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Article

A Palynological Atlas of the Amazon *canga* Vegetation

Luiza Araújo Romeiro ¹, Edilson Freitas da Silva ¹, Luiza Santos Reis ¹,
Léa Maria Medeiros Carreira ², Tarcísio Magevski Rodrigues ³, Delmo Fonseca da Silva ⁴,
Tereza Cristina Giannini ¹, Markus Gastauer ¹, Pedro Walfir Martins e Souza-Filho ⁵,
Lourival Tyski ⁶ and José Tasso Felix Guimarães ^{1,*}

¹ Vale Institute of Technology, Rua Boaventura da Silva 955, Nazaré 66055-090, Belém, PA and Brazil

² Museu Paraense Emílio Goeldi, Departamento de Botânica, Terra Firme 66040-170, Belém, PA, Brasil

³ WSP Brasil, Rua Antônio de Albuquerque 194, 7 andar, Funcionários 30112-010, Belo Horizonte, MG, Brazil

⁴ Independent researcher, Rua Benjamin 454 – Betânia, 68515-000, Parauapebas, PA, Brazil

⁵ Universidade Federal do Pará, Geosciences Institute, Belém, 66075-110, Brazil

⁶ Gerência de Meio Ambiente – Minas de Carajás, Departamento de Ferrosos Norte, Estrada Raymundo Mascarenhas, S/N Mina de N4, 68516 000, Parauapebas, Pará, Brasil

* Correspondence: tasso.guimaraes@itv.org

Abstract: *Canga* formations are ancient ecosystems characterized by high levels of endemic and threatened plant species that thrive on iron-rich substrates in the Southeastern Amazon uplands. Recent taxonomic validation of these species enables more accurate distribution modeling across past, present, and future time scales. This work presents a comprehensive palynological database for the Amazon *canga* vegetation, resulting from extensive field and herbarium surveys, as well as the compilation and taxonomic validation of species in the Carajás Mountain Region (CMR). The atlas includes 204 plant species: 10 ferns and lycophytes, 62 monocots, and 132 eudicots and magnoliids, mainly herbs, lianas, and trees. Most flowering plants are pollinated by bees, with secondary pollination by insects and wind. The taxa co-occur in two geoenvironments: (1) forested slopes and caves over plinthosols and ferralsols and (2) slopes with *canga* vegetation over plinthosols. Seventeen species are potential domesticates used by indigenous peoples. This highlights *canga* vegetation as a unique and diverse ecosystem with various survival strategies, emphasizing the need for precise habitat definitions in paleoenvironmental and paleoclimate reconstructions. The atlas provides a valuable reference for palynological studies, enhancing vegetation reconstruction, climate history analysis, pre-Columbian influences on vegetation patterns, and ecological monitoring.

Keywords: *Canga* vegetation; Carajás; palynology; Amazonia; pollen; spores

1. Introduction

Amazonia is often cited as having the most diverse flora on the planet [1–3], which includes mountain areas with small surface area but with a fascinating endemism [4]. However, these regions are seriously threatened by extensive land use and land cover changes that have occurred over the past few decades [5,6]. In fact, the flora of these areas presents a great variety of endangered, endemic and rare taxa in conjunction with species diversity representing a highly relevant reserve of biodiversity for the global prioritization of conservation efforts [7], defined as Key Biodiversity Areas – KBAs [8].

From the 149 KBAs identified within the Amazon Rainforest biome, Carajás Mountain Range – CMR, in the southeastern Amazonia presents 10 rare species [9]. The CMR hosts one of the largest mineral provinces in the world [10], with mountain tops covered by herbaceous and shrubby montane savanna (*canga* vegetation) associated with lateritic outcrops at 600-800m altitude, which

are surrounded by rainforests on mountain slopes [11,12]. *Canga* vegetation occupied an area of 144.2 km² in the CMR in 1973, before the implementation of the Carajás N4-N5 open pit mines and up to 2016, 22 km² of *canga* vegetation was suppressed in response to iron ore exploitation [13]. Analogous to the south-western Australian Banded Iron Formations (BIFs), the *canga* formations in Brazil are considered ancient ecosystems, characterized by a rich flora associated with the weathering of the iron-rich substrate [14–17]. In both countries, such areas provide unique island-like environments with high levels of species turnover between different sites, high levels of endemism and rare geographically restricted species [16–20].

Based on a huge effort for collect, compile, and taxonomic validation of plant species from 2015 to 2018 during the Flora of Carajás project, a certified list of 856 species of seed plants and 186 species of ferns and lycophytes were made available online [16,17]. From these lists, three monotypic genera and thirty-eight species were reported as endemic [4]. This presents a significant opportunity to create a comprehensive palynological database for the Amazon *canga* vegetation. Indeed, a certified pollen database integrated by a precise morphological description favored the development of palynotaxonomic (Convolvulaceae; [21] Poaceae; [22], melissopalynological (Honey pollen samples of *Melipona seminigra pernigra* Moure & Kerr 1950; [23]), pollen loads from bee specimens deposited in biological collections [24], and paleoecological (lake sediments; [25–30]. Pollen and spores from bat guano found in the Carajás caves [31,32] enhance our understanding of the area's ecology. However, significant effort is needed for identification at the lowest taxonomic levels. This is highly necessary to (1) develop accurate pollen interaction networks based on floral visitors, (2) precisely describe the paleobiogeographic patterns of *canga* vegetation, and (3) model Quaternary paleohydrology and paleoclimate based on palynological data. Consequently, this work aims to create an illustrated and descriptive pollen atlas, serving as a valuable tool for researchers worldwide who wish to further explore the palynology of Amazon *canga* vegetation.

Study Area

The CMR is situated in the Carajás Mineral Province (Figure 1a, b), i.e., is a major Neoproterozoic tectonic province of the Amazonian Craton, where banded iron formations and metavolcano-sedimentary sequences represent the middle-upper geological succession of this province [33]. The iron-rich deposits were formed during successive weathering events of these rocks in the Cretaceous-Paleogene transition, which occurred under humid paleoclimate conditions allowing the formation of extensive mature lateritic profiles [34,35].

These crusts contain a variety of geoenvironments with unique geological, geomorphological, and pedological characteristics, which influence nutrient availability and energy flows within an essentially open system [12], as follow (Figure 1 b-d): (1) slopes with rupestrian *canga* vegetation over plinthosols, (2) forested slopes and caves over plinthosols and ferralsols, (3) poorly drained depressions and levels covered by grasslands over plinthosols and histosols, as well as, (4) doliniform lakes with organic mud sediment at the bottom.

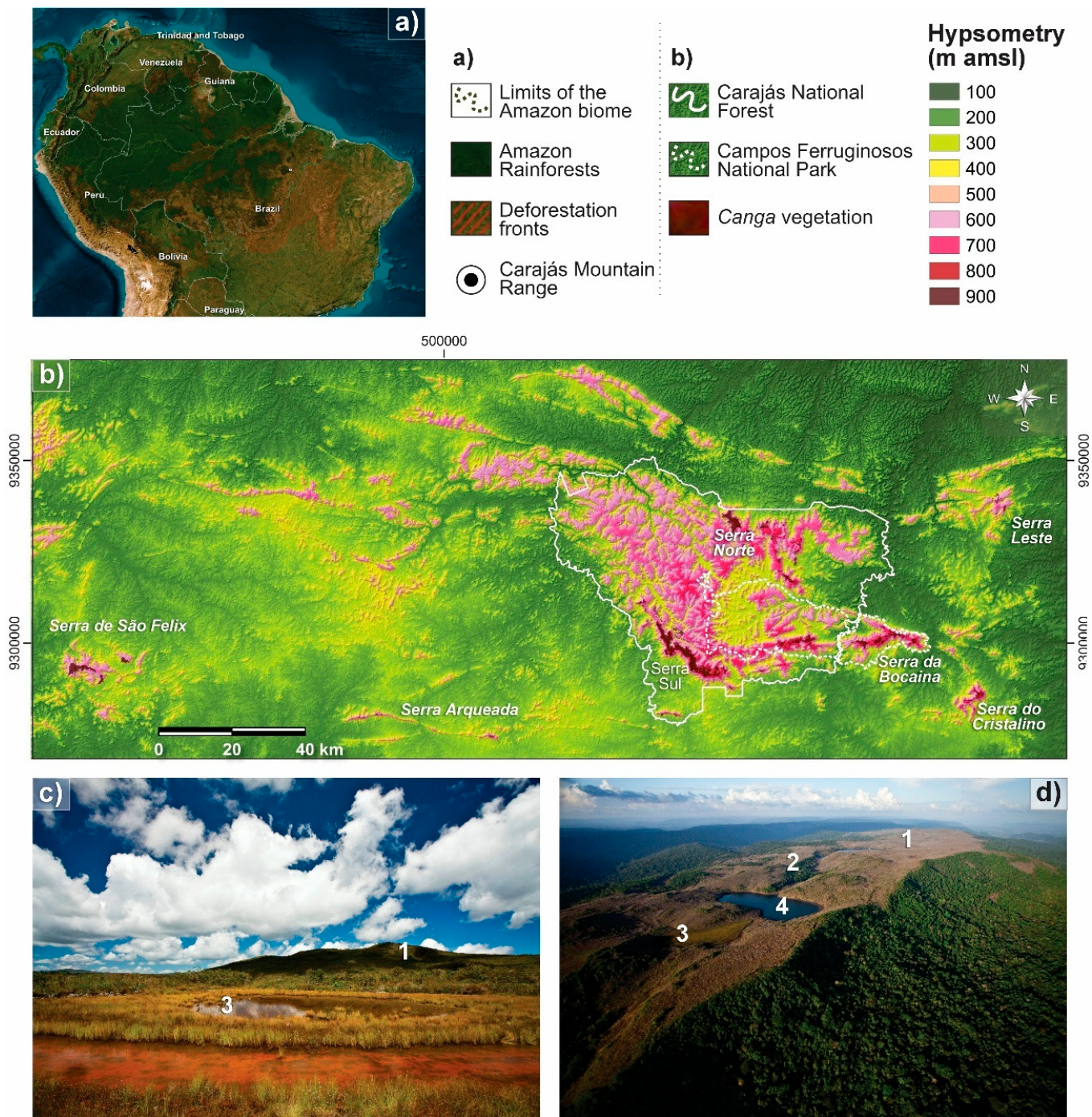


Figure 1. The study site location. (a) the location within South America, highlighting the deforestation fronts in the Amazon Biome from 2014 to 2020 [36], which have exerted greater pressure on the southeastern region; (b) the distribution of *canga* outcrops along the Carajás Mountain Range – CMR [37], particularly within law-protected areas such as the Carajás National Forest and the Campos Ferruginosos National Park; Hypsometry in meters above mean sea-level (amsl); (c) and (d), front view and aerial photographs, respectively, of the *Canga* geoenvironments (by João M. Rosa); 1: slopes with rupestrine *canga* vegetation over plinthosols; 2: forested slopes and caves over plinthosols and ferralsols; 3: poorly drained depressions and levels covered by grasslands over plinthosols and histosols; 4: doliniform lakes with organic mud sediment at the bottom.

The climate is characterized by two distinct seasons: a rainy season and a dry season [38]. During the rainy season, which lasts from November to May, total rainfall ranges from 1,545 mm to 1,863 mm. In contrast, the dry season, occurring from June to October, receives between 159 mm and 321 mm of rainfall. The average recorded temperature is 27.2 °C, with a minimum of 26.6 °C in January and a maximum of 28.1 °C in September [39].

2. Material and Methods

The examined specimens are stored in the herbaria of the Museu Paraense Emílio Goeldi (MPEG), Bioparque Vale Amazônia (HCJS), and Instituto Nacional de Pesquisas da Amazônia (INPA). Mature flower buds were extracted from the exsiccate collections and treated using standard pollen preparation methods. This included extracting flower buds before anthesis from duplicate specimens, followed by fixation in acetic acid and acetolysis [40]. For light microscopy, the pollen was mounted in glycerol jelly and sealed with paraffin [40,41]. All prepared slides were deposited in the Palinoteca of the Instituto Tecnológico Vale (PALIITV). Subsequently, the grains were examined, measured, and photographed using a Zeiss AXIO Imager M2 microscope with a Pan-APOCHROMAT 20x, 40x and 100x objective. The descriptive palynology terminology used in this study follows [42].

Main morphological parameters are abbreviated, as follows: polar diameter (P); equatorial diameter (E) or simply diameter (D). The types are grouped into Ferns and Lycophytes, Monocots, Eudicots and Magnoliids. Within each group, plant families are alphabetically organized according to [43] and [44], as well as their corresponding Species. Species names, life forms and habitats were verified by consulting the Brazilian Species database of the Flora of Carajás project [16] and REFLOA [45]. The geoenvironments terminology of [12] were applied according to the habitats and geographic coordinates of each species available in the cited database. Pollination syndromes according to [46], degree of domestication [47] and main uses [48] were also included (Table S1).

3. Results

Ferns and Lycophytes present 10 species, 8 genera, and 5 families of the Polypodiales Link, Hort. Bterol., and 2 species of Isoëtales Prantl, Leherb. Monocots are represented by 6 orders, encompassing 12 families, 36 genera, and 63 species. Magnoliids order is only represented by 2 species and genera of the Annonaceae Juss. Eudicots are the most representative of this pollen atlas with 130 Species, 91 genera, and 38 families. Table S1 provides a summary of the plant species from the *canga* vegetation whose pollen and spore grains are described in this atlas.

Description of Spores and Pollen

FERNS AND LYCOPHYTES

Order: Polypodiales Link

Family: Aspleniaceae Newman

Species: Asplenium serratum L. (Figure 2: 1-2)

Herbarium number: HCJS 1548

Description: Spores single, bilaterally symmetrical, elliptical and with rounded ends; monolete, laesura straight, margo narrow; sclerine ~ 3µm thick, exospore distinct, laevigate to scabrate with thin and irregular undulating membrane, resembling a hamulate pattern. E: 50.6-56 µm; P: 29-39 µm.

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Polypodiales Link

Family: Blechnaceae Newman

Species: Blechnum polypodioides Raddi (Figure 2: 3-4)

Herbarium number: HCJS 4365

Description: Spores single, bilaterally symmetrical, elliptical and with rounded ends; monolete, laesura straight, margo 2-3 µm thick, protruding; exospore laevigate to microreticulate. E: 36-47.6 µm; P: 28-34 µm.

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Family: Dennstaedtiaceae Lotsyaz

Species: *Pteridium esculentum* (G. Forst.) Cockayne (Figure 2: 5-6)

Herbarium number: BHCB 601

Description: Spores single, heteropolar, elliptical and with rounded ends; monolete, laesura indistinct; exospore 1.5-2.4 μm thick, densely rugulate. E: 34-41 μm ; P: 30.4-35 μm .

Life form: Herb.

Geoenvironment: Upland anthropic areas.

Order: Isoëtales C.Agardh

Family: Isoëtaceae Rchb.f.

Species: *Isoëtes cangae* J.B.S.Pereira, Salino & Stützel (Figure 2: 7-8)

Herbarium number: HCJS 6277

Description: Spores single, heteropolar, elliptical with pointed ends; monolete, laesura straight, without prominent invagination; perispore microechinate in proximal view and microechinate to tuberculate in distal view. E: 30-34 μm ; P: 23-29 μm .

Life form: Herb.

Geoenvironment: Doliniform lakes; Amendoim Lake, S11D, active lake

Species: *Isoëtes serracarajensis* J.B.S.Pereira, Salino & Stützel (Figure 2: 9-10)

Herbarium number: HCJS 5433

Description: Spores single, heteropolar, elliptical with pointed ends; monolete, laesura straight, without prominent invagination; perispore laevigate in proximal view and microechinate to tuberculate in distal view. E: 30-37 μm ; P: 25-30 μm .

Life form: Herb

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Order: Polypodiales Link

Family: Pteridaceae E.D.M.Kirchn.

Species: *Hemionitis palmata* L. (Figure 2: 11,12)

Herbarium number: HCJS 1465

Description: Spores single, radially symmetrical, triangular-obtuse-convex, rounded corners; trilete; curvature absent, margo indistinct, commissure straight; endospore 1 μm thick; exospore 1 μm thick, densely echinate, echinae 1-2 μm height. P: 30-35.4 μm ; E: 27-31 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Pteris denticulata* Sw. (Figure 2: 13-14)

Herbarium number: HCJS 1007

Description: Spores single, radially symmetrical, triangular-obtuse-straight, rounded corners; curvature absent, commissure curved, margo ~3 μm thick, very distinct; endospore 1 μm thick, exospore 1 μm thick, cingulate, cingulum about 4-5 μm thick and likely varying in thickness until radial area, densely hamulate. P: 45-53 μm ; E: 28-35 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Pteris pungens* Willd. (Figure 2: 15-16)

Herbarium number: HCJS 1559

Description: Spores single, radially symmetrical, triangular-obtuse-straight to convex, rounded corners; margo indistinct, commissure straight; endospore indistinct, exospore 1 μm thick, cingulate, cingulum about 5 μm thick and not varying in thickness, verrucate to hamulate. E: 50-53 μm ; P: 40-47 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Family: Thelypteridaceae Pic.Serm.

Species: *Christella hispidula* (Decne.) Holttum (Figure 2: 17-18)

Herbarium number: HCJS 4775

Description: Spores single, bilaterally symmetrical, elliptical and with rounded ends; monolete, laesura straight to curved, margo indistinct; sclerine ~ 2-3 μm thick, exospore distinct, laevigate to hamulate. E: 35-39.2 μm ; P: 24-26.2 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Cyclosorus interruptus* (Willd.) H. Ito (Figure 2: 19-20)

Herbarium number: HCJS 3009

Description: Spores single, bilaterally symmetrical, elliptical and with rounded ends; monolete, laesura straight to curved, margo indistinct; exospore densely hamulate-baculate, 2 μm thick. E: 54-65 μm ; P: 36-37.3 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

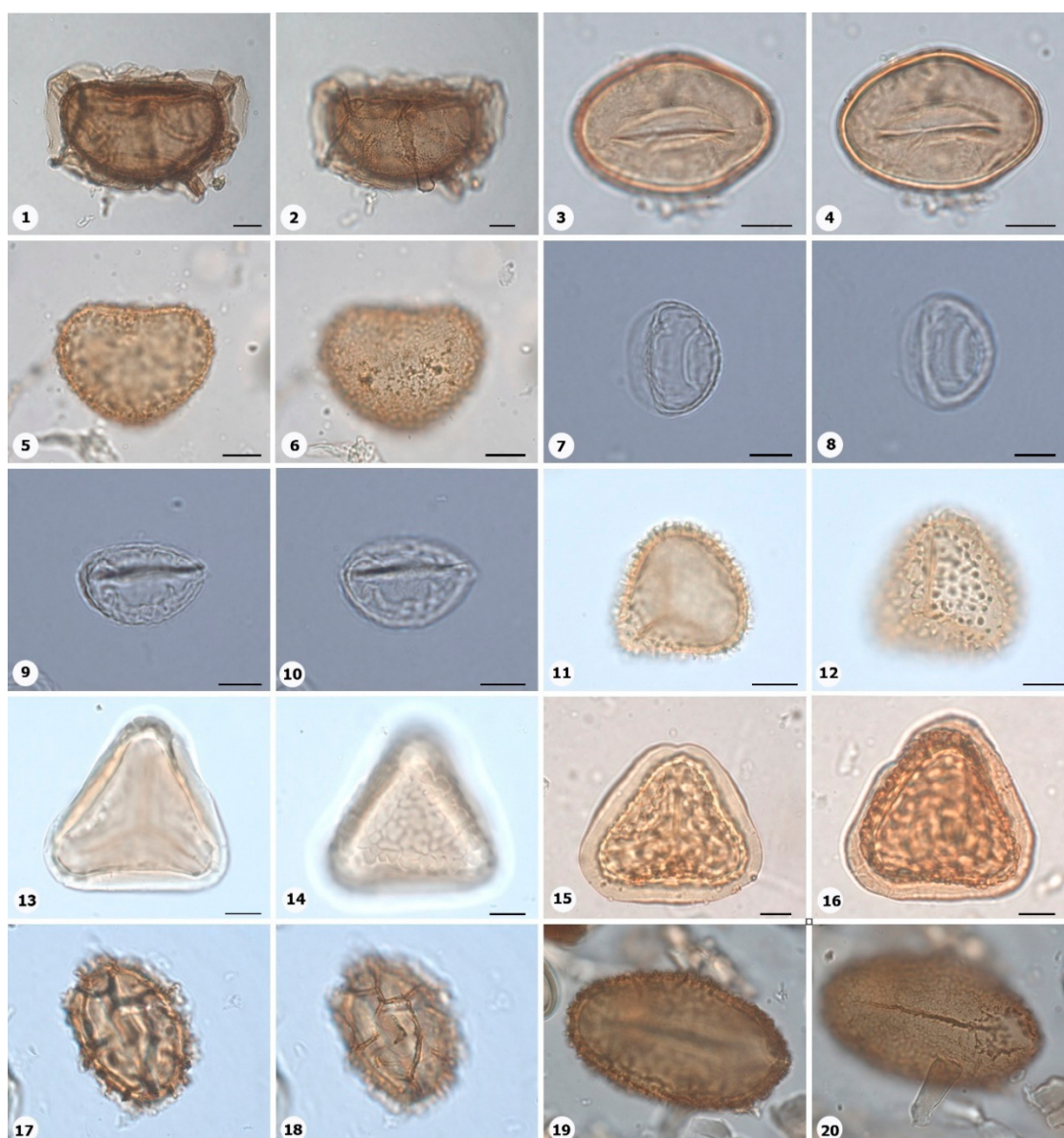


Figure 2. Ferns and Lycophytes. 1-2: *Asplenium serratum* 3-4: *Blechnum polypodioides*; 5-6: *Pteridium esculentum*; 7-8: *Isoetes cangae*; 9-10: *Isoetes serracarajasensis*; 11-12: *Hemionitis palmata*; 13-14: *Pteris denticulata*; 15-16: *Pteris pungens*; 17-18: *Christella hispidula*; 19-20: *Cyclosorus interruptus*. Scale: 10 μm .

MONOCOTS

Order: Alismatales R. Br. ex Bercht. & J. Presl

Family: Araceae Juss.

Species: *Philodendron wulfschlaegelii* Schott (Figure 3: 1-2)

Herbarium number: MG 214008

Description: Monads, large, heteropolar; monocolpate, marginate; amb elliptical, oblate; exine 1.2 μm thick, tectate, ornamentation striate. E: 48-57 μm , P: -37-41.5 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Arecales Bromhead

Family: Arecaceae Bercht. & J.Presl.

Species: *Acrocomia aculeata* (Jacq.) Lodd. ex Mart. (Figure 3: 3-4)

Herbarium number: HCJS 0646

Description: Monad, large, heteropolar; trichotomosulcate, marginate; amb triangular-obtuse-concave, oblate spheroidal; exine 7.3 μm thick, tectate, ornamentation microreticulate. E: 83-92 μm , P: 79-89 μm .

