Systematic Botany (2025), 00(00): pp. 1–12
ISSN 0363-6445 (print); ISSN 1548-2324 (online)

DOI 10.1600/036364425X17466502618821
Date of publication May 30, 2025

Ecclinusa nervosa (Sapotaceae, Chrysophylloideae), a New Species Discovered in Central Amazonia

Caroline C. Vasconcelos,[1,6] Isolde D. K. Ferraz,[1,2] Flávia M. Durgante,[1,3,4] Florian Wittmann,[1,3,4] Jochen Schöngart,[1,4] Maria T. F. Piedade,[1,4] José Luís C. Camargo,[1,5] and Mário H. Terra-Araujo[1]

[1]Programa de Pós-Graduação em Botânica (PPGBOT), Instituto Nacional de Pesquisas da Amazônia (INPA), Av. André Araújo 2936, Manaus, Amazonas 69067-375, Brazil; cc_vasconcelos@hotmail.com; araujo.mht@gmail.com
[2]Coordenação de Biodiversidade (COBIO), Instituto Nacional de Pesquisas da Amazônia (INPA), Av. André Araújo 2936, Manaus, Amazonas 69067-375, Brazil; isolde.ferraz@gmail.com
[3]Department of Wetland Ecology, Institute of Geography and Geoecology (IFGG), Karlsruhe Institute of Technology (KIT), Josefstraße 1, Rastatt 76437, Germany; flaviamdflorestal@gmail.com; florian.wittmann@kit.edu
[4]Ecologia, Monitoramento e Uso Sustentável de Áreas Úmidas (MAUA), Coordenação de Dinâmica Ambiental (CODAM), Instituto Nacional de Pesquisas da Amazônia (INPA), Av. André Araújo 2936, Manaus, Amazonas 69067-375, Brazil; jschongart@gmail.com; maua.manaus@gmail.com
[5]Projeto Dinâmica Biológica de Fragmentos Florestais (PDBFF), Coordenação de Dinâmica Ambiental (CODAM), Instituto Nacional de Pesquisas da Amazônia (INPA), Av. André Araújo 2936, 69067-375, Manaus, Amazonas, Brazil; zeluiscamargo@gmail.com
[6]Author for correspondence (cc_vasconcelos@hotmail.com)

Communicating Editor: Shawn Krosnick

Abstract—A new tree species of *Ecclinusa* (Sapotaceae, Chrysophylloideae) from Central Amazonia is described and illustrated. It occurs in non-flooded upland forests (*terra-firme*) in the municipalities of Manaus, Presidente Figueiredo, and Rio Preto da Eva in Amazonas state, Brazil. ***Ecclinusa nervosa*** sp. nov. resembles *E. ulei*, *E. parviflora*, and the sympatric *E. guianensis*, as these species share overall similar foliage at first sight. However, it differs by the combination of the presence of intersecondary veins (vs. absent in all congeners, except in *E. lancifolia*) and flowers with a sparse tomentulose indumentum inside the sepals (vs. glabrous inside in all congeners, except in *E. ramiflora* and *E. psilophylla*) and shorter styles (≤ 0.7 mm long vs. > 0.7 mm long in the morphologically similar taxa). We compare the new species with similar taxa through diagnostic morphological features, geometric morphometrics, and infrared spectral analyses of dried leaves. Additionally, we provide information on habitat, distribution, phenology, and a preliminary conservation assessment. An identification key for *Ecclinusa* species from the Brazilian Amazonia is also presented.

Keywords—Amazonian tree flora, integrative taxonomy, leaf spectroscopy, outline analysis, *terra-firme* forests.

The Neotropical genus *Ecclinusa* Mart. (Sapotaceae Juss., Chrysophylloideae Luerss.) currently comprises twelve accepted species of shrubs, sub-canopy treelets, and large canopy trees (Pennington 1990; Swenson and Anderberg 2005; Terra-Araujo et al. 2015). It occurs in dry and wet tropical forests from Central America (Panama) to most of South America (Pennington 1990; C. C. Vasconcelos et al. in mss.). According to previous molecular studies, the genus has been recovered as monophyletic (Swenson and Anderberg 2005; Swenson et al. 2008, 2023; Faria et al. 2017) and is currently positioned in a significant lineage in the Chrysophylloideae subfamily that also encompasses *Elaeoluma* Baill., *Nemaluma* Baill., and *Ragala* Pierre (Swenson et al. 2023).

Ecclinusa was established by Martius (1839) and has been accepted by almost all taxonomists, except Baehni (1965), who reduced it to a synonym of *Chrysophyllum* L. However, the presence of stipules is an unusual feature across species of Neotropical Chrysophylloideae, distinguishing *Ecclinusa* and *Chromolucuma* Ducke from other related genera (Faria et al. 2017; Swenson et al. 2023). Although stipules may sometimes be caducous, they typically leave conspicuous scars on the two sides of the petiole. Additional consistent morphological characters for *Ecclinusa* against *Chromolucuma* are white latex, sessile flowers, and the absence of staminodes (vs. yellow latex, pedicellate flowers, and the presence of staminodes) (Pennington 1990; Alves-Araújo and Alves 2012b; Terra-Araujo et al. 2015; Faria et al. 2017; Vasconcelos et al. 2021).

At least six species of *Ecclinusa* have been reported in Brazil, all of which are found in the Amazonian ecoregion, a major center of diversity for Sapotaceae (Pennington 1990, 1991, 2006; BFG 2015; Terra-Araujo et al. 2015; C. C. Vasconcelos et al. in mss.). The most widespread species in Brazil, *Ecclinusa ramiflora* Mart., is distributed from Amazonia to the Atlantic Forest biomes (Pennington 1990; C. C. Vasconcelos et al. in mss.). Central Amazonia is recognized as a center of high tree species richness and an overlapping area for several biogeographic regions (Oliveira and Daly 1999; ter Steege et al. 2023; Householder et al. 2024; Luize et al. 2024). In this region, *Ecclinusa* species grow in different ecosystems (sensu Junk et al. 2011), including dense non-flooded upland forests (known as *terra-firme*), white-sand forests (*campina* or *campinarana*), as well as in both black- or clear-water (*igapó*) and white-water (*várzea*) floodplain forests (Pennington 1990, 2006; Terra-Araujo et al. 2015).

The last comprehensive taxonomic revision of *Ecclinusa* was conducted by Pennington (1990), who recognized almost all currently known species and identified several taxonomic challenges related to poorly sampled species and insufficiently understood morphological variation. However, in the last three decades, many collections of South American Sapotaceae have been included in herbarium collections, providing a more comprehensive understanding of the geographic range and morphological variability within existing species. Overall, since Pennington (1990, 2006), new species of Sapotaceae have been described from Brazil in the last decade, especially from Central Amazonian forests (Terra-Araujo et al. 2012, 2015; Vasconcelos et al. 2020, 2021; Lima et al. 2024) and the Atlantic Forest (Alves-Araújo and Alves 2011, 2012a, 2012b; Terra-Araujo et al. 2013; Popovkin et al. 2016; Alves-Araújo 2020; Alves-Araújo and Mônico 2017; Sossai et al. 2017; Lima et al. 2021).

This study was conducted as part of a taxonomic treatment of South American *Ecclinusa* (Vasconcelos et al. in mss.). In 2016, during a field expedition in the municipality of Presidente Figueiredo (Amazonas state), we collected a flowering tree of *Ecclinusa* that differed from any known congeners. The plant matched earlier some collections from the same locality and vicinities archived in the Projeto Dinâmica Biológica de Fragmentos Florestais (PDBFF hereafter) and Programa de Pesquisa em Biodiversidade (PPBio hereafter) reference collections. After a careful inspection, these specimens were identified as representatives of a distinct and undescribed taxon, which was also corroborated by leaf geometric morphometrics and infrared spectral analyses. Hence, we describe and illustrate *Ecclinusa nervosa* C.C.Vasconc. & Terra-Araujo as a new species.

Materials and Methods

Species Concept—Our concept of a species corresponds to a metapopulation lineage that evolves independently (De Queiroz 2007). In this way, any property that provides evidence for lineage separation can be used to infer species limits, but none of them is individually necessary. Here, we considered diagnosable morphology, infrared spectral differences, and geographic distribution as lines of evidence.

Species Description—Unless otherwise indicated, the measurements and descriptions are based on dried collections. Flowers (n = 15) from the type collection were dissected and measured with a stereomicroscope (Leica® model S8APO, with a DFC295 camera coupled). The general plant descriptive terminology follows Hickey and King (2000), Harris and Harris (2001), and Ellis et al. (2009). Characters used in the identification key are from our data and previously published studies (Pennington 1990, 2006; Terra-Araujo et al. 2015). The illustrations are based on specimens and photographs taken in the field and laboratory. All type specimens of *Ecclinusa* spp. in different herbaria (acronyms according to Thiers 2024) were consulted from images (viz. COL, G, K, M, MO, NY, RB, and U) on JSTOR Global Plants (https://plants.jstor.org/) and the REFLORA Virtual Herbarium (https://floradobrasil.jbrj.gov.br/reflora/herbarioVirtual/) or while visiting INPA.

