FIRST REPORT OF PERIDISCACEAE FOR THE VASCULAR FLORA OF COLOMBIA

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Abstract. *Peridiscus lucidus* (Peridiscaceae) is recorded for the first time for the vascular flora of Colombia based on a collection from the upper Río Cuyarí, Guianía Department. This locality extends the northwestern distribution of the species in the Amazon basin to the upper Río Negro basin. Notes about the phytogeography and habitats of *P. lucidus* and an updated overview of the currently known specimens using a geographic distribution map of this taxon are also included. In addition, we provide information on the distinctive vegetative characters that help identify this genus in absence of flowers and fruits. Finally, a lectotype of *P. lucidus* is newly designated. The discovery of this family in the upper Rio Negro region of Colombia demonstrates the value of field work through alliances between private initiatives and the Kuripaco nation.

Resumen: Se registra la familia Peridiscaceae para la flora vascular de Colombia y la región del alto Río Negro basándose en una colección de *Peridiscus lucidus* en la cuenca alta del río Cuyarí, departamento del Guianía. Esta localidad extiende la distribución de esta familia al noroeste de la región Amazónica, en la cuenca alta del Río Negro. Se incluyen notas acerca de la fitogeografía, hábitats de *P. lucidus* y un mapa de la distribución geográfica elaborado a partir de la actualización de las colecciones de esta especie. Adicionalmente se presenta información para la identificación del género en ausencia de flores o frutos y se propone el lectotipo para *P. lucidus*. El hallazgo de *P. lucidus* en la región del alto Río Negro de Colombia demuestra el valor de los trabajos de campo a través de la alianza de iniciativas privadas y el pueblo Kuripaco.

Yaakuti iipenaa (Kuripaco): Padana Peridiscaceae shapuko inakuapanaa Colombia likuperi jaiko jnete payawiya jiwidan tsakja wakapa waikawa pada naniwanda lipitana *Peridiscus lucidus* Benth kuwialiriku, departamento del Guianía. Paaketa natawiñakawa jnaja jaiko puawajle amazonia isro jnete escudo guayanés tsakja. Warueta yaakuti wakaitekawa kjaleka nema jnaja jaiko, kuame natawiñaka jnaja *P. lucidus* jnete pada mapa wakaitekawa kjaleka neema wadzekatanda waniwakaujle jnapepe jaiku. Waruetatsakja yaakuti yajnekaru ikapaka jlieje jaiko karukadanaku lisro liiwi o liinaka jnete wakaite isro pada yajneshopa *P. lucidus*. Waaketa jlieje *P. lucidus* payawiya jiwidansre karukawa naapiñeta nenkani nenshopa kanakaidali jlieje idejnikjeti awakadaliko napidza jnaja empresas privadas jnete kuripako nai.

Keywords: Peridiscaceae, Colombian Flora, upper Río Negro, new family record

Peridiscaceae Kuhlmann *nom. cons*. are a tropical group included in Saxifragales (Soltis et al., 2013; APG-IV, 2016). The family comprises four genera: *Medusandra* Brenan*, Soyauxia* Oliv.*, Peridiscus* Benth., and *Whittonia* Sandwith (Bayer, 2007). These genera have a disjunct distribution, with *Peridiscus* occurring in Guyana, Venezuela, northern Brazil and now in Colombia (Fig. 1), *Whittonia* in Guyana, *Medusandra* in Cameroon, and *Soyauxia* in tropical West Africa. The genus *Whittonia* is known only from the type specimen collected below Kaieteur Falls in Guyana, in the Potaro River basin; a field effort to collect more material in 2006 was not successful (Wurdack and Davis, 2009).

