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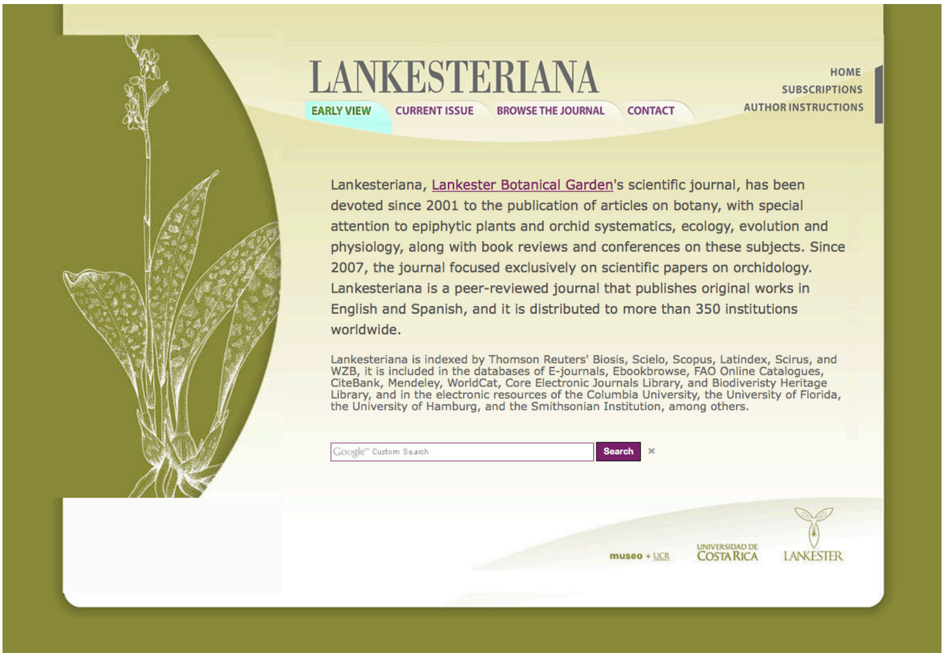

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MACROCLINIUM CHASEI (ORCHIDACEAE, ONCIDIINAE): A NEW RECORD FOR BRAZIL

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Abstract. We present a new record for Brazil, *Macroclinium chasei*, until now known only from Bolivia and Peru. A description, illustration and photographs are presented, together with data of geographic distribution, and taxonomical and ecological comments.

Resumo. É apresentado o registro de *Macroclinium chasei* para o Brasil, conhecida até o momento apenas para a Bolívia e Perú. São fornecidas a descrição, ilustração, prancha fotográfica, além de dados de distribuição geográfica, comentários taxonômicos e ecológicos da espécie.

Key words / Palavras chave: Amazon, Amazônia, *Macroclinium*, Mato Grosso, Oncidiinae, Rio Teles Pires

Introduction. The neotropical genus *Macroclinium* Barb.Rodr. is constituted by 44 species (Govaerts 2016), found from Mexico to Bolivia and Brazil (Pupulin 1997). Six species had been previously recorded from Brazil: *Macroclinium brasiliense* (Pabst) Dodson, *M. mirabile* (C.Schweinf.) Dodson, *M. paraense* Campacci & da Silva, *M. roseum* Barb. Rodr., *M. saraca-taquerense* Campacci & da Siva, and *M. wullschlaegelianum* (Focke) Dodson. The species are distributed in the states of Amazonas, Goiás, Maranhão, Pará, Rio de Janeiro, Rondônia, Roraima, Tocantins and in Distrito Federal (BFG 2015, Campacci *et al*. 2015).

During the flora rescue at the Hydroeletric Power Plant of Colíder (Mato Grosso State), material of *Macroclinium chasei* Dodson & Benn. was collected, corresponding to a new record for Brazil. The species is here presented with a description, illustration, photographs, as well as taxonomical and ecological comments.

Taxonomic treatment

Macroclinium chasei Dodson & D.E.Benn., Icon. Pl. Trop., ser. 2, 1: t. 98 (1989).

TYPE: Peru. Huanuco: Leôncio Prado, 5–7 Km towards La Divisoria from Tingo Maria, 850 m, 20.VII.1987, *L. Moore ex D. Bennett & M. Chase 4092* (holotype MO, illustration!).

Epiphytic *herbs*. *Roots* ca. 0.5 mm thick, terete, whitish. *Stem* compact, pseudobulbs absent. *Leaves* alternate and imbricate, 4–6 by sympodium, 0.7–1.4 × 0.4–0.5 cm, laterally compressed, falcate, slightly fleshy, apex acute to obtuse, green, with reticulate, brownish and thick ribs. *Inflorescence* axillar, bi-flowered, at beginning simple, becoming composed with the production of new secundary inflorescences; main peduncle 15–33 mm long, 0.25 mm thick, terete, brown to greenish; secundary peduncle 2–3 mm long, 0.25 mm thick, terete, brown to greenish. *Flowers* resupinates. *Ovary* and *pedicel* ca. 4 mm long, 0.3 mm in diameter, terete, pale green. *Dorsal sepal* ca. 4 × 2 mm, elliptic to elliptic-oblanceolate, obtuse to acute, white. *Lateral sepals* ca. 5.0 × 2.0–2.5 mm, lanceolate-ovate, obtuse, white. *Petals* ca. 4 × 1 mm, narrowly elliptic, acute, white with purple-pink dots. *Lip* 5.0–6.0 × 1.5–2.0 mm, unguiculate, white to white slightly pink; claw adaxially sub-canaliculate; blade elliptic to elliptic-oblanceolate, acute to obtuse, the margin sometimes slightly ondulate. *Column* ca. 1.5 mm long, clinandrium minutely denticulate,

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white with base purple-pink. *Anther* ca. 0.6 mm long, dorsifixed, subovate, with two globoses protuberances at the base, these with inconspicuously alveolate surface, apex minutely denticulate, white with base purple-pink. *Pollinia* 2, ca. 0.3 mm, ovate, laterally flattened, yellow; stipe ca. 1 mm long, subspathulate, translucid-white; viscidium ca. 0.1 mm long, rounded, white-brownish. *Fruits* and *seeds* not seen.

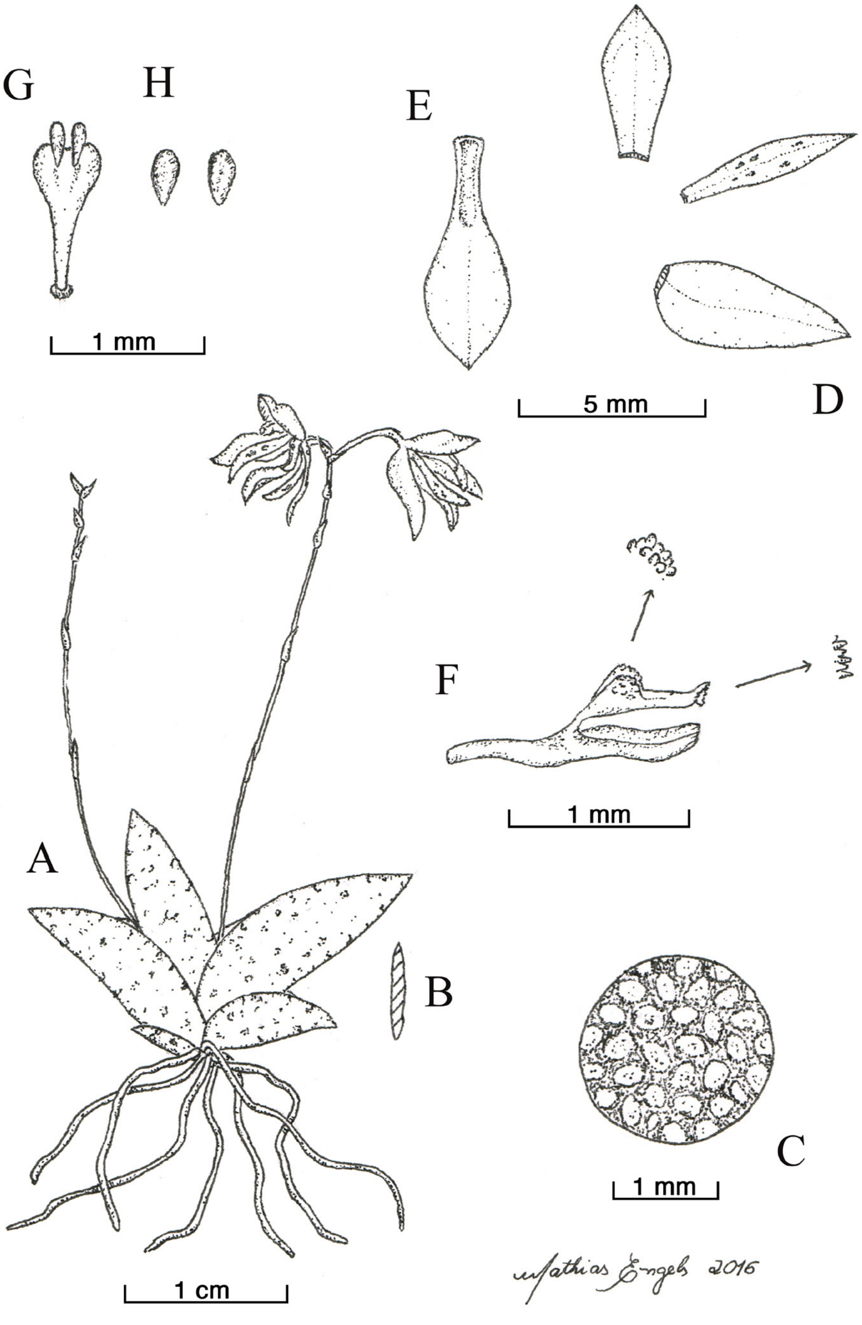

Figure 1. *Macroclinium chasei*. A. Habit. B. Section of leaf. C. Detail of texture of the leaf. D. Perianth flattened. E. Lip flattened. F. Column with anther. G. Pollinarium. H. Pollinia in lateral view. Illustration by M.E.Engels based on *Engels & Bezerra 4773*, MBM.

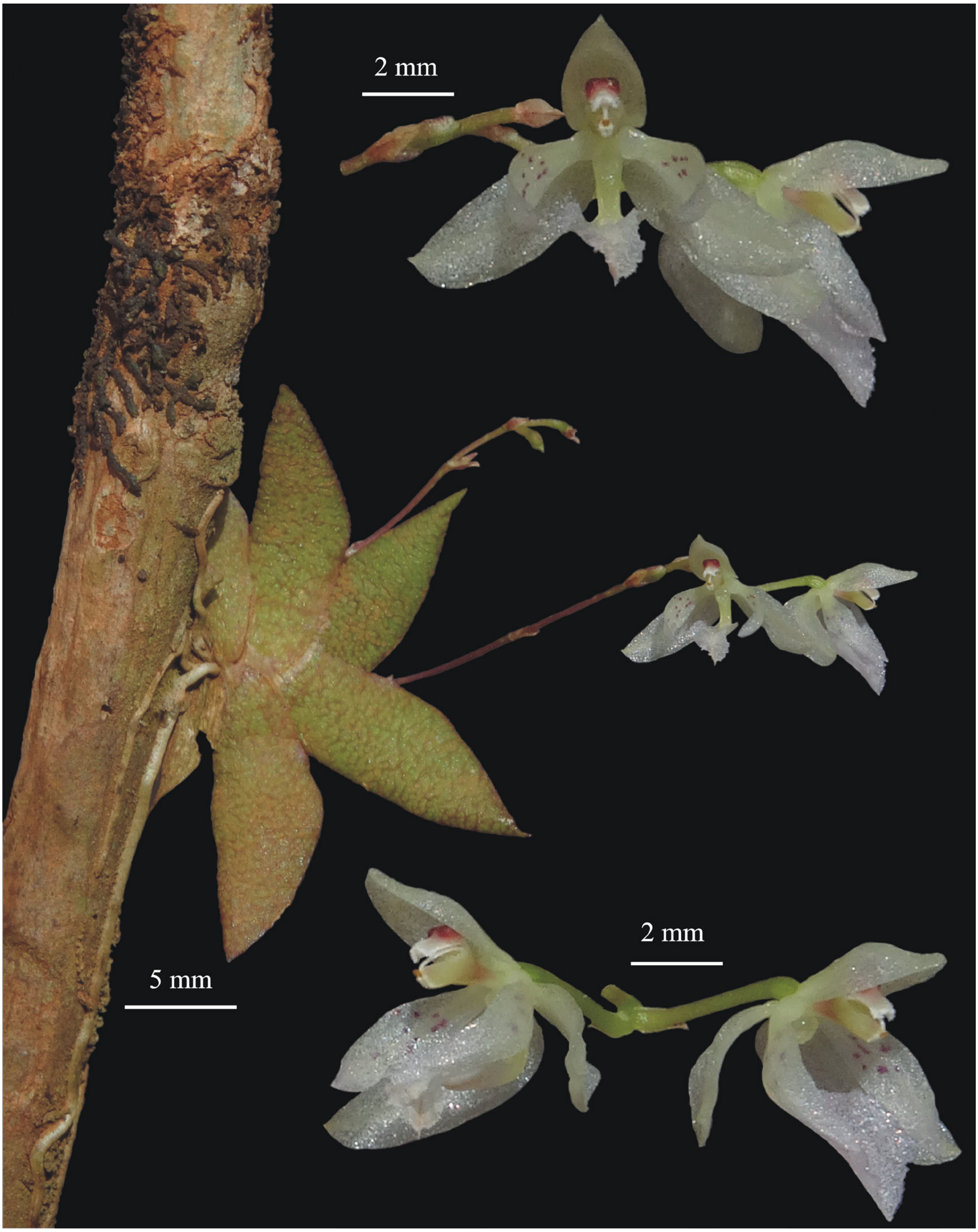

Figure 2. *Macroclinium chasei*. Habit and flowers (*Engels & Bezerra 4773*, MBM). Photographs by M.E. Engels.

Examined material. Brazil. Mato Grosso: Itaúba, Flora rescue from UHE Colíder, fl., 21 July 2016, *M.E. Engels & A.S. Bezerra 4773* (MBM, RB, TANG – spirit collection). Fig. 1–3.

Macroclinium chasei occurs in Bolivia, Peru (Bennet & Christenson 1994, Pupulin 1997, Carnevali & Cetzal-Ix 2012, Govaerts 2016) and Brazil, in the Mato Grosso State (Fig. 3). This material correspond

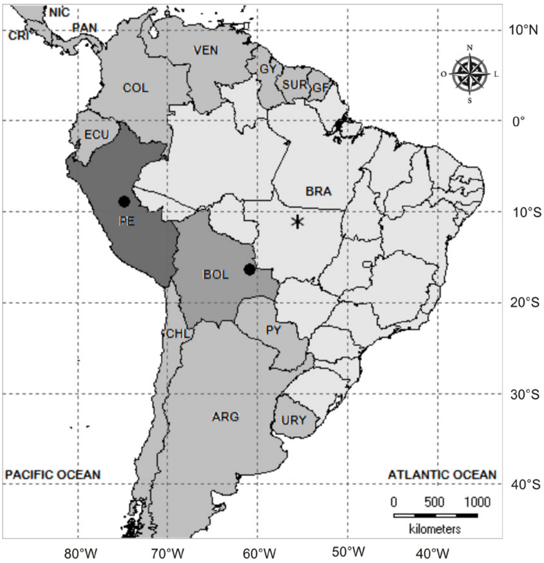

Figure 3. Distribution map of *Macroclinium chasei*. Circle: previous records. Asterisk: current record.

to the first record of the species in Brazil. It was found as an epiphyte of thin branches in the canopy in the paludose forest (Stational Forest Always Green Aluvial) crossed by a tributary stream of the Teles Pires river, in southern Amazonia. Flowering occurs from July to October.

We believe that this species may occur in other areas of the Brazilian southern Amazonian that share the same ecological and phytophysiognomics conditions. According to Miranda and Menini Neto (2010) several orchids are seldom collected because they are rare, occur in places with difficult access (in this case, trees canopy) and are not easily seen during collect expeditions due to their small size. This facts may explain the lack of records of *Macroclinium chasei* in Brazil until now.

Macroclinium chasei belongs to *M.* sect. *Hirtzae* Dodson & Pupulin, a group characterized by plants without pseudobulbs, non-articulated leaves, bi-flowered inflorescences, column with thickened apex, dorsal anther, opercule fixed at base of clinandrium, and discoid and flat pollinia (Pupulin 2001). In addition to *M. chasei*, other species belonging to this section are *M. biflorum* Bennet & Christenson, *M. brasiliense*, *M. dentiferum* Thiv, *M. hirtzii* Dodson, *M. mirabile*, *M. paraense* and *M. saraca-taquerense*. Besides *M. chasei*, other four species of *M.* sect. *Hirtzae* occur in Brazil: *M. brasiliense*, *M. mirabile, M. paraense* and *M. saraca-taquerense*. It differs from these by the entire lip, acute to obtuse apex, without callous and by the apex of the clinandrium and anter minutely denticulate.

The leaf surface of *M. chasei* presents thick and brown reticulations over the green blade (Dodson & Bennet 1989), a texture that is more evident in individuals living in places with higher exposition to the sun light.

Conservation – Data Deficient (DD): known only from one collect in Brazil, lack of additional individuals from the site and neighboring regions (IUCN 2010).

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NOCTUID MOTHS AS POTENTIAL HYBRIDIZATION AGENTS FOR *PLATANTHERA* ORCHIDS

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Abstract. Zoophilous flowering plants communicate with pollinators to ensure pollen transfer. Pin-pointing which species are effective pollinators is not only essential to better understand plant-pollinator networks, but equally so to better understand the potential of hybridization in plant systems, such as in orchids. As a case study, we studied two sympatric populations of the congeneric orchids *Platanthera bifolia* and *P. chlorantha* in order to assess their nocturnal pollinators by checking which moth species carried pollinaria, and of which orchid species. Moths carrying *Platanthera* pollinaria were photographed and identified. The carried pollinaria were identified and counted, and their attachment position on the moth's head was scored. Based on these observations we show that three species of noctuid moths visited the *Platanthera* inflorescences. Although *Noctua pronuba* visited *P. chlorantha*, only *Cucullia umbratica* and *Autographa gamma* turned out to be potential pollinators for both orchid species. As such, we here demonstrate that the latter two noctuids have high potential to facilitate hybridization among these two orchid species, especially so in sympatric populations.

Key words: *Autographa gamma*; *Cucullia umbratica*; light traps; macro-moths; *Platanthera*; pollination.

Introduction. Zoophilous flowering plants communicate with pollinators, often specifically so by using specific floral rewards and signalling apparatus, to help ensure pollen transfer between conspecific plants (Wester & Lunau 2016). Although pin-pointing which species are effective pollinators is essential to better understand the functioning and resilience of plant-pollinator networks (Kühsel & Blüthgen 2015, Macgregor, Pocock, Fox & Evans 2015, Weiner, Werner, Linsenmair & Blüthgen 2014), direct observation (Peter *et al.* 2009, Raguso & Willis 2005, Robertson & Wyatt 1990) is time consuming – even via continuous video monitoring – since the proportion of visited flowers is often low. Moreover, findings obtained via direct observation are typically not fully trustworthy (Suetsugu & Fukushima 2014 a, b). Thus, in general, foraging pollinators are identified via indirect methods, for example the identification of an orchid's pollinarium on moths' hairy bodies (Darwin 1877, Maad & Nilsson 2004, Nilsson 1983). Such research is also essential to better understand the potential for hybridization in (orchid) plant systems (Cozzolino & Widmer 2005, Schiestl & Schlüter 2009). Insects visiting orchid flowers can be divided into three main groups: (i) 'flower-visitors, which land on a flower, without any pollinaria attached to their body; (ii) 'potential pollinators', if pollinia adhere somewhere on the insect's body (e.g. antennae, head, abdomen), or if they are just likely to carry pollinaria to another flower, and (iii) 'effective pollinators', when pollinia attached to the insect's body are eventually deposited on the stigma of another flower (Bournérias *et al.* 2005, Ruiz 2009).

Moths, an insect group capable of pollinating a wide range of plant species, constitute the majority of nocturnal pollinators (Macgregor *et al.* 2014). However, as studies on networks of plants and their nocturnal pollen vectors are rare, the role of moths as pollinators is most likely underestimated (Hahn & Brühl 2016). More specifically, moths are known to be the primary pollinators of orchids from the Orchidoideae subfamily (Catling & Catling 1991, Hahn & Brühl 2016). This is also the case for certain orchids of the *Platanthera* genus, such as the threatened

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P. praeclara native to the North American prairie, which are highly specialized for pollination by moths (i.e. moth pollination syndrome, or phalaenophily) (Argue 2012, Westwood & Borkowsky 2004).

The *Platanthera* genus contains *ca*. 150 species (Karasawa 2003) and is as such the largest genus of northern temperate terrestrial orchids (Hapeman, 1997, Hapeman & Inoue 1997, Wood, Beaman & Beaman 1993). Species belonging to this genus can be found in a wide range of environments, from grasslands to forest understories. They may show ecotypic variation due to co-evolutionary relationships with local pollinators, which are mostly represented by nocturnal moth species (Hapeman & Inoue 1997). Noctuid and sphingid moths represent the majority of *Platanthera* pollinator species, but there are also some species that are pollinated by beetles, bumblebees, butterflies, flies and even mosquitos (Hapeman & Inoue 1997, Inoue 1985, Nilsson 1983).

