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Catasetum × *grasineideae* (Orchidaceae: Catasetinae), a new nothospecies from Brazilian Amazon and taxonomic notes for the genus

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Abstract

Hybridization is a process that can occur randomly in nature between different genetically compatible species, as is observed within the genus *Catasetum*. Thus, this work proposes the description of a new nothospecies found in the lake of Castanho located in the municipality of Careiro Castanho. It is described, illustrated and compared with its parental species: *C. gnomus* and *C. saccatum*. In addition, information regarding the distribution, habitat and phenology as well as a key to the natural hybrids occurring in the Brazilian state of Amazonas are presented. Taxonomic notes are presented for five taxa of the genus currently treated as species that, after performing controlled pollination and germination *in vitro*, have proven to be in reality natural hybrids. Finally, we propose to place *C. sanguineum* into the synonymy of *C. naso*.

Keywords: Amazon, *Catasetum gnomus*, *Catasetum saccatum*, Catasetinae, natural hybrid, Igapó

Introduction

The process of hybridization between different taxa is usually associated with places where distinct populations previously isolated by pre-zygotic or post-zygotic barriers come into contact and cross each other producing descendants with mixed characters (Barton & Hewitt 1989, Arnold 1992). In this sense, the crossing between different compatible species becomes relevant, as it plays an important role in the evolution and diversification of flowering plants (van der Pijl & Dodson 1966, Vieira *et al.* 2017, Pessoa *et al.* 2021).

In Orchidaceae the formation of natural hybrids is an extremely common process and it is possible to observe the formation of several taxa, mainly interspecific (*e.g.* Borba & Semir 1998, Azevedo *et al.* 2006, Solano *et al.* 2019, Krahl *et al.* 2020, Cantuária *et al.* 2021, Krahl *et al.* 2021a, Batista & Medeiros 2022) and, more rarely, intergeneric (*e.g.* Braga 1978, Pupulin 2015). It is worth to note that many of these taxa are described on the basis of intermediate characters shared with the parents (see Pupulin 2015, Krahl *et al.* 2020, 2021a, Cantuária *et al.* 2021, Batista & Medeiros 2022), even if the expression of these morphological characters may be an unpredictable factor in hybrids (Rieseberg & Ellstrans 1993). In this family the barriers preventing gene flow between different taxa, such as geographical barriers, differences in the perfume composition, morphological incompatibility of pollinators, among others (van der Pijl & Dodson 1966) seem rather weak when we consider the number of known hybrids, especially in *Catasetum* Richard

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ex Kunth (1822: 330). This genus is the largest within the subtribe Catasetinae Lindley (1843a: sub. t. 23) with about 200 species (Petini-Benelli & Chiron 2020, Krahl *et al.* 2021b,c, Damián *et al.* 2021, Krahl *et al.* 2022a,b, Govaerts *et al.* 2022) and approximately 30 natural hybrids (Cantuária *et al.* 2021, Govaerts *et al.* 2022). These taxa are widely distributed in the Neotropical area, from Mexico to southern Brazil and northern Argentina (Romero & Jenny 1993, Romero & Carnevali 2009). In the above count of hybrids, *C.* × *riotianum* Castro-Neto (2012: t. 229) is not included because it is considered as a synonym of *C. semicirculatum* Miranda (1986: 156) (see Petini-Benelli 2022). It is also emphasized that the Amazon basin is considered as the center of diversity and endemism of the genus (Romero & Jenny 1993, Silva & Silva 1998, Romero & Carnevali 2009).

During field visits to the interior of the Brazilian state of Amazonas in order to register species of Orchidaceae in the frame of the long-term project so-called "Flora do Amazonas: Orchidaceae", a specimen of *Catasetum* was collected, showing intermediate characters between *Catasetum gnomus* Linden & Reichenbach (1870: pl. 170) and *Catasetum saccatum* Lindley (1840a: 76). It is here described as a nothospecies resulting from the occasional crossing of these taxa. Additionally, we propose the transfer of five taxa described as species to the status of nothospecies based on artificial crossings and we also propose the synonymization of two taxa.

Material and methods

The new natural hybrid has been collected on the Castanho lake, located just above the city of Careiro Castanho (3°44'08.35"S; 60°26'41.44"W) (Figure 1). The local phytophysiognomy is the igapó forest, which consists of a constantly flooded vegetation (Quaresma *et al.* 2018) and the climate is classified as tropical humid ("Afi") according to Köppen (1948) with temperatures between 24 and 27°C and higher rainfall levels between the end and the middle of the year (Luizão 1995).

The holotype was deposited at INPA (acronym according to Thiers 2022) after having been treated according to process described by Fidalgo & Bononi (1989). The morphological description follows terminology adopted by Dressler (1993) and Harris & Harris (2001). The new entity was compared to its parental species, *C. gnomus* and *C. saccatum* (see Lindley 1840a, Linden & Reichenbach 1870, Pessoa *et al.* 2015, Petini-Benelli 2017, 2022, Krahl 2020). We consider these two taxa as the parental of the new nothospecies because the latter shows a number of traits intermediate between those of these taxa and because the three entities share the same environment (see Borba & Semir 1998, Azevedo *et al.* 2006, Braga 1978, Krahl *et al.* 2020, Cantuária *et al.* 2021, Krahl *et al.* 2021a, Batista & Medeiros 2022).

Besides we examined the types and original descriptions of a few *Catasetum* taxa hitherto considered as species and which should be treated, in our opinion, as nothospecies (natural hybrids). For all of them phenotype of individuals obtained from *in vitro* germination were compared to original description and illustrations.

Taxonomy

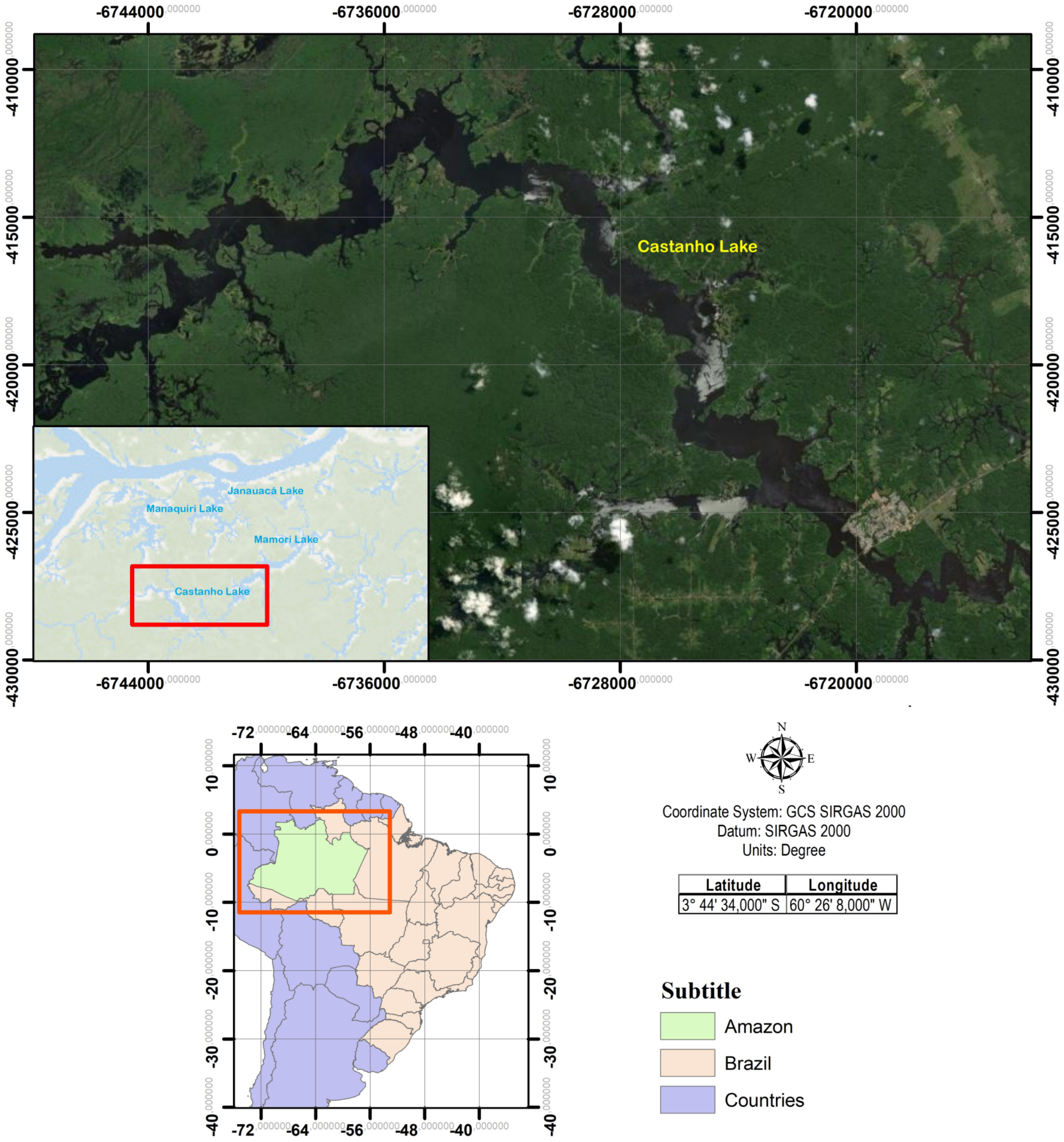
Catasetum × *grasineideae* D.R.P.Krahl**,** Krahl, Chiron & J.B.F.Silva, *nothosp. nov.* (Figures 2–3).