The genus *Peridiscus* has had a rather significant taxonomic history. Using Richard Spruce´s collections made in 1853–1854 along the Pasiva and Pacimoni rivers, tributaries of the Casiquiare Channel (Venezuela), and along the lower Rio Uaupés (Brazil), George Bentham established the genus in *Genera Plantarum* (1862), describing a single species, *Peridiscus lucidus*. In addition, the genus was illustrated (Fig. 2) with a renewed description in Hooker's *Icones Plantarum* (Oliver, 1896). These authors both placed it, with some doubt, in the *Bixaneae*, a part of the group which he called "*Tribus Flacourtieae*" (Bentham and Hooker, 1862), and which later would be known as the family Flacourtiaceae. In his description, Bentham wrote no etymology for the name, but it is generally believed that the name refers to the fact that the stamens are attached along the outer edge of the nectary disk (Quattrocchi, 2000). The genus was placed in Bixaceae, tribe *Flacourtieae,* by Eichler (1871) in Martius's *Flora Brasiliensis*, and with doubt in Flacourtiaceae in the first and second editions of the *Pflanzenfamilien* (Warburg, 1893; Gilg, 1925). The family Flacourtiaceae was a polyphyletic lineage, as Hermann Sleumer intimated (Miller, 1975; Chase et al., 2002),

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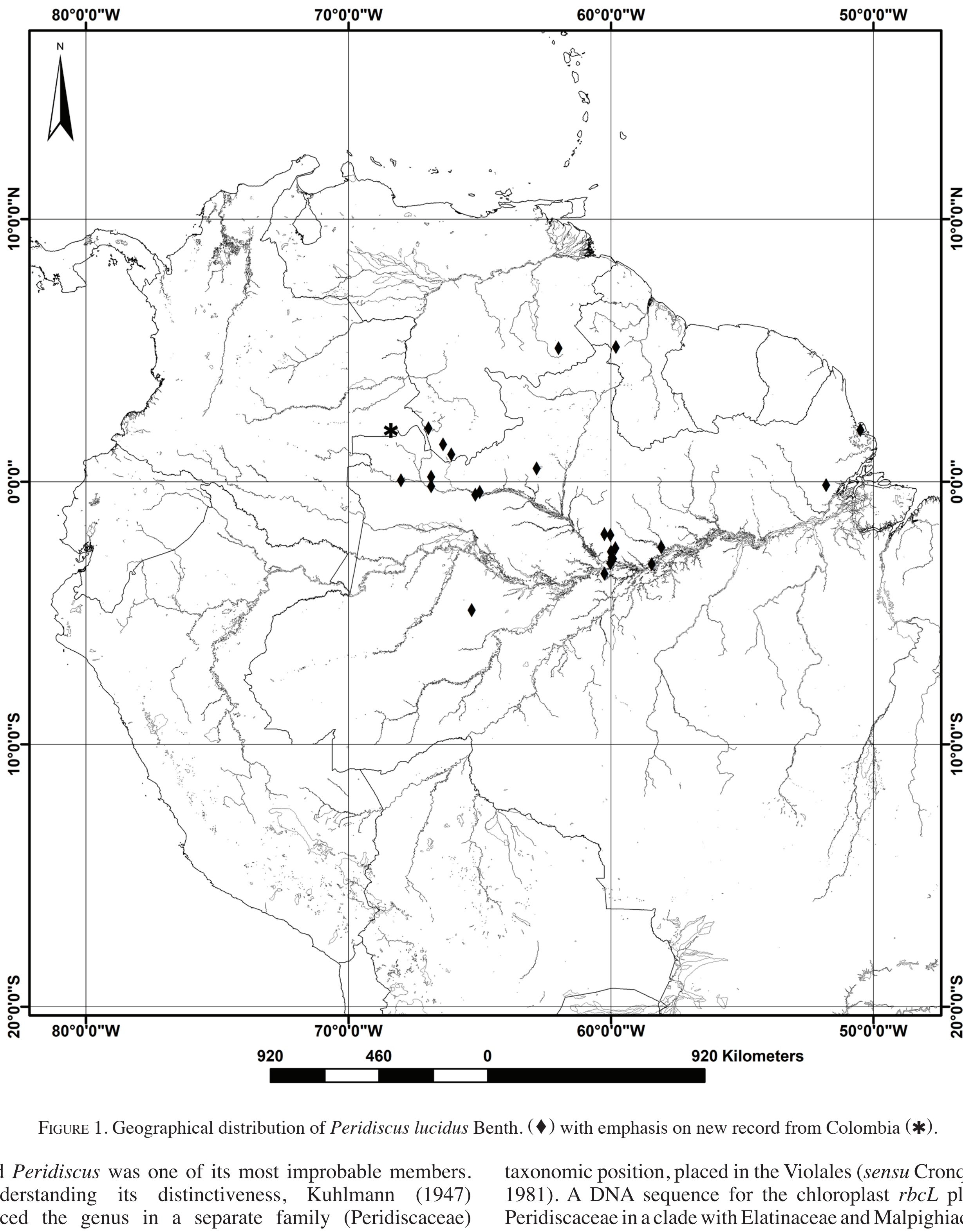