Within the framework of our research devoted to *Platanthera* in Belgium (Esposito, Jacquemyn, Waud & Tyteca 2016), we here focus on the observation of moth visitors of two *Platanthera* species, namely *P. bifolia* (L.) Rich. and *P. chlorantha* (Custer) Rchb. The *P. bifolia* group is of particular significance because it generated one of the classic textbook examples of presumed selection-mediated co-evolution between orchids and their pollinating insects (e.g., Bateman, James & Rudall 2012, Hapeman & Inoue 1997, Maad & Nilsson 2004, Nilsson 1983, 1985). The flowers of *Platanthera* are strongly scented, and the scent emission, which happens in the late evening to night, matches the feeding times of many nocturnal moths (Nilsson 1983, Tollsten & Bergström 1993). The two studied species differ in their floral scent composition, which may represent a cue, and which may hence explain the occurrence of different moth visitors (Nilsson 1983, Tollsten & Bergström 1993). Also, the column morphology differs between both species, and a significant difference is also represented by the spur length (Darwin, 1862, Nilsson 1978, 1983, 1985), which plays an important role in pollination effectiveness (Bateman & Sexton 2008; Claessens & Kleynen 2006). Additionally, two morphological traits are especially discriminant between both species: the length of the caudicles and the distance between the viscidia (Nilsson 1983). The latter is particularly significant because it leads to the placement of pollinaria on different parts of the moths' heads (Claessens & Kleynen 2006, Esposito, Vereecken, Rinaldi, Laurent & Tyteca unpublished, Maad & Nilsson 2004, Nilsson 1983, 1985, Schiestl & Schlüter 2009). Generally, moths will probe deep into the spur to reach the nectar until the head comes into contact with the sticky discs at the base of the pollinaria. In *Platanthera,* only the visitors that present a suitable scale- or hairless part of the head may be able to touch the viscid disc when the head is forced against the spur mouth (Nilsson 1983). *P. chlorantha*'s pollinaria generally stick to the eyes of pollinators, and those of *P. bifolia* to their proboscises (Nilsson 1978, 1983). Consequently, putative hybrids –possessing a column that is morphologically intermediate between the column structures of both species– are expected to interact imperfectly with the flower visitors due to the narrowly delimited surfaces on moths' heads that are suitable for attachment of viscidia (Claessens & Kleynen 2006, Nilsson 1978). The fact that such intermediately placed pollinaria are not generally found on moths indicates that they regularly become detached, generally from the hairy labial palps of the moths (Nilsson 1983, 1985). Consequently, introgressive hybridization is considered rare and only of temporal and local occurrence. Nevertheless, hybridization has been reported in a few populations, such as in Scandinavia (Nilsson 1985), in southern England (Bateman 2005; Bateman & Sexton 2008), in South Limburg, The Netherlands (Claessens, Gravendeel & Kleynen 2008, Claessens & Kleynen 2006) and in the upper valley of Lavant, Austria (Perko 1997, 2004). In the latter two situations, a large number of intermediate individuals were observed, even in the (quasi-) absence of parent species.

However, in a study that we conducted on two mixed populations of *P. bifolia* and *P. chlorantha* in Belgium, molecular data showed that hybridization and genetic admixture occurred only at a very low rate, despite the fact that species of both noctuids and sphingids have been observed visiting both *P. bifolia* and *P. chlorantha* (Claessens *et al.* 2008, Claessens & Kleynen 2006, Nilsson 1983). Moreover, most morphologically intermediate individuals turned out to be genetically identical to *P. bifolia*, and could therefore not be identified as hybrids (Esposito *et al.* unpublished).

Here, as a follow-up to this finding, we wanted to uncover the identity of effective pollinators able to visit these intermediate morphotypes in such sympatric populations. As such, we identified flower-visitors of the congeneric orchids *Platanthera bifolia* and *P. chlorantha* as well as the morphologically intermediate orchid individuals in these two mixed populations.

Material and methods

Study species. — Both *P. bifolia* and *P. chlorantha* species are rewarding, and their nectar is hidden deeply in their long spurs, and hence available only to pollinator species with long proboscises. Their flowering period in central Europe occurs between May and July and is partly overlapping in areas of sympatry (Delforge 2005). Both species show a significant different morphology of the column. *P. bifolia* displays a small column and two anther pockets that are set almost parallel to each other. Pollinaria are generally transferred by 'massulae' units (Johnson & Edwards 2000). *P. bifolia* shows a distance between the viscidia of 0.2 to 1.1 mm and the pollinium shows a very short caudicle (0.2–0.5 mm); these characteristics imply that pollinia will be attached to the proboscis of pollinators. Pollinators of *P. bifolia* are mostly sphingids (Boberg, Alexandersson, Jonsson, Maad, Ågren & Nilsson 2013, Nilsson 1983, 1988). The column of *P. chlorantha* is wider with the anther pockets set strongly divergent at the base. Its pollinarium has a relatively long caudicle (1.2–2.2 mm) with a distance between the viscidia varying between 2.3 and 4.9 mm. This particular characteristic is considered an adaptation for attachment to the eyes of the pollinators (Maad & Nilsson 2004), which are mostly represented by noctuid moths (Claessens & Kleynen 2011, Nilsson 1978, 1983, 1985, Sexton 2014, Steen 2012). The distance between the viscidia of intermediate individuals is, on average, larger than in *P. bifolia* and smaller than in *P. chlorantha* (1.3–2.3 mm).

The visual assessment method that allows the assignment of the visited *Platanthera* species based on the morphology of pollinaria and on their position on pollinators' head was proposed firstly by Nilsson (1983) and confirmed by the study of Claessens *et al.* (2008).

Study area and sampling. — The study was performed in the Calestienne region in southern Belgium, in 2013 and 2014. Floral visitors were recorded during the peak flowering times in two sympatric *Platanthera* populations on the 22nd of June 2013, again in one of these on the 27th of June 2013 and finally in the other sympatric site on the 3rd of June and the 4th of July 2014. Light traps were running from 21:00 h and checked early next morning from 04:00 h onwards. One of the mixed populations was located on a calcareous grassland (Tienne de Botton), while the other was located in a light birch-ash wood (Bois Niau). In order to catch pollen-vectors, we utilised light traps that have proven to be highly suitable for sampling moth communities (Heath 1965, Merckx *et al.* 2009a, b, Merckx, Marini, Feber & Macdonald 2012a, Merckx *et al.* 2012b, Young 1997). Sampling moths with light traps has also some additional advantages in terms of cost and ease of use, compared to video monitoring for instance (Steen & Mundal 2013).

Two light traps were deployed for each of the sympatric zones, where two *Platanthera* species and the morphologically intermediate individuals were growing intermixed, hence possibly sharing pollinators. Light traps were placed in close vicinity (3–10 m) to inflorescences in good flowering conditions. Moths were sampled using Heath pattern actinic light traps (6 W), which operate on the 'lobster-pot principle', whereby individuals are drawn to an actinic tube, which is secured vertically between baffles, fall unharmed down a funnel, and rest inside the trap (Fig. 1). At dawn, captured moths were checked for the presence of *Platanthera* pollinaria by visual assessment. To facilitate the identification of the species/type of pollinaria we utilised a Peak scale magnifier. Moreover, during two observations nights, we photographed moth individuals, which were seen visiting *Platanthera* species without the support of light traps. Moths bearing pollinaria were identified, whilst the type and number of pollinaria was accurately checked. Specifically, we measured the length of the caudicle of the pollinaria attached to the moths' heads. Additionally, moths carrying pollinaria were photographed with a digital camera (Canon Eos 7D, Nikon D-200). We lumped data obtained with and without light trapping for analyses.

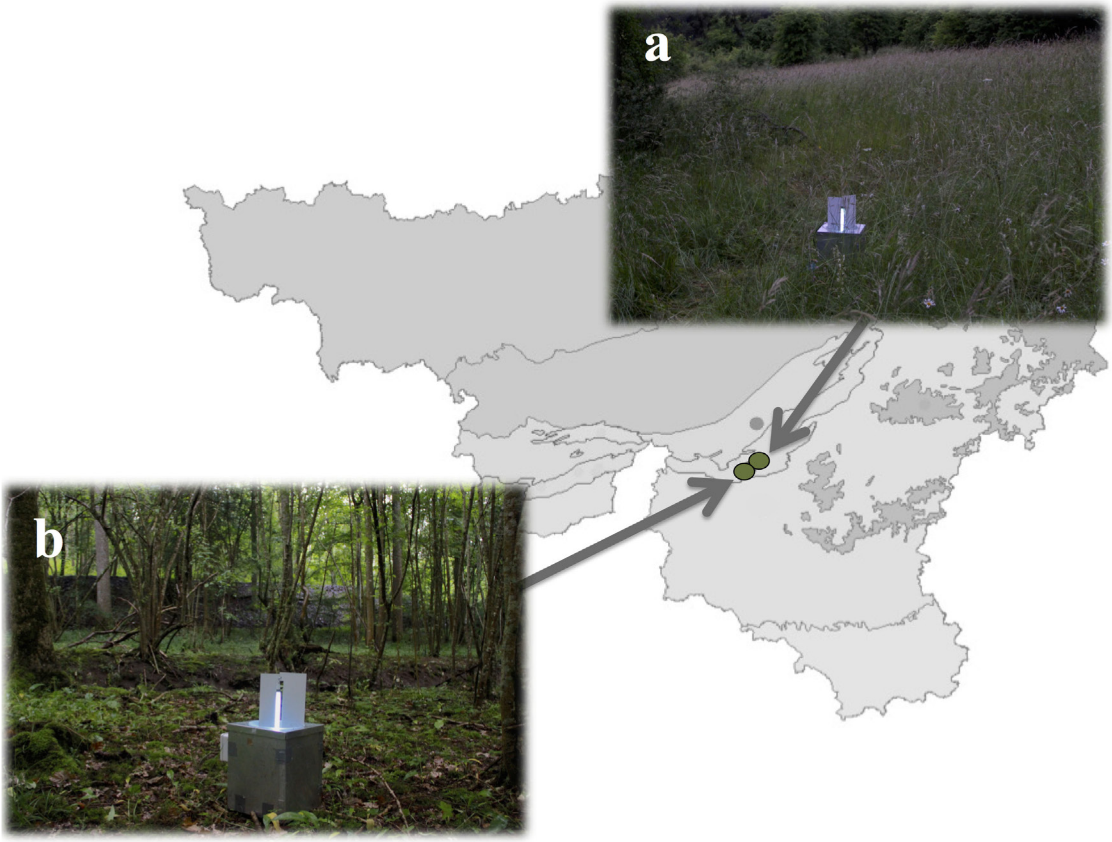

Figure 1. Map of Wallonia (Southern-Belgium) showing the locations of the sympatric populations of *P. bifolia* and *P. chlorantha* in the Calestienne region: (a) Botton and (b) Bois Niau (pictures F. Esposito). Pictures depict light traps at each location.

Results. Table SI1 gives the total number of nocturnal moths light-trapped during the observation nights at the sympatric sites of Botton and Bois Niau. On the whole, seven individuals from two medium-sized crepuscular-nocturnal species were carrying *Platanthera* pollinaria (Table 1).

Generally speaking, these observations show that pollinaria were carried according to expectations, i.e., one *P. chlorantha* pollinarium on the eye, two *P. bifolia* pollinaria on the proboscis, and one or two intermediate's pollinaria on the cheeks. The measurement of the length of each pollinarium determined the assignment (according to Nilsson's criteria 1983) to *Platanthera* species previously visited, and also confirmed the species attribution according to the position of pollinaria on the moths' heads (measurements of pollinia's length not shown).

These results also show that, in both sympatric locations, although the majority of species caught were belonging to the Geometridae family (Table 2), we only observed individuals of the Noctuidae family carrying *Platanthera* pollinia. More specifically, the total amount of moth species belonging to the Noctuidae family found with the pollinaria attached on the body was two species out of six. The only noctuid species found to carry intermediate's pollinaria turned out to be *Cucullia umbratica*.

Besides these light trap experiments, during two observation nights on 3rd June and 4th July 2014 at the Botton site, we managed to take a picture of a *Cucullia umbratica* moth visiting a *P. chlorantha* inflorescence with one pollinium attached to the cheek and (probably) two to the proboscis (Fig. 2F). Another visitor was also observed; this was *Noctua pronuba* with a pollinarium of *P. chlorantha* on the eye (Fig. 2G).

Table 1. Overview of moth individuals observed carrying orchid pollinaria during four nights of monitoring. Superscript numbers in front of the moth species name indicate different individuals of moths.

Date	Site	Plant species	Number pollinaria	Moth species	Position pollinaria	Figure
22/06/13	Botton	*P. chlorantha*	1	^{1}*Cucullia umbratica*	Eyes	2-D
		Intermediate	2	^{2}*Cucullia umbratica*	Cheeks	2-E
		P. bifolia	2	^{3}*Cucullia umbratica*	Proboscis	2-C
22/06/13	Bois Niau	*P. bifolia*	2	^{1}*Autographa gamma*	Proboscis	-
		P. chlorantha	1	^{2}*Autographa gamma*	Eyes	-
27/06/13	Bois Niau	*P. bifolia*	2	^{1}*Cucullia umbratica*	Proboscis	2-A
		P. bifolia	2	^{1}*Cucullia umbratica*	Proboscis	2-A
		P. bifolia	2	^{2}*Cucullia umbratica*	Proboscis	2-B
3/6/14	Botton	Intermediate	1	*Cucullia umbratica*	Cheeks	2-F
		P. bifolia	2	*Cucullia umbratica*	Proboscis	2-F
4/7/14	Botton	*P. chlorantha*	1	*Noctua pronuba*	Eyes	2-G

Discussion. The position and shape of the pollinaria attached to the caught moths proved sufficient to identify which orchid species had been visited, even if the visits themselves were not observed. One of the three observed moth species, *Cucullia umbratica*, here observed with pollinaria of *P. bifolia* and *P. chlorantha*, was already known to be a visitor of both *Platanthera* species (e.g. Nilsson 1978, 1983). However, contrary to the assumption of Nilsson (1983), who states that efficient transport of pollinaria on cheeks is impossible for putative hybrids, our observations in one of the sympatric populations show that the species visits flowers of intermediates, because their pollinaria were firmly stuck to the cheeks. This result corroborates earlier observations by Claessens *et al*. (2008) who captured the images of *C. umbratica* in the act of removing pollinaria via their proboscises from putative hybrids in the Netherlands. We succeeded in photographing one individual of *C. umbratica* approaching an inflorescence of *P. chlorantha* with three pollinaria attached to its cheeks (i.e. from intermediate orchid individuals; see Fig. 2F). This observation may represent a proof of the potentiality of intermediate morphotypes to act not only as pollen recipients but also as pollen donors.

In this case, crossing between intermediate forms could be effective (Claessens *et al*. 2008). It thus appears there is scope for hybridization and subsequent introgression, but this needs further testing. Furthermore, during our observations in one of the mixed populations (Bois Niau), we recorded two *Autographa gamma* individuals carrying both *P. bifolia* and *P. chlorantha* pollinaria on the proboscis and on the eye, respectively. The common and widespread noctuid *A. gamma* had already been described as one of the prominent pollinators of *P. chlorantha* in Sweden (Nilsson 1978), in south-central Scotland (Sexton & McQueen 2005) and in Spain (Ruiz 2009). Moreover, this moth species had also already been observed visiting *P. bifolia* (Plepys, Ibarra, Francke & Lofstedt 2002) and carrying its pollinaria (Ruiz 2009). *Noctua pronuba* too, which in this study was photographed with one *P. chlorantha* pollinium on the eye (Fig. 2G), had already been observed visiting *P. chlorantha* in Sweden (Hammarstedt 1980), in Central Scotland (Sexton 2014) and in the Iberian Peninsula (Ruiz 2009).

Thus, contrary to the literature (Nilsson 1983), which mentions mostly sphingids (especially *Deilephila* species) as the potential vector of hybridization, our observations show that it may well be possible that both orchid species are mainly pollinated by noctuid moths, and more specifically by *C. umbratica* and *A. gamma* effectively carrying pollinaria of both *Platanthera* species, with *C. umbratica* even observed carrying pollinaria of morphologically intermediate individuals. However, the dominance of these specific noctuids may be a matter of local and regional occurrence, influenced too by the availability of vegetation types, with other

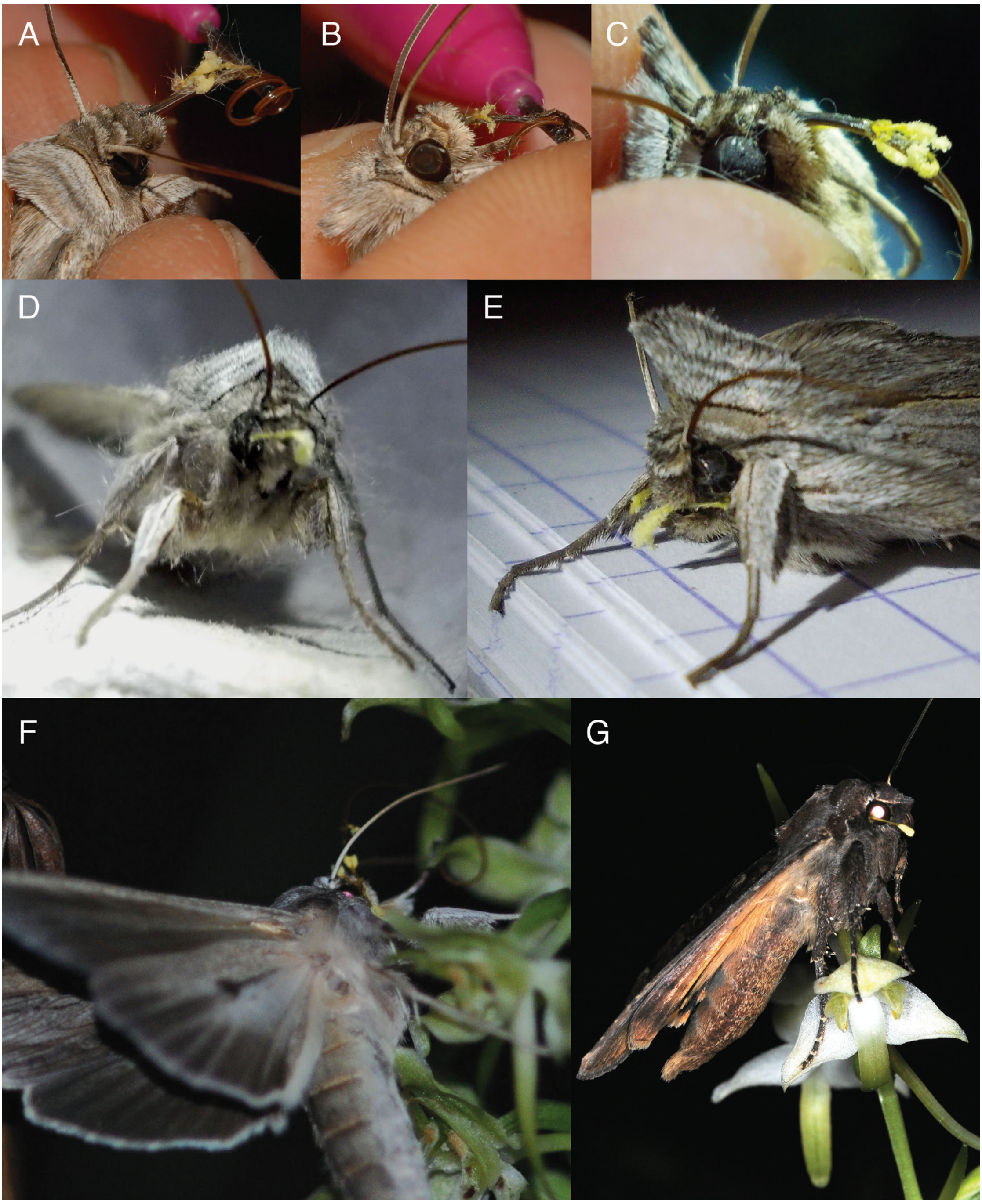

FIGURE 2. A–B: Bois Niau: two individuals of *Cucullia umbratica* with two pollinaria of *P. bifolia* on the proboscis (pictures D. Tyteca); C–D–E: Botton: three individuals of *Cucullia umbratica,* one with *P. bifolia* pollinaria on the proboscis*,* one with one *P. chlorantha* pollinarium on the eyes, and the other with two intermediates' pollinaria on the cheeks (pictures F. Esposito); F–G: Botton: *Cucullia umbratica* visiting *P. chlorantha* inflorescence with one pollinarium stuck to the cheek (coming from intermediate plant) and two to the proboscis (coming from *P. bifolia*), and *Noctua pronuba* with one *P. chlorantha* pollinarium stuck to the eye (pictures Guy Deflandre).

Cucullia and Plusiinae species being pollinators at sites in other regions (Hammarstedt 1980, Nilsson 1983, Sexton 2014).

Most noctuids and sphingids are described as strong fliers, able to cover large distances (Nieminen & Hanski 1998). Specifically, *A. gamma* and *N. pronuba* have been recorded to move distances of several hundred kilometres (Chapman *et al.* 2010, 2012, Hu, Lim, Reynolds, Reynolds & Chapman 2016, Waring, Townsend, & Lewington 2009). Their high mobility, both in terms of routine, daily movements (Slade *et al*. 2013) as in terms of (partial) migratory behaviour, possibly may have important effects on pollen dispersal ability and the extent of hybridization (Brys, Broeck, Mergeay & Jacquemyn 2014).

Reproductive isolation as well as the level of introgression are generally controlled through three kinds of integrated interactions: temporal, ethological (i.e. pollinators reacting to floral fragrances and to nectar availability) and morphological (i.e. interactions between the morphology of pollinators and the morphology of columns and spurs) (Esposito *et al*. unpublished, Nilsson 1983, 1985). Within the framework of the *Platanthera* study system, we hypothesize that the mechanical barrier preventing (or reducing) effective hybridization involves that the pollinia of *P. chlorantha* may often not be adequately placed in order to fit the position of *P. bifolia*'s stigma. This hypothesis contrasts with the alternative hypothesis, which suggests that the mechanical barrier may be due to the improper placement of pollinia from intermediate plants on visiting moths (Nilsson 1983). However, both hypotheses may fit with the rarity of real hybrid individuals, but does not explain why those intermediate plants, which appear to belong mainly to the gene pool of *P. bifolia*, appear in mixed populations. A previous hypothesis was formulated to give an explanation for the presence of these intermediate individuals (Esposito *et al*. unpublished). It seems that among those intermediate plants, the individuals tending towards *P. chlorantha* (which have a greater distance between their viscidia, and which flower earlier) are positively selected in order to attract and exploit *P. chlorantha* pollinators too. We have evaluated the validity of this hypothesis by exploring the effect of morphological traits on phenotypic selection through observing the relationship between plant trait expression and male versus female fitness, as a result of the interactions with pollinators (Esposito *et al*. unpublished). Thus, it seems that there is higher morphological variability within *P. bifolia* when the species comes in sympatry with *P. chlorantha*, probably because there is a higher selective pressure exerted by *P. chlorantha*'s pollinators. However, we do not know if *Platanthera* species just respond plastically to environmental conditions or whether they are in a process of early speciation and specialization in response to local pollinators.

