

Research article

Catasetum × *luanae* (Orchidaceae, Catasetinae): a new nothospecies from the Brazilian Central Amazon

Catasetum × *luanae* (Orchidaceae, Catasetinae): una nueva notoespecie de la Amazonia Central Brasileña

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ABSTRACT

A new natural hybrid of *Catasetum* is illustrated with photographic plates and described here based on collections made in the Trombetas River basin, in the municipality of Oriximiná, state of Pará (Brazilian Amazon). It is compared with the parental species (*C. galeritum* and *C. macrocarpum*), with which it shares characteristics that are clearly intermediate between these two taxa. Data relating to the habitat, ecology and geographic distribution of the hybrid described here are also presented. This finding reinforces the Amazon region as a center of diversification for *Catasetum*.

Keywords: Amazon basin, biodiversity, natural hybrid, taxonomy, Trombetas River.

RESUMEN

Se describe e ilustra con láminas fotográficas un nuevo híbrido natural de *Catasetum*, a partir de colecciones realizadas en la cuenca del Río Trombetas, en el municipio de Oriximiná, estado de Pará (Amazonía brasileña). Se compara con las especies parentales (*C. galeritum* y *C. macrocarpum*), con las que comparte características claramente intermedias entre estos dos taxones. También se presentan datos relativos al hábitat, ecología y distribución geográfica del híbrido descrito aquí. Este descubrimiento refuerza a la Amazonía como centro de diversificación para *Catasetum*.

Palabras Clave: Biodiversidad, cuenca amazónica, híbrido natural, río Trombetas, taxonomía.

INTRODUCTION

The genus *Catasetum* Rich. ex Kunth is one of the larger genera within the subtribe Catasetinae with approximately 195 validly described species (Krahl *et al.*, 2023a, 2023b, 2023c, 2023d, 2023e, 2024a, 2025a; POWO, 2024). Its members are widely distributed from Mexico to north of Argentina and south of Brazil (Romero and Carnevali, 2009). However, many of them are found within the Brazilian territory, that houses 105 species (Krahl *et al.*, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2024a, 2024b, 2024c; Petini-Benelli, 2024). *Catasetum* members are characterized by fusiform, elliptic, ovate or conical pseudobulbs; leaves deciduous, plicate, usually elliptic or oblanceolate, with their several leaves distributed in the pseudobulb; basal, racemose inflorescences producing unisexual (staminate or pistillate) or rarely hermaphrodites (staminate + pistillate) flowers (Holst, 1999). Because of their weak variation, vegetative morphology as well as the characters of the female and/or the hermaphrodite flowers are considered as useless to identify the species (Walker-Larsen and Harder, 2000). Therefore, only the staminate flowers take on fundamental importance in the genus as their morphological characters, presenting a great variation according to each taxon (Holst, 1999), are essential to differentiate the species (Walker-Larsen and Harder, 2000).

Staminate flowers are characterized by the presence of two modified staminodes anterior to the gynostemium (=column) called “antennae” and whose primary function is to trigger the pollinarium into the body of the pollinator during the visit (Romero, 1992). Based on antennae, the genus has historically been divided into two subgenera: subgenus *Pseudocatasetum* (antennae poorly developed or absent) and subgenus *Catasetum* (antennae visibly developed). This second subgenus is subdivided into two different sections: section *Catasetum* (crossed and asymmetrical antennae) and section *Isoceras* (symmetrical antennae). Three subsections are recognized for the section *Isoceras*, namely: *Isoceras*, *Divaricatae* and *Convergentia*. (Bicalho and Barros 1988; Senghas 1990, 1991). Interestingly, variation also exists in the placement of the pollinarium on pollinators: in species of *Pseudocatasetum*, for instance, the pollinarium is typically deposited on the ventral section of the bee’s thorax, while in the other groups the pollinarium is normally deposited on the back (Romero, 1992). However, recent phylogenetic studies indicate that the groups based on the morphology of this structure are not supported as natural clades in any of the available phylogenetic reconstructions, which proved to be polyphyletic lineages (Pérez-Escobar *et al.*, 2017; Mauad *et al.*, 2022). The species are thus best grouped according to biogeographical criteria (Mauad *et al.*, 2022).

Catasetum is also a record holder when considering the number of registered nothospecies (POWO, 2024). A

total of 46 natural hybrids have been documented (Krahl *et al.*, 2020, 2023a, 2024c, 2024d, 2025b, 2025c, 2025d; Cantuária *et al.*, 2021; Ferreira and Malaspina, 2023a, b; Assis and Ferreira, 2024; POWO, 2024) of which 76,09 % (35 hybrids) are found in Brazil and 26 in the Brazilian Amazon (Krahl *et al.*, 2020, 2023a, 2024c, 2024d, 2025b, 2025c, 2025d; Cantuária *et al.*, 2021; Ferreira and Malaspina, 2023a, b; Petini-Benelli, 2024). Despite this high concentration of records, the state of Pará accounts for only four known natural hybrids, a surprisingly low number, given its vast territory and ecological heterogeneity. This scarcity highlights a significant knowledge gap regarding the hybrid diversity of *Catasetum* in the region (Krahl *et al.*, 2020, 2023a; Cantuária *et al.*, 2021; Petini-Benelli, 2024).

Thus, the present study aims to contribute to filling this gap by reporting a new natural hybrid from the Brazilian Amazon, more precisely from the Trombetas River basin, in the state of Pará. Specifically, we (1) provide a detailed morphological description of the new nothospecies, (2) compare it with its putative parental species, *C. galeritum* Rchb.f. and *C. macrocarpum* Rich. ex Kunth, and (3) present data on its geographical distribution, habitat, and ecology.

MATERIALS AND METHODS

The specimen here described was found and collected during occasional expeditions in the Trombetas River basin, in the municipality of Oriximiná, in northwest Pará, Brazil. When compared to the other members of the genus, mainly sympatric, we concluded that the specimen resulted from a cross between *C. macrocarpum* Rich. ex Kunth and *C. galeritum* Rchb.f. It is therefore described as a new natural hybrid for science and compared to its parents based on protocols and secondary literature. The specimen was prepared as an herbarium specimen according to the usual process described in Mori *et al.* (1989) and later deposited in the HUAM (acronym according to Thiers, 2024), located at the Federal University of Amazonas (UFAM). The descriptive terminology follows Dressler (1993) and Gonçalves and Lorenzi (2007). The comparison of the new nothospecies with its putative parents was carried out through the consultation of protologues and the analysis of materials deposited in the herbaria ALCB, BHCB, CEN, EAC, F, HUAM, HUEFS, HUESB, HUTO, IAN, INPA, K, MAC, MBML, MFS, MO, NY, RB, RBR, P, SAMES, SLUI, UPCB, and VIES (acronyms according to Thiers, 2024).