Distribution and Conservation Assessment—Georeferenced specimen data were used to prepare the distribution map using QGIS (v3.28.1; QGIS Development Team 2022) and as input to calculate the extent of occurrence (EOO), area of occupancy (AOO; 2 km grid), number of locations (10 km grid), and number of subpopulations (5 km radius). We used these parameters to assess the preliminary conservation status of the new species, following the IUCN Red List categories and criteria (IUCN 2012, 2024).

Geometric Morphometrics and Spectra Acquisition—The dataset includes a total of 62 core specimens (fertile and sterile) comprising *Ecclinusa nervosa* and five morphologically related congeners: *Ecclinusa guianensis* Eyma, including two informal morphotypes in Central Amazonia sensu Ribeiro et al. (1999) named as *E. guianensis* FormaA and *E. guianensis* FormaB (coded here as GUIA and GUIB, respectively); *Ecclinusa parviflora* T.D. Penn. (PARV); *Ecclinusa psilophylla* Sandwith (PSIL); *Ecclinusa ramiflora* Mart. (RAMI); and *Ecclinusa ulei* (K.Krause) Gilly ex Cronquist (ULEI). This set of physical specimens was based on representative collections borrowed from the INPA, IAN, RB, and MO herbaria (Thiers 2024), as well as local reference collections from Central Amazonia (PDBFF and PPBio), and collections from fieldwork expeditions (see Table S1).

Geometric morphometrics approaches directly capture geometry, which can be separated into size and shape (Quitzau et al. 2022). For this, we digitized all specimens at high resolution to extract at least two complete leaves per specimen. In cases where leaves were overlapping or damaged, we post-processed the images. We then applied the Fourier-based outline analysis (leaf contour) to describe the coordinates of points along the outline of the leaves using mathematical functions, ensuring objectivity in describing their morphology (Adams et al. 2004).

The spectroscopy approaches capture the spectral response of the leaf tissue in terms of internal chemical composition and anatomical structure (Asner and Martin 2008; Feret and Asner 2013), detecting with high accuracy any molecule in which the principal chemical bonds are CH, OH, NH, SH, or C=O (Pasquini 2003). Despite among-lineage heterogeneity, leaf spectra can retain a detectable phylogenetic signal, capturing the phylogenetic history of seed plants and the evolutionary dynamics of leaf chemistry and structure (Meireles et al. 2020). The spectral data were collected using an ASD® FieldSpec® 4 portable high-resolution spectroradiometer (ASD Inc., Boulder, Colorado, USA). Each spectrum has 2151 reflectance values spanning the 350–2500 nm wavelength region. The spectral resolution was 3 nm for the VIS (visible light, 350–700 nm) and NIR (near-infrared, 700–1000 nm) regions and 8 nm for the SWIR region (short-wave infrared, 1000–2500 nm). Before each measurement session, a reference baseline was established by placing the ASD® contact probe over a white Spectralon® plate. To assure the quality of the data, we consider the average spectrum of six readings for each specimen (Durgante et al. 2013), consisting of three readings on each of the adaxial and abaxial leaf surfaces of at least three different leaves. A black body of ethylene vinyl acetate (rubber material) was used in the reading area of the samples to avoid light scattering.

Data Processing and Analysis—The raw spectra were processed by removing scans with reflectance values exceeding 1.0 (Stasinski et al. 2021). We combined the leaf geometric morphometrics and spectral variables in a unique dataset and scaled them to have unit variance. We tested the species identity using Discriminant Analysis of Principal Components (DAPC), a multivariate analysis that transforms variables by PCA before performing Discriminant Analysis (DA). This method ensures that variables are uncorrelated, making it a suitable methodological approach for phenotypic data (e.g., morphometrics and spectral data), which typically present high correlation (Jombart et al. 2010). We used 85% of the combined data to classify species as a training set to build a predictive model. We used all combined data for the testing set. Posterior probabilities of group membership resulting from the DAPC model were used to assess species hypotheses. The overall accuracy of the DAPC model was defined as the ratio of correctly predicted samples to the total number of samples. Correct and incorrect predictions were summarized in a confusion matrix.

All analyses were conducted using the open-source statistical software R (v4.2.2; R Core Team 2022), employing a custom R script alongside add-on packages such as ‘ConR’ for conservation assessment; ‘EBImage’ and ‘Momocs’ for outline analysis (leaf contour), ‘asdreader’ and ‘dplyr’ for data wrangling; ‘factoextra’, ‘adegenet’, and ‘caret’ for multivariate analyses; and ‘ggplot2’, ‘ggConvexHull’, ‘gridExtra’, and ‘NIRtools’ for data visualization (see Table S2).

Taxonomic Treatment

Ecclinusa nervosa C.C. Vasconc. & Terra-Araujo, sp. nov. Type: Brazil. Amazonas: Mun. Presidente Figueiredo, AM-240 highway, Balbina village, Sussuarana trail, a few meters from the central trail, on a slope of “terra-firme” forest on clayish soil, 01°54′23.70"S, 59°24′41.70"W, 146 m, 22 Oct 2016 (fl.), *M.H. Terra-Araujo 1325B* (holotype: INPA barcode INPA0203794; isotypes: EAFM, HUAM, IAN, MG, MO, RB, VIES).

At first sight, the foliage of *E. nervosa* resembles that of *E. guianensis*, *E. parviflora*, and *E. ulei*, which all usually share coriaceous, broadly elliptic or obovate leaves (vs. lanceolate or oblanceolate). The new species can be morphologically distinguished by the presence of intersecondary veins (absent in all congeners, except in *E. lancifolia*) and flowers with a sparse tomentulose indumentum inside the sepals (vs. glabrous inside in all other congeners, except in *E. ramiflora* and *E. psilophylla*) and style ≤ 0.7 mm long (vs. > 0.7 mm long in the morphologically related species).

Description—Medium-sized **trees** up to 18 m tall; trunk 25 cm in diameter at breast height (dbh), cylindrical, unbuttressed; bark blackish brown and slightly rough, slash pale yellowish with copious white latex; young twigs golden-brown tomentulose, eventually glabrous, rugulose, without lenticels, turning pale grayish with age. **Stipules** 4.6–8.0 mm long, lanceolate, golden-brown tomentulose on inner surface, adjacent on the two sides of the petiole. **Leaves** entire alternate, spaced, coriaceous, discolorous, obovate to elliptic, 8.5–17.8 × 4.9–8.4 cm; base cuneate to rounded, apex usually acuminate, rounded or emarginate, rarely acute, margin revolute, adaxial surface glabrous, abaxial surface golden-brown tomentulose on midrib and veins, sparser on the blade; venation mixed eucampto-brochidodromous, sometimes with a marginal vein, midrib sunken on the adaxial surface; secondary veins in 10–16 pairs, slightly arcuate; intersecondary veins present, short; tertiary veins oblique, conspicuous, numerous; higher order veins often forming a visible reticulum. **Petiole** 0.8–1.9 cm long, slightly channeled, appressed golden-brown tomentulose. **Fascicles** 2–5-flowered, axillary, and ramiflorous. **Flowers** sessile, 5-merous, ♀ unisexual, plant probably dioecious; ♂ not seen. **Sepals** quincuncial, 2.9–3.9 mm long, ovate or suborbicular, apex acute to obtuse, appressed tomentulose outside, sparse tomentulose at the apex inside, often with a glabrous margin. **Corolla** cup-shaped, greenish-yellow in vivo, 4.2–6.0 mm long, tube 1.8–3.8 mm long, lobes, 1.2–2.9 mm long, ovate, apex acute, glabrous, not papillate. **Staminodes** absent. **Ovary** broadly globose, ca. 2.0 mm long, densely strigose, style 0.2–0.7 mm long, glabrous; style head simple or minutely 5-lobed, glabrous. **Fruit** ca. 2.0 cm, globose, with remnant trichomes (based on *Brito et al. 47*). **Seed** solitary (based on *Brito et al. 47*), but not described here because of the limited material. Figures 1, 2.

Distribution and Habitat—So far as we know, *Ecclinusa nervosa* occurs only in the municipalities of Manaus, Presidente Figueiredo, and Rio Preto da Eva in Amazonas state, Central Amazonia, Brazil (Fig. 3). The type specimen was discovered in the Sussuarana trail, which is part of a touristic complex of waterfalls in Presidente Figueiredo. The vegetation along the trail (ca. 4.5 km) changes from *terra-firme* forest (Fig. 2A) on yellow clay soil at higher elevations (120 m) to formations of *campinarana* (Fig. 2B) on white-sand soil at lower elevations (70 m), leading to Sussuarana waterfall (Sobreira 2018). This area is accessible through Balbina village, located near the Balbina Dam in the Uatumã River Basin. Moreover, it has been recorded in two protected areas in Rio Preto da Eva (some permanent plots in the PDBFF) and Manaus (the PPBio grid at Reserva Ducke), in *terra-firme* forests at 50–150 m elevation. The region's topography consists mainly of flat, clay-rich plateaus dissected by numerous streams and river gullies (Bohlman et al. 2008).