In conclusion, although our study shows that noctuids have the potential to cause hybridization in *Platanthera*, more observational and genetic research is needed. Studies that test successful pollen deposition across species, whilst assessing pollen dispersal distances, are essential in order to eventually (dis)prove hybridization is actually happening, and to hence better understand *Platanthera*-pollinator networks.

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TABLE 2. Abundance of all macro-moth species, with indication of the family they belong to, light-trapped at the two sympatric sites.

Site – Date	N. ind.	Moths species	Moths family
Botton 22/6/13, 3/6/14 4/7/14	2	*Arctia villica*	Erebidae
	1	*Eilema griseola*	
	2	*Laspeyria flexula*	
	1	*Spilosoma lubricipeda*	
	1	*Anticollix sparsata*	Geometridae
	2	*Campaea margaritaria*	
	1	*Camptogramma bilineata*	
	1	*Chiasmia clathrata*	
	1	*Hylaea fasciaria*	
	4	*Hypomecis punctinalis*	
	1	*Lomographa temerata*	
	1	*Macaria liturata*	
	1	*Opisthograptis luteolata*	
	1	*Thera obeliscata*	
	2	*Thera spec.*	
	1	*Xanthorhoe designata*	
	1	*Xanthorhoe montanata*	
	2	*Pharmacis lupulina*	Hepialidae
	1	*Dendrolimus pin*	Lasiocampidae
	1	*Agrotis exclamationis*	Noctuidae
	3	*Apamea sublustris*	
	2	*Autographa gamma*	
	4	*Cucullia umbratica*	
	1	*Noctua pronuba*	
	1	*Pachetra sagittigera*	
	2	*Rusina ferruginea*	
Botton	1	*Ptilodon capucina*	Notodontidae
	1	*Laaothoe populi*	Sphingidae
Bois Niau 22/6/13, 27/6/13	1	*Habrosyne pyritoides*	Drepanidae
	1	*Thyatira batis*	
	1	*Herminia grisealis*	Erebidae
	2	*Spilosoma lubricipeda*	
	3	*Spilosoma lutea*	
	3	*Angerona prunaria*	Geometridae
	2	*Cabera exanthemata*	
	2	*Campaea margaritaria*	
	1	*Cepphis advenaria*	
	2	*Colostygia pectinataria*	
	2	*Dysstroma truncata*	
	1	*Ecliptopera capitata*	
	1	*Ecliptopera silaceata*	
	1	*Eupithecia haworthiata*	
	2	*Hypomecis roboraria*	
	2	*Ligdia adustata*	
	1	*Lomaspilis marginata*	
	2	*Macaria liturata*	
	1	*Melanthia procellata,*	
	1	*Parectropis similaria*	
	3	*Xanthorhoe montanata*	
	3	*Pharmacis lupulina*	Hepialidae
	2	*Calliteara pudibunda*	Lymantriidae

Table 2 (continues). Abundance of all macro-moth species, with indication of the family they belong to, light-trapped at the two sympatric sites.

Site – Date	**N. ind.**	**Moths species**	**Moths family**
Bois Niau 22/6/13, 27/6/13	1	*Abrostola tripartita*	Noctuidae
	1	*Apamea sublustris*	
	1	*Agrotis exclamationis*	
	2	*Autographa gamma*	
	1	*Autographa pulchrina*	
	2	*Cucullia umbratica*	
	1	*Deltote pygarga*	
	1	*Euplexia lucipara*	
Bois Niau 22/6/13, 27/6/13	1	*Hoplodrina octogenaria*	Noctuidae
	1	*Hypena proboscidalis*	
	1	*Lacanobia thalassina*	
	1	*Ochropleura plecta*	
	1	*Drymonia obliterata*	Notodontidae
	1	*Gluphisia crenata*	
	2	*Phalera bucephala*	
	1	*Stauropus fagi*	

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A NEW AND STRIKING *SPATHOGLOTTIS* (ORCHIDACEAE: COLLABIINAE), HONORING HER MAJESTY THE QUEEN OF BHUTAN

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Abstract. A new, attractive and morphologically unique species of *Spathoglottis* is described, illustrated and compared with the most similar species. The new species is currently only known from two localities in southeastern Bhutan and differs distinctly from its closest relative, *Spathoglottis hardingiana*, by the glabrous pedicels, forward-curved acuminate apices of the petals, a yellow hypochile of the lip, two pairs of unequal callus "horns" and swellings, and a spirally coiled epichile of the lip, versus a densely pubescent inflorescence and pedicels, a pale purple hypochile, a single pair of erect and clavate, or"bubble-shaped", callus swellings, and a projecting and narrowly triangular epichile of the lip for *S. hardingiana*.

Key words: Orchidaceae, Collabiinae, new species, *Spathoglottis*, Bhutan

Introduction. The genus *Spathoglottis* Blume was described in 1825 in *Bijdragen tot de Flora van Nederlandsch Indië* (Blume 1825-1827). The genus currently consists of approximately 50 species (Govaerts 2017) with some additional varieties and natural hybrids, distributed in India, Nepal, Bhutan, throughout subtropical SE Asia, China, Indonesia, New Guinea, Australia and the Pacific Islands.

On November 3, 2016, the remote region of Ngangla-Kaktong in the Zhemgang district of Bhutan (Fig. 1) was explored by National Biodiversity Centre's (NBC) Biodiversity Researchers Nima Gyeltshen and Kezang Tobgyel, and former contract staff Tandin Wangchuk, currently a Forest Ranger I in Trashigang Forest Division. The objective was to collect seeds for the Tree Seed Conservation Project.

The chosen location is also known to support small populations of *Paphiopedilum fairrieanum* (Lindl.) Stein (Fig. 2A, and *P. venustum* (Wall. ex Sims) Pfitzer (Fig. 2B). These orchid species are considered critically endangered throughout their known distribution in the Himalayan tropical to subtropical region but fortuitously grow together in limestone areas in the Ngangla-Kaktong area.

During the 2016 trip, it was observed that, although small and vulnerable, populations of *Paphiopedilum fairrieanum* (Lindl.) Stein and *P. venustum* (Wall. ex Sims) were still present and appearing healthy. The NBC team therefore decided to make a survey to document the species composition with a total of three plots where *Paphiopedilum* plants were present, with an area of 10 x 10 m2 for tree vegetation and 2 x 2 m2 for the ground vegetation (Fig. 3). During the composition survey of ground vegetation, a striking terrestrial orchid in full bloom was discovered inside the selected plot, which was at 1038 m.a.s.l. elevation. After returning to the base camp the specimen was processed and scanned and tentatively identified as an unusual *Spathoglottis* species. Later, photos were sent for a positive identification to Dhan Bdr. Gurung (College of Natural Resources, Lobesa, Bhutan), and Stig Dalström who confirmed that the attractive flowers indeed belong to a new and striking *Spathoglottis* species (Fig. 4–6).

Later, on November 8, 2016, the same NBC team made a trip to the remote villages of Martshala and Sarjung in the Samdrup Jongkhar district for additional tree seed collection and pre-collection assessments. Amazingly, another observation of the new *Spathoglottis* species was made growing on

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FIGURE 1. The mountains of southern Zhemgang are vast and difficult to explore.

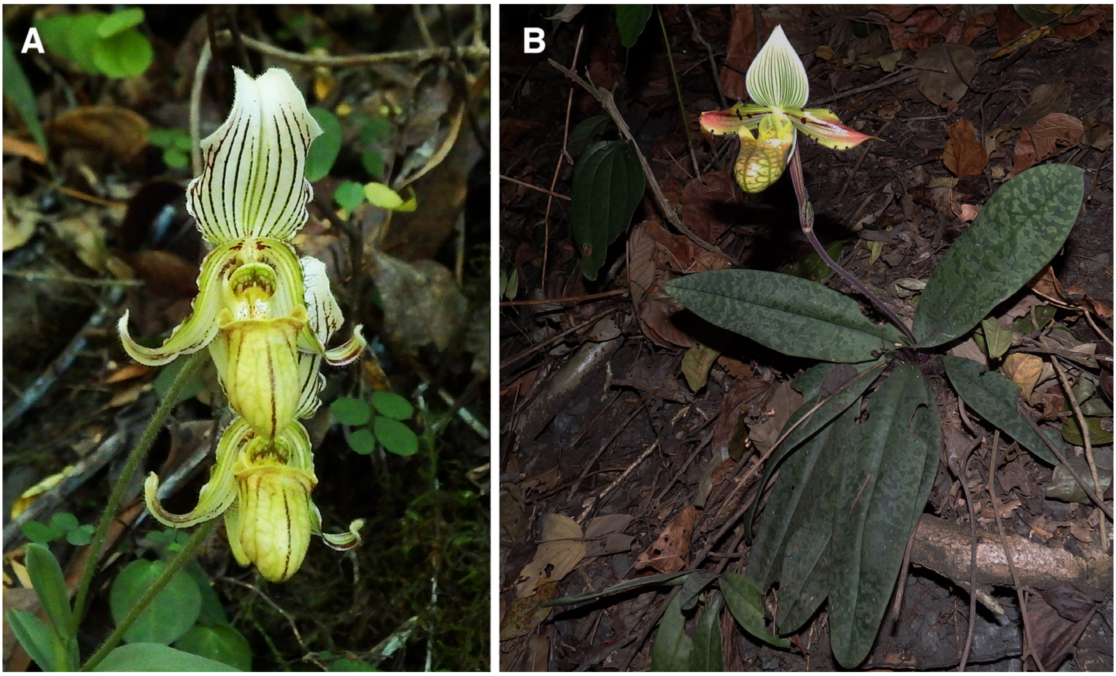

FIGURE 2. Species of *Paphiopedilum* at Ngangla-Kaktong region, Zhemgang, Bhutan. A, *P. fairrieanum*. B, *P. venustum*.

FIGURE 3. Tandin Wangchuk and Kezang Tobgyel collecting data at the type locality of *Spathoglottis jetsunae*.

FIGURE 4. Natural habitat of *Spathoglottis jetsunae* in Zhemgang. Photo by Nima Gyeltshen.

limestone outcrops together with *P. fairrieanum*. At this site only a single *Spathoglottis* plant was seen; in a larger population of the *Paphiopedilum*. Additional studies are desirable to achieve a better understanding of the natural distribution, occurrence and threats to this newly discovered and hence, little known *Spathoglottis*.

Only *Spathoglottis ixioides* (D.Don) Lindl., a rather small and yellow-flowered species was previously listed for Bhutan (Pearce & Cribb 2002). The discovery of the new and striking *Spathoglottis* is therefore a welcome contribution to the continuously increasing number of known orchid species documented for the small country known as the "Land of the Thunder Dragon".

TAXONOMIC TREATMENT

Spathoglottis jetsunae N.Gyeltshen, K.Tobgyel & Dalström, ***sp. nov.***

Type: Bhutan. Zhemgang, Ngangla Trong, terrestrial in shallow layers of soil on or below limestone outcrops, alt. 1038 m.a.s.l., 3 Nov. 2016, *N. Gyeltshen, K. Tobgyel* & *T. Wangchuk Ni.G-708-2016* (holotype: THIM). Fig. 4–6.

Diagnosis. *Spathoglottis jetsuniae* is similar to *S. hardingiana* C.S.P.Parish & Rchb.f. (Fig.7), but differs by having sub-glabrous inflorescence, axis and pedicels, petals with abruptly acuminate apices curved forward, a yellow lip with a pair of spreading fleshy callus lobes and an additional, parallel pair of digitate, or "sausage-shaped", callus structures above, and a narrow and coiled-up, strap-like mid-lobe. In contrast, *S. hardingiana* has distinctly pubescent inflorescence, axis, ovaries and pedicels, acute petals, a pale mauve lip with a single pair of thick and clavate, or bulbous, erect callus structures, and a porrect and narrowly triangular mid-lobe (Parish & Reichenbach 1875; Curtis's Botanical Magazine 1904).

Terrestrial *herb*. *Roots* thin and fibrous, *ca*. 1–2 mm thick. *Pseudobulbs* globose-ovoid, *ca*. 2.5 × 2.0 cm, covered by fibrous sheaths. *Leaves* 1 to 3, oblanceolate, narrowly acute to broadly acuminate, plicate, *ca*. 34 × 4 cm long, proximately narrowed into a *ca*. 3.5 cm long petiole-like base. *Inflorescence* axillary from the base of the pseudobulb, slender, erect to slightly arching, mainly glabrous turning micro-pubescent towards the apex; *raceme* many-flowered; *peduncle* slender with 5 tubular, acute *ca*. 1.5–3.5 cm long sheaths; *rachis* straight, *ca*. 13 cm long and rather dense-flowered; floral bracts narrowly acuminate, 4–10 mm long. *Pedicel* with *ovary* slender, glabrous, 4.0–5.5 cm long. *Flowers* *ca.* 2.5–2.8 cm across; *dorsal sepal* white turning bluish magenta with maturity, cuneate, elliptic and bluntly acute, *ca.* 14 × 6 mm; *lateral sepals* similar in color and shape, obtuse, *ca.* 13.0–13.5 × 6.0–6.5 mm; *petals* similar in color, cuneate, broadly elliptic, slightly oblique apically with an abruptly acuminate, *ca.* 2.3 mm long apex which is distinctly curved forward in the natural state, *ca.* 13.5–14.0 × 7.0 mm; *lip* flexibly attached at the base of the column, basally shallowly concave and indistinctly 3-lobed; lateral lobes rounded, *ca*. 5.0–5.5 mm long, margins basally entire but increasingly pilose near the base

FIGURE 5. The striking flowers of *Spathoglottis jetsunae*. Photo by Nima Gyeltshen

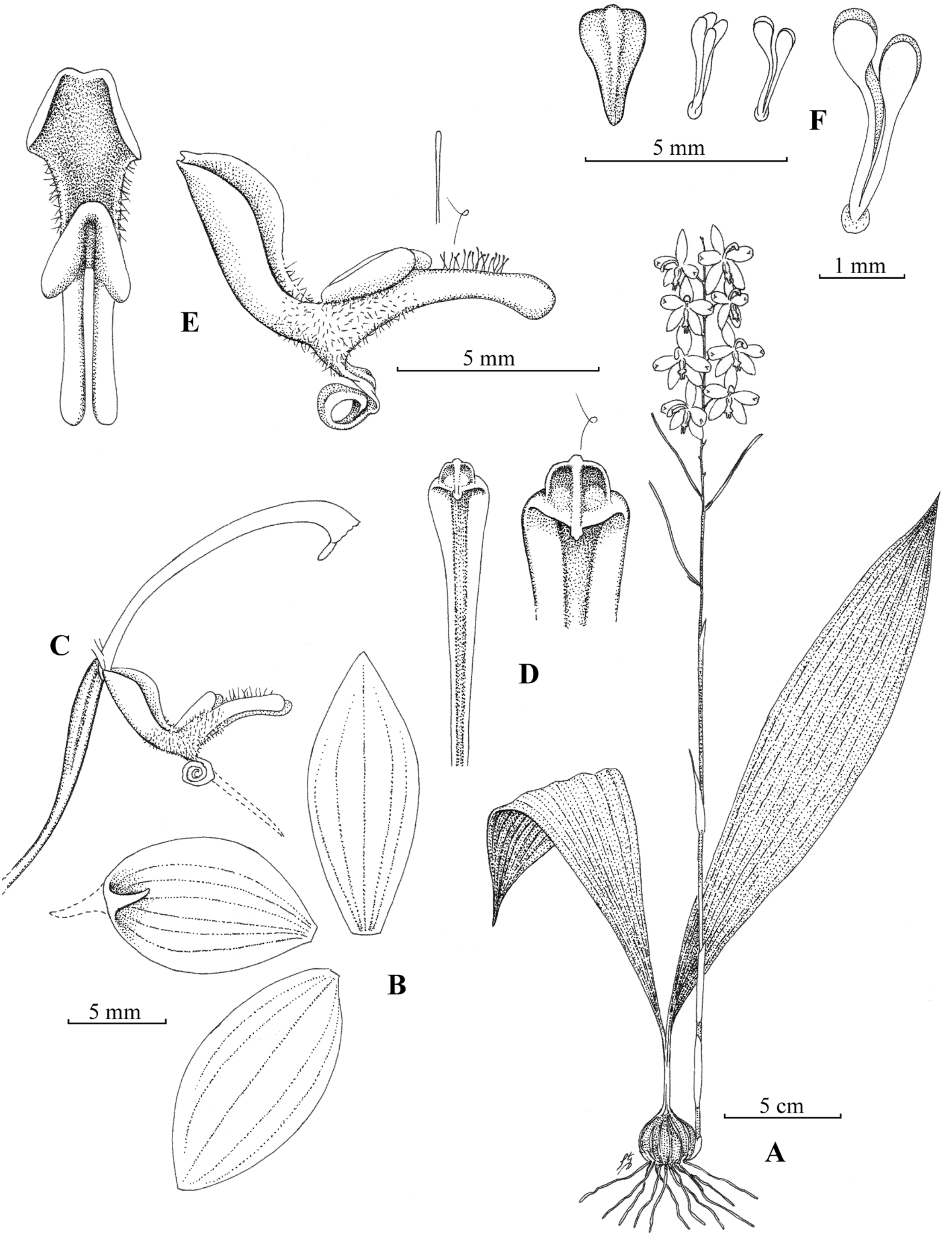

FIGURE 6. *Spathoglottis jetsunae* N.Gyeltshen, K.Tobgyel & Dalström. A. Plant habit. B. Dissected flower without the lip. C. Lateral view of the lip and column. D. Ventral views of the column. E. Dorsal and lateral views of the lip. F. Dorsal view of the anther cap, and pollinaria. Drawn from the holotype by Stig Dalström.

Figure 7. *Spathoglottis hardingiana* from the Curtis' *Botanical Magazine*, plate 7964 (1904).

of the callus, front-lobe reduced to a coiled-up, *ca.* 6 mm long narrow strap-like structure, callus of a pair of basally pubescent spreading fleshy lobes, with an additional erect and parallel pair of *ca.* 5.8–6.0 mm long digitate, or "sausage-shaped", structures; *column* slender, erect and gradually arcuate, narrowly winged throughout and becoming broader towards the apex, *ca.* 14 mm long; *anther* campanulate, pyriform in upper view, dorsally indistinctly lobulate; *pollinarium* of two sets of four elongate, clavate *ca.* 2.0–2.3 mm long pollinia. *Capsule* not seen.

Paratype: Bhutan, Zhemgang, Ngangla Trong, same area as the holotype, terrestrial on or below limestone outcroppings, alt. *ca.* 1038 m.a.s.l., 3 Nov. 2016, *N. Gyeltshen, K. Tobgyel & T. Wangchuk Ni.G-708* (THIM).

Other material studied: Samdrup Jongkhar, Martshala and Sarjung, terrestrial in thin layer of soil on limestone outcrops, alt. 981 m.a.s.l., 8 Nov. 2016, *N. Gyeltshen, K. Tobgyel & T. Wangchuk s.n.* (digital photographs in authors' archives).

Ecology: *Spathoglottis jetsuniae* grows terrestrially in shallow soil on or below NW facing limestone outcrops at approximately 980 – 1000 m.a.s.l. elevation, with the soil pH of 7.1 – 7.8, and in close proximity of *Paphiopedilum fairrieanum* populations. The forest vegetation in the selected plot is mostly dominated by evergreen trees including *Rapanea capitellata* (Wall.) Mez. (RBA = 28.99 %), *Phoebe lanceolata* (Nees.) Nees. (RBA = 27.87 %) and *Acer oblongum* Wall. ex DC. (RBA = 18.11 %), RBA of *P. fairrieanum* was 0.02 % and *P. venustum* was 0.03 %. Total RBA of evergreen tree species in Ngangla and Kaktong habitats were 67.4 % and 63.4 % respectively.

Distribution: *Spathoglottis jetsuniae* is so far only known from two localities in southeastern Bhutan.

Eponymy: *Spathoglottis jetsuniae* is named in loving and respectful honor of Her Majesty the Queen Jetsun Pema Wangchuck of Bhutan, who has a dedicated and sincere interest in the protection of the environment and the wild flora and fauna of Bhutan.

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A NEW SPECIES OF *CATASETUM* (ORCHIDACEAE: CATASETINAE) FROM CASANARE, COLOMBIA

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Abstract. A new species of *Catasetum* was found in eastern Colombia, Casanare Department, in the Orinoquía bioregion. The species is described and illustrated, and data associated with its phenology, distribution and conservation status are discussed. The new species, *C. lucisuareziae*, is related to other species found in the same region, like *C. rectangulare* and *C. callosum,* from which it mainly differs by the three-lobed labellum and the presence of two subglobular calli at the base.

Resumen. Una nueva especie de *Catasetum* fue encontrada en el departamento de Casanare hacia el oriente de Colombia, en la bioregión de la Orinoquía. Se describe e ilustra la especie y se estipulan parámetros asociados a su fenología, distribución y estado de conservación. La nueva especie, *Catasetum lucisuareziae,* es comparable con otras especies que se encuentran en la misma región, como *C. rectangulare* y *C. callosum*, pero difiere de ellas principalmente por su labelo trilobulado y la presencia de dos callos subglobulares en la base.

Key words / Palabras clave: biodiversidad, biodiversity, *Catasetum bicolor*, *Catasetum lucisuareziae*, conservación, conservation, Cymbidieae, Epidendroideae, Orinoquía

Introduction. Orchidaceae include about 28,000 species and, together with Asteraceae, it is the most diverse group of angiosperms (Chase *et al*. 2015). Colombia is one of the countries with the greatest diversity of Orchidaceae, with 4,270 species in 270 genera; about 35% of the species are endemic (Betancourt, Sarmiento, Toro-González & Valencia 2015). Most of the endemic species are native to the Andean bioregion. The areas with the lowest diversity are the Orinoco river basin and the Atlantic slopes, with only 143 species recorded (Betancourt *et al*. 2015, Sarmiento 2007).

The genus *Catasetum* includes about 140 species distributed throughout the Neotropics (Romero & Jenny 1993, Romero 2012), although Chase *et al*. (2015) accept up to 176 taxa. For Colombia, Ortiz and Uribe (2007, 2014), Bonilla, Mosquera and Otero (2013a), Ortiz (2015) and Betancourt *et al*. (2015) recognize 37 species.