The map showing the type locality was made using the QGIS software (Version 3.28 Firenze) and the shapefile layers were obtained directly from the Ministério do Meio Ambiente do Brasil (MMA) and the Instituto Brasileiro de Geografia e Estatística (IBGE). The occurrence records of the supposed parental species were obtained through the SpeciesLink (Canhos *et al.*, 2024), JABOT (Silva *et al.*, 2017), and GBIF (Barve, 2023) databases, in order to delimit the occurrence zone of each species and evaluate the overlap in

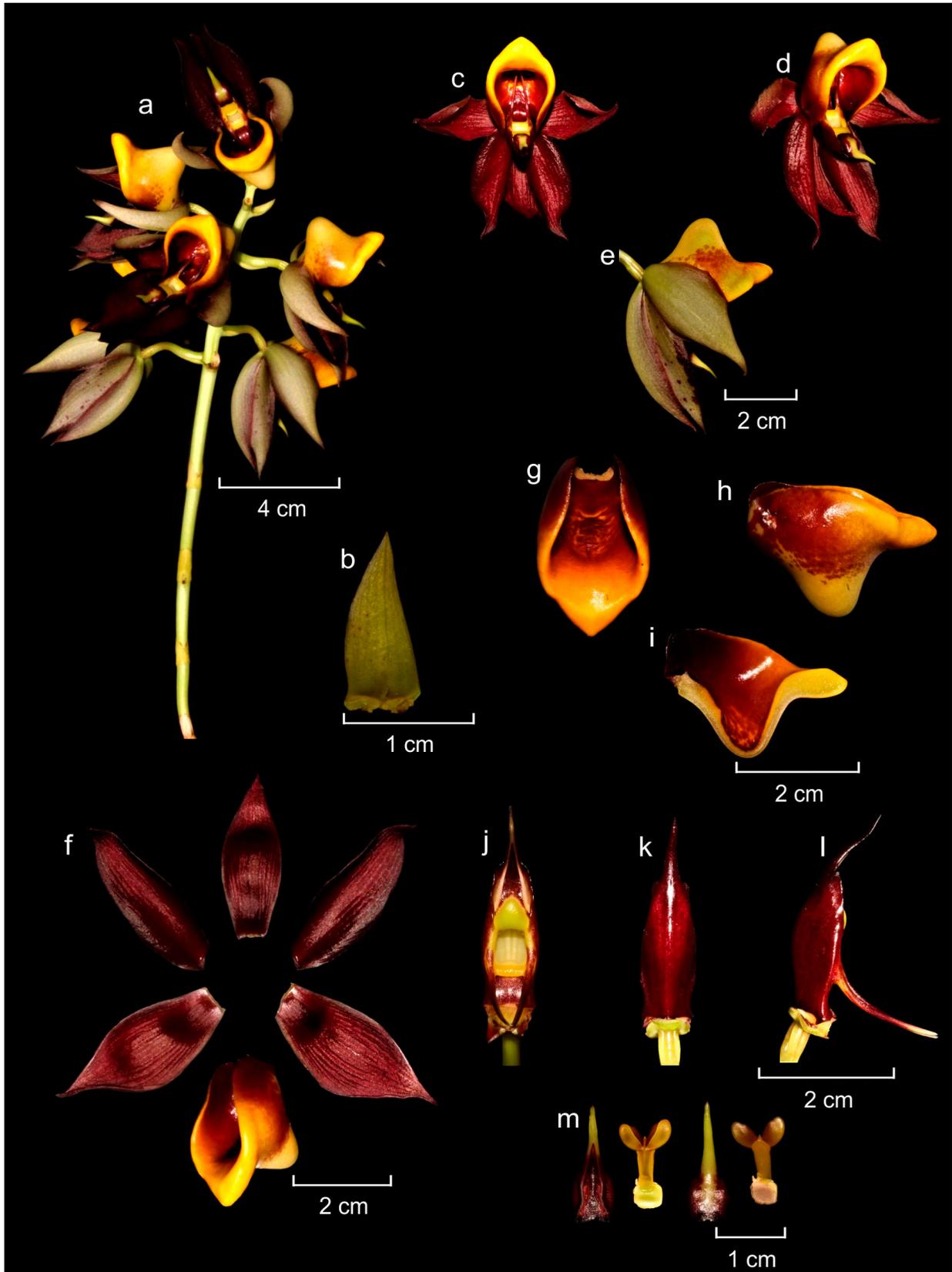


Figure 1. Composite color plate of *Catasetum* × *luanae* D.R.P.Krahl, Krahl, M.S.Oliveira & Cantuária. **(a)** inflorescence; **(b)** floral bract; **(c-e)** flowers; **(f)** floral segments; **(g-i)** labellum in front view, side view and longitudinal section; **(j-l)** column; **(m)** anther cap and pollinarium. Photos and plate by A. H. Krahl.

geographic distribution between them. Materials (consulted through SpeciesLink, JABOT and GBIF) from the herbaria ALCB, AMES, BHCN, CEN, CEPEC, CNMT, CVJBFZB, EAC, EAN, F, HABIT, HAMAB, HBRA, HEPH, HF, HRB, HTO, HUAM, HUEFS, HUTO, HSTM, IAN, INPA, IPA, JPB, K, L, LBMBP, MAC, MAR, MBM, MBML, MSF, MO, NY, R, RB, RBR, P, SAMES, SLUI, SP, UFMT, UFRN, UFP, UPCB, US, VIES and WAG (acronyms according to Thiers, 2024) were analyzed in order to determine the flowering period of the supposed parental species and evaluate an overlapping period in flowering.

RESULTS

Taxonomic treatment

Taxonomy: *Catasetum* × *luanae* D.R.P.Krahl, Krahl, M.S.Oliveira & Cantuária, *nothosp. nov.* (Fig. 1).

Type: BRAZIL. Pará: Oriximiná, Trombetas River, “igapó” forest (flooded forest), 1°41'01.7”S, 55°55'47.3”W, 01.III.2023, fl. ♂, Krahl & Krahl 1683 (Holotype: HUAM012683!).

Diagnosis

Hybrida naturalis inter Catasetum galeritum Rchb. f. et Catasetum macrocarpum Rich. ex Kunth cum characteribus intermediis: inflorescentia erecta, flores haud resupinati, labellum trilobatum, lobi laterales rotundati, lobus terminalis ovatus obtusus carnosus, antennae parallelae tantum apice contiguae.