FIGURE 1. Geographical distribution of *Peridiscus lucidus* Benth. (♦) with emphasis on new record from Colombia (✱).

and *Peridiscus* was one of its most improbable members. Understanding its distinctiveness, Kuhlmann (1947) placed the genus in a separate family (Peridiscaceae) after its differences from Flacourtiaceae in many features of morphology and anatomy. Peridiscaceae was accepted and placed in order Tiliales by Hutchinson (1959) in the second edition of his *Families of Flowering Plants*, but rejected in the third edition (Hutchinson, 1967). Thereafter, Peridiscaceae was viewed as a family of uncertain taxonomic position, placed in the Violales (*sensu* Cronquist, 1981). A DNA sequence for the chloroplast *rbcL* placed Peridiscaceae in a clade with Elatinaceae and Malpighiaceae, a very surprising and unexpected result (Savolainen, et al., 2000). In 2004, using DNA from *Peridiscus*, it was shown that Elatinaceae and Malpighiaceae are indeed sister families, and that Peridiscaceae belongs to Saxifragales (Davis and Chase, 2004). Two additional studies also found strong support for the inclusion of Peridiscaceae into

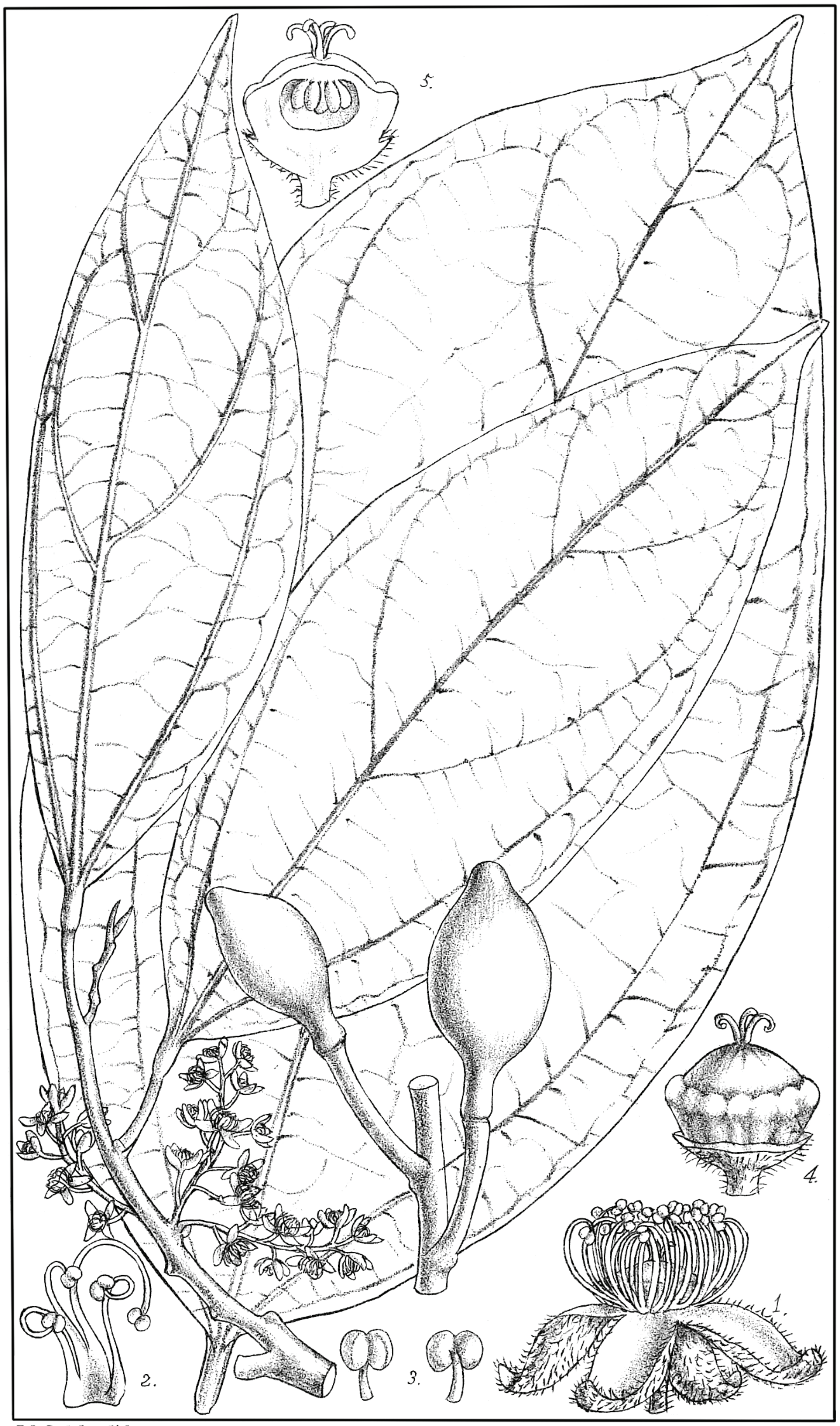

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FIGURE 2. *Peridiscus lucidus* Benth. in Hooker's *Icones Plantarum* (Oliver, 1896). 1, Flower; 2, Group of stamens; 3, Anther, from and back views; 4, Pistil with adnate disk; 5, Vertical section of ovary.

Saxifragales (Soltis et al., 2007; Shuguang et al., 2008), and the latter showed that Peridiscaceae is sister to the rest of Saxifragales as it maintained in the last Angiosperm Phylogeny Group classification (APG-IV, 2016).

In Neotropical forests, *Peridiscus* should be considered a rare component, known only from 52 collections (from 1853 to present) mainly in terra-firme and high plains on clays soils. It is also found in black-water floodplain forests on white sand soils (Daly, 2004). The occurrence of Peridiscaceae in the flora the Colombia, as well as the extension of their distribution along the northern of the upper Rio Negro basin, are reported here for the first time based on a collection of *P. lucidus* from