Materials and methods. Casanare is one of the least studied departments of Colombia (Usma & Trujillo 2011). In the Orchidaceae, 32 genera and 58 species have been recorded from this area (Betancourt *et al*. 2015). However, recent studies conducted in the Orinoco river basin addressed the importance of the region's biodiversity, showing that 77 orchid species were recorded in the Meta Department alone (Jiménez 2011). Two years after the start of the explorations in this region, the number of documented orchid species already overcome the 300 taxa (Bonilla *et al.* 2013b).

The material examined for this study was collected in 2013, during the exploration of Casanare, when a population of a unidentfied species of *Catasetum* was found in the town of Hato Corozal. The plants were cultivated in a greenhouse at Villavicencio (Meta), in the farm of Luci Suárez, for their documentation and study.

Results. Based on floral morphology, the new species described hereafter, *Catasetum lucisuareziae*, belongs to a small group of species that in Colombia includes *C. bicolor* Klotzsch*, C. callosum* Lindl. and *C. rectangulare* G.F.Carr.

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Key to the Colombian species of *Catasetum* related to *C. lucisuareziae*

1. Petals linear to oblong-lanceolate	2
2. Lateral sepals falcate, labellum rectangular	*C. rectangulare*
2’. Lateral sepals reflexed or oblique, labellum lanceolate, ovate or trilobed	3
3. Labellum lanceolate, ovate or slightly off site with a central callus apiculate	*C. callosum*
3’. Labellum trilobed, without a callus	*C. boyi*
1’. Petals elliptic or elliptic-lanceolate	4
4. Labellum trilobed, the mid-lobe slightly elliptic	*C. lucisuareziae*
4’. Labellum pentalobed, the mid-lobe triangular	*C. bicolor*

Catasetum lucisuareziae M. Bonilla, J. Mosquera & Benelli, ***sp.nov.*** Fig. 1–2.

TYPE: Colombia. Casanare: Hato Corozal, Bosque de Sabana, 6.133541° -71.728464°, 222 m, 26-VI-2013, *M Bonilla-M.*, *J Mosquera*, *A Velázquez* & *L Suárez, s.n.* (holotype, LLANOS!).

Diagnosis: *Catasetum lucisuareziae* is similar to *C. bicolor*, from which it mainly differs by the 3-lobed labellum (vs. 5-lobed) and the two subglobular calli at the base of the lip (vs. two ligules); it also resembles *C. rectangulare* and *C. callosum*, from which it differs by the ovate-lanceolate bracts, elliptic petals, 3-lobed labellum with 2 basal subglobular calli, and erect staminal column.

Epiphytic, cespitose *herb*, 15–40 cm tall when leafy. *Pseudobulb* ca. 13 × 6 cm, terete, elliptical-spindle, of 1–9 internodes. *Leaves* ca. 25 × 4 cm, oblong-lanceolate, distichous, plicate, deciduous. *Inflorescence* basal, 1–2 symultaneous, many-flowered (12–20) racemes, straight or curved at the apex, ca. 25 cm long, provided with basal bracts. Male *flowers* resupinate, fragrant, brown, the labellum yellow-green. *Pedicel* ca. 45 mm long, including the short ovary. *Floral bracts* lanceolate-ovate, 9 × 3 mm. *Dorsal sepal* oblong-elliptic, acute, concave, membranous, ca. 29 × 7 mm. *Lateral sepals* elliptic, acute, convex, membranous, ca. 30 × 7 mm. *Petals* elliptic, convex, membranous, ca. 26 × 5 mm. *Labellum* 3-lobed, sacciform, cordate when spread, fleshy, 6–7 mm long, 10.0–10.8 mm wide, 9 mm deep, the lateral lobes elliptic with the margin sometimes undulate, the midlobe triangular, round, with two subglobular calli at the base. *Column* trigonous, erect, ca. 18 mm long, 3–4 mm wide toward the apex, yellowish-green stained brown; rostellum 6–8 mm, slim and projected forward and backward. *Anther* operculate, apiculate, unilocular, ca. 9 × 3 mm, the apex yellowish-green. *Pollinia* 2, elliptic-obovate, flattened dorsiventrally, split, yellow, ca. 3 × 1 mm, on a oblong stipe and sticky viscidium. Female *flowers* not observed. Immature *fruit* green, trilocular.

Distribution: The species has been hiterto recorded only from the municipality of Hato Corozal (Fig. 3).

Eponymy: In honor of Luci Suárez, who has taken charge of the conservation and management of native orchid species of Meta.

Phenology: This species flowered in January in cultivation.

Conservation Status: According to the criteria of the IUCN (2014), *C. lucisuareziae* is characterized as Data Deficient (DD). The only known population of the species is not located within any conservation unit. However, *ex situ* conservation management performed by Mrs. Luci Suárez and his son on their farm is highly relevant for its preservation.

Catasetum lucisuareziae belongs to subgenus *Catasetum* section *Isoceras* (Mansf.) Senghas, characterized by symmetrical antennae (Senghas 1990, Romero 2009).

Among the species found in the bioregion of the Orinoco (Bonilla *et al.* 2014), the most alike are *C. rectangulare* and *C. callosum*. The three species can be easily distinct, however, on the basis of their characteristic floral morphology (Table 1). *Catasetum rectangulare* and *C. callosum* have linear and oblong-lanceolate floral bracts, respectively, while *C. lucisuareziae* has ovate-lanceolate bracts. While in *C. lucisuareziae* the petals are elliptic, they are linear to oblong-lanceolate in *C. rectangulare* and *C. callosum*.

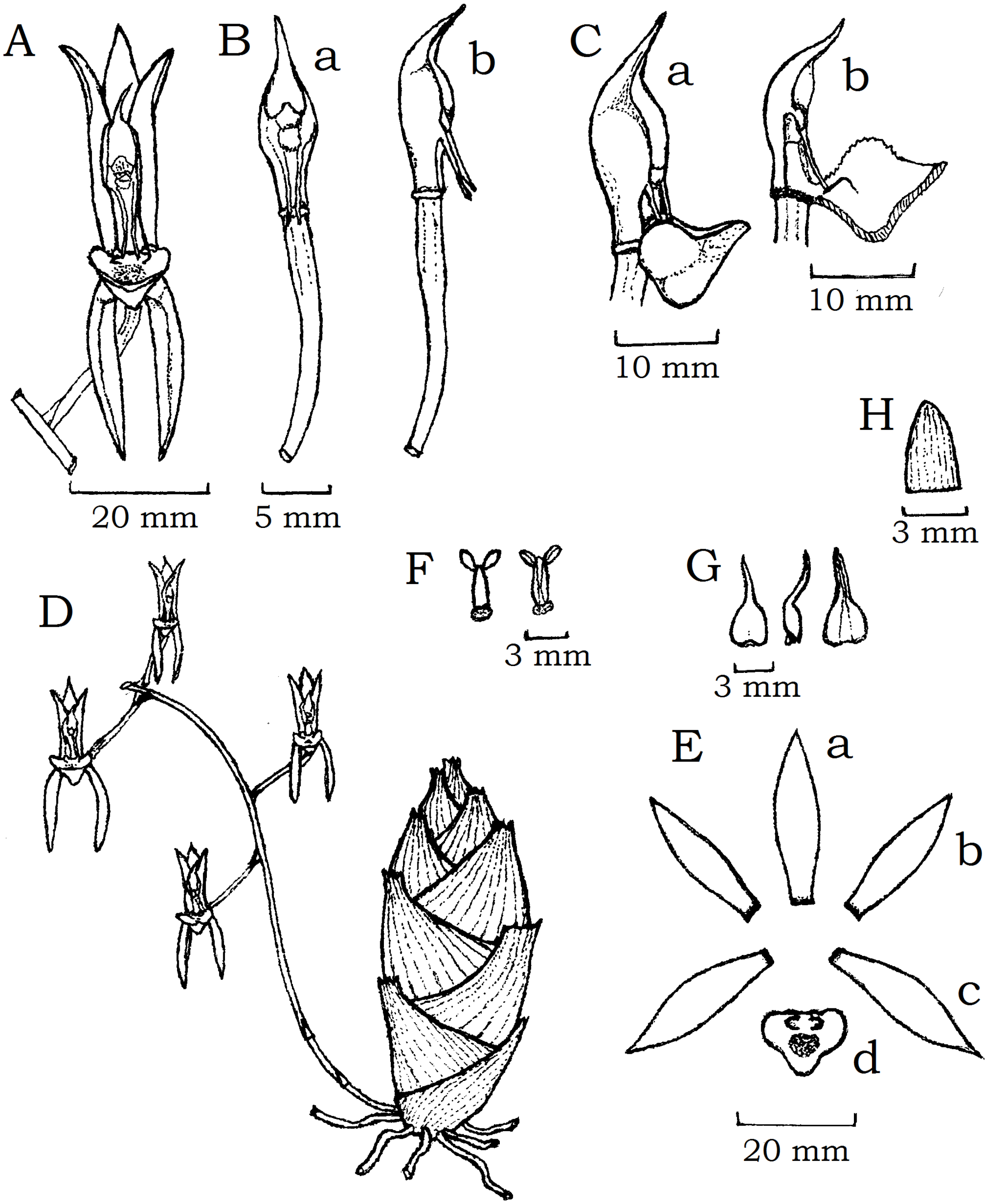

Figure 1. *Catasetum lucisuareziae*. A. Male flower, frontal view. B. Column set: a, frontal view; b, lateral view. C. Column with labellum set: a, lateral view; b, same, with the labellum longitudinally sectioned. D. General view of the plant habit without leaves, the inflorescence with male flowers. E. Male flower, dissected perianth: a, dorsal sepal; b, petal; c, lateral sepal; d, labellum, frontal view. F. Pollinarium, two views. G. Anther cap in frontal, lateral and dorsal views. H. Floral bract. Illustration by M. M. Bonilla-M. from the type.

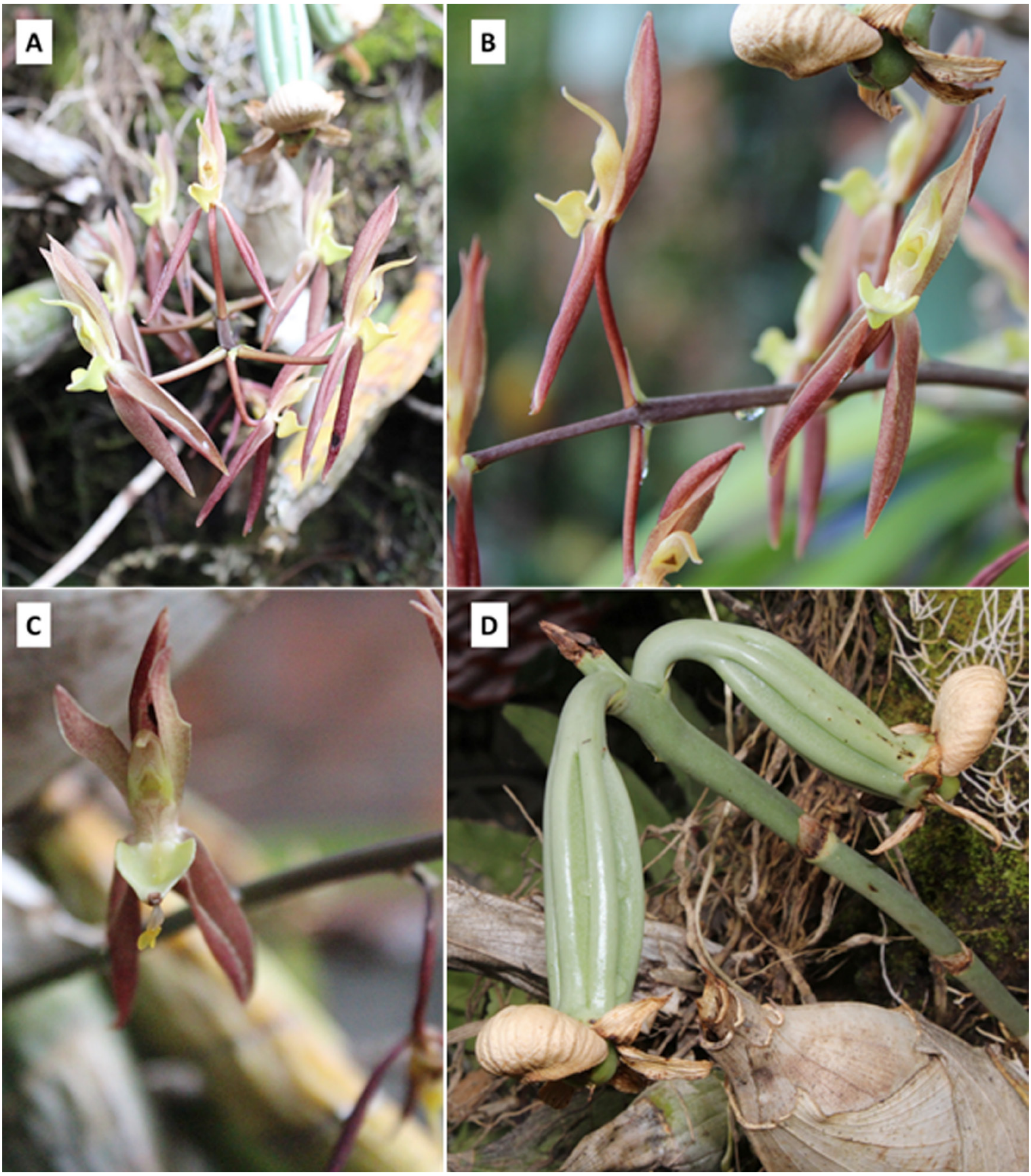

Figure 2. *Catasetum lucisuareziae* M. Bonilla, J. Mosquera & Benelli. A. Inflorescence. B. Male flower, lateral view. C. Male flower, frontal view. D. Imature fruit. Illustration by M. M. Bonilla-M.

In addition, *C. lucisuareziae* has a lobed labellum with two subglobulares calli (*vs*. entire with a single callus), and the apex straight basck (*vs*. arched and slightly curved) (Table 1).

Catasetum lucisuareziae can also be compared to *C. bicolor*, which is recorded for Colombia in the bioregion of the Atlantic and the Middle Magdalena valley between the Cordillera Central (CC) and the Cordillera Oriental (CO), on the western flank. However, it was not registered from the eastern flank of the CO or the bioregion of the Orinoco (Bonilla *et al*. 2013b, Ortiz 2015). Nevertheless, the 3-lobed labellum

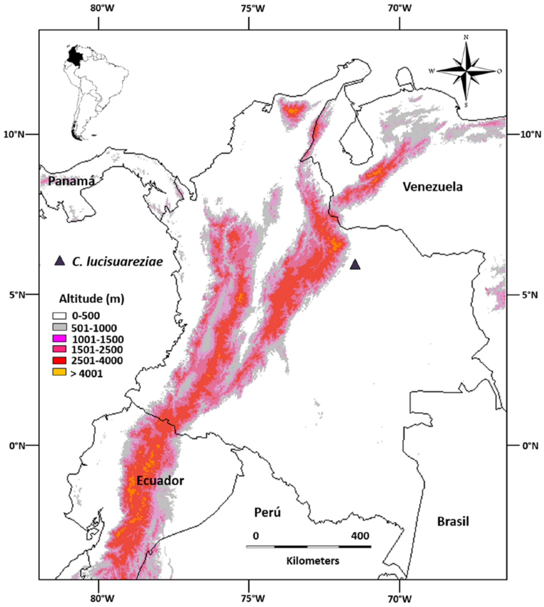

Figure 3. Distribution of *C. lucisuareziae* in Colombia. Illustration by M. M. Bonilla-M.

with elliptical lobes distinguishes this species, whereas in *C. bicolor* the lip is 5-lobed with three lobes at the apex (the triangular central lobe triangular and the other two linear), and the laterals lobes are upright. Moreover, instead of the two subglobular calli at the base of the lip, *C. bicolor* presents two ligules, one on each side lobe.

The new species and *C. bicolor* can also be compared to *C. boyi* Mansf. However, while *C. bicolor* is distributed from Panama to Venezuela, *C. boyi* is exclusively known from Brazil (Govaerts *et al.* 2015), in regions quite distant from the area of occurrence of *C. lucisuareziae* in the Colombian Orinoquia. The main morphologic differences between the species of this complex can be by observed in Figure 4, where the flowers of the four species related to *C. lucisuareziae* are shown. *Catasetum lucisuareziae* differs from *C. boyi* by its elliptic oblong, 2.9 cm long dorsal sepal *versus* elliptic-lanceolate, 2.5 cm long. The lateral lobes of the labellum are suberect in C. *lucisuareziae, vs*. distinctly erect in *C. boyi* (Fig. 5); in the first species they have slightly undulate margins and the mid-lobe is smooth, whilst in the latter the margins of the lateral lobes and the midlobe are strongly undulate; in the central portion, the labellum of *C. lucisuareziae* is 9 mm depth*,* while in *C. boyi* it is only 3 mm depth; the calli of the lip are subglobular in *C. lucisuareziae,* but they are triangular and obliquely erect in *C. boyi*.

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Table 1. Comparison of floral details between *Catasetum lucisuareziae* and its closest relatives.

	Catasetum lucisuareziae	***C. rectangulare***	***C. callosum***	***C. boyi***
Bract	Oval-lanceolate	Lanceolate	Oblong	Ovate-lanceolate
Peduncle	30 ×4–5 mm	25–30 × 3.5–4 mm	25–30 × 3.5–4 mm	40 × 2-3 mm
Dorsal sepal	29 × 7 mm	25–31 × 5–6 mm	25–42 × 6–8 mm	25 × 8 mm
Lateral sepal	30 × 7 mm, reflexed	23–27 × 5–7 mm, falcate	24–4 × 8–9 mm, reflexed somewhat oblique	38 × 4 mm, reflexed
Petals	26 × 5 mm, elliptic	22–25 × 5–7 mm, linear to oblong-lanceolate	22–38 × 5–55 mm, linear to oblong-lanceolate	25 × 8 mm
Labellum	6 mm long × 10 mm wide × 9 mm deep	17 mm long × 6 mm wide × 4 mm deep	13–21 mm long × 8–10 mm wide × 5–6 mm deep	6 mm long × ca 4 mm wide × ca 3 mm deep
Labellum ornament	Trilobed, lateral lobes with denticulate margin, slightly elliptical margin entire central lobe and two subglobular calluses, smooth, basal	Entire, rectangular, margin entire or denticulate, triangular apex, callus I dispersed in the base with a central uplift.	Entire, lanceolate, ovate or slightly pandurate, smooth or irregularly toothed margin, acute apex, central callus and a lifting apiculate	Trilobed, lateral lobes with filiform margin, semiovate margin filiform central lobe and two erect triangular calluses, basal
Staminate Column	Erect, 18 × 3–4 mm	Arched, 14 × 7 mm	Slightly curved, 12 × 5–6 mm	Erect, 20 × 4 mm

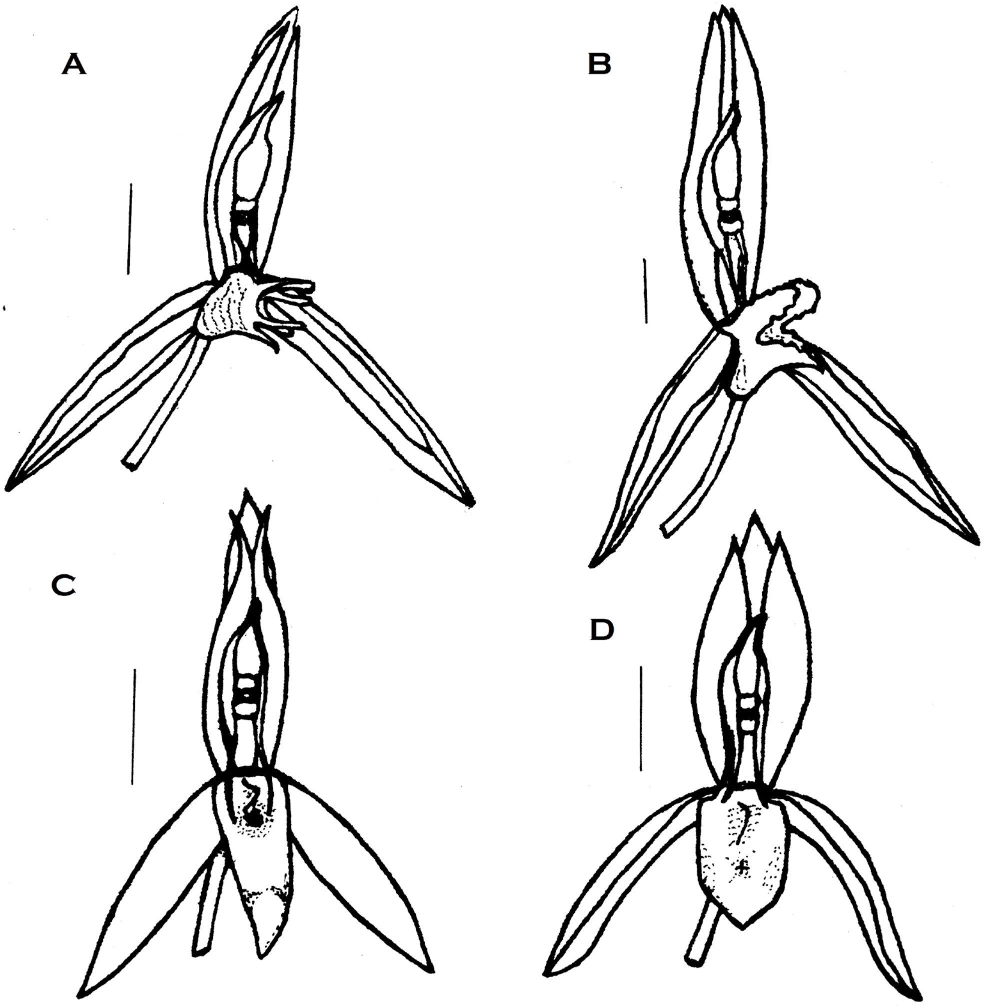

Figure 4. Comparison of the flowers between A. *Catasetum bicolor*, B. *C. boyi*, C. *C. callosum* and D. *C. retangulare*. Illustration by M. M. Bonilla-M. and A. Petini-Benelli.

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Figure 5. *Catasetum boyi*, frontal and lateral view, with closeups of the labellum. Photography by A. Petini-Benelli.