Description

Plant epiphytic and caespitose. Roots whitish, thick, and with negative geotropism. Rhizome inconspicuous, short. Pseudobulb 7.4–1.6 × 2.5–3.6 cm, conical to fusiform, 5–7-leaved, covered by the leaf sheaths. Leaves 10.3–33.1 × 3.5–10.9 cm, oblanceolate, plicate, with 5–7 prominent nerves on the abaxial face, membranous, green, margin entire, apex acute. Staminate inflorescence 27.6–31.1 cm long, erect, lateral, racemose, 4–7 flowered, produced from foliated pseudobulbs; peduncle cylindrical, light green; floral bract ca. 1.4 × 0.8 cm, lanceolate, greenish, margin entire, apex acute. Staminate flowers wine-colored, labellum yellow, sepals and petals lightly greyish on the adaxial face, partly grouped on the first apical third, not resupinate, pedicelled; pedicel ca. 2.6 × 0.4 cm, cylindrical, erect to slightly sinuate, greenish; dorsal sepal ca. 3.9 × 1.5 cm, elliptic, concave, symmetrical, margin entire, apex acute; lateral sepals ca. 4.7 × 2.1 cm, broadly elliptic, concave, asymmetrical, margin entire, apex acute; petals ca. 4.7 × 1.7 cm, narrowly elliptic, slightly asymmetrical, margin entire, apex acute; labellum ca. 3.5 × 2.3 cm, 3-lobed, oval in scope, thick, smooth; labellum bottom ca. 1.5 cm deep, conical; lateral lobes ca. 2.3 × 1.9 cm, semi-elliptic to semi ovate,

margin entire; midlobe ca. 0.8 × 1.3 cm, ovate to rhomboid, thick, symmetrical, margin entire, apex obtuse; column ca. 3.9 cm long, subtriangular, thick, wine-coloured, slightly contracted at the base, apex rostrate; antennae ca. 0.5 cm long, filiform, parallel, apically touching, wine-coloured; anther cap ca. 1.6 × 0.6 cm, subtriangular, wine-coloured at base and greenish at apex, apex rostrate; viscidium ca. 0.4 × 0.4 cm, subquadrate, sticky; stipe ca. 0.5 × 0.2 cm, laminar, rolled, yellowish; pollinia 2, ca. 0.4 × 0.2 cm, oblong, hard, sulcate, compressed, yellowish. Pistillate and hermaphrodite structures not seen. Fruit not seen.

Etymology

The specific epithet is in honor of Luana Passos Krahl (with her consent), daughter of the first two authors of the new nothotaxon name and a young woman fascinated by orchids and who helped in the cultivation of the plant until it bloomed.

Distribution, habitat and ecology

Hitherto, the taxon has been observed only in the type locality, i.e., Trombetas River basin. More precisely it has been found as an epiphytic plant in the forest of Igapó (flooded environment typical of the Amazonian region) of the left bank of this river, at about 10 km from the city of Oriximiná (Fig. 2). It is worth noting that this area is comprised within a region where the distribution areas of the parents overlap: *C. macrocarpum* is widely distributed on the Brazilian territory (occurring in the southeast, northeast, midwest and north of the country) as well as in Colombia, Venezuela, French Guiana, Guyana, Suriname and Trinidad & Tobago; *C. galeritum* is endemic to Brazilian Amazon, distributed from the east of Amazonas state to the western part of the Pará state and from the extreme north of the state of Mato Grosso to the north of Pará (Fig. 2) (Petini-Benelli, 2024; POWO, 2024). In this context, we further emphasize that both supposed parental species coexist in the same habitat (*vázea* and *igapó*) (Petini-Benelli, 2024).

Phenology and pollination

It was observed flowering in the first half of the year, between the months of March and June. Analysis of the herbarium materials revealed an overlap in the flowering period of the putative parents between April and May, coinciding with the end of flowering of *C. macrocarpum* (December to April), and the beginning of flowering of *C. galeritum* (April to July). This overlap highlights the possibility of cross-pollination between the two species.

The literature indicates that the parental species are initially visited by distinct groups of pollinators: *C. macrocarpum* is pollinated by bees of the genera *Eulaema* and *Euglossa* (Carvalho and Machado, 2002; Milet-Pinheiro and

Gerlach, 2017), while *C. galeritum* is associated with bees of the genus *Eufriesea* (Milet-Pinheiro *et al.*, 2018). However, personal observations have recorded the occasional visit of *Eulaema nigrita* to flowers of *C. galeritum* in cultivation. This bee species, already known as a floral visitor to *C. macrocarpum* (Carvalho and Machado, 2002), may have acted as a vector of cross-pollination between these two species, explaining the origin of the natural hybrid proposed here. Analogous situations have already been documented, as in the case of *C. × joaquinianum* Campacci & G.F.Carr, whose putative parents (*C. hookeri* Lindl. and *C. fimbriatum* (C.Morren) Lindl.) have different pollinator guilds (Krahl *et al.*, 2024c).

DISCUSSION

It is possible to notice in the genus *Catasetum* the great influence of hybridization, a process partly responsible for the remarkable species richness observed today (Mauad *et al.*, 2022). The crossing of different species can indeed produce fertile offspring with genetic and phenotypic variations that are relevant for adaptation in a given environment (Arnold, 1997), which, in turn, may lead to future speciation when these offspring manage to survive and perpetuate themselves (Seehausen, 2004; Arnold, 2006). This capacity for hybrid formation is also a consequence of the recent divergence of these taxa from a common ancestor, which has limited the accumulation of strong isolating barriers. Therefore, especially considering the high number of natural hybrids, it is clear that the pre and postzygotic barriers that would normally prevent interspecific reproduction remain weak in this genus. Consequently, the emergence of new nothospecies (for example, Valsko *et al.*, 2019; Krahl *et al.*, 2020, 2021a, b, 2022a, b, 2023a, b, c, d, e, 2024a, b, c; Cantuária *et al.*, 2021; Ferreira and Malaspina, 2023a, b; Assis and Ferreira, 2024) is expected, as exemplified by *C. × luanae*, which corroborates this idea. Therefore, the origin of *Catasetum* can be understood as the result of a relatively recent evolutionary emergence, associated with neotropical geoclimatic events, combined with the adoption of a unique reproductive system whose plasticity contributed decisively to the rapid diversification of the genus (Pérez-Escobar *et al.*, 2017; Mauad *et al.*, 2022).

Hitherto, the genus contains 38 natural hybrids, which represents about 16 % of all valid taxa for *Catasetum* (Krahl *et al.*, 2020, 2023a, 2024c; Cantuária *et al.*, 2021; Ferreira and Malaspina, 2023a, b; Assis and Ferreira, 2024; POWO, 2024). However, these numbers should not be stationary as various hybrids may be found as highlighted and demonstrated by Krahl *et al.* (2023a, 2024c). These authors also predicted that several current species might prove to be hybrids and that the elucidation of these taxa will be done only with the use of other tools besides

phylogeny (see Mauad *et al.*, 2022), such as artificial crossing between different species with subsequent in vitro germination and comparison of the offspring with the current species.