the Cuyarí River, Guianía Department (Fig. 1). In addition, we provide information on the morphological features to help identify this species in the absence of flowers and fruits, and updated information about its geographical distribution and the structure and floristic composition of the habitats that it occupies in Colombia and Venezuela, respectively.

Material and Methods

The specimen was determined consulting pertinent literature (Riviero et al., 1999; Holst, 2003. Daly, 2004; Keller, 2004; Every, 2010). An updated database and a map of the geographic distribution of this species (Fig. 1) was compiled using information from Tropicos (www.Tropicos.org), the speciesLink Network (http://www.splink.org.br), *Lista de espécies da Flora do Brasil* (Medeiros, 2015), Jabot (http://www.jbrj.gov.br/jabot), and the Amazon Tree Diversity Network (http://atdn.myspecies.info/). In the last decade, the use of geographic information has become increasingly important tool to interpret the analysis of species distribution (Franklin, 2009), due the available digital biodiversity databases that permit assembly of species occurrence data from various sources, such as herbaria and museums, as well as data from literature. The current demand for reliable, easily accessible and free biodiversity data makes electronic infrastructures fundamental for facilitating access (Canhos *et al.,* 2015).

In addition, we incorporate the specimens of *P. lucidus* deposited in the following herbaria: GH, MO, US, and NY (acronyms according to Thiers, 2012). Our updated database has 52 records (Brazil: 46; Colombia: 1; Guyana: 1; Venezuela: 4; see Appendix 1).

Results

Peridiscus is known from the northestern Guayana Shield, where it can be found at an altitude of 800 m. This species also is known from the upper Rio Negro region of Brazil and Venezuela, and now in Colombia, which extends its southern range to central Amazon basin (e.g., the Manaus area), with two disjunct populations in Maracá region and Urubú river in Amapá and Amazonas states (Brazil), respectively (Fig. 2).

Peridiscus Benth. Genera Plantarum 1: 127. 1862.

Type species: *Peridiscus lucidus* Benth.