Life form: Palm.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Attalea maripa* (Aubl.) Mart (Figure 3: 5-6)

Herbarium number: HCJS 0383

Description: Monad, large, heteropolar; monosulcate, marginate; amb elliptical, prolate to perprolate; exine 2.6 μm thick, tectate, ornamentation microreticulate. P: 44-51 μm , E: 26.7-30.8 μm .

Life form: Palm.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Euterpe oleraceae* Mart. (Figure 3: 7-8)

Herbarium number: HCJS 0272

Description: Monad, large, heteropolar; monosulcate with a slight margo; amb elliptical with acute ends, perprolate; exine 1 μm thick, tecta indistinct, ornamentation microreticulate. P: 55-60 μm , E: 24-27 μm .

Life form: Palm.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, doliniform lakes with organic mud sediment at the bottom.

Species: *Oenocarpus distichus* Mart. (Figure 3: 9-10)

Herbarium number: HCJS 0370

Description: Monad, medium, heteropolar; trichotomosulcate with a slight margo; amb triangular-obtuse-concave, perprolate; exine 2-2.3 μm thick, tectate, ornamentation microreticulate. P: 47-55 μm , E: 24-31 μm .

Life form: Palm.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Socratea exorrhiza* (Mart.) H.Wendl. (Figure 3: 11-12)

Herbarium number: HCJS 1433

Description: Monad, large, apolar; monosulcate; circular, prolate; exine 3.5-5 μm thick, tectate, ornamentation scabrate to echinate. D: 52-60 μm .

Life form: Palm.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Poales Small**Family: Bromeliaceae Juss.****Species: *Aechmea bromeliifolia* (Rudge) Baker (Figure 3: 13-14)**

Herbarium number: HCJS 1335

Description: Monad, large, heteropolar; di(tri)porate with large pores 7-8 μm diameter; circular, oblate spheroidal; exine 2.5 μm thick, ornamentation reticulate to rugulate. E: 65 μm , P: 63.5 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Aechmea castelnavii* Baker (Figure 3: 15-16)

Herbarium number: MG 214066

Description: Monad, medium, apolar; inaperturate; spheroidal; tectados, columelados, exine 1.2 μm thick, ornamentation reticulate heterobrochate. D: 27-34 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Aechmea mertensii* (G.Mey.) Schult. & Schult.f. (Figure 3: 17-18)

Herbarium number: HCJS 1410

Description: Monad, large, apolar; inaperturate; spheroidal; exine 4.2 μm thick, tectate, ornamentation reticulate heterobrochate to rugulate. D: 55-50 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Dyckia duckei* L.B.Sm. (Figure 3: 19-20)

Herbarium number: MG 222350; HCJS 1040

Description: Monad, medium, heteropolar; monosulcate, margo indistinct; amb elliptical, subprolate to prolate; exine 1.6 μm thick, tectate, ornamentation reticulate heterobrochate. P: 41-46 μm , E: 19-26 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

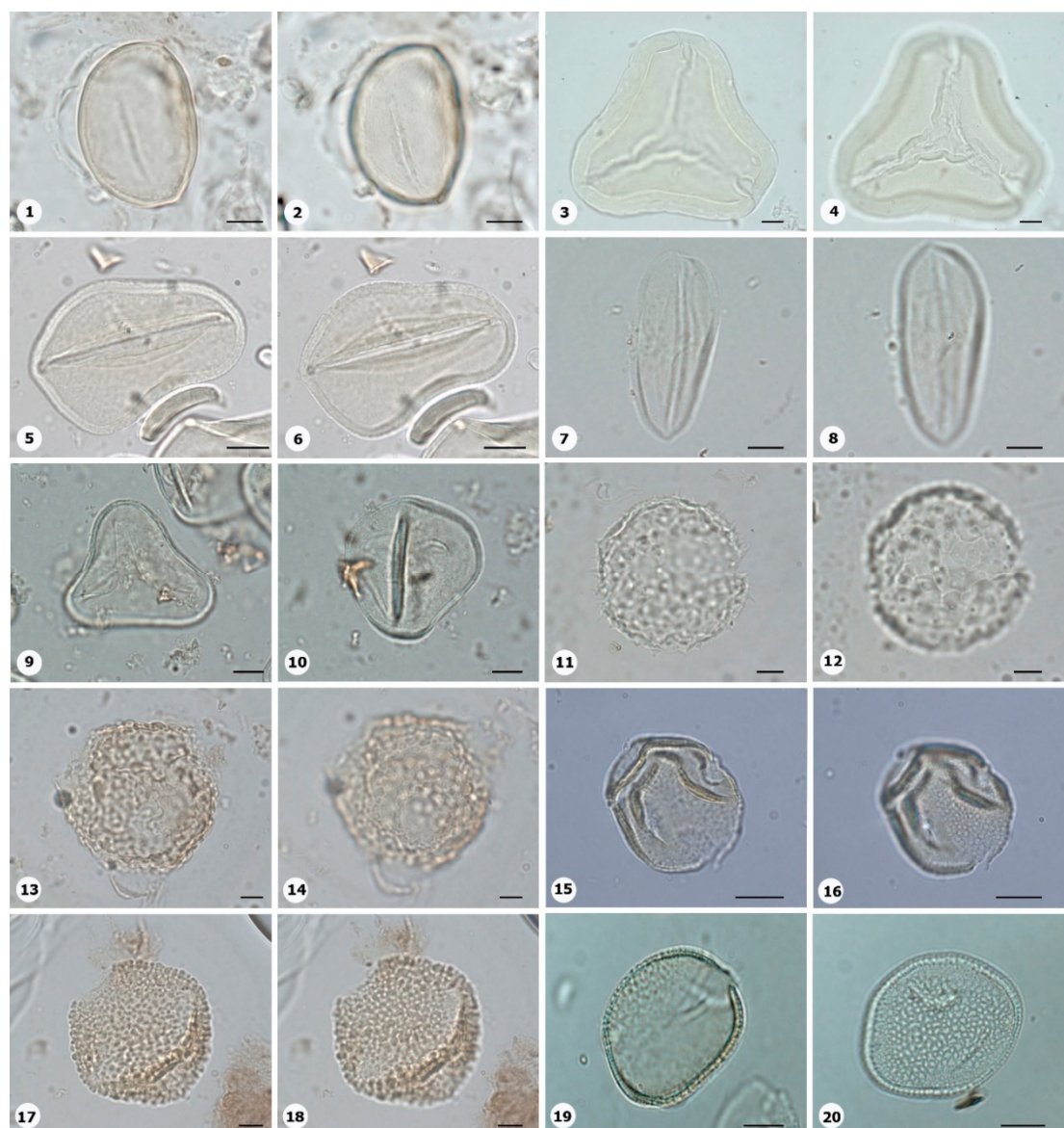


Figure 3. Monocots. 1-2: *Philodendron wulschlaegelii*; 3-4: *Acrocomia aculeata*; 5-6: *Attalea maripa*; 7-8: *Euterpe oleracea*; 9-10: *Oenocarpus distichus*; 11-12: *Socratea exorrhiza*; 13-14: *Aechmea bromeliifolia*; 15-16: *Aechmea castelnavii*; 17-18: *Aechmea mertensii*; 19-20: *Dyckia duckei*. Scale: 10 μ m.

Species: *Pitcairnia lanuginosa* Ruiz & Pav. (Figure 4: 1-2)

Herbarium number: MG 222323

Description: Monad, medium, heteropolar; monosulcate, margo indistinct; amb elliptical, prolate spheroidal; exine 1 μ m thick, tectate, ornamentation reticulate heterobrochate. P: 49-52 μ m, E: 41.3-48 μ m.

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Order: Zingiberales Grisebach

Family: Costaceae Nakai

Species: *Chamaecostus acualis* (S.Moore) T.André & C.D.Specht (Figure 4: 3-4)

Herbarium number: INPA 257238, 109585

Description: Monad, very large, isopolar; pantoporate (6 pores); spheroidal; exine 4-5 μ m thick, tectate, ornamentation psilate to punctate. D: 139-142 μ m.

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Chamaecostus lanceolatus* (Petersen) C.D.Specht & D.W.Stey (Figure 4: 5-6)

Herbarium number: INPA 98074, 53463

Description: Monad, very large, isopolar; pantoporate (6 pores), slightly annulate; spheroidal; exine 5-6 μm thick, tectate, ornamentation psilate to punctate. D: 119-125 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Costus scaber* Ruiz & Pav. (Figure 4: 7-8)

Herbarium number: INPA 163081, 262903

Description: Monad, gigantic, isopolar; pantoporate (6 pores); spheroidal; exine 5 μm thick, tectate, ornamentation psilate to punctate. D: 204-212 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Poales Small

Family: Cyperaceae Juss.

Species: *Bulbostylis paraensis* C.B.Clarke (Figure 4: 9-10)

Herbarium number: BHCB 115277

Description: Monad, medium, heteropolar; inaperturate; spheroidal; exine 1 μm thick, tectate, ornamentation microreticulate. D: 39-42 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Cyperus aggregatus* (Willd.) Endl. (Figure 4: 11-12)

Herbarium number: BHCB 137680

Description: Monad, medium, heteropolar; inaperturate with pseudoapertures; spheroidal; exine 1.5 μm thick, tectate, ornamentation microreticulate. D: 31-33 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Cyperus amabilis* Vahl (Figure 4: 13-14)

Herbarium number: BHCB 115278

Description: Monad, medium, heteropolar; inaperturate with pseudoapertures; spheroidal; exine 1.5 μm thick, tectate, ornamentation microreticulate. D: 30-34 μm .

Life form: Herb

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Cyperus haspan* L. (Figure 4: 15-16)

Herbarium number: BHCB 139491, MG 214017

Description: Monad, medium, heteropolar; inaperturate with pseudoapertures; elliptical, proximal pole slightly smaller than distal pole; exine 1.3 μm thick, tectate, ornamentation microreticulate. D: 25-29 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols, doliniform lakes with organic mud sediments at the bottom.

Species: *Cyperus laxus* Lam. (Figure 4: 17-18)

Herbarium number: BHCB 137669

Description: Monad, medium, heteropolar; inaperturate; elliptical, proximal pole slightly smaller than distal pole; exine 1.3 μm thick, tectate, ornamentation microreticulate. D: 29-23 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Cyperus sphacelatus* Rottb. (Figure 4: 19-20)

Herbarium number: MG 214013

Description: Monad, small, heteropolar; inaperturate; elliptical, proximal pole slightly smaller than distal pole; exine 0.5-0.6 μm thick, tectate, ornamentation microreticulate. D: 16-21 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

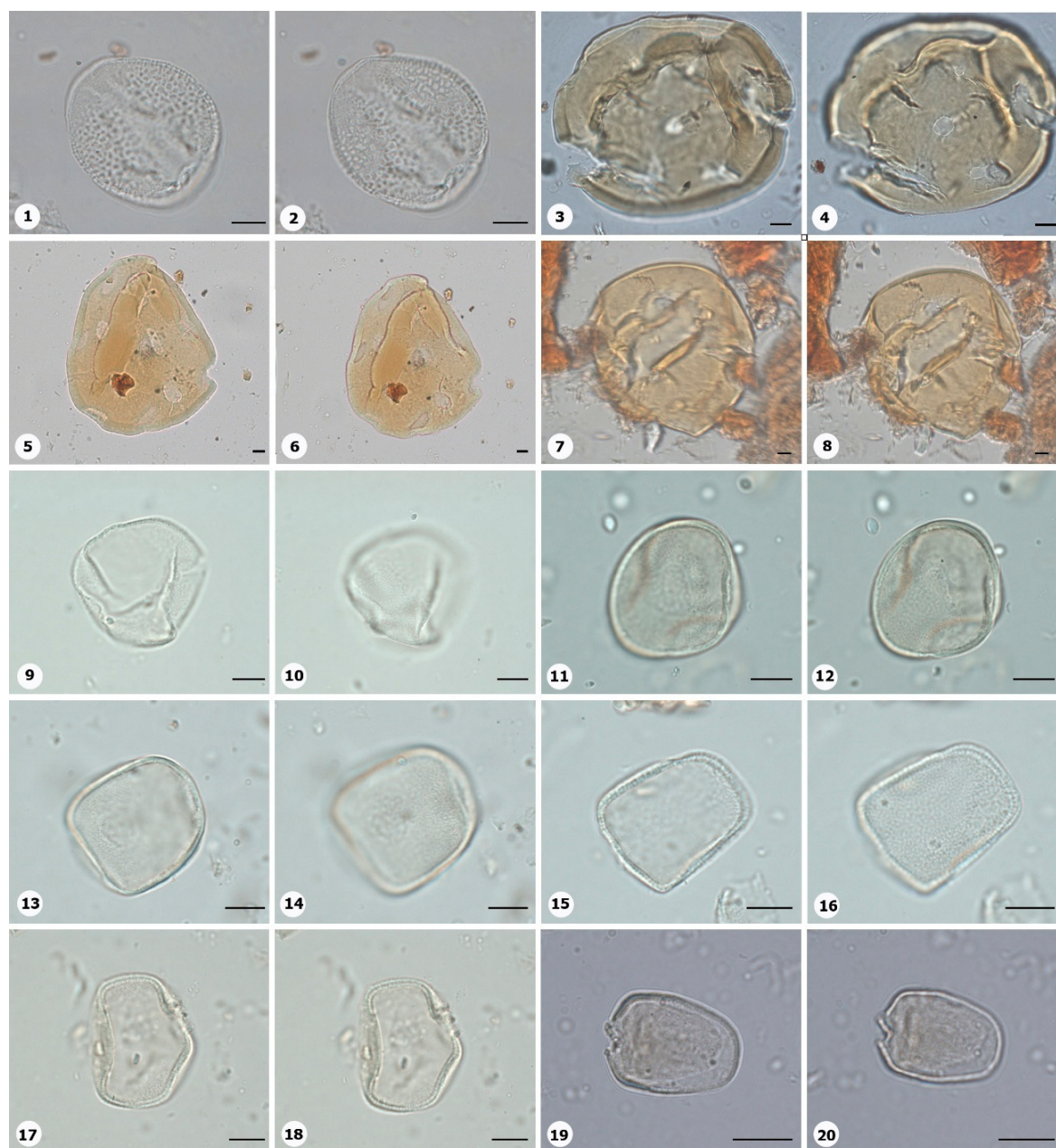


Figure 4. Monocots. 1-2: *Pitcarnia lanuginosa*. 3-4: *Chamaecostus acualis*; 5-6: *Chamaecostus lanceolatus*; 7-8: *Costus scaber*; 9-10: *Bulbostylis paraensis*; 11-12: *Cyperus aggregatus*; 13-14: *Cyperus amabilis*; 15-16: *Cyperus haspan*; 17-18: *Cyperus laxus*; 19-20: *Cyperus sphacelatus*. Scale: 10 μm .

***Species: Cyperus surinamensis* Rottb. (Figure 5: 1-2)**

Herbarium number: BHCB 142679

Description: Monad, small, heteropolar; inaperturate; elliptical, proximal pole smaller than distal pole; exine 0.8-0.9 μm thick, tectate, ornamentation microreticulate. D: 18-21 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

***Species: Eleocharis flavescens* (Poir.) Urb. (Figure 5: 3-4)**

Herbarium number: MG 214003

Description: Monad, medium, heteropolar; inaperturate; elliptical, proximal pole smaller than distal pole; exine 0.8 μm thick, tectate, ornamentation microreticulate. D: 21-27 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

***Species: Rhynchospora barbata* (Vahl) Kunth (Figure 5: 5-6)**

Herbarium number: BHCB 130685, MG 213983, 222341

Description: Monad, medium, heteropolar; inaperturate; elliptical, proximal pole slightly smaller than distal pole; exine 1.5 μm thick, tectate, ornamentation microreticulate with coarse muri. D: 25-30 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Rhynchospora corymbosa* (L.) Britton (Figure 5: 7-8)**

Herbarium number: BHCB 115300

Description: Monad, medium, heteropolar; inaperturate; elliptical, proximal pole slightly smaller than distal pole; exine 1 μm thick, tectate, ornamentation microreticulate. D: 17-23 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Rhynchospora seccoii* C.S. Nunes, P.J.S. Silva Filho & A. Gil (Figure 5: 9-10)**

Herbarium number: HCJS 0732, HCJS 0791

Description: Monad, medium, heteropolar; inaperturate; spheroidal; exine 1-1.2 μm thick, tectate, ornamentation microreticulate. D: 27-32 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Rhynchospora tenuis* Link (Figure 5: 11-12)**

Herbarium number: BHCB 137678, BHCB 155861

Description: Monad, medium, heteropolar; inaperturate; spheroidal; exine 1 μm thick, tectate, ornamentation microreticulate. D: 22-29 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Scleria cyperina* Willd. ex Kunth (Figure 5: 13-14)**

Herbarium number: MG 214081

Description: Monad, medium, heteropolar; inaperturate; spheroidal; exine 1-1.2 μm thick, tectate, ornamentation microreticulate. D: 34-38 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Scleria verticillata* Muhl. ex Willd (Figure 5: 15-16)**

Herbarium number: BHCB 158212

Description: Monad, medium, heteropolar; inaperturate; spheroidal; exine 1 μm thick, tectate, ornamentation microreticulate. D: 31-33 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

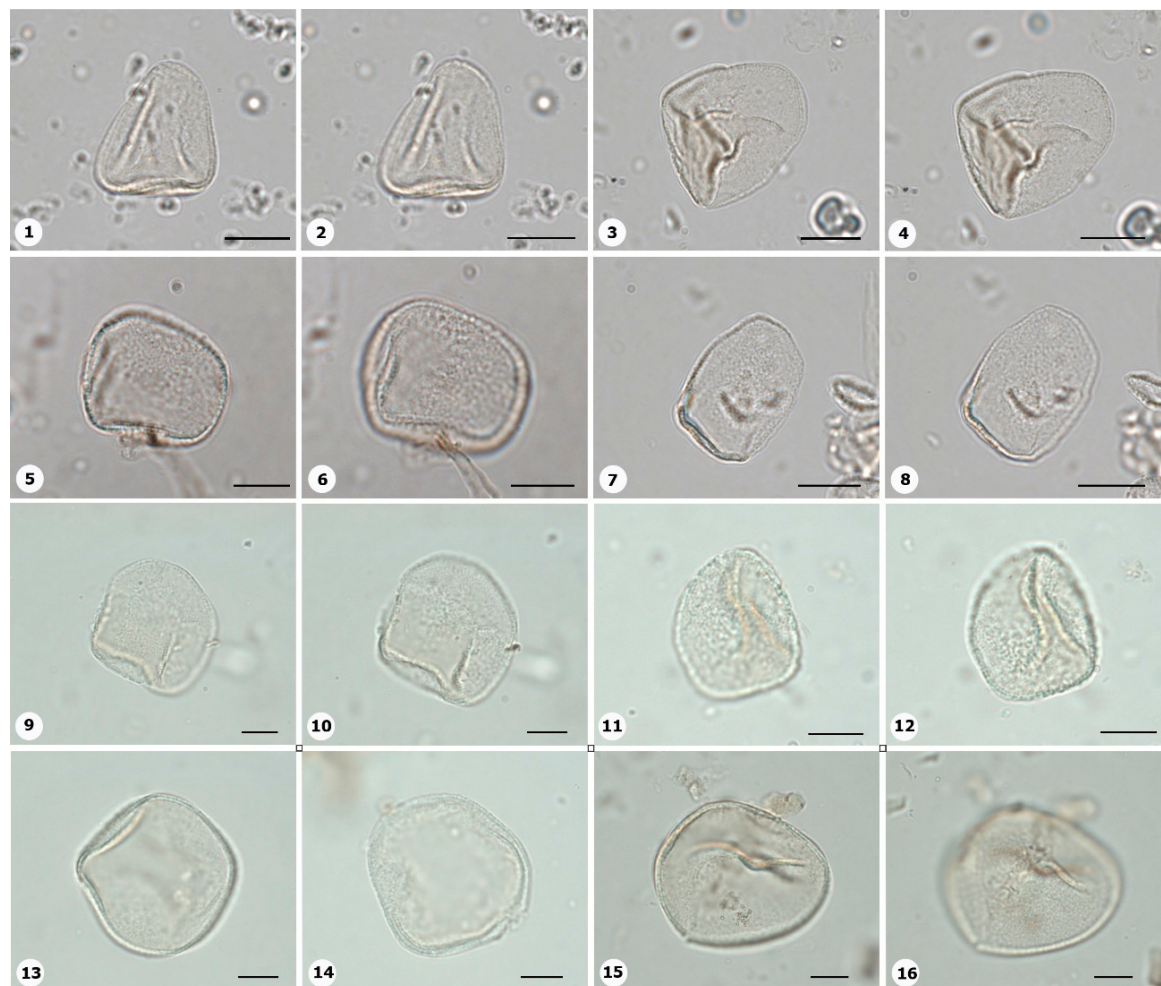


Figure 5. Monocots. 1-2: *Cyperus surinamensis*; 3-4: *Eleocharis flavescens*; 5-6: *Rhynchospora barbata*; 7-8: *Rhynchospora corymbosa*; 9-10: *Rhynchospora seccoii*; 11-12: *Rhynchospora tenuis*; 13-14: *Scleria cyperina*; 15-16: *Scleria verticillata*.

Order: Dioscoreales R.Br.

Family: Dioscoreaceae (R. Br.)

Species: *Dioscorea glandulosa* (Klotzsch ex Griseb.) Kunth (Figure 6: 1-2)

Herbarium number: HCJS 0806

Description: Monad, medium, apolar; inaperturate; spheroidal; exine 0.6 μm thick, tectate, ornamentation microreticulate. D: 29-31 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Dioscorea pohlilii* Griseb. (Figure 6: 3-4)

Herbarium number: HCJS 0482

Description: Monad, large, inaperturate; elliptical; exine 1.8-2 μm thick, tectate, ornamentation striate. D: 38-52 μm .

Life form: Liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Order: Poales Small

Family: Eriocaulaceae Martinov

Species: Eriocaulon aff. setaceum L. (Figure 6: 5-6)

Herbarium number: HCJS 1578

Description: Monad, medium, apolar; spiraperturate in a crosshatch pattern, with 2-3 apertures; spheroidal; exine 1.8-2 μm thick, tectate, ornamentation microechinate and microreticulate. D: 42-47 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: Eriocaulon setaceum L. (Figure 6: 7-8)

Herbarium number: MG 214910

Description: Monad, small, apolar; spiraperturate in a crosshatch pattern, with 2-3 apertures; spheroidal; exine 1.2-1.3 μm thick, tectate, ornamentation microechinate and microreticulate. D: 22-25 μm

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: Paepalanthus aff. fasciculatus (Rottb.) Kunth (Figure 6: 9-10)

Herbarium number: MG 85842

Description: Monad, small, apolar; spiraperturate in a crosshatch pattern, with 2-3 apertures; spheroidal; exine 1.7-1.8 μm thick, tectate, ornamentation microechinate and microreticulate. D: 41-44 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: Syngonanthus caulescens (Poir.) Ruhland (Figure 6: 11-12)

Herbarium number: HCJS 0541, MG 223908

Description: Monad, small, apolar; spiraperturate with apertures tracing various designs (many arrangements); spheroidal; exine 1 μm thick, tectate, ornamentation microechinate and microreticulate. D: 26-31 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: Syngonanthus discretifolius (Moldenke) M.T.C.Watan. (Figure 6: 13-14)

Herbarium number: MG 214016

Description: Monad, small, apolar; spiraperturate with apertures tracing various designs (many arrangements); spheroidal; exine 1 μm thick, tectate, ornamentation microechinate and microreticulate. D: 29-34 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: Syngonanthus heteropeplus (Koern.) Ruhland (Figure 6: 15-16)

Herbarium number: MG 117013

Description: Monad, small, apolar; spiraperturate with apertures tracing various designs (many arrangements); spheroidal; exine 1 μm thick, tectate, ornamentation microechinate and microreticulate. D: 26-34 μm .

