

Notes on taxonomy, distribution and conservation of *Dichaea* species (Orchidaceae: Zygopetalinae) in Brazilian Amazon

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Abstract

In this article we first propose to treat *Dichaea integrilabia* and *D. saraca-taquerensis* as synonyms based on analysis of the types, original descriptions and other material conserved in Amazonian herbaria. We also better address the taxonomic issues relating to *D. fusca* and *D. weigeltii* which have been wrongly considered as synonymous species. Besides we document the geographical expansion of *D. fusca* to the state of Pará (Brazil) whereas it was hitherto thought to be restricted to the state of Amazonas (Brazil). For both taxa (*D. saraca-taquerensis* and *D. fusca*) we give a taxonomic description, a photograph plate, information about the geographical distribution (with a map) as well as a preliminary conservation status according to IUCN criteria.

Key words: Amazon, Amazonas State, *Dichaea* sect. *Dichaeopsis*, new record, Pará State, synonymization

Introduction

Dichaea Lindley (1833: 208) is the largest genus in the subtribe Zygopetalinae (Chase *et al.* 2003, Whitten *et al.* 2005) and it is a monophyletic group recognizable by distichous leaves, elongated stems not forming pseudobulbs, flower with a lip mostly anchor-shaped and a gynostemium usually provided with infrastigmatic ligules (Neubig 2009). It is comprised of 128 species (Govaert *et al.* 2023) distributed from Mexico to Bolivia and Argentina and occurring also in the Caribbean. It shows its greatest species richness and diversity in South America (Dodson 2004).

It is usually subdivided into four sections according to the Cogniaux (1906) classification based on the characters of the leaves and the ovary: I) *Dichaea* sect. *Dichaeopsis* (Pfitzer 1887: 107) Kuntze (1904: 171) (glabrous ovary and articulated leaves); II) *Dichaea* sect. *Pseudodichaea* Cogniaux (1906: 490) (papillose ovary and articulated leaves); III) *Dichaea* sect. *Dichaeastrum* Cogniaux (1906: 490) (glabrous ovary and non-articulated leaves); and IV) *Dichaea* sect. *Eudichaea* Kuntze (1904: 171) (papillose ovary and non-articulated leaves). However, this classification is not fully supported by phylogeny. Thus Neubig (2009) found that only the section *Pseudodichaea* is supported because it is monophyletic. The section *Dichaeastrum* is potentially polyphyletic but together with sect. *Dichaea* it forms a monophyletic group which therefore is treated as one section, *Dichaea lato sensu*. Finally, the section *Dichaeopsis* proved to be polyphyletic.

At the moment Brazil has a total of 25 species of which 18 have been reported for the Brazilian Amazon. The

states Amazonas and Pará (two largest Brazilian states), that are entirely located in the Amazonian biome, are the species richest states with, respectively, 16 and eight species (Meneguzzo & Hall 2023). We also highlight that many species have been described in the last decade for these states (e.g. Krahl *et al.* 2014, Krahl *et al.* 2016, Valsko *et al.* 2014a, b).

When carrying out an updating of the list of Orchidaceae of the Amazonas (project “Flora do Amazonas: Orchidaceae”), we noticed the conspecificity of two species recently and almost simultaneously published. Consequently, we propose to put *D. integrilabia* Valsko, Krahl & Chiron (in Krahl *et al.* 2016: 146) into the synonymy of *D. saraca-taquerensis* Campacci & Silva (2015: 410), both taxa presenting the same distinctive feature (lip entire ovate). We also evaluated the erroneous proposal of synonymizing *D. fusca* Valsko, Holanda & Krahl (in Valsko *et al.* 2014a: 134) with *D. weigeltii* Reichenbach (1859: 328) suggested by Meneguzzo & Hall (2023). With this aim in view we present a short comparative taxonomic discussion. Besides we update the geographical distribution of *D. fusca* hitherto restricted to the Amazonas state (AM) and now extended to the Pará state (PA). Moreover, for both species (*D. saraca-taquerensis* and *D. fusca*), we propose a taxonomic description, a photograph plate, information on the geographical distribution (with a map) and a preliminary conservation status.