Etymology—The specific epithet refers to the conspicuous intersecondary and tertiary veins on the abaxial surfaces of the leaf blades. It derives from the Latin word nervus, which means rope or tendon.

Phenology—The sexual system of *Ecclinusa* is thought to consist of unisexual or bisexual flowers (Pennington 1990; Terra-Araujo et al. 2015). Unisexual female flowers of *E. nervosa* were recorded in September and October and fruits in November, which is the end of the dry season in this region. To date, male or bisexual flowers are unknown. Nevertheless, we suspect the species to be dioecious.

Preliminary Conservation Status—The new species has an EOO of 3279 km^2 and an AOO of 24 km^2 and is known from only four locations (grid res. 10 km) in Amazonas state. These represent four subpopulations and three within protected areas (PDBFF and Reserva Ducke). This species is restricted to a small area, but the subpopulations are reasonably protected from deforestation. Therefore, declines in the EOO, AOO, habitat extent and quality, number of subpopulations, and number of mature individuals are not expected to be potential threats in the future. Thus, we assign *E. nervosa* a preliminary status of Least Concern (LC) according to IUCN.

Taxonomic Comments and Species Discrimination Using Geometric Morphometrics and Infrared Spectroscopy of Leaves—Specimens of *Ecclinusa nervosa* from the PDBFF and Reserva Ducke were previously misidentified as *E. guianensis* due to the similarity in foliage observed in sterile material. However, *E. nervosa* is easily distinguished from *E. guianensis* by a combination of features: the presence of intersecondary veins (vs. absence of intersecondary veins), conspicuous tertiary veins (vs. inconspicuous) (see Fig. 1A, C), fewer secondary veins (up to 16 pairs vs. up to 30 pairs), sparse indumentum on the abaxial leaf surface (vs. glabrous both surfaces), twigs without lenticels (vs. lenticellate), and tree bark blackish brown without conchoidal scars (see Fig. 2C) (vs. reddish to grayish brown with conchoidal scars; see Carvalho et al. 2024, Fig. 1B). These two species occur sympatrically and syntopically (same habitat and location) in Central Amazonia. In contrast, the other morphologically related species are known from northeastern Pan-Amazonia (mainly Venezuela) and occur on mountain slopes at 1400–2200 m (*E. ulei*) or in low forests on granitic rocks at 80 m (*E. parviflora*) (Pennington 1990). Some morphological differences between *E. nervosa* and these three morphologically related species are summarized in Table 1.

It is worth mentioning that *Ecclinusa guianensis* is considered a morphologically variable species in terms of overall foliage (Pennington 1990), with distinct morphotypes recognized throughout its distribution range. In Central Amazonia, our understanding of this variation is improving, as some of the previously recognized morphotypes (e.g., Ribeiro et al. 1999; Carvalho 2017) have been confirmed as new species (this study and Vasconcelos et al. in mss.) or as the result of phenotypic plasticity (Carvalho et al. 2024). This evidence is supported by morphological characters of both vegetative and reproductive structures, and infrared spectral, ecological, and geographic data (Carvalho et al. 2024; Vasconcelos et al. in mss.).

The results of the multivariate analysis combining the leaf geometric morphometrics and infrared spectral datasets are shown in Figs. 4, 5, and Supplemental Figs. S1–S3. The first PC axis captured 75.9% and the second PC axis 9.5% of total variation in the combined dataset (Fig. S1). The DAPC model achieved an overall accuracy of 98.39% (95% CI = 91.34–99.96%) in assigning specimens to morphologically defined species (Fig. S2). All core specimens of *E. nervosa* were correctly predicted as such (Fig. 4), supporting our hypothesis of it being a new taxon. Previous studies have successfully used laboratory- or field-based spectroscopy approaches to identify closely related species, often surpassing the accuracy typically achieved by DNA barcoding in tropical plant lineages (Draper et al. 2020). These methods have been effective using both dried leaves (e.g., Durgante et al. 2013; Lang et al. 2017; Vasconcelos et al. 2021) and bark spectra of standing trees (Hadlich et al. 2018), as well as by integrating geometric morphometrics and spectra of dried leaves (Gaem et al. 2022).

In the DAPC ordination derived from geometric morphometrics and infrared spectral data, we observed minimal

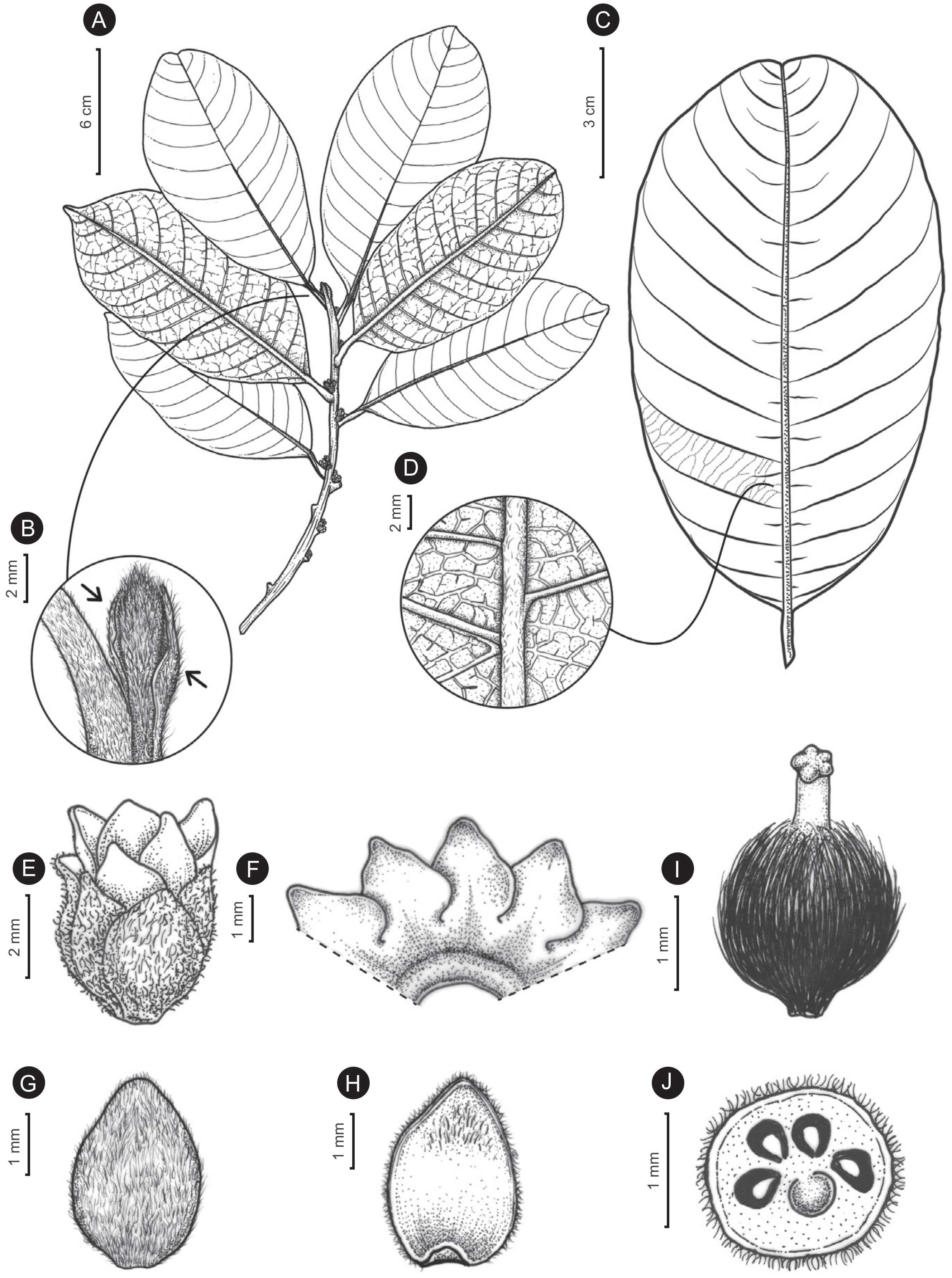

FIG. 1. *Ecclinusa nervosa*. A. Flowering branch. B. Close-up of twig apex showing stipules (arrows). C. Leaf showing the short intersecondary and oblique tertiary veins (abaxial surface). D. Close-up of reticulate high-order veins (abaxial surface). E. Flower (side view). F. Open corolla of the female flower (non-staminate). G. Sepal from the outside. H. Sepal from the inside. I. Gynoecium. J. Ovary (cross section). A–J from the holotype, *Terra-Araujo 1325B*. (Drawings: A–B and D–J by M. Del Rei; C by C. C. Vasconcelos).