Type:—BRAZIL. Amazonas: Careiro Castanho, Castanho Lake, epiphyte in *Igapó*, 3°44'08.35"S; 60°26'41.44"W, 8-10 m, 12 January 2022, *A.H. Krahl & D.R.P. Krahl 1635* (holotype: INPA!).

Hoc taxon naturalis hybrida inter C. gnomus et C. saccatum est, characteres intermedios efficiens. Non-resupinatos flores, elliptico-lanceolata sepala petalaque, integrum suborbiculatum labellum com denticulato-serrato margine apice reflexo, parte centrali sacciformi conica, ostio latiore quam longo et duabus parvis protuberationibus in columnae proximali margine.

Description:—Epiphytic caespitose plant. Rhizome short inconspicuous. Pseudobulb 3.7–7.5 × 1.0–1.5 cm, fusiform, erect, clustered, 4-5–leaved, covered by leaf sheaths. Leaves 4.9–19.8 × 1.5–2.7 cm, linear-lanceolate, plicate, 3-5–nerved, entire and slightly undulate margin, apex acute. Male inflorescence ca. 21.2 cm long, lateral, racemose, 1-5–flowered, erect then arched under the flower weight; peduncle cylindrical, greenish lightly purplish; floral bract ca. 0.7 × 0.6 cm, triangular, lightly greenish, margin entire, apex acute to obtuse. Male flower yellowish with brownish spots, especially on the sepals and petals, non-resupinated, pedicelled; pedicel ca. 3.3 cm long, cylindrical, erect and apically curved, purplish; sepals ca. 4.0 × 1.5 cm, elliptic-lanceolate, symmetrical, concave, margin entire, apex acute; petals ca. 4.1 × 1.6 cm, elliptic-lanceolate, symmetrical, margin entire and reflexed, apex acute; lip 3.0 × 4.5

cm, entire, subtrilobed, suborbicular, margins reflexed near the apex, denticulate to serrate, central part sacciform and conical; ostium ca. 0.9 × 1.4 cm, ca. 1.3 cm deep, opening somewhat flattened (transverse diameter longer), with two little protuberances on the edge nearest to the column; column ca. 3.2 × 1.0 cm, apex rostrate; antennae ca. 1.1 cm long, crossed; anther cap ca. 1.7 × 0.5 cm, rostrate; viscidium 0.25 × 0.35 cm, whitish, sticky; stipe ca. 0.6 × 0.2 cm, lamellate, rolled up, dark; pollinia 2, ca. 0.6 × 0.4 cm, obovate, thick, compressed, sulcate, yellowish. Female inflorescence and fruit not seen.



Latitude	Longitude
3° 44' 34,000" S	60° 26' 8,000" W

FIGURE 1. Location of the Castanho Lake in the municipality of Careiro Castanho, state of Amazonas, Brazil.

Distribution and ecology:—the new taxon was found and collected on a phorophyte on the shore of the Castanho lake, in an igapó forest, in the municipality of Careiro Castanho, AM, Brazil. Based on personal observations, the parental species have already been observed in this place and in neighboring municipalities (*e.g.* Careiro da Várzea), especially along the BR 319 road.

According to Petini-Benelli (2022), *C. gnomus* occurs in the states of Amazonas, Pará and Rondônia and *C. saccatum* in the entire North-Brazilian region as well as in the states of Mato Grosso and Mato Grosso do Sul. Thus, the geographical distribution of both species overlaps, including in the state of Amazonas where the new hybrid has been found.

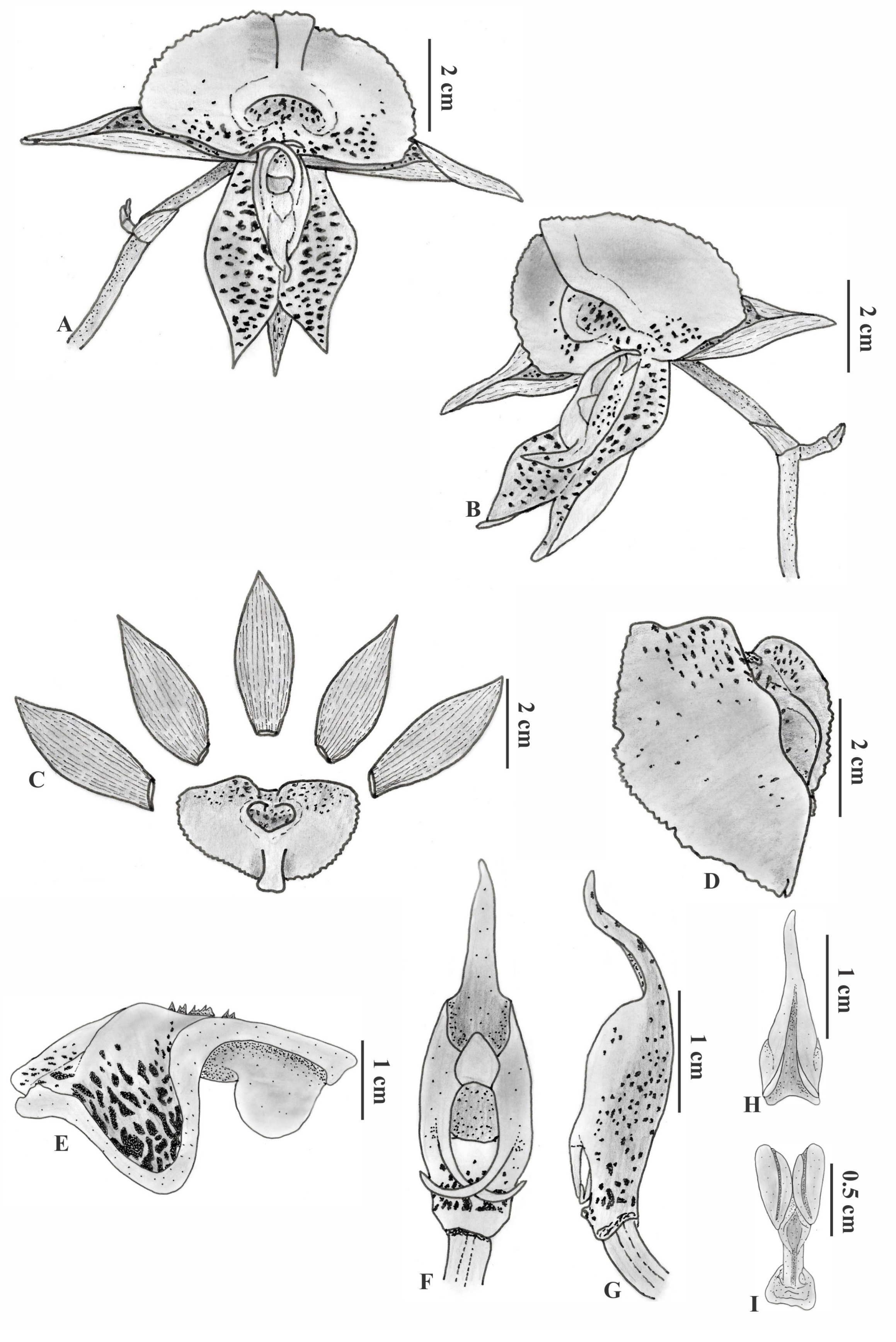


FIGURE 2. *Catasetum* × *grasineideae* (male flowers). **A–B**. Male flowers. **C**. Perianth**. D–E**. Lip**. F–J**. Column. **H**. Anther cap. **I**. Pollinarium. Illustration by A.H. Krahl.