Material and methods

The analysis and comparison between the specimens studied here were carried out, when possible, through original descriptions (Reichenbach 1859, Valsko *et al.* 2014a, Campacci & Silva 2015, Krahl *et al.* 2016) and examination of the type materials deposited at AMES, INPA, K and MG and other materials deposited in INPA and MG (all acronyms according to Thiers 2023). The geographical expansion of *D. fusca* in Brazilian territory to the Pará state is based on material deposited in MG. We emphasize that the MG herbarium underwent an extensive period of structural renovations and was closed for consultation of its collection. However, before the provisional closure, all *Dichaea* material had been requested on loan and subsequently, upon return, it was placed in a cabinet different from its original institution, a fact that made our consultation possible through one of our partners. We also highlight that at the moment the MG herbarium has been provisionally reopened during the 73rd National Botany Congress (in October 2023).

The taxonomic descriptions are based on the consulted herbarium material and terminology here adopted follows Dressler (1993), Harris & Harris (2001) and Gonçalves & Lorenzi (2007). Photographs used here are from specimens that we consulted in the above-cited herbaria and also represent collections that we mostly made. They have been made with a Canon T5 camera equipped with a Canon EFS 18–55mm lens. Photographic plates were built from these images using Adobe Photoshop® 2020.

For both species we present a preliminary conservation status based on the IUCN (2022) criteria. The Extent of Occurrence (EOO) and the Area of Occupancy (AOO), two parameters used in the process of estimating the conservation status, were evaluated thanks to the on-line platform Geospatial Conservation Assessment Tool (GeoCAT—<http://geocat.kew.org/>). The AOO was estimated using 2 × 2 km grid cells (a cell area of 4 km²) (Bachman *et al.* 2011) as guided by IUCN (2022). The geographical distribution maps were constructed using the software QGIS 3.28 Firenze (Datum: SIRGAS 2000 / EPSG: 4674).

Taxonomy

1. *Dichaea saraca-taquerensis* Campacci & Silva (2015: 410). (Figure 1).

Type:—BRAZIL. Pará: Oriximiná: Porto Trombetas, FLONA Saracá-Taquera, platô Taquera, 31 March 2009, *J.B.F. da Silva* 2163 (holotype: MG!).

= *Dichaea integrilabia* Valsko, Krahl & Chiron (in Krahl *et al.* 2016: 146), *syn. nov.*

Type:—BRAZIL. Amazonas: Manaus: “Projeto Dinâmica Biológica de Fragmentos Florestais” (PDBFF), Fazenda Porto Alegre, 2°21'19.19"S; 59°57'31.81"W, 21 September 2012, 9 December 2012, *J.J. Valsko* 111 (holotype: INPA!).

Description:—Plant epiphytic subpendulous. Stem not swollen into pseudobulb, 6.2–25.5 × 0.2–0.5 cm, compressed or cylindrical, elongated, unbranched, 20–40-leaved. Leaves 2.0–4.1 × 0.3–0.6 cm, oblong-elliptic to oblong-lanceolate, distichous, conduplicate, apex acute. Inflorescence 1.8–2.5 long, lateral, 1-flowered, floral bract double; external

bract $0.2\text{--}0.3 \times 0.2\text{--}0.3$ cm, ovate, apiculate; internal bract $0.3\text{--}0.4 \times 0.05$ cm, linear, acute. Flower greenish yellow, pedicellate; pedicel + ovary $1.3\text{--}2.0$ cm long; dorsal sepal $0.6\text{--}0.7 \times 0.2\text{--}0.3$ cm, oblong to elliptic, apex obtuse; lateral sepals $0.6\text{--}0.7 \times 0.2\text{--}0.3$ cm, oblong to elliptic, asymmetrical, apex obtuse; petals $0.5\text{--}0.7 \times 0.1\text{--}0.3$ cm, oblanceolate to elliptic, apex obtuse; lip $0.5\text{--}0.6 \times 0.3\text{--}0.5$ cm, entire, obovate, concave, apex obtuse; column $0.3\text{--}0.4$ cm long; pollinia 4. Fruit not seen.