Life form: Herb

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: Syngonanthus sp. 1 (Figure 6: 17-18)

Collection number: ITV 1774

Description: Monad, small, apolar; spiraperturate with apertures tracing various designs (many arrangements); spheroidal; exine 1.2-1.3 μm thick, tectate, ornamentation microechinate and microreticulate. D: 26-30 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Order: Zingiberales Grisebach

Family: Heliconiaceae Nakai

Species: *Heliconia adelianna* Emygdio & E.Santos (Figure 6: 19-20)

Herbarium number: MG 251426

Description: Monad, large, apolar; inaperturate; spheroidal; exine 6.5-7 μm thick, nexine significantly thicker than endexine, tectate, ornamentation punctate. D: 70-73 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

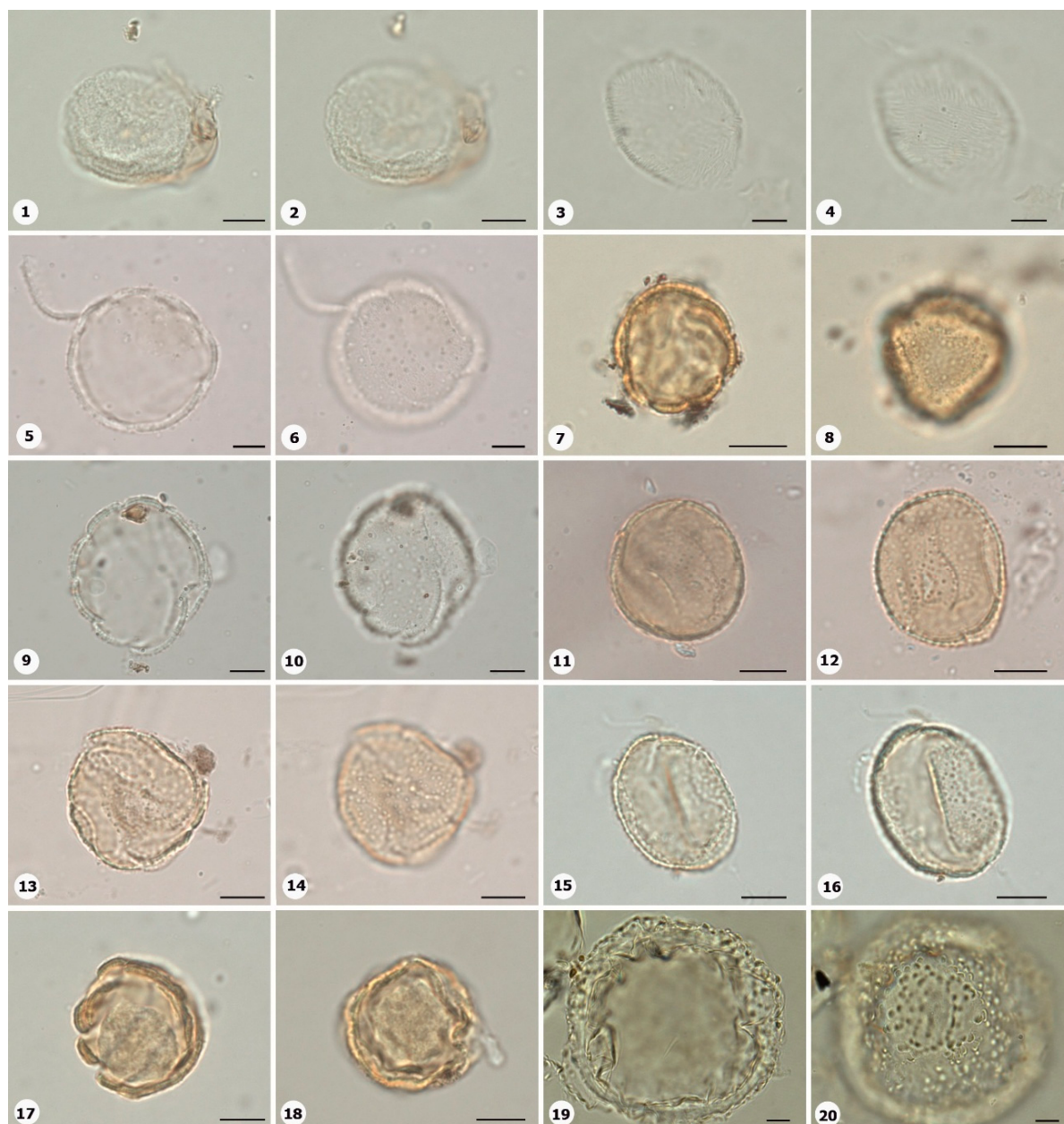


Figure 6. Monocots. 1-2: *Dioscorea glandulosa*. 3-4: *Dioscorea pohlii*; 5-6: *Eriocaulon aff. setaceum*; 7-8 *Eriocaulon setaceum*; 9-10: *Paepalanthus aff. fasciculatus*; 11-12: *Syngonanthus caulescens*; 13-14: *Syngonanthus discretifolius*; 15-16: *Syngonanthus heteropeplus*; 17-18: *Syngonanthus sp. 1*; 19-20: *Heliconia adeliana*. Scale: 10 μm .

Order: Poales Small

Family: Mayacaceae Kunth

Species: *Mayaca fluviatilis* Aubl. (Figure 7: 1-2)

Herbarium number: MG 222303

Description: Monad, medium, heteropolar; inaperturate; elliptical; exine 1.5-1.6 μm thick, tectate, ornamentation microreticulate. D: 20-31 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, doliniform lakes with organic mud sediment at the bottom.

Family: Poaceae Barnhart

Species: *Axonopus capillaris* (Lam.) Chase (Figure 7: 3-4)

Herbarium number: MG 116782

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1.1-2 μm thick, tectate, ornamentation microreticulate-microrugulate. D: 27-26 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Axonopus carajasensis* Bastos (Figure 7: 5-6)

Herbarium number: BHCB 155944

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 0.7-0.8 μm thick, tectate, ornamentation microreticulate. D: 31-34 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Axonopus longispicus* (Döll) Kuhlmann (Figure 7: 7-8)

Herbarium number: MG 99379

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 0.9-1.5 μm thick, tectate, ornamentation microreticulate. D: 30-36 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Eragrostis maypurensis* (Kunth) Steud (Figure 7: 9-10)

Herbarium number: MG 147039

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 0.8-1.3 μm thick, tectate, ornamentation microreticulate. D: 20-31 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Eragrostis rufescens* Schrad. ex Schult (Figure 7: 11-12)

Herbarium number: MG 213985

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1.5 μm thick, tectate, ornamentation microreticulate. D: 32-39 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Hildaia breviscrops* (Döll) C.Silva & R.P. Oliveira (Figure 7: 13-14)

Herbarium number: HCJS 1740

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1.3-1.5 μm thick, tectate, ornamentation microreticulate. D: 20-23 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Ichnanthus calvescens* (Nees ex Trin.) Döll (Figure 7: 15-16)

Herbarium number: MG 214084

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1.3-1.5 µm thick, tectate, ornamentation microreticulate. D: 34-42 µm.

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Isachne polygonoides* (Lam.) Döll (Figure 7: 17-18)

Herbarium number: MG 222316

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1 µm thick, tectate, ornamentation microreticulate. D: 21-28 µm.

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Mesosetum cayennense* Steud. (Figure 7: 19-20)

Herbarium number: MG 105630

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 0.9-1.4 µm thick, tectate, ornamentation microreticulate. D: 32-41 µm.

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

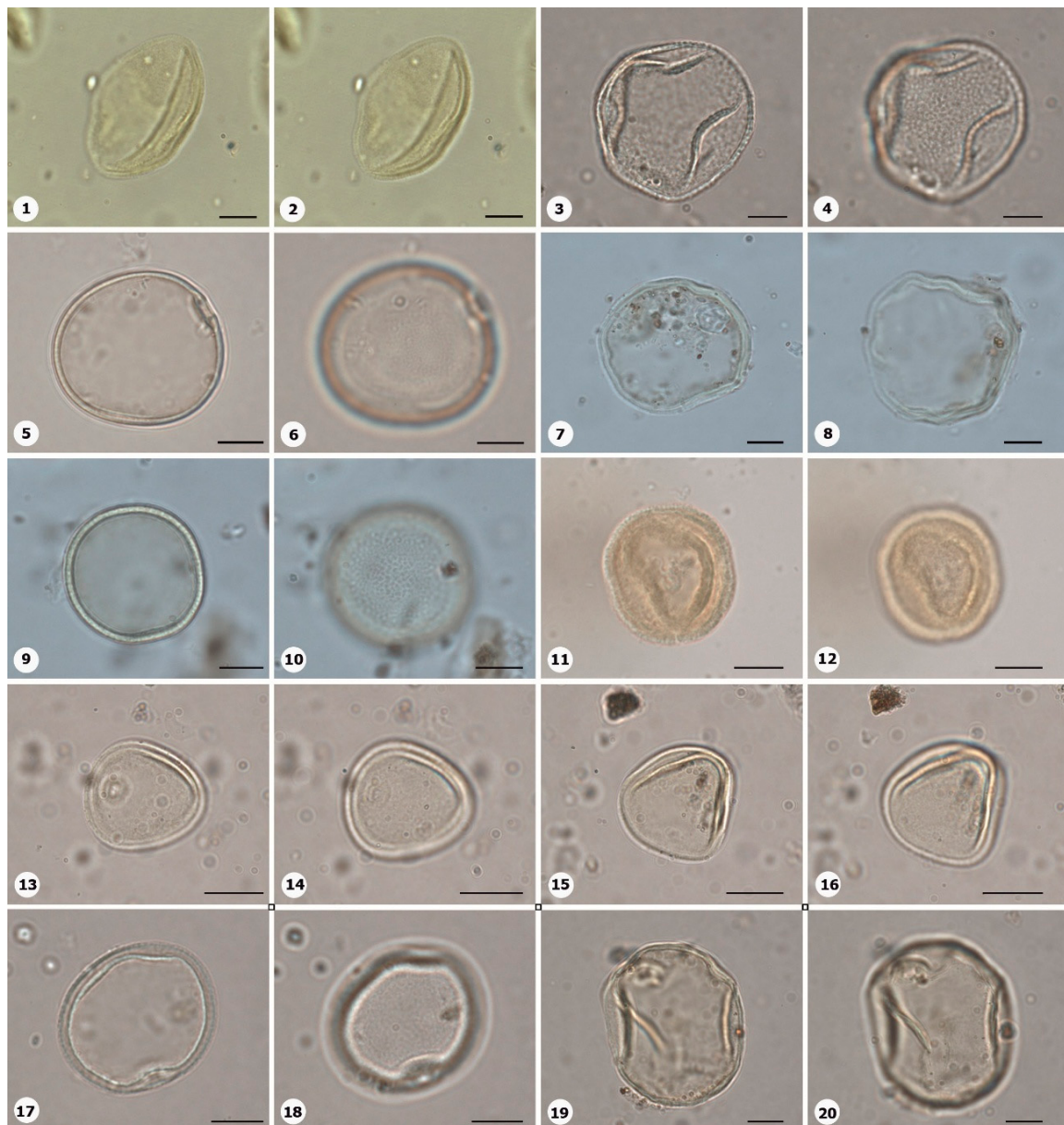


Figure 7. Monocots. 1-2: *Mayaca fluviatilis*; 3-4: *Axonopus capillaris*; 5-6: *Axonopus carajasensis*; 7-8: *Axonopus longispicus*; 9-10: *Eragrostis maypurensis*; 11-12: *Eragrostis rufescens*; 13-14: *Hildebrandia brevifolia*; 15-16: *Ichnanthus calvenscens*; 17-18: *Isachne polygonoides*; 19-20: *Mesosetum cayennense*. Scale: 10 μ m.

Species: *Mnesithea aurita* (Steud.) de Koning & Sosef (Figure 8: 1-2)

Herbarium number: MG 67183

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 0.8-1 μ m thick, tectate, ornamentation microreticulate. D: 32-36 μ m.

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Otachyrium versicolor* (Döll) Henrard (Figure 8: 3-4)

Herbarium number: BHCB 139242

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1-1.4 μ m thick, tectate, ornamentation microreticulate. D: 31-41 μ m.

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Paspalum carajasense* S.Denham (Figure 8: 5-6)

Herbarium number: MG 208828

Description: Monad, large, apolar; monoporate, annulate but some grains are indistinct; spheroidal; exine 2-2.8 μm thick, tectate, ornamentation microreticulate. D: 51-61 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Paspalum carinatum* Humb. & Bonpl. ex Flügge (Figure 8: 7-8)

Herbarium number: MG 214010

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1.5-3 μm thick, tectate, ornamentation microreticulate. D: 42-63 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Paspalum virgatum* L. (Figure 8: 9-10)

Herbarium number: MG 67531

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 0.9-1.7-3 μm thick, tectate, ornamentation microreticulate. D: 42-58 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Rhytachne gonzalezii* Davidse (Figure 8: 11-12)

Herbarium number: MG 135244

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1.3-3.4 μm thick, tectate, ornamentation microreticulate. D: 48-65 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Sporobolus multiramosus* Longhi-Wagner & Boechat (Figure 8: 13-14)

Herbarium number: MG 213981

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1.1-1.8 μm thick, tectate, ornamentation microreticulate-reticulate. D: 31-35 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Trichanthecium parvifolium* (Lam.) Zuloaga & Morrone (Figure 8: 15-16)

Herbarium number: MG 213975

Description: Monad, medium, apolar; monoporate with operculum, annulate; spheroidal; exine 1.1-1.7 μm thick, tectate, ornamentation microreticulate-reticulate. D: 34-40 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Trichanthecium polycomum* (Trin.) Zuloaga & Morrone (Figure 8: 17-18)

Herbarium number: MG 215537

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1-1.5 μm thick, tectate, ornamentation microreticulate-reticulate. D: 29-37 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Trichanthecium* sp. 1 (Figure 8: 19-20)

Herbarium number: MG 213989

Description: Monad, medium, apolar; monoporate, annulate; spheroidal; exine 1-1.5 μm thick, tectate, ornamentation microreticulate. D: 29-32 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

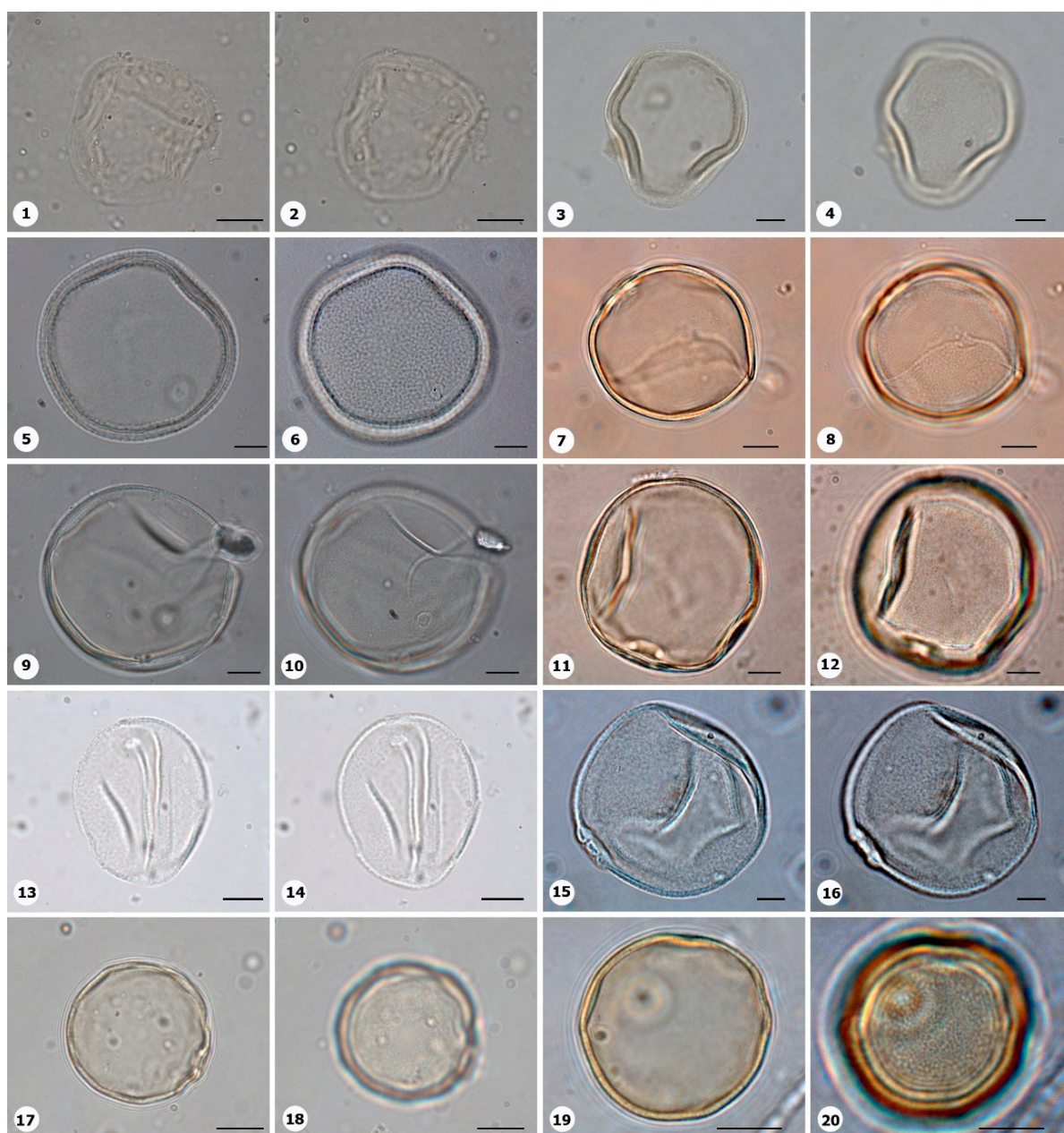


Figure 8. Monocots. 1-2: *Mnesithea aurita*. 3-4: *Otachyrium versicolor*; 5-6: *Paspalum carajasense*; 7-8: *Paspalum carinatum*; 9-10 *Paspalum virgatum*; 11-12: *Rhytachne gonzalezii*; 13-14: *Sporobolus multiramosus*; 15-16: *Trichantheum parvifolium*; 17-18: *Trichantheum polycomum*; 19-20: *Trichantheum* sp. 1. Scale: 10 μm .

Order: Liliales Perleb

Family: Velloziaceae J.Agardh

Species: *Vellozia* sp. 1 (Figure 9: 3-4)

Collection code: ITV 2114

Description: Tetragonal tetrad, large, apolar; inaperturate; spheroidal; exine 2.5-3 μm , ornamentation reticulate. D: 80-85 μm .

Life form: Shrub and herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Vellozia* sp. 2 (Figure 9: 3-4)

Collection code: ITV 2115

Description: Tetragonal tetrad, large, apolar; inaperturate; spheroidal; exine 2-2.5 μm , ornamentation reticulate, lumina 4-5 μm width. D: 62-70 μm .

Life form: Shrub and herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Order: Poales Small

Family: Xyridaceae C.Agardh

Species: *Xyris brachysepala* Kral. (Figure 9: 5-6)

Herbarium number: MG 213994

Description: Monads, large, heteropolar; inaperturate; elliptical; exine 3 μm thick, tectate, ornamentation reticulate. D: 34-62 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, doliniform lakes with organic mud sediments at the bottom.

Species: *Xyris macrocephala* Vahl (Figure 9: 7-8)

Herbarium number: MG 214073

Description: Monads, medium, heteropolar; inaperturate; elliptical; exine 1-2 μm thick, tectate, ornamentation microreticulate. D: 35-48 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, doliniform lakes with organic mud sediments at the bottom.

EUDICOTS AND MAGNOLIIDS

Order: Lamiales Bromhead

Family: Acanthaceae Juss.

Species: *Justicia birae* A.S.Reis, F.A.Silva, A.Gil & Kameyama (Figure 9: 9-10)

Herbarium number: HCJS 0728

Description: Monads, large, isopolar; dicolporate, brevicolpi; amb elliptical, prolate; exine 2-3 μm thick, ornamentation echinate and microreticulate. P: 98-105 μm , E: 58-60 μm .

Life form: Shrub and herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Sapindales Juss. ex Bercht. & J. Presl

Family: Anacardiaceae R.Br.

Species: *Anacardium occidentale* L. (Figure 9: 11-12)

Herbarium number: MG 112455

Description: Monads, large, isopolar; tricolporate; amb triangular-obtuse-convex, prolate/oblate spheroidal; exine 5-5.6 μm thick, densely collumelate, tectate, ornamentation striate-reticulate. P: 50-59 μm , E: 44-55 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Magnoliales Bromhead

Family: Annonaceae Juss.

Species: *Onychopetalum amazonicum* R.E.Fr. (Figure 9: 13-14)

Herbarium number: HCJS 1436

Description: Monads, large, isopolar; zonosulcate with a prominent zonosulcus subprolate; amb elliptical, subprolate; exine 1-1.5 μm thick, ornamentation rugulate. E: 52.8-57.6 μm , P: 42.8-49 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Xylopia aromatica* (Lam.) Mart. (Figure 9: 15-16)

Herbarium number: MG 59152

Description: Monads, medium, isopolar; tricolporate, pore costate, pore diameter 5 μm ; amb circular, prolate spheroidal; exine 2-3 μm thick, tectate, ornamentation reticulate. P: 28-30 μm , E: 27-29 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Gentianales Juss. ex Bercht. & J. Presl

Family: Apocynaceae Juss.

Species: *Mandevilla hirsuta* (A.Rich.) K.Schum. (Figure 9: 17-18)

Herbarium number: MG 222310

Description: Monads, very large, isopolar; pantoporate, 4-5 pores with annuli; amb circular, prolate spheroidal; exine 1.4-2 μm thick, ornamentation psilate and microreticulate near apertural region. D: 100-110 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Mandevilla tenuifolia* (J.C.Mikan) Woodson (Figure 9: 19-20)

Herbarium number: MG 57360

Description: Monads, medium, isopolar; pantoporate, 5 pores with prominent annuli; amb circular, prolate spheroidal; exine 2-3 μm thick, tectate, ornamentation reticulate. D: 34-48 μm .