FIGURE 3. *Catasetum* × *grasineideae* (male flowers). **A**. Habit with male inflorescence. **B–D**. Male flowers. **E**. Floral bract. **F**. Perianth. **G–I**. Lip. **J–L**. Column. **M**. Anther cap. **N**. Pollinarium. Photographs by A.H. Krahl.

The new natural hybrid has been observed in bloom in January, a time when the parental species can flower. Based on author's personal observations and on herbarium registers (*e.g.* CRIA database, 2022), we know that *C. gnomus* flowering generally begins in December and stops in April whereas *C. saccatum* is in bloom from August up to February. Consequently, the blooming times of both species overlap during at last three months (December, January and February), making possible their crossed pollination.

As for the flower visitors, we already observed visit of male *Eulaema* bees on both parental species, which, once more, makes a genetic flux between them possible. These bees visit the flowers looking for volatile compounds (perfume) present on the lip.

Etymology:—the specific epithet is given in honor to Maria Grasineide Gomes Passos, mother of the first author, orchid lover and great incentive to orchid study.

Taxonomic Discussion:—the new entity shows characters intermediate between *C. gnomus* and *C. saccatum* (Figure 3), which allowed us to infer its taxonomic position as a nothospecies. As in most species within the genus it is impossible to define diagnostic vegetative features because these species practically share the same characters (Holst 1999, Walker-Larsen & Harder 2000).

As for the floral morphology, especially in male flowers, we can mention various characters shared with the parental species. Flowers are not resupinate, as in *C. gnomus* (*vs*. resupinate in *C. saccatum*). Floral segments are elliptic-lanceolate as in *C. saccatum* (*vs*. obovate-lanceolate and linear-lanceolate in *C. gnomus*) (Pettini-Benelli 2022). The lip is entire and subtrilobed (*vs*. trilobed in *C. gnomus* and *C. saccatum*), but suborbicular as in *C. saccatum*, with the margin next to the apex reflexed and overall denticulate to serrate as in both parents (serrate in *C. gnomus* and fimbriate, laciniate or denticulate in *C. saccatum*). The central part of the lip is sacciform and conical with a transverse ostium as in *C. saccatum* and with two small protuberances on the edge next to column as in both parents, however less acute as in *C. saccatum*. The column shows a more rounded shape and a beak shorter and broader as in *C. gnomus* (*vs*. column narrower and oblong with a beak filiform in *C. saccatum*) (see Figure 4) (Lindley 1840a, Linden & Reichenbach 1870, Pessoa *et al.* 2015, Petini-Benelli 2017, 2022, Krahl 2020).

We propose here a key to all the natural hybrids present in the Brazilian state of Amazonas (Figure 5), *i.e. C.* × *grasineideae* (*C. gnomus* × *C. saccatum*); *C.* × *issanense* Pabst (1975: 405) (*C. pileatum* Reichenbach (1882: 492) × *C. longifolium* Lindley (1839: 94)); *C.* × *louiseae* Krahl *et al.* (2020: 216) (*C. discolor* (Lindley 1835: t. 1735) Lindley (1844: Misc. 34) × *C. macrocarpum* Kunth (1822: 331)); *C.* × *roseo-album* (Hooker 1840: t. 3796) Lindley (1840b: 65) (*C. discolor* × *C. longifolium*); and *C.* × *tapiriceps* Reichenbach (1888: 133) (*C. macrocarpum* × *C. pileatum*) (according to Krahl *et al.* 2020 and Petini-Benelli 2022). It should be noted that *C.* × *sheyllae* Krahl, Cantuária & J.B.F.Silva in Cantuária *et al.* (2021) perhaps occurs in Amazonas but it is not confirmed. It occurs in fact in a border region between Amazonas and Pará (see Cantuária *et al.* 2021).

We treated *C.* × *roseo-album* as a nothospecies, so disagreeing with Barbarena (2021) who treats it as an independent species. We have a large field knowledge as for the occurrence of *C.* × *roseo-album* in localities of Brazilian Amazon where *C. discolor* and *C. longifolium* are clearly sympatric species a few meters away from each other (eg. Pessoa *et al.* 2015). Moreover, the nothospecies clearly presents intermediate features between the parental taxa, what we already could observe in artificial crossings. In this way we agree with the opinion of Romero & Carnevalli (1989).

Identification key to the *Catasetum* natural hybrids of the Amazonas state, Brazilian

1. Lip ≤ 3 × 3 cm 2
2. Leaves elliptical; leaf lamina patent or erect .... *C.* × *louiseae*
2'. Leaves linear-lanceolate; pending leaf lamina .... *C.* × *roseo-album*
1'. Lip ≥ 3.1 × 3.1 cm 3
3. Flowers not resupinate (lip facing up) .... *C.* × *grasineideae*
3'. Flowers resupinate (lip facing down) 4
4. Lip rounded and entire; lip margin ciliate; antennae short (not touching the column base), symmetrical and parallel .... *C.* × *issanense*
4'. Lip trilobed; lip margin lightly denticulate; antennae long, asymmetrical and crossed .... *C.* × *tapiriceps*

Taxonomic notes on *Catasetum*

A thorough analysis of the *Catasetum* species is necessary as we observed that species described as independent are in fact natural hybrids (see Romero & Carnevali 1989, Romero & Jenny 1992, Petini-Benelli & Grade 2012). With such an increasing number of nothospecies (*e.g.* Petini-Benelli & Grade 2010, Petini-Benelli & Grade 2012, Ferreira 2013, Petini-Benelli 2014, Ferreira 2016, Petini-Benelli 2016, Ferreira 2019, Ferreira & Filho 2019, Ferreira & Malaspina 2019, Krahl *et al.* 2020, Cantuária *et al.* 2021) we believe that, from now, a proposal of new species in *Catasetum* should be very well evaluated in order to avoid misunderstandings in this genus. We also emphasize that the increase in the number of hybrids may have a direct connection with the large deforestation leading to the appearance of large open areas (see Krahl *et al.* 2020, Cantuária *et al.* 2021). This fact may have facilitated the flight of some orchid bees, especially the large ones, between forest fragments (Cândido *et al.* 2021), or even between isolated trees, facilitating gene flow. Another thing to take into consideration is that orchid bees can fly several kilometers a day looking for food or aromatic compounds (Janzen 1971, Pokorny *et al.* 2015).