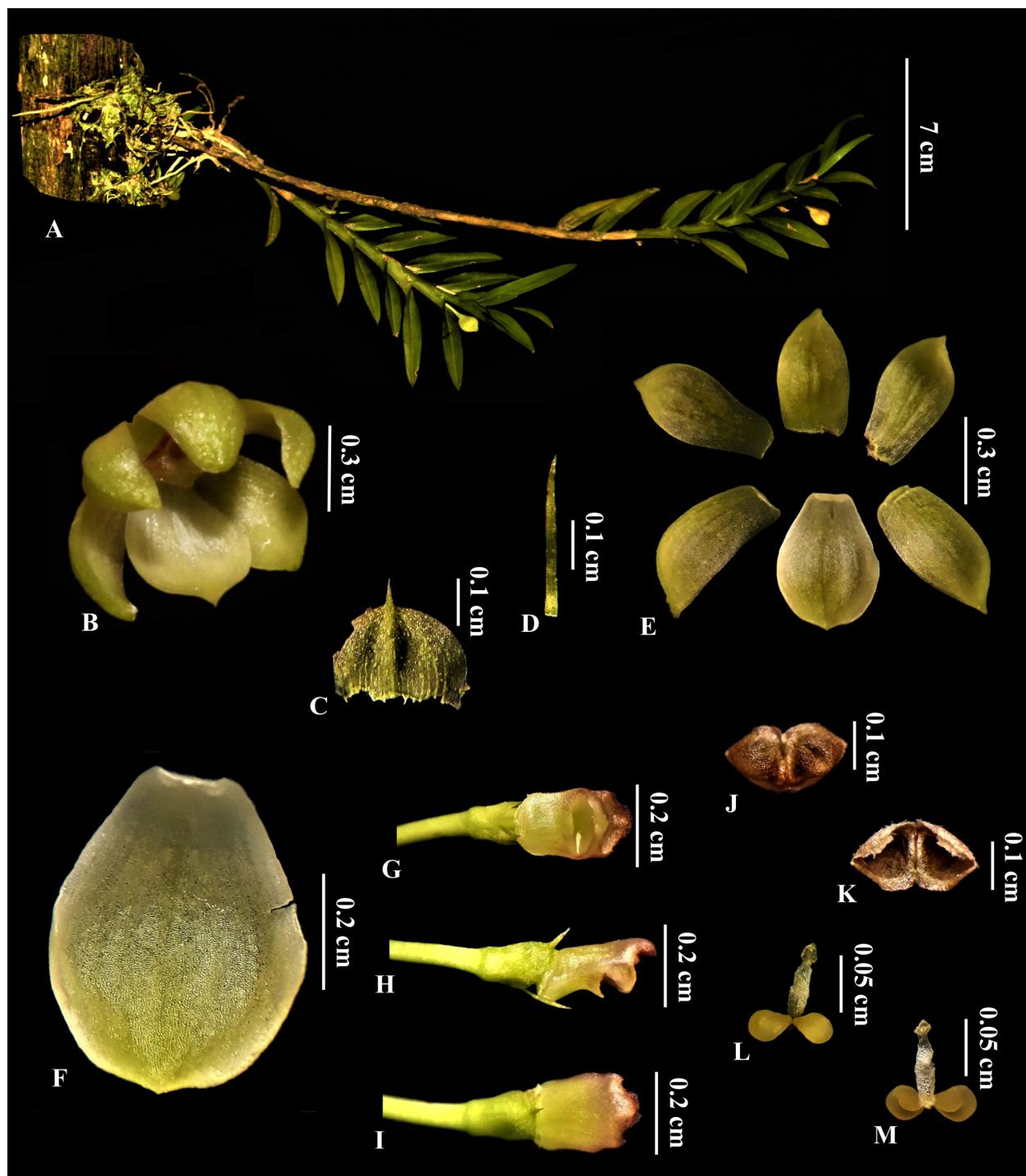


FIGURE 1. *Dichaea saraca-taquerensis*. A. Habit. B. Flower. C. External floral bract. D. Internal floral bract. E. Perianth. F. Lip. G–I. Column. J–K. Anther cap. L–M. Pollinarium. Photographs by A.H. Krahel.

Distribution and ecology:—The material examined and consulted revealed that *D. saraca-taquerensis* is restricted to the Brazilian Amazon and occurs in two states (Figure 2). In the state of Amazonas, in the municipalities of Manaus and Presidente Figueiredo, it grows in Dense Ombrophylous Forest in a “terra-firme” vegetation (not flooding environment) in areas de “baixio” (close to streams) and it also occurs near a stream however among in a different vegetation, “campinarana” (on sandy soil). In the Pará state it is also found in Dense Ombrophylous Forest

with a “terra-firme” vegetation of the municipalities of Terra Santa and Oriximiná. However, it was also observed in areas of “Platô” (areas higher and usually far from streams).