Life form: Liana.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

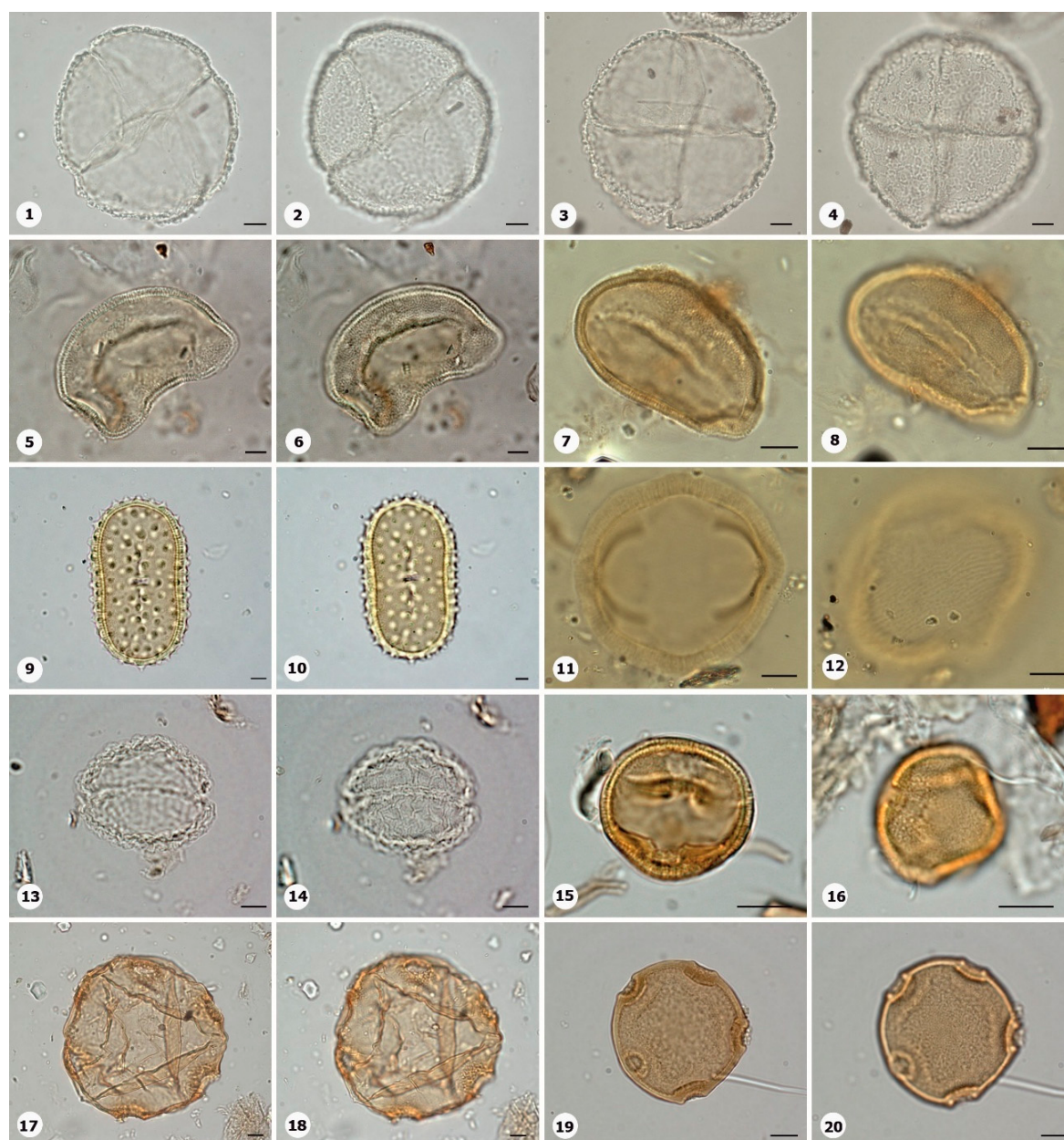


Figure 9. Monocots, Eudicots and Magnoliids. 1-2: *Vellozia* sp. 1; 3-4: *Vellozia* sp. 2; 5-6: *Xyris brachysepala*; 7-8: *Xyris macrocephala*; 9-10: *Justicia birae*; 11-12: *Anacardium occidentale*; 13-14: *Onychopetalum amazonicum*; 15-16: *Xylopia aromática*; 17-18: *Mandevilla hirsuta*; 19-20: *Mandevilla tenuifolia*; Scale: 10 μ m.

Order: Asterales Link

Family: Asteraceae Bercht. & J.Presl

Species: *Cavalcantia glomerata* (G.M.Barroso & R.M.King) R.M.King & H.Rob. (Figure 10, 1-2)

Herbarium number: MG 37869

Description: Monad, small, isopolar; tricolporate, brevicolpi; amb circular, prolate spheroidal; exine 3-4 μ m thick, densely columellate, ornamentation echinate and punctate. P: 22-25 μ m, E: 20-25 μ m.

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Emilia* sp. 1 (Cass.) Cass. (Figure 10, 3-4)

Herbarium number: MG 222326

Description: Monad, small, isopolar; tricolporate, brevicolpi; amb circular, prolate spheroidal; exine 3 μm thick, columellate, ornamentation echinate and punctate. P: 24-25 μm , E: 23-24 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Ichthyothere terminalis* (Spreng.) S.F.Blake (Figure 10, 5-6)

Herbarium number: MG 213971

Description: Monad, medium, isopolar; tricolporate, brevicolpi; amb circular, prolate spheroidal; exine 3-3.5 μm thick, columellate, ornamentation echinate and punctate. P: 31-38 μm , E: 32-33 μm .

Life form: Herb

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols, doliniform lakes with organic mud sediment at the bottom.

Species: *Lepidaploa paraensis* (H.Rob.) H.Rob. (Figure 10, 7-8)

Herbarium number: MG 213957

Description: Monad, medium, isopolar; tricolporate, brevicolpi, echinolophate; amb circular, oblate spheroidal; exine 4-6 μm thick, columellate, ornamentation echinate. P: 40-54 μm , E: 40-55 μm .

Life form: Subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Monogereion carajensis* G.M.Barroso & R.M.King (Figure 10, 9-10)

Herbarium number: MG 213951

Description: Monad, small, isopolar; tricolporate, brevicolpi; isopolar; tricolporate, brevicolpi, amb circular, oblate spheroidal; exine 3-4 μm thick, columellate, ornamentation echinate. P: 20-28 μm , E: 20-27 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Riencourtia pedunculosa* (Rich.) Pruski (Figure 10, 11-12)

Herbarium number: MG 222330

Description: Monad, medium, isopolar; tricolporate, brevicolpi, elongated pores; amb circular, subprolate; exine 2 μm thick, indistinct tectum, ornamentation echinate. P: 31-33 μm , E: 28-30 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Order: Cucurbitales Juss. ex Bercht. & J.Presl

Family: Begoniaceae C.Agardh

Species: *Begonia guaduensis* Kunth (Figure 10: 13-14)

Herbarium number: MG 213986

Description: Monad, small, isopolar; tricolporate; amb circular, prolate, isopolares; exine 0.5-1 μm thick, tectate, ornamentation psilate and slightly striate. P: 20-24.4 μm , E: 11-12 μm .

Life form: Subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Order: Lamiales Bromhead

Family: Bignoniaceae Juss.

Species: *Anemopaegma carajasense* A.H. Gentry ex Firetti-Leggieri (Figure 10: 15-16)

Collector number: Carreira et al. 3429

Description: Monad, very large, isopolar; stephanocolpate, 8 colpi; amb circular; exine 7-7.5 μm thick, tectate, ornamentation reticulate heterobrochate. D: 110-124 μm .

Life form: Shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Handroanthus serratifolius* (Vahl) S.Grose (Figure 10: 17-18)

Herbarium number: MG 69537

Description: Monad, large, isopolar; tricolporate, colpi long and pores, costate; amb circular, subprolate; exine 1-2 μm thick, semitectate, columelados, ornamentation reticulate, homobrochate. P: 70-80 μm , E: 52-70 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Jacaranda copaia* (Aubl.) D.Don (Figure 10: 19-20)

Herbarium number: MG 72382

Description: Monad, medium to large, isopolar; tricolporate, costate pores; amb circular, prolate; exine 1.5-2 μm thick, ornamentation microreticulate. P: 50-58 μm , E: 33-55 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

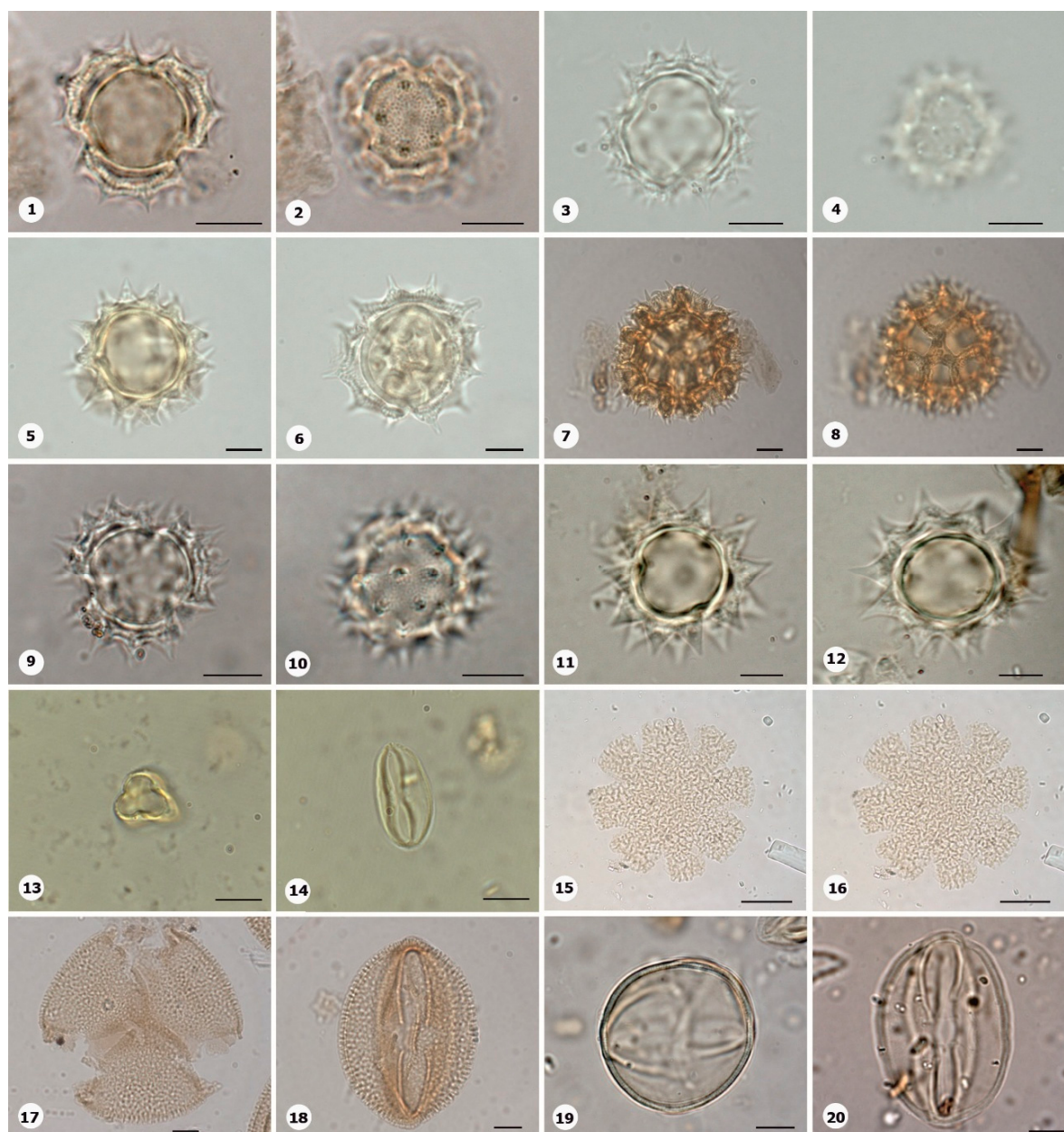


Figure 10. Eudicots. 1-2: *Cavalcantia glomerata*; 3-4: *Emilia* sp. 1; 5-6: *Ichthyothere terminalis*; 7-8: *Lepidaploa paraensis*; 9-10: *Monogereion carajensis*; 11-12: *Riencourtia pedunculosa*; 13-14: *Begonia guaduensis*; 15-16: *Anemopaegma carajasense*; 17-18: *Handroanthus serratifolius*; 19-20: *Jacaranda copaia*; Scale: 10 μ m.

Order: Malvales Juss.

Family: Bixaceae Kunth

Species: *Bixa orellana* L. (Figure 11: 1-2)

Herbarium number: MG 116597

Description: Monad, large, isopolar; tricolporate, parasyncolporate; amb triangular-obtuse-convex, subprolate; exine 1.5-2 μ m thick, tectate, ornamentation microreticulate, perforate forming equatorial lobes. P: 54-65 μ m, E: 41-63 μ m.

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Caryophyllales Juss. ex Bercht. & J. Presl

Family: Cactaceae Juss.

Species: *Cereus hexagonus* (L.) Mill. (Figure 11: 3-4)

Herbarium number: HCJS 4810

Description: Monad, very large, isopolar; tricolpate, colpi long; amb circular, oblate spheroidal; exine 2-2.2 μm thick, tectate, ornamentation reticulate, echinate e microequinate. E: 110-115 μm ; P: 98-105 μm .

Life form: Tree and shrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Order: Malpighiales Juss. ex Bercht. & J. Presl

Family: Clusiaceae Lindl.

Species: *Clusia nemorosa* G.Mey. (Figure 11: 5-6)

Herbarium number: MG 213956

Description: Monad, medium, isopolar; tricolporate; amb circular, prolate spheroidal; exine 1-1.5 μm thick, tectate, ornamentation microreticulate. P: 34.3-42.4 μm , E: 29.4-38 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Solanales Juss. ex Bercht. & J. Presl

Family: Convolvulaceae Juss.

Species: *Aniseia cernua* Moric. (Figure 11: 7-8)

Herbarium number: MG 222367

Description: Monad, large, apolar; pantocolpate, brevicolpi; spheroidal; exine 7-8 μm thick, tectate, ornamentation microreticulate and microequinate. D: 76-83 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Cuscuta insquamata* Yunck. (Figure 11: 9-10)

Herbarium number: MG 215432

Description: Monad, medium, isopolar; tricolpate; amb circular, subprolate; exine 2-3 μm thick, tectate, ornamentation microreticulate and microequinate. P: 25-48 μm , E: 18-39 μm .

Life form: Shrub, subshrub, herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Distimake macrocalyx* (Ruiz & Pav.) A.R. Simões & Staples (Figure 11: 11-12)

Herbarium number: MG 215937

Description: Monad, large, isopolar; tricolpate, colpi longi; amb circular, subprolate; exine 4-5 μm thick, tectate, ornamentation microreticulate and microgranulate. P: 69-86.6 μm , E: 72-83 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Evolvulus filipes* Mart. (Figure 11: 13-14)

Herbarium number: MG 215006

Description: Monad, medium, apolar; pantocolpate, brevicolpi; spheroidal; exine 1-2 μm thick, tectate, ornamentation microreticulate. D: 28-32 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Evolvulus* sp. 1 (Figure 11: 15-16)

Herbarium number: MG 214054

Description: Monad, large, isopolar; pantocolpate, 5 brevicolpi; amb circular, prolate spheroidal; exine 4-5 thick, tectate, ornamentation microreticulate. P: 71-93 μm , E: 69-92 μm .

Life form: Shrub, subshrub, herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Ipomoea asplundii* O'Donell (Figure 11: 17-18)

Herbarium number: MG 226331

Description: Monad, large, apolar; pantoporate, large pores; spheroidal, exine 6 μm thick, ornamentation echinate and microreticulate with granules, conical echinae. D: 78-82 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Ipomoea carajasensis* D.F. Austin (Figure 11: 19-20)

Herbarium number: MG 214004

Description: Monad, large, apolar; pantoporate, large pores; spheroidal, exine 6.5-8 μm thick, ornamentation echinate and microreticulate with granules, conical echinae. D: 80-90 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

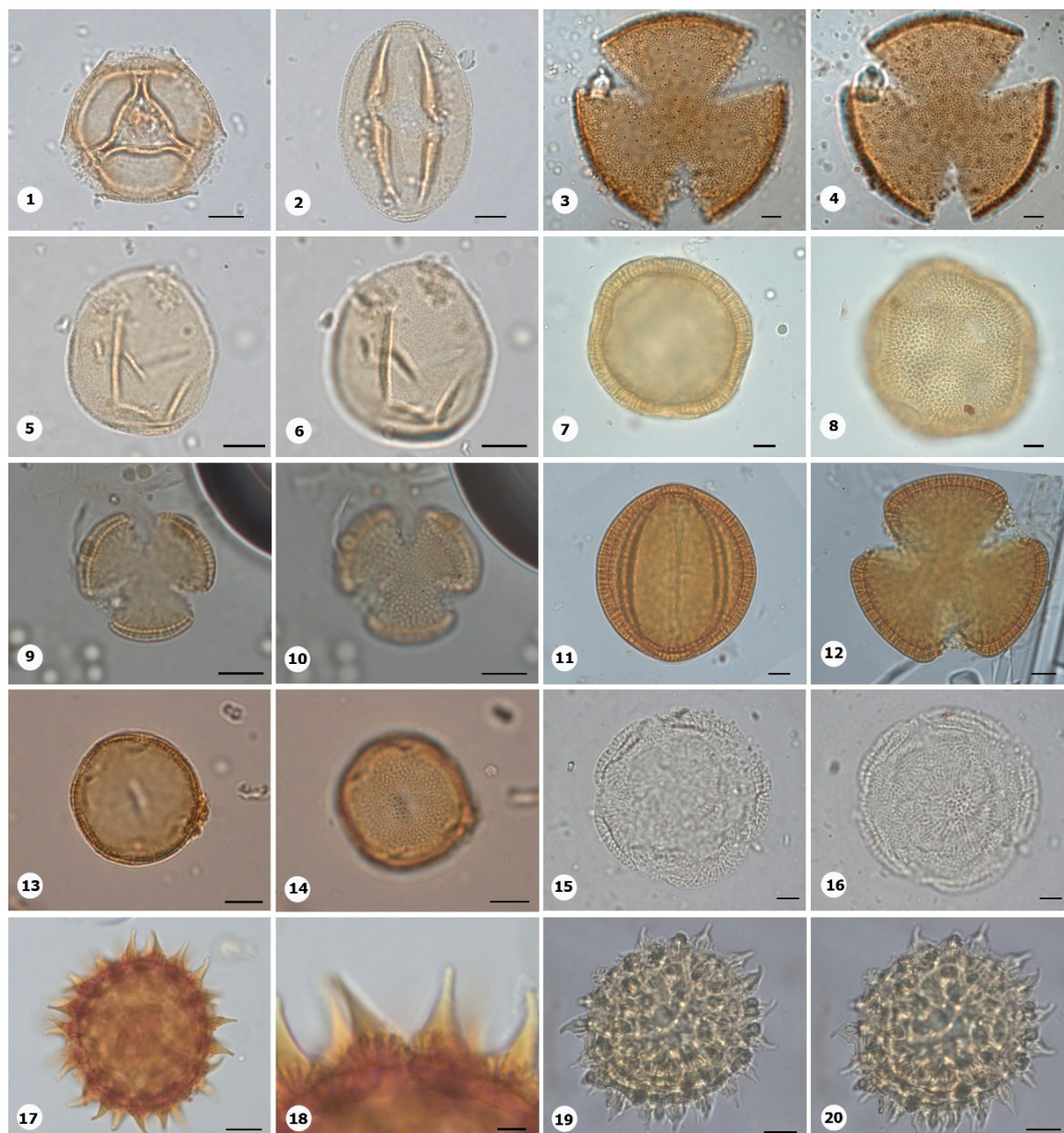


Figure 11. Eudicots. 1-2: *Bixa orellana*; 3-4: *Cereus hexagonus*; 5-6: *Clusia nemorosa*; 7-8: *Aniseia cernua*; 9-10: *Cuscuta insquamata*; 11-12: *Distimake macrocalyx*; 13-14: *Evolvulus filipes*; 15-16: *Evolvulus* sp. 1; 17-18: *Ipomoea asplundii*; 19-20: *Ipomoea carajasensis*; Scale: 10 μm .

***Species: Ipomoea cavalcantei* D.F. Austin (Figure 12: 1-2)**

Herbarium number: MG 215128

Description: Monad, large to very large, apolar; pantoporate, large pores; spheroidal, exine 4-7 μm thick, ornamentation echinate and microreticulate with granules, bulbous echinae (type 3). D: 85-115 μm .

Life form: Liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Ipomoea cavalcantei x marabaensis* (Figure 12: 3-4)**

Herbarium number: MG 223638

Description: Monad, large, apolar; pantoporate, large pores; spheroidal, exine 6 μm thick, ornamentation echinate and microreticulate with granules, bulbous echinae (type 2). D: 85-87 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

***Species: Ipomoea decora* Meisn. (Figure 12: 5-6)**

Herbarium number: MG 213191

Description: Monad, large to very large, apolar; pantoporate, large pores; spheroidal, exine 8-9 μm thick, ornamentation echinate and microreticulate with granules, bulbous echinae (type 2). D: 94-103 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

***Species: Ipomoea goyazensis* Gardner (Figure 12: 7-8)**

Herbarium number: MG 227195

Description: Monad, very large, pantoporate, large pores; spheroidal, exine 7-8 μm thick, ornamentation echinate and microreticulate, bulbous echinae (type 1). D: 118-125 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

***Species: Ipomoea marabaensis* D.F.Austin & Secco (Figure 12: 9-10)**

Herbarium number: MG 227199

Description: Monad, very large, apolar; pantoporate, large pores; spheroidal, exine 7-9 μm thick, ornamentation echinate and microreticulate with granules, bulbous echinae (type 2). D: 120-145 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

***Species: Ipomoea procumbens* Mart. ex Choisy (Figure 12: 11-12)**

Herbarium number: MG 222344

Description: Monad, large to very large, apolar; pantoporate, large pores; spheroidal, exine 8-9 μm thick, ornamentation echinate and microreticulate, conical echinae. D: 113-117 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

***Species: Ipomoea setifera* Poir. (Figure 12: 13-14)**

Herbarium number: MG 165270

Description: Monad, large to very large, apolar; pantoporate, large pores; spheroidal, exine 7-8 μm thick, columellate near echinae region, ornamentation echinate and microreticulate, conical echinae. D: 98-102 μm .

Life form: Herb and liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Jacquemontia tamnifolia* (L.) Griseb. (Figure 12: 15-16)

Herbarium number: MG 223119

Description: Monad, large, apolar; pantocolporate, 4-5 colporus, brevi colpi; spheroidal; exine 4-5 μm thick, columellate, tectate, ornamentation microechinate and microreticulate. D: 60-65 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Turbina cordata* (Choisy) D.F.Austin & Staples (Figure 12: 17-18)

Herbarium number: MG 165294

Description: Monad, large to very large, apolar; pantoporate, large pores; spheroidal, exine 7-8 μm thick, columellate near echinae region, ornamentation echinate and microreticulate, bulbous echinae (Type 2). D: 156-160 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Malpighiales Juss. ex Bercht. & J. Presl

Family: Erythroxylaceae Kunth

Species: *Erythroxylum carajasense* Plowman (Figure 12: 19-20)

Herbarium number: MG 22354

Description: Monad, medium, isopolar; tricolporate, costate pores; amb circular, prolate spheroidal; exine 2-3 μm thick, columellate, semitectate, ornamentation reticulate heterobrochate, larger lumina in the apocolpia region. P: 33 μm , E: 29 μm .