Peridiscus lucidus Benth., Genera Plantarum 1: 127. 1862. TYPE: BRAZIL. Amazonas: Rio Uaupés, 1853, *R. Spruce 2843* (Syntypes: BR, G, K); VENEZUELA. Amazonas. Casiquiare, Pasiva et Pasimoni, Casiquiari, 1853–1854, *R. Spruce 3389* (Syntypes: BR, G, RB), Lectotype, here designated: VENEZUELA. Amazonas. Casiquiare, Pasiva et Pasimoni, 1853–1854, *R. Spruce 3389* (G 00440028; isolectotype BR).

In the JSTOR database, *Spruce 3389* deposited in RB (a single leaf) is annotated as *P. lucidus*, but based on an examination of this material we conclude the leaf belongs to a species of *Aspidosperma* (Apocynaceae), and it is therefore excluded from the lectotypification.

Medium to large *trees* up 25 m tall. *Branches and bractlets* terete, glabrous, bark fisured, rough, dark brown. *Leaves* alternate, 15–25 x 5–12 cm, entire, lustrous above, glabrous on both sides, coriaceous, ovate to elliptic or oblong, acute to acuminate, acumen 2–3.5 cm long, base obtuse or acute, leaf blades strongly 3-veined from the base, the tertiary venation finely reticulate, the lower surface with a small to medium pit in the axil of each of basal lateral nerve; stipules intrapetiolar, villous, early deciduous and leaving a narrow oblique amplexicaul scars; petioles 1.5–2.5 cm long, glabrous, strongly pulvinate at both ends, with an adaxial plate. *Inflorescences* short, in clusters of elongate axillary racemes, axes and pedicels ferruginous-villous (short branched trichomes), bracts ovate-oblong, early deciduous. *Sepals* 4–5(6), imbricate, ferruginous-villous outside, glabrous inside; *petals* 0; *ovary* without a central column; *stamens* inserted outside the large several-lobed disk; *filaments* partly united at the base, incurved, glabrous; *anthers* bisporangiate, dehiscing by slits. *Ovary* subhemispheric, glabrous, half immersed in the nectary disk. Fruit ovoid, obovoid or ellipsoidal drupe, narrowed at the base into a short stipe. Seed one; embryo small; endosperm copious, horny.

Whittonia differs from *Peridiscus* by having the leaves villous, pliveined (versus, glabrous, strongly trinerved), flowers in fascicles (versus elongate racemes), an annular disk that subtends the ovary (versus the half of the ovary immersed in the nectary disk), and ovary densely pubescent (versus glabrous). The position of *Whittonia* within Peridiscaceae is uncertain due to lack of material, but it is most likely sister to *Peridiscus* since the two genera share several potential morphological synapomorphies (Soltis et al., 2011).

Additional Specimen examined: COLOMBIA. Guainía: Panapaná, río Cuyarí, ca. 3.5 km al norte de la comunidad de Miraflores, 1°56'51,5976"N; 68°22'8,6344"W, 115 m, 21 April 2014, *G. Aymard, F. Castro-Lima, V. Minorta-C., A. Lozano, M. González y C. Villegas 14158* (COL, COAH, FMB, HUA). Fig. 3–4.

Figure 3. Specimen I of *Peridiscus lucidus* from Cuyarí river, Guianía, Colombia (*G. Aymard, F. Castro-Lima, V. Minorta-C., A. Lozano, M. González y C. Villegas 14158*, (COL 604628).

FIGURE 4. Specimen II of *Peridiscus lucidus* from Cuyarí river, Guianía, Colombia (*G. Aymard, F. Castro-Lima, V. Minorta-C., A. Lozano, M. González y C. Villegas 14158*, (COL 604629).

Field identification in absence of flowers and fruits. Because of its alternate leaves, entire, coriaceous, leaf blades strongly 3-veined from the base, and petioles strongly pulvinate at both ends, specimens of *Peridiscus* are sometimes referred to *Abuta* sp. (Menispermaceae). However, *Peridiscus* is easy to distinguish in absence of flowers and fruits by the combination of the following characters: trees, leaves alternate, entire, lustrous above, glabrous on both sides, coriaceous, ovate to elliptic or oblong, acute to acuminate, acumen 2–3.5 cm long, leaf blades strongly 3-veined from the base, the tertiary venation finely reticulate, the lower surface with a small to medium pit in the axil of each of basal lateral nerve; stipules intrapetiolar, villous, early deciduous and leaving a narrow oblique amplexicaul scars, and petioles 1.5–2.5 cm long, glabrous, strongly pulvinate at both ends.

