on *Pleurothallis* sect. *Apoda-Prorepentes* Lindl. and elevated at generic rank by Luer (2004), includes in the present treatment 8 species, mostly characterized by the repent and often pendent habit, but with highly diverse floral morphology. According to the author, the genus ranges from Mexico to Brazil, Ecuador, and the West Indies, with a main center in northwestern Andes. A key to the species, full descriptions and notes, and a composite plate for each species are provided in the acclaimed style of previous *Icones Pleurothallidinarum* systematic treatments.

Six monotypic genera [namely *Cucumeria* Luer, *Empusella* (Luer) Luer, *Mirandopsis* Szlach. & Marg., *Mixis* Luer, *Mystacorchis* Szlach. & Marg., and *Psedoctomeria* Kraenzl.] are monographed; references are given to the species illustrations that appeared in previous volumes, with the exception of *Mixis incongrua* Luer, which is depicted at page 104 of the present volume. Also monographed are *Physosiphon* Lindl. (2 species from Mexico to Peru, both illustrated,

P. emarginatum in two different morphs), and *Physothallis* Garay (2 species endemic to Ecuador, illustrated on page 105).

In the Addenda section (pp. 106-130), devoted to miscellaneous new genera, species, and combinations, Luer describes *Effusiella*, a genus based on *Pleurothallis* subgen. *Effusia* Luer, and *Niphantha*, with 2 species segregated from the same subgenus (all treated a *Stelis sensu lato* by Pridgeon & Chase, 2001). The first new genus is admittedly polymorphic and scarcely distinct from *Pabstiella* Brieger & Senghas, at the point that generic assignments should rely "on interpretation of subtle floral characters and distribution". Although noting that *Effusiella* and *Pabstiella* might constitute a single genus, 40 new combinations are published here under *Effusiella* (pp. 106-107, plus *E. vellozoana* amid Pabstiellas on p. 121), while 67 species are formally transferred to *Pabstiella* (pp. 119-121). Two new species of *Effusiella* are described and illustrated from Peru and Ecuador. *Nyphantha* is mainly distinguished from *Effusiella* by a comparative large spathe and the lateral sepals free nearly to the base, and allegedly supported by an unpublished DNA analysis.

Additionally, new species are described and illustrated in the genera *Alaticaulia* (a recent segregate from *Masdevallia*, of which the author describes 3 new species from Ecuador and Peru) *Lepanthes* (4 species from Colombia and Ecuador), *Pleurothallis* (*P. davisii* from Ecuador), *Restrepia* (the Colombian *R. fritillina*), *Spilotantha* (another genus split from Masdevallia, of which a new species is described from Ecuador), *Stelis* (*S. maduroi* from Panama), *Trichosalpinx* (*T. sipapoensis* from Venezuela), and *Trisetella* (the Ecuadorean *T. klingeri*). Among nomenclatural changes, the volume offers 4 new combinations in *Acianthera*, 8 in *Alaticaulia*, 12 in *Anathallis*, 2 in *Echinosepala* [but *E. vittata* (Pupulin & M.A. Blanco) Luer is a superfluous name predated by *E. vittata* (Pupulin & M.A. Blanco) C.O. Murales & N. Villal. 2004), 1 each in *Reichantha*, *Specklinia*, and *Tigivesta* (replacing name for *Vestigium* Luer, predated by a fungal genus), and 4 in *Teagueia*.

The plates of the four new species referable to genera allied to *Masdevallia* (*Alaticaulia inamoena, A. neukermansii, A. rojohnii* and *Spilotantha nigricans,* pp. 122-130) are numbered according to the format of *Systematics of Masdevallia*, bringing the total of numbered illustrations to 695.

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