Life form: Shrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

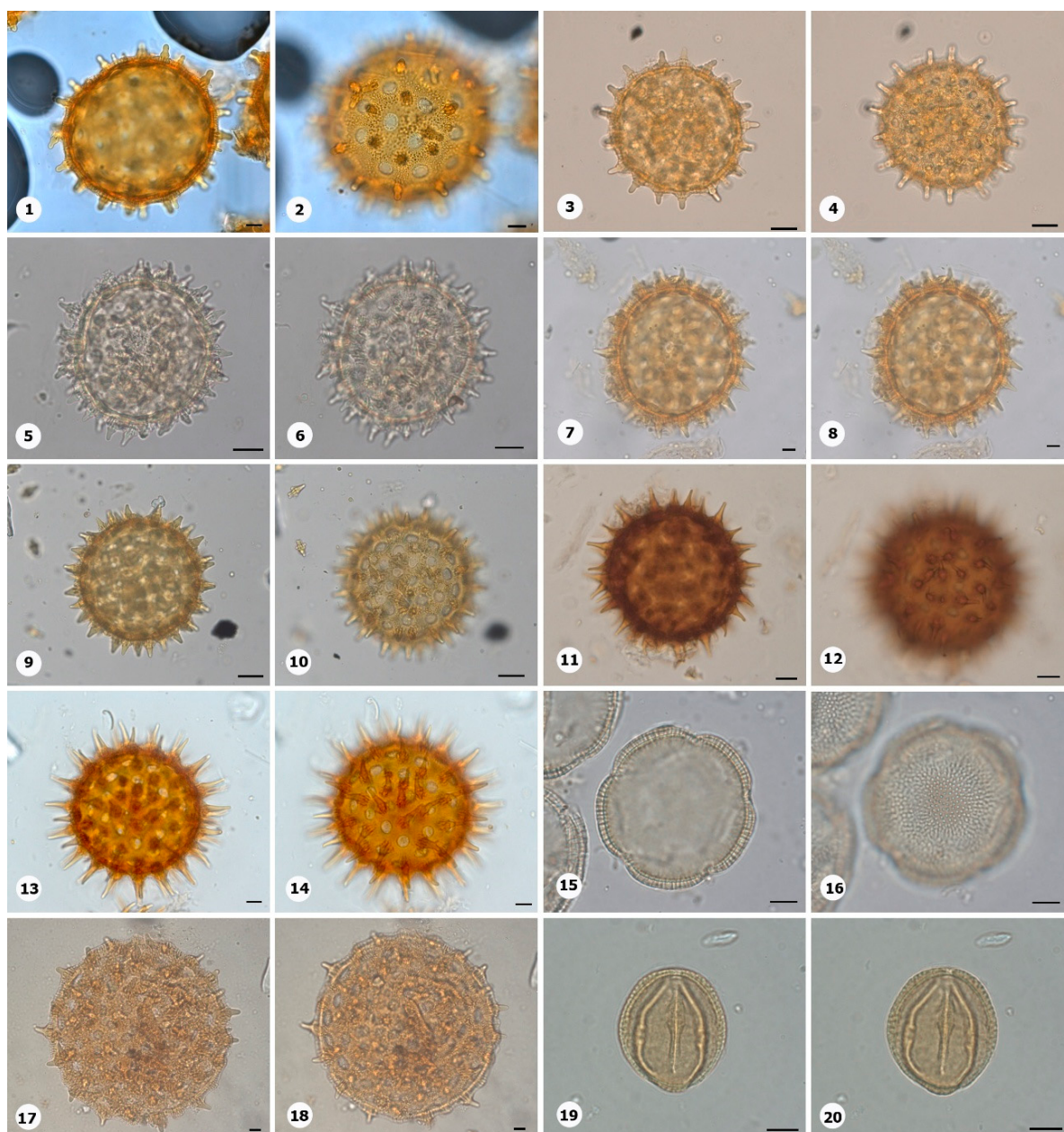


Figure 12. Eudicots. 1-2: *Ipomoea cavalcantei*; 3-4: *Ipomoea cavalcantei* x *marabaensis* (hibrid); 5-6: *Ipomoea decora*; 7-8: *Ipomoea goyazensis*; 9-10: *Ipomoea marabaensis* 11-12: *Ipomoea procumbens*; 13-14: *Ipomoea setifera*; 15-16: *Jacquemontia tamnifolia*; 17-18: *Turbina cordata*; 19-20: *Erythroxylum carajasense*. Scale: 10 μ m.

Species: *Erythroxylum nelson-rosae* Plowman (Figure 13: 1-2)

Herbarium number: MG 112462

Description: Monad, large, isopolar; tricolporate; amb circular, prolate spheroidal; exine 3-4 μ m thick, columellate, tectate, columellate, ornamentation reticulate heterobrochate. P: 56-60 μ m, E: 45-52 μ m.

Life form: Tree and shrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Family: Euphorbiaceae Juss.

Species: *Alchornea discolor* Poepp. (Figure 13: 3-4)

Herbarium number: MG 86323

Description: Monad, medium, isopolar; tricolporate; amb circular, prolate spheroidal to subprolate; exine 1.5-2 μm thick, tectate, ornamentation microreticulate. P: 26-28 μm , E: 24-25 μm .

Life form: Tree.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Aparisthmium cordatum* (A.Juss.) Baill. (Figure 13: 5-6)

Herbarium number: MG 131797

Description: Monad, medium, isopolar; tricolporate, operculate; amb triangular-obtuse-convex to straight, subspheroidal; exine 2-2.6 μm thick, tectate, ornamentation rugulate-punctate. P: 25-30 μm , E: 32-39 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Astraea lobata* (L.) Klotzsch (Figure 13: 7-8)

Herbarium number: MG 213977

Description: Monad, large, isopolar; inaperturate; spheroidal; exine 4 μm thick, columellate, capitate columellae, croton pattern. D: 59-63 μm .

Life form: Shrub and herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Sapium glandulosum* (L.) Morong (Figure 13: 9-10)

Herbarium number: MG 59033

Description: Monad, large, isopolar; tricolporate, lalongate endoaperture; amb triangular-obtuse-convex, prolate, exine 3-4 μm thick, columellate, tectate, ornamentation reticulate. P: 60-68 μm , E: 40-45 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Fabales Bromhead

Family: Fabaceae Juss.

Species: *Abrus fruticulosus* Wight & Arn. (Figure 13: 11-12)

Herbarium number: MG 222313

Description: Monad, medium, isopolar; tricolporate, lalongate endoaperture; amb circular, prolate; exine 1.5-2 μm thick, columellate, ornamentation psilate to punctate. E: 39-45.8 μm , P: 31-32 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Aeschynomene rudis* Benth. (Figure 13: 13-14)

Herbarium number: MG 222328

Description: Monad, small, isopolar; tricolporate, colpi with margo; amb circular, subprolate; exine 1 μm thick, columellate, tectate, ornamentation microreticulate heterobrochate. P: 23.5-29 μm , E: 20.1-22 μm .

Life form: Subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Andira inermis* (W.Wright) DC. (Figure 13: 15-16)

Herbarium number: IAN 195824

Description: Monad, small, isopolar; tricolporate, annulate; amb triangular-obtuse-convex, prolate spheroidal; exine 1 μm thick, tectate, ornamentation microreticulate. P: 21-26.3 μm , E: 20-22.6 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Bauhinia pulchella* Benth. (Figure 13: 17-18)

Herbarium number: INPA 139259

Description: Monad, very large, isopolar; tricolporado, colpi longi, large pores; amb triangular-obtuse-convex, oblate; exine 7-8 μm thick, columellate, ornamentation gemmate and microreticulate. E: 130-165 μm , P: 60-70 μm .

Life form: Tree and shrub.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols, doliniform lakes with organic mud sediments at the bottom.

Species: *Centrosema carajasense* Cavalcante (Figure 13: 19-20)

Herbarium number: MG 214006

Description: Monad, large, isopolar; stephanocolpate, 6 colpi, brevicolpate; amb hexangular, oblate; exine 2-3 μm thick, tectate, ornamentation microreticulate. E: 56-59 μm , P: 28-33.2 μm .

Life form: Liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

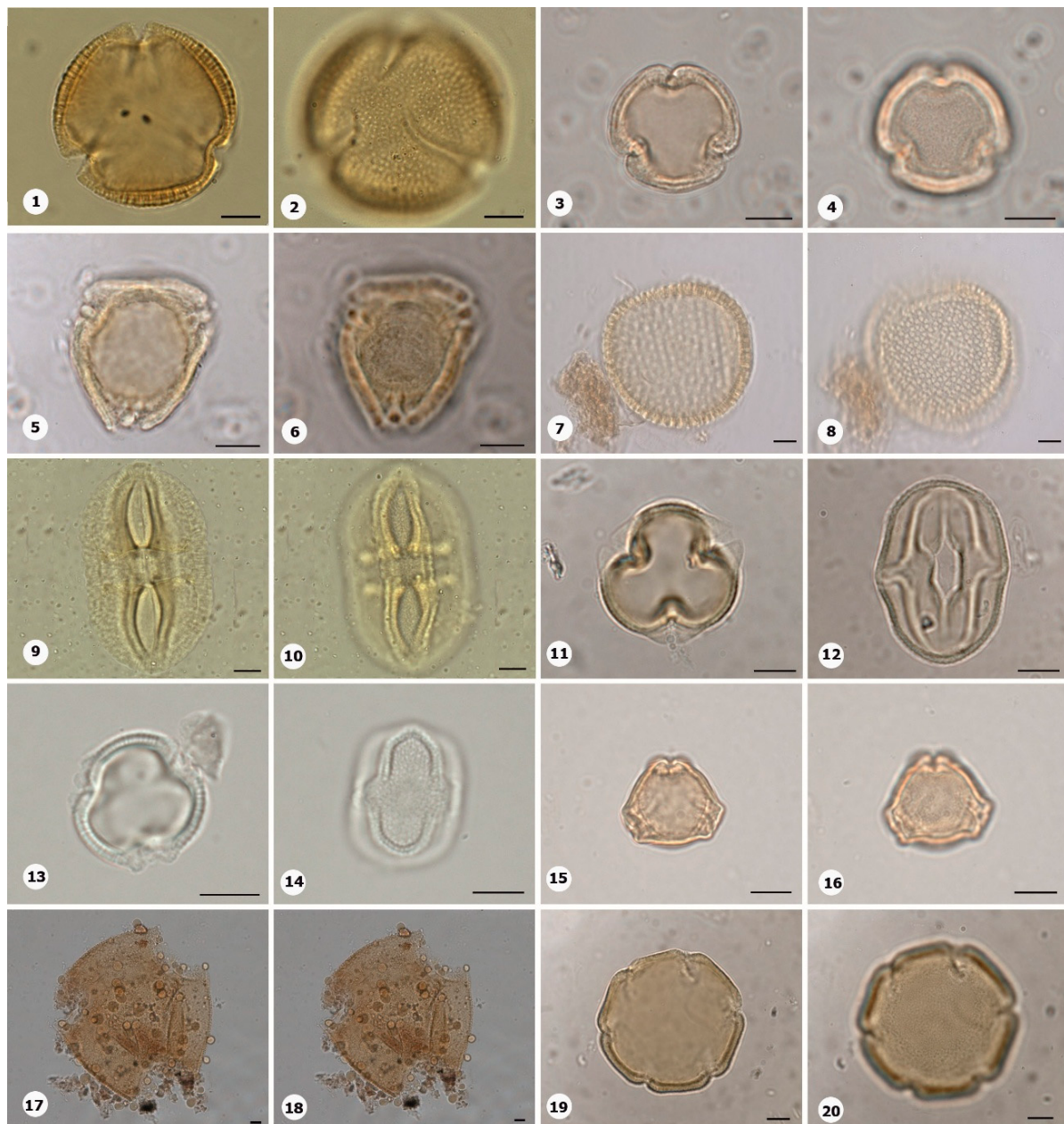


Figure 13. Eudicots. 1-2: *Erythroxylum nelson-rosae*; 3-4: *Alchornea discolor*; 5-6: *Aparisthmium cordatum*; 7-8: *Astraea lobata*; 9-10: *Sapium glandulosum*; 11-12: *Abrus fruticulosus*; 13-14: *Aeschynomene rudis*; 15-16: *Andira inermis*; 17-18: *Bauhinia pulchella*; 19-20: *Centrosema carajasense*. Scale: 10 μ m.

Species: *Cerradicola elliptica* (Desv) L.P.Queiroz (Figure 14: 1-2)

Herbarium number: MG 36728

Description: Monad, large, isopolar; tricolporate; amb triangular-obtuse-convex, subprolate; exine 1.5-2 μ m thick, tectate, ornamentation reticulate heterobrochate. P: 53-54 μ m, E: 43-44 μ m.

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Chamaecrista desvauxii* (Collad.) Killip (Figure 14: 3-4)

Herbarium number: MG 214058

Description: Monad, large, isopolar; tricolporate, costate; amb triangular-obtuse-convexo, perprolate; exine 2-2.5 μ m thick, tectate, ornamentation psilate. P: 69.1-79.4 μ m, E: 34-41.3 μ m.

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

***Species: Chamaecrista flexuosa* (L.) Greene (Figure 14: 5-6)**

Herbarium number: MG 213980

Description: Monad, large, isopolar; tricolporate, costate; amb triangular-obtuse-convexo, prolate; exine 3 μm thick, tectate, ornamentation microreticulate. P: 84-85 μm , E: 50 μm .

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Chamaecrista* sp. 1 (Figure 14: 7-8)**

Herbarium number: MG 214055

Description: Monad, large, isopolar; tricolporate, lalongate; amb triangular-obtuse-convexo, prolate; exine 2-2.5 μm thick, tectate, ornamentation microreticulate. P: 80-90 μm , E: 45.7-56.6 μm .

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Clitoria fairchildiana* R.A.Howard (Figure 14: 9-10)**

Herbarium number: IAN 195827

Description: Monad, large, isopolar; pantocolpate, 5 colpi; amb circular, oblate; exine 1.5-2 μm thick, tectate, ornamentation microreticulate and punctate. E: 72-77 μm , P: 39-45 μm .

Life form: Tree.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

***Species: Copaifera martii* Hayne (Figure 14: 11-12)**

Herbarium number: MG 116170

Description: Monad, medium, isopolar; tricolporate; amb triangular-obtuse-straight, suboblate; exine 1-1.5 μm thick, tectate, ornamentation psilate and scabrate. E: 30-40 μm , P: 20-30 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

***Species: Crotalaria maypurensis* Kunth (Figure 14: 13-14)**

Herbarium number: MG 222334

Description: Monad, large, isopolar; tricolporate, costate; amb triangular-obtuse-convex, prolate; exine 1.5-2 μm thick, columellate, ornamentation microreticulate. P: 36-45 μm , E: 22-28 μm .

Life form: Subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

***Species: Dioclea apurensis* Kunth (Figure 14: 15-16)**

Herbarium number: MG 214377

Description: Monad, large, isopolar; parasyncolporate; amb triangular-obtuse-straight, oblate; exine 5 μm thick, tectate, ornamentation rugulate to reticulate, being predominantly reticulate in the apocolpial field. E: 75-80 μm , P: 40 μm .

Life form: Liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

***Species: Dioclea virgata* (Rich.) Amshoff (Figure 14: 17-18)**

Herbarium number: MG 213961

Description: Monad, large, isopolar; tricolporate; amb triangular-obtuse-straight, peroblate; exine 4 μm thick, tectate, ornamentation reticulate. E: 82.3-94.8 μm , P: 39.5-47 μm

Life form: Liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

***Species: Dipteryx odorata* (Aubl.) Forsyth F. (Figure 14: 19-20)**

Herbarium number: MG 33470

Description: Monad, large, isopolar; parasyncolporate, marginate; amb triangular-obtuse-convex, subspheroidal; exine 2.5 μm thick, columellate, ornamentation microreticulate. P: 46-60 μm , E: 40-54 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

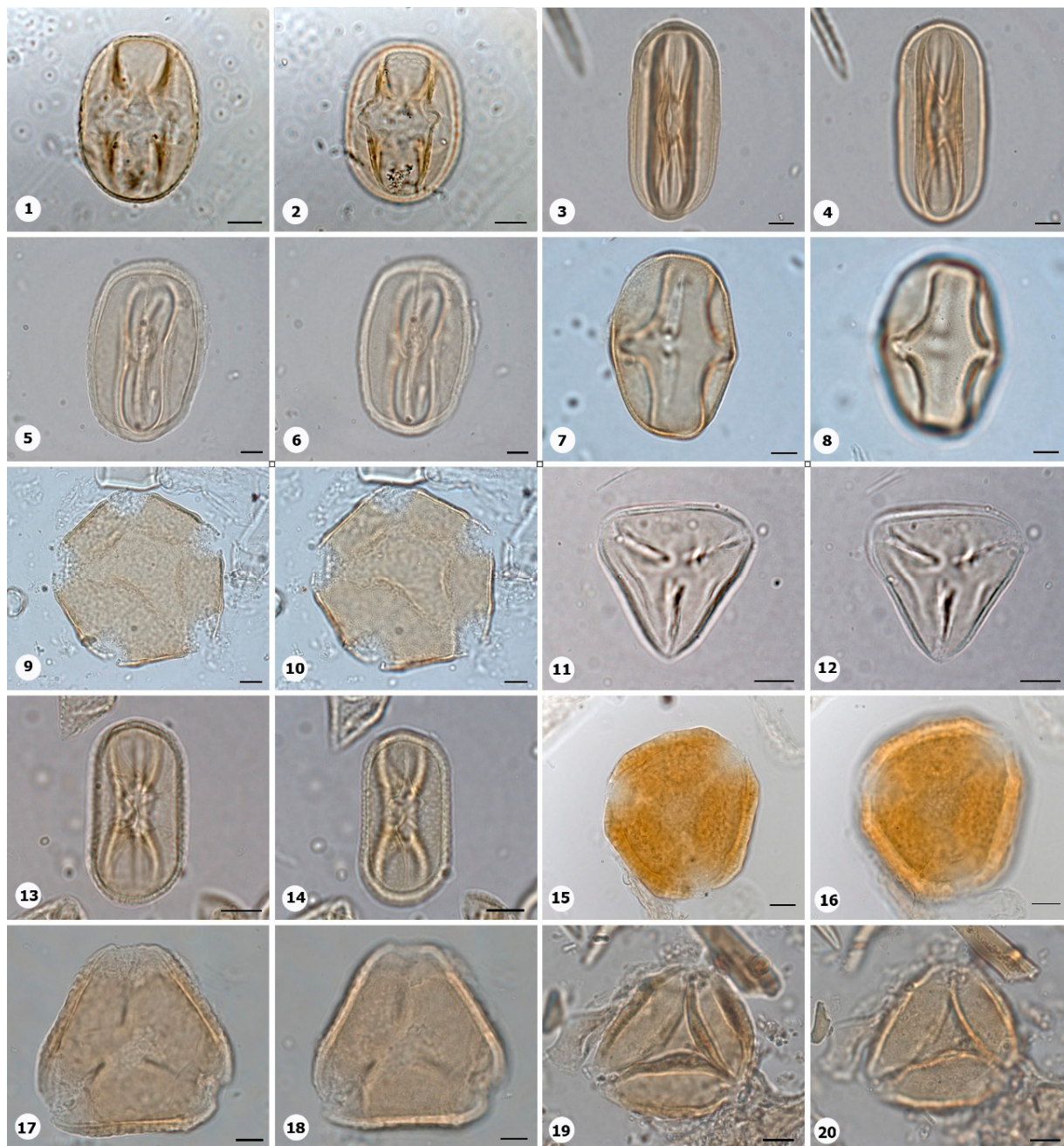


Figure 14. Eudicots. 1-2: *Cerradicola elliptica*; 3-4: *Chamaecrista desvauxii*; 5-6: *Chamaecrista flexuosa*; 7-8: *Chamaecrista* sp. 1; 9-10: *Clitoria fairchildiana*; 11-12: *Copaifera martii*; 13-14: *Crotalaria maypurensis*; 15-16: *Dioclea apurensis*; 17-18: *Dioclea virgata*; 19-20: *Dipteryx odorata*. Scale: 10 μm .

Species: *Mimosa acutistipula* var. *ferrea* Barneby (Figure 15: 1-2)

Herbarium number: MG 213962

Description: Tetragonal tetrad, small, apolar; tetrad calymmate; elliptical; exine 0.6-0.7.5 μm thick, ornamentation microreticulate and psilate. D: 10-14 μm .

Life form: Tree and shrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Mimosa aff. skinneri* Benth. (Figure 15: 3-4)

Herbarium number: MG 222306

Description: Tetrahedral tetrad, very small, apolar; tetrad calymmate; spheroidal; exine 0.5-0.8 μm thick, ornamentation psilate. D: 7-9 μm .

Life form: Shrub and herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols, doliniform lakes with organic mud sediments at the bottom.

Species: *Mimosa carajarum* (Barneby) T.P.Mendes & M.J.Silva (Figure 15: 5-6)

Herbarium number: MG 213978

Description: Tetragonal tetrad, very small, apolar; tetrad calymmate; spheroidal; exine 0.5 μm thick, ornamentation psilate. D: 7-8 μm .

Life form: Shrub and herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Mimosa somnians* var. *viscida* (Willd.) Barneby (Figure 15: 7-8)

Herbarium number: MG 213987

Description: Tetragonal tetrad, small, apolar; tetrad calymmate; elliptical; exine 1 μm thick, ornamentation microreticulate. D: 13-20 μm .

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Mimosa xanthocentra* Mart. (Figure 15: 9-10)

Herbarium number: MG 22307

Description: Tetragonal tetrad, small, apolar; tetrad calymmate; elliptical; exine 0.5-1 μm thick, ornamentation microreticulate. D: 18-20 μm .

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Mimosa xanthocentra* var. *mansii* (Mart.) Barneby (Figure 15: 11-12)

Herbarium number: MG 198053

Description: Tetragonal tetrad, very small, apolar; tetrad calymmate; spheroidal; exine 0.5 μm thick, ornamentation psilate. D: 7-8 μm .

Life form: Subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Parkia platycephala* Benth. (Figure 15: 13-14)

Herbarium number: MG 112372

Description: Polyads, very large, apolar; polyads calymmate with > 20 united grains; elliptical; exine 3.5-5 μm thick, ornamentation psilate to scabrate. D: 160-185 μm .

Life form: Tree.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols, doliniform lakes with organic mud sediments at the bottom.

Species: *Periandra coccinea* (Schrad.) Benth. (Figure 15: 15-16)

Herbarium number: MG 99510

Description: Monad, large, isopolar; tricolporate, colpi longi, marginate, pores large; amb triangular-obtuse-straight, subprolate; exine 3 μm thick, ornamentation punctate. P: 62-64 μm , E: 53-53 μm .