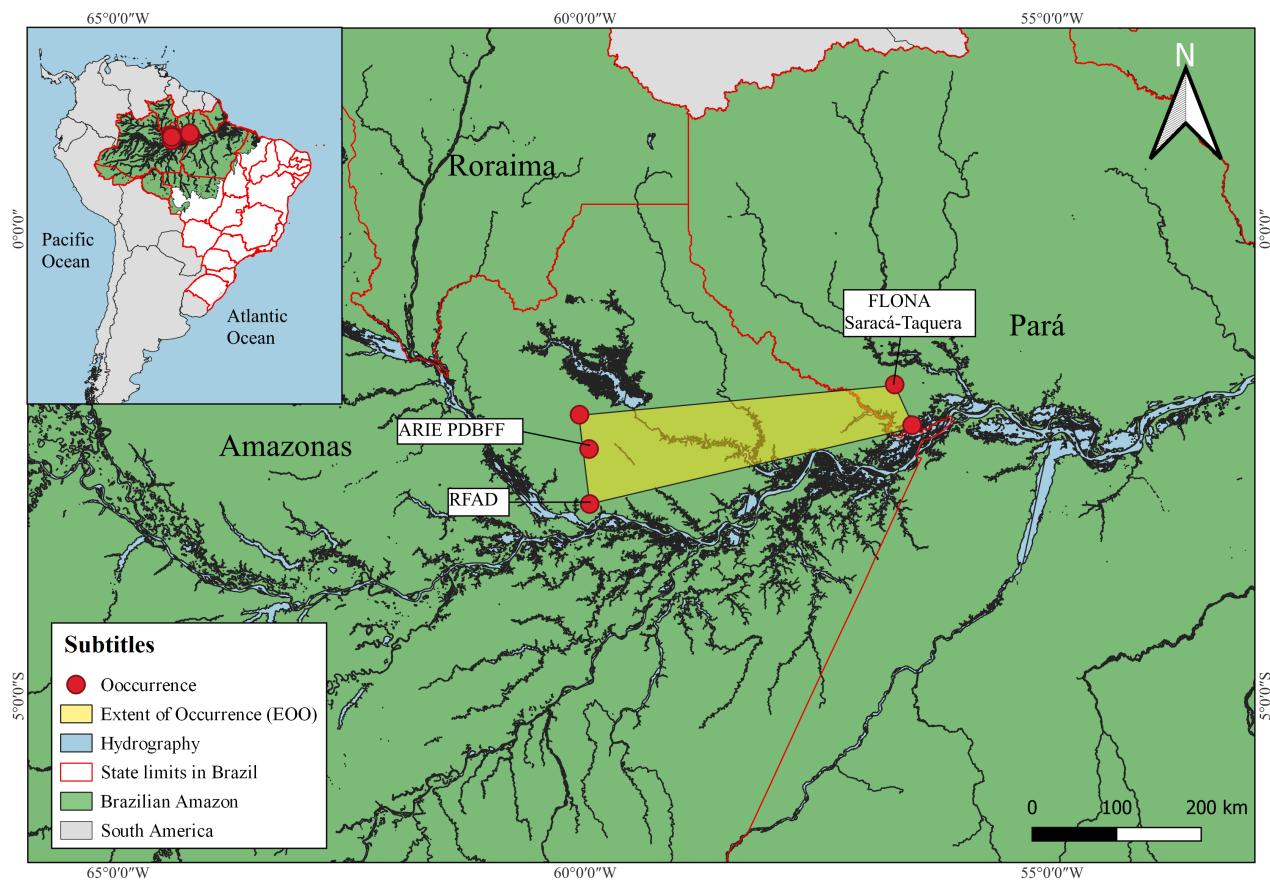


FIGURE 2. Geographic distribution map of *Dichaea saraca-taquerensis*.

Conservation status:—The Area of Occupancy (AOO) is estimated at 20 km². According to the criteria defined in IUCN Guidelines (IUCN 2022), the threshold for Endangered category (EN) is met (criterion B). Besides the species occurs in five localities (criterion Ba). Three of these localities are within conservation units however the total area of occupancy suffers a continuing decline (criterion Bb) due to deforestation, mostly out of the conservation units but non-only. The total number of mature individuals (criterion D) is estimated to 100. Consequently the taxon may be treated as Endangered (EN category—criteria B2ab[II],D).

Taxonomic notes:—According to the holotype and protologue of Campacci & Silva (2015), *D. saraca-taquerensis* presents, as an evident distinctive character when compared to other congeneric species, a lip entire and obovate and an infrastigmatic ligule papillose. Based on these features and after analyzing the holotype and protologue of Krahl *et al.* (2016), we can note that *D. integrilabia* presents the same morphology. Consequently, we propose here its synonymization. Having been published a year before, the name *D. saraca-taquerensis* must be retained.