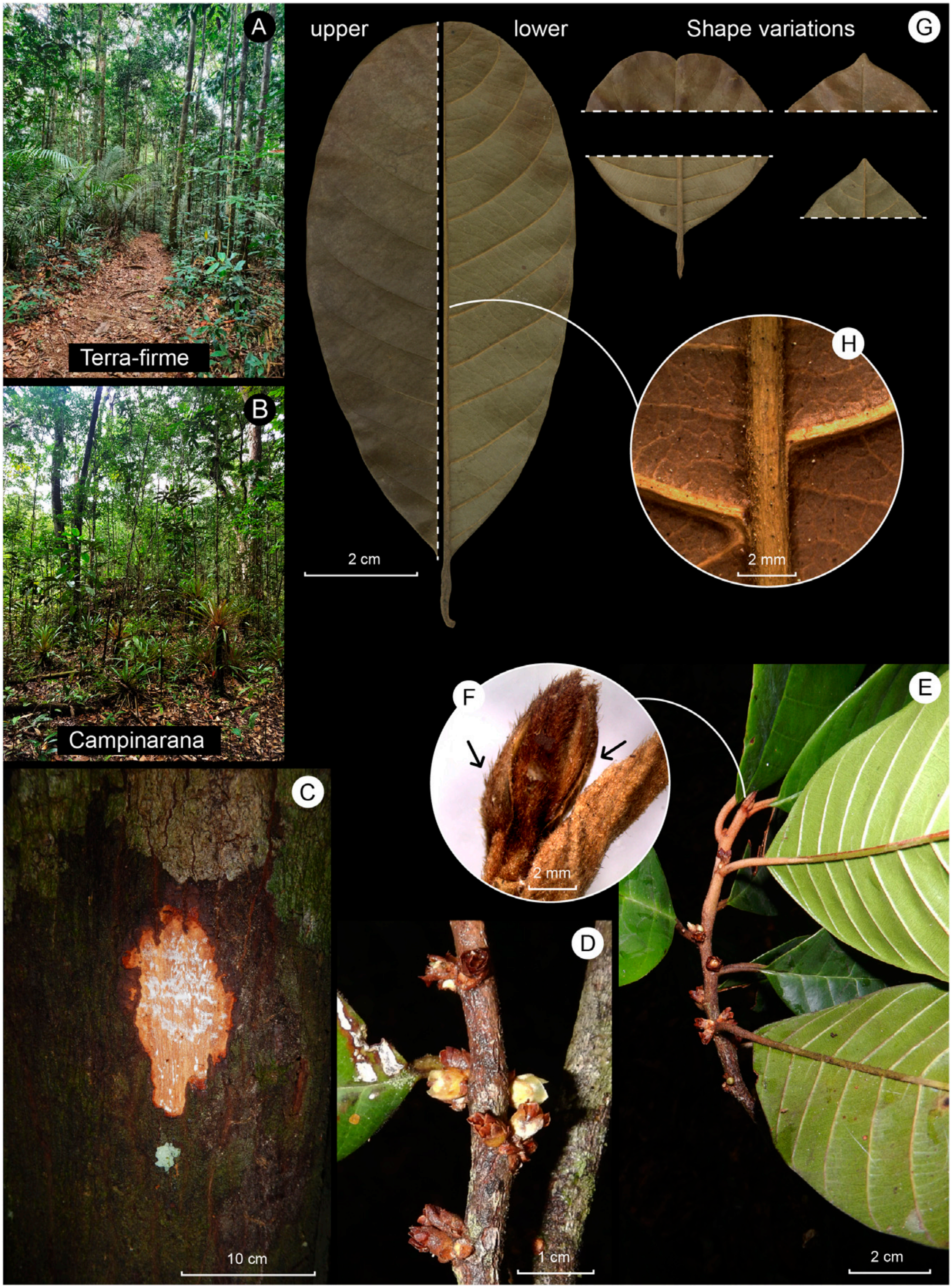

FIG. 2. A–B. Forest types on the Sussuarana trail, Presidente Figueiredo, type locality of *Ecclinusa nervosa*. C. Bark slash showing the white latex. D. Flowers. E. Flowering branch showing leaf arrangement and inflorescences. F. Close-up of twig apex showing lateral stipules (black arrows). G. Adaxial and abaxial leaf surface and shape variations of the leaf apex and base. H. Close-up of trichomes on midrib. C–H from holotype, *M. H. Terra-Araujo 1325B*. (Photos: A by J. V. Caranha; B by G. P. Calvi; C–E by M. H. Terra-Araujo; F–H by C. C. Vasconcelos).

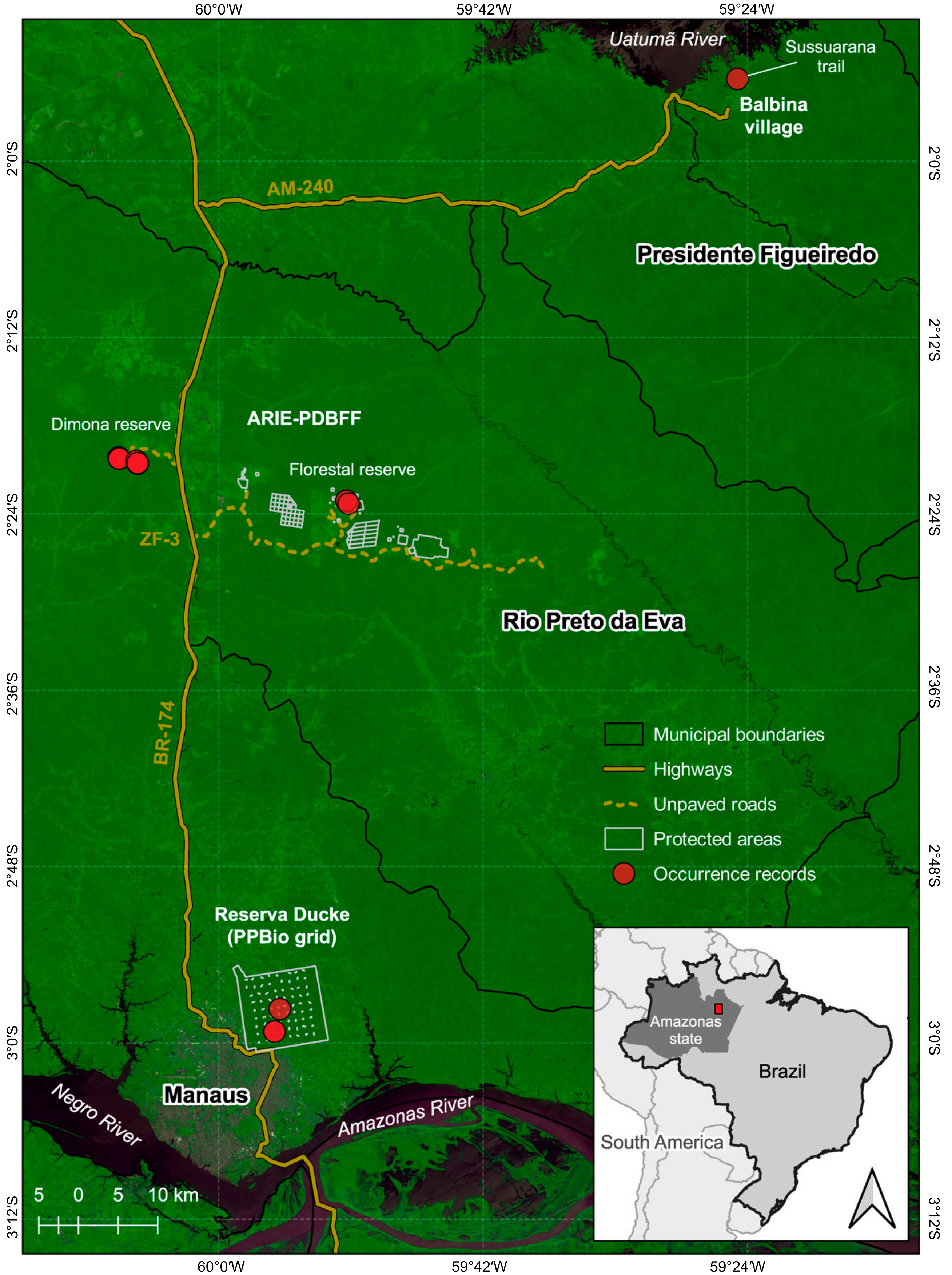

FIG. 3. Distribution of *Ecclinusa nervosa* (marked by red circles) in some permanent plots of PDBFF (Dimona and Florestal sites) and PPBio (within Reserva Ducke), and Balbina village (Sussuarana trail) along of 100 km north of Manaus region, central Amazonia. Credit: C. C. Vasconcelos.

TABLE 1. Distinctive morphological features of *Ecclinusa nervosa* and its most similar taxa (*E. ulei*, *E. parviflora*, and *E. guianensis*).