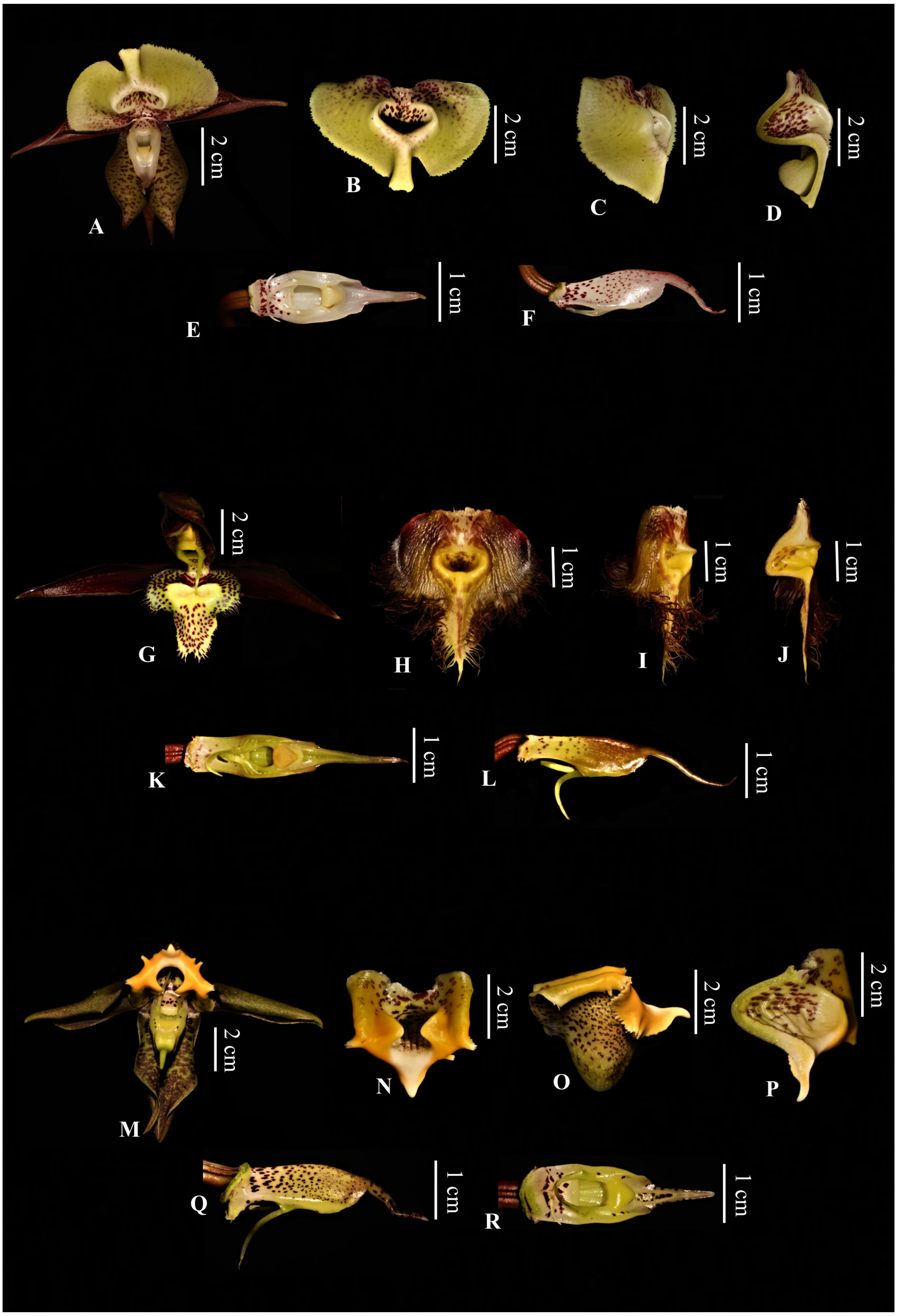


FIGURE 4. Comparison between the flower, lip (in front, side and cross-section views) and column of *Catasetum* × *grasineideae* and their parents. **A–F**. *C.* × *grasineideae*. **G-L**. *C. saccatum*. **M–R**. *C. gnomus.* Photographs by A.H. Krahl.

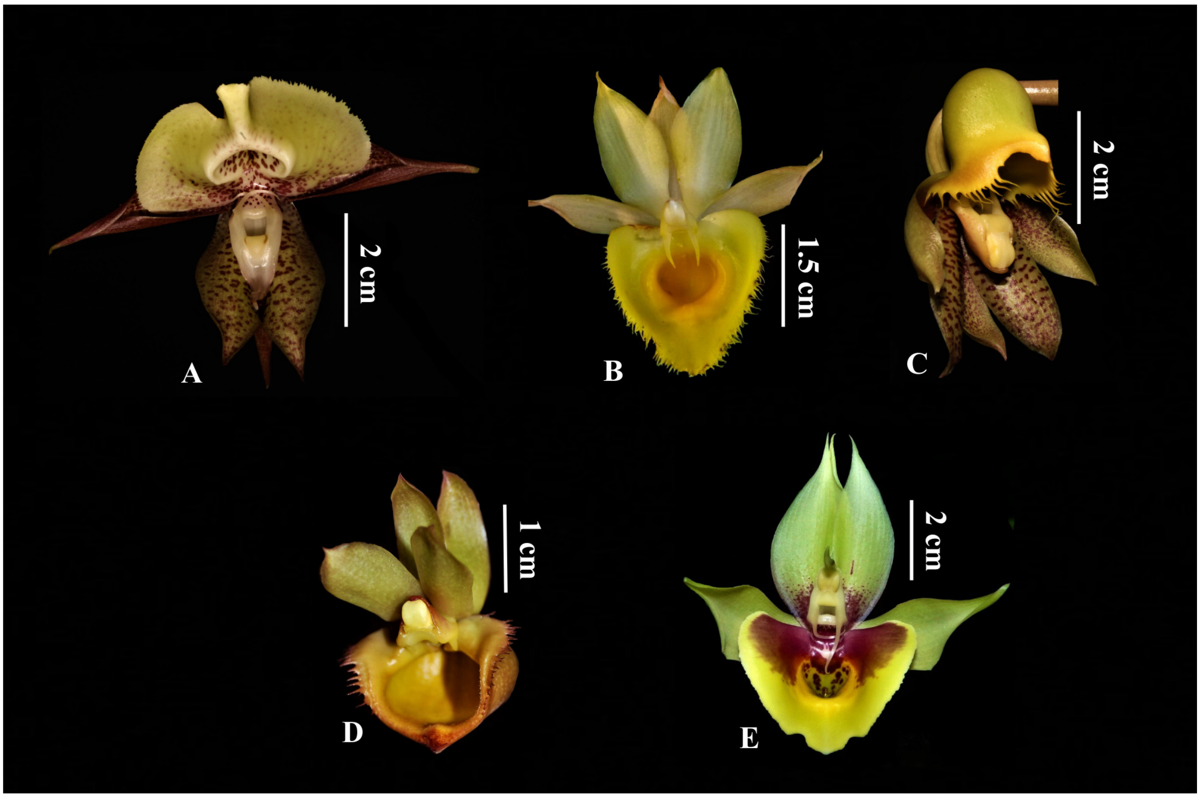


FIGURE 5. Hybrids occurring in the state of Amazonas, Brazil. **A**. *C.* × *grasineideae*. **B**. *C.* × *issanense*. **C**. *C.* × *louiseae*. **D**. *C.* × *roseo-album*. **E**. *C.* × *tapiriceps*. Photos A and C by A.H. Krahl, B by S. Araújo, D by V.A. Gil and E by S. Queiroz.

Thus, after having thoroughly analyzed various *Catasetum* taxa we could verify that some of them, hitherto treated as species, are in fact natural hybrids. In all cases, the phenotype of individuals obtained by germination *in vitro* were compared. Consequently, taxonomic corrections and notes are presented hereafter.

1. *Catasetum* × *aripuanense* Bicalho (1963: 1) (pro. sp.), *nothosp. nov.* (Figure 6A–B).

Type:—BRAZIL. Mato Grosso: Aripuanã, mata ciliar do Rio Juruena, perto da Cachoeira Dois Irmãos, cultivada no Jardim Botânico de São Paulo, 15 May 1963, *M. Mee s/n* (holotype: SP-68441, photograph!).

Taxonomic Note:—Based on controlled crossing and germination *in vitro* carried out by J. Fernández G. this taxon proved to be a natural hybrid between *C. gladiatorium* Lacerda (1998: 90) and *C. rooseveltianum* Hoehne (1916: 35, t. 172). Phenotype resulting from the crossing of these species (Figure 6A–B) was compared to the original description given by Bicalho (1963) and the holotype deposited in herbarium SP. The same morphological features were observed. In addition, two materials deposited in SP and ESA were analyzed and, once more, the same floral morphology was observed. It is also emphasized that both parental species occur in the state of Mato Grosso, as *C.* × *aripuanense* (see Bicalho 1963, Petini-Benelli 2022), which strengthens the possibility of hybridation.

Catasetum × *aripuanense* presents an ovate lip as in *C. rooseveltianum* (*vs.* trapezoidal in *C. gladiatorium*), with at base a tripartite callosity similar to that of *C. gladiatorium* (*vs*. absent in *C. rooseltianum*) and the margins are dentate to fimbriate (a character intermediate between *C. gladiatorium*, that has a fimbriate margin, and *C. rooseveltianum*, that presents a smooth margin). Moreover, the column in *C.* × *aripuanense* presents parallel antennae as in *C. gladiatorium* (*vs*. parallel and divaricate in *C. rooseveltianum*) (see Bicalho 1963, Petini-Benelli 2022).

Additional specimens examined:—BRAZIL. Mato Grosso: Aripuanã, mata ciliar do rio Juruena perto da cachoeira Dois Irmãos, 07 august 1962, *M. Whitten 93112* (SP-175250, photograph!); Mato Grosso do Sul: Costa Rica, 02 january 1997, *A.P. Santo s/n* (ESA-108221, photograph!).

2. *Catasetum* × *dalastranum* Petini-Benelli & Chiron (2018: 13) (pro. sp.), *nothosp. nov.* (Figure 6C).

Types:—BRAZIL. Mato Grosso: Sinop, 15 km da estrada da cidade, 7 february 2012, *Plácido Dalzotto APB961* (holotype: HERBAM, photograph!).

