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PALAEONTOGRAPHICA

BEITRÄGE ZUR NATURGESCHICHTE DER VORZEIT

Abt. B. Bd. 258

Middle Paleogene palynology of Central Colombia, South America: A study of pollen and spores from tropical latitudes

by

CARLOS A. JARAMILLO and DAVID L. DILCHER, Gainesville

With 23 plates, 14 text-figures and 6 tables

STUTTGART
E. SCHWEIZERBART'SCHE VERLAGSBUCHHANDLUNG
(NÄGELE u. OBERMILLER)
2001

#166

Palaeontographica Abt. B	258	Lfg. 4–6	87–213	Stuttgart, Juni 2001

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Abstract

The late Paleocene-early Eocene interval is characterized by a long period of global warming that culminated with the highest temperatures of the Tertiary. This time interval is associated with plant extinctions and subsequent migrations and increase in plant diversity in mid and high latitudes. However, data from neotropical regions remain largely unknown. This time interval is also of strategic interest in northern South America because most hydrocarbon reservoirs occur in Paleogene strata. Detailed chronostratigraphy is necessary in order to develop a clear understanding of stratigraphy and structural geology.

The palynostratigraphy of three upper Paleocene-Eocene sections in the Colombian Eastern Andes (Llanos Foothills, southern Catatumbo, and northern Middle Magdalena) was analyzed with the aim of achieving three major goals: a) to produce a detailed taxonomic survey of palynomorphs b) to produce a time-framework using pollen, spores, and dinoflagellates, and c) to compare this palynoflora with contemporaneous floras from tropical Africa, USA Gulf Coast, Central America, and the Caribbean.

Two-hundred seventy-six species are described and illustrated, 38 spores species, 225 pollen species, 11 dinoflagellate cysts, and 2 incertae sedis. One new genus *Poloretitricolpites*, sixty-nine new species (57 pollen, 11 spores, 1 incertae sedis), and 28 new combinations are proposed (3 spores, 25 pollen species). A biostratigraphic framework for the late Paleocene-middle Eocene is developed using graphic correlation.

Paleocene and Eocene palynofloras from northern South America have 11.5% and 11% similarities respectively with those from tropical Africa. One third of the shared taxa are coastal plain elements. The first occurrences of these shared taxa are during the Paleocene or Eocene suggesting that tropical African-South America interchange still was continuing into the Eocene, including especially the coastal plain taxa. Paleocene data from the North American Gulf Coast indicate a 0.7% similarity with northern South America palynofloras. Similarities during the Eocene with Central American/Caribbean and Gulf coast palynofloras are 6.6 and 5.2% respectively. One third of those Eocene shared taxa are coastal plain elements. Migration was restricted to the Eocene, probably relating to the expansion of tropical zones during the Eocene warming.

Key words: Colombia – palynology – Eocene – Paleocene – dinoflagellates.

Zusammenfassung

Die spätpaläozän-früheozäne Zeit ist durch eine lange Periode globaler Erwärmung charakterisiert, die in den höchsten Temperaturen des Tertiärs kulminiert. Dieser Zeitabschnitt ist mit dem Aussterben von Pflanzen, der nachfolgenden Migration neuer Arten und einer Zunahme der Diversität in den mittleren und hohen Breiten verbunden. Leider blieben die Daten aus den Regionen der Neotropis lange unbekannt. Aber der Zeitabschnitt ist für das nördliche Südamerika von strategischem Interesse, weil in den paläogenen Schichten dort die meisten Kohlenwasserstoff-Vorräte vorkommen. Eine detaillierte Chronostratigraphie ist im Hinblick auf die Entwicklung eines klaren Verständnisses von Stratigraphie und Strukturgeologie notwendig.

Die Palynostratigraphie von drei oberpälaozän-eozänen Sektionen in den kolumbianischen Ostanden (Llanos Vorberge, südliches Catatumbo und nördliches Mittel-Magdalena) wurde mit dem Ziel analysiert, drei große Ergebnisse zu erreichen: a) einen genauen taxonomischen Überblick über die Palynomorphe zu geben, b) einen Zeitrahmen mit Pollen, Sporen und Dinoflagellaten

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0375-0299/01/0258-0087 $ 72.00
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zu erarbeiten, c) diese Palynofloren mit gleichaltrigen Floren des tropischen Afrika, der nordamerikanischen Golfküste, Zentralamerikas und der Karibik zu vergleichen.

Zweihundertsechsundsiebzig (276) Arten werden beschrieben und abgebildet, davon 38 Sporen-, 225 Pollen-, 11 Dinoflagellaten- und 2 incertae sedis-Arten. Die neue Gattung *Poloretitricolpites*, 69 neue Arten (57 Pollen, 11 Sporen, 1 incertae sedis) und 28 neue Kombinationen (3 Sporen, 25 Pollen) werden aufgestellt. Ein biostratigraphisches Schema für das Spätpaläozän bis Mitteleozän wird unter Benutzung der graphischen Korrelation entwickelt.

Die paläozänen und eozänen Palynofloren des nördlichen Südamerika haben 11,5 % bzw. 11 % Ähnlichkeiten mit jenen des tropischen Afrika. Ein Drittel der gemeinsamen Taxa sind Elemente der Küstenebenen. Das erste Auftreten von gemeinsamen Taxa während des Paläozäns oder des Eozäns deutet an, daß ein Austausch zwischen tropischem Afrika und Südamerika sich in das Eozän hinein fortsetzte, speziell was die Taxa der Küstenebenen betrifft. Paläozäne Daten von der Golfküste Nordamerikas zeigen nur eine 0,7-prozentige Ähnlichkeit mit den Palynofloren des nördlichen Südamerika an. Die Ähnlichkeiten mit Zentralamerika/Karibik und der Golfküste während des Eozäns waren 6,6 % bzw. 5,2 %. Ein Drittel der gemeinsamen Eozäntaxa sind ebenfalls Elemente der Küstenebene. Die Migration war auf das Eozän beschränkt und ist möglicherweise in Beziehung zur Expansion der tropischen Zone während der eozänen Erwärmung zu sehen.

Schlüsselwörter: Kolumbien – Palynologie – Eozän – Paläozän – Dinoflagellaten.

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1. Introduction

The Paleocene-Eocene history of northern South America has been the focus of several researchers since the 1950s (Van der Hammen 1954, Gonzalez 1967, Muller et al. 1987). Still, this time interval remains poorly known and more detailed geologic research is necessary. Important large-scale events developed during the Paleogene such as the Eocene Thermal Maximum (Miller et al. 1987), the beginning of the Andes uplift process (Etayo-Serna et al. 1983), and the closure of the Tethys. Additional data of vegetation and its stratigraphic and geographic positions in the Neotropics adds new insights into the evolution and distribution of vegetation in tropical areas. The Paleogene history of northern South America is also important regionally because the most important hydrocarbon reservoirs in the region are located in Paleocene and Eocene continental rocks. These reservoirs are frequently located in zones with high structural complexity where an excellent biostratigraphic framework is crucial toward understanding the stratigraphy, defining oil-bearing structures, and planning new exploration targets.

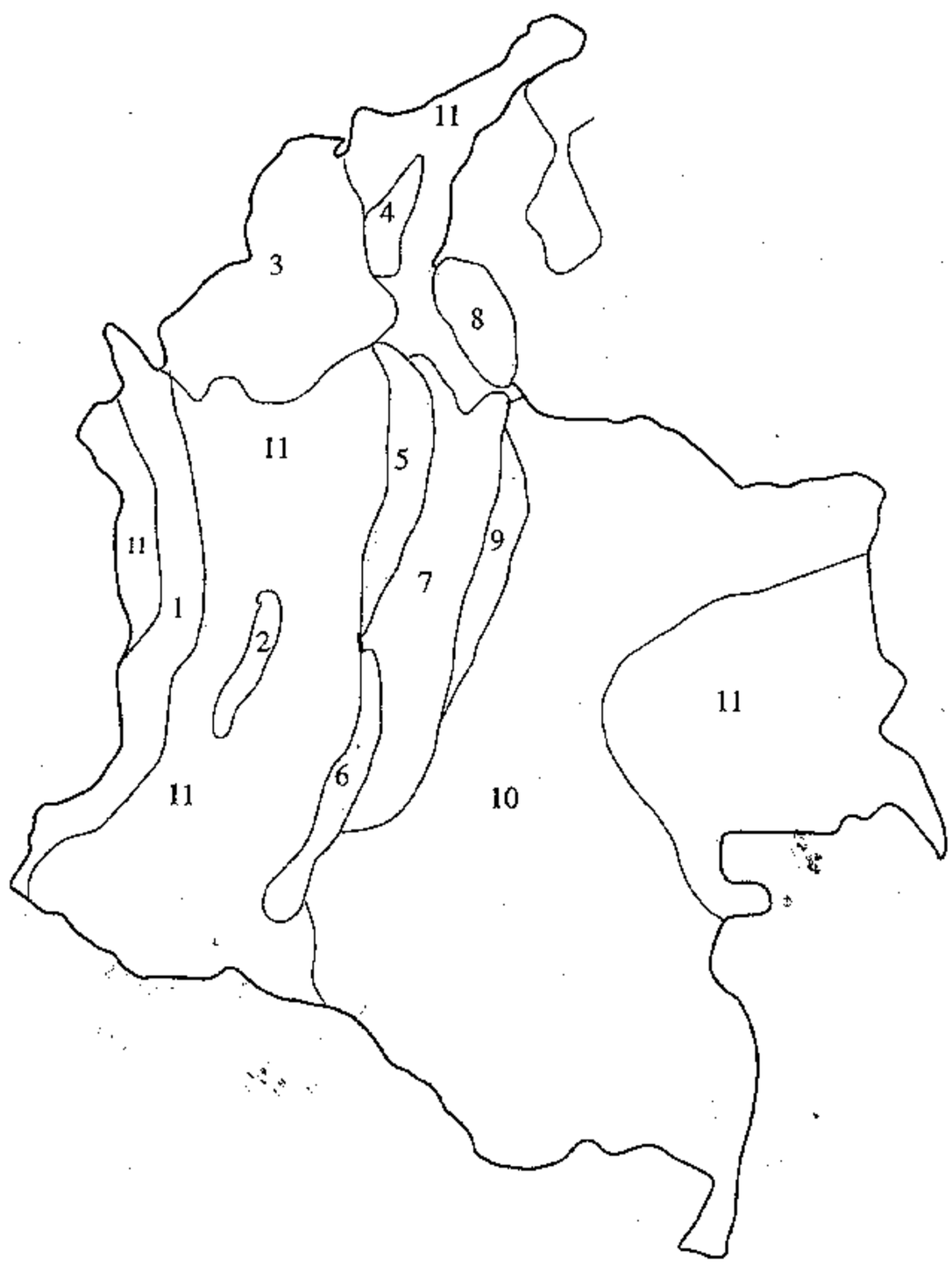
Colombian stratigraphy is composed mainly of Tertiary continental sedimentary rocks. These strata are in structurally complex areas related to the Pliocene Andes uplift. For the last 60 years, intensive geological exploration of Colombian Tertiary rocks has been carried out (Wheeler 1935, Morales 1958, Cooper et al. 1995, oil companies unpublished reports). Most of this work has been related to oil exploration. Unfortunately, only a small fraction of this information has been published.