Discussion

Currently, understanding the diversity of plants, their distribution patterns (e.g., rarity versus hyperdominance), dispersal events, and endemisms in the entire Amazon watershed (*sensu lato*: 8,121,313 km^2), with its four peripheral region (Amazon *sensu stricto*, Guayana Shield, Plateau, Andes foothills and Gurupi basin, *sensu* ter Steege et al., 2013; Antonelli et al., 2018; Alves Valles et al., 2018a) continues to be a major challenge (Prance, 2014; ter Steege et al., 2015; 2016; Pennington et al., 2015).

Amazonia represents the world's most diverse rainforest, and it is also the region in tropical America with the largest biodiversity (Gentry, 1982a,b, 1992; ter Steege 1998; Ter Steege et al., 2010, 2013, 2016; Dexter and Chave, 2016; Dexter et al., 2017; Antonelli et al., 2018). Many regions inside the basin are not represented by even a single collection, perhaps implying that many species distributions are still poorly known and/or not well understood (Nelson et al., 1990; Hopkins, 2007; Schulman et al., 2007; ter Steege et al., 2011, 2016; Cardoso et al., 2015). However, several areas inside the basin (e.g. the Rio Negro basin, Manaus, and, s.l., the Guayana Shield) had been relatively well explored and studied, the information about the explorations were summarized in Aymard et al. (2016) and ter Steege et al. (2016), respectively. As a result, currently there exists a relatively good understanding of the structure and floristic composition of forests inside the Amazon basin (Prance, 1989, 2001; Tuomisto et al., 1995, 2016: ter Steege 1998; ter Steege et al., 2003, 2006, 2010, 2015, 2016; Pitman et al., 2008; Aymard et al., 2009; Higgins et al., 2011; Prance, 2014; Slik et al., 2018). In addition a considerable number of endemics (Carvalho, 2011; Alves Valles et al., 2018b), and rare species are found there (Zizka et al., 2018). No doubt due by the environmental variables, the biographical history and the dispersal mechanism allow assembly of unique habitats, such as numerous and diverse terra-firme and flooded forests growing in white-sand and clay soils as well; the Amazonian Caatinga, and abundant plants communities mixed of palms over black and white water rivers vegetation (Kristiansen et al., 2012; Alves Valles et al., 2018a).

Currently, very little information is known about the habitats occupied by *Peridiscus lucidus*. After the R. Spruce's collections of 1853–1854, the next ones took place ca. 80 years later (A. Ducke, 1931; L. Williams, 1942; and R. L. Froes, 1947) on terra-firme forests in the Manaus region (Rio Taruma), and the upper Rio Negro (Piedra de Cocuy and Tapuruquara, respectively). Other localities and habitats of this species are: in montane forests over lateritic soils (Guyana, Potaro-Siparuni region. Mt. Wokokomung, 790 m). In Brazil it is found through the central to eastern Brazilian Amazon, where it is found along terra-firme and flooded forests growing in sand and clay soils (e.g., Amazonas: Manaus area, Rodovia Manaus-Itacoatiara, R. F. A. Ducke, São Sebastião do Uatumã e Urucará, Sierra da Lua, Rio Urubu, Rio Cuieiras), and in terra-firme forests growing in clay soils (e.g., Amapá: Matará, Macapá, Pará: Monte Dourado). It is also found growing in the middle and upper Rio Negro (e.g., Santa Isabel do Rio Negro, São Gabriel da Cachoeira, Rio Uaupés) over sandy and clay soils tall forests, and in black water communities subject to flooding dominated by *Tachigali odoratissima* (Spruce ex Benth.) Zar. & Herend., *Protium reticulatum*. (Engl.) Engl., *Molongum laxum* (Benth.) Pichon, *Heisteria duckei* Sleumer, *Guatteria dura* R. E. Fr. and *G. punctata* (Aubl.) R. A. Howard (e.g., middle Río Baria, Venezuela).