Catasetum × luanae (Fig. 3a–f) exhibits morphological characters intermediate between those of its two congeneric and sympatric species from the Brazilian Amazon, *C. galeritum* (Fig. 3g–l) and *C. macrocarpum* (Fig. 3m–r) (Petini-Benelli, 2024). This supports its taxonomic status as a nothospecies. As in most *Catasetum* species (Holst, 1999), the new nothospecies shows no distinctive vegetative traits, as it shares the same vegetative morphology with its parental species and with most other members of the genus. Regarding the staminate flower morphology, several characters are intermediate between those of both putative parents, especially the flower color, the petal shape, the labellum structure, and the antennae disposition. Additional comparisons are presented in (Table 1).

Catasetum × luanae presents an erect inflorescence with spaced flowers only present in the apical third, as it is observed in both parents. Flowers show a color pattern somewhat intermediate resembling some forms of *C. galeritum*, with wine-colored flowers with a light greyish hue on the outer surface. The labellum shows a yellowish color similar to that of *C. macrocarpum*. The sepals are similar to what we observe in *C. galeritum* and *C. macrocarpum*, i.e. dorsal sepal elliptic, concave, symmetrical and lateral ones broadly elliptic, concave, asymmetrical. The petals, narrowly elliptic, have a shape intermediate between those of the parents, oblong to elliptic in *C. galeritum* and elliptic in *C. macrocarpum*.

As expected, it is evident that the labellum of *C. × luanae* is the structure that exhibits the most intermediate characteristics between *C. galeritum* and *C. macrocarpum*. It is 3-lobed as in both parents and has an intermediate outline between an ovate shape in *C. macrocarpum* and an oblong shape in *C. galeritum*. Besides it has a deep conical base as in *C. macrocarpum* (*vs.* oblong and less deep in *C. galeritum*). The lateral lobes are semi-elliptic to semi-ovate and turned inwards, as observed in *C. galeritum* (*vs.* semi-ovate and turned outwards in *C. macrocarpum*). The midlobe is ovate to rhomboid whereas it is orbicular in *C. galeritum* and triangular to rhomboid in *C. macrocarpum*; its size is also intermediate (ca. 8 mm long *vs.* ca. 13 mm in *C. galeritum* and ca. 5 mm in *C. macrocarpum*). We may also observe on a longitudinal section of the lip a large thickening as happens in *C. galeritum* (Fig. 3) (Reichenbach, 1886; Kunth, 1822; Petini-Benelli, 2024). Antennae are symmetrical as in *C. galeritum* (*vs.* asymmetrical in *C. macrocarpum*) and almost parallel, i.e. parallel but touching at apex, whereas they are parallel in *C. galeritum* and crossed in *C. macrocarpum*.

Identification key for *Catasetum* species with symmetrical and parallel antennae occurring in the State of Pará. Occurrences based on Petini-Benelli (2024), Krahl *et al.* (2021a, 2021b, 2022a, 2023d, 2023e, 2024a, 2024b, 2025a).

| | |
|---|--|
| 1. Non-resupinate flowers (label facing upwards) | 2 |
| 1` . Resupinate flowers (label facing downwards) | 3 |
| 2. Middle lobe of the labellum oval to rhomboid | <i>C. × luanae</i> D.R.P.Krahl, Krahl, M.S.Oliveira & Cantuária |
| 2` . Middle lobe of the labellum orbicular | <i>C. galeritum</i> Rchb.f. |
| 3. Smooth labellum (without fimbriae) | <i>C. maranhense</i> K.G.Lacerda & J.B.F.Silva |
| 3` . Labellum with fimbriae or with a denticulated margin | 4 |
| 4. Labellum without any type of callus inside | <i>C. × guianense</i> G.A. Romero & Jenny |
| 4. Labellum with some type of callus inside | 5 |
| 5. Trilobate labellum | 6 |
| 5` . Entire labellum | 10 |
| 6. Base of the labellum with two calluses | <i>C. boyi</i> Mansf. |
| 6` . Base of the labellum with a rounded or tripartite callus | 7 |
| 8. Margin of the labellum with multilacerated fimbriae at the apex | <i>C. multifidum</i> F.E.L.Miranda |
| 8` . Margin of the labellum with simple fimbriae | 9 |
| 9. Apex of the labellum smooth | <i>C. rolfeanum</i> Mansf. |
| 9` . Apex of the labellum provided with a set of 2–3 distinguishable fimbriae fused at the base | <i>C. binarum</i> D.R.P.Krahl, Krahl, Cantuária & J.B.F.Silva |
| 10. Labellum apex with a callus..... | 11 |
| 10` . Labellum apex without a callus..... | 15 |
| 11. Labellum basal callus 3-partite..... | 12 |
| 11` . Labellum basal callus acute and flanked with small “horns”..... | 13 |
| 12. Inflorescence dense; labellum ovate, with rather short fimbriae on the margin; lip apical callus bifid | <i>C. marinhoi</i> Krahl, Cantuária & J.B.F.Silva |
| 12` . Inflorescence lax; labellum oblong to triangular or subtriangular fimbriate; lip apical callus simple, bifid or toothed | <i>C. barbatum</i> (Lindl.) Lindl. |
| 13. Labellum apical callus triangular | <i>C. tomasellii</i> Campacci & J.B.F.Silva |
| 13` . Labellum apical callus oblong, simple or bifurcate | 14 |
| 14. Labellum obtriangular, with spaced fimbriae on the margin..... | <i>C. nhamundaense</i> D.R.P.Krahl, Krahl, Cantuária & J.B.F.Silva |
| 14` . Labellum subtriangular, with fimbriae less spaced at the margin | <i>C. tavaresii</i> Cantuária, D.R.P.Krahl, Krahl & J.B.F.Silva |
| 15. Labellum surface fully covered by appendices | 16 |
| 15` . Labellum surface glabrous | 17 |
| 16. Labellum oblong to ovate and densely covered by thick, papillose crests | <i>C. cristatum</i> Lindl. |
| 16` . Labellum oblong and densely covered by thin fimbriae | <i>C. saracataquerense</i> Krahl, Cantuária & J.B.F.Silva |
| 17. Denticulated labellum margin | <i>C. oriximinaense</i> Campacci & J.B.F.Silva |
| 17` . Fimbriated labellum margin | 18 |
| 18. Labellum triangular or obtriangular | 19 |
| 18` . Labellum oblong | 20 |
| 19. Lip greenish and obtriangular; margin densely fimbriate | <i>C. riosianum</i> D.R.P.Krahl, Krahl, Cantuária & J.B.F.Silva |
| 19` . Lip whitish and triangular; margin with relatively spaced fimbriae | <i>C. taquerense</i> Krahl, Cantuária & J.B.F.Silva |
| 20. Lip apex with a globular concentration of thick fimbriae, slightly recurved | <i>C. queirozii</i> D.R.P.Krahl, Krahl, Cantuária & J.B.F.Silva |
| 20` . Lip apex acute and glabrous, strongly recurved | <i>C. cantuariae</i> Krahl, D.R.P.Krahl, Chiron & J.B.F.Silva |