There is no high-resolution chronostratigraphic data currently available for the Paleogene of central Colombia. This paper is an attempt to supply and apply the data needed to fill this gap. The most abundant fossils present in the Paleogene sediments of continental Colombia are pollen and spores. Relatively few publications exist on Colombian pre-Pliocene palynology; this may be due to the confidentiality of information used by various oil companies operating in the area. However, some previously published palynologic studies in the region (Gonzalez 1967, Germeraad et al. 1968) reported highly diverse and abundant pollen/spores assemblages and showed that palynomorphs are the most reliable biostratigraphic tool in terrestrial Paleogene strata of Colombia.

In the present study a detailed taxonomic and distribution analysis of palynomorphs, from the late Paleocene to the middle Eocene in the eastern Andes of Colombia, are presented with the aim of producing a biostratigraphic model. Comparisons of these palynofloras are made with contemporaneous assemblages from Central America, U.S. Gulf Coast, and tropical Africa demonstrating the extent of exchange of these floral elements.

2. Stratigraphy

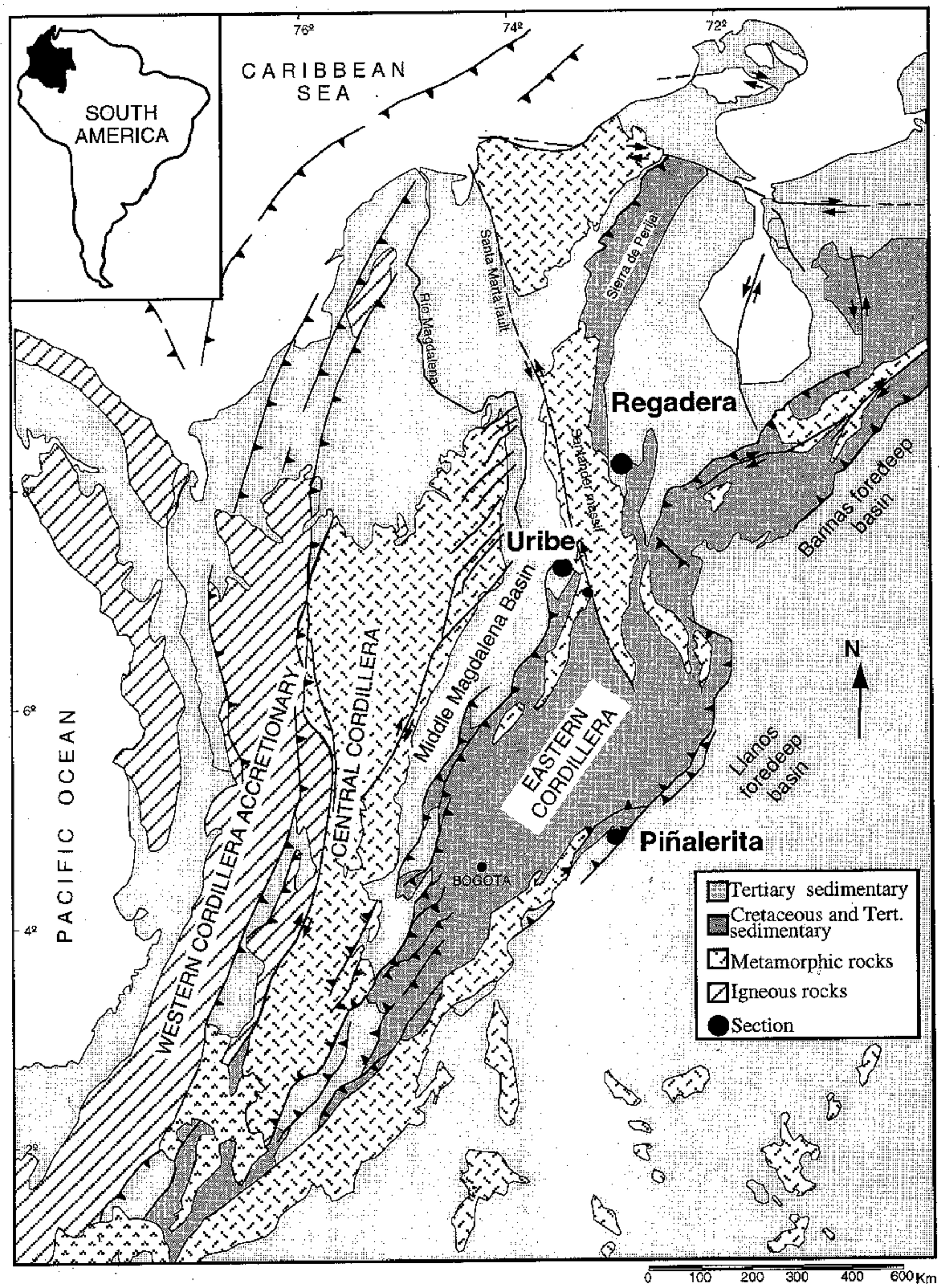
The geology of Colombia has been complicated by uplift attributed to the Andean orogeny that began during the late Cretaceous and was most active during the Pliocene (VAN DER HAMMEN et al. 1973). In general, sedimentary rocks comprise 70 % of all the rocks in Colombia (ETAYO-SERNA et al. 1983). Forty percent of the sedimentary strata which outcrops is Cretaceous, approximately 55 % is Tertiary and Quaternary, while 5 % is Paleozoic, Triassic and Jurassic (ETAYO-SERNA et al. 1983). The sedimentary rocks can be found in ten tectono-stratigraphic provinces (Text-fig. 1). Paleozoic sedimentary and metamorphic rocks, Triassic red beds and marine limestones, and Jurassic tuffs constitute the basement onto which Cretaceous rocks onlapped (CEDIEL et al. 1981) The late Jurassic-early Cretaceous sea first inundated the northwestern Andean Basin possibly through a western corridor situated in the area that is now Central Colombia at the latitude of Santafé de Bogotá. Subsequently this sea extended into most of southern and northern Colombia (ETAYO-SERNA et al. 1976). Cretaceous facies have been interpreted as representing marine environments of deposition, especially during the Turonian to Campanian interval (ETAYO-SERNA