We report here that *Peridiscus lucidus* also occurs in the upper Rio Negro basin of Colombia, specifically in the upper Río Cuyarí (Fig. 1); the latter is a black water river, the basin of which includes largely unexplored flooded and non-flooded forests (Aymard and Castro-Lima, 2015; Aymard et al., 2016). The collection from the Río Cuyarí is represented by a single individual, and was made during inventories made to compare tree communities. This locality is dominated by terra-firme tall forests, in high plains over clays soils with an important presence of *Micrandra spruceana* (Baill.) R. E. Schult. ("Cunuri tierra firme") and *Caryocar gracile* Wittm ("Jigua montera"). Other trees species found in this forest are: *Iryanthera coriacea* Ducke, *Aspidosperma excelsum* Benth., *Swartzia acuminata* Willd. ex Vogel, *Ocotea rhodophylla* A. Vicentini, *Faramea anisocalyx* Poepp. & Endl., *Dacryodes cuspidata* (Cuatr.) Daly, *D. negrensis* Daly & M. A. Martínez, *Qualea acuminata* Spruce ex Warm., and *Ferdinandusa goudotiana* K. Schum. The forests dominated by *Micrandra spruceana* (Baill.) R. E. Schult. are common in many places inside the northeastern portion of the Amazon basin, with the same habitat preferences described above such as San Carlos de Rio Negro, Venezuela (Dezzeo et al. 2000; Aymard et al., 2009), Amacayacu, Caquetá, Loretoyacu and Mirití rivers, Colombia (Rangel, 2008) and Pico da Neblina National Park, Brazil (Boubli, 2002). The variety of habitats where *Peridiscus lucidus* is found indicates that this species is not a soil specialist, and also suggests that the terra-firme forests growing in sand and clay soils may have a common evolutionary history, and support the model that advises the ability of plants to grow across a wide range of soils (Duivenvoorden, 1995; Pitman et al., 2001; ter Steege et al., 2003; Aymard et al., 2009, 2016).

When the geographical distribution of *Peridiscus lucidus* is plotted and analyzed (Fig. 1), it shows us that this taxon is mainly a Rio Negro basin element (from its headwaters to Manaus area), with only five collections outside of this basin. The family so far is absent in Ecuador, Peru, Bolivia, and the southeastern and northwestern Amazon basin region (Gentry, 1983). It would be easy to treat the absence of *P. lucidus* from this large area as a collection artifact because the area is still vastly unexplored, which we regard as an unlikely explanation given the large number of plant collectors who have worked in this particular area in the last 250 years, since the age of exploration in the Neotropics began (Aymard et al., 2016; ter Steege et al., 2016). The latter is an area that comprises a large portion of the Amazon basin of Colombia, Ecuador and Peru, considered one of the world's last zone of high biodiversity with an extraordinary number of species across taxa and where large tracts of forests still remain largely intact (Pitman et al., 2008; Bass et al., 2010). The absence of this family in southeastern and northwestern Amazonia could be related to the Pebas wetland system (Hoorn et al., 2010b; Sacek, 2014), which may also have played a role as a dispersal barrier for pre-Pebas groups, and could account for the well-known pattern of Andean-centered vs. Amazonian-centered biodiversity (Gentry, 1982; Antonelli and Sanmartín, 2011).

A modern ecological insight is that some Amazonian tree species are consistently more abundant than would be expected from chance alone (ter Steege et al., 2013). An estimated 16,000 tree species make up Amazonian forests, yet over half the stems belong to just 227 of them; this subset of disproportionately common trees has been dubbed the "hyperdominants" (ter Steege et al., 2013). The contribution of rare species to this diversity has been recognized (Wills et al., 2006: Kenfack et al., 2007), however their spatial distribution remains poorly understood (Zizka et al., 2018). Wills et al. (2006) presented census data from seven New and Old World tropical forest dynamics plots that all showed that the erosion of diversity can be prevented over the short term if recruits are highly diverse as a result of preferential recruitment of rare species or, alternatively, if rare species survive preferentially, which increases diversity as the ages of the individuals increase.

The current distribution of *P. lucidus*, based on a few collections (52) in 161 years, and only 42 individuals measured in 16 one-hectare plots (ter Steege et al., 2013), suggest that this is a rare species. However, the lack of material for DNA extraction and information about the dispersal biology (although the fruits are most likely dispersed by animals, perhaps birds) provide us with elements to explore an alternative hypothesis to explain it distribution, based in its present in both white-sand and clay soils in the North and Central Amazon lowlands, as well as in medium altitudes in the Guayana Shield.