Character	*E. nervosa*	*E. ulei*	*E. parviflora*	*E. guianensis*
Indumentum on abaxial leaf surface	Golden-brown tomentulose on midrib and veins, sparser on the blade	Tomentose with very short crisped ferruginous trichomes on the blade (very contrasting color)	Shortly crisped brown pubescent on midrib and veins, sparser on the blade	Glabrous
Intersecondary veins	Present	Absent	Absent	Absent
Sepals (inner surface)	Sparsely tomentulose at the apex	Glabrous	Glabrous	Glabrous
Gynoecium	Ovary broadly globose; style 0.2–0.7 mm long	Ovary broadly ovoid or pulvinate; style 1.0–1.5 mm long	Ovary broadly ovoid; style ca. 1.0 mm long	Ovary broadly globose; style 0.7–1.0 mm long

overlap only between core specimens of *E. nervosa*, *E. guianensis* FormaA (sensu Ribeiro et al. 1999), and *E. psilophylla* (Figs. 5, S3). *Ecclinusa ulei* is the most distinct from the other species compared here, probably because it has a ferruginous indumentum on the abaxial leaf surface that strongly contrasts with the adaxial surface (vs. glabrous or glabrescent abaxial surface), which is further captured by the spectral signal of the leaves.

Unlike the morphologically similar species compared in Table 1, E. *nervosa* has a sparse tomentulose indumentum inside the sepals (Fig. 1H), which helps distinguish it from congeners. This floral feature was previously described only for *E. ramiflora* and *E. psilophylla* (Pennington 1990). The former species is widespread and morphologically variable but easily distinguished from *E. nervosa* (see the identification key), while the latter is a white-sand specialist endemic to Guyana and Suriname (Pennington 1990; ter Steege et al. 2000). We have also included core specimens of these two species in our analysis to ensure robust results in the species discrimination.

Description of *Ecclinusa nervosa* increases the number of known species of the genus to thirteen in the Neotropics. However, most species need to be better known, reinforcing the importance of continuous botanical surveys, especially in the Amazonian region, to provide sound data for taxonomic and systematic studies.

***Paratypes*—Brazil.** —AMAZONAS: Mun. Manaus. Rodovia AM-10, Manaus-Itacoatiara, km 26, Reserva Florestal Ducke, Tinga, floresta de vertente, 2°57′42.1″S, 59°55′50.5″W, 91 m, 25 Nov 1997 (fr.), *J. M. Brito et al. 47* (IAN!, INPA!, S). Rodovia BR-174, Manaus-Presidente Figueiredo, km 72, PDBFF, leste da Estrada ZF-3, Fazenda Dimona, Sítio amostral Dimona, Reserva 2206, Parcela 2206–3, Quadrante 66, 2°20′10.0″S, 60°06′49.1″W, 96.5 m, 14 Oct 1982 (fl. bud), *R.B. B. Magalhães 2206–1736* (INPA). Mun. Rio Preto da Eva. Rodovia BR-174, Manaus-Presidente Figueiredo, km 64, PDBFF, Estrada ZF-3, Fazenda Esteio, Sítio amostral Florestal, Reserva 1301, Parcela 1301–7, Quadrante 159, 2°23′18.7″S, 59°51′09.5″W, 108.7 m, 25 Sep 1986 (fl.), *N. I. Ahmad-Junior 1301–3997* (INPA).

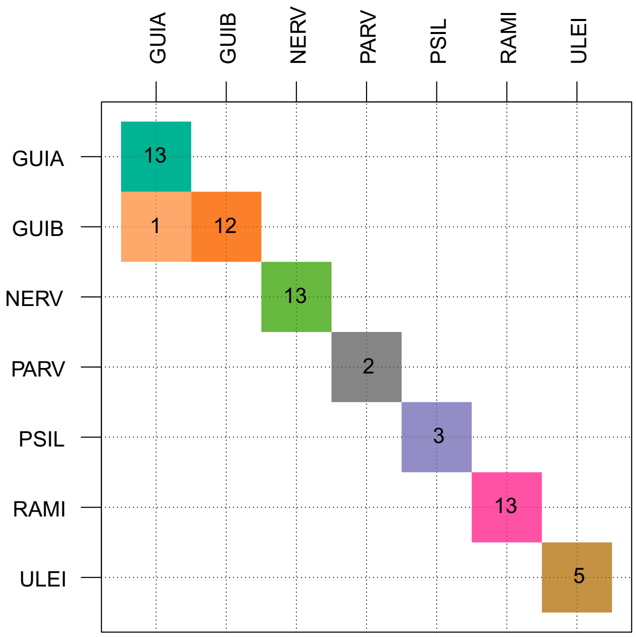

FIG. 4. Confusion matrix of inferred (rows) vs. expected (columns) species using Discriminant Analysis of Principal Components (DAPC) model to discriminate *Ecclinusa nervosa* from its similar congeners (*E. guianensis* FormaA and FormaB, *E. parviflora*, *E. psilophylla*, *E. ramiflora*, and *E. ulei*).

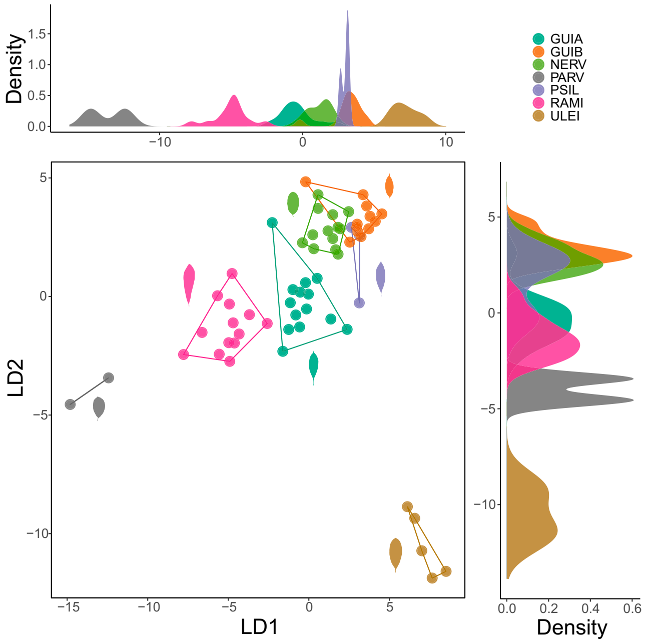

FIG. 5. Discriminant Analysis of Principal Components (DAPC) scatter plot of leaf geometric morphometrics and spectral dataset for *Ecclinusa nervosa* and its similar congeners (*E. guianensis* FormaA and FormaB, *E. parviflora*, *E. psilophylla*, *E. ramiflora*, and *E. ulei*).

Key to the *Ecclinusa* (Sapotaceae) from the Brazilian Amazonia

This key is based on vegetative characters also to facilitate the identification of sterile specimens.

1. Shrubs up to 7 m tall (already flowering when 2 m tall) 2
   2. Petioles 1.0–1.5 cm long; secondary veins of 11–14 pairs, arcuate near the margin; tertiary veins oblique or laxly reticulate .... *Ecclinusa campinae*
   2. Petioles 0.6–1.0 cm long; secondary veins of 25–40 pairs, straight; tertiary veins admedial, becoming laxly reticulate only near the margin .... *Ecclinusa lancifolia*
1. Medium to large-sized trees between 10–35 m tall (flowering when they reach more than 10 m tall) 3
   3. Leaf blade completely glabrous on both surfaces .... *Ecclinusa guianensis*
   3. Leaf blade glabrous on adaxial surface and with visible indumentum on abaxial surface 4
      4. Stipules 0.4–0.8 cm long; leaves obovate or elliptic; intersecondary veins present .... *Ecclinusa nervosa*
      4. Stipules (0.6–)0.8–3.7 cm long; leaves predominantly oblanceolate; intersecondary veins absent 5
         5. Abaxial leaf surface with sparse indumentum restricted to midrib .... *Ecclinusa lanceolata*
         5. Abaxial leaf surface with dense indumentum covering the blade, midrib, and veins 6
            6. Leaves strongly bullate .... *Ecclinusa bullata*
            6. Leaves not bullate .... *Ecclinusa ramiflora*

Acknowledgments

This paper is part of the doctoral thesis of the first author at the Programa de Pós-Graduação em Botânica (PPGBOT) of the Instituto Nacional de Pesquisas da Amazônia (INPA). The research was funded by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, finance code 001), Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM), American Society of Plant Taxonomists (ASPT), International Association for Plant Taxonomy (IAPT), Thomas Lovejoy Fieldwork Supporting Program (PDBFF), Amazon Tall Tower Observatory (ATTO), German Federal Ministry of Education and Research (BMBF; process numbers 01LK1602F and 01LK2101D), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq; Call 01/2022, process number 440166/2022-5), Universal FAPEAM (Call 006/2019), and Programa Mulher Faz Ciência (Call 006/2024, SpectraPop project). CCV received a doctoral scholarship from the CNPq (process number 142214/2018-3). We are grateful to the curators and staff of the IAN, INPA, MO, and RB herbaria, as well as the teams of the Projeto Dinâmica Biológica de Fragmentos Florestais (PDBFF) and the Centro de Estudos Integrados da Biodiversidade Amazônica (CENBAM) – Programa de Pesquisa em Biodiversidade (PPBio), for loans of collections, especially Michael Hopkins, Ana Andrade, Alberto Vicentini, and Flávia Costa. We sincerely thank Kaio da Cunha and Jaqueline Gomes for the overall support; Michella Del Rei for drawing the line art; and Jairo Caranha and Geângelo Calvi for permission to use their images. The first author also thanks the Seed Lab team at INPA for all the support provided. We are grateful to Editor-in-Chief Daniel Potter, Associate Editor Shawn Krosnick, and three anonymous reviewers for their careful reading of our manuscript and their many insightful comments and suggestions. This is contribution number 882 of the PDBFF Technical Series.