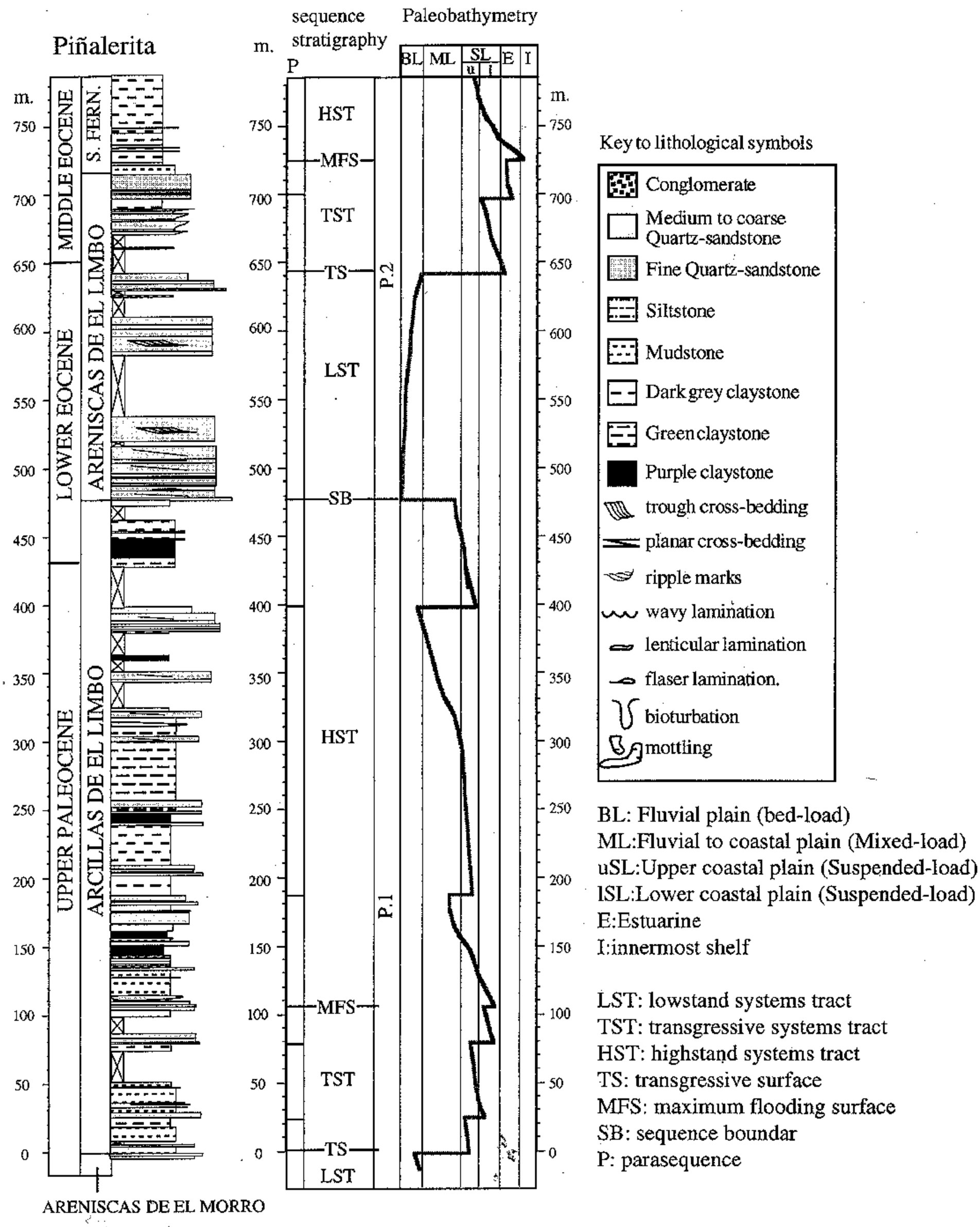
Tectonostratigraphic provinces

1. Atrato
2. Cauca
3. Lower Magdalena Valley
4. Cesar
5. Middle Magdalena Valley
6. Upper Magdalena Valley
7. Eastern Cordillera
8. Catatumbo
9. Llanos Foothills
10. Llanos-Amazon
11. Non-sedimentary rocks

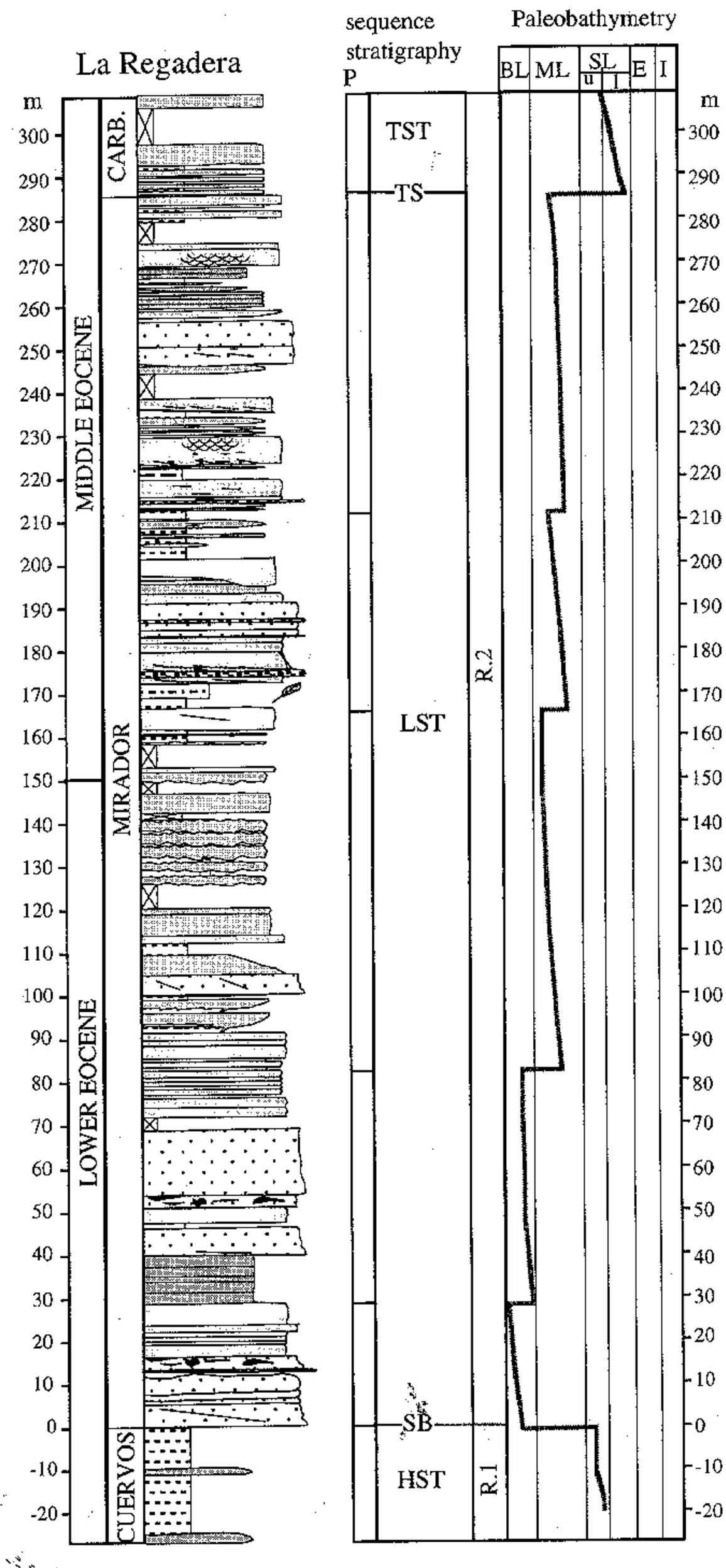
Text-fig. 1. Sedimentary tectono-stratigraphic provinces of Colombia. The sections studied are in terranes 5, 8, and 9 indicated by dotted pattern (after ETAYO-SERNA et al. 1983).



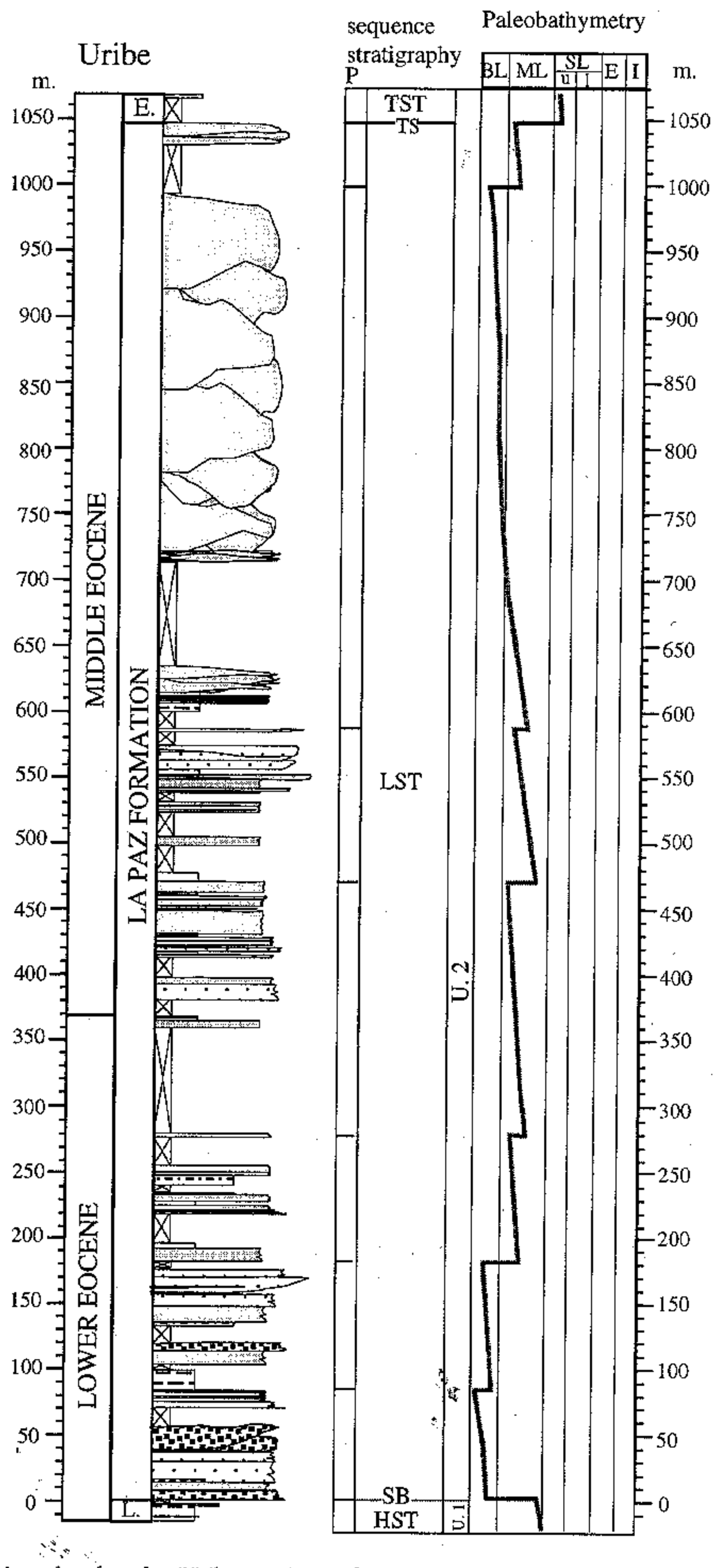
Text-fig. 2. Geologic map of Colombia showing the three sections studied (modified from DENGO & COVEY 1993).