The Guayana Shield (GS) has been considered the place of origin of some widespread lineages in South America (Frasier et al., 2008; Rull, 2008, 2010; Givnish et al., 2011). Perhaps *P. lucidus* is currently migrating from the GS to the lowlands forests located inside the North and Central Amazon region. Furthemore, the GS was above water at time of high sea levels (23 to 10 Ma, 10 to 7 Ma), which allowed the survival of forests, active speciation, and the maintenance of high levels of sympatric species diversity (Givnish et al., 2000, 2011; Rull, 2005, 2007); during this period, the current Amazon basin was inundated as a result of sea levels up to 50 m higher than the present (Hoorn et al., 2010a,b; Sacek, 2014). The lowland rainforest could not have existed in the mega-wetlands or Pebas system during 16 to 10 Ma.

During this phase, the Pebas wetland in western Amazonia was possibly separated from the fluvial eastern Amazonia by the Purus Arch (Wesselingh, 2006; Figueiredo et al., 2009). Later, 10 to 6 Ma ago, the sea level was low again, and warm tropical climates drier prevalence than the one existing today in the Amazon. During this interval the sediment accumulation was reduced and/or ceased, erosion took place under warm, tropical weather having well defined dry seasons which, resulting in deep lateritic paleosol and spodozol horizons (Montes et al., 2011) that allowed the formation of the first fluvial plains in eastern and western Amazonia and, consequently, marked the beginning of an unstoppable processes of distribution, dispersion and a high turnover of species, a scenario implicating high rates of speciation through space and time in the basin, resulting in the highly diversity of the modern rainforest (Morley, 2000; Burnham and Johnson, 2004; Hughes et al., 2013; Pennington et al., 2015). This process was supported by the establishment of the transcontinental drainage post Pebas System of the present Amazon by an overfilling of the Andean foreland basin in the Late Miocene (Wesselingh et al., 2010; Hoorn et al., 2010b; Antonelli and Sanmartín, 2011). All this evidence show that the GS region may have allowed old lineages to survive over time, with diverse traits that provide the stock for species diversifications through time to neighborhood regions (Rull, 2008; 2010; Désamoré et al., 2010) contributing to the accumulation of diversity, at least in part, detectable in the current species richness of tropical forests.

The first occurrence of Peridiscaceae reported herein for the flora of Colombia expands the geographical distribution and improves the family-level information of the floras of Brazil, Colombia, and Amazon basin as well (Medeiros, 2015; Rangel, 2015; Bernal et al., 2016; ter Steege et al., 2016; Cardozo et al., 2017; Ulloa-Ulloa et al., 2017).

A recent work on rarity in the Neotropics identified 26,315 species for Amazonia, of this 10,080 species as putatively rare within this region (Zizka et al., 2018). Inside Amazonia most collections of rare species were in the sub-Andean region and on the GS, and in few areas scattered across the study area. The authors also found that rare species are homogeneously distributed through most parts of the lowland Neotropics and Amazonia, but more concentrated in highlands, with no clear disjunction patterns within lowland areas. These results suggest that a considerable proportion of rare plant species have surprisingly large distribution ranges (e.g., *P. lucidus*), and that collections of rare species across most of the lowland Neotropics, and in particular in Amazonia, show no clear directionality.

The Amazon basin has outstanding global conservation significance because this region represents the largest tropical rain forest in the world, storing ca. 40% of the global biomass of tropical forests (Saatchi et al., 2007, 2011). However, this tropical forest is at risk due to the impact of increases in drought frequency (Longo et al., 2018) and fires (Carmenta et al., 2018) that are altering the Amazon forest's composition, structure and functioning. This situation, suggests that parts of the Amazon basin may be susceptible to biome shifts, biodiversity loss and depletion of carbon stores because of changes in climate and weather variability (Duffy et al., 2015; Boit et al., 2016; Bathiany et al., 2018). In addition, mining activities, selective logging, and new road developments will threaten its as yet unvalued conservation status. These findings help to form the scientific basis for policy recommendations, including stopping new destructive events, and creating more areas off limits to large-scale development in adjacent regions of the three countries that comprises the basin. Finally, this report is yet another example that demonstrates the need for continued taxonomic and floristic studies in regions where there are large geographic gaps in the knowledge of Amazonian flora.

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