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CUATRO NUEVOS REGISTROS DE ORCHIDACEAE PARA HONDURAS

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Abstract. Four new records for the Honduran orchid flora are recorded: *Chysis bruennowiana* (department of Comayagua), *Lycaste cruenta* var. *minor* (Ocotepeque), *Ornithidium tonsoniae* (Comayagua) and *Sobralia powellii* (Ocotepeque).

Resumen. Se reportan cuatro nuevos registros para la orquideoflora de Honduras: *Chysis bruennowiana* (departamento de Comayagua), *Lycaste cruenta* var. *minor* (Ocotepeque), *Ornithidium tonsoniae* (Comayagua) y *Sobralia powellii* (Ocotepeque).

Key words / Palabras clave: Comayagua, Ocotepeque, orquídeas

Introducción. Honduras es un país con una extensión de 112,492 km^2 y está ubicado en el centro de América Central. En su compleja geografía, sobresalen tres regiones: las llanuras de la costa del Caribe, la región montañosa compuesta por tres cordilleras (norte, central y del sur) y las llanuras del golfo de Fonseca. El estudio se realizó en dos zonas: en la Sierra de Comayagua, de la cordillera central y en la Sierra del Merendón, en el departamento de Ocotepeque, que pertenece a la cordillera del sur, atraviesa Honduras desde este departamento en el occidente, hasta el departamento de Gracias a Dios, en el este del país. Las tres regiones están divididas por valles de profundos ríos (Mejía & House 2002).

La heterogeneidad de hábitats a diferentes elevaciones, así como la espacial, dada por los efectos de montaña y los parteaguas, entre otros, afectan la distribución y abundancia de las poblaciones de orquídeas, incrementando su diversidad (Heywood 1995). El clima de Honduras es tan variado como la configuración de su suelo, y esto también afecta la diversidad y el endemismo.

Aunque los investigadores residentes tengan conocimiento que poblaciones de determinadas especies se encuentran en el país, al no estar éstas documentadas formalmente, la comunidad internacional no tiene acceso a esta información. Esta situación ha hecho que investigadores como Ossenbach, Pupulin y Dressler (2007) digan que Honduras es como un "agujero negro" en cuanto a la información sobre la distribución y abundancia de orquídeas en Centroamérica. El número de registros proporcionado por Nelson Sutherland (2008), quien registró 146 géneros y 652 especies de Orchidaceae, se ha venido incrementando recientemente con los trabajos de investigadores residentes, como los de Linares y Ancalmo (2016), Pérez Munguía (2015a, b), y Vega y colaboradores (2014, 2016) .

Nuevos registros para la flora de Honduras

1. ***Chysis bruennowiana*** Rchb.f. & Warsz., Bot. Zeit. (Berlin) 15 (10): 157. 1857. TIPO: Perú. Sin localidad específica, *J. Warczewicz s.n.* (holotipo, W, no visto).

Hierba epífita de hasta 79 cm de altura. *Raíces* fuertes, cespitosas, teretes, oscuras, de color verde oscuro, cubiertas de vainas. *Seudobulbos* carnosos, claviformes, que se van ensanchando gradualmente hacia el ápice redondeado, pendulosos, segmentados, recubiertos de vainas, 16–45 cm de largo por 3.5–6.0 cm de ancho. *Hojas* 4 por seudobulbo, con margen entero, nervaduras carinadas en el envés, de color verde brillante, plicadas, lanceoladas, agudas, con la base imbricada, 22–43 cm de largo por 5.6–9.4 cm de ancho. *Inflorescencia* en racimo que mide 37–45 cm de longitud, con 4-6 flores; el pedúnculo con brácteas, 3.4–4.5 cm de longitud. *Flores* de color amarillo, con manchas de color lila en el labelo. *Sépalo dorsal* arqueado, oblongo-elíptico, carnoso,

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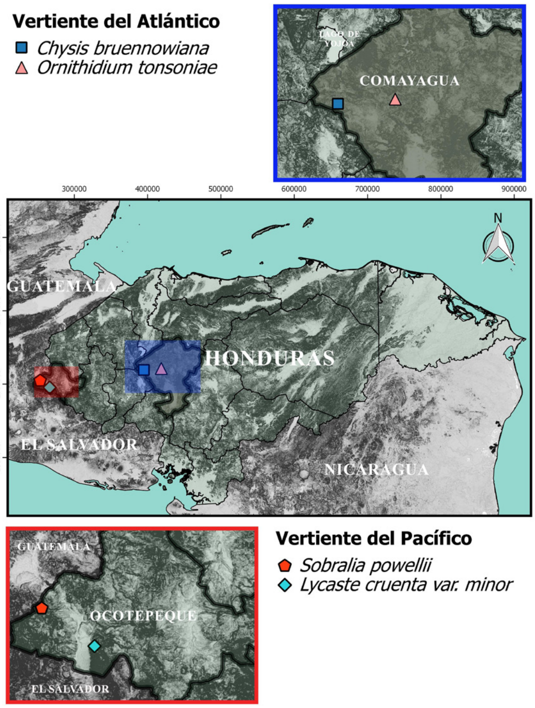

Figura 1. Ubicación de los nuevos registros en Honduras.

3.0–3.5 cm de largo por 1.5–2.0 cm de ancho. *Sépalos laterales* oblongo-elípticos, unidos a la columna, connados en la base, formando un mentón, 2.0–2.5 cm de largo por 1.7-2.0 cm de ancho. *Pétalos* de obovados a lanceolados, 2.5–3.0 cm de largo por 1.0–1.5 cm de ancho. *Labelo* trilobado, reflexo, disco con tres quillas grandes y otra más pequeña a cada lado, todas de color blanco, carnosas; lóbulos laterales subfalcados, agudos de 2.0–2.5 cm de largo por 1.2–1.5 cm de ancho (Fig. 2A).

Figura 2. Características morfológicas de *Chysis bruennowiana*. A. Inflorescencia B. Pseudobulbos.

Reconocimiento: Planta grande y robusta, con seudobulbos claviformes, pendulosos, con el ápice redondeado. Labelo trilobado, reflexo, con cinco quillas carnosas de color blanco, las de los lados, más pequeñas. Las manchas color lila en el labelo son características de esta especie (Fig. 2A–B). *Chysis tricostata* Schltr., que se encuentra en forma simpátrica, es una planta más pequeña, con los seudobulbos de arqueados a erectos y posee manchas en el labelo de color rojo.

Adopto aquí el nombre de *Chysis bruennowiana*, el cual se ha usado en tratamientos recientes de las orquídeas del área mesoamericana (ej. Pupulin 2002, Dressler 3003, Ossenbach *et al.* 2007, Bogarín *et al.* 2014), aunque el tipo de esta especie es del Perú, una región que florísticamente comparte pocos elementos con la parte septentrional del istmo de Centro América.

Distribución: Honduras, Nicaragua, Costa Rica, Panamá, Perú y Bolivia.

Hábitat en Honduras: Hierba epífita de hasta 80 cm de altura, en árboles de bosque montano inferior y bosque tropical siempre verde (Mejía y House, 2002) (Fig. 6A) sobre árboles de café, en cafetal abandonado, junto a *Chysis trichostata* Schltr.

Fenología: Los tres especímenes estudiados florecieron en abril.

Material examinado: Honduras. Comayagua: cerca de la comunidad de El Rosario, Taulabé, 14°38’44.1”N, 87°58’34.1”O, 1153 m, 29 de abril de 2016, *D.E. Pérez 678* (EAP).

2. ***Lycaste cruenta*** var. ***minor*** Oakeley, Lycaste, Ida and Anguloa Essential Guide: 50-52. 2008. TIPO: Guatemala. En la colección de Otto Tinschert, ciudad de Guatemala, 4 de septiembre de 1991, *Oakeley A63* (holotipo, K-HFO).

Hierba epipétrica, de hasta 23 cm de altura. *Raíces* cespitosas, blanquecinas. *Seudobulbos* piriformes con vainas escariosas hasta la mitad del seudobulbo, 8–10 cm de largo por 6–7 cm de ancho. *Flores* color amarillo verdoso con labelo amarillo naranja, con fuerte esencia a vainilla. *Inflorescencia* 12–14 cm de longitud, con vainas triangulares. *Sépalo dorsal* cóncavo, acuminado, oblongo lanceolado, 3.5–3.8 cm de largo por 1.9–2.0 cm de ancho. *Sépalos*

FIGURA 3. Características morfológicas de *Lycaste cruenta* var. *minor*. A. Inflorescencia. B. Flor.

laterales similares, 4–5 cm de largo por 1.5–2.3 cm de ancho. *Pétalos* superpuestos, ondulados, 1.5–3.0 cm de largo por 1.3 cm de ancho. *Labelo* trilobulado con la base con manchas de color rojo, la base del labelo del mismo largo que ancho, con un callo muy pequeño; el lóbulo central 1.0–1.2 cm de largo por 0.8–1.2 cm de ancho. Produce néctar, pero no tiene nectario.

RECONOCIMIENTO: el color rojo en la base del labelo, así como su tamaño pequeño (Fig. 3A–B), distingue a esta variedad. Difiere de *Lycaste* x *cobani,* en que esta última tiene la base del labelo más larga que ancha, los lóbulos laterales son elongados, lo que hace que los márgenes de enfrente se vean casi verticales (Oakeley 2008).

DISTRIBUCIÓN: Guatemala, El Salvador y Honduras. La especie ya estaba reportada para Honduras, no así la variedad, que fue determinada por H. Oakeley en 2016.

HÁBITAT EN HONDURAS: Hierba terrestre y litofítica, a lo largo de quebradas intermitentes, sobre rocas, en asociación con *Sobralia* sp. y *Lycaste cochleata* Lindl. Bosque montano inferior, de 1100 msnm, semicaducifolio (Mejía & House 2002), con predominancia de tres tipos de robles (Fagaceae), *Quercus segoviensis* Liebm., *Q. bumelioides* Liebm., y *Q. oleoides* Schltdl. & Cham. (Fig. 6B). Flores de color amarillo (Fig. 3A–B).

FENOLOGÍA: Florece en enero, febrero, marzo y agosto.

MATERIAL EXAMINADO: Honduras. El Roblerón, municipio de Ocotepeque, Ocotepeque 14°25’15.3”N, 89°09’59.3”O, 1105 m, 3 de Marzo de 2016, *D.E. Pérez et. al. 661* (EAP).

FIGURA 4. Características morfológicas de *Ornithidium tonsoniae* . A. Inflorescencia B. Seudobulbos.

3. ***Ornithidium tonsoniae*** (Soto Arenas) Senghas, Orchideen (ed. 3) I/C (44-45). 2001. TIPO: México. Chiapas: Mun. Ocosingo, 850 m, 20 de julio de 1989, *M.A.Soto Arenas, E.Martínez & S.Purata 5710* (holotipo: AMO; isotipo: SEL).

Hierba epífita hasta 50 cm de alto. *Raíces* largas, teretes. *Seudobulbos* ovoides a globosos, de un solo entrenudo, progresivamente más pequeños hacia el ápice, 1.5–3.5 cm de largo por 1.0–2.5 cm de ancho. *Tallos* ramificados secundariamente, con vainas escariosas, imbricada, saliendo de la axila de las vainas foliáceas del seudobulbo. *Inflorescencias* 9–12, unifloras, producidas en grupos sobre los tallos; pedúnculo 1 cm de longitud. *Flores* de color blanco cremoso. *Sépalo dorsal* espatulado, 6 mm de largo por 3 mm de ancho. *Sépalos laterales* erectos, 10 mm de largo por 1 mm de ancho. *Pétalos* espatulados, 5 mm de largo por 2 mm de ancho. *Labelo* amarillo en la base, entero y triangular.

RECONOCIMIENTO: Soto Arenas (2002), reconoce esta especie por ser epífita sub arbustiva, con seudobulbos de ovoides a globosos, hojas carnosas, y las flores agrupadas y de color crema (Fig. 4A–B).

DISTRIBUCIÓN: México, Guatemala y Honduras.

HÁBITAT EN HONDURAS: Epífita de flores color blanco cremoso, (Fig. 4A) en bosque mesófilo de montaña. (Fig. 6C).

FENOLOGÍA: Florece en diciembre.

MATERIAL EXAMINADO: Honduras. Comayagua: Montaña Los Imposibles, hacia Santa Rita de El Rosario, 14°39’50”N, 87°45’18”O, 1371 m, 19 de diciembre 2015, *D. E. Pérez, 651* (EAP).

Figura 5. A, B y C: distintos colores y tonalidades de *Sobralia powellii*.

4. ***Sobralia powellii*** Schltr., Repert. Spec. Nov. Regni. Veg. Beih. 17: 11. 1922. TIPO: Panamá. An den hinterwässern des Gatun-Sees, *C. W. Powell 2* (holotype, B, destroyed; lectotype designated by Christenson [1991], AMES, isolectotypes, MO).

Hierba terrestre, robusta, formando grandes masas, de 106–175 cm de altura. *Raíces* gruesas, café. *Tallos* delgados, tipo caña, con vainas entre los entrenudos, escariosas y de color café. *Hojas* alternas, conduplicadas, de 4–10 por tallo, oblicuas, elípticas, fuertemente acuminadas, multinervadas (9–10), 13–22 cm de largo por 6–8 cm de ancho, de color verde claro con vainas foliares punteadas. *Inflorescencia* solitaria, con flores vistosas de color blanco cremoso, con bandas lila tanto en los sépalos como en los pétalos; garganta amarilla. *Sépalo dorsal* retuso, oblongo, acuminado, márgenes lisos, 6 cm de largo por 2 cm de ancho. *Sépalos laterales* de lanceolados a oblongo lanceolados, horizontales, retusos, 4–6 cm de largo por 2.0–2.5 cm de ancho. *Pétalos* anchos, oblongos a obovados, 4.5–5.0 cm de largo por 3 cm de ancho. *Labelo* doblado alrededor de la columna

Figura 6. Hábitats donde crecen los nuevos registros de Honduras. A. *Chysis bruennowiana*. B. *Lycaste cruenta* var. *minor*. C. *Ornithidium tonsoniae*. D. *Sobralia powellii*.

como trompeta, o embudo, algo retuso, con márgenes sumamente ondulados (Fig. 5A–C).

Reconocimiento: Dodson (1984) reconoce esta especie por su tamaño grande, robusto, con flores grandes de color blanco, con el labelo amarillo y las líneas blancas en la porción expandida y reflexa de la porción apical del labelo (Fig. 5A–C). Por su tamaño puede confundirse con *Sobralia macrantha* Lindl., pero ésta tiene colores sólidos, sin bandas.

Distribución: Honduras, Nicaragua, Costa Rica, Panamá, Colombia, Ecuador y Perú.

Hábitat en Honduras: Terrestre y rupícola, en cañones de quebradas y planicies cerca de las quebradas. Bosque tropical semicaducifolio, montano inferior, 1100–1200 msnm; bosque de pino (Pinaceae) y roble (Fagaceae) con *Pinus oocarpa* Schiede ex Schltdl. y *Quercus oleoides*, *Q. sapotifolia* Liebm., *Byrsonima crassifolia* (L.) Kunth (Malpighiaceae) (Mejía y House, 2002) (Figura 6D). Flores grandes con un conjunto de colores y tonalidades desde casi blanco, lila, hasta casi violeta (Figura 5A–C).

Fenología: Florece en enero, febrero, y marzo.

Material examinado: Ocotepeque: Piedras Bonitas, 14°30’11.1’’N y 89°17’11.9’’O, 1179 m, 31 de enero 2016, *D. E. Pérez et. al.* 657 (EAP).

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CYPRIPEDIUM CALCEOLUS (ORCHIDACEAE) IN CENTRAL RUSSIA: A CASE STUDY FOR ITS POPULATIONS IN TWO PROTECTED AREAS IN THE REPUBLIC OF MORDOVIA (RUSSIA)

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Abstract. *Cypripedium calceolus* is considered as one of the flagship plant species of nature conservation. It is legally protected throughout Eurasia. Due to its wide distribution range, this Eurasian species could be considered as Least Concern, Near Threatened, Vulnerable, Endangered or Critically Endangered taxon. We performed an analysis of the status for some *C. calceolus* populations in Central Russia located in the Republic of Mordovia, with emphasis on populations situated in the federal protected areas. The aim of our study was to asses the modern state and the endangerment of *C. calceolus* populations. The environment conditions and species composition in five habitats with rare species in Mordovia were compared using phytoindication methods. Changes in stage spectrum and total abundance dynamics in *C. calceolus* populations over 2011–2016 were estimated and compared with available data from other locations within species' range. Reproductive ability of populations from the federal protected area, Mordovia State Nature Reserve, were studied. The results showed that *C. calceolus* grows in three habitat types that differed in environment conditions and floristic composition. *Convallaria majalis* was the only species registered in all studied locations, together with *C. calceolus*. In Central Russia this species occurs in broad-leaved, coniferous and mixed forests. The three populations of *C. calceolus* within the Mordovia State Nature Reserve and National Park "Smolny" were characterized by the dominance of vegetative individuals in stage spectrum, while generative plants predominated in two other populations located in mixed forests. No correlation between total abundance of individuals and stage spectrum in populations of threatened species has been found over the study period. The population in Mordovia Reserve showed a higher fruit set (36.7% as a mean) than others reported within its range. Continued population monitoring of *C. calceolus* in Central Russia from different habitat types is suggested. Generalization of jointly obtained demographic, ecological, phytocoenological data will be appropriate in order to develop measures for conservation and management of *C. calceolus* habitats.

Key words: stage spectrum, critically endangered species, *Cypripedium calceolus*, fruit set, plant population, protected areas

Introduction. The orchid family is one of the most species rich families of seed plants. It includes about 880 genera with more than 25,000 species in the world (Cribb *et al*. 2003). Due to mycorrhizal specificity (McCormick & Jacquemyn 2014), pollinator specialization (Cozzolino & Widmer 2005) and limited germination rates (Dearnaley *et al*. 2012), most orchids are extremely susceptible to habitat disturbance as compared to other plants (Cozzolino & Widmer 2005, Jacquemyn *et al*. 2007). Orchids frequently occur in very specific habitats (Wotavova *et al*. 2004). They are particularly vulnerable to climate and land-cover changes due to their narrow ecological preferences. A high proportion of species have declined in abundance and are considered to be rare, threatened, or endangered, primarily as a result of habitat loss (Kull & Hutchings 2006, Pillon & Chase 2007). Patterns of orchid richness are regulated by habitat size and elevation range at large scales (Acharya *et al*. 2011), while by light availability, soil moisture, canopy height and area (especially for the epiphytic orchids) at fine scales (McCormick & Jacquemyn 2014).

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About 130 orchid species belonging to 42 genera are documented in the Russian Federation (Varlygina 2011). Due to the increase of anthropogenic influence and natural features of orchid species many of these plants are endangered and 65 species were included in the Red Data Book of the Russian Federation (Bardunov & Novikov 2008). There are 39 orchid species belonging to 20 genera in Central Russia (Averyanov 2014). Of these, 19 species were included in the Red Data Book of Russian Federation (Bardunov & Novikov 2008).

Cypripedium calceolus L. is one of the most attractive terrestrial representatives of Orchidaceae in Eurasia. Its distribution ranges from Great Britain and Scandinavia across Northern and Central Europe to North-Eastern Spain, Northern Italy, and from Western Europe through southern Siberia to Rebun Island (Bardunov & Novikov 2008, Cribb 1997, Hultén & Fries 1986, Kull 1999, Vakhrameeva *et al*. 2014). Although, *C. calceolus* is included in the Global IUCN Red List with category Least Concern (LC), this is one of the most endangered orchid species in Europe (Kull 1999). In different regions of Eurasia, *C. calceolus* has been estimated as Near Threatened (Bilz 2011, Turis *et al*. 2014), Vulnerable (Rassi *et al*. 2001), Endangered (Witkowski *et al*. 2003), and Critically Endangered (Blinova & Uotila 2011, Khapugin *et al*. 2017a, Khapugin *et al*. 2017c). International studies on *C. calceolus* related to its genetic diversity (Brzosko *et al*. 2009, Brzosko *et al*. 2011, Fay *et al*. 2009, Kļaviņa *et al*. 2014, Minasiewicz & Znaniecka 2014), population ecology and biology (Blinova 2002, Brzosko 2002, Davison *et al*. 2013, Fardeeva *et al*. 2010, Gajewski & Marcisz 2014, Khapugin *et al*. 2014, Korczyński & Krasicka-Korczyńska 2014, García *et al*. 2002, García *et al*. 2010, Gorchakovskii & Igosheva 2003, Kirillova 2015, Kull 1998, Nicolè *et al*. 2005, Puchnina 2017, Stetsuk 2013, Zheleznaya 2015), impacts of environment conditions and stress-factors on the species (Blinova 2002, 2012, Czerepko *et al*. 2014, Kirillova 2016, Kirillova *et al*. 2012, Puchnina 2017, Shefferson *et al*. 2012), pollination (Antonelli *et al*. 2009, Tremblay 1994), as well as the list of publications with new records of this threatened species is continuously enlarging (e.g. Balázs *et al*. 2016, Matysek *et al*. 2014, Piwowarski 2013, Puchnina *et al*. 2015, Randić *et al*. 2013). However, there is a lack of data on the status of *C. calceolus* populations in many parts of its natural distribution range.

Cypripedium calceolus is included in the Red Data Book of the Russian Federation (Bardunov & Novikov 2008). It is known from 20 populations in the Republic of Mordovia (Central Russia). However, 14 sites are located outside of the existing protected areas network (Khapugin *et al*. 2017b). Moreover, actual protection of *C. calceolus* is provided only for three populations in the Mordovia State Nature Reserve. Thus, the status of other populations still needs to be monitored in order to understand what factors could contribute to deplete the *C. calceolus* populations there.

Cypripedium calceolus is an emblematic plant species in the Republic of Mordovia. Its picture has been portrayed on the cover page of 1st edition of the Red Data Book of the Republic of Mordovia (plants, fungi, lichens) (Silaeva 2003). Recently, the regional IUCN status of this species was estimated as Critically Endangered (Khapugin *et al.* 2017a,c). However, data on individual populations are fragmented. Continuous six-year studies have been carried out only in the Mordovia State Nature Reserve. Two local *C. calceolus* populations at the boundary of the National Park "Smolny" have been studied for three years. In addition, fragmentary data of different years on two more *C. calceolus* populations in Bolshie Berezniki district of Mordovia, are available. But to date these fragmented data were not generalized.