Text-fig. 3. Sequence stratigraphy for the Piñalerita section (after JARAMILLO 1999). S. Fern. = San Fernando Formation.



Text-fig. 4. Sequence stratigraphy interpretation for the La Regadera section (after JARAMILLO 1999). Key to symbols in Text-fig. 3. Carb = Carbonera Formation.



Text-fig. 5. Sequence stratigraphy for the Uribe section (after JARAMILLO 1999). Key to symbols in Text-fig. 3. L = Lisama Formation, E = Esmeraldas Formation.

1979, BARRIO & COFFIELD 1992). Tertiary rocks accumulated in alluvial plain to littoral environments (ETAYO-SERNA et al. 1983) with the exception of the marine strata of the Atrato Basin and Lower Magdalena Valley (GALVIS 1980, DUQUE 1990).

Three late Paleocene-Eocene stratigraphic sections were studied in the Eastern Andes of Colombia (Text-fig. 2). The first section is located in the Llanos Foothills, along Piñalerita Creek. The second section occurs in the Catatumbo area, along the La Regadera Creek, and the third section is located in the eastern middle Magdalena Valley, along the Rio Negro River, near Uribe.

For the Llanos foothills (Piñalerita section) the VAN DER HAMMEN (1958) stratigraphic nomenclature is followed. Three formations comprise the upper Paleocene-Eocene: Arcillas de El Limbo, Areniscas de El Limbo, and San Fernando Formations. Two sequences and 6 systems tracts are recognized in this section (Text-fig. 3; JARAMILLO 1999). Sequence P.1 is composed of a lowstand systems tract (LST) in the upper Areniscas de El Morro, a transgressive systems tract (TST) in the lower Arcillas de El Limbo Formation (0 to 105 meters), and a highstand systems tract (HST) in the upper Arcillas de El Limbo Formation (105–477 meters). The second sequence P.2, is composed of a LST in the lower Areniscas de El Limbo Formation (477–643 m); a TST, 643–725 m, in upper Areniscas de El Limbo (upper 71.6 m) to lowermost San Fernando (lower 10.4 m) Formations; and a TST, 725–786.6 m, lower San Fernando Formation (meters 10.4 to 72). Environments range from bed-load dominated channels of the fluvial plain to bay-head estuarine deltas.

In the Catatumbo area (La Regadera Creek section) three formations comprises the Paleocene-Eocene: Cuervos, Mirador, and Carbonera Formations. Two sequences and 3 systems tracts are recognized in this section (Text-fig. 4, JARAMILLO 1999). For the first sequence, R.1, only the upper part of the HST was studied, the upper Cuervos Formation. The second sequence, R.2, also was partially studied, and it is composed of a LST, meters 0 to 285.5, Mirador Formation, and a TST in which only the lowermost part, 285.5–307.5 m, was studied (lower Carbonera Formation, meters 0 to 20.5). Environments range from braided/chute channels in bed-load dominated channels of the fluvial plain to floodplain and overbank deposits of suspension-load dominated channels in the coastal plain environment.

In the eastern middle Magdalena Valley (Uribe section) most of Tertiary sedimentation was controlled by syndepositional faults and folds. While sedimentation is continuous in the synclines, major unconformities are found in the anticlines (PORTA 1974). The stratigraphic nomenclature of this area was a chaos for the first 30–40 years of exploration in the area. Similar names were used by different companies for different units, or different names for same unit. Here, the terminology suggested by PORTA (1974) was followed. The Paleocene-Eocene stratigraphy comprises Lisama, La Paz, and Esmeraldas Formations (PORTA 1974). Two sequences and 3 systems tracts are recognized in this section (Text-fig. 5, JARAMILLO 1999). For the first sequence, U.1, only the upper part of the HST was studied, the upper Lisama Formation. The second sequence, U.2, also was partially studied, and it is composed of a LST, meters 0 to 1046, Lisama Formation, and a TST which only the lowermost part, 1046–1066 m, was studied (lower Esmeraldas Formation, meters 0 to 20). Environments range from braided/chute channels in bed-load channels of the fluvial plain to suspended-load dominated channels in the upper coastal plain.

3. Materials and methods

The three sections were measured and described in detail (scale 1:100), recording major physical and biogenic sedimentary structures. The first section is located in the Llanos Foothills, along Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N. The second section is located in the Catatumbo area, south of Cúcuta, Near La Donjuana, along the La Regadera Creek, 72° 37′ W – 7° 42′ N. The third section occurs in the eastern middle Magdalena Valley, along the Rio Negro river, near Uribe, 73° 20′ W – 7° 20′ N. Rock samples were collected at five to ten meter intervals, for palynologic purposes, a reasonable sampling interval given the thickness of the sections analyzed (averaging 700 m/section).

The palynologic samples were prepared by the standard procedure of digesting the sample in HF and HCl acids, separating organic matter by heavy liquids, and oxidizing (TRAVERSE 1988). Most of samples were prepared by RUSS HARMS (Global Geolab 729B – 15th Street S.W., Medicine Hat, Alberta T1A 4W7,

Canada). A Carl Zeiss light microscope (Scope 2, #4311267, Paleobotany Laboratory, Florida Museum of Natural History) was used for palynologic analyses. At least one complete oxidized slide per sample was scanned with a 40× Zeiss planapochromatic objective and 300 to 600 palynomorphs per slide were counted when possible. Examination of the fossil taxa was done using a 100× Zeiss oil immersion planapochromatic objective. Photographs were taken using a Nikon AFX-DX camera. Black and white negatives were then scanned using a LS-2000 Nikon scanner. Plates were digitally composed using Adobe Photoshop 4.0 in an Apple PowerPC 9500.

Identification of fossil taxa was done through comparison with published photographs and descriptions, and the holotype material in the palynological collections of University of Amsterdam (Holland), Petrobras in Rio de Janeiro (Brazil), and Pedevesa in Caracas (Venezuela). The holotypes of ENRIQUE GONZALEZ in Venezuela and GUSTAVO SARMIENTO in Colombia are not available. These collections could not be observed because they are poorly preserved and inaccessible (GONZALEZ, personal communication), or have been misplaced in the Ingeominas, Bogotá (SARMIENTO, personal communication). Many of the holotypes observed were badly damaged, especially those described before 1970, and we had to rely on the published descriptions and photographs.

4. Systematics

Palynomorphs (spores, pollen, and dinoflagellates) are categorized in five groups: pteridophyte-bryophyte spores, gymnosperm pollen, angiosperm pollen, dinoflagellate cysts, and incertae sedis. Within each category, the fossil genera are arranged in alphabetic order. All the genera treated herein are form-genera as recognized in the "Tokyo Code" (GREUTER et al. 1994). Full synonymies are given only when new combinations are proposed. Some of the genera proposed by VAN DER HAMMEN (1954, 1956a, b) are invalid names, such as *Psilamonoletes*, *Monoporites*, *Psilatricolpites*, *Psilatricolporites*, *Psilatriporites*, *Retitricolpites*, *Retitricolporites*, *Scabratricolpites*, *Scabratricolporites*, *Stephanocolpites*, and *Striatricolpites* (JANSONIUS & HILLS 1976). Approximately 89 species have been named in the past 40 years using these genera. They represent 25% of the total number of species (359) named for the Paleogene of tropical South America. These genera should not be used any more, and eventually all of these species will be transferred to existing valid genera, or new genera will be created to accommodate cohesive and distinct morphological groups. These changes will take place gradually and slowly as the taxonomic work of tropical fossil pollen and spores continues in the coming years. Even though, these genera have been extensively used by researchers all over the tropics (e.g. JAN DU CHENE et al. 1978b in tropical Africa, GONZALEZ 1967, DUEÑAS 1980, SARMIENTO 1992 in tropical America), their use should be abandoned, not only because they are invalid, but also because the genera definitions are too vague and encompass major morphological variations. e.g., the genus *Retitricolporites* is defined to encompass tricolporate, reticulate pollen grains. This definition would cover a large percentage of all fossil pollen grains ever described, as this morphological combination is very common among fossil and extant taxa.

New species are only proposed when several grains were observed and the morphological variability within the species could be established. Only in a few cases new species are proposed based in a single or two individuals. This is done when the specimen had very distinctive or unusual characteristics. Many probable new species are illustrated and fully described but not formally named because only a few or a single specimen could be observed. The large amount of new species indicate both the large diversity of Eocene floras of Colombia and the relatively scarce taxonomic work that has been done on this time period.