FIGURE 6. Hybrid *Catasetum*. **A–B**. *C.* × *aripuanense*. **C**. *C.* × *dalastranum*. **D**. *C.* × *fergusonii*. **E–F**. *C.* × *mojuense*. **G–H**. *C.* × *yarigii*. Photos A–B, D and G–H by J. Fernández G., C by F. Godoy and E–F by E. Pontes.

Taxonomic Note:—This taxon is in fact the natural hybrid between *C. juruenense* Hoehne (1915: 55) and *C. matogrossense* Bicalho (1964: 1) because of some data which have been stressed by Petini-Benelli & Chiron (2018). First, *C.* × *dalastranum* has a certain phenotypic plasticity, which is common in hybrids and was highlighted by Petini-Benelli & Chiron (2018). The lip may vary, being sometimes more closed (as in *C. matogrossense*) sometimes more open (as in *C. juruenense*). Besides it has internal carinae much similar to those observed in *C. matogrossense*. In addition, we can also note that *C. juruenense* and *C. matogrossense* share the same ecological niche which makes possible the crossing between them. Another important and relevant factor is the result of the artificial crossing between *C. juruenense* and *C. matogrossense* that we obtained from a commercial nursery in Brazil (Figure 6C). In this artificial obtaining, we observe the same characteristics pointed out by Petini-Benelli & Chiron (2018).

Petini-Benelli & Chiron (2018) primarily rule out the possibility of hybridization because *C.* × *dalastranum* produces resupinate flowers while *C. matogrossense* shows non-resupinate ones. However, it is a feature inherited from *C. juruenense* that also has resupinate flowers (see Petini-Benelli 2014). The other differences, such as for example width of sepals and petals, depth and dimensions of the lip, may be due to combination of characters of *C. juruenense* and *C. matogrossense*, the result of which is unpredictable (Rieseberg & Ellstrans 1993).

Additional specimens examined:—BRAZIL. Mato Grosso: Alta Floresta, próximo à área urbana, 15 march 2010, *A. Grade & A. Petini-Benelli 35APG* (paratype UFMT-30849, photograph!); Nova Canaã do Norte, entrada da cidade, em árvores remanescentes de área desmatada para formação de pastagem, 07 february 2012, *A. Grade & H.S. Lima APB962* (paratype HERBAM, photograph!); Itaúba, na margem da BR sentido Sinop, 10 february 2017, *S.M. Araújo APB1148* (paratype HERBAM, photograph!).

3. *Catasetum* × *fergusonii* Dodson ex W.E.Higgins & Dalström (in Higgins & Dalström 2007: 103) (pro. sp.), *nothosp. nov.* (Figure 6D).

Type:—PERU. Arequipa: 10 kilometers West of Arequipa, ca. 1100 m [sie 2000 m], january 1976, *G. Ferguson s/n* (holotype: SEL, OIC-6748).

Taxonomic Note:—The true taxonomic identity of this taxon was revealed through artificial crossings and germination *in vitro* carried out by J. Fernández G. It is a natural hybrid between *C. saccatum Lindley (1840a: 76)* and *C. tenebrosum* Kraenzlin (1910: 229). The result of the artificial crossing has the same characters as those presented in the original description, differing only by the lip color (more yellow) which is clearly acceptable in hybrids since their morphology may present a large variability, included coloration. In addition, *C. saccatum* as well as *C. tenebrosum* show various morphological variations linked to the particular locality where they grow in Amazon, which may in any event lead to hybrid with large variations.

It is interesting to note that Higgins & Dalström (2007), when describing the taxon as an independent species, ignore the possibility of hybridization but use for comparison *C. saccatum* and *C. tenebrosum* as closest and more related species even though they show different features as for the arrangement of antennae (respectively, section *Catasetum*—asymmetric and crossed antennas / section *Isoceras* subsection *Convergentes*—symmetrical antennae that come towards each other). Another curious fact is the record made by M. Whitten, deposited in herbarium FLAS, mentioning that we are unaware of the possibility for this taxon to be a hybrid between *C. saccatum* and *C. tenebrosum*.

We can observe in *C.* × *fergusonii* that the lip is trilobed and saccate as in *C. saccatum*, whereas it is more or less triangular, as in *C. tenebrosum*. Its margin is sparsely lacerate/fimbriate what is an intermediate form, since the margin is dentate in *C. tenebrosum* and fimbriate/laciniate in *C. saccatum*. Besides the margin is reflexed as in *C. saccatum*. Finally, *C.* × *fergusonii* shows on the lip a callus which looks like a variation of the callus of *C. tenebrosum* (see Higgins & Dalström 2007).

Additional specimens examined:—PERU. Arequipa: road to Quilca. Cultivated, from Oak Hill Gardens; accessioned as Whitehill 0008, 04 october 1993, *M. Whitten 93112* (FLAS-178428, photograph!).

4. *Catasetum* × *mojuense* Oliveira & Silva (1998: 110) (pro. Sp.), *nothosp. nov.* (Figure 6E–F).

Type:—BRAZIL. Pará: Mojú, 13 june 1996, *J.B.F. da Silva 562* (holotype: MG-150477!).

Taxonomic Note:—this is another taxon proven to be a natural hybrid. Artificial crossing and germination have been carried out by E. Pontes between *C. ciliatum* Barbosa-Rodrigues (1877: 130) and *C. macrocarpum* Kunth (1822: 331). As for other hybrids this one may show, in any event, a large morphological variability (Figure 6E–F) linked to the variations that *C. macrocarpum* may present according to the different populations that we can find. *Catasetum* *macrocarpum* has an extensive geographical distribution and it occurs, as *C. ciliatum*, in the state of Pará in which *C.* × *mojuense* was found. This, as well as the extremely rare records (only two—see Oliveira & Silva 1998 and Barbarena *et al.* 2020), strengthen its status of natural hybrid.

We can note that *C.* × *mojuense* presents flowers with the lip turned upwards (as in *C. ciliatum* and *C. macrocarpum*), a lip deep and sac-shaped (mainly as in *C. ciliatum*), trilobed (as in *C. macrocarpum*), with lateral lobes erect and slightly fimbriate (as in *C. ciliatum*) and a midlobe apiculate (as in *C. macrocarpum*). Besides the antennae traits are intermediate: they are not very developed, and crossed, whereas they are absent in *C. ciliatum* and well developed, asymmetrical and crossed in *C. macrocarpum* (see Oliveira & Silva 1998, Barbarena *et al.* 2020, Petini-Benelli 2022).

5. *Catasetum naso* Lindley (1843b: Misc. 71).

Type:—Origin unknown, "received last year from Linden by Mr. Rucker (holotype: K).

= *Catasetum sanguineum* Lindley & Paxton (1851: 168), *syn. nov.*,

Type:—"Central America". *Ex Hort.* T. Brocklehurst (lectotype designated by Romero & Jenny (1993): K).

Taxonomic Note:—*Catasetum naso* Lindley (1843b: Misc. 71) and *C. sanguineum* Lindley & Paxton (1851: 168) are two species described in the middle of 19th century and, from that time, several morphological variations were observed which caused each of them to have at least three different variations described. However, all these variations present morphological features in common (see Hooker 1854, Dunsterville & Garay 1961). In a general way *C. naso* and *C. sanguineum* only differ by the lip dimensions (lip larger with an apex broader *vs*. lip smaller with an apex more tapered), by basal margins of the lip more lacerate and pedicel longer in *C. sanguineum* (Lindley 1843b, Lindley & Paxton 1851). However, we think that these characters may vary in an acceptable way among individuals and among populations (*i.e.* intraspecific variation). In addition, both taxa have virtually the same geographical distribution (Govaerts *et al.* 2022). Therefore, we consider them as conspecific and we propose the synonymization of *C. sanguineum*, retaining the older name *C. naso*.

Additional specimens examined (*C. naso*):—Origin unknown, no date, s. coll. s.n. (K000588878, photograph!); Origin unknown, no date, s. coll. s.n. (K001458456, photograph!); VENEZUELA: Est. Trujilo, 15 august 1947, *J. Renz 4257* (RENZ, photograph!); idem, J. Renz 4272 (RENZ, photograph!); idem, 11 september 1947, *J. Renz 4488* (RENZ, photograph!); idem, J. Renz 4489 (RENZ, photograph!); idem, 27 september 1952, *J. Renz 7827* (RENZ, photograph!); idem, 10 september 1958, *J. Renz 9169* (RENZ, photograph!).