CONCLUSIONS

The description of a new nothospecies of *Catasetum* from the Brazilian Amazon reinforces the idea that this biome is the center of diversity of the genus, where many taxa can be observed in the most diverse types of vegetation. Furthermore, with the discovery of *C. × luanae* and many other natural hybrids, it is also possible to infer that the genus may still be

in the process of speciation. It is also reinforced the need for investment in sampling efforts of Amazonian flora and in the training of specialized taxonomists in Amazonian plants, so that many other previously unknown taxa can be described before they possibly disappear in an extensive and important biome that suffers intensely from negative action human being. In addition, future tests, such as phylogenetic analyses using molecular markers with different inheritance patterns

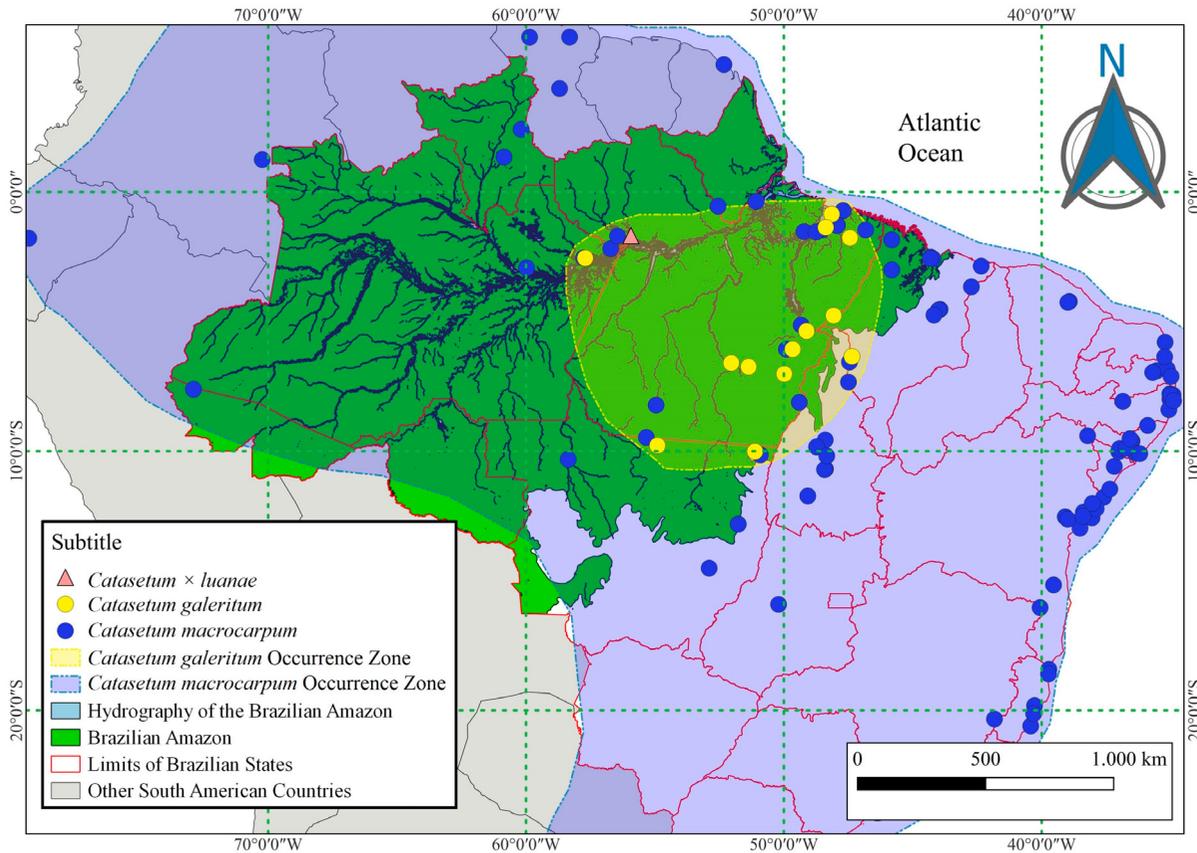


Figure 2. Geographic distribution of *Catasetum* × *luanae* D.R.P.Krahl, Krahl, M.S.Oliveira & Cantuária and its putative parents. Map by A. H. Krahl.

Table 1. Comparison between *C. x luanae* D.R.P.Krahl, Krahl, M.S.Oliveira & Cantuária and its parents.

| CHARACTERS | TAXA | | |
|----------------|---|--|--|
| | <i>C. x luanae</i> | <i>C. galeritum</i> | <i>C. macrocarpum</i> |
| Inflorescence | 27.6–31.1 cm long, erect, 4–7-flowered, peduncle light green | 15.6–21.9 cm long, erect to arched, 4–7-flowered, peduncle light green | 16.5–36.7 cm long, erect, 2–8-flowered, peduncle greenish |
| Flowers | Wine-colored with a yellowish hue on the lip, sepals and petals slightly greyish on the adaxial face, not resupinate, grouped in the apical third | From wine-coloured and lightly greyish outside to yellowish with wine-colored stripes, not resupinate, grouped in the apical third | Greenish yellow with wine-colored spots, not resupinate, grouped in the apical third |
| Dorsal sepal | ca. 3.9 × 1.5 cm, elliptic, concave, symmetrical, apex acute | ca. 3.4 × 1.5 cm, elliptic, concave, symmetrical, apex acute | ca. 3.4 × 1.5 cm, elliptic, concave, symmetrical, apex acute |
| Lateral sepals | ca. 4.7 × 2.1 cm, broadly elliptic, concave, asymmetrical, apex acute | ca. 3.9 × 1.5 cm, broadly elliptic, concave, asymmetrical, apex acute | 4.4 × 1.9 cm, broadly elliptic, concave, asymmetrical, apex acute |
| Petals | ca. 4.7 × 1.7 cm, narrowly elliptic, margin entire, slightly asymmetrical, apex acute | ca. 4.1 × 1.1 cm, oblong to elliptic, margin entire, apex acute | ca. 3.9 × 1.6 cm, elliptic, margin entire, slightly asymmetrical, apex acute |
| Labellum | ca. 3.5 × 2.3 cm, 3-lobed, outline oval, thick, smooth, with a conical bottom | ca. 3.1 × 1.6 cm, 3-lobed, outline oblong, thick, smooth, with an oblong bottom | ca. 2.5 × 2.3 cm, 3-lobed, outline ovate, thick, smooth, with a conical bottom |
| Lateral lobes | ca. 2.3 × 1.9 cm, semi-elliptic to semi-ovate, margin entire | ca. 1.6 × 0.6 cm, semi-elliptic to semi-ovate, margin entire | ca. 2.4 × 1.4 cm, semi-ovate, margin minutely denticulate to smooth |
| Midlobe | ca. 0.8 × 1.3 cm, ovate to rhomboid, thick, margin entire, symmetrical, apex obtuse | ca. 1.3 × 1.5 cm, orbicular, thick, margin entire, symmetrical, rounded | ca. 0.5 × 0.4 cm, triangular to rhomboid, thick, margin entire, symmetrical, apex obtuse |
| Column | ca. 3.9 cm long, wine-colored, apex rostrate | ca. 3.1 cm long, wine-colored, apex rostrate | ca. 3.5 cm long, greenish yellow, apex rostrate |
| Antennae | Symmetrical, parallel, apically converging | Symmetrical, parallel | Asymmetrical, crossed |