Author Contributions

CCV wrote, analyzed, and organized all parts of this manuscript. MHTA, IDKF, and JLCC supervised the first author throughout the process. MHTA collected the specimens of the new species, obtained the field images, and provided taxonomic expertise on *Ecclinusa*. FMD, FW, JS, and MTFP secured funds to acquire the spectral device. All co-authors contributed to the discussions, critically reviewed the manuscript, provided feedback, and approved the final version.

Literature Cited

Adams, D. C., F. J. Rohlf, and D. E. Slice. 2004. Geometric morphometrics: Ten years of progress following the 'revolution'. *Italian Journal of Zoology* 71: 5–16.

Alves-Araújo, A. G. 2020. A new species of *Pouteria* (Sapotaceae) from northeastern Brazil. *Phytotaxa* 461: 55–61.

Alves-Araújo, A. G. and M. Alves. 2011. Two new species of *Pouteria* (Sapotaceae) from the Atlantic Forest in Brazil. *Systematic Botany* 36: 1004–1007.

Alves-Araújo, A. G. and M. Alves. 2012a. *Pouteria ciliata*, *P. confusa*, *P. nordestinensis* and *P. velutinicarpa* spp. nov. (Sapotaceae) from Brazil. *Nordic Journal of Botany* 30: 399–406.

Alves-Araújo, A. G. and M. Alves. 2012b. Two new species and a new combination of Neotropical Sapotaceae. *Brittonia* 64: 23–29.

Alves-Araújo, A. G. and A. Z. Mônico. 2017. *Pouteria samborae*, a new species of Sapotaceae (Chrysophylloideae) from Espírito Santo, Brazil. *Systematic Botany* 42: 358–363.

Asner, G. P. and R. E. Martin. 2008. Spectral and chemical analysis of tropical forests: Scaling from leaf to canopy levels. *Remote Sensing of Environment* 112: 3958–3970.

Baehni, C. 1965. Mémoires sur les Sapotacées III. Inventaire des genres. *Boissiera* 11: 1–262.

BFG. 2015. The Brazil Flora Group. Growing knowledge: An overview of Seed Plant diversity in Brazil. *Rodriguésia* 66: 1085–1113.

Bohlman, S. A., W. F. Laurance, S. G. Laurance, H. E. M. Nascimento, P. M. Fearnside, and A. Andrade. 2008. Importance of soils, topography and geographic distance in structuring central Amazonian tree communities. *Journal of Vegetation Science* 19: 863–874.

Carvalho, T. C. R. 2017. Ecclinusa guianensis Eyma (Chrysophylloideae, Sapotaceae): Uma ou mais espécies? M.S. thesis. Manaus, Amazonas: INPA. https://repositorio.inpa.gov.br/handle/1/37630 (last accessed May 2024).

Carvalho, T. C. R., C. C. Vasconcelos, and M. H. Terra-Araujo. 2024. Testing the morphotype-based classification of two leaf shapes in Ecclinusa guianensis (Sapotaceae) from Central Amazonia. Brittonia 76: 398–410.

De Queiroz, K. 2007. Species concepts and species delimitation. *Systematic Biology* 56: 879–886.

Draper, F. C., T. R. Baker, C. Baraloto, J. Chave, F. Costa, R. E. Martin, R. T. Pennington, A. Vicentini, and G. P. Asner. 2020. Quantifying tropical plant diversity requires an integrated technological approach. *Trends in Ecology & Evolution* 35: 1100–1109.

Durgante, F. M., N. Higuchi, A. Almeida, and A. Vicentini. 2013. Species spectral signature: Discriminating closely related plant species in the Amazon with Near-Infrared Leaf-Spectroscopy. *Forest Ecology and Management* 291: 240–248.

Ellis, B., D. C. Daly, L. J. Hickey, K. R. Johnson, J. D. Mitchell, P. Wilf, and S. L. Wing. 2009. *Manual of Leaf Architecture*. Ithaca, New York: Cornell University Press.

Faria, A. D., J. R. Pirani, J. E. L. S. Ribeiro, S. Nylinder, M. H. Terra-Araujo, P. P. Vieira, and U. Swenson. 2017. Towards a natural classification of subfamily Chrysophylloideae (Sapotaceae) in the Neotropics. *Botanical Journal of the Linnean Society* 185: 27–55.

Feret, J.-B. and G. P. Asner. 2013. Tree species discrimination in tropical forests using airborne imaging spectroscopy. *IEEE Transactions on Geoscience and Remote Sensing* 51: 73–84.

Gaem, P. H., A. Andrade, F. F. Mazine, and A. Vicentini. 2022. Tree species delimitation in tropical forest inventories: Perspectives from a taxonomically challenging case study. *Forest Ecology and Management* 505: 119900.

Hadlich, H. L., F. M. Durgante, J. Santos, N. Higuchi, J. Q. Chambers, and A. Vicentini. 2018. Recognizing Amazonian tree species in the field using bark tissues spectra. *Forest Ecology and Management* 427: 296–304.

Harris, J. G. and M. W. Harris. 2001. *Plant Identification Terminology: An Illustrated Glossary*, 2nd edition. Spring Lake, Utah: Spring Lake Publishing.

Hickey, M. and C. King. 2000. *The Cambridge Illustrated Glossary of Botanical Terms.* Cambridge, England: Cambridge University Press.

Householder, J. E, F. Wittmann, J. Schöngart, M. T. F. Piedade, W. J. Junk, et al. 2024. One sixth of Amazonian tree diversity is dependent on river floodplains. *Nature Ecology & Evolution* 8: 901–911.

IUCN. 2012. International Union for Conservation of Nature. IUCN Red List Categories and Criteria. Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. http://www.iucnredlist.org/technical-documents/categories-and-criteria/ (last accessed July 2024).

IUCN. 2024. International Union for Conservation of Nature. Guidelines for using the IUCN Red List Categories and Criteria. Version 16. Prepared by the Standards and Petitions Committee. https://www.iucnredlist.org/documents/RedListGuidelines.pdf/

Jombart, T., S. Devillard, and F. Balloux. 2010. Discriminant analysis of principal components: A new method for the analysis of genetically structured populations. *BMC Genetics* 11: 94.

Junk, W. J., M. T. F. Piedade, J. Schöngart, M. Cohn-Haft, J. M. Adeney, and F. Wittmann. 2011. A classification of major naturally-occurring Amazonian lowland wetlands. *Wetlands* 31: 623–640.

Lang, C., D. R. A. Almeida, and F. R. C. Costa. 2017. Discrimination of taxonomic identity at species, genus and family levels using Fourier Transformed Near-Infrared Spectroscopy (FT-NIR). *Forest Ecology and Management* 406: 219–227.

Lima, R. G. V. N., L. F. Lima, and C. S. Zickel. 2021. *Chrysophyllum lancisepalum* (Sapotaceae, Chrysophylloideae): A new endemic species from the Brazilian Atlantic Forest. *Phytotaxa* 478: 131–140.

Lima, R. G. V. N., U. Swenson, E. B. Almeida Jr., and C. S. Zickel. 2024. *Prieurella lenticellata* sp. nov. (Sapotaceae), a new species from the Amazon rainforest. *Acta Amazonica* 54: e54bc23243.

Luize, B. G, et al. 2024. The biogeography of the Amazonian tree flora. *Communications Biology* 7: 1240.

Martius, C. F. P. 1839. Ecclinusa Ramiflora Mart. *Flora* 22: 2–3.

Meireles, J. E., J. Cavender-Bares, P. A. Townsend, S. Ustin, J. A. Gamon, A. K. Schweiger, M. E. Schaepman, G. P. Asner, R. E. Martin, A. Singh, F. Schrodt, A. Chlus, and B. C. O'Meara. 2020. Leaf reflectance spectra capture the evolutionary history of seed plants. *New Phytologist* 228: 485–493.

Oliveira, A. A. and D. C. Daly. 1999. Geographic distribution of tree species occurring in the region of Manaus, Brazil: Implications for regional diversity and conservation. *Biodiversity and Conservation* 8: 1245–1259.

Pasquini, C. 2003. Near Infrared Spectroscopy: Fundamentals, practical aspects and analytical applications. *Journal of the Brazilian Chemical Society* 14: 198–219.

Pennington, T. D. 1990. *Flora Neotropica Monograph 52: Sapotaceae.* Bronx, New York: New York Botanical Garden.