Life form: Liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Periandra mediterranea* (Vell.) Taub. (Figure 15: 17-18)

Herbarium number: MG 213963

Description: Monad, medium, isopolar; tricolporate, marginate; amb triangular-obtuse-convex, prolate spheroidal; exine 1.5-2 μm thick, ornamentation microreticulate. P: 36-44 μm , E: 34-39 μm .

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Schizolobium parahyba* var. *amazonicum* (Huber ex Ducke) Barneby (Figure 15: 19-20)

Herbarium number: MG 30663

Description: Monad, medium, isopolar; tricolporate, marginate; amb circular, prolate spheroidal; exine 2-2.5 μm thick, ornamentation reticulate heterobrochate. P: 37-43.5 μm , E: 29.8-36.1 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

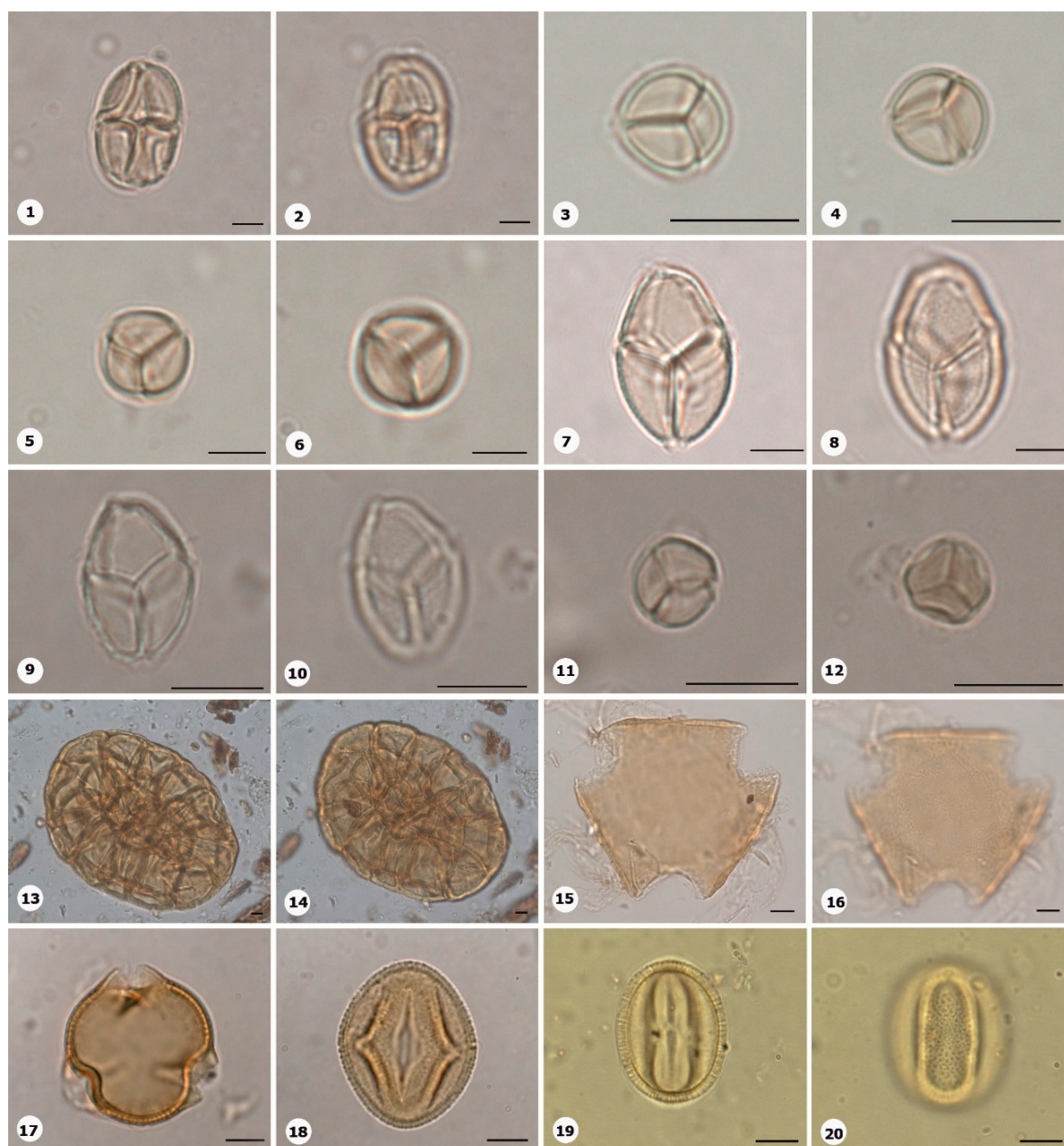


Figure 15. Eudicots. 1-2: *Mimosa acutistipula* var. *ferrea*; 3-4: *Mimosa* aff. *skinneri*; 5-6: *Mimosa carajorum*; 7-8: *Mimosa somnians* var. *viscida*; 9-10: *Mimosa xanthocentra*; 11-12: *Mimosa xanthocentra* var. *mansii*; 13-14: *Parkia platycephala*; 15-16: *Periandra coccinea*; 17-18: *Periandra mediterranea*; 19-20: *Schizolobium parahyba* var. *amazonicum*. Scale: 10 μ m.

Species: *Senna multijuga* (Rich.) H.S.Irwin & Barneby (Figure 16: 1-2)

Herbarium number: MG 3175

Description: Monad, medium, isopolar; tricolporate, costate; amb triangular-obtuse-convex, prolate; exine 2-2.5 μ m thick, ornamentation microreticulate. P: 50-58 μ m, E: 30-48 μ m.

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Senna siamea* (Lam.) H.S.Irwin & Barneby (Figure 16: 3-4)

Herbarium number: IAN 195829

Description: Monad, medium, apolar; tricolporate, brevicolpi; circular; prolate spheroidal; exine 2-2.5 μ m thick, ornamentation rugulate and reticulate. D: 49-50 μ m.

Life form: Tree.

Geoenvironment: Exotic species, forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Stryphnodendron pulcherrimum* (Willd.) Hochr. (Figure 16: 5-6)

Herbarium number: MG 147939

Description: Polyads, medium, apolar; polyads calymmate with 16 united grains; elliptical; exine 1-1.5 μm thick, ornamentation psilate to scabrate. D: 25-32 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Stylosanthes humilis* Kunth (Figure 16: 7-8)

Herbarium number: MG 120653

Description: Monad, large, isopolar; tricolporate; amb elliptical, prolate; exine 2-2.5 μm thick, columellate, ornamentation microreticulate. P: 62-69 μm , E: 41-50.7 μm .

Life form: Subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Tachigali vulgaris* L.G.Silva & H.C.Lima (Figure 16: 9-10)

Herbarium number: MG 59069

Description: Monad, medium, isopolar; tricolporate, colpi slightly marginate; amb circular, prolate; exine 2-2.5 μm thick, columellate, ornamentation microreticulate. P: 30-35 μm , E: 22-25 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Gentianales Juss. ex Bercht. & J. Presl

Family: Gentianaceae Juss.

Species: *Chelonanthus purpurascens* (Aubl.) Struwe et al. (Figure 16: 11-12)

Herbarium number: MG 214028

Description: Tetrahedral tetrad, large, apolar; 3-hemicolporate, marginate, calymmate; triangular in lateral view; 4-5 μm thick, tectate, columellate, ornamentation reticulate. D: 70-80 μm .

Life form: Tree.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Schultesia benthamiana* Klotzsch ex Griseb (Figure 16: 13-14)

Herbarium number: MG 214028

Description: Tetrahedral tetrad, large, apolar; 3-hemicolporate, marginate, calymmate; triangular in lateral view; 5-6 μm thick, tectate, columellate, ornamentation reticulate, curvimurate. D: 80-92 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Order: Malpighiales Juss. ex Bercht. & J. Presl

Family: Hypericaceae Juss.

Species: *Vismia cayennensis* (Jacq.) Pers. (Figure 16: 15-16)

Herbarium number: MG 87024

Description: Monad, medium to large, isopolar; parasyncolporate, syncolporate, marginate; amb circular, prolate; exine 1-1.5 μm thick, tectate, columellate, ornamentation reticulate heterobrochate, microreticulate near margines. P: 40-52 μm , E: 30-38 μm

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Lamiales Bromhead

Family: Lamiaceae Lindl.

Species: *Hyptis atrorubens* Poit. (Figure 16: 17-18)

Herbarium number: MG 87024

Description: Monad, medium, isopolar; stephanocolpate, 6 colpi longi; amb circular, oblate; exine 2.5-3 μm thick, tectate, columellate, ornamentation reticulate heterobrochate. E: 30-40 μm , P: 15-20 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Hyptis parkeri* Benth. (Figure 16: 19-20)

Herbarium number: MG 120793

Description: Monad, medium, isopolar; stephanocolpate, 6 colpi longi; amb circular, oblate; exine 2.5-3 μm thick, tectate, columellate, ornamentation reticulate heterobrochate. E: 35-45 μm , P: 20-25 μm .

Life form: Herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

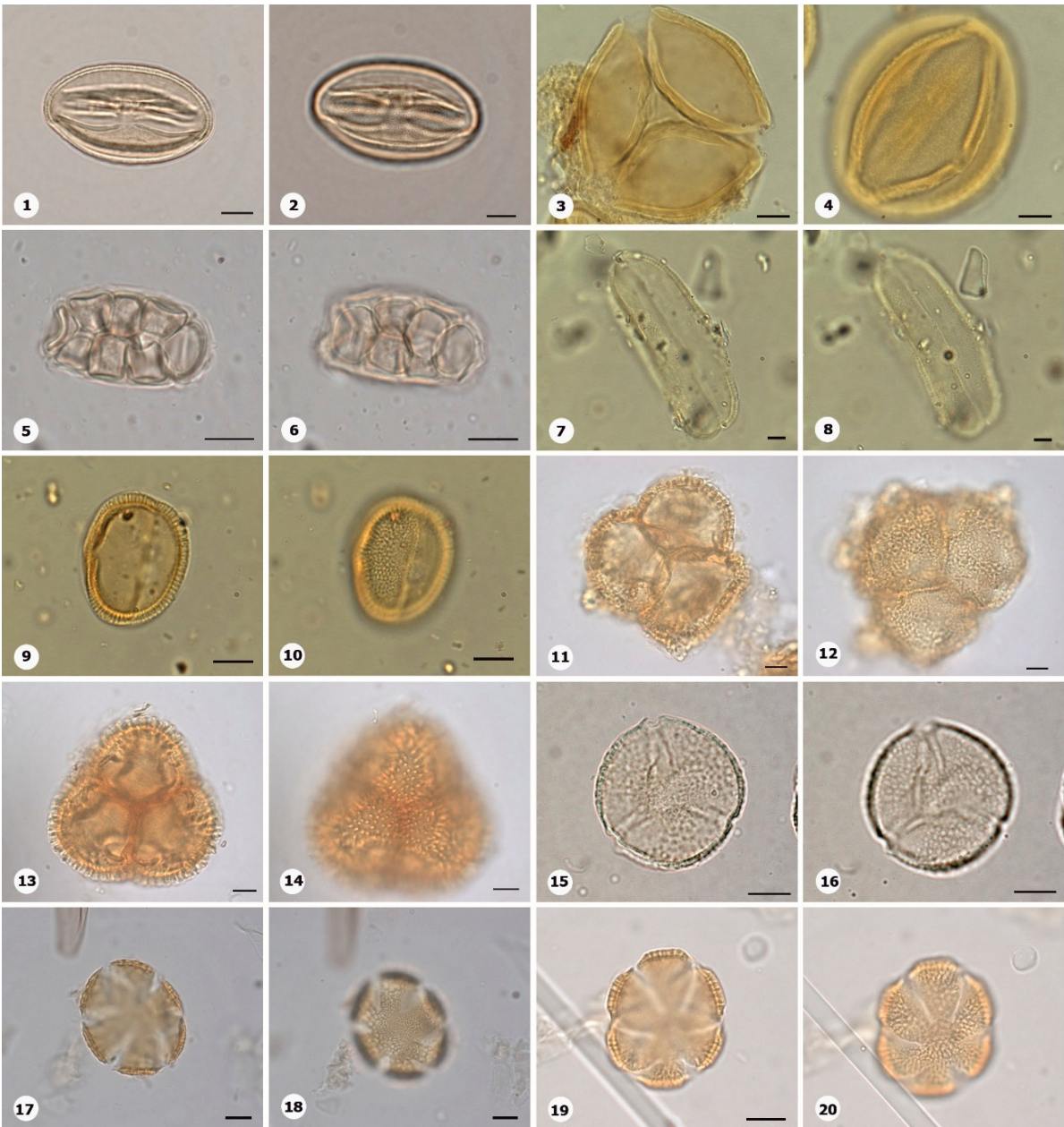


Figure 16. Eudicots. 1-2: *Senna multijuga*; 3-4: *Senna siamea*; 5-6: *Stryphnodendron pulcherrimum*; 7-8: *Stylosanthes humilis*; 9-10: *Tachigali vulgaris*; 11-12: *Chelonanthus purpurascens*; 13-14: *Schultesia benthamiana*; 15-16: *Vismia cayennensis*; 17-18: *Hyptis atrorubens*; 19-20: *Hyptis parkeri*. Scale: 10 μm .

Order: Ericales Mart.

Family: Lecythidaceae A.Juss.

Species: *Bertholletia excelsa* Bonpl. (Figure 17: 1-2)

Herbarium number: MG 60382

Description: Monad, medium, isopolar; tricolporate; amb triangular-obtuse-convex, subprolate; exine 2 μm thick, tectate, columellate, ornamentation microreticulate. P: 42-50 μm , E: 29-32.8 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Lamiales Bromhead

Family: Lentibulariaceae Rich

Species: *Utricularia pusilla* Vahl (Figure 17: 3-4)

Herbarium number: MG 222342

Description: Monad, small, isopolar; stepahnocolporate, 8-9 colporus; amb circular, subprolate; exine 1 μm thick, tectate, ornamentation psilate to scabrate. P: 18-23 μm , E: 15-17 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, doliniform lakes with organic mud sediment at the bottom.

Species: *Utricularia* sp. 1 (Figure 17: 5-6)

Herbarium number: MG 213996

Description: Monad, small, isopolar; stepahnocolporate, 9-10 colpi; amb circular, subprolate; exine 0.5-0.7 μm thick, tectate, ornamentation psilate to scabrate. P: 15-17.5 μm , E: 10.9-13.4 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, doliniform lakes with organic mud sediment at the bottom.

Species: *Utricularia* sp. 2 (Figure 17: 7-8)

Herbarium number: MG 214072

Description: Monad, medium, isopolar; stepahnocolporate, 13-15 colporus; amb circular, prolate spheroidal; exine 1.5-2 μm thick, tectate, ornamentation microreticulate. P: 26-30 μm , E: 23-27 μm .

Life form: Herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, doliniform lakes with organic mud sediment at the bottom.

Order: Myrtales Juss. ex Bercht. & J. Presl

Family: Lythraceae J.St.-Hil.

Species: *Cuphea annulata* Koehne (Figure 17: 9-10)

Herbarium number: MG 213965

Description: Monad, medium, isopolar; syncolporate, short colpi, protruding pores; amb triangular-obtuse-straight, oblate; exine 1-3 μm thick, thickening in the region between the endoapertures, tectate, ornamentation striate. E: 33.8-37.2 μm , P: 22-17.4 μm .

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Cuphea carajasensis* Lourteig (Figure 17: 11-12)

Herbarium number: MG 222339

Description: Monad, medium, isopolar; syncolporate, short colpi, protruding and large pores with 4-5 μm diameter; amb triangular-obtuse-straight, oblate; exine 1-3 μm thick, thickening in the region between the endoapertures, tectate, ornamentation striate. E: 26-29 μm , P: 16-20 μm .

Life form: Shrub and subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Cuphea* sp. 1 (Figure 17: 13-14)

Herbarium number: MG 214023

Description: Monad, medium, isopolar; syncolporate, short colpi, protruding pores; amb triangular-obtuse-straight, oblate; exine 1-3 μm thick, thickening in the region between the endoapertures, tectate, ornamentation striate. E: 33-37.6 μm , P: 23.3-29.9 μm .

Life form: Shrub, subshrub, herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Cuphea* sp. 2 (Figure 17: 15-16)

Herbarium number: MG 214065

Description: Monad, small, isopolar; parasyncolporate, marginate; amb triangular-obtuse-convex, subprolate; exine 1-3 μm thick, ornamentation psilate. P: 22-24 μm , E: 17-21 μm .

Life form: Shrub, subshrub, herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Cuphea* sp. 3 (Figure 17: 17-18)

Herbarium number: MG 213967

Description: Monad, medium, isopolar; tricolporate, brevicolpi, protruding pores; amb triangular-obtuse-concave, oblate; exine 1-2 μm thick, tectate, ornamentation microreticulate. E: 21-24.7 μm , P: 18-21 μm .

Life form: Shrub, subshrub, herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Order: Malpighiales Juss. ex Bercht. & J. Presl

Family: Malpighiaceae Juss.

Species: *Banisteriopsis appressa* (B.Gates) R.F.Almeida & M.Pell. (Figure 17: 19-20)

Herbarium number: MG 213959

Description: Monad, large, apolar; pantoporate, large pores, pseudocolpate; quadrangular; exine 3-4 μm thick, tectate, ornamentation microreticulate. D: 43-54 μm .

Life form: Shrub, subshrub, liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

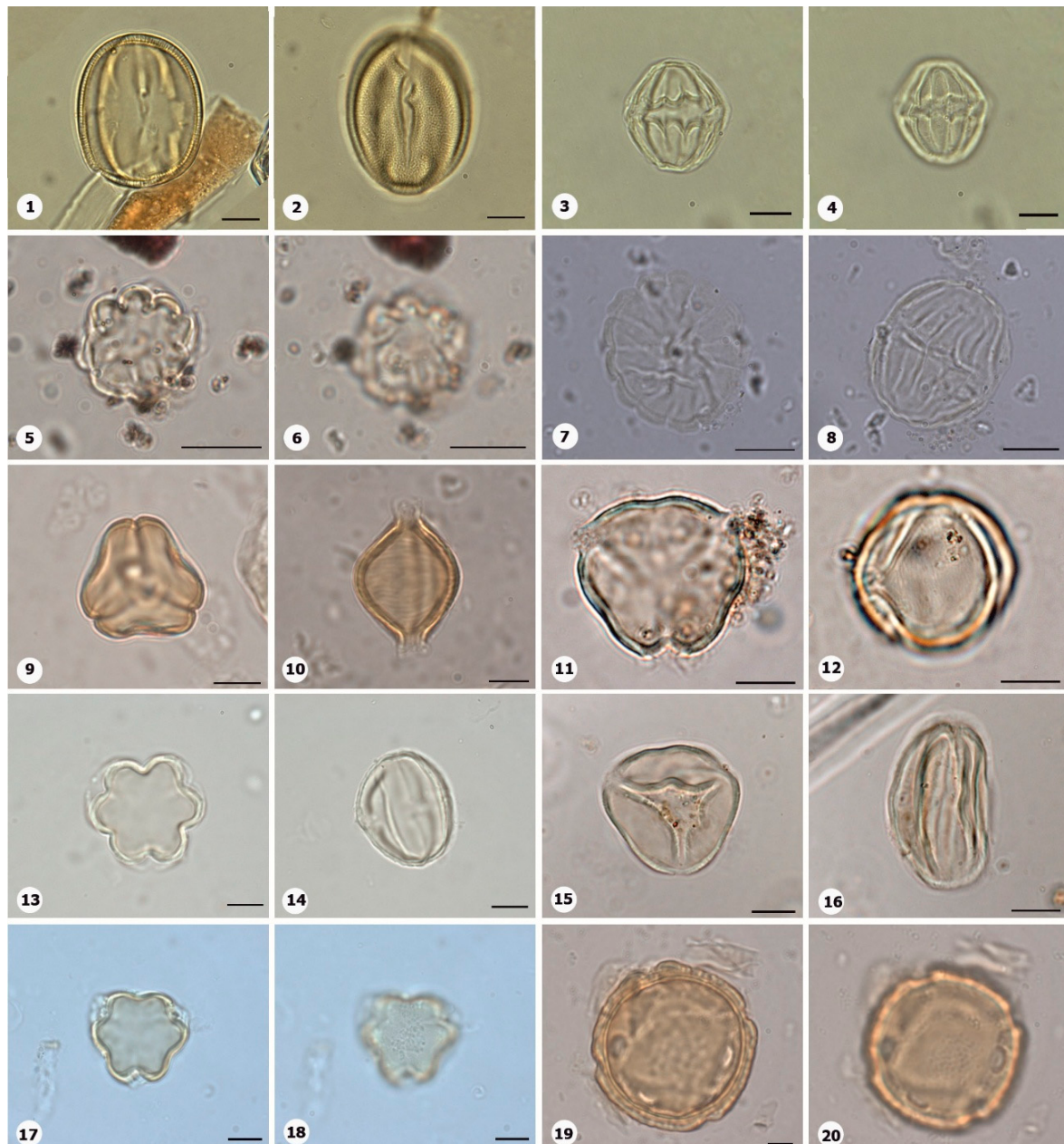


Figure 17. Eudicots. 1-2: *Bertholletia excelsa*; 3-4: *Utricularia pusilla*; 5-6: *Utricularia* sp. 1; 7-8: *Utricularia* sp. 2; 9-10: *Cuphea annulata*; 11-12: *Cuphea carajasensis*; 13-14: *Cuphea* sp. 1; 15-16: *Cuphea* sp. 2; 17-18: *Cuphea* sp. 3; 19- 20: *Banisteriopsis appressa*. Scale: 10 μ m.

Species: *Banisteriopsis malifolia* (Nees & Mart.) B.Gates (Figure 18: 1-2)

Herbarium number: MG 222352

Description: Monad, large, apolar; pantoporate, large pores, pseudocolpate; spheroidal to quadrangular; exine 8-9 μ m thick, tectate, ornamentation microreticulate. D: 50-55 μ m.

Life form: Shrub and subshrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Banisteriopsis* sp. 1 C.B.Rob. ex Small (Figure 18: 3-4)

Herbarium number: MG 214076

Description: Monad, large, apolar; pantoporate, large pores, pseudocolpate; spheroidal to hexangular; exine 5-6 μ m thick, tectate, ornamentation microreticulate. D: 60-70 μ m.

Life form: Shrub, subshrub, liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Byrsonima chrysophylla* Kunth (Figure 18: 5-6)

Herbarium number: MG 125695

Description: Monad, small, isopolar; tricolporate, protruding pores, brevicolpi; amb circular, spheroidal; exine 1 μm thick, tectate, columellate, ornamentation microreticulate. P: 20-23 μm , E: 19-21 μm .

Life form: Tree and shrub.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Byrsonima spicata* (Cav.) DC. (Figure 18: 7-8)

Herbarium number: IAN 195825

Description: Monad, small, isopolar; tricolporate, protruding pores, brevicolpi; amb circular, spheroidal; exine 1 μm thick, tectate, columellate, ornamentation microreticulate. P: 15.8-14.2 μm , E: 14.2-14.9 μm .