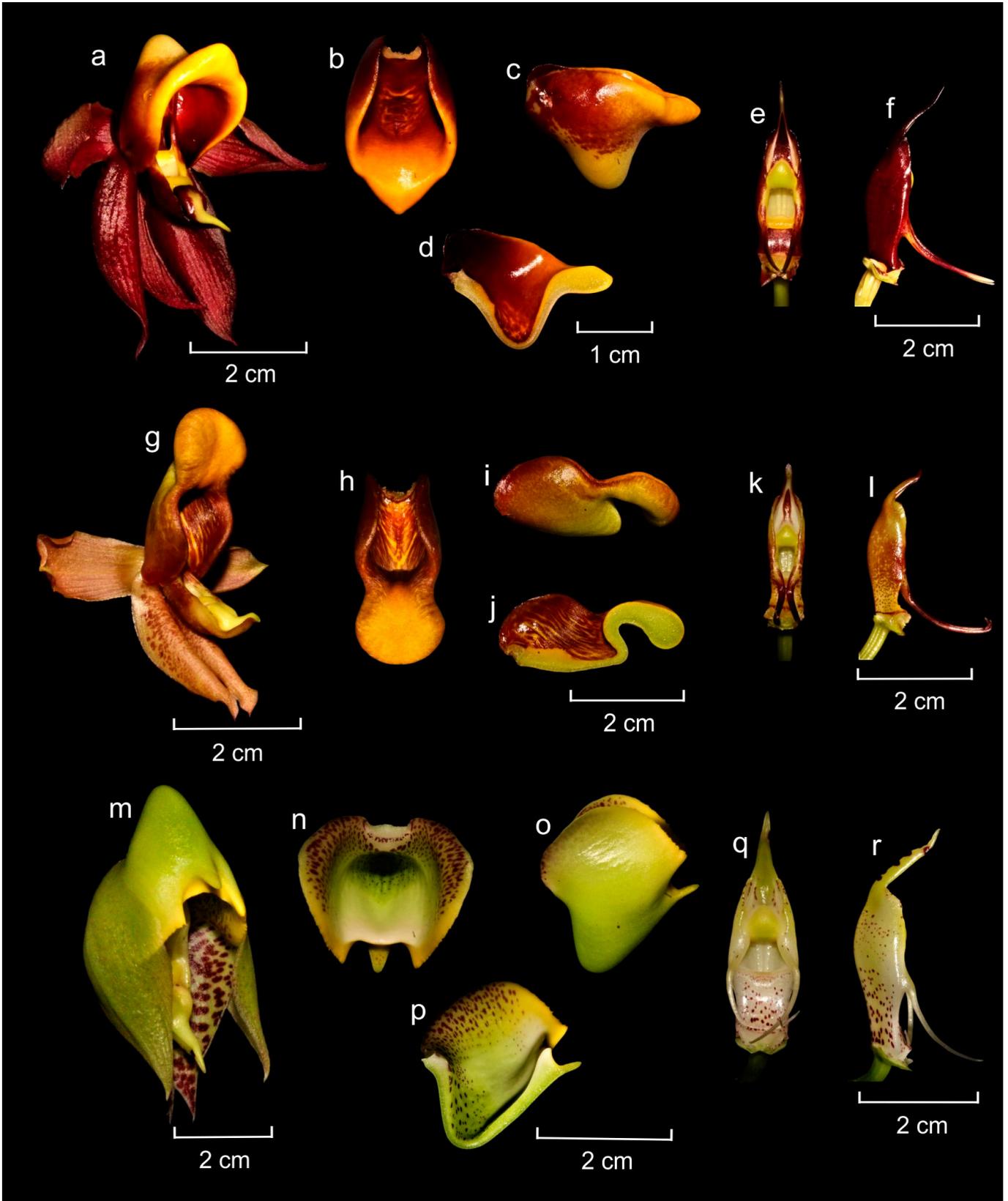


Figure 3. Color plate referring to the comparison between *Catasetum x luanae* D.R.P.Krahl, Krahl, M.S.Oliveira & Cantuária (a-f), *Catasetum galeritum* Rchb. f. (g-l) and *Catasetum macrocarpum* Rich. ex Kunth (m-r). (a) flower; (b-d) lip; (e-f) column; (g) flower; (h-j) labellum; (k-l) column; (m) flower; (n-p) lip; (q-r) column. Photos and plate by A. H. Krahl.

or experimental crossings between the putative parents, could corroborate the morphological inferences presented here, helping to determine whether the progeny resembles one parent more closely or even represents a backcross.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHORS PARTICIPATION

AHK, DRPK: writing the first draft of the text. AHK, PCC: made the figures. AHK, GC, PS, MSO: performed the morphological description and taxonomic comparison. AHK, DRPK, GC: analysis of geographical distribution, phenology and floral visitors. GC, JBFS, MSO, PCC, PS: final review of the manuscript. All authors approved the final version of the manuscript.