The aim of the present study was to study population structure, biology and ecology of *C. calceolus* in Central Russia, emphasizing its populations in two federal Protected Areas in the Republic of Mordovia: Mordovia State Nature Reserve and National Park "Smolny". The following questions were addressed: (I) What is the status of *C. calceolus* populations protected by Mordovia State Nature Reserve and National Park "Smolny"? (II) Are there differences between the *C. calceolus* populations studied?

Materials and methods. The Republic of Mordovia is located on the border of the forest and forest-steppe zones in Central Russia. The eastern part of the Republic of Mordovia covers the north-west of the Volga Upland, and its western part is located on the west of the Oka-Don lowland. High habitat diversity is observed, coniferous and mixed forests are distributed in the west and north-west, broad-leaved forests are distributed in the central and eastern parts, and forest-steppe landscapes dominate in the east and south-east (Yamashkin 1998, 2012).

Cypripedium calceolus is a long-lived perennial that may survive more than 30 years (Kull 1988). This is a geophyte with a horizontal rhizome growing up to 10 cm underground. Stems are 20–60 cm in height with 3–5 elliptical to ovate-oblong leaves, which are 11–17 cm long and 5.5–8 cm wide. It produces one or two (rarely three) large flowers, with a purple-brown perianth and yellow shoe-shaped labellum. The fruit is a capsule (3 cm long and about 0.9 cm in diameter) with 6,000–17,000 seeds (Denisova & Vakhrameeva 1978, Tatarenko 1996, Kull 1999).

Most well-studied populations of *C.calceolus* in the Republic of Mordovia are located in the Mordovia State Nature Reserve (MR), National Park "Smolny" (NP) and in the vicinity of the biological station of the Mordovia State University (BS). Of the three populations in MR, only one is still known. One population has disappeared after a wildfire in 2010, while a second population is very small (up to 10 individuals) and does not appear every year. Results of population-based studies in the Mordovia State Nature Reserve (MR) and in National Park "Smolny" (NP) were compared. Data for the populations' stage structure and floristic composition in the vicinity of the biological station of the Mordovia State University (BS1: about 750 m^2, 54.188541 N, 46.172314 E; BS2: about 350 m^2, 54.183617 N, 46.175930 E) were available from 2012 and 2015. The field investigations were carried out for the populations in MR (about 1000 m^2, 54.716110 N, 43.205170 E) in 2011–2016, for population NPt near Tashkino village in 2014–2016 (about 100 m^2, 54.736807 N, 45.505268 E), and for the population NPk near Kamchatka village during 2012, 2014 and 2016 (about 350 m^2, 54.726835 N, 45.457555 E).

To get a complete overview of the species' situation, abundance of individuals and morphometric traits of plants of *Cypripedium calceolus* populations were studied on established square (1×1 m) plots. In total, three (NPt) and six (NPk, MR) square plots were established in studied habitats. The composition of the accompanying flora was recorded on square plots (15×15 m) with respect to each location for further interpretation. The abundance of each species has been estimated in accordance with the scale of Braun-Blanquet (1964). The nomenclature is in accordance with The Plant List (2013) and Euro+Med Plantbase (Euro+Med 2006+). Jaccard's similarity index was calculated (Jaccard 1901).

Based on the species composition of flora within each *C. calceolus* location, the mean environment indicator values (EIVs) for each studied habitat was calculated. For this purpose, Tsyganov's (1983) ecological scale was used, where EIVs are arranged as intervals. Therefore, for each plant species the range of its existence in relation to a concrete factor, for instance, soil nitrogen, moisture etc., can be defined. Values could be evaluated in conventional units covering the total factor range from the minimum up to the maximum in relation to concrete species. Mean values were calculated using an algorithm suggested by Buzuk & Sozinov (2009). Six environmental factors were examined: shadiness (L), temperature (T), continentality (C), moisture (M), pH (R), and soil nitrogen (N).

In the framework of our study each above-ground shoot was the accounting unit being conditionally treated as an individual. Based on revealed morphometrical data (height of shoot, number of leaves and leaf veins, presence/absence of flowers), individuals of *C. calceolus* were divided into four ontogenetic stages: juvenile (j), immature (im), mature vegetative (v) (non-flowering adults) and generative (g) (flowering adults) (Denisova & Vakhrameeva 1978, Vakhrameeva & Tatarenko 1998). The group of mature vegetative individuals comprised both virginal and generative plants which failed to form generative shoots and, hence, were in the vegetative state in the study year. Depending on the ratio between these age groups, three types of the stage spectra of populations were distinguished according to Gorchakovskii & Igosheva (2003): vegetatively-oriented (with the prevalence of juvenile, immature, or mature vegetative individuals), generatively-oriented (with the prevalence of generative individuals), and bimodal (with two peaks – one accounted for by vegetative and the other, by generative individuals). Stage spectra of *C. calceolus* populations at the Republic of Mordovia were compared with results of previous demographic studies carried out in Spain, Estonia, Poland, Central and Northern Russia and Siberia (Fig. 1).

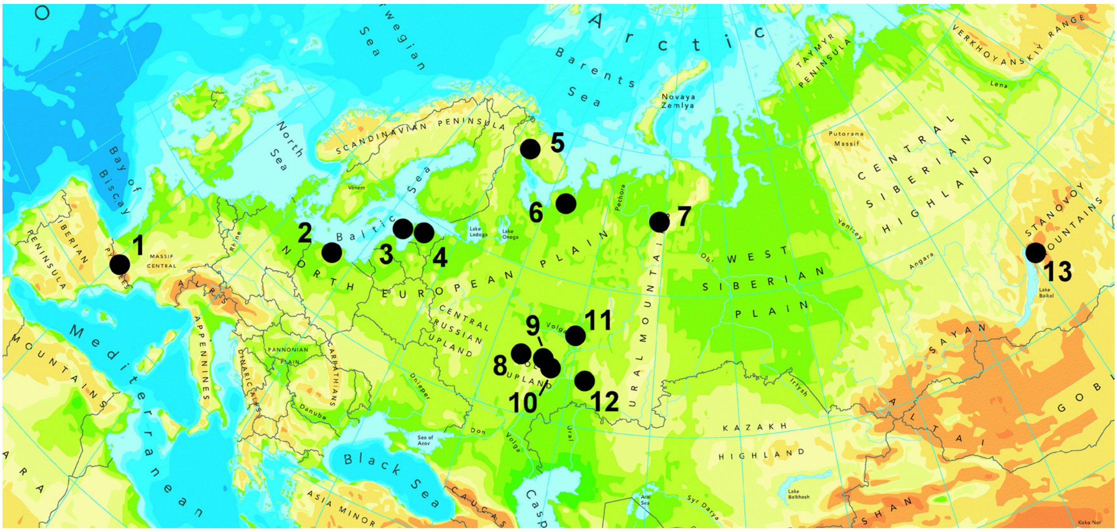


FIGURE 1. Geographical location of some *Cypripedium calceolus* populations within its range. Locations: 1. Sallent, Pineta, Tormosa, Ordesa; 2. Lake Kwiecko; 3. Muhu I, Muhu II, Hiiumaa, Puhtu; 4. Ussisoo, Tooma, Õisu I; 5. Apatity; 6. Pinega 1, Pinega 2; 7. “Yugyd va” 1–7; 8. Mordovia State Nature Reserve (MR); 9. neighbourhoods of villages Tashkino (NPt) and Kamchatka (NPk) near National Park “Smolny”; 10. neighbourhood of the biostation of the Mordovia State University (BS1, BS2); 11. Republic of Tatarstan; 12. Buzuluksky Bor; 13. Barguzinsky Reserve. Detail data on each location – in Table 3. Map with modifications from http://www.eea.europa.eu/legal/copyright

In 2014, the *C. calceolus* population in the Mordovia State Nature Reserve was suggested as the most sustainable in the region. The total number of generative individuals, number of plants with two flowers and the fruit set were investigated in the same population in our study. The sustainability of the population was estimated on the basis of successful reproduction of plants (e.g. Bizoux *et al*. 2011, Hegazy *et al*. 2010, Oostermeijer *et al*. 2003).

Statistical analyses were carried out using PAST 3.15 (Hammer *et al*. 2001). The ordination techniques, using the principal component analysis (PCA), defined the major gradients in the spatial arrangement of studied habitats of the analyzed dataset. For ecological interpretation of the ordination axes, average environment indicator values were calculated for established plots and were plotted onto the PCA ordination diagram as supplementary environmental data.

Results. The composition of flora accompanying *C. calceolus* was documented in all five locations studied. The list includes 80 species of vascular plants from 69 genera and 37 families (Table 1). Of these, 36 species from 32 genera and 22 families in MR, 15 species from 15 genera and 13 families in NPk, 27 species from 25 genera and 21 families in NPt, 27 species from 26 genera and 16 families in BS1 and 28 species from 27 genera and 20 families in BS2. The Jaccard’s similarity index amongst accompanying flora varied from 6.7% (amongst MR and NPk) to 42.9% (amongst NPt and NPk) (Table 2).

Cypripedium calceolus inhabited shade or semi-shade forest communities, where only *Convallaria majalis* L. was an obligatory component. Four species (*Lathyrus vernus* (L.) Bernh., *Poa nemoralis* L., *Quercus robur* L., *Rubus saxatilis* L.), were registered in four of the five habitats; and seven species (*Aegopodium podagraria* L., *Carex digitata* L., *Maianthemum bifolium* (L.) F.M. Schmidt, *Tilia cordata* Mill., *Trientalis europaea* L., *Vaccinium vitis-idaea* L., *Viola mirabilis* L.) were found in three of the five studied sites.

The spatial arrangement of studied locations demonstrated that the MR site clearly separated from all other habitats on the base of higher soil moisture and lower values of soil pH and light level. Both habitats from the vicinity of Mordovia University biostation (BS1, BS2) are closely located at the PCA-ordination diagram due to their close geographical position. Consequently, these habitats have similar environmental conditions (Fig. 2). These three locations

Table 1. List of flora accompanying *Cypripedium calceolus* in the Republic of Mordovia (Central Russia).

Species			**Locations**		
	MR	**NPk**	**NPt**	**BS1**	**BS2**
Acer platanoides L.			+		
Acer tataricum L.					+
Actaea spicata L.			+		
Aegopodium podagraria L.		+	+	+	
Alnus glutinosa (L.) Gaertn.	+				
Angelica archangelica L.					+
Antennaria dioica (L.) Gaertn.					+
Asarum europaeum L.			+		
Betonica officinalis L.				+	+
Betula pendula Roth		+			
Brachypodium sylvaticum (Huds.) Beauv.	+				
Calamagrostis epigejos (L.) Roth					+
Carex digitata L.	+	+	+		
Carex disperma Dew.	+				
Carex loliacea L.	+				
Carex pilosa Scop.			+		+
Epilobium angustifolium L.	+				
Circaea alpina L.	+				
Cirsium oleraceum (L.) Scop.				+	+
Convallaria majalis L.	+	+	+	+	+
Corylus avellana L.		+	+		
Cypripedium calceolus L.	+	+	+	+	+
Dryopteris carthusiana (Vill.) H.P. Fuchs	+				
Dryopteris cristata (L.) A. Gray	+				
Epilobium angustifolium L.	+				
Euonymus verrucosa Scop.			+		
Festuca gigantea (L.) Vill.	+				
Filipendula ulmaria (L.) Maxim.				+	+
Fragaria vesca L.	+				+
Frangula alnus Mill.	+				+
Galium palustre L.	+				
Galium spurium L.				+	
Geum urbanum L.			+		
Glechoma hederacea L.			+		
Gymnocarpium dryopteris (L.) Newm.	+				
Heracleum sibiricum L.				+	
Hieracium umbellatum L.				+	
Impatiens noli-tangere L.					+

Table 1 (*continues*).

Species			**Locations**		
	MR	**NPk**	**NPt**	**BS1**	**BS2**
Lathyrus pratensis L.				+	
Lathyrus vernus (L.) Bernh.		+	+	+	+
Linnaea borealis L.	+				
Lonicera xylosteum L.	+				
Luzula pilosa (L.) Willd.	+				
Lysimachia vulgaris L.	+			+	
Majanthemum bifoliun (L.) F. M. Schmidt	+		+	+	
Melampyrum nemorosum L.				+	+
Melampyrum pratense L.					+
Melica nutans L.				+	
Mercurialis perennis L.			+		
Milium effusum L.				+	+
Orthilia secunda (L.) House	+				
Oxalis acetosella L.	+				
Padus avium Mill.	+				
Paris quadrifolia L.	+			+	
Picea abies (L.) Karst.	+				
Pinus sylvestris L.	+			+	+
Poa nemoralis L.		+	+	+	+
Populus tremula L.		+	+		
Potentilla erecta (L.) Raeusch.				+	
Pteridium aquilinum (L.) Kuhn				+	
Pulmonaria obscura Dumort.			+		
Pyrola rotundifolia L.				+	+
Quercus robur L.	+	+	+		+
Ranunculus auricomus L.			+		
Rhamnus cathartica L.		+	+		
Rubus caesius L.		+	+		
Rubus saxatilis L.	+		+	+	+
Solanum dulcamara L.	+				
Sorbus aucuparia L.		+	+		
Stellaria holostea L.	+		+		
Tilia cordata Mill.		+	+		+
Trientalis europaea L.	+			+	+
Trifolium pratense L.				+	
Vaccinium myrtillus L.	+				
Vaccinium vitis-idaea L.	+			+	+
Veronica chamaedrys L.					+

TABLE 1 (*continues*).

Species	Locations				
	MR	NPk	NPt	BS1	BS2
Viburnum opulus L.	+				
Vicia sylvatica L.					+
Viola mirabilis L.		+	+	+	
Viola palustris L.	+				
Viscaria vulgaris Bernh.					+
IN TOTAL:	36	15	27	27	28

(MR, BS1, BS2) are well separated from the NPk and NPt sites on the basis of low values of soil nitrogen, soil pH and light level. The NPk and NPt sites are closely located at the PCA-ordination diagram. The same picture is obtained for BS1 and BS2 sites. Revealed data obtained using phytoindication method (Fig. 1) are very similar to the results found using Jaccard's similarity index (Table 2).

The stage spectrum in *C. calceolus* populations in Mordovia was presented by four ontogenetic stages (Fig. 3). Due to the poor and random demographic data from populations in both the BS1 and BS2 sites, these have been excluded from analysis.

Vegetative (juvenile + immature + mature vegetative) individuals dominated in the stage structure of *C. calceolus* populations during the study period (Fig. 2). Therefore, these populations could be considered as vegetatively-oriented. However, in certain years some fluctuations were recorded, allowing interpreting these populations as moderate or even generatively-oriented: NPk population in 2012, NPt population in 2014 or MR population in 2016. In contrast, fragmentary demographic data on both BS1 and BS2 populations showed dominance or equality of generative individuals in stage spectra (Khapugin *et al.* 2014).

TABLE 2. Compositional similarity (Jaccard's index, 100 × J) of the accompanying flora in five locations with *Cypripedium calceolus* in the Republic of Mordovia (Central Russia).

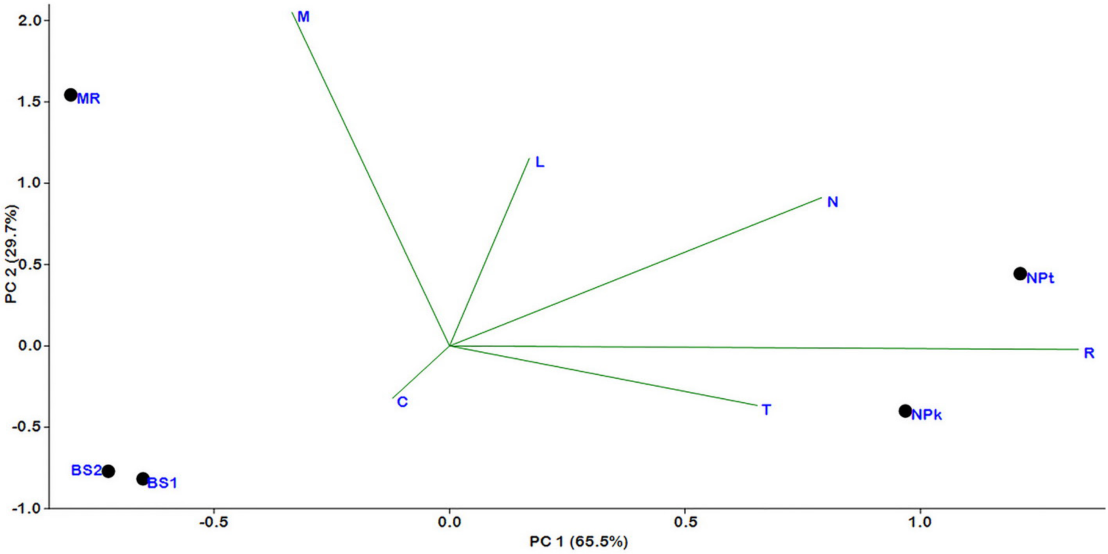
	NPk	BS2	BS1	MR
NPt	42.9	14.9	15.2	8.8
NPk		11.1	14.7	6.7
BS2			29.3	14.8
BS1				15.1

We estimated the reproductive ability of *C. calceolus* in the most sustainable population in Mordovia based on a number of two-flowered generative individuals and fruit set in the population (Fig. 4). We found that the percentage of plants with two flowers varied from 0.0% in 2015 to 16.7% in 2016. And there was no correlation of this parameter neither with the number of generative plants in a population nor with the percentage of two-flowered individuals there. Similarly, we didn't find a correlation of these parameters with values of fruit set in the MR population during the study period. It varied from 27.8% in 2016 to 46.7% in 2012.

Discussion. The accompanying flora in the studied sites was similar. In accordance with both PCA-analysis and Jaccard's similarity index, the most significant similarity was found for NPt vs. NPk and BS1 vs. BS2 respectively. These results can be explained by similar environment conditions in these habitats. At the same time, three types of plant communities were defined, demonstrating the ecological variability of *C. calceolus* due to its inhabitation in boreal (MR), steppefied nemoral (NPt, NPk) and mixed (BS1, BS2) forest communities. Unfortunately, there is no record of *C. calceolus* in grassland habitats in the Republic of Mordovia. Similar results shown using the Jaccard similarity index and phytoindication methods allow us to propose their conjoint use for other plant species as it was tested earlier (e.g. Couto *et al*. 2016, Khapugin *et al*. 2016, Khapugin 2017, Michálková 2007).

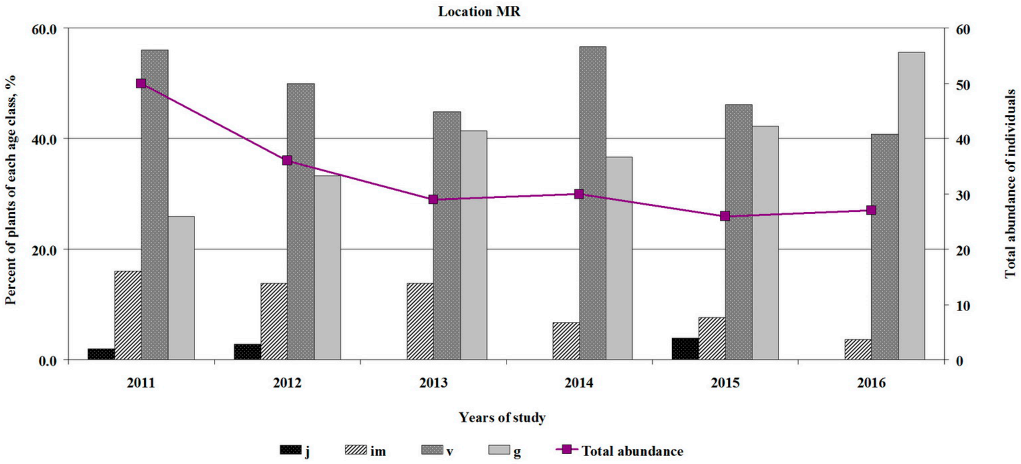
Cypripedium calceolus populations protected by Mordovia State Nature Reserve and National Park "Smolny" could be considered as vegetatively-oriented. However, the portion of generative individuals was significant over the whole study period varying from 31.3% in NPk to 39.2% in MR. Generative plants

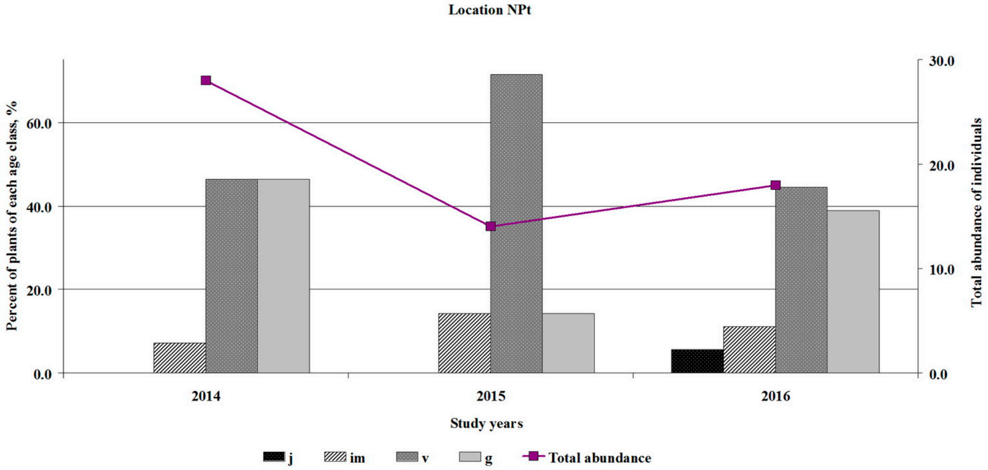
FIGURE 2. Principal component analysis (PCA) ordination diagram of habitats with *Cypripedium calceolus* in the Republic of Mordovia (Central Russia) based on mean environmental indicator values. Designations: L. shadiness, T. temperature, C. continentality, M. soil moisture, R. soil pH, N. soil nitrogen. To reveal ecological gradients the mean environmental indicator values were plotted onto PCA-ordination diagram as supplementary environmental variables.



had dominated in different time periods of the study in these habitats, even though there are some populations characterized by the dominance of generative plants in the region. On the basis of previous studies (Khapugin *et al.* 2014), with additions (Table 3), both populations BS1 and BS2 had generatively-oriented stage spectra. The total abundance of individuals in a population did not affect its stage spectrum structure. For instance, a general low decrease of total abundance in MR population led to the dominance of generative individuals in 2016, while the general increase of individuals' number in the NPk population led to the dominance of vegetative individuals in the same year. These results are consistent with data of Kull (2003) who suggested that neither short-term nor long-term studies of *C. calceolus* populations could show any clear trends in their stage spectrum structure due to the effect of annual fluctuations in abundance of individuals. The author also proposed that a large percentage of juvenile plants could be considered as a good indicator of a vital population, and that the population with few juvenile plants may persist, as long as the habitat conditions are suitable if vegetative reproduction in the population is significant and a number of generative individuals is not too low (Kull 2003). Most *C. calceolus* populations were estimated as vegetatively-oriented in different locations within its range (Table 3). Of all compiled data, the populations located at open or semi-open habitats are characterized by dominance or equality of generative individuals in stage spectra. For instance, these are semi-shade and grassland habitats in locations Sallent and Pineta in Spain Pyrenees (García *et al.* 2010), the edge of the spruce-larch forest in the National Park "Yugyd va" (Kirillova 2015), populations BS1 and BS2 in Mordovia (Khapugin *et al.* 2014, with additions). Light level may perhaps be one of the factors determining the stage spectrum of *C. calceolus* populations.