Slides, residues, and rock samples are deposited in the Paleobotanical Collection of the Florida Museum of Natural History (UFP), University of Florida, Gainesville, Florida, USA. Coordinates are measured on Zeiss scope # 2 of the Paleobotanical laboratory of Florida Museum of Natural History and can be translated to any other microscope with a reference slide that has marked 5 coordinates and is stored with the material studied.

The terminology used for describing sporomorphs (pollen and spores) follows the glossary of pollen/spores terminology developed by University of Utrecht (PUNT et al. 1994), and TRAVERSE (1988). In the spores description, an index (TLI or MLI) was used to indicate the relative proportion of the radius versus the length of the grain. TLI (trilete index) = radius length/(spore diameter/2) and it is used for trilete spores. MLI (monolete index) = laesura length/spore length. In the pollen description two

indexes were used, CPi and CEi, to indicate the proportion of colpi versus grain dimensions. CPi was calculated for grains in equatorial view, CPi = colpi length/polar diameter. CEi was calculated for grains in polar view, CEi = colpi length/equatorial diameter.

Five measures are given to express the dimension of the grains. The extreme sizes and the average size between parenthesis, the standard deviation (SD), the proportions of polar diameter versus equatorial diameter, the number of grains that were fully measured (nm), and the total number of grains that were observed (no). The equatorial diameter length and width were measured in equatorial view of grains. The polar and equatorial diameter were measured in polar view.

A comparison of the species that is being described with morphologically similar species is given in the Comparisons section. The name of the species that is being described is not included in this section, but it is understood that all comparisons are referred to it.

The terminology proposed by EVITT (1985) is used for describing dinocysts. Name of the authors and dates of valid publications that follow generic names of pollen and spores are according to JANSONIUS & HILLS (1976, 1985, 1987, 1990), and they not were cited in the references. Name of the authors and dates of valid publications that follow genera and species names of dinoflagellate cysts are according to WILLIAMS et al. (1998), and not were cited in the references list.

4.1 Pteridophyte and bryophyte spores

Genus *Apiculatasporites* IBRAHIM 1933 emend. RAVN 1986

Apiculatasporites? cingulatus n. sp.

Plate 2, Figs. 7–9

Diagnosis: Echitrilete, mid-sized (24–35 µm), cingulate, cingulum 1.5 µm thick, contact surface scabrate, sculpture echinate, 1–3 µm long.

Specimens: Holotype UFP 43, 7.4 × 81.5, pl. 2, figs. 7–9

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After the cingulum.

Description: Spores single, symmetry radial, amb triangular-obtuse-convex; trilete, margo 1 µm wide, <1.0 µm thick, distinct, curvatura perfect, radii long, TLI 0.9, commisure slightly undulating; sporoderm 1-layered, cingulate, intexine thickening at equator to 1.5 µm; sculpture echinate, contact surface scabrate < 0.5 µm long/wide, remainder of wall echinate, spines 1–3 µm long, 1–2 µm wide, 4–10 µm apart, sized unevenly, distributed sparsely. Dimensions: Equatorial diameter 25 (29) 34 µm, SD 3.5, equatorial diameter length/width 1.1, nm: 6; no: 8.

Comparisons: These specimens have a unique cingulate-echinate combination, that is not reported in any described genus. This species is placed provisionally in genus *Apiculatasporites* IBRAHIM 1933 that accommodates echinate azonotriletes (JANSONIUS & HILLS 1987).

Apiculatasporites obscurus n. sp.

Plate 2, Figs. 10–12

Diagnosis: Echitrilete, mid-sized (23–34 µm), contact area laevigate to scabrate, echinate, spines 1–2.5 µm long, expanded at base, surface interspines microechinate.

Specimens: Holotype UFP 15, 21.2 × 92.1, pl. 2, fig. 10–11; paratype UFP 15, 3.6 × 91.9, pl. 2, fig. 12

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After indistinct margo.

Description: Spores single, symmetry radial, amb triangular-obtuse-convex to circular; trilete, margo 0.5 µm wide, indistinct, curvatura absent, radii long, TLI 0.9, commisure indistinct to slightly distinct, straight, ends pointed; sporoderm 1-layered, intexine 0.5–1 µm thick; sculpture echinate, contact surface laevigate to scabrate, remainder of the wall echinate, spines tall, 1–2.5 µm long, 1.5–4 µm wide, conical, greatly expanded at the base, ends pointed, 2–5 µm apart, shaped evenly, distributed densely over entire

grain, occasionally two spines fuse at the base, intexine interspines echinate, spines short, 0.5 µm wide/long. Dimensions: Equatorial diameter 20 (27) 34 µm, SD 4.2, equatorial diameter length/width 1.1, nm: 9; no: 10.

Comparisons: *Echitriletes muelleri* REGALI et al. 1974 has longer spines (> 6 µm), wider spaced (6 µm), and spine tips are highly variable in same grain, *Echinatisporis minutus* VAN DER KAARS 1983 is smaller (16–26 µm), and spines are thinner (1 µm), *Echinatisporis brevispinosus* n. sp. has homogeneous spines, not expanded at the base, and margo is distinct, *Planisporites* sp. 2 has a raised laesura, and intexine is slightly scabrate.

Genus *Baculatisporites* PFLUG & THOMSON in THOMSON & PFLUG 1953

Baculatisporites sp. 1

Plate 1, Figs. 1–3

Diagnosis: Baculatrilete, mid-sized (28 µm), bacula 2 µm long, surface interbacula baculate-clavate < 1 µm long.

Specimens: UFP 48, 4.6 × 85.5

Description: Spores single, symmetry radial, amb circular to triangular-obtuse-convex; trilete, margo < 0.5 µm wide, very thin and indistinct, curvatura absent, radii mid-sized, TLI 0.7, comissure straight, ends pointed; sporoderm 1-layered, intexine < 1.0 µm thick, sporoderm very thin; sculpture baculate, bacula 1.5–2.5 µm long, 1.5–2 µm wide, 7–10 µm apart, circular, surface interbacula baculate-clavate, short, 0.5–1 µm long, 0.5 – < 1.0 µm wide, 2–8 µm apart, circular in plain view, distributed sparsely to densely. Dimensions: Equatorial diameter 27 µm, equatorial diameter length/width 1.1, nm: 1; no: 2.

Comparisons: *Baculatisporites* sp. 2 has uniform bacula, *Clavatisporites mutisii* (VAN DER HAMMEN 1954) n. comb. has a thicker intexine (1.5 µm), density of sculptural elements is higher, and clavae predominate.

Baculatisporites sp. 2

Plate 1, Figs. 4–6

Diagnosis: Baculatrilete, mid-sized (26–35 µm), curvatura perfect, bacula 2–3 µm long, 1–1.5 µm wide, uniform, densely distributed.

Specimens: UFP 41, 5.6 × 109.7

Description: Spores single, symmetry radial, amb circular to triangular-obtuse-convex; trilete, margo < 0.5 µm wide, very thin and indistinct, curvatura perfect, radii long, TLI 0.9, comissure straight; sporoderm 1-layered, intexine 1 µm thick, sporoderm thin; sculpture baculate, contact area close to y mark laevigate, remainder of the wall baculate, bacula 2–3 µm long, 1–1.5 µm wide, circular, uniform in shape, distributed densely, occasionally a pair of bacula fuse at base. Dimensions: Equatorial diameter 26 (29) 35 µm, equatorial diameter length/width 1.1, nm: 3; no: 3.

Comparisons: *Baculatisporites* sp. 1 has irregularly-sized bacula.

Genus *Camarozonosporites* PANT ex POTONIÉ 1956, emend. KLAUS 1960

Camarozonosporites sp. 1

Plate 1, Figs. 7–9

Diagnosis: Trilete, mid-sized (27–30 µm), interradial crassitude 2 µm thick, proximal face laevigate, distal face rugulate.

Specimens: UFP 84, 13.9 × 112.1

Description: Spores single, symmetry radial, amb triangular-obtuse-convex; trilete, curvatura absent, radii mid-sized, TLI 0.7, comissure distinct, borders straight, ends pointed; sporoderm 1-layered, intexine 1 µm thick, with interradial crassitude 2 µm wide, thickness variable; sculpture psilate-rugulate, proximal face laevigate, distal face rugulate, muri 1.5 µm wide, groove 0.5 µm wide, 3–7 µm long, elongated, sometimes bifurcating. Dimensions: Equatorial diameter 27 (28.5) 30 µm, equatorial diameter length/width 1, nm: 2; no: 3.

Comparisons: *Hamulatisporis caperatus* (VAN HOEKEN-KLINKENBERG 1964) SCHRANK 1994 lacks interradial crassitude.

Genus *Chomotriletes* NAUMOVA 1939 ex 1953

Chomotriletes minor (KEDVES 1961) POCOCK 1970

Plate 1, Fig. 10

Diagnosis: Circular, mid-sized (29–45 µm), trilete mark indistinct, concentric ridges and grooves.

Specimens: UFP 36, 17.9 × 86.5

Description: Spores single, symmetry radial, amb circular; trilete mark indistinct, TLI 0.7; sporoderm 1-layered, intexine 1 µm; sculpture striate, concentric ridges and grooves. Dimensions: Equatorial diameter width 24 (29) 35 µm, SD 4.2; equatorial diameter length 29 (36.5) 45 µm, SD 5.2, equatorial diameter length/width 1.2, nm: 8; no: 19. Affinities are uncertain, SCHRANK (1994) suggested that is a flattened freshwater algal cyst.