REFERENCES

- Arnold, M. L. (1997). *Natural Hybridization and Evolution*. Oxford University Press, New York. <https://doi.org/10.1093/oso/9780195099744.001.0001>
- Arnold, M. L. (2006). *Evolution through genetic exchange*. Oxford University Press, New York. <https://doi.org/10.1093/acprof:oso/9780199229031.001.0001>
- Assis, L. C. and Ferreira, U. L. C. (2024). Um novo híbrido natural de *Catasetum* (Orchidaceae) descrito para o Brasil. *Richardiana, nouvelle série*, 8, 1–7.
- Barve, V. (2023). Elevating the fitness of use of GBIF occurrence datasets: A proposal for peer review. *Biodiversity Information Science and Standards*, 7, e112237. <https://doi.org/10.3897/biss.7.112237>
- Bicalho, H. D. and Barros, F. (1988). On the taxonomy of *Catasetum* subsection *Isoceras*. *Lindleyana*, 3, 87–92.
- Canhos, D. A. L., Almeida, E. A., Assad, A. L., Cunha-Bustamante, M. M. D., Canhos, V. P., Chapman, A. D., Giovanni, R.D., Imperatriz-Fonseca, V. L., Lohmann, L. G., Maia, L. C., Miller, J. T., Nelson, G., Peterson, A. T., Pirani, J. R., Souza, S., Stehmann, J. R. and Thiers, B. (2022). SpeciesLink: Rich data and novel tools for digital assessments of biodiversity. *Biota Neotropica*, 22, 1–15. <https://doi.org/10.1590/1676-0611-BN-2022-1394>
- Cantuária, P. C., Krahl, D. R. P., Krahl, A. H., Chiron, G. and Silva, J. B. F. (2021). *Catasetum* × *sheyllae* (Orchidaceae: Catasetinae), a new natural hybrid from Brazilian Amazon. *Phytotaxa*, 527(4), 257–265. <https://doi.org/10.11646/phytotaxa.527.4.3>
- Carvalho, R. and Machado, I. C. (2002). Pollination of *Catasetum macrocarpum* (Orchidaceae) by *Eulaema bombiformis* (Euglossini). *Lindleyana*, 17, 85–90.
- Dressler, R. L. (1993). *Phylogeny and Classification of the Orchid Family*. Dioscorides Press, Portland.
- Ferreira, U. L. C. and Malaspina, T. K. (2023a). *Catasetum* × *incarnatum* U. L. C. Ferreira. and T. K. Malaspina hyb. nat. nov. *Coletânea de Orquideas Brasileiras*, 19, 770–773.
- Ferreira, U. L. C. and Malaspina, T. K. (2023b). *Catasetum* × *ornaghiae* U. L. C. Ferreira. and T. K. Malaspina hyb. nat. nov. *Coletânea de Orquideas Brasileiras*, 19, 774–777.
- Gonçalves, E. G. and Lorenzi, H. (2007). *Morfologia vegetal: Organografia e dicionário ilustrado de morfologia das plantas vasculares*. Instituto Plantarum, São Paulo.
- Holst, A. W. (1999). *The world of Catasetums*. Timber Press, Portland.
- Krahl, D. R. P., Krahl, A. H. and 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., Cantuária, P. C. and Silva, J. B. F. (2021a). *Catasetum saracataquerense* (Orchidaceae, Catasetinae), a new species of Brazilian Amazon. *Richardiana, nouvelle série*, 5, 206–216.
- Krahl, A. H., Chiron, G., Cantuária, P. C. and Silva, J. B. F. (2021b). A new species of *Catasetum* (Orchidaceae, Catasetinae) for the Brazilian Amazon. *Richardiana, nouvelle série*, 5, 283–294.
- Krahl, D. R. P., Krahl, A. H., Cantuária, P. C. and Silva, J. B. F. (2022a). *Catasetum nhamundaense* (Orchidaceae: Catasetinae), uma nova espécie da Amazônia Brasileira. *Orquidário*, 36, 24–36.
- Krahl, A. H., Krahl, D. R. P., Cantuária, P. C., Chiron, G. and Silva, J. B. F. (2022b). *Catasetum marinhoi* (Orchidaceae, Catasetinae), a new species of Brazilian Amazon. *Richardiana, nouvelle série*, 6, 100–110.
- Krahl, D. R. P., Schmal, P., Chiron, G., Silva, J. B. F., Krahl, A. H. and Cantuária, P. C. (2023a). *Catasetum* × *grasineideae* (Orchidaceae: Catasetinae), a new nothospecies from Brazilian Amazon and taxonomic notes for the genus. *Phytotaxa*, 594(2), 89–104. <https://doi.org/10.11646/phytotaxa.594.2.1>
- Krahl, D. R. P., Oliveira, M. S., Silva, J. B. F., Chiron, G. and Cantuária, P. C. (2023b). *Catasetum krahlii* (Orchidaceae, Catasetinae): a new and threatened species from the Brazilian Amazon. *Acta Botanica Brasilica*, 37, e20220258. <https://doi.org/10.1590/1677-941X-ABB-2022-0258>