Life form: Tree.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Diplopterys pubipetala* (A.Juss.) W.R.Anderson & C.C.Davis (Figure 18: 9-10)

Herbarium number: MG 85808

Description: Monad, large, apolar; pantoporate, large pores, pseudocolpate; spheroidal to quadrangular; exine 5-6 μm thick, tectate, ornamentation microreticulate. D: 50-60 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Spachea lactescens* (Ducke) R.F.Almeida & M.Pell. (Figure 18: 11-12)

Herbarium number: MG 30032

Description: Monad, small, isopolar; tricolporate, protruding pores, brevicolpi; amb circular, prolate spheroidal; exine 1.5-1.7 μm thick, tectate, columellate, ornamentation microreticulate. P: 22-26 μm , E: 22-25 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Malvales Juss.

Family: Malvaceae Juss.

Species: *Guazuma ulmifolia* Lam. (Figure 18: 13-14)

Herbarium number: MG 30109

Description: Monad, small, isopolar; tricolporate; amb circular, prolate spheroidal; exine 1.5 μm thick, tectate, ornamentation reticulate heterobrochate. P: 22-24 μm , E: 22-23 μm .

Life form: Tree.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Species: *Melochia arenosa* Benth. (Figure 18: 15-16)

Herbarium number: MG 222336

Description: Monad, large, isopolar; tricolporate, brevicolpi, lalongate; amb circular, prolate spheroidal; exine 2-3 μm thick, tectate, columellate; ornamentation microreticulate. P: 54.4-57 μm , E: 53-54.7 μm .

Life form: Tree and shrub.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Melochia spicata* (L.) Fryxell (Figure 18: 17-18)

Herbarium number: HCJS 023

Description: Monad, medium to large, isopolar; tricolporate, brevicolpi, protruding pores; amb triangular-obtuse-convex, oblate spheroidal; exine 2-3 μm thick, tectate, columellate, ornamentation microreticulate, reticulate near the apertural region. P: 45-48 μm , E: 45-52 μm .

Life form: Tree and shrub.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Theobroma grandiflorum* (Willd. ex Spreng.) K.Schum. (Figure 18: 19-20)

Herbarium number: IAN 195841

Description: Monad, small to medium, isopolar; tricolporate, brevicolpi, lalongate; amb circular, prolate spheroidal; exine 1-1.5 μm thick, tectate, columellate, ornamentation reticulate heterobrochate. P: 24-32, E: 22-30.

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

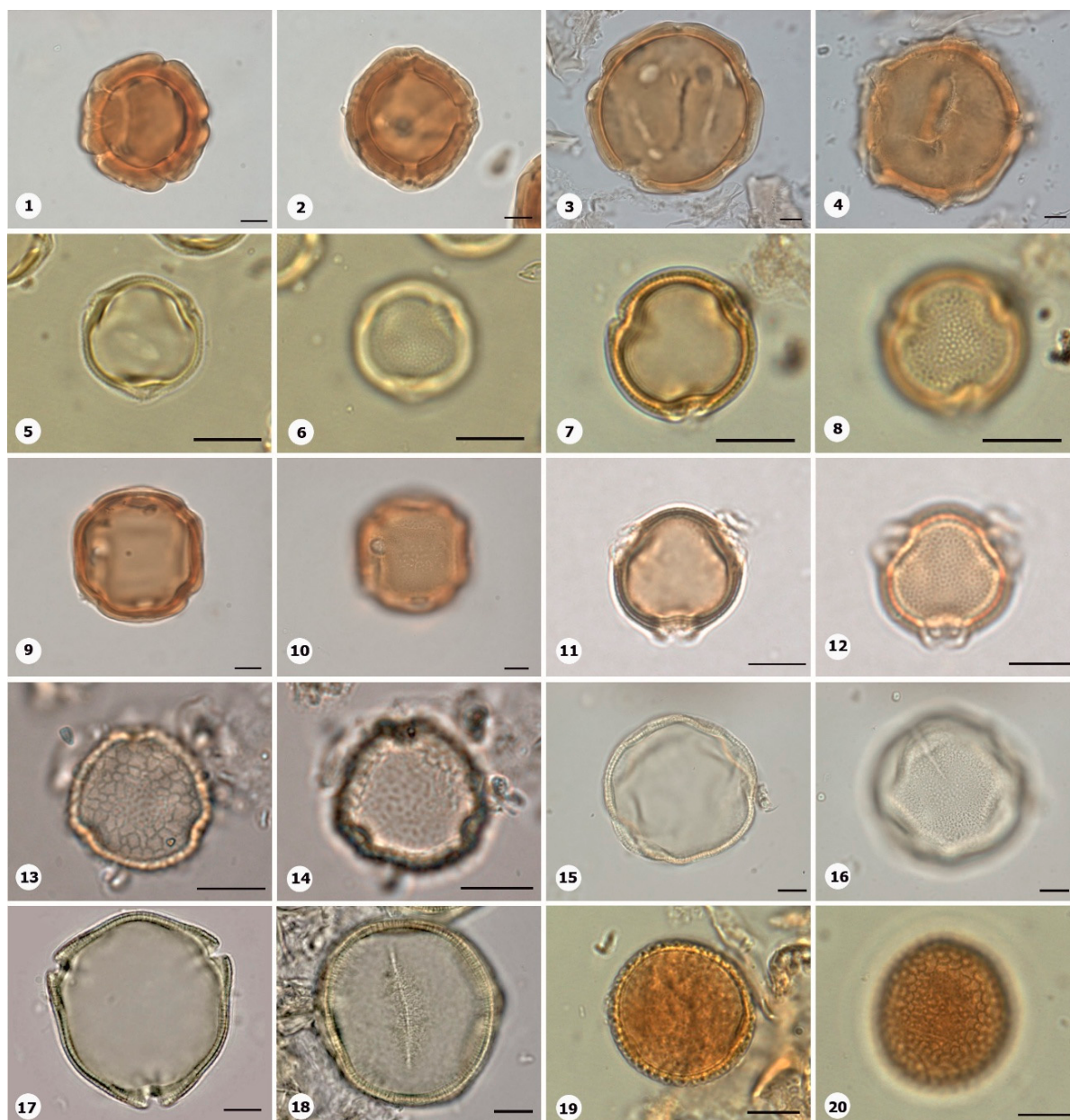


Figure 18. Eudicots. 1-2: *Banisteriopsis malifolia*; 3-4: *Banisteriopsis* sp. 1; 5-6: *Byrsonima chrysophylla*; 7-8: *Byrsonima spicata*; 9-10: *Diplopterys pubipetala*; 11-12: *Spachea lactescens*; 13-14: *Guazuma ulmifolia*; 15-16: *Melochia arenosa*; 17-18: *Melochia spicata*; 19-20: *Theobroma grandiflorum*. Scale: 10 μm .

Order: Ericales Bercht. & J. Presl

Family: Marcgraviaceae Bercht. & J.Presl

Species: *Norantea guianensis* Aubl. (Figure 19: 1-2)

Herbarium number: MG 222339

Description: Monad, medium, isopolar; tricolporate, brevicolpi; amb circular, oblate spheroidal to prolate spheroidal; exine 3.5-4 μm thick, tectate, columellate, ornamentation microreticulate to scabrate. P: 26-36, E: 27-37.

Life form: Liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Order: Myrtales Juss. ex Bercht. & J. Presl

Family: Melastomataceae Juss.

Species: *Miconia chamissois* Naudin (Figure 19: 3-4)

Herbarium number: MG 214002

Description: Monad, medium, isopolar; tricolporate, 3 pseudocolpi, lalongate; amb circular, subprolate to prolate; exine 2 μm thick, tectate, ornamentation psilate. P: 36-40 μm , E: 28-32 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Pleroma stenocarpum* (Schränk et Mart. ex DC.) Triana (Figure 19: 5-6)

Herbarium number: MG 214035

Description: Monad, small, isopolar; tricolporate, slightly, costate, 3 pseudocolpi; amb circular, subprolate; exine 1-1.5 μm thick, tectate, ornamentation psilate. P: 20-24 μm , E: 17-20 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Sapindales Juss. ex Bercht. & J. Presl

Family: Meliaceae Juss.

Species: *Carapa guianensis* Aubl. (Figure 19: 7-8)

Herbarium number: MG 77934

Description: Monad, large, isopolar; pantocolporate, 4 brevicolpi, marginate; amb circular, oblate spheroidal; exine 2-4 μm thick, tectate, columellate, ornamentation microreticulate. E: 52-61 μm , P: 50-60 μm .

Life form: Tree.

Geoenvironment: Managed species, forested slopes and caves over plinthosols and ferralsols.

Order: Asterales Link

Family: Menyanthaceae Dumort.

Species: *Nymphoides humboldtiana* (Kunth) Kuntze (Figure 19: 9-10)

Herbarium number: MG 214022

Description: Monad, small, isopolar; parasyncolporate, large colpi, marginate; amb triangular-obtuse-straight, oblate; exine 2 μm thick, tectate, columellate, ornamentation microreticulate. E: 42-55 μm , P: 30-35 μm .

Life form: Herb.

Geoenvironment: Doliniform lakes with organic mud sediments at the bottom.

Order: Magnoliales Bromhead

Family: Myristicaceae R.Br.

Species: *Virola michelii* Heckel (Figure 19: 11-12)

Herbarium number: IAN 146780

Description: Monad, medium, heteropolar; monocolpate, large colpi, marginate; amb triangular-obtuse-straight, oblate to suboblate; exine 1.5-2 μm thick, tectate, columellate, ornamentation reticulate heterobrochate. E: 30-44 μm , P: 25-28 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Myrtales Juss. ex Bercht. & J. Presl

Family: Myrtaceae Juss.

Species: *Eugenia flavescens* DC. (Figure 19: 13-14)

Herbarium number: MG 112463

Description: Monad, small, isopolar; syncolporate, 3 colpi; amb triangular-obtuse-convex, oblate; exine 1 μm thick, tectate, ornamentation microreticulate. E: 18-22 μm , P: 12-14 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Eugenia puniceifolia* (Kunth) DC. (Figure 19: 15-16)

Herbarium number: MG 174698

Description: Monad, small to medium, isopolar; parasyncolporate, 3-4 colpi; amb triangular-obtuse-concave to quadrangular, oblate; exine 1 μm thick, tectate, ornamentation microreticulate to scabrate. E: 24-28 μm , P: 15-18 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Myrcia multiflora* (Lam.) DC. (Figure 19: 17-18)

Herbarium number: MG 112459

Description: Monad, small, isopolar; syncolporate, 3 colpi; amb triangular-obtuse-straight, oblate; exine 1.5-2 μm thick, tectate, ornamentation microreticulate to scabrate. E: 20-25 μm , P: 15-18 μm .

Life form: Tree and shrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Family: Passifloraceae Juss. ex Roussel

Species: *Passiflora glandulosa* Cav. (Figure 19: 19-20)

Herbarium number: MG 216102

Description: Monad, large, isopolar; syncolpate, 3-mesocolpi fused in pairs; amb circular, prolate spheroidal; exine 9-10 μm thick, tectate, columellate, ornamentation reticulate, curvimate, sometimes bacula are observed. P: 90-94 μm , E: 88-92 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

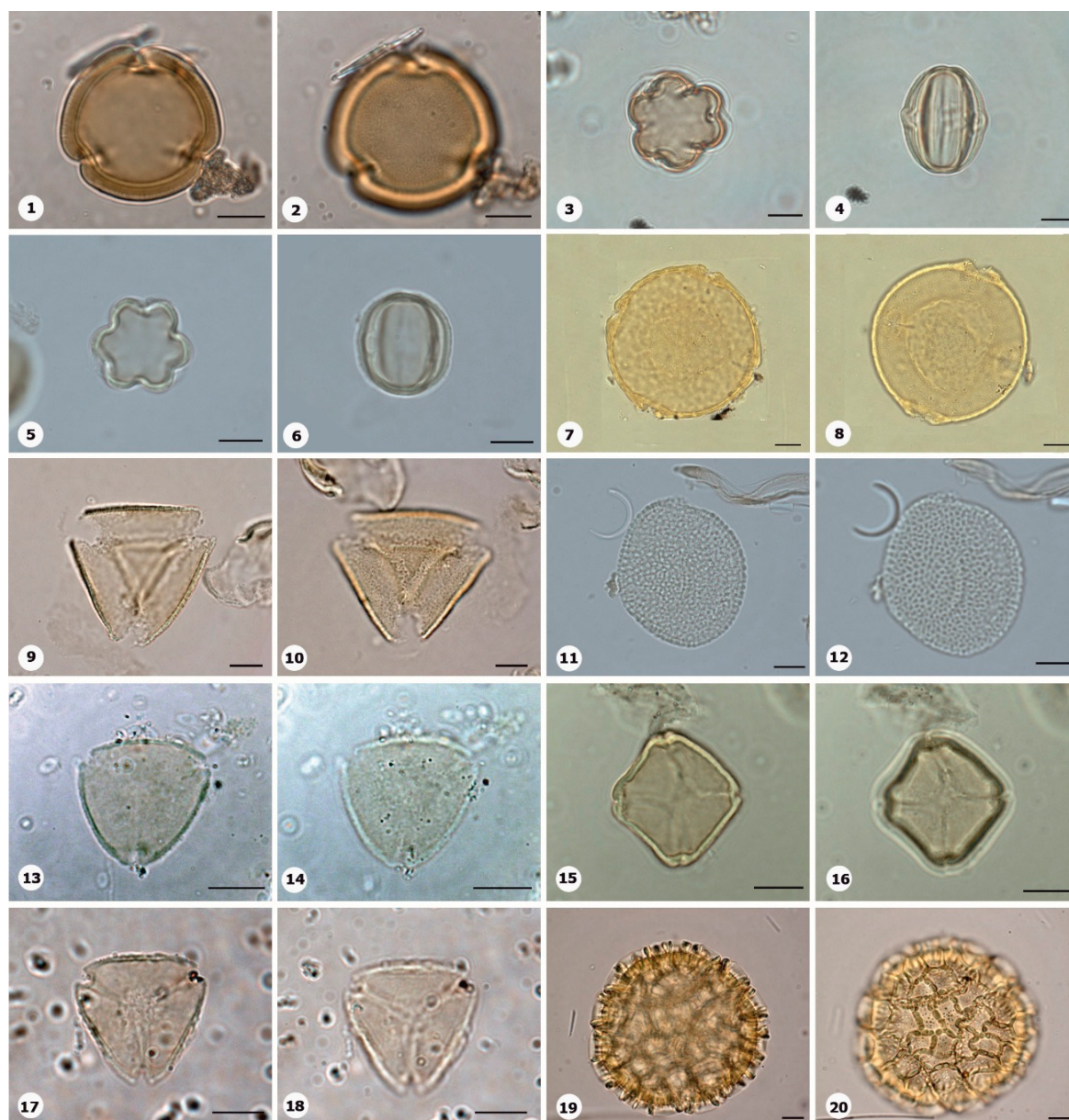


Figure 19. Eudicots. 1-2: *Norantea guianensis*; 3-4: *Miconia chamissois*; 5-6: *Pleroma stenocarpum*; 7-8: *Carapa guianensis*; 9-10: *Nymphoides humboldtiana*; 11-12: *Virola michelii*; 13-14: *Eugenia flavescens*; 15-16: *Eugenia punicifolia*; 17-18: *Myrcia multiflora*; 19-20: *Passiflora glandulosa*. Scale: 10 μ m.

Species: *Passiflora tholozanii* Sacco (Figure 20: 1-2)

Herbarium number: MG 216123

Description: Monad, large, isopolar; syncolpate, 3-mesocolpi fused in pairs; amb circular, prolate spheroidal; exine 8-9 μ m thick, tectate, columellate, ornamentation reticulate, curvimate, sometimes bacula are observed. P: 70-82 μ m, E: 68-80 μ m.

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Family: Phyllanthaceae Martinov

Species: *Phyllanthus hyssopifolioides* Kunth (Figure 20: 3-4)

Herbarium number: MG 216123

Description: Monad, medium, isopolar; tricolporate, costate, marginate; amb elliptical, perprolate; exine 1 μm thick, tectate, columellate, ornamentation reticulate hetebrochate. P: 38-42 μm , E: 15-17 μm .

Life form: Shrub and herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Order: Fabales Bromhead

Family: Polygalaceae Hoffmanns. & Link

Species: *Caamembeca spectabilis* (DC.) J.F.B.Pastore (Figure 20: 5-6)

Herbarium number: MG 222363

Description: Monad, large to very large, isopolar; stephanocolporate, 12 colporus, zonorate; amb elliptical, prolate; exine 4-5 μm thick, tectate, ornamentation microreticulate to perforate. P: 100-110 μm , E: 69-70 μm .

Life form: Subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Securidaca diversifolia* (L.) S.F.Blake (Figure 20: 7-8)

Herbarium number: MG 222364

Description: Monad, medium, isopolar; stephanocolporate, 12 colporus, zonorate; amb elliptical, prolate; exine 2-3 μm thick, tectate, ornamentation microreticulate to perforate. P: 40-46 μm , E: 30-35 μm .

Life form: Liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Senega adenophora* (DC.) J.F.B.Pastore (Figure 20: 9-10)

Herbarium number: MG 222337

Description: Monad, large, isopolar; stephanocolporate, 12 colporus, zonorate; amb elliptical, prolate; exine 3-4 μm thick, tectate, ornamentation microreticulate. P: 40-46 μm , E: 75-80 μm , P: 55-60 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Order: Gentianales Juss. ex Bercht. & J. Presl

Family: Rubiaceae Juss.

Species: *Borreria alata* (Aubl.) DC. (Figure 20: 11-12)

Herbarium number: MG 115799

Description: Monad, medium, apolar; pantoporate; spheroidal; exine 3-3.5 μm thick, tectate, columellate, ornamentation puntate with microechinae. D: 35-40 μm .

Life form: Subshrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Borreria elaiosulcata* E.L.Cabral & L.M.Miguel (Figure 20: 13-14)

Herbarium number: MG 222332

Description: Monad, medium, apolar; pantoporate; spheroidal; exine 2-3 μm thick, tectate, columellate, ornamentation puntate with microechinae. D: 33-40 μm .

Life form: Subshrub.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols, forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols, doliniform lakes with organic mud sediments at the bottom.

Species: *Borreria latifolia* (Aubl.) K.Schum (Figure 20: 15-16)

Herbarium number: MG 115799

Description: Monad, large, apolar; pantoporate; spheroidal; exine 4 μm thick, tectate, columellate, ornamentation puntate with microechinae. D: 50-60 μm .

Life form: Shrub and herb.

Geoenvironment: Poorly drained depressions and levels over plinthosols and histosols.

Species: *Borreria paraensis* E.L.Cabral & Bacigalupo (Figure 20: 17-18)

Herbarium number: MG 214083

Description: Monad, small, apolar; pantoporate; spheroidal; exine 2-2.5 μm thick, tectate, columellate, ornamentation puntate with microechinae. D: 20-24 μm .

Life form: Shrub and herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Carajasia cangae* R.M.Salas, E.L.Cabral & Dessein (Figure 20: 19-20)

Herbarium number: MG 213972

Description: Monad, medium, apolar; stephanocolporate, 5-7 brevicolpi; spheroidal; exine 2 μm thick, tectate, columellate, ornamentation microreticulate, sometimes curvimurate. D: 25-30 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

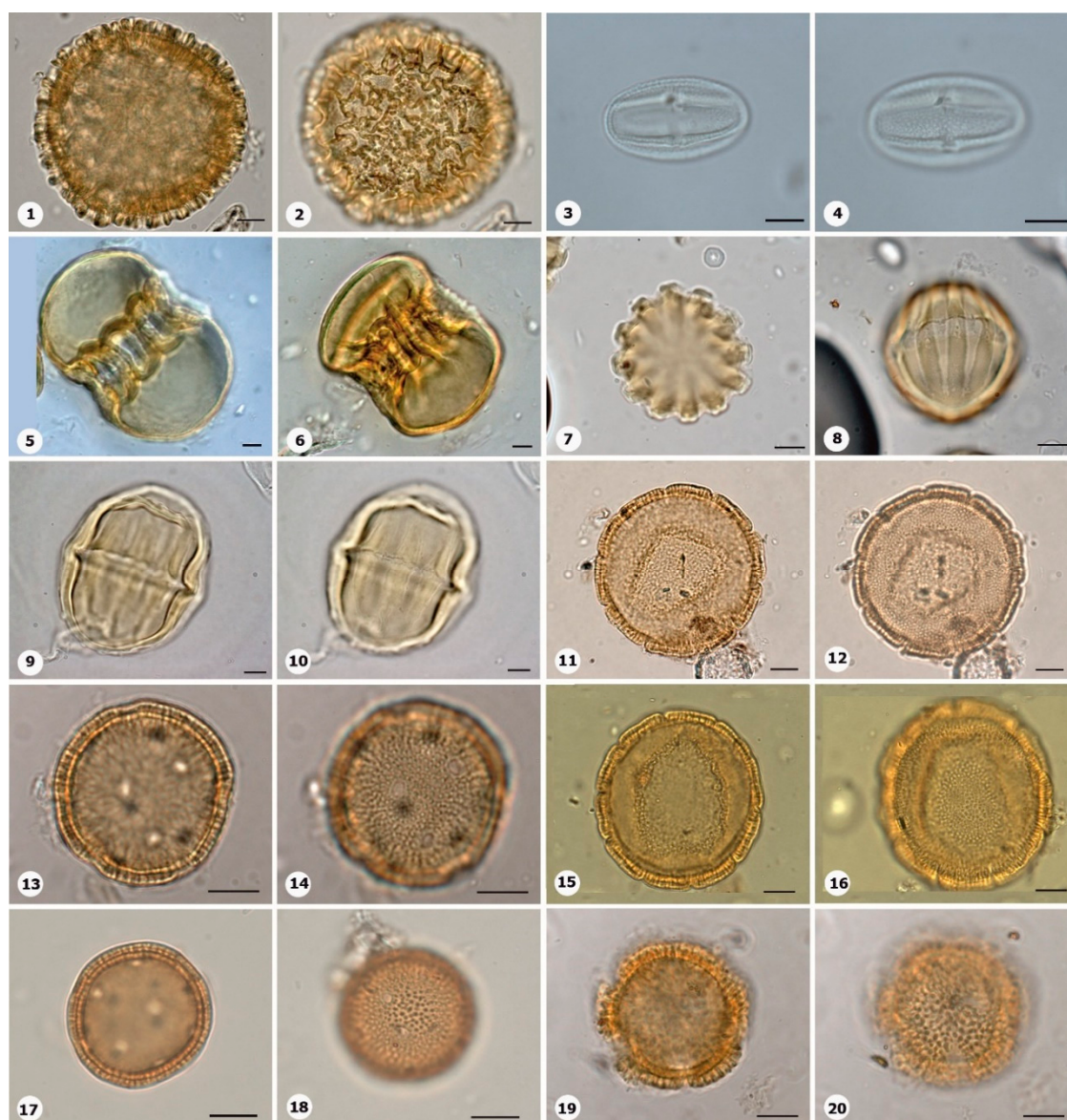


Figure 20. Eudicots. 1-2: *Passiflora tholozanii*; 3-4: *Phyllanthus hyssopifolioides*; 5-6: *Caamembeca spectabilis*; 7-8: *Securidaca diversifolia*; 9-10: *Senega adenophora*; 11-12: *Borreria alata*; 13-14: *Borreria elaiosulcata*; 15-16: *Borreria latifolia*; 17-18: *Borreria paraensis*; 19-20: *Carajasia cangae*. Scale: 10 μm .