Among all studied populations in Mordovia, only the MR population could be considered as such a population with low but persisting number of juveniles, active vegetative reproduction and the appropriate number of generative individuals. Thus, this population may be considered as the most sustainable. However, an increase of red squirrel (*Sciurus vulgaris* Linnaeus, 1758) abundance in MR habitat in recent years led to increasing of young *Picea abies* abundance in the shrub layer. Thus, conditions of special protection regime could lead to the decrease of *C. calceolus* population vitality (Kull 2003). Hence, a further decline in





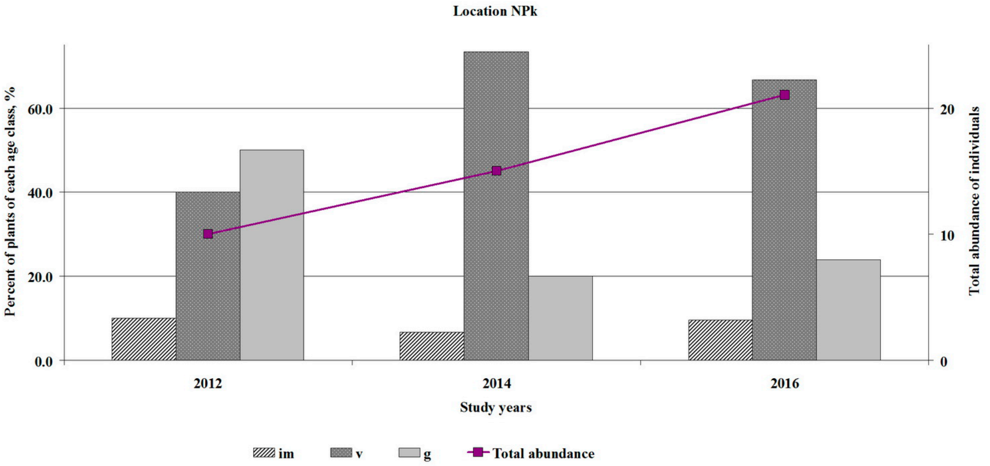


FIGURE 3. Structure of stage spectra in *Cypripedium calceolus* populations (locations MR, NPk, NPt) in the Republic of Mordovia (Central Russia). Ontogenetic stages of individuals: juvenile (j), immature (im), mature vegetative (v), generative (g).

TABLE 3. Lady's Slipper (*Cypripedium calceolus*) locations and habitats where age spectra were estimated

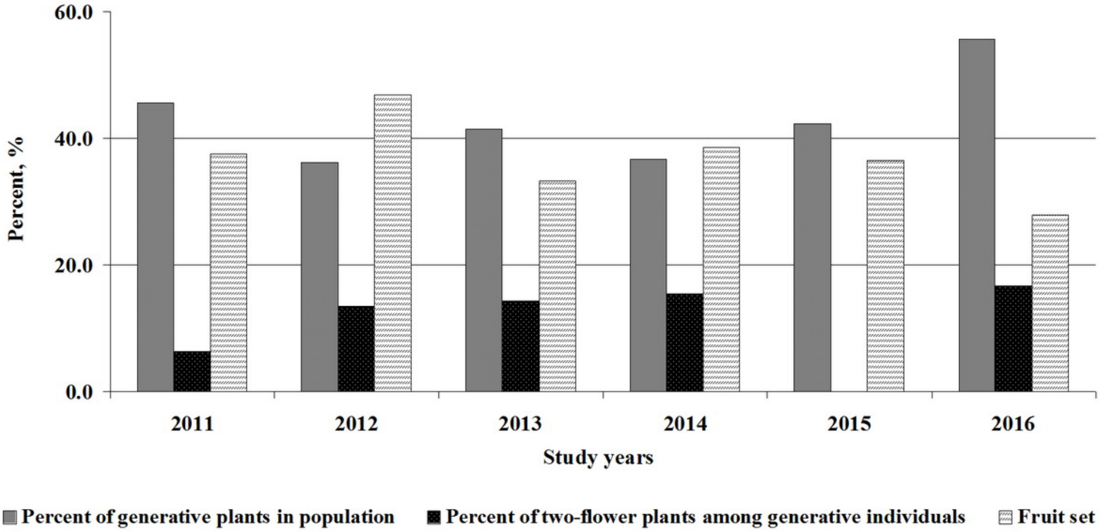
Location	**Population habitat**[a]	**Percent of individuals of each age class, %**				**Reference**
		j	***im***	***v***	***g***	
Data on incomplete age structure of populations						
Sallent[b]	Forest	–	–	–	23	García *et al.* 2010
Sallent[b]	Semishade	–	–	–	49	García *et al.* 2010
Sallent[b]	Grassland	–	–	–	60	García *et al.* 2010
Pineta[b]	Forest	–	–	–	12	García *et al.* 2010
Pineta[b]	Semishade	–	–	–	58	García *et al.* 2010
Tormosa[b]	Grassland	–	–	–	66	García *et al.* 2010
Ordesa[b]	Forest	–	–	–	0	García *et al.* 2010
Lake Kwiecko	Floodplain forest	2.1	–	–	7.8	Korczyński & Śpiewakowski 1991, Korczyński & Krasicka-Korczyńska 2014
Ussisoo	Boreo-nemoral spruce forest	1.7	–	–	–	Kull 2003
Tooma	Drained marshy forest	2.2	–	–	–	Kull 2003
Muhu I	Wooded meadow	7.5	–	–	–	Kull 2003
Muhu II	Alvar forest	5.7	–	–	–	Kull 2003
Õisu I	Drained marshy forest	31.5	–	–	–	Kull 2003
Hiiumaa	Coastal alvar forest	39.0	–	–	–	Kull 2003
Puhtu	Nemoral forest	2.9	–	–	–	Kull 2003
Data on complete age structure of populations						
Apatity[b]	Pine forest	1.9	15.4	74.1	8.4	Blinova 2002
Republic of Tatarstan	Forests	2.0	8.5	37.0	52.5	Fardeeva *et al.* 2010
"Yugyd va" 1	Slope covered by larch	3.7	17.5	51.0	27.9	Kirillova 2015
"Yugyd va" 2	Former gold mining site	8.9	16.4	28.0	46.7	Kirillova 2015
"Yugyd va" 3	Shrub-lichen communities on the rocks	2.5	18.0	67.3	12.2	Kirillova 2015
"Yugyd va" 4	Willow stand on the rocks	1.0	8.5	37.9	52.6	Kirillova 2015
"Yugyd va" 5	Fir-spruce grass forest	4.7	9.2	34.7	51.4	Kirillova 2015
"Yugyd va" 6	Edge of the spruce-larch forest	1.2	6.2	19.3	73.3	Kirillova 2015
"Yugyd va" 7	The yernik on the rocks	6.7	46.7	26.7	20.0	Kirillova 2015
Buzuluksky Bor	Mixed forests	6.1	13.6	40.2	40.2	Stetsuk 2013
Barguzinsky Reserve 1	Pine forest	0.0	14.3	35.7	50.0	Zheleznaya 2015
Barguzinsky Reserve 2	Mixed (*Pinus sibirica* + *P. sylvestris*) forest	3.9	27.5	19.6	49.0	Zheleznaya 2015
Barguzinsky Reserve 3	Spruce forest with aspen	5.6	16.7	27.8	50.0	Zheleznaya 2015
Pinega 1	Spruce forest	0.2	7.4	48.4	44.0	Puchnina 2017
Pinega 2	Larch forest	13.1	41.7	26.7	18.5	Puchnina 2017
MR	Spruce-pine forest	1.4	10.3	49.1	39.2	This study
NPt	Broad-leaved forest	1.9	10.8	54.1	33.2	This study
NPk	Broad-leaved forest	0.0	8.7	60.0	31.3	This study
BS1	Open glade in the pine forest	0.0	1.3	40.1	58.6	Khapugin *et al.* 2014 with additions
BS2	Pine forest at the mire edge	0.0	0.0	43.3	56.7	Khapugin *et al.* 2014 with additions

[a] We use the names of habitats referred in relevant publications

[b] Populations on the limit of species range

Age classes: *j* – juvenile, *im* – immature, *v* – mature vegetative, *g* – generative.

FIGURE 4. Parameters of reproductive ability of MR population of *Cypripedium calceolus* in the Republic of Mordovia (Central Russia).



vitality of MR population can be expected in next 10–20 years, if this tendency remains. Also, extremely low numbers of immature plants and a lack of juveniles in both BS1 and BS2 populations could be a result of low seed reproduction. It could be considered as a threat to their survival and existence.

Data on the reproductive ability of MR population showed the relatively low number of two-flower plants in comparison to some populations in other parts of species' range (Kull 1995, Stetsuk 2013). Fruit-set has been estimated by various authors, it varies considerably throughout species' range. Levels of fruit set were 33–57% in Belorussia (Stavrovskaya 1984), 4–14% in the Moscow district (Varlygina & Matsenko 1986), 0–25% (7.7% mean over four locations and four years) in Sweden (Nilsson 1979), 11% in Estonia (Kull 1998), 6.8% in Buzuluksky Bor National Park (Stetsuk 2013). Korczyński & Krasicka-Korczyńska (2014) found that "in 2013, out of 24 blooming stems 8 fruits were set" in the population near the Lake Kwiecko, without indicating of flowers number at blooming stems. However, the fruit set shown in MR population (36.7% as a mean over study period) was higher than, for instance, in Estonia (Kull 1998), Sweden (Nilsson 1979), the Moscow region of Russia (Varlygina & Matsenko 1986), Buzuluksky Bor National Park (Stetsuk 2013) and Lake Kwiecko in West Pomerania (Korczyński & Krasicka-Korczyńska 2014). The values of fruit set are comparable only with data from Belorussia (Stavrovskaya 1984). As this species is considered as pollinator-limited in some locations (Brzosko *et al*. 2017, Kull 1998, Nilsson 1979), higher values of the fruit set in comparison with other available data could be explained as a result of presence of habitats suitable for pollinators (wild bees *Andrena*) in this location. It is in contrast to other studied locations in Mordovia (Fig. 3, Table 3), where percentage of immature and juvenile individuals was extremely low or these were absent.

Conclusions. Our results demonstrate that *C. calceolus* in the Republic of Mordovia (Central Russia) shows wide ecological variability. Its presence is confined in diverse habitat types: broad-leaved forests, coniferous forests and mixed forests. We suggest the definition of at least one more habitat (pure grassland (see García *et al.* 2010)) within the range of this species. Based on the comparison of stage spectra of *C. calceolus* populations both in Mordovia and in other locations within its native range, MR population could be considered as most sustainable and stable in the region due to annually observed juvenile plants, with high percent of mature vegetative and generative individuals in population stage spectrum. Almost annually observed juveniles could be a result of relatively high fruit set found for the population in compared with other available data throughout the whole distribution range of *C. calceolus*. However, the overgrowth of woody species during natural succession may have a negative impact on the population (Czerepko *et al.* 2014, Kull 2003, Nicolè *et al.* 2005). Thus, we can declare on the higher significance of habitat conservation than individual conservation for protection of *C. calceolus*.

In order to better understand the environmental preferences of *C. calceolus*, we suggest continue dmonitoring and assessment of its population in Central Russia. The metadata allows us to assume that generalization of jointly obtained demographic, ecological, phytocoenological data will be appropriate for successful conservation and management of *C. calceolus*.

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PIONEERS OF THE BOTANICAL EXPLORATION OF SOUTH AMERICA – EARLY 19TH CENTURY
JEAN-THÉODORE DESCOURTILZ (1796–1855)

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Abstract. Jean-Théodore Descourtilz (1796-1855) was a well-known ornithologist who produced beautiful illustrated books on Brazilian birds. Less-known is an unpublished manuscript with water-colours of Brazilian orchids, which was acquired by the wealthy French Baron Delessert, who send it on loan to John Lindley. Lindley described dozens of new orchid species based on Descourtilz' illustrations and used several of them as models for his beautiful publication *Sertum Orchidaceum*. Here we present a large selection of Descourtilz' original illustrations of Brazilian orchids, including all the drawings that have been used by Lindley to typify his new taxa based on Descourtilz' exploration.

Key words: Brazil, Jules Paul Benjamin Delessert, Jean-Théodore Descourtilz, John Lindley, *Sertum Orchidaceum*

The Descourtilz family in America. Michael-Etienne Descourtilz (1775-1835), after completing his medical studies, traveled to Charleston, South Carolina and Santiago de Cuba, arriving in Haiti on 2 April 1799. After many hardships during the slave revolts at the turn of the century, he was held captive for some time and finally obtained freedom after being liberated by a French Army column, leaving the island on *"1 Prairial, an XI"* of the revolutionary calendar (May 23, 1803). After his return to France, he worked as a physician in a hospital at Beaumont and served as president of the Paris Linnean Society. He never travelled to America again.

Descourtilz published *Flore médicale des Antilles ou Traité des Plantes Usuelles des Colonies Francaises, Anglaises, Espagnoles et Portugaises* (*Medicinal Flora of the Antilles or Treatise of the usual plants of the French, English, Spanish and Portuguese colonies*) between 1821 and 1829*,* illustrated by his son Jean Théodore Descourtilz (1796-1855), a physician and botanist like his father. Five orchids were described and illustrated in this work.

The illustrations are of little botanical value. Grisebach went further and called them "*a series of execrable chiefly copied drawings,* […] *of little or no scientific value"* (Grisebach, 1859-64: vii) (Fig. 1–2). Looking at the illustrations, one must go along with Grisebach´s opinion, as Descourtilz' illustrations lack detail.

Jean-Theodore Descourtilz travelled to South America, and arrived in Brazil in about 1826, since in 1831 his lavishly illustrated manuscript on the hummingbirds of São Paulo and Rio de Janeiro was acquired by the library of the National Museum. In this work, referring to a particular hummingbird, he states that it was a species so rare that in five years of research he collected only two specimens. Descourtilz was an interested and meticulous observer, concerned about the accuracy of his notes which concisely described the habits and appearance of each species. His poetic and flowery text was in keeping with the period, and was invariably accompanied by colour plates of the species studied. In 1834, his *Oiseaux brillans du Brésil* was published in Paris, again with magnificent water-colour illustrations (Figs. 3–4), so that one comes to doubt that they came from the same hand that had produced the "*execrable chiefly copied drawings"* published ten years earlier and so harshly criticized by Grisebach.

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FIGURE 1. Descourtilz – *Angrec en coquille* from his father's *Flore médicale des Antilles…*

Figure 2. Descourtilz – *Angrec à feuilles obtuses* from his father's *Flore médicale de Antilles*...

Figure 3. Descourtilz – Plate VI from his *Oiseaux brillans du Brésil.*

A reason may be that Descourtilz Jr. was only seven years old when his father returned from Haiti and therefore never saw the Antillean orchids of which Descourtilz Sr. wrote with his own eyes. His illustrations in the *Flore des Antilles* must have been based either on herbarium specimens or perhaps on sketches made in the field by his father. Another possibility is that he never produced the illustrations of the *Flore des Antilles*, and that they came from the hand of another artist, perhaps his father himself. Either way, the two sets of illustrations have little in common.

So far, Jean-Théodore Descourtilz had no apparent relation with the Brazilian orchid world, but around 1836 our story took and unexpected turn. At the end to the description of the new Brazilian species, *Bolbophyllum tripetalum* (Lindl., Ann. Nat. Hist. vol. 10, p. 185), John Lindley cited the provenance of the type in this way: *Wild in Brazil, in the province of St.Paul's — Descourtilz — (v. ic. pict. in bibl. De Lessert)*[1]. This somewhat cryptic annotation can only be understood as that Lindley found an illustration by Descourtilz of the plant now described as a new species. This is corroborated after further studying Lindley's descriptions of other new Brazilian species, when we read, in his description of *Ionopsis paniculata*: *...a very remarkable species, with which I am acquainted through an extensive unpublished collection of excellent water-colour drawings, by Mons. Descourtilz, of Brazilian Orchideous plants, obligingly lent to me by Baron Delessert.*

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[1] *vidi iconam pictam in bibliotheca* De Lessert (= I saw a colored illustration in De Lessert's library).

Figure 4. Descourtilz: plate XI from his *Oiseaux brillans du Brésil.*

Figure 5. Baron Jules Paul Benjamin Delessert (1773.1847).

As life goes, the one responsible for *execrable chiefly copied drawings* produced now – one decade later - *excellent water-colour drawings*! And being Lindley a skilled illustrator himself, one must trust his judgement.

A parenthesis is here required to comment on Baron Jules Paul Benjamin Delessert (1773-1847) (Fig. 5). Born in Lyon in a wealthy family of bankers, he started many commercial enterprises, among them a sugar factory where the industrial manufacture of sugar from beet was developed, and for which he was named a 'baron of the Empire'.

A strong advocate for many humane measures, the suppression of the death penalty, and the improvement of the penitentiary system, he was made regent of the Bank of France in 1802, and was also member of, and, indeed, founder of many, learned and philanthropic societies. He was also an ardent botanist and conchologist; his botanical library embraced 30,000 volumes, of which he published a catalogue, the *Musée botanique de M. Delessert* (1845). He bought specimens from famous herbaria, among them those from Humboldt and Bonpland, de Candolle, and Robert Brown, and at the time of his death his herbarium contained 250,000 sheets representing 85,000 different species. It is therefore no surprise to us that Descourtilz' water-colours of Brazilian orchids fell somehow in his hands. It may even be that they were produced on a contract given by Delessert to Descourtilz.

Our search for a publication of Descourtilz' drawings was fruitless, simply – as we soon found out – because they were never published. After a long search and with more than a bit of fool's luck, we found, in the library of the Institut de France[2], in Paris, an unpublished manuscript by Jean-Théodore Descourtilz, consisting of 83 water-colour illustrations of Brazilian orchids, and the corresponding explanatory texts detailing the structure and anatomy of the plants, their habitat, and their locality of collection. The manuscript carries the title: *Epidendres des forêts vierges du Brésil* (*Epidendra from the virgin forests of Brazil*) (Fig. 6) and attached to it are a few – almost unreadable notes and fragments of letters that give us an idea of the timeline.

- The 3 volumes were received from M. Descourtilz by Delessert on Sept. 3rd 1832. Descourtilz was paid an advance of 300 P (?).
- 83 water-color designs were sent to Mr. Lindley plus one manuscript text through Mr. Percy on the 1st of May (?) of 1836 for determination.
- The water-colours were returned to the heirs of M. Delessert on February 18, 1852 by way of Mr. Weddell[3] (Delessert had died in 1847).

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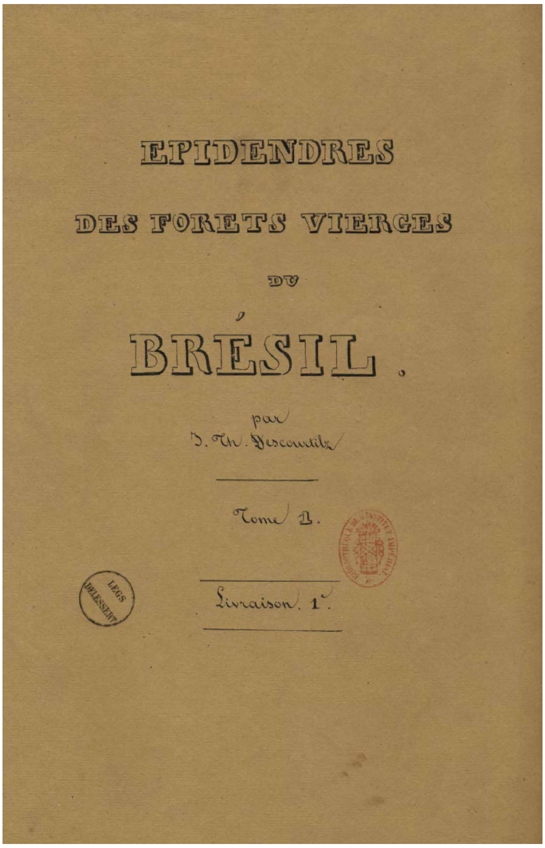
[2] The Institute de France is an umbrella institution founded in 1795 during the French Revolution, comprising the *Académie Française,* the *Académie des Beaux-Arts,* the *Académie des Inscriptions et Belles-Lettres*, the *Académie des sciences*, and the *Académie des sciences morales et politiques.*

[3] Hugh Algernon Weddell (22 June 1819 – 22 July 1877) was a physician and botanist, specializing in South American flora.



EPIDENDRES

DES FORETS VIERGES

DU

BRÉSIL.

par
J. Th. Descourtilz

Tome 1.

Livraison. 1e.

FIGURE 6. Title page of Descourtilz' manuscript.

FIGURE 7. *Sertum Orchidaceum.* Plate 5: *Sophronits grandiflora* and *Cattleya bicolor*.

As we will see later, Lindley described quite a few new species based on Descourtilz' drawings. In his descriptions, Lindley often mentioned the original French names given by Descourtilz to his species (using always the name Epidendre for all species, and never once using the family name *Orchideae* or *Orchidaceae*) and sometimes also the plate number used by Descourtilz. With no exception, both name and plate number coincide with the unpublished manuscript which we now have the possibility to study. The manuscript held at the Institut de France is the same that Delessert gave on loan to Lindley in 1836.