Pennington, T. D. 1991. *The Genera of Sapotaceae.* Kew, Richmond: Royal Botanic Gardens.

Pennington, T. D. 2006. Flora da Reserva Ducke, Amazonas, Brasil: Sapotaceae. *Rodriguésia* 57: 252–366.

Popovkin, A. V., A. D. Faria, and U. Swenson. 2016. *Pouteria synsepala* (Sapotaceae: Chrysophylloideae): A new species from the northern littoral of Bahia, Brazil. *Phytotaxa* 286: 39–46.

QGIS Development Team. 2022. QGIS geographic information system. Open Source Geospatial Foundation Project. http://qgis.org/ (last accessed July 2022).

Quitzau, M., R. Frelat, V. Bonhomme, C. Möllmann, L. Nagelkerke, and S. Bejarano. 2022. Traits, landmarks and outlines: Three congruent sides of a tale on coral reef fish morphology. *Ecology and Evolution* 12: e8787.

R Core Team. 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing. https://www.r-project.org/ (last accessed December 2022).

Ribeiro, J., M. Hopkins, A. Vicentini, C. Sothers, M. Costa, J. Brito, M. Souza, L. Martins, L. Lohmann, P. Assunção, E. Pereira, C. Silva, M. Mesquita, and L. Procópio. 1999. Flora Da Reserva Ducke. *Guia de Identificação Das Plantas Vasculares de Uma Floresta de Terra-Firme Na Amazônia Central.* Manaus, Amazonas: INPA, DFID.

Sobreira, P. H. M. 2018. Riqueza e Composição de Briófitas e Pteridófitas entre Campinarana e Terra Firme em Duas Localidades na Amazônia Central. M.S. thesis. Manaus, Amazonas: INPA. https://repositorio.inpa.gov.br/handle/1/12746 (last accessed May 2022).

Sossai, B. G., G. Viégas-Aquije, F. A. R. Santos, and A. G. Alves-Araújo. 2017. A new species of *Chrysophyllum* (Sapotaceae) from the Brazilian Atlantic Forest. *Phytotaxa* 331: 131–136.

Stasinski, L., D. M. White, P. R. Nelson, R. H. Ree, and J. E. Meireles. 2021. Reading light: Leaf spectra capture fine-scale diversity of closely related, hybridizing arctic shrubs. *New Phytologist* 232: 2283–2294.

Swenson, U. and A. A. Anderberg. 2005. Phylogeny, character evolution, and classification of Sapotaceae (Ericales). *Cladistics* 21: 101–130.

Swenson, U., J. E. Richardson, and I. V. Bartish. 2008. Multi-gene phylogeny of the pantropical subfamily Chrysophylloideae (Sapotaceae): Evidence of generic polyphyly and extensive morphological homoplasy. *Cladistics* 24: 1006–1031.

Swenson, U., B. Lepschi, P. P. Lowry, II, M. H. Terra-Araujo, K. Santos, S. Nylinder, and A. Alves-Araújo. 2023. Reassessment of generic boundaries in Neotropical Chrysophylloideae (Sapotaceae): Eleven reinstated genera and narrowed circumscriptions of *Chrysophyllum* and *Pouteria*. *Taxon* 72: 307–359.

ter Steege, H., M. J. Jansen-Jacobs, and V. K. Datadin. 2000. Can botanical collections assist in a National Protected Area Strategy in Guyana? *Biodiversity and Conservation* 9: 215–240.

ter Steege, H., N. C. A. Pitman, I. L. do Amaral, L. de Souza Coelho, et al. 2023. Mapping density, diversity and species-richness of the Amazon tree flora. *Communications Biology* 6: 1130.

Terra-Araujo, M. H., A. D. Faria, and A. Vicentini. 2012. A new species of *Pradosia* (Sapotaceae) from central Amazonia. *Brittonia* 64: 139–142.

Terra-Araujo, M. H., A. D. Faria, A. G. Alves-Araujo, and M. Alves. 2013. *Pradosia restingae* sp. nov. from the Atlantic Forest, Brazil. *Nordic Journal of Botany* 31: 437–441.

Terra-Araujo, M. H., F. M. Costa, R. B. Carvalho, and A. Vicentini. 2015. *Ecclinusa campinae* (Sapotaceae), a new species from the middle Rio Negro region, Amazonas, Brazil. *Brittonia* 67: 180–184.

Thiers, B. M. 2024 (continuously updated). Index Herbariorum: A global directory of public herbaria and associated staff. http://sweetgum.nybg.org/ih/ (last accessed May 2024.

Vasconcelos, C. C., M. U. Adrianzén, J. L. C. Camargo, and M. H. Terra-Araujo. 2020. *Pouteria kossmanniae* (Sapotaceae): A new species from central Amazonia, Brazil. *Phytotaxa* 447: 265–275.

Vasconcelos, C. C., I. D. K. Ferraz, M. U. Adrianzén, J. L. C. Camargo, and M. H. Terra-Araujo. 2021. *Chromolucuma brevipedicellata* (Sapotaceae, Chrysophylloideae), a new tree species from central Amazonia, Brazil. *Brittonia* 73: 211–219.

Table S1. List of specimens used in the multivariate analysis. Herbarium acronyms follow Thiers (2024). Specimens also include reference collections from permanent plots of PPBio (Programa de Pesquisa em Biodiversidade) and PDBFF (Projeto Dinâmica Biológica de Fragmentos Florestais), specifically: PPBio-BR319 (samples collected along the BR-319 highway), PPBio-RFAD (samples from Reserva Ducke), and PDBFF (samples from some sampling sites). *leg. ign.* refers to the Latin abbreviation *legit ignotus*, meaning "unknown collector". PFRD refers to the Reserva Ducke Flora Project, where Ribeiro et al. (1999) recognized two informal morphotypes in *Ecclinusa guianensis*.

N	Group	Code	Voucher	Collection
1	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*leg. ign. MO6TN3500-232*	PPBIO-BR319
2	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*leg. ign. MO4TN0500-452*	PPBIO-BR319
3	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*leg. ign. MO9TS2500-467*	PPBIO-BR319
4	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*leg. ign. MO6TN0500-49*	PPBIO-BR319
5	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*leg. ign. MO9TS2500-577*	PPBIO-BR319
6	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*Assunção 503*	INPA
7	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*Castilho LO2-0000–7826*	PPBIO-RFAD
8	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*Coêlho INPA1094*	INPA
9	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*Ferreira 57–16*	INPA
10	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*Ferreira 57–34*	INPA
11	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*Ferreira 57–5*	INPA
12	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*Terra-Araujo 1148*	Fieldwork
13	*Ecclinusa guianensis* FormaA-PFRD	GUIA	*Terra-Araujo 1149*	Fieldwork
14	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Blanco 531*	MO
15	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Carvalho-Sobrinho 1644*	INPA
16	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Castro 1850*	RB
17	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Davidse 16,325*	MO
18	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Evans 3155*	MO
19	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Fróes 22,977*	IAN
20	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Irwin 47,967*	IAN
21	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Marcano-Berti 282*	MO
22	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Marcano-Berti 523*	MO
23	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Mori 20,671*	INPA
24	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Nascimento 60*	INPA
25	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Ribeiro 19*	IAN
26	*Ecclinusa guianensis* FormaB-PFRD	GUIB	*Vasconcelos 188*	Fieldwork
27	*Ecclinusa nervosa* sp. nov.	NERV	*Martins 1301–48*	PDBFF
28	*Ecclinusa nervosa* sp. nov.	NERV	*Ahmad-Junior 1301–3997*	INPA
29	*Ecclinusa nervosa* sp. nov.	NERV	*Magalhães 2206–1736*	INPA
30	*Ecclinusa nervosa* sp. nov.	NERV	*Menezes 2206–2465*	PDBFF
31	*Ecclinusa nervosa* sp. nov.	NERV	*Pereira 2303–2157*	PDBFF
32	*Ecclinusa nervosa* sp. nov.	NERV	*Silva 2303–5249*	PDBFF
33	*Ecclinusa nervosa* sp. nov.	NERV	*Pereira 2303–6172*	PDBFF
34	*Ecclinusa nervosa* sp. nov.	NERV	*Menezes 2206–2574*	PDBFF
35	*Ecclinusa nervosa* sp. nov.	NERV	*Silva 2303–4854*	PDBFF
36	*Ecclinusa nervosa* sp. nov.	NERV	*Castilho LO8-2500–11076*	PPBIO-RFAD
37	*Ecclinusa nervosa* sp. nov.	NERV	*Castilho LO8-2500–11198*	PPBIO-RFAD
38	*Ecclinusa nervosa* sp. nov.	NERV	*Brito 47*	INPA
39	*Ecclinusa nervosa* sp. nov.	NERV	*Terra-Araujo 1325B*	Fieldwork
40	*Ecclinusa parviflora*	PARV	*Gentry 36,586*	MO
41	*Ecclinusa parviflora*	PARV	*Vásquez 2032*	MO
42	*Ecclinusa psilophylla*	PSIL	*Lindeman 390*	MO
43	*Ecclinusa psilophylla*	PSIL	*Lindeman 789*	INPA
44	*Ecclinusa psilophylla*	PSIL	*Sandwith 281*	RB
45	*Ecclinusa ramiflora*	RAMI	*Amaral 716*	INPA
46	*Ecclinusa ramiflora*	RAMI	*Coêlho 1958*	INPA
47	*Ecclinusa ramiflora*	RAMI	*Ducke 1073*	IAN
48	*Ecclinusa ramiflora*	RAMI	*Fróes 20,259*	IAN
49	*Ecclinusa ramiflora*	RAMI	*Lanjouw 2221*	IAN
50	*Ecclinusa ramiflora*	RAMI	*Maguire 60,094*	IAN
51	*Ecclinusa ramiflora*	RAMI	*Monteiro INPA53465*	INPA
52	*Ecclinusa ramiflora*	RAMI	*Pires 12,988*	IAN
53	*Ecclinusa ramiflora*	RAMI	*Prance 7691*	INPA
54	*Ecclinusa ramiflora*	RAMI	*Schultes 26142A*	INPA
55	*Ecclinusa ramiflora*	RAMI	*Silveira 702*	INPA
56	*Ecclinusa ramiflora*	RAMI	*Sperling 6285*	MO
57	*Ecclinusa ramiflora*	RAMI	*Terra-Araujo 740*	RB
58	*Ecclinusa ulei*	ULEI	*Berry 4842*	MO
59	*Ecclinusa ulei*	ULEI	*Perdiz 3680*	Fieldwork
60	*Ecclinusa ulei*	ULEI	*Steyermark 109,285*	MO
61	*Ecclinusa ulei*	ULEI	*Steyermark 127,975*	MO
62	*Ecclinusa ulei*	ULEI	*Steyermark 97,984*	IAN