Some differences linked to the descriptive terminology used by Campacci & Silva (2015) and Krahl *et al.* (2016) can be observed in the descriptions of *D. saraca-taquerensis* and *D. integrilabia* respectively. However, they do not directly affect the fact that these taxa have the same morphological circumscription: it is only a matter of points of view. Acceptable differences are observed in the color of some flower segments such as: flower whitish with pale greenish nuances in *D. saraca-taquerensis* (vs. yellowish cream in *D. integrilabia*), column whitish in *D. saraca-taquerensis* (vs. cream with a slight pinkish to reddish hue near the apex in *D. integrilabia*) and an anther cap pinkish in *D. saraca-taquerensis* (vs. brownish in *D. integrilabia*). These differences in the color can be due to different stages of flower ripeness or represent some population variation.

In Campacci & Silva (2015), the leaf of *D. saraca-taquerensis* is described as oblong-lanceolate whereas Krahl *et al.* (2016) describe the leaf of *D. integrilabia* as elliptic. Other differences can be noted in the shape of the flower segments: dorsal sepal elliptic apiculate in *D. saraca-taquerensis* (vs. lanceolate acute in *D. integrilabia*), lateral sepals and petals respectively elliptic-lanceolate and lanceolate and lip respectively sub-orbicular and ovate (Campacci & Silva 2015, Krahl *et al.* 2016). However, based on our analyses, both materials can be best described as having oblong-

elliptic to oblong-lanceolate leaves, oblong to elliptic sepals and oblanceolate to elliptic petals. The lip must be mainly described as obovate, wider near the apex than near the base (definition according to Gonçalves & Lorenzi 2007).

Additional material examined:—BRAZIL. Amazonas: Manaus: Reserva Florestal Adolpho Ducke, 31 January 2019, *D.R.P. Krahl & A.H. Krahl* 360 (INPA!); idem, 07 March 2019, *A.H. Krahl & D.R.P. Krahl* 1131 (INPA!); Presidente Figueiredo: Cachoeira da Iracema, 18 April 2020, *A.H. Krahl & D.R.P. Krahl* 1445 (INPA!); Pará: Oriximiná: Porto Trombetas, FLONA Saracá-Taquera-MRN, Platô SW4, 16 January 2010, *J.B.F. da Silva* 3334 (MG!); Terra Santa: Abaocu, 14 March 2018, *R. Sousa* 27 (MG!); idem, *R. Sousa* 33 (MG!); idem, *R. Sousa* 34 (MG!); idem, *R. Sousa* 35 (MG!).

2. *Dichaea fusca* Valsko, Holanda & Krahl (in Valsko *et al.* 2014a: 134). (Figure 3).

Type:—BRAZIL. Amazonas: Manaus: “Projeto Dinâmica Biológica de Fragmentos Florestais” (PDBFF), Fazenda Colosso, 2°24'21"S; 59°52'32"W, 15 February 2006, *J.J. Valsko* 107 (holotype: INPA!).

Description:—Plant epiphytic, cespitose. Stem not swollen into a pseudobulb, 1.9–10.9 × 0.1 cm, elongated, compressed, usually unbranched, 10–40-leaved. Leaves 0.9–1.9 × 0.1–0.3 cm, narrowly elliptical, distichous, forming an angle of about 45° with the stem, conduplicate, apex acute. Inflorescence 0.7–1.2 cm long, lateral, 1-flowered, floral bract double; external bract 0.1–0.3 × 0.1–0.2 cm, ovate, apex apiculate; internal bract 0.2–0.3 × 0.05 cm, lanceolate, apex acute to acuminate. Flower brownish with a whitish lip, pedicellate; pedicel + ovary 0.2–0.5 cm long; dorsal sepal 0.3–0.5 × 0.15 cm, lanceolate, apex acute; lateral sepals 0.3–0.5 × 0.2 cm, lanceolate, apex acute; petals 0.2–0.4 × 0.1–0.2 cm, lanceolate, apex acute; lip 0.3–0.4 × 0.3–0.4 cm, trullate, trilobed; hypochile cuneate and slightly denticulate; epichile rounded and with an entire margin; lateral lobes triangular, asymmetrical, falcate and acute; apical lobe triangular, symmetrical and acute; column 0.1–0.3 cm long; pollinia 4. Fruit not seen.

Distribution and ecology:—From the material that we examined and referred to we can conclude that *D. fusca* is restricted to the Brazilian Amazon and occurs in two states. Hitherto it was known through the type material (holotype and paratypes) and some collections from the municipality of Manaus (Amazonas state) deposited in the INPA herbarium. However, from the specimens conserved in the herbarium MG, we could note its geographical expansion in the municipalities of Oriximiná and Terra Santa, both located in the far western part of the Pará state. In these localities *D. fusca* grows in dense rain-forests among a “terra-firme” vegetation in areas of “baixio” and “platô”. It occurs also among a vegetation of “campinarana”.