Genus *Cicatricosisporites* POTONIÉ & GELLETICH 1933

Cicatricosisporites dorogensis POTONIÉ & GELLETICH 1933

Plate 1, Figs. 11–13

Diagnosis: Cicatricosisporate, trilete, mid-sized (36–58 µm), muri 1.5–2 µm wide, 0.5–1 µm long, groove 1.5 µm wide.

Specimens: UFP 37, 8.1 × 88.5

Description: Spores single, symmetry radial, pyramidal, amb triangular-obtuse-convex to almost circular; trilete, margo 1.5 µm wide produced by thickening of sporoderm, curvatura absent, radii short to mid-sized, TLI 0.7, commisure slightly irregular, ends pointed; sporoderm 1-layered, intexine 1.5–2 µm thick; sculpture cicatricosate, contact area of proximal face laevigate, remainder of the wall cicatricosate or cicatricosate-rugulate, muri 1.5–2 µm wide, 0.5–1 µm long, groove 1.5 µm wide, margin of muri straight to slightly undulating. Dimensions: Equatorial diameter 36 (48) 58 µm, SD 7.2, equatorial diameter length/width 1, nm: 11; polar diameter 35 (44.7) 55 µm, SD 7.8, equatorial/polar diameter 1.1, nm: 7; no: 407.

Affinities: Schizaeaceae, similar to *Mohria* and *Anemia* (GERMERAAD et al. 1968).

Cicatricosisporites dorogensis subsp. *minor* forv. *rugulatearis* KEDVES 1961

Plate 1, Figs. 14–16

Diagnosis: Cicatricosisporate, trilete, mid-sized (50–57 µm), rugulate to rugulate-cicatricosate, muri 2–3 µm wide, 0.5–1.5 µm long, groove 1.5–2 µm wide.

Specimens: UFP 37, 8.1 × 88.5

Description: Spores single, symmetry radial, pyramidal, amb triangular-obtuse-convex to almost circular; trilete, margo 3 µm wide, produced by thickening of sporoderm, margo borders highly irregular and undulating, curvatura absent, radii mid-sized, TLI 0.6, commisure slightly irregular, ends pointed; sporoderm 1-layered, intexine 2 µm thick; sculpture rugulate, contact area of proximal face laevigate, rest of wall rugulate to rugulate-cicatricosate, muri 2–3 µm wide, 0.5–1.5 µm long, groove 1.5–2 µm wide, rugae elliptic, v-shaped, or elongated, sculpturing seems a gradation from *C. dorogensis*, but it is retained as a separated morphospecies because it may have a chronostratigraphic significance. Dimensions: Equatorial diameter 50 (54) 57 µm, equatorial diameter length/width 1, nm: 3; no: 6.

Cicatricosisporites sp. 1

Plate 1, Figs. 17–19

Diagnosis: Trilete, mid-sized (40 µm), proximal face laevigate, distal face cicatricosate with concentric ridges, intexine 1 µm thick, infrafoveolate-micropitted.

Specimens: UFP 5, 4 × 86.7

Description: Spores single, symmetry radial, amb triangular-obtuse-straight; trilete, margo 0.5–1.0 µm wide, slightly distinct, curvatura perfect, radii long, TLI 0.8, almost reaching equator, commisure straight; sporoderm 1-layered, intexine 1 µm thick, infrafoveolate-micropitted, lumina < 0.5 µm wide, < 1.0 µm apart, circular, distributed uniformly and densely; sculpture cicatricosate, contact surface laevigate, remainder of the wall cicatricosate, muri 2 µm long, 2–4 µm wide, groove 2–3 µm wide, forming 3 concentric triangular rings, inner ring segmented in 3 parts. Dimensions: Equatorial diameter 40 µm, equatorial diameter length/width 1.1, nm: 1; no: 1.

Genus *Cicatricososporites* PFLUG & THOMSON in THOMSON & PFLUG 1953, emend. POTONIÉ 1960

Cicatricososporites decussatus n. sp.

Plate 1, Figs. 20–22

Diagnosis: Monolete, mid-sized (57 µm), cicatricosate, muri diagonal to laesura, 1 µm wide, 0.5 µm apart.

Specimens: Holotype UFP 44, 5.4 × 92.3, pl. 1, figs. 20–22

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After sculpturing that resembles letter X.

Description: Spores single, symmetry radial, plane-convex, amb; monolete, margo 2 µm wide, produced by slight thickening of intexine, curvatura absent, laesura mid-sized, MLI 0.7, commisure straight, ends pointed; sporoderm 1-layered, intexine 2 µm thick; sculpture cicatricosate, muri 1 µm wide, 0.5 µm long, 0.5 µm apart, ridges are parallel to each other and diagonal to laesura giving a cross-like pattern when both sides of spore are compared, striations emerge from entire length of the laesura and have an oblique orientation of striations at distal side. Dimensions: Equatorial diameter 57 µm; polar diameter 34 µm, equatorial/polar diameter 1.7, nm: 1; no: 1.

Comparisons: *Cicatricososporites eocenicus* (SELLING 1944) JANSONIUS & HILLS 1976 has ridges that are parallel to the laesura, *Cicatricososporites parallatus* (MATHUR 1966) AWAD 1994 has striae that are almost parallel to the striae mark, *Schizaeoisporites* POTONIÉ 1951 ex DELCOURT & SPRUMONT 1955 is a junior synonym of *Cicatricososporites* (JANSONIUS & HILLS 1976, card 2530). *Schizaeoisporites obliques* SINGH 1992 is larger (75–100 µm), has a two-layered exine 3–5 µm thick, and wider ridges (2 µm wide).

Cicatricososporites eocenicus (SELLING 1944) JANSONIUS & HILLS 1976

Plate 2, Figs. 1–2

Diagnosis: Monolete, mid to large-sized (50–63 µm), cicatricosate, muri parallel to laesura, 1.5–2 µm wide, 0.5–1 µm apart.

Specimens: UFP 43, 6 × 102.6; UFP 37, 17.6 × 110

Description: Spores single, symmetry radial, plane-convex, amb elliptic; monolete, margo 2 µm wide, produced by one ridge on each side of the commisure, curvatura absent, laesura mid-sized, MLI 0.6, commisure straight, ends pointed; sporoderm 1-layered, intexine 1.5 µm wide; sculpture cicatricosate, muri 1.5–2 wide, 0.5 µm long, 0.5–1 µm apart, arranged parallel to laesura. Dimensions: Equatorial diameter 50 (56) 63 µm, SD 5.2; polar diameter 21 (31) 40 µm, SD 7.1, equatorial/polar diameter 1.9, nm: 6; no: 11.

Genus *Clavatisporites* KEDVES & SIMONCSICS 1964

Clavatisporites mutisii (VAN DER HAMMEN 1954) n. comb.

Plate 2, Figs. 3–4

Basionym = *Triletes mutisi* VAN DER HAMMEN 1954, p. 102, pl. 17.

1992 *Clavatriletes mutisi* (VAN DER HAMMEN) SARMIENTO, in SARMIENTO 1992, p. 63, pl. 1, figs. 1–2.

Diagnosis: Clavatrilete, mid-sized (31 µm), clavae predominate but also granules, bacula, and spines all in same grain, 0.5–1.5 µm long.

Specimens: UFP 12, 14.1 × 85.5

Description: Spores single, symmetry radial, amb circular to triangular-obtuse-convex; trilete, margo < 0.5 µm wide, very thin and indistinct, curvatura absent, radii long-sized, TLI 0.8, commisure straight, ends rounded; sporoderm 1-layered, intexine 1.5 µm thick; sculpture clavate, contact area granular (0.5 µm wide/long), remainder of the wall clavate, clavae predominate, but also bacula, granules, and spines of different height all in same grain, 0.5–1.5 µm long, 0.5–1.5 µm wide, 0.5–1.0 µm apart, elements shaped unevenly, distributed densely. Dimensions: Equatorial diameter width 25 µm; equatorial diameter length 31 µm, equatorial diameter length/width 1.2, nm: 1; no: 1.

Comparisons: *Clavatriletes* REGALI et al. 1974 is a junior homonym and possible latter synonym of *Clavatriletes* HERBST 1965, *Clavatriletes* HERBST 1965 probably is a junior synonym of *Clavatisporites* KEDVES & SIMONCSICS 1964 (JANSONIUS & HILLS 1976, card 521).

Genus *Echinatisporis* KRUTZSCH 1959a

Echinatisporis brevispinosus n. sp.

Plate 2, Figs. 5–6

Diagnosis: Echitrilete, mid-sized (24–36 µm), intexine 1 µm thick, spines 3–5 µm long, ends pointed, homogeneous, distributed densely.

Specimens: Holotype UFP 49, 9.4 × 84.5, pl. 2. fig. 5–6; paratypes UFP 34, 6.3 × 98.5; UFP 57, 21.2 × 90

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After the short size of spines.

Description: Spores single, symmetry radial, amb triangular-obtuse-convex; trilete, margo 1 µm wide, distinct, border slightly undulating, curvatura absent, radii long, TLI 0.8, commisure distinct, straight, ends pointed; sporoderm 1-layered, intexine 1 µm thick; sculpture echinate, spines 3–5 µm long, 1.5–2 µm wide, conical, ends pointed, 1.5–4 µm apart, shaped evenly, distributed densely over entire grain. Dimensions: Equatorial diameter 24 (29) 36 µm, SD 3.9, equatorial diameter length/width 1, nm: 12; no: 19.