Species: *Ixora coccinea* L. (Figure 21: 1-2)

Herbarium number: IAN 195851

Description: Monad, medium, isopolar; tricolporate, lalongate, slightly marginate; amb circular, prolate spheroidal; exine 2 μm thick, tectate, columellate, ornamentation reticulate heterobrochate. P: 35-40 μm , E: 35-40 μm .

Life form: Shrub.

Geoenvironment: Anthropic areas.

Species: *Mitracarpus carajasensis* E.L.Cabral, Sobrado & E.B.Souza (Figure 21: 3-4)

Herbarium number: MG 208513

Description: Monad, small, isopolar; pantocolpate, 5 brevi colpi; amb circular, prolate spheroidal; exine 2-3 μm thick, tectate, columellate, ornamentation punctate with microechinae. P: 20-24 μm , E: 20-24 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, doliniform lakes with organic mud sediment at the bottom.

Species: *Perama carajensis* J.H.Kirkbr. (Figure 21: 5-6)

Herbarium number: MG 222331

Description: Monad, medium, isopolar; pantocolporate, 4-5 brevi colpi; amb circular, prolate spheroidal; exine 3 μm thick, tectate, columellate, ornamentation microreticulate. P: 44-50 μm , E: 44-50 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Perama* sp. 1 (Figure 21: 7-8)

Collection number: ITV 2116

Description: Monad, medium, isopolar; tricolporate, brevi colpi, protruding large pores; amb circular, prolate spheroidal; exine 3 μm thick, tectate, columellate, ornamentation rugulate. P: 30-33 μm , E: 30-33 μm .

Life form: Herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, poorly drained depressions and levels over plinthosols and histosols.

Species: *Spermacoce* sp. 1 (Figure 21: 9-10)

Herbarium number: MG 214024

Description: Monad, medium, apolar; pantoporate; spheroidal; exine 2.5-3 μm thick, tectate, columellate, ornamentation microreticulate. D: 30-35 μm .

Life form: Shrub, subshrub, herb.

Geoenvironment: Doliniform lakes with organic mud sediments at the bottom.

Species: *Spermacoce* sp. 2 (Figure 21: 11-12)

Herbarium number: MG 222338

Description: Monad, medium, apolar; pantoporate; spheroidal; exine 2.5 μm thick, tectate, columellate, ornamentation microreticulate. D: 27-30 μm .

Life form: Shrub, subshrub, herb.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Order: Sapindales Juss. ex Bercht. & J. Presl

Family: Rutaceae Juss.

Species: *Pilocarpus microphyllus* Stapf ex Wardlew. (Figure 21: 13-14)

Herbarium number: MG 37903

Description: Monad, medium, isopolar; tricolporate; amb elliptical, prolate; exine 2 μm thick, columellate, ornamentation reticulate heterobrochate, sometimes curvilinear. P: 25-34 μm , E: 20-26 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Species: *Zanthoxylum gardneri* Engl. (Figure 21: 15-16)

Herbarium number: MG 222372

Description: Monad, medium, isopolar; tricolporate, costate; amb elliptical, prolate spheroidal; exine 2 μm thick, columellate, ornamentation reticulate heterobrochate. P: 20-24 μm , E: 16-17 μm .

Life form: Tree.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Family: Sapindaceae Juss.

Species: *Serjania caracasana* (Jacq.) Willd. (Figure 21: 17-18)

Herbarium number: MG 214067

Description: Monad, medium, heteropolar; syncolporate, longi colpi, likely lolongate; amb triangular-acute-straight to concave, oblate; exine 1.5 μm thick, thickening towards the apertural region, tectate, columellate, ornamentation microreticulate. E: 47-53 μm , P: 35-38 μm .

Life form: Liana.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols.

Order: Solanales Juss. ex Bercht. & J. Presl

Family: Solanaceae Adans.

Species: *Solanum crinitum* Lam. (Figure 21: 19-20)

Herbarium number: MG 115832

Description: Monad, medium, isopolar; tricolporate, marginate, slightly protruding pores, costate; amb circular, prolate spheroidal; exine 2 μm thick, tectate, ornamentation microreticulate. P: 32-35 μm . E: 32-34 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

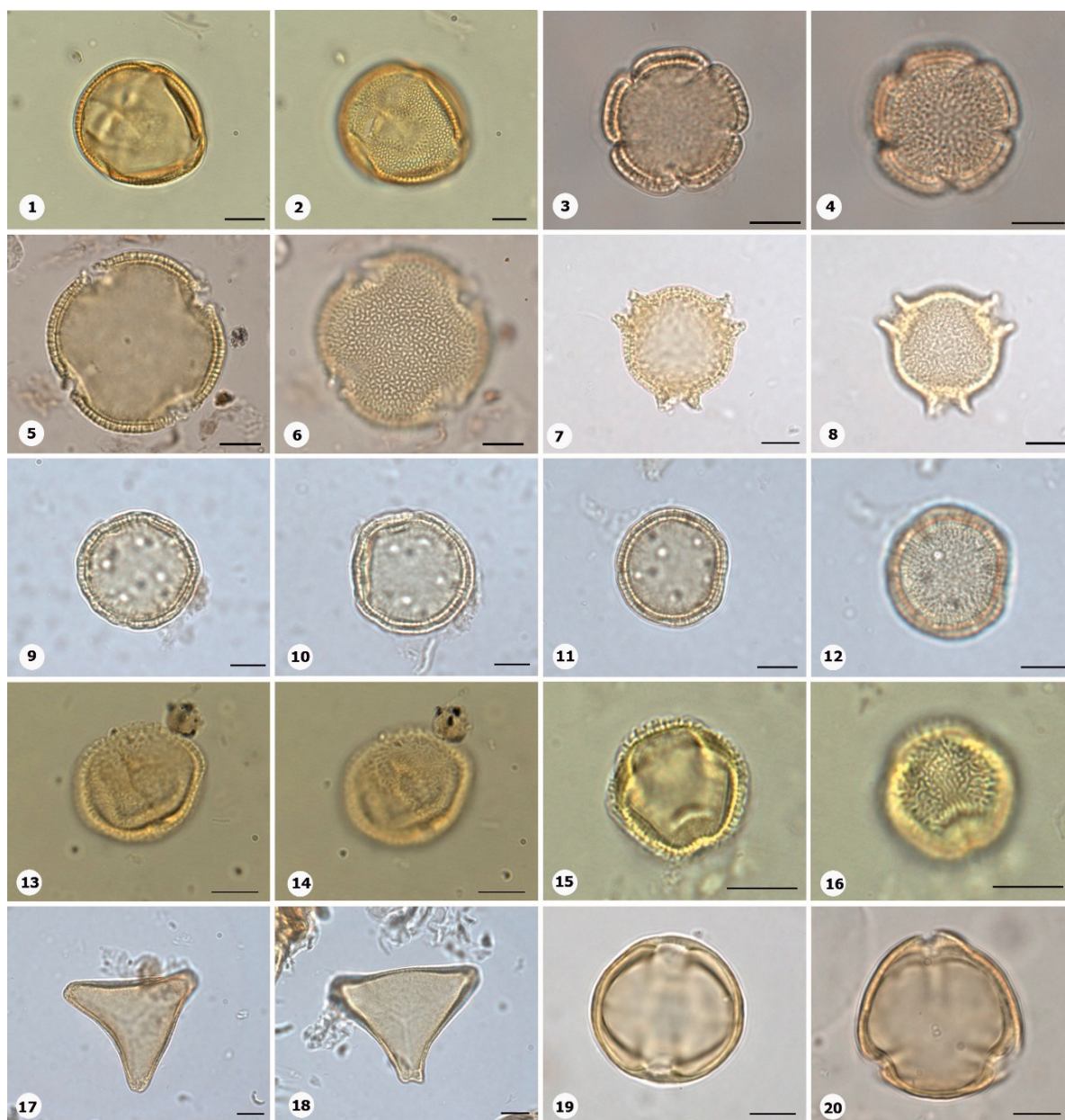


Figure 21. Eudicots. 1-2: *Ixora coccinea*; 3-4: *Mitracarpus carajasensis*; 5-6: *Perama carajensis*; 7-8: *Perama* sp. 1; 9-10: *Spermacoce* sp. 1; 11-12: *Spermacoce* sp. 2; 13-14: *Pilocarpus microphyllus*; 15-16: *Zanthoxylum gardneri*; 17-18: *Serjania caracasana*; 19-20: *Solanum crinitum*. Scale: 10 μ m.

Order: Ericales Bercht. & J. Presl

Family: Styracaceae DC. & Spreng.

Species: *Styrax ferrugineus* Nees & Mart (Figure 22: 1-2)

Herbarium number: MG 213964

Description: Monad, large, isopolar; tricolporate, large pores; amb triangular-obtuse-straight to convex, prolate spheroidal; exine 3.5-4 μ m thick, tectate, columellate, ornamentation microreticulate. P: 48-56 μ m. E: 46-54 μ m.

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Malpighiales

Family: Turneraceae Kunth ex DC.

Species: *Turnera glaziovii* Urb. (Figure 22: 3-4)

Herbarium number: MG 222359

Description: Monad, very large, isopolar; dicolporate, brevicolpi, large elliptical pores; amb elliptical, prolate; exine 4.5-5 μm thick, thickening towards the distal face, tectate, columellate, ornamentation microreticulate in distal face, regularly microechinate. P: 105-110, E: 55-58 μm .

Life form: Shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Order: Lamiales Bromhead**Family: Verbenaceae J.St.-Hil.****Species: *Lantana* sp. 1 (Figure 22: 5-6)**

Herbarium number: MG 222359

Description: Monad, medium, isopolar; stephanocolpate, 6 colpi; amb circular, spheroidal; exine 3.5 μm thick, tectate, columellate, ornamentation reticulate heterobrochate, sometimes curvimate. P: 38-42 μm .

Life form: Shrub, subshrub, herb.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

Species: *Lippia grata* Schauer (Figure 22: 7-8)

Herbarium number: MG 213955

Description: Monad, medium, isopolar; tricolporate, brevicolpi, marginate, lalongate; amb triangular-obtuse-straight to convex, prolate spheroidal; exine 2-2.5 μm thick, tectate, ornamentation microreticulate. P: 30-34 μm . E: 25-30 μm .

Life form: Shrub.

Geoenvironment: Slopes with *canga* vegetation over plinthosols.

Order: Vitales Juss. ex Bercht. & J. Presl**Family: Vitaceae Juss.****Species: *Cissus erosa* Rich. (Figure 22: 9-10)**

Herbarium number: MG 214070

Description: Monad, large, isopolar; tricolporate, lalongate, large pores, costate; amb elliptical, prolate; exine 2.3-3.5 μm thick, tectate, columellate, ornamentation microreticulate. P: 55-64 μm . E: 35-44 μm .

Life form: Shrub and liana.

Geoenvironment: Slopes with *canga* vegetation over plinthosols, forested slopes and caves over plinthosols and ferralsols, poorly drained depressions and levels over plinthosols and histosols.

Order: Myrtales Juss. ex Bercht. & J. Presl**Family: Vochysiaceae A.St.-Hil.**

Collection number: ITV 2253

Species: *Callisthene microphylla* Warm. (Figure 22: 11-12)

Description: Monad, small, isopolar; tricolporate, slightly marginate; amb circular, prolate; exine 1 μm thick, tectate, ornamentation psilate. P: 18-20 μm . E: 18-20 μm .

Life form: Tree and shrub.

Geoenvironment: Forested slopes and caves over plinthosols and ferralsols, slopes with *canga* vegetation over plinthosols.

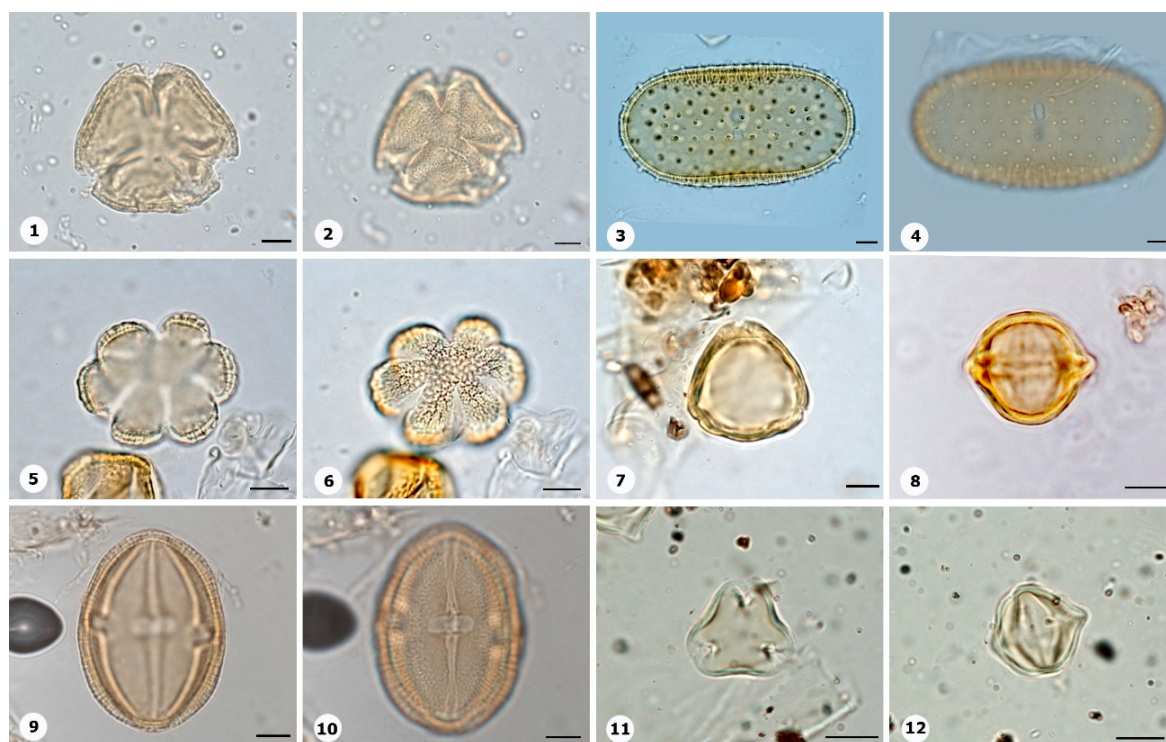


Figure 22. Eudicots. 1-2: *Styrax ferrugineus*; 3-4: *Turnera glaziovii*; 5-6: *Latana* sp. 1; 7-8: *Lippia grata*; 9-10: *Cissus erosa*; 11-12: *Callisthene microphylla*. Scale: 10 μ m.

4. Discussion

The palynology of the *canga* vegetation of Carajás offers valuable insights into the region's floral diversity and ecological processes. The pollen atlas reveals the dominance of eudicots (130 species) compared to monocots (62 species). This distribution aligns with the high diversity of flowering plants in the Amazonian ecosystem, emphasizing the ecological importance of eudicots, which often dominate terrestrial vegetation in terms of species richness and functional roles [49].

Among the pollination syndromes, melittophily (bee pollination) was the most prevalent (78 species), followed by entomophily (general insect pollination, 39 species), and anemophily (wind pollination, 35 species) (Figure 2a). This data highlights the significant role of insects, particularly bees, as primary pollinators in this environment. Less common syndromes such as ornithophily (bird pollination, 14 species), chiropterophily (bat pollination, 3 species), and specialized insect pollination syndromes (e.g., psychophily, phanelophily, and cantharophily, ≤ 3 species) indicate niche adaptations that sustain biodiversity in the ironstone habitats.

The flora of *canga* vegetation is categorized into six types of life forms: trees, shrubs, subshrubs, palms, lianas, and herbs. Herbaceous plants are the most abundant, with a total of 81 species. Lianas and trees follow, each with about 25 species. Subshrubs, shrubs, and palms are less common. Among monocots, there are 53 species of herbs and 5 species of palms. In contrast, most lianas and trees (25 species) and tree/shrubs (21 species) belong to the eudicots. (Figure 2b).

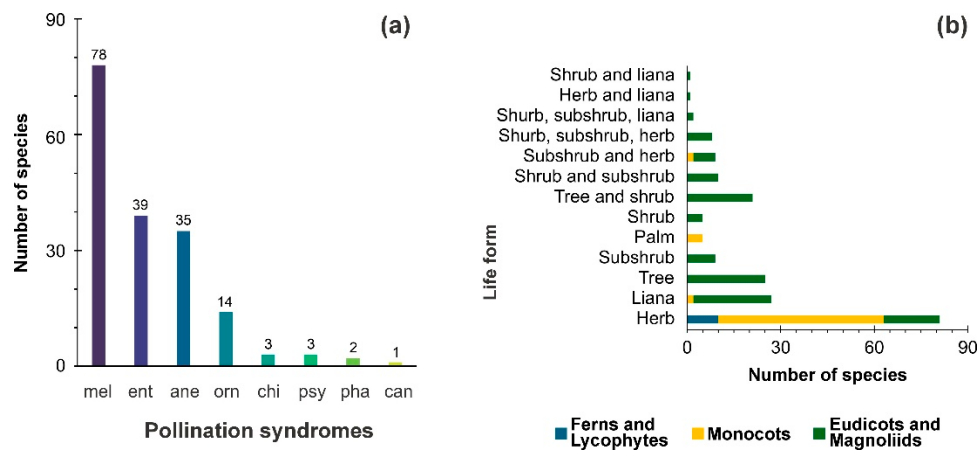


Figure 23. Overview of key ecological characteristics of the *canga* flora: (a) Distribution of pollination syndromes (mel: melittophily; ane: anemophily; ent: entomophily; orn: ornithophily; chi: chiropterophily; psy: psychophily; pha: phanelophily; can: cantharophily) among plant species in the *canga* vegetation; (b) Proportions of life forms (tree/shrub, subshrub, palm, liana, and herb) within monocotyledons and eudicotyledons in the *canga* flora.

Most of the studied species can be found in forested slopes and caves over plinthosols and ferralsols and slopes with *canga* vegetation over plinthosols (Figure 3). Exclusive occurrences in forested slopes corresponded to 34 species, while 30 species are exclusively found in slopes with *canga*. In addition, 18 and 3 species are restricted to poorly drained depressions and levels and doliniform lakes, respectively.

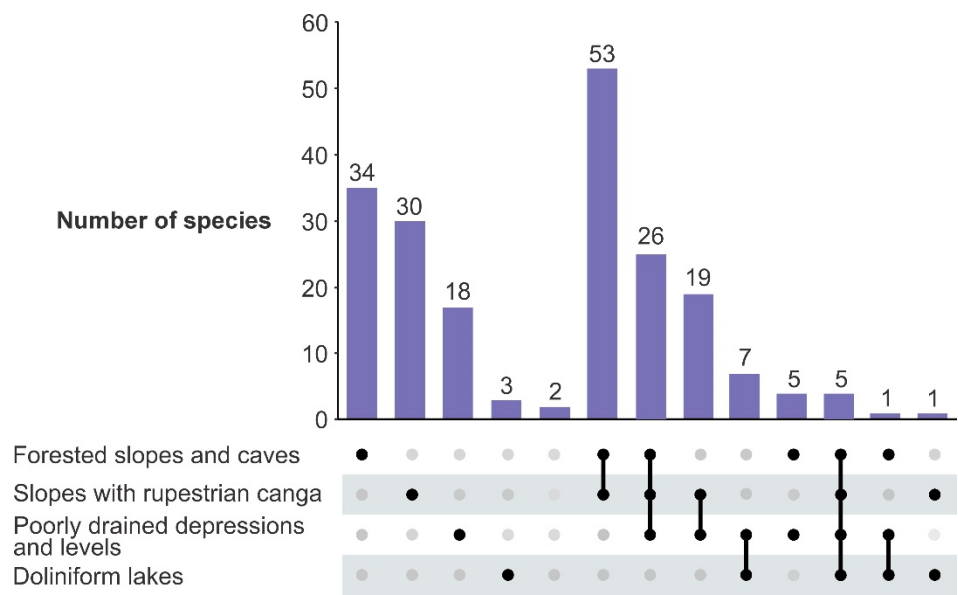


Figure 24. Distribution of the species studied according to their occurrences per geoenvironments [12]. 1: slopes with *canga* vegetation over plinthosols; 2: forested slopes and caves over plinthosols and ferralsols; 3: poorly drained depressions and levels over plinthosols and histosols; 4: doliniform lakes with organic mud sediment at the bottom; 5: anthropic areas. This latter is not a geoenvironment and thus, it was not counted.

This structural distribution reflects adaptations to the challenging edaphic conditions of the ferruginous environment, where shallow, nutrient-poor soils demand distinct survival strategies across plant groups [12,15]. The presence of diverse life forms also underscores the habitat's ecological complexity and resilience, and the integrity of plant-pollinator interactions [50]. Unfortunately, these essential relationships are increasingly at risk due to widespread human activities [13,37].

A recent study of pre-Columbian influences on Amazonian forests found more cultivated plant species in forests near archaeological sites [47]. This shows that people practiced plant domestication in these areas for a long time. The research resulted in a list of 51 plant species that are in the early stages of domestication, providing strong evidence of their cultivation and management over time. Additionally, useful plants found near the archaeological sites of Serra de Carajás were compared to our palynological database to offer an integrated perspective on potential domesticated plants used by both ancient and contemporary indigenous people. As a result, 17 species (3 palms and 14 eudicots) have been identified with multiple uses, including food supply, building materials, various medicinal applications, firewood, and hunting strategies (Table S1).

5. Conclusion

This pollen atlas has important implications for future research. It serves as a reference framework for palynological studies, assisting in the reconstruction of vegetation, analysis of climate history, pre-Columbian influences on vegetation patterns, and monitoring of ecological changes. Additionally, these findings improve our understanding of plant-pollinator interactions, which are essential for conserving biodiversity in ironstone outcrops that are increasingly threatened by changes in land use and land cover. Future studies could investigate temporal changes in pollen diversity to evaluate the impacts of environmental disturbances, helping to ensure the preservation of this ecologically unique region.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org, Table S1. Plant species of the Amazon *canga* pollen database with pollination syndromes.

Author Contributions: LAR: EFdS: LSR, TMR, DFS, TCG, MG and J.T.F.G. contributed to the conceptualization, methodology, data curation, formal analysis, writing – Original draft preparation, and writing – Review & Editing; LMMC, PWMesF and LT supervised and worked on the review and editing; J.T.F.G. supervised and provided resources. All authors have read and agreed to the published version of the manuscript.

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Data availability: The ecological data presented in this article can be found in the Re flora database (<https://reflora.jbrj.gov.br/reflora/herbarioVirtual/>) which represents a virtual herbarium.

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Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. The authors declare no conflict of interest.

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