Conservation status:—The Area of Occupancy (AOO) is estimated at 36 km². According to the criteria defined in IUCN Guidelines (IUCN 2022), the threshold for Endangered category (EN) is met (criterion B). However, the species occurs in nine localities (corresponding to the category Vulnerable [VU] through the criterion Ba), five of them being within conservation units. Even so the total area of occupancy suffers a continuing decline (criterion Bb) due to deforestation, mostly out of the conservation units but non-only. The total number of mature individuals is estimated to 250 which is just the limit between the categories VU and EN (criterion D). Consequently the taxon may be treated as Vulnerable (VU category – criteria B2ab[II],D).

Taxonomic notes:—*Dichaea fusca* has been described by Valsko *et al.* (2014a) on the basis of material from the municipality of Manaus and has been erroneously and arbitrarily treated as a synonym of *D. weigeltii* (see Meneguzzo & Hall 2023), the type material of which is from Suriname, as shown in the drawing of the type deposited in the AMES herbarium (AMES00098867! – photography). Besides the presence of *D. weigeltii* in Brazil (Amazonas) is somewhat questionable. It is based on material deposited in the K herbarium (K000879277! – photography) which was treated as the species holotype according to Meneguzzo & Hall (2023). However, this material contradicts the information contained in the drawing of the type. In the illustration we see that the material is from Suriname and that Weigelt is the collector (C. Weigelt s.n.) and in the material indicated by Meneguzzo & Hall (2023) as holotype we see that the material is probably from Rio Negro (Brazil, Amazonas) and that Spruce is the collector (R. Spruce 1719). Although Reichenbach (1859) does not formally indicate any type material for *D. weigeltii* in his protologue, we must trust the information contained in the type drawing because (a) it indicates C. Weigelt as the collector and (b) the taxon has been dedicated to him. Furthermore, Reichenbach (1859) confirms that *D. weigeltii* was collected by Weigelt in Suriname. He writes in his observation: “*Nova videtur species, quam tenemus ab Weigelt in Surinamo lectam et quae sub 1779 “Barra on trees in Forest. Jul. 1851. flowers pink” a Spruceo missa*”. (A new species, which we hold from Weigelt collected in Suriname and which was sent to Spruce under the number 1779 [...]).

Moreover, the material deposited in K (K000879277!), as we could see, clearly corresponds to *Dichaea tenuis* Schweinfurth (1952: 510) mainly on the basis of the vegetative characters and because it is frequently common in the

collection region indicated on the exsiccata when it was determined: "Probably a collection made by Spruce in Rio Negro, Brazil.". This species is a taxon widely distributed in the Amazon basin (Govaerts *et al.* 2023) and very common along the Rio Negro, mainly in the Manaus region (Amazonas) (personal observations). In *D. tenuis* the leaves are patent in relation to the stem, linear and relatively long in comparison to its size (Schweinfurth 1952, 1961), features clearly observed in the material K000879277. Based on these characters present in both specimens AMES00098867 and K000879277, we could decide to treat *D. weigeltii* and *D. tenuis* as conspecific. However, the illustration of the lip of *D. weigeltii* in the former presents some clear differences compared to the illustration of the lip of *D. tenuis* (see Schweinfurth 1961), differences that prevent us to make such an affirmation.