Probably the best proof for the quality of Descourtilz' illustrations lies in Lindley's publication of his *Sertum Orchidaceum, a wreath of the most beautiful orchidaceous flowers* (1838), one of his most applauded publications (Fig. 7, 10, 12). A book review (Anonymous, 1838: 148-151) wrote about it: *It is almost needless to add that, though the 'Orchidaceae'* [Bateman's work on Mexico and Guatemala] *and the 'Sertum' are of not absolute perfection in regard to the execution of the plates, yet they are in every other respect so excellent, and in point of magnificence so far before all other works on the Orchidaceae, that they cannot fail to command the admiration of all botanists and patrons of botany…*

And as we will see, Lindley's admiration for Descourtilz' illustrations went so far that in three plates of his *Sertum* he made almost exact copies of four plates of the Frenchman's work (Fig. 8–9, 11, 13). In his description of *Burlingtonia venusta* in his *Sertum*, Lindley confessed: "*This lovely flower is at present only known from a drawing made in Brazil by Mons. J. Th. Descourtilz and forming part of a manuscript description, with figures, of Orchidaceous plants now the property of M. le Baron Benjamin*

Figure 8. Descourtilz' manuscript (fragment). Plate 10: *Epidendre ponceau.*

FIGURE 9. Descourtilz’ manuscript (fragment). Plate 49: *Epidendre irideé.*

Figure 10. *Sertum Orchidaceum*. Plate 7: *Cyrtochilum stellatum*.

Figure 11. Descourtilz' manuscript (fragment). Plate 37: *Epidendre etoilé*.

Delessert. As I have the permission of their liberal proprietor to publish such as are most remarkable in this collection, I shall have frequent occasion to avail myself of its materials, in illustration of the present work."

New species among Descourtilz' illustrations. Perhaps the most important contribution of Jean-Théodore Descourtilz to orchidology was the fact that Lindley described no less than 31 new species among the illustrations contained in the manuscript loaned to him by Baron Delessert. Among these we find five species' descriptions in which Lindley mentions specimens by other collectors besides Descourtilz' illustration of the plant, which must therefore be considered a syntype. The remaining 25 illustrations by Descourtilz are holotypes, since they constitute the sole basis for Lindley's description (Table 1). The rest of the manuscript, 52 illustrations, corresponds to species already described by other authors at the time of the arrival of the manuscript in England, or to species which Lindley, for any reason whatsoever, was not able to determine (Fig. 14–41).

All these species were described by Lindley between 1836 — the year in which he received the document from Delessert Plate 49 — and 1842.

About Jean-Théodore Descourtilz as botanist, there is little to be said. A search through the main herbaria of the world that have digitalized catalogues shows — with the exception of Kew- nothing with regard to Descourtilz' collecting activity. Even Delessert's herbarium, now in Geneva, contains not a single specimen collected

TABLE 1. New orchid species described by Lindley among Descourtilz' illustrations.

Plate N° in MS	Name by Descourtilz	Type status	Location	Name by Lindley
2	*Epidendre tripétale*	Holotype	Bananal, São Paolo	*Bolbophyllum tripetalum*
4	*Epidendre aerien*	Holotype	Bananal, São Paolo	*Zygostates lunata*
8	*Epidendre fritillé*	Holotype	Rio de Pirapitinga, Bananal, São Paolo	*Huntleya meleagris*
10	*Epidendre ponceau*	Holotype	Bananal and Ilha Grande, São Paolo	*Cattleya coccinea*
12	*Epidendre panduriforme*	Syntype (+ Herb. *von Martius s.n.*)[4]	Morro-Quemado, Macahé, Bom Jesus de Bananal / *Martius*: *s.loc.*	*Burlingtonia fragrans*
14	*Epidendre heteracé*	Holotype	'Tout le Brésil'	*Stelis grandiflora*
18	*Epidendre graminé*	Syntype (+ *Gardner 637*)[5]	Bananal, São Paolo / *Gardner*: Organ Mountains	*Oncidium raniferum*
21	*Epidendre tricolore*	Holotype	Bananal, São Paolo	*Aspasia lunata*
22	*Epidendre bilabié-tigré*	Holotype	'Toute la zone elevé du Brésil'	*Pleurothallis fusca*
23	*Epidendre bilabié-ligulé*	Holotype	Haut Macahé and Bananal	*Pleurothallis uniflora*
24	*Epidendre bilabié- lemnoide*	Holotype	'Toute les districts du Brésil eloignés des côtes'	*Pleurothallis parvifolia*
26	*Epidendre napel*	Syntype (+ *Miers s.n.*)[6]	Route du Bananal à Ilha Grande / *Miers*: Brazil	*Bolbophyllum napelli*
28	*Epidendre ficoïde*	Holotype	Haute Macahé, Ilha Grande	*Leptotes serrulata*
31	*Epidendre ephêmère*	Holotype	s. loc.	*Pleurothallis ephemera*
33	*Epidendre à chainons*	Holotype	Montagnes de la Bucahna, bois de la Parahyba, Rezende	*Trigonidium latifolium*
35	*Epidendre spiral*	Syntype (+ Herb. *von Martius s.n.*)	Rezende / *Martius*: Brazil	*Spiranthes lineata*
37	*Epidendre* étoilé	Holotype	Macahé, Bananal	*Cyrtochilum stellatum*
39	*Epidendre peint*	Holotype	Ilha Grande	*Physurus pictus*
41	*Epidendre porte-glaive*	Holotype	Bananal, São Paolo	*Bolbophyllum gladiatum*
43	*Epidendre delicat*	Holotype	s. loc.	*Stelis caespitosa*
49	*Epidendre irideé*	Holotype	Bananal, São Paolo	*Cattleya bicolor*
50	*Epidendre cirrhifère-aurore*	Holotype	Haute Macahé	*Masdevallia aurantiaca*
51	*Epidendre cirrhifère-tricolor*	Holotype	Bananal, São Paolo	*Masdevallia tridentata*
53	*Epidendre miliaire*	Syntype (+ *Gardner 681*)	Ilha Grande / *Gardner: idem*	*Prescottia lancifolia*
54	*Epidendre paniculé*	Holotype	São Paolo	*Ionopsis paniculata*
60	*Epidendre antropomorphe*	Holotype	Bananal, São Paolo	*Fernandezia lunifera*
61	*Epidendre porte-glume*	Holotype	Rio de Pirahy	*Pleurothallis glumacea*
62	*Epidendre auriculé*	Holotype	Fleuve Macahé	*Pleurothallis auriculata*
63	*Epidendre jonquille*	Syntype (+ *Gardner 652*)	Ilha Grande / *Gardner*: Organ Mountains	*Maxillaria xanthina*
64	*Epidendre bec-d'oiseaux*	Holotype	Bom Jesus de Bananal	*Ornithocephalus myrticola*
66	*Epidendre amaranthe*	Syntype (+ *Prescott s.n.*)[7]	Fazenda du Lumiar, district du Haute Macabé / *Prescott: s. loc.*	*Physurus debilis*

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[6] Carl Friedrich Philipp von Martius (1794–1868)

[7] George Gardner (1812–1849)

[8] John Miers (1789–1879)

[9] John D. Prescott (?–1837)

Figure 12. *Sertum Orchidaceum*. Plate 40: *Leptotes serrulata*.

Figure 13. Descourtilz' manuscript (fragment). Plate 28: *Epidendre ficoïde*.

by Descourtilz. And even Kew shows only two obscure and badly prepared specimens of *Huntleya meleagris* and *Plerothallis fusca*, attributed to Descourtilz, and a pencil sketch of *Trigonidium latifolium*, supposedly by Robert Allan Rolfe, which is an exact copy of plate 33 of Descourtilz' manuscript (Fig. 41).

In the late 1840s or early 1850s, Descourtilz was sent by the Brazilian Government to the province of Espírito Santo, the north-east of Rio de Janeiro, to investigate the animal life and to report on precious minerals. He discovered traces of gold and iron in the vicinity of the village Laurinha, created by the provincial government to house and proselytize the Puri Indians. However, the ill-treatment suffered by the Indians drove them away and led to the decay of the village. At the site there was a village that eventually became the city of Conceição do Castelo on the headwaters of the Rio Castelo, a tributary of the Itapemirim. Descourtilz explored the city of Itapemirim and nearby towns, gathering various minerals and a collection of crystals, all lodged with the National Museum of Rio de Janeiro, where he took up an appointment in 1854.

Descourtilz was a member of the *Société Linnéenne de Paris* and of the *Société Auxiliaire de l'Industrie de Rio de Janeiro*. He died of arsenic poisoning caused by chemicals he used in the preparation of specimens.

From the geographical point of view, it seems clear that Jean-Théodore Descourtilz produced most of his scientific work –biological, geological and otherwise- along the coastal strip covered by the adjoining provinces of Espírito Santo, Rio de Janeiro and São Paolo.

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Figure 14. Descourtilz' manuscript. Plate 2: *Epidendre tripétale – Bolbophyllum tripetalum.*

FIGURE 15. Descourtilz' manuscript. Plate 4: *Epidendre aerien – Zygostates lunata.*

Figure 16. Descourtilz' manuscript. Plate 8: *Epidendre fritillé – Huntleya meleagris*.

Figure 17. Descourtilz' manuscript. Plate 12: *Epidendre panduriforme* – *Burlingtonia fragrans*.

Figure 18. Descourtilz' manuscript. Plate 14: *Epidendre heteracé – Stelis grandiflora.*

FIGURE 19. Descourtilz’ manuscript. Plate 18: *Epidendre graminé — Oncidium raniferum.*

Figure 20. Descourtilz' manuscript. Plate 21: *Epidendre tricolore – Aspasia lunata.*

Figure 21. Descourtilz' manuscript. Plate 22: *Epidendre bilabié-tigré* – *Pleurothallis fusca.*

Figure 22. Descourtilz’ manuscript. Plate 23: *Epidendre bilabié-ligulé – Pleurothallis uniflor.*

Figure 23. Descourtilz' manuscript. Plate 24: *Epidendre bilabié-lemnoide – Pleurothallis parvifolia.*

Figure 24. Descourtilz' manuscript. Plate 26: *Epidendre napel* – *Bolbophyllum napelli*.

FIGURE 25. Descourtilz' manuscript. Plate 31: *Epidendre ephêmère – Pleurothallis ephemera.*

Figure 26. Descourtilz' manuscript. Plate 33: *Epidendre à chainons – Trigonidium latifolium.*

Figure 27. Descourtilz' manuscript. Plate 28: *Epidendre spiral – Spiranthes lineata.*

Figure 28. Descourtilz' manuscript. Plate 39: *Epidendre peint – Physurus pictus*.

FIGURE 29. Descourtilz' manuscript. Plate 41: *Epidendre porte-glaive- Bolbophyllum gladiatum.*

Figure 30. Descourtilz' manuscript. Plate 43: *Epidendre delicat – Stelis caespitosa.*

FIGURE 31. Descourtilz' manuscript. Plate 50: *Epidendre cirrhifère-aurore – Masdevallia aurantiaca.*

Figure 32. Descourtilz' manuscript. Plate 51: *Epidendre cirrhifère-tricolor – Masdevallia tridentate.*

FIGURE 33. Descourtilz' manuscript. Plate 53: *Epidendre miliaire – Prescottia lancifolia.*

Figure 34. Descourtilz' manuscript. Plate 54: *Epidendre paniculé – Ionopsis paniculata.*

Figure 35. Descourtilz' manuscript. Plate 60: *Epidendre antropomorphe – Fernandezia lunifera*.

Figure 36. Descourtilz' manuscript. Plate 61: *Epidendre porte-glume – Pleurothallis glumacea.*

FIGURE 37. Descourtilz' manuscript. Plate 62: *Epidendre auriculé – Pleurothallis auriculata.*

FIGURE 38. Descourtilz' manuscript. Plate 63: *Epidendre jonquille – Maxillaria xanthina.*

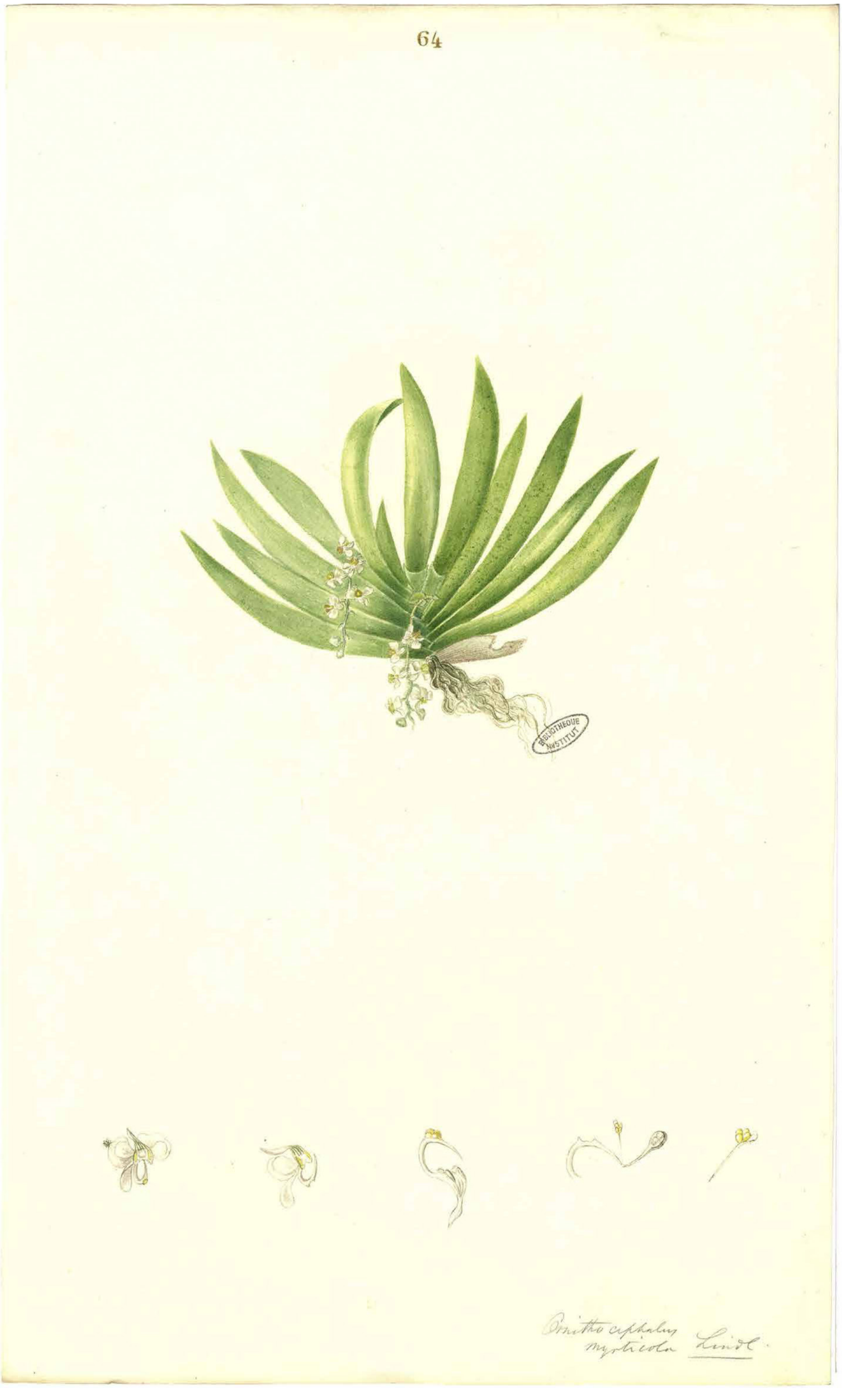

FIGURE 39. Descourtilz' manuscript. Plate 64: *Epidendre bec-d'oiseaux – Ornithocephalus myrticola.*

Figure 40. Descourtilz' manuscript. Plate 66: *Epidendre amaranthe – Physurus debilis.*

FIGURE 41. Pencil copy supposedly by Robert A.Rolfe of plate 33 in Decourtilz manuscript, in Kew under number K000857183.

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BOOK REVIEWS

Botanical Sketchbooks

Helen Bynum & William Bynum (Editors). 288 pages, 250 color illustrations, 20.5 x 26.5 cm (8.4 x 10.9”), hardcover. ISBN-10: 1616895888; ISBN-13: 978-1616895884. New York, Princeton Architectural Press, and London, Thames and Hudson, in association with the Royal Botanic Gardens, Kew, 2017. Ca. €35.00, $40.00.

Let me begin, for once, with the quality of the physical book itself. Solidly bound with particularly thick cardboards, with the spine in black editorial canvas, the book is printed on a beautiful opaque, heavy (I would say more than 120 gr/m^2), off-white paper, which enhances the quality of the print, do not tire your eyes with unnecessary reflections, and gives great justice to the beauty of the original works. These are often printed in full page, and it is a pity that the layout has not taken into consideration the option of printing the works without borders to maximize the quality of the details. The very dimension of the book, conceived as a coffee table book, is not excessively large and makes it easier and more pleasant to flip through the pages when the volume is not resting on a plain.

The curators of the book, Helen and William Bynum, are both historians of science and medicine, and passionates about botany and horticulture. They made an excellent job in gathering the best and more diverse among the millions of botanical skecthes made by modern botanists, artists, adventurers and simple (but often famous) people passionate of plants, to write a story made up by preparatory sketches, first impressions, scribbled notes, anf unfinished works. Through a long journey, which begins in fifteenth century to reach early 1900s, *Botanical Sketchbooks* focuses not on the final product of botanical illustration (the print, the painting, the catalog) but instead on the “making of”, the taking of quick notes around the wonders of nature on a piece of paper or in the pages of a diary with quick and fresh signs, colors and descriptive annotations. In this way, the Bynums illuminate a range of intriguing characters from many different countries and cultures, giving unprecedented insights to the immediate reactions of humans facing the glories of the plant world. So, proper sketchbooks are intermixed with journals, albums, note-books, manuscripts and letters, loose pieces of paper and vellum, herbarium sheets and even drawings on the back of envelopes, sourced from collections all over the world. The works are often presented in their complete physical context, which allow the readers appreciate the kind of tactile qualities of the bindings, folders and albums used in this six-century story.

The selection of the 80 artists pays obvious tribute to the exploratory and colonial efforts made by British and North Americans, but nonetheless also includes artists from Australia, Germany, France, Italy, together with some non-Western authors from Japan and China. The cast is impressive, featuring well known names as Charles Darwin, Leonardo Da Vinci, Albrecht Dürer, Carl Linné, Pierre Joseph Redouté, and Josh Ruskin, together with other maybe less known (but not for that less relevant) figures, as Fabio Colonna, John Day, Niccolò Gualtieri, Margarte Mee, Beatrix Potter, the sisters Hellen and Margaret Shelley, and Robert Schomburgk, just to cite a few. Particularly noteworthy is how amateurs (and even accidental) sketchers are profiled by the curators alongside famous artists and scientists, with the same simpathy and respect.

The book is organized in four main thematic chapters (drawing on location, for science, for art and for leisure), in turn divided in sub-chapters, each devoted to different figures in the world of plants and plant illustration: explorers, collectors, naturalists, and botanists. Biographical portraits and artist profiles, enlightening the main type of work the artists are known for, are provided along the entire book. Being a compendium of how plants have been observed, studied, and immortalized in art, and how the strange beauty of the natural world fired the imagination of travelers and naturalists, it is not surprising that orchids are preminently featured among the presented works as they often captivate the attention also from the most accidental observer.

Three flower views of *Angraecum eburneum* var. *giryamae* (p. 27) are portrayed by John Kirk, medical officer and botanist to Dr. Livingstone's second Zambesi expedition. A preparatory sketch of *Catasetum macrocarpum* by Margaret Mee is reproduced on page 37. The "prospector" of South America, Frierdich Carl Lehmann (a proficient illustrator, whose work has been extensively discussed by Cribb, 2010) is represented by six beautiful sketches of *Pescatoria*, *Oncidium*, *Dracula*, *Maxillaria callichroma* (erroneously refered to *Masdevallia*), and *Epidendrum* sp. (correctely, *Prosthechea hartwegii*). Another beautiful species of *Oncidium* (*Odontoglossum*), *O. hallii*, is illustrated from the sketchbook of its discoverer, the Colonel Francis Hall. On the other side of the world, another British Colonel, John Eyre, succembed in front to the beauty of *Renanthera coccinea* (p. 72). Other orchids are taken form the scrapbook of the victorian British clergyman Rev. Charles Parish (pp. 84–89), who revealed the orchid richness of Burma (Myanmar). Male and female flowers of *Cycnoches clorochilon* (p. 104), and a flower of *Prosthechea cochleata* (p.106) were sketched by Juan de la Cerda *or* Atanasio Echeverría, two of the illustrators of the "Expedición Botánica a Nueva España", who traveled together and let several unsigned drawings that can not be attributed with any certainty to either one. Darwin's crude and famous sketch of *Gavilea patagonica* is reproduced on page 119. A beautiful sketch of *Stanhopea grandiflora* (p. 225) is taken from the illustrations prepared by Alfred Riocreux, one of the last Redouté's pupils, for the *Herbier géneral de l'amateur* by Jean Luois Auguste Loiseleur-Deslongchamps. Finally, they could not miss the examples of the great master of the sketch of orchids, the British wine merchant John Day, who ordered his collection in ten greenhouses and travelled to the tropics to fill his scrapbooks with glorious and famous images. Six pages, of his sketchbooks are reproduced, with paintings of *Aerides rosea*, *Anguola clowesii, Dactylorhiza incarnata*, *Paphiopedilum fairrieanum*, *P. purpuratum, and Vanda coerulea*, and a gorgeous double-page illustrating *Grammangis ellisii* (pp. 267–267), a now rare, endemic species from Madagascar.

Frequently thought just as prepratory stages of something more elaborate, the first botanical impressions on paper by the artists weren't often saved and many have probably disappeared. However, they represent "another glance" at documenting the beauty of the natural world, a look behind the scenes of the finished drawings and paintings of which they form the foundation. Hidden and locked away in private collections and the rear of public collections, sketches are rarely seen and appreaciated: Bynum and Bynum's work has the great merit of bringing them to the fore.

Franco Pupulin

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Cribb, P. (2010). The orchid collection and illustrations of Consul Freidrich C. Lehmann. *Lankesteriana,* 10(2,3), 9–30.

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