Additional specimens examined (*C. sanguineum*):—USA (specimens in cultivation): Florida: Alachua Country, ex. Hort., living material obtained from Craing Morrell at U. of Florida. F1226, 03 october 1987, *H.G. Hills 87089* (FLAS-181559, photograph!); idem, ex. hort. Living material obtained from Lester Poole, 22 october 1987, H.*G. Hills 87088* (FLAS-181557, photograph!); idem, cultivated, without locality, flowered in cultivation at the Univ. of Florida, 01 december 1993, *W.C. Whitehill & W.M. Whitten 91527* (FLAS-181738, photograph!); idem, cultivated, obtained from Craig Morrell, flowered in cultivation at the Univ. of Florida, 04 january 1994 (FLAS-181558, photograph!); Pennsylvania: Allegheny Country, Pittsburgh, Phipps Conservatory, Orchid Greenhouse, 10 january 1989, *E. Lobdell 976* (CM-342563, photograph!).

6. *Catasetum* × *yariguii* Uribe-Velez & Sauleda (2018a: 1) (pro. sp.), *nothosp. nov.* (Figure 6G–H).

Type:—COLOMBIA. Santander: Cañon del Rio Chicamocha, no date, *Jimenez s/n* (holotype: HPUJ).

= *Catasetum cucutaense* Uribe-Velez & Sauleda (2018b: 1), *syn. nov.*

Type:—COLOMBIA. Cucuta: Norte de Santander, near La Esperanza, no date, *collector unknown* (holotype: HPUJ).

= *Catasetum bolivarii* Uribe-Velez & Sauleda (2018c: 1), *syn. nov.*

Type:—COLOMBIA. San José de Cucutá: Norte de Santander, near La Esperanza, no date, *collector unknown* (holotype: HPUJ-29766).

= *Catasetum pamploanense* Salueda (2019: 1), *syn. nov.*

Type:—COLOMBIA. Santander: Norte de Santander, near Pamplona, 18 july 2019, *collector unknown* (holotype: HPUJ).

Taxonomic Note:—during the years 2018 and 2019 four closely related species were described from Colombia, all from virtually the same locality. The first was *C. yariguii* Uribe-Velez & Sauleda (2018a: 1) that, in our opinion, resembles *C. naso* in the lip shape and is sympatric to it (Govaerts *et al.* 2022). Then, *C. cucutaense* Uribe-Velez & Sauleda (2018b: 1), *C. bolivarii* Uribe-Velez & Sauleda (2018c: 1) and *C. pamploanense* Salueda (2019: 1) were successively described, and always compared to each other, with the distinguishing features being rather weak, especially between *C. yariguii* and *C. bolivarii*. All this led us to treat them as conspecific, under the oldest name, *C. yariguii*.

Another fact that caught our attention was the phenotypic plasticity shown by these taxa, which led us to consider them as hybrids between *C. lucis* P. Ortiz & G. Arango (1994: 29) and *C. naso* on the basis of habit, flower color and lip shape, intermediate between these two species, both being sympatric to *C. yariguii* in Colombia (Govaerts *et al.* 2022). Moreover, the artificial crossing made by J. Fernández G. produced a plant compatible with the phenotype of *C. yariguii* and *C. bolivarii* (see Figure G–H). The other phenotypes should be expressed according to the countless varieties of *C. naso*.

All these nothotaxa present, in fact, similar features, intermediate between *C. lucis* and *C. naso*. The flower colour goes from reddish (mostly similar to *C. naso*) to greenish (mainly as in *C. lucis*). All of them have a lip presenting some concavity as observed in *C. naso* (*vs.* subcordate and convex in *C. lucis*). The inside of the lip is protruding on both sides by thick projections that form a transverse wall along the lip (as well as in *C. naso*), however these projections can vary in size and shape due to the existence of two obtuse appendages observed in *C. lucis*. The lip margin can be either smooth (as in *C. lucis*) or fimbriate (as in *C. naso*). The lip apex can be apiculate as in *C. naso* or more rounded because *C. lucis* has a lip apex ending into a fleshy structure. When analyzing the images in the descriptions we can note that all of them present antennae first parallel and becoming slightly divergent at apex as in *C. naso* (*vs.* antennae strongly divergent in *C. lucis*) (see Lindley 1843b, Lindley & Paxton 1851, Dunsterville & Garay 1961, Ortiz & Arango 1994, Uribe-Velez & Sauleda 2018a,b,c, Salueda 2019). Since the phenotype is unpredictable in hybrids, especially when the parents present different morphological variations (Rieseberg & Ellstrans 1993), we consider as quite acceptable the variations observed in the four discussed taxa.

TABLE 1. Comparison between *C.* × *grasineideae*, *C. gnomus* and *C. saccatum*, according to Lindley 1840, Linden & Reichenbach 1870, Pessoa *et al.* 2015, Petini-Benelli 2017, 2020 and Krahl 2020.

	Taxon		
Characteristics	*C.* × *grasineideae*	*C. gnomus*	*C. saccatum*
Inflorescence	Erect, 1-5–flowered.	Arched to pendent, 4-15–flowered.	Recurved to pendent, ca. 27-flowers
Flowers	Yellowish with brownish spots, lip more yellow, non-resupinate.	Yellowish with strongly brownish spots on sepals and petals, non-resupinate.	Yellowish with brownish spots, lip more yellow, resupinate.
Sepals	ca. 4 × 1.5 cm, elliptic-lanceolate.	4–5 × 1.5–2 cm, obovate-lanceolate to elliptic.	5–6 × 1 cm, elliptic-lanceolate.
Petals	ca. 4.1 × 1.6 cm, elliptic-lanceolate.	4–5 × 1.5–2 cm, linear-lanceolate.	5–6 × 1 cm, elliptic-lanceolate.
Lip	ca. 3 × 4.5 cm, entire, subtrilobed, suborbicular, margin next to apex reflexed, margin denticulate to serrate, central area sacciforme, with a transverse ostium and two small protuberance on the edge next to column.	0.9–1.2 × 1.6–1.8 cm, trilobed, elmiform, margins reflexed and serrate, with two acute protuberances on the internal margin.	2–3 × 3 cm, trilobed, suborbicular, lateral and median lobes reflexed, margin fimbriate, laciniate or denticulate, central area sacciform with a transverse ostium and two small protuberances on the edga next to column.
Column	ca. 3.3 × 1 cm long.	2–3 × 0.4 cm long.	5–6 × 0.8 cm long.
Antennae	ca. 1.1 cm long, crossed.	ca. 2 cm long., crossed.	ca. 1.5 cm long., crossed.

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References

Arnold, M.L. (1992) Natural hybridization as an evolutionary process. *Annual Review Ecology and Systematics* 23: 237–261. https://doi.org/10.1146/annurev.es.23.110192.001321

Azevedo, C.O., Borba, E.L. & van den Berg, C. (2006) Evidence of natural hybridization and introgression in *Bulbophyllum involutum* Borba, Semir & F. Barros and *B. weddellii* (Lindl.) Rchb.f. (Orchidaceae) in the Chapada Diamantina, Brazil, by using allozyme markers. *Revista Brasileira de Botânica* 29: 415–421. https://doi.org/10.1590/S0100-84042006000300008

Barbarena, F.F.V.A., Costa, D.L.L. & Rocha-Júnior, J.A.L. (2020) Re-discovery of *Catasetum mojuense* (Orchidaceae: Catasetinae), a poorly-known Amazonian species. *Neotropical Biology and Conservation* 15: 447–452. https://doi.org/10.3897/neotropical.15.e54142

Barbarena, F.F.V.A. (2021) Taxonomic notes on *Catasetum roseoalbum* (Orchidaceae: Epidendroideae): reaffirming *Catasetum ciliatum* as a synonym. *Phytotaxa* 529: 171–173. https://doi.org/10.11646/phytotaxa.529.1.13

Barbosa-Rodrigues, J. (1877) *Genera et species orchidearum novarum I*. Fleiuss, Rio de Janeiro, 209 pp. https://doi.org/10.5962/bhl.title.585

Barton, N.H. & Hewitt, G.M. (1989) Adaptation, speciation and hybrid zones. *Nature* 341: 497–503. https://doi.org/10.1038/341497a0

Batista, J.A.N. & Medeiros, A.S. (2022) A new putative natural hybrid of *Cyrtopodium* (Orchidaceae) from the south coast of Brazil. *Phytotaxa* 536: 279–286. https://doi.org/10.11646/phytotaxa.536.3.8

Bicalho, H.D. (1963) Uma nova espécie de *Catasetum* L. C. Rich. (Orchidaceae) da flora do estado de Mato Grosso. *Loefgrenia* 8: 1–2.