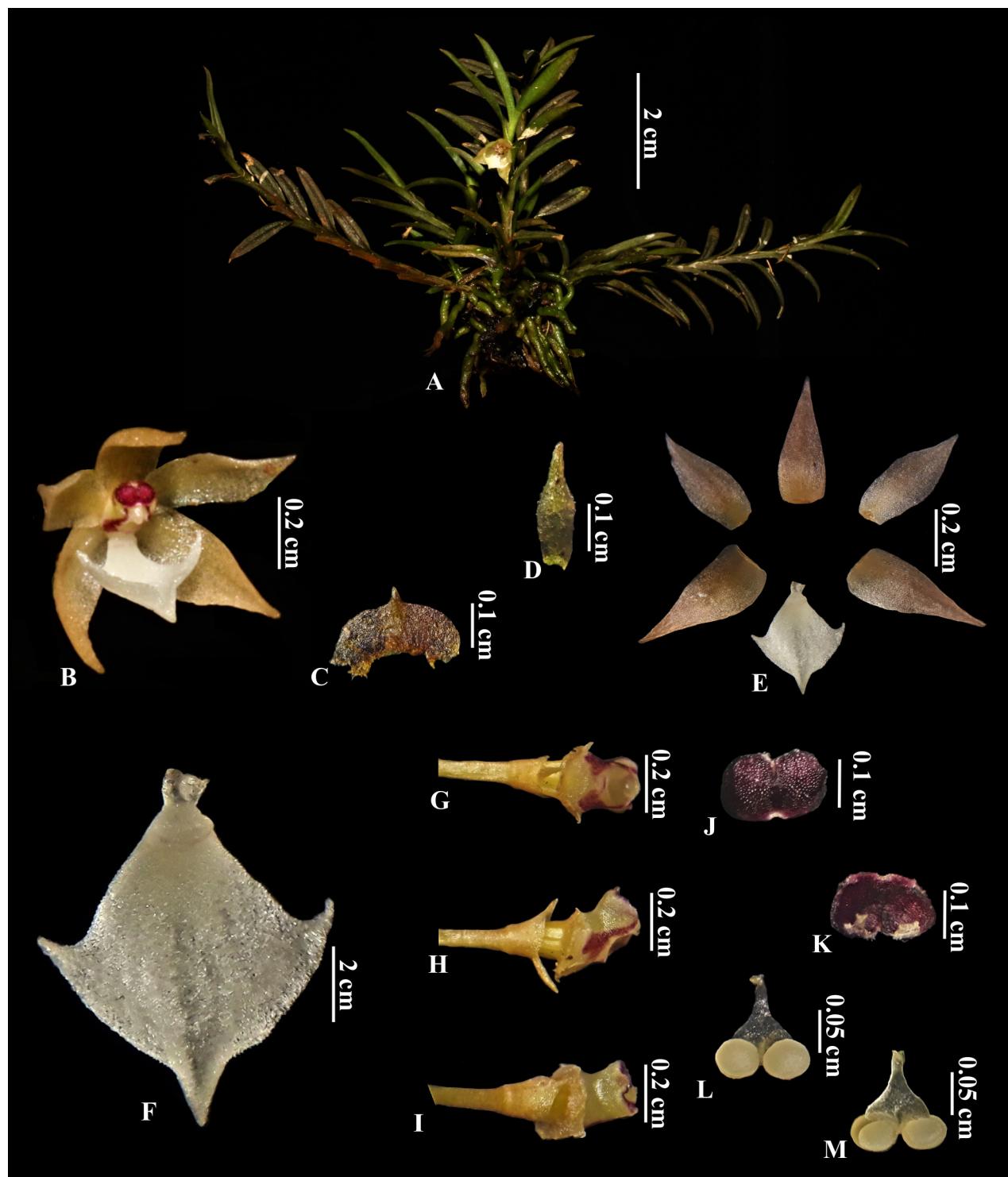


FIGURE 3. *Dichaea fusca*. A. Habit. B. Flower. C. External floral bract. D. Internal floral bract. E. Perianth. F. Lip. G–I. Column. J–K. Anther cap. L–M. Pollinarium. Photographs by A.H. Krahl.

Thus, we conclude that *D. weigeltii* is a taxon needing to be better elucidated and that its real determination should be better investigated before proposing any taxonomic conclusion as, for example, deciding that *D. fusca* is a synonym. *Dichaea fusca* is somewhat different from what is proposed in the illustration of *D. weigeltii*. The leaves of the former are narrowly elliptic (vs. linear in the latter) and arranged at a 45° angle (vs. patent) in relation to the stem. In the former the hypochile is cuneate and broader (vs. oblong and narrower) and the epichile is triangular apiculate concave (vs. anchor-shaped and rather acute) (Reichenbach 1859, Valsko *et al.* 2014a). Consequently, *D. fusca* must, for now, be considered as a valid and independent species.