TABLE S2. List of add-on packages used in our study.

Package	Authorship	Identifier
Data preparation		
asdreader	Roudier and Laliberté (2017)	https://doi.org/10.32614/CRAN.package.asdreader
dplyr	Wickham et al. (2023)	https://doi.org/10.32614/CRAN.package.dplyr
EBImage	Pau et al. (2010)	https://doi.org/10.18129/B9.bioc.EBImage
Momocs	Bonhomme and Claude (2023)	https://doi.org/10.32614/CRAN.package.Momocs
Data analysis		
adegenet	Jombart et al. (2023)	https://doi.org/10.32614/CRAN.package.adegenet
caret	Kuhn et al. (2023)	https://doi.org/10.32614/CRAN.package.caret
ConR	Dauby et al. (2017)	https://doi.org/10.1002/ece3.3704
factoextra	Kassambara and Mundt (2020)	https://doi.org/10.32614/CRAN.package.factoextra
Data visualization		
ggConvexHull	Martin (2017)	https://github.com/cmartin/ggConvexHull
ggplot2	Wickham et al. (2024)	https://doi.org/10.32614/CRAN.package.ggplot2
gridExtra	Auguie and Antonov (2017)	https://doi.org/10.32614/CRAN.package.gridExtra
NIRtools	Perdiz (2021)	https://github.com/ricoperdiz/NIRtools

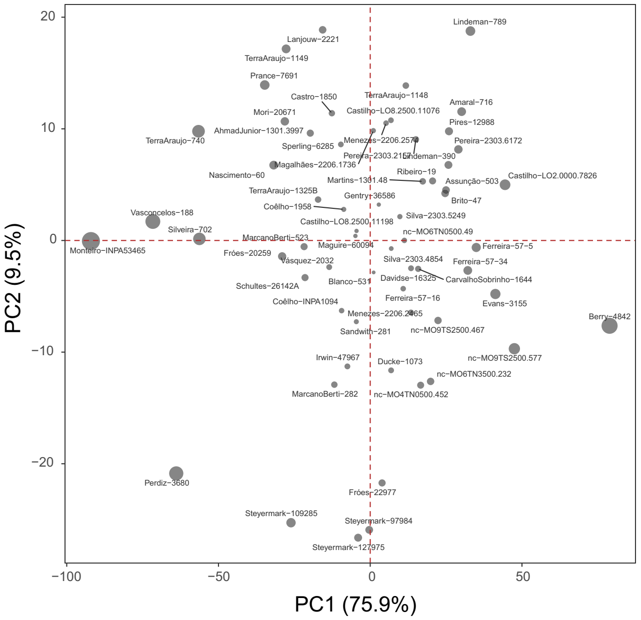

FIG. S1. Principal Component Analysis (PCA) scatter plot based on geometric morphometrics and spectral dataset. Gray circles refer to the core specimens of *Ecclinusa nervosa* and its similar congeners (*E. guianensis*, *E. parviflora*, *E. psilophylla*, *E. ramiflora*, and *E. ulei*). The size of the gray circles represents the individual contribution regarding PCA.

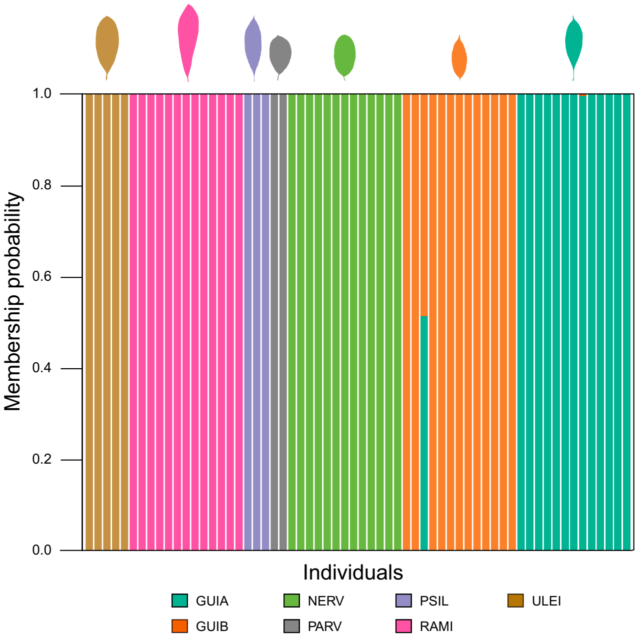

FIG. S2. Membership probability from Discriminant Analysis of Principal Components (DAPC), where each vertical-colored bar represents an individual specimen and mixture groups refer to the incongruity between membership posterior assignments.

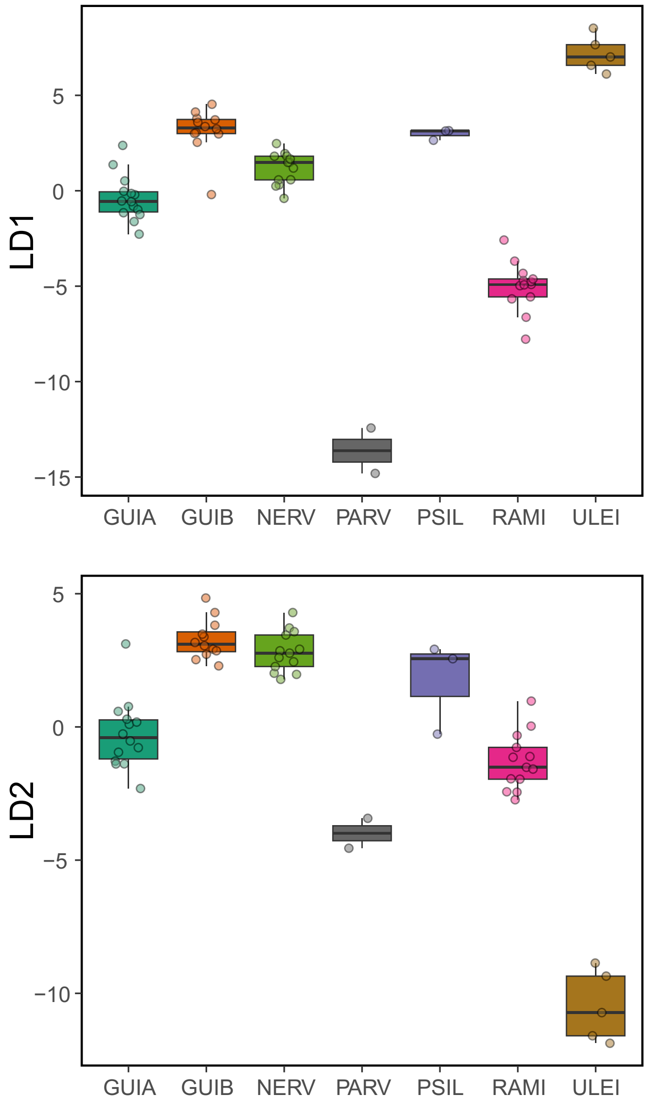

FIG. S3. Comparisons of *Ecclinusa nervosa* and its similar congeners by the first two Linear Discriminant axes (LD1) and (LD2) from Discriminant Analysis of Principal Components (DAPC).