Comparisons: *Echitriletes muelleri* REGALI et al. 1974 has longer spines (> 6 µm), wider spaced (6 µm), and spine tips are highly variable in same grain, *Echinatisporis minutus* VAN DER KAARS 1983 is smaller (16–26 µm), has a trilete mark that is not always distinct, and shorter spines (< 2.5 µm), *Apiculatasporites obscurus* n. sp. has two size-classes of spines, expanded at the base, and margo is indistinct.

Genus *Foveotriletes* VAN DER HAMMEN ex POTONIÉ 1956

Foveotriletes margaritae (VAN DER HAMMEN 1954) GERMERAAD et al. 1968

Plate 2, Figs. 19–20

Diagnosis: Foveotrilete, mid-sized (40–53 µm), intexine 1–2 µm thick, foveolae 0.5–2 µm wide, 1–2 µm part.

Specimens: UFP 45, 17.6 × 106

Description: Spores single, symmetry radial, pyramidal, amb circular to triangular-obtuse-convex; trilete, curvatura absent, radii short to mid-sized, TLI 0.7, commisure straight, ends pointed, sometimes indistinct; sporoderm 1-layered, intexine 1–2 µm thick; sculpture foveolate, foveolae 0.5–2 µm wide, 1–2 µm apart, circular to ellipsoid, shaped uniformly, distributed densely and uniformly over entire grain. Dimensions: Equatorial diameter 38 (45.5) 53 µm, equatorial diameter length/width 1.1, nm: 2; no: 2.

Comparisons: These specimens are probably reworked from Late Cretaceous or early Paleocene strata in which this species is very common.

Foveotriletes sp. 1

Plate 2, Figs. 21–24

Diagnosis: Foveotrilete, mid-sized (30–35 µm), proximal face laevigate, distal face foveolate-fossulate.

Specimens: UFP 49, 12.2 × 111.8; UFP 43, 5 × 82.3

Description: Spores single, symmetry radial, pyramidal, amb triangular-obtuse-convex; trilete, margo 0.5 µm wide, indistinct to absent, curvatura absent, radii long, TLI 0.9, comissure straight; sporoderm 1-layered, intexine 1 µm thick; sculpture foveolate-fossulate, proximal face laevigate, distal face foveolate-fossulate, lumina 2 µm wide, 2–5 µm long, elongated to rhomboid, angles rounded, 1–1.5 µm apart, shaped irregularly, distributed densely. Dimensions: Equatorial diameter 30 (32.5) 35 µm, equatorial diameter length/width 1.1, nm: 2; no: 2.

Comparisons: *Crassoretitriletes vanraadshooveni* GERMERAAD et al. 1968 has reticula coarse over the entire grain, *Foveotriletes margaritae* (VAN DER HAMMEN 1954) GERMERAAD et al. 1968 has sculpturing over the entire grain and it is larger (38–53 µm).

Genus *Ischyosporites* BALME 1957, emend. FENSOME 1987

Ischyosporites problematicus n. sp.

Plate 2, Figs. 25–28

Diagnosis: Trilete, mid-sized (30–40 µm), intexine 2 µm thick, fossulate, fossulae large, with undulating margins, bifurcating, and being connected with each other.

Specimens: Holotype UFP 27, 12 × 114, pl. 2, figs. 25–27; paratype UFP 15, 13.9 × 85.6, pl. 2, fig. 28

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After the irregular shape of fossulae in distal face.

Description: Spores single, symmetry radial, amb triangular-obtuse-convex; trilete, margo 2 µm wide, distinct, produced by thickening of intexine, curvatura absent, radii long, TLI 0.8, commisure straight, ends pointed; sporoderm 1-layered, intexine 2 µm thick; sculpture fossulate, proximal and distal face fossulate, fossulae 2 µm wide, 1 µm deep, 4–12 µm long, irregular in shape tending to be elongated with margins sinuous, fusing with each other forming a system of channels connected, muri 3–4 µm wide, sometimes risen producing a verruca-like protuberance. Dimensions: Equatorial diameter 30 (38) 40 µm, SD 4, equatorial diameter length/width 1.1, nm: 6; no: 6.

Comparisons: Other species of *Ischyosporites* BALME 1957, emend. FENSOME 1987 have circular, polygonal or irregularly-shaped lumina that are generally isolated from each other (JANSONIUS & HILLS 1976), *Reticulatisporites* IBRAHIM 1933, emend. NEVES 1964 is cingulate and muri are thinner (JANSONIUS & HILLS 1976).

Genus *Kirchheimerisporites* KEDVES 1995 ex KEDVES, hoc loco

Kirchheimerisporites tenuiradiatus n. sp.

Plate 2, Figs. 29–30

Diagnosis: Psilatrilete, mid-sized (24–29 µm), internal thickenings oriented radially, 1 µm wide, 2 µm long, < 0.5 µm long.

Specimens: Holotype UFP 44, 5.1 × 99.5, pl. 2, figs. 29–30

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After the thin internal thickenings radially oriented.

Description: Spores single, symmetry radial, pyramidal, amb triangular-acute-convex; trilete, margo 1 µm wide, 1 µm long, distinct, highly risen, curvatura absent, radii long, almost reaching equator, TLI 0.95, commisure straight, ends pointed; sporoderm 1-layered, intexine < 1.0 µm thick, with internal thickenings radially oriented, 1 µm wide, 2 µm long, < 0.5 µm long, 1.5–3 µm apart; sculpture laevigate. Dimensions: Equatorial diameter 24 (27) 29 µm, SD 2.5, equatorial diameter length/width 1, nm: 3; no: 3.

Comparisons: *Kirchheimerisporites khargaensis* KEDVES 1995 is larger (40–56 µm), and has other thickenings around the laesura.

Genus *Laevigatosporites* IBRAHIM 1933

Laevigatosporites tibuensis (VAN DER HAMMEN 1956a) n. comb.

Plate 2, Figs. 31

Basionym = *Psilamonoletes tibui* VAN DER HAMMEN 1956a, p. 108, pl. 2, fig. 6.

Diagnosis: Monolete, mid-sized (30–50 µm), elliptic, plane-convex to reniform, sporoderm 0.5–1 µm thick, laevigate.

Specimens: UFP 6, 6.6 × 91.1

Description: Spores single, symmetry radial, plane-convex to reniform, amb elliptic; monolete, margo 0.5–1 µm wide, absent to slightly distinct, curvatura absent, laesura mid-sized, MLI 0.7, commisure straight, ends pointed, not always clearly defined; sporoderm 1-layered, intexine 0.5–1 µm wide; sculpture laevigate. Dimensions: Equatorial diameter width 20 (28) 35 µm, SD 4.8; equatorial diameter length 30 (40) 50 µm, SD 6.6, equatorial diameter length/width 1.4, nm: 8; equatorial diameter 30 (39) 50 µm, SD 5.3; polar diameter 20 (29) 40 µm, SD 4.4, equatorial/polar diameter 1.4, nm: 41; no: 1292.

Comparisons: SRIVASTAVA (1971) considers *Psilamonoletes* VAN DER HAMMEN 1956a a junior synonym of *Laevigatosporites* IBRAHIM 1933, emend. SCHOPF et al. 1944.

Laevigatosporites sp. 1

Plate 2, Figs. 32–34

Diagnosis: Monolete, mid-sized (33 µm), intexine < 0.5 µm, granular, granules < 0.5 µm long/wide, distributed irregularly forming patches.

Specimens: UFP 9, 10 × 108.1

Description: Spores single, symmetry radial, plane-convex; monolete, margo absent, curvatura absent, laesura mid-sized, MLI 0.6, commisure straight, slightly intruding, ends pointed; sporoderm 1-layered, intexine < 0.5 µm thick, sporoderm very thin; sculpture granular, granules < 0.5 µm long, < 0.5 µm wide, circular, uniform in shape, distributed irregularly forming patches. Dimensions: Equatorial diameter 33 µm; polar diameter 25 µm, equatorial/polar diameter 1.3, nm: 1; no: 1.

Comparisons: *Laevigatosporites catanejensis* MULLER et al. 1987 has a thicker sporoderm (2.5 µm), and wider granules (1 µm wide), *Laevigatosporites* sp. 2 has a thicker sporoderm (1 µm), and wider granules (0.5 – < 1.0 µm).

Laevigatosporites sp. 2

Plate 3, Figs. 1–3

Diagnosis: Monolete, mid-sized (50 µm), intexine 1 µm thick, granular, granules < 0.5 µm long, 0.5 – < 1.0 wide, irregularly distributed forming patches.

Specimens: UFP 37, 15.5 × 93

Description: Spores single, symmetry radial, amb elliptic; monolete, margo 1 µm wide, faint, produced by a slight darkening of sporoderm, curvatura absent, laesura short, MLI 0.5, commisure straight, ends pointed; sporoderm 1-layered, intexine 1 µm thick; sculpture granular, granules < 0.5 µm long, 0.5 – < 1.0 µm wide, circular, uniform in shape, distributed irregularly forming patches. Dimensions: Equatorial diameter width 36 µm; equatorial diameter length 50 µm, equatorial diameter length/width 1.4, nm: 1; no: 1.