Bicalho, H.D. (1964) Um novo *Catasetum* L.C. Rich. (Orchidaceae) da flora brasileira. *Loefgrenia* 17: 1–3.

Borba, E.L. & Semir, J. (1998) *Bulbophyllum ×cipoense* (Orchidaceae), a new natural hybrid from the Brazilian "campos rupestres": description and biology. *Lindleyan*a 13: 113–120.

Braga, P.I.S. (1978) Estudos da flora orquidológica do Estado do Amazonas III - × *Brassocattleya rubyi* Braga (Orchidaceae) híbrido natural novo da flora amazônica. *Acta Amazonica* 8: 371–378 https://doi.org/10.1590/1809-43921978083371

Cândido, M.E.M.B.; Miranda, P.N. & Morato, E.F. (2021) Orchid bees in riparian and terra-firme forest fragments in an urban matrix in southwestern Brazilian Amazonia. *Acta Amazonica* 51: 214–223. https://doi.org/10.1590/1809-4392202003781

Campacci, M.A. & Carr, G.F. (2011) *Catasetum joaquinianum*. *Coletânea de orquídeas brasileiras* 9: 320.

Cantuária, P.C., Krahl, D.R.P., Krahl, A.H., Chiron, G. & Silva, J.B.F. (2021) *Catasetum × sheyllae* (Orchidaceae: Catasetinae), a new natural hybrid from Brazilian Amazon. *Phytotaxa* 527: 257–265. https://doi.org/10.11646/phytotaxa.527.4.3

Castro-Neto, V.P. (2012) *Catasetum × riotianum*. *Icones Orchidacearum Brasiliensis* 3: t. 229.

CRIA—Centro de Referência em Informação Ambiental. (2022) *Catasetum gnomus* and *Catasetum saccatum*. Available from: https://specieslink.net/ (accessed 16 April 2022).

Damián, A., Mitidieri, N., Bonilla, M. & Huayllani, J.T. (2021) A new species, lectotypification and new records in *Catasetum* (Orchidaceae: Catasetinae) from Peruvian Amazon. *Botany Letters* 168: 191–199. https://doi.org/10.1080/23818107.2020.1871404

Dressler, R.L. (1993) *Phylogeny and Classification of the Orchid Family.* Dioscorides Press, Portland, 314 pp.

Dunsterville, G.C.K. & Garay, L.A. (1961) *Venezuelan Orchids Illustrated 2*. Andre Deutsch, London, 360 pp.

Ferreira, U.L.C. (2013) *Catasetum × valdisonianum* U.L.C. Ferreira, um novo híbrido natural. *Orquidário* 27: 93–97.

Ferreira, U.L.C. (2016) *Catasetum × mesquitae* U.L.C. Ferreira, novo híbrido natural. *Orquidário (Rio de Janeiro)* 30: 37–43.

Ferreira, U.L.C. (2019) Two new natural hybrids in *Catasetum* (Orchidaceae) from Centre-West Brazil. *Richardiana* 3: 80–91.

Ferreira, U.L.C. & Filho, R.M.C. (2019) Two new natural hybrids in *Catasetum* (Orchidaceae) from Brazil. *Richardiana* 3: 39–49.

Ferreira, U.L.C. & Malaspina, T.K. (2019) *Catasetum × aikoae* U.L.C.Ferreira & T.K.Malaspina *hyb. nat. nov. Coletânea de Orquídeas Brasileira* 15: 594–597.

Fidalgo, O. & Bononi, V.L.R. (1989) *Técnica de coleta, preservação e herborização de material botânico*. Instituto de Botânica, São Paulo, 62 pp.

Govaerts, R., Dransfield, J., Zona, S., Hodel, D.R. & Henderson, A. (2022) *World Checklist of Orchidaceae*. Facilitated by the Royal Botanic Gardens, Kew. Available from: http://apps.kew.org/wcsp/ (accessed 16 April 2022).

Harris, J. & Harris, M. (2001) *Plant identification terminology—an illustrated glossary*. Spring Lake Publishing, Payson, Utah.

Higgins, W.E & Dalström, S. (2007) A *Catasetum* (Orchidaceae) from Peru. *Selbyana* 28: 103–105.

Hoehne, F.C. (1915) *Catasetum juruenense*. *Commissão de Linhas Telegraphicas Estrategicas de Matto-Grosso ao Amazonas* 5: 55.

Hoehne, F.C. (1916) *Catasetum rooseveltianum* Hoehne. *Commissão de Linhas Telegraphicas, Botanica* 47: 35, t. 172.

Holst, A.W. (1999) *The world of Catasetums.* Timber Press, Portland, 560 pp.

Hooker, W.J. (1840) *Monochanthus roseo-albus*. *Curtis's Botanical Magazine* 67: t. 3796.

Hooker, W.J. (1854) *Catasetum naso*. *Curtis's Botanical Magazine* 80: t. 4792.

Janzen, D. (1971) Euglossini bees as long-distance pollinators of tropical plants. *Science* 171: 203–205. https://doi.org/10.1126/science.171.3967.203

Köppen, W. (1948) *Climatologia: con un estudio de los climas de la tierra*. Fondo de Cultura Económica, México, 479pp.

Kraenzlin, F.W.L. (1910) *Catasetum tenebrosum*. *The Gardeners' Chronicle & Agricultural Gazette* 48: 229

Krahl, D.R.P. (2020) Riqueza de Orchidaceae em três diferentes áreas da Amazônia Central e a biologia reprodutiva de *Prosthechea aemula* (Lindl.) W.E. Higgins. Dissertation, National Institute of Amazon Research, 446 pp.

Krahl, D.R.P., Krahl, A.H. & Chiron, G. (2020) *Catasetum* × *louisiae* (Orchidaceae, Catasetinae), a new natural hybrid for the Brazilian Amazon. *Richardiana, nouvelle série* 4: 214–223.

Krahl, A.H., Krahl, D.R.P. & Pansarin, E. (2021a) *Ionopsis* × *atalibae* (Orchidaceae, Oncidiinae), a new natural hybrid from the Brazilian Amazon. *Phytotaxa* 478: 268–274. https://doi.org/10.11646/phytotaxa.478.2.8

Krahl, A.H., Krahl, D.R.P., Cantuária, P.C. & Silva, J.B.F. (2021b) *Catasetum saracataquerense* (Orchidaceae, Catasetinae), a new species of Brazilian Amazon. *Richardiana, nouvelle série* 5: 206–216.

Krahl, A.H., Chiron, G., Cantuária, P.C. & Silva, J.B.F. (2021c) A new species of *Catasetum* (Orchidaceae, Catasetinae) for the Brazilian Amazon. *Richardiana, nouvelle série* 5: 283–294.

Krahl, A.H., Krahl, D.R.P., Cantuária, P.C., Chiron, G. & Silva, J.B.F. (2022a) *Catasetum marinhoi* (Orchidaceae, Catasetinae), a new species of Brazilian Amazon. *Richardiana* 6: 100–110.

Krahl, D.R.P., Krahl, A.H., Cantuária, P.C. & Silva, J.B.F. (2022b) *Catasetum nhamundaense* (Orchidaceae: Catasetinae), uma nova espécie da Amazônia Brasileira. *Orquidário* 36: 24–36.

Kunth, K.S. (1822) *Catasetum*. *Synopsis Plantarum* 1: 330–331.

Lacerda, K.G. (1998) Estudos em Catasetineas. *Bradea* 8: 90–94.

Linden, J.J. & Reichenbach, H.G. (1870) *Catasetum gnomus*. *Xenia Orchidaceae* 2: 171.

Lindley, J. (1825) *Catasetum hookeri*. *Botanical Register* 10: sub. t. 840.

Lindley, J. (1835) *Monachanthus discolor*. *Edwards's Botanical Register* 20: t. 1735.

Lindley, J. (1839) *Catasetum longifolium*. *Edwards's Botanical Register* 25 (misc.): 94.

Lindley, J. (1840a) *Catasetum saccatum. Edwards's Botanical Register* 26: 76.

Lindley, J. (1840b) *Catasetum (Monachanthus) roseo-album*. *Edwards's Botanical Register* 26 (misc.): 65

Lindley, J. (1843a) Catasetinae. *Edward's Botanical Register* 29: sub. t. 22.

Lindley, J. (1843b) *Catasetum naso*. *Edward's Botanical Register* 29: Misc. 71.

Lindley, J., 1844. *Catasetum discolor*. *Edwards's Botanical Register* 30 (misc.): 34.