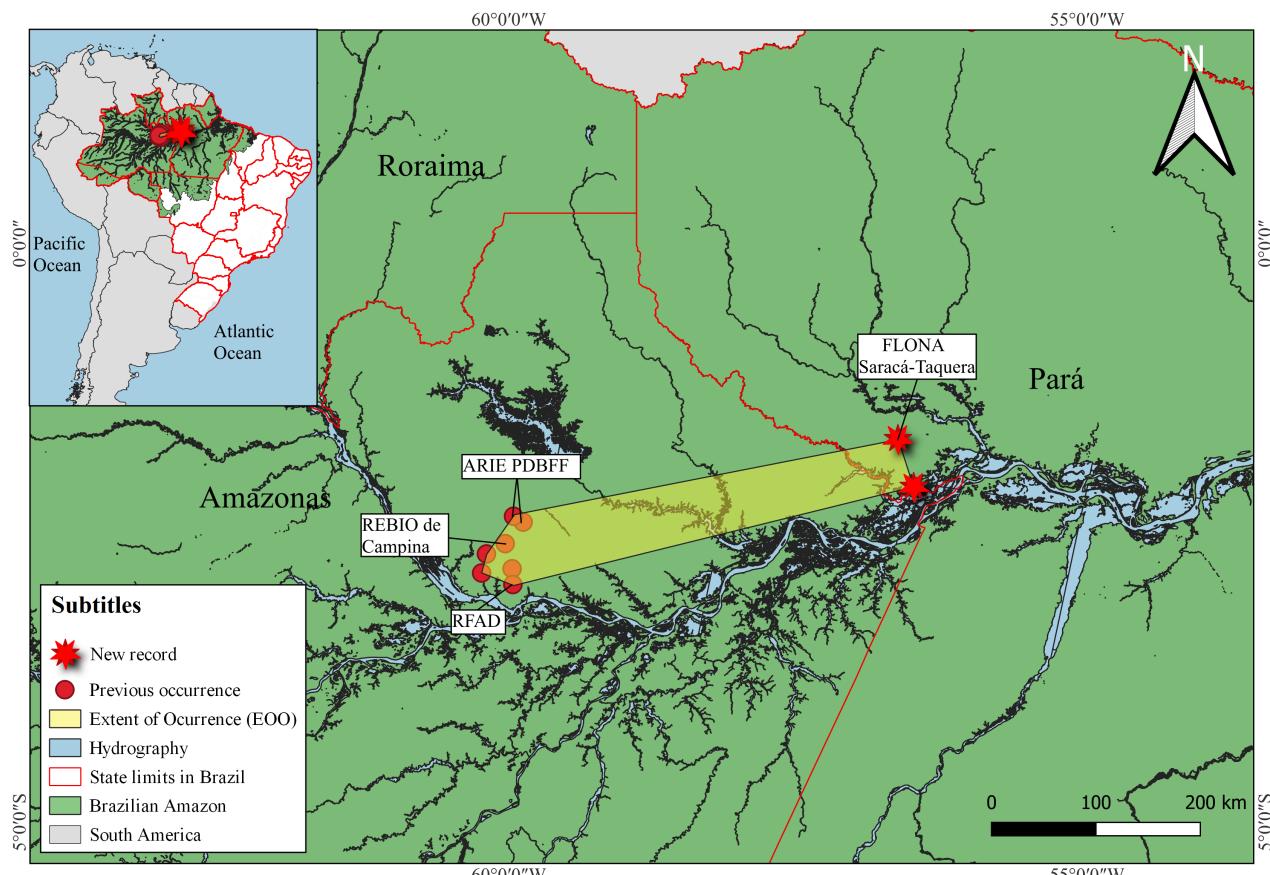


FIGURE 4. Geographic distribution map of *Dichaea fusca* in the Brazilian Amazon with our new records.

Additional material examined:—BRAZIL. Amazonas: Manaus: “Projeto Dinâmica Biológica de Fragmentos Florestais” (PDBFF), Fazenda Porto Alegre, 2°21'19"S; 59°57'31"W, 17 February 2012, J.J. Valsko 109 (INPA!); BR 174, Km 45, Reserva Biológica de Campina, 2°35'29.9"S; 60°01'49.5"W, 20 December 2012, A.H. Krahl & D.R.P. Krahl 404 (INPA!); Ramal Vale do Novo Amanhecer, 20 February 2016, A.H. Krahl & J.J. Valsko 547 (INPA!); Ramal Castanheira, 24 February, 2019, A.H. Krahl 1112 (INPA!); Reserva Florestal Adolpho Ducke, 03 May 2019, D.R.P. Krahl & A.H. Krahl 512 (INPA!); idem, 12 June 2019, A.H. Krahl & D.R.P. Krahl 1254 (INPA!); idem, 22 February 2020, D.R.P. Krahl & A.H. Krahl 639 (INPA!); Ramal da Usina, 02 February 2022, A.H. Krahl & D.R.P. Krahl 1639 (INPA!); Pará: Oriximiná: Porto Trombetas, Floresta Nacional de Saracá-Taquera, platô Saracá, 13 March 2018, J.B.F. da Silva 3569 (MG!); Terra Santa: Abaocu, ilha do Rio Nhamundá, 14 March 2018, R. Sousa & J.B.F. da Silva 23 (MG!).

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