- Krahl, D. R. P., Chiron, G., Silva, J. B. F., Krahl, A. H. and Cantuária, P. C. (2023c). *Catasetum dianneae* (Orchidaceae, Catasetinae): a new species of the *C. barbatum* complex for the Brazilian Amazon. *Richardiana, nouvelle série*, 7, 187–201.
- Krahl, D. R. P., Krahl, A. H., Silva, J. B. F. and Cantuária, P. C. (2023d). *Catasetum riosianum* (Orchidaceae: Catasetinae), a new species for the Brazilian Amazon. *Biota Amazônia*, 13, 56–58.
- Krahl, D. R. P., Oliveira, M. S., Schmal, P., Chiron, G., Silva, J. B. F., Krahl, A. H., Almeida, S. S. M. S. and Cantuária, P. C. (2023e). *Catasetum tavaresii* (Catasetinae), a new species from the Central Brazilian Amazon. *Lankesteriana*, 23(3), 485–493. <https://doi.org/10.15517/lank.v23i3.55794>
- Krahl, D. R. P., Schmal, P., Chiron, G., Silva, J. B. F., Krahl, A. H. and Cantuária, P. C. (2023f). Taxonomic notes on *Catasetum meeae* (Orchidaceae: Catasetinae). *Phytotaxa*, 609(3), 240–246. <https://doi.org/10.11646/phytotaxa.609.3.7>
- Krahl, D. R. P., Schmal, P., Chiron, G., Silva, J. B. F., Krahl, A. H. and Cantuária, P. C. (2024a). *Catasetum queirozii* (Orchidaceae: Catasetinae): a new species from the Brazilian Amazon. *Acta Amazônica*, 54(1), e54bc23180. <https://doi.org/10.1590/1809-4392202301801>
- Krahl, D. R. P., Schmal, P., Oliveira, M. S., Silva, J. B. F., Chiron, G. and Krahl, A. H. (2024b). *Catasetum cantuariiae* (Orchidaceae, Catasetinae), a new species from the Brazilian Amazonian biome. *Kew Bulletin*, 79, 583–595. <https://doi.org/10.1007/s12225-024-10191-7>
- Krahl, D. R. P., Oliveira, M. S., Schmal, P., Chiron, G., Krahl, A. H., Silva, J. B. F. and Cantuária, P. C. (2024c). Revealing the true taxonomic status of *Catasetum joaquinianum* (Orchidaceae: Catasetinae). *Phytotaxa*, 664(2), 123–131. <https://doi.org/10.11646/phytotaxa.664.2.4>
- Krahl, D. R. P., Oliveira, M. S., Schmal, P., Krahl, A. H., Chiron, G., Silva, J. B. F. and Cantuária, P. C. (2024d). *Catasetum × vilhenense* (Orchidaceae: Catasetinae), a new natural hybrid from the Amazon Forest. *Darwiniana, nueva serie*, 12(2), 308–317. <https://doi.org/10.14522/darwiniana.2024.122.1251>
- Krahl, D. R. P., Schmal, P., Chiron, G., Silva, J. B. F., Oliveira, M. S., Krahl, A. H. and Cantuária P. C. (2025a). *Catasetum binarum* (Orchidaceae, Catasetinae): a new species from the Brazilian Amazon. *Richardiana, nouvelle série*, 9, 43–60.
- Krahl, D. R. P., Schmal, P., Chiron, G., Silva, J. B. F., Oliveira, M. S., Krahl, A. H. and Cantuária P. C. (2025b). *Catasetum × abreuanum* (Orchidaceae, Catasetinae), a new nothospecies from the Brazilian Amazon belonging to the *C. cristatum* complex. *Botany Letters*, 172(3), 340–350. <https://doi.org/10.1080/23818107.2025.2486760>
- Krahl, D. R. P., Oliveira, M. S., Schmal, P., Silva, J. B. F., Chiron, G., Krahl, A. H. and Cantuária, P. C. (2025c). *Catasetum × angelae* (Orchidaceae: Catasetinae), a new nothospecies from the Brazilian Amazon in the subgenus *Pseudocatasetum*, and taxonomic notes for *C. pusillum*. *New Zealand Journal of Botany*, 63(5), 1347–1366. <https://doi.org/10.1080/0028825X.2025.2469623>
- Krahl, D. R. P., Oliveira, M. S., Schmal, P., Silva, J. B. F., Chiron, G., Krahl, A. H. and Cantuária, P. C. (2025d). *Catasetum × humaitaense* (Orchidaceae: Catasetinae), a new nothospecies from the Brazilian Amazon. *Biota Colombiana*, 26, 1–14. <https://doi.org/10.21068/26193124.1263>
- Kunth, K. S. (1822). *Catasetum macrocarpum*. *Synopsis Plantarum*, 1, 331.
- Mauad, A. V. S. R., Petini-Benelli, A., Izzo, T. J. and Smidt, E. C. (2022). Phylogenetic and molecular dating analyses of *Catasetum* (Orchidaceae) indicate a recent origin and artificial subgeneric groups. *Brazilian Journal of Botany*, 45, 1235–1247. <https://doi.org/10.1007/s40415-022-00840-1>
- Mori, S. A., Silva, L. A., Lisboa, G. and Coradin, L. (1989). *Manual de Manejo do Herbário Fanerogâmico*. CEPLAC, Ilhéus.
- Milet-Pinheiro, P. and Gerlach, G. (2017). Biology of the Neotropical orchid genus *Catasetum*: A historical review on floral scent chemistry and pollinators. *Perspectives in Plant Ecology, Evolution and Systematics*, 27, 23–34. <https://doi.org/10.1016/j.ppees.2017.05.004>
- Milet-Pinheiro, P., Silva, J. B. F., Navarro, D. M. A. F., Machado, I. C. S. and Gerlach, G. (2018). Notes on pollination ecology and floral scent chemistry of rare neotropical orchid *Catasetum galeritum* Rchb.f. *Plant Species Biology*, 33(2), 158–163. <https://doi.org/10.1111/1442-1984.12202>
- Pérez-Escobar, O. A., Chomicki, G., Condamine, F. L., Vos, J., Martins, A., Smidt, E., Klitgård, B., Gerlach, G. and Heinrichs, J. (2017). Multiple geographical origins of environmental sex determination enhanced the diversification of Darwin's favourite Orchids. *Scientific Reports*, 7, 12878. <https://doi.org/10.1038/s41598-017-12300-y>
- Petini-Benelli, A. (2024). *Catasetum*. In *Flora do Brasil 2020*. Jardim Botânico do Rio de Janeiro. Available at: <http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB11312>. Cited: 04 Sep 2024.
- POWO (2024). *Plants of the World Online*. Royal Botanic Gardens, Kew. Available at: <http://www.plantsoftheworldonline.org/>. Cited: 04 Sep 2024.
- Reichenbach, H. G. (1886). *Catasetum galeritum*. *The Gardeners' Chronicle & Agricultural Gazette*, 2, 616.
- Romero, G. A. (1992). Non-functional flowers in *Catasetum* orchids (Catasetinae, Orchidaceae). *Botanical Journal of the Linnean Society*, 109(2), 305–313. <https://doi.org/10.1111/j.1095-8339.1992.tb00274.x>

- Romero, G. A. and Carnevali, G. (2009). *Catasetum*. In: A. M. Pridgeon, P. J. Cribb, M. W. Chase and F. N. Rasmussen (Eds.), *Genera Orchidearum, Epidendroidea Vol. 5 – Part II*. (pp. 13–18). Oxford University Press, New York.
- Seehausen, O. (2004). Hybridization and adaptive radiation. *Trends in Ecology & Evolution*, 19(4), 198–207. <https://doi.org/10.1016/j.tree.2004.01.003>
- Senghas, K. (1990). Einige neue Arten aus der Subtribus *Catasetinae* I – *Catasetum* sektion *Anisoceras*. *Die Orchidee*, 41, 212–218.
- Senghas, K. (1991). Einige neue Arten aus der Subtribus *Catasetinae* I – *Catasetum* sektion *Isoceras*. *Die Orchidee*, 42, 19–24.
- Silva, L. A. E., Fraga, C. N., Almeida, T. M. H., Gonzalez, M., Lima, R. O., Rocha, M. S., Bellon, E., Ribeiro, E. S., Oliveira, F. A., Clemente, L. S., Magdalena, U. R., Medeiro, E. S. M. and Forzza, R. C. (2017). Jabot—Sistema de Gerenciamento de Coleções Botânicas: a experiência de uma década de desenvolvimento a avanços. *Rodriguésia*, 68(2), 391–410. <https://doi.org/10.1590/2175-7860201768208>
- Thiers, B. (2024, continuously updated). *Index Herbariorum: A Global Directory of Public Herbaria and Associated Staff*. New York Botanical Garden's Virtual Herbarium. Available at: <http://sweetgum.nybg.org/science/ih/>. Cited: 04 Sep 2024.
- Valsko, J. J., Krahl, A. H., Petini-Benelli, A. and Chiron, G. (2019). *Catasetum sophiae*, a new species of Orchidaceae (*Catasetinae*) from northern Brazil. *Phytotaxa*, 402(2), 104–120. <https://doi.org/10.11646/phytotaxa.402.2.5>
- Walker-Larsen, J. and Harder, L. D. (2000). The evolution of staminodes in Angiosperms: patterns of stamen reduction, loss, and functional re-invention. *American Journal of Botany*, 87(10), 1367–1384. <https://doi.org/10.2307/2656866>