Lindley, J. & Paxton, J. (1850) *Catasetum fimbriatum*. *Paxton`s flower Garden* 1: 124.

Lindley, J. & Paxton, J. (1850) *Catasetum sanguineum*. *Paxton`s flower Garden* 2: 168.

Luizão, F.J. (1995) *Ecological studies in contrasting forest types in Central Amazonia*. PhD Thesis, University of Stirling, 288 pp.

Miranda, F.E.L. (1986) New orchid species from Brazil: 1. *Lindleyana* 1: 148–157.

Morren, C.J.E. (1848) *Myanthus fimbriatus*. *Annales de la Societe Royale d`Agriculture et de Botaniqu de Gand: Journal d`Horticulture et des Sciences Accessoires* 4: 453.

Oliveira, A.T. & Silva, J.B.F. (1998) *Catasetum mojuense* e *Catasetum tucuruiense*: novas espécies de Orchidaceae para o Estado do Pará. *Boletim do Museu Paraense Emílio Goeldi, Série Botânica* 14: 109–115.

Ortiz, P. & Arango, G. (1994) *Catasetum lucis*. *Orquideologia* 19: 29.

Pabst, G.F.J. (1975) New or Critical Orchids from Brazil—VII. *Orchid Review* 83 (990): 405–406.

Pessoa, E.M., Barros, F. & Alves, M. (2015) Orchidaceae from Viruá National Park, Roraima, Brazilian Amazon. *Phytotaxa* 192: 61–96. https://doi.org/10.11646/phytotaxa.192.2.1

Pessoa, E.M., Nollet, F., Magalhães, R.F., Viruel, J., Pinheiro, F. & Chase, M. (2021) Nuclear-plastid discordance indicates past introgression in species (Laeliinae: Orchidaceae) with highly variable chromosome numbers. *Botanical Journal of the Linnean Society* 198: 357–371. https://doi.org/10.1093/botlinnean/boab080

Petini-Benelli, A. & Grade, A. (2010) Novo Híbrido Natural de *Catasetum* L.C. Rich. *ex* Kunth (Orchidaceae) para o Norte de Mato

Grosso, Brasil. *Orquidário* 24: 124–132.

Petini-Benelli, A. & Grade, A. (2012) *Catasetum apolloi* Benelli & Grade (Orchidaceae): correction taxinomique. *Richardiana* 12: 153–157.

Petini-Benelli, A. (2014) Novelties in *Catasetum* (Orchidaceae) in the State of Rondônia, Brazil. *Feddes Repertorium* 125: 1–11. https://doi.org/10.1002/fedr.201400028

Petini-Benelli, A. (2016) Un novel hybride naturel de *Catasetum* (Cymbidieae, Epidendroideae, Orchidaceae) du Mato Grosso (Brésil). *Richardiana* 16: 327–342.

Petini-Benelli, A. (2017) *Catasetum* Rich. *ex* Kunth (Orchidaceae): filogenia e monografia do gênero para a flora de Mato Grosso, Brasil. Dissertation, Federal University of Mato Grosso, 408 pp.

Petini-Benelli, A. & Chiron, G. (2018) Nouvelle espèce de *Catasetum* (Orchidaceae) du Mato Grosso (Brésil). *Richardiana, nouvelle série* 2: 8–17.

Petini-Benelli, A. & Chiron, G. (2020) Une nouvelle espèce d'orchidée du Rôndonia: *Catasetum desouzae*. *Richardiana, nouvelle série* 4: 238–246.

Petini-Benelli, A. (2022) *Catasetum*. Flora do Brasil 2020 by Jardim Botânico do Rio de Janeiro, JBRJ. Available from: http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB11312 (accessed 16 April 2022).

Pokorny, T., Loose, D., Dyker, G., Quezada-Euan, J.J.G. & Eltz, T. (2015) Dispersal ability of male orchid bees and direct evidence for long-range flights. *Apidologie* 46: 224–237. https://doi.org/10.1007/s13592-014-0317-y

Pupulin, F. (2015) × *Cochlezella costaricensis*, a name for a rare natural hybrid in the Zygopetalinae (Orchidaceae). *Harvard Papers in Botany* 20: 199–208. https://doi.org/10.3100/hpib.v20iss2.2015.n8

Quaresma, A.C., Piedade, M.T.F., Wittmann, F. & ter Steege, H. (2018) Species richness, composition, and spatial distribution of vascular epiphytes in Amazonian black-water floodplain forests. *Biodiversity and Conservation* 27: 1981–2002. https://doi.org/10.1007/s10531-018-1520-3

Reichenbach, H.G. (1882) *Catasetum pileatum*. *The Gardeners` Chronicles, new series* 17: 492.

Reichenbach, H.G. (1888) *Catasetum tapiriceps*. *The Gardeners` Chronicles* 3: 136.

Rieseberg, L.H. & Ellstrand, N.C. (1993) What can molecular and morphological markers tell us about plant hybridization? *Critical Reviews in Plant Sciences* 12: 213–241. https://doi.org/10.1080/07352689309701902

Romero, G.A. & Carnevali, G. (1989) Notes in the orchid flora of Southern Venezuela. *Annals of the Missouri Botanical Garden* 76: 454–461. https://doi.org/10.2307/2399494

Romero, G.A. & Carnevali, G. (2009) *Catasetum*. *In:* Pridgeon, A.M., Cribb, P.J., Chase, M.W. & Rasmussen, F.N. (Eds.) *Genera Orchidearum, Epidendroidea—Part II*. Oxford University Press, New York, pp. 13–18.

Romero, G.A. & Jenny, R (1992) New natural hybrids and nomenclatural novelties in *Catasetum* (Orchidaceae) from the Guianas, Ecuador, and Peru. *Novon* 2: 241–248. https://doi.org/10.2307/3391560

Romero, G.A. & Jenny, R. (1993) Contributions toward a monograph of *Catasetum* (Catasetinae, Orchidaceae) I: A checklist of species, varieties, and natural hybrids. *Harvard Papers in Botany* 1: 59–84.

Sauleda, R.P. (2019) A new species of *Catasetum* Rich. ex Kunth (Orchidaceae), *Catasetum pamplonaense* Sauleda, is described from Norte de Santander, Colombia. *New World Orchidaceae—Nomenclatural Notes* 54: 1–7.

Silva, J.B.F. & Silva, M.F.F. (1998) *Orquídeas Nativas da Amazônia Brasileira: gênero Catasetum L. C. Rich. ex Kunth*. Museu Paraense Emílio Goeldi, Belém, 518 pp.

Solano, R., Huerta-Espinoza, H., Cruz-García, G. & Ortiz-Riveros, F. (2019) A new natural hybrid in the genus *Laelia* (Orchidaceae) from Oaxaca, Mexico. *Phytotaxa* 402: 232–240. https://doi.org/10.11646/phytotaxa.402.5.2

Thiers, B.M. (ed.) (2022) [continuously updated] *Index Herbariorum*: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Avaiable from: http://sweetgum.nybg.org/ih/ (accessed 19 February 2022).

Uribe-Velez, C. & Sauleda, R.P. (2018a) A new species of *Catasetum* Rich. ex Kunth (Orchidaceae) from Colombia. *New World Orchidaceae—Nomenclatural Notes* 40: 1–6.

Uribe-Velez, C. & Sauleda, R.P. (2018b) A new species of *Catasetum* Rich. ex Kunth (Orchidaceae) is described from Norte de Santander, Colombia. *New World Orchidaceae—Nomenclatural Notes* 42: 1–7.

Uribe-Velez, C. & Sauleda, R.P. (2018c) A second new species of *Catasetum* Rich. Ex Kunth (Orchidaceae) from Norte de Santander, Colombia. *New World Orchidaceae—Nomenclatural Notes* 43: 1–5.

van der Pijl, L. & Dodson, C.H. (1966) *Orchid flowers: their pollination and evolution.* University of Miami Press, Florida, 214 pp.

Vieira, B.C., Pansarin, L.M., Martucci, M.E.P., Gobbo-Neto, L. & Pansarin, E.R. (2017) Pollinarium size as a hybridization barrier between sympatric inter-compatible orchids. *Australian Journal of Botany* 65: 497–506. https://doi.org/10.1071/BT17081

Walker-Larsen, J. & Harder, L.D. (2000) The evolution of staminodes in Angiosperms: patterns of stamen reduction, loss, and functional re-invention. *American Journal of Botany* 87: 1367–1384. https://doi.org/10.2307/2656866