Comparisons: *Laevigatosporites catanejensis* MULLER et al. 1987 has a thicker sporoderm (2.5 µm), and wider granules (1 µm wide), *Laevigatosporites* sp. 1 has a thinner sporoderm (< 0.5 µm), and narrower granules (< 0.5 µm wide).

Genus *Microfoveolatosporis* KRUTZSCH 1959a

Microfoveolatosporis skottsbergii (SELLING 1946) SRIVASTAVA 1971

Plate 3, Figs. 4–5

Diagnosis: Foveomonolete, large-sized (60–89 µm), foveolae 1–2 µm wide, 1 µm deep, 1–1.5 µm apart, circular, uniform, distributed densely.

Specimens: UFP 53, 6.8 × 92.3; UFP 49, 13.2 × 112

Description: Spores single, symmetry radial, plane-convex; monolete, curvatura absent; sporoderm 1-layered, intexine 2 µm thick; sculpture foveolate, foveolae 1–2 µm wide, 1 µm deep, 1–1.5 µm apart, circular, occasionally elongate, uniform in shape, distributed densely over entire grain, with the tendency to be arranged in rows and columns. Dimensions: Equatorial diameter 60 (74.5) 89 µm; polar diameter 42 (46) 50 µm, equatorial/polar diameter 1.6, nm: 2; no: 2.

Genus *Osmundacidites* COUPER 1953, emend. NORRIS 1986

Osmundacidites minor n. sp.

Plate 3, Figs. 6–8

Diagnosis: Trilete, mid-sized (25–30 µm), amb circular, intexine 1.0 µm, laesura simple, radii long, sculpture granular, granules densely distributed.

Specimens: Holotype UFP 45, 14.8 × 87.4, pl. 3. figs. 6–8

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After the small size.

Description: Spores single, symmetry radial, amb circular; trilete, curvatura absent, radii long almost reaching equator, TLI 0.96, commisure straight, ends pointed, slightly intruding; sporoderm 1-layered, intexine 1 µm thick; sculpture granular, granules < 0.5 µm wide and long, < 0.5 µm part, shaped uniformly, distributed densely and uniformly. Dimensions: Equatorial diameter 25 (27) 30 µm, SD 2.1, equatorial diameter length/width 1, nm: 4; no: 6.

Comparisons: *Osmundacidites wellmanii* COUPER 1953 is larger (40–63 µm wide), and exine is thicker (1.5 µm, KEDVES 1995), *Hydrosporis farafraensis* KEDVES 1995 is two layered.

Genus *Planisporites* KNOX 1950 emend. POTONIÉ 1960

Planisporites? sp. 1

Plate 2, Figs. 13–15

Diagnosis: Trilete, mid-sized (27 µm), intexine thin, microechinate.

Specimens: UFP 35, 19.1 × 88.2

Description: Spores single, symmetry radial, amb circular to triangular-obtuse-convex; trilete, margo < 0.5 wide, indistinct, curvatura absent, radii long, TLI 0.8, commisure straight, ends rounded; sporoderm 1-layered, intexine 0.5 µm thick, sporoderm very thin; sculpture microechinate, microspines < 0.5 µm long, < 1.0 µm wide, conical, < 1 µm apart, distributed uniformly and densely over entire grain. Dimensions: Equatorial diameter 27 µm, equatorial diameter length/width 1.1, nm: 1; no: 3.

Comparisons: These specimens cannot be placed in an existing genus. They are temporarily placed in the genus *Planisporites* Knox 1950 that accommodates circular azonate echinate triletes with small spines (JANSONIUS & HILLS 1976). *Echinatisporis minutus* VAN DER KAARS 1983 has longer spines (1.5–2.5 µm long).

Planisporites sp. 2

Plate 2, Figs. 16–18

Diagnosis: Echitrilete, small-sized (24 µm), laesura raised, intexine scabrate, spines shaped unevenly, 0.5–2 µm long.

Specimens: UFP 37, 5.2 × 87.1

Description: Spores single, symmetry radial, amb triangular-obtuse-convex; trilete, TLI 0.9, margo 1 µm wide, distinct, highly risen (2 µm high), forming an elevated tabular ridge that also rises commisure, curvatura absent, radii long, commisure straight, ends pointed; sporoderm 1-layered, intexine 0.5 µm thick, sporoderm very thin; sculpture echinate, spines 0.5–2 µm long, 0.5 µm-2 µm wide, 1.5–3 µm apart, irregular in shape and size, conical, subconical, cylindrical, ends blunted, distributed sparsely, intexine interspines scabrate. Dimensions: Equatorial diameter width 20 µm; equatorial diameter length 24 µm, equatorial diameter length/width 1.2, nm: 1; no: 1.

Comparisons: *Apiculatasporites obscurus* n. sp. has spines that are expanded at the base, and margo is indistinct.

Genus *Polypodiaceoisporites* Potonié 1951 ex Potonié 1956

Polypodiaceoisporites? fossulatus n. sp.

Plate 3, Figs. 9–12

Diagnosis: Trilete, mid-sized (33–46 µm), cingulate, laesura simple, proximal face verrucate or granular, sometimes kyrtomate, distal face fossulate.

Specimens: Holotype UFP 87, 20.7 × 88.5, pl. 3. figs. 9–11; paratypes UFP 43, 6.7 × 112, pl. 3, fig. 12; UFP 9, 10.5 × 107.2; UFP 84, 5.3 × 97; UFP 48, 5.5 × 79.1

Type locality: Rio Negro river, near Uribe, 7° 20'N – 73° 20 W, Colombia; La Paz Formation, early to middle Eocene.

Etymology: After the fossulate sculpturing.

Description: Spores single, symmetry radial, pyramidal, amb triangular-obtuse-straight; trilete, curvatura absent, radii long reaching equator without extending into cingulum, TLI 1, commisure straight, ends pointed; sporoderm 1-layered, intexine 2 µm thick, cingulate-kyrtomate, cingulum 4–5 µm wide at interradial region and 3 µm wide at radial region, kyrtome sometimes present and produced by verrucae aligned, sometimes fused to each other along both sides of comissure; sculpture verrucate, proximal face verrucate to granular, verrucae 2–3 µm wide, 0.5–2 µm long, < 2 µm apart, granules 0.5–1 µm wide, < 1 µm long, 0.5–4 µm apart, both are circular to slightly elliptic, rounded in cross section, distributed densely, irregular in size and shape, occasionally two or more fusing to form small ridges, distal face fossulate, fossulae 1–2 wide, 5–15 µm long, isolated or fusing to each other forming isolated networks, muri 2–5 µm wide, sometimes muri are also isolated, large intraspecific variation in coarseness and density of sculptural elements in proximal and distal faces. Dimensions: Equatorial diameter 33 (38) 46 µm, SD 3.3, equatorial diameter length/width 1.1, nm: 17; polar diameter 36 µm, equatorial/polar diameter 1.1, nm: 1; no: 49.

Comparisons: These specimens cannot be placed in any existing genus. They are provisionally placed in the genus *Polypodiaceoisporites* Potonié 1951 ex Potonié 1956 that is very similar but has a reticulate distal face (Jansonius & Hills 1976).

Genus *Polypodiisporites* Potonié 1931? in Potonié & Gelletich 1933 ex Potonié 1956, emend. Khan & Martin 1972

Polypodiisporites echinatus n. sp.

Plate 3, Figs. 13–15

Diagnosis: Monolete, plane-convex, mid-sized (30–43 µm), echinate, spines 4–8 µm wide, 2–5 µm long, 2–5 µm apart, shaped irregularly.

Specimens: Holotype UFP 11, 15.5 × 108.5, pl. 3, figs. 13–15

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After the echinate sculpturing.

Description: Spores single, symmetry radial, plane-convex; monolete, curvatura absent, laesura indistinct, not clearly seen in lateral view, MLI 0.6; sporoderm 1-layered, intexine 0.5–1.0 µm thick; sculpture echinate, spines 4–8 µm wide, 2–5 µm long, 2–5 µm apart, sized and shaped irregularly, rounded in plain view, conical, bases highly expanded and darker in color, tips pointed and light colored, or rounded

with a small tip pointed. Dimensions: Equatorial diameter 30 (35) 43 µm, SD 4.7; polar diameter 25 (29.5) 35 µm, SD 3.9, equatorial/polar diameter 1.2, nm: 9; no: 24.

Comparisons: *Polypodiisporites turbinatus* SAH 1967 has projections that are shorter and conical.

Polypodiisporites aff. *inangahuensis* (COUPER 1953) POTONIÉ 1956 emend. POCKNALL & MILDENHALL 1984

Plate 3, Figs. 16–18

Diagnosis: Monolete, reniform, mid-sized (48–60 µm), proximal face scabrate, distal verrucate, verrucae flat, < 0.5 µm long, forming a negative reticula.

Specimens: UFP 86, 17.6 × 106.5

Description: Spores single, symmetry radial, reniform, amb elliptic; monolete, curvatura absent, laesura mid-sized, MLI 0.6, commisure straight, ends pointed; sporoderm 1-layered, intexine 2 µm thick; sculpture verrucate, proximal surface scabrate, remainder of grain verrucate, verrucae 2–4 µm wide, < 0.5 µm long, 0.5 µm apart, polygonal with rounded vertices, forming a negative reticula, occasionally few gemmae large and isolated are present. Dimensions: Equatorial diameter 48 (52) 60 µm, SD 5.4; polar diameter 32 (39) 49 µm, SD 7.4, equatorial/polar diameter 1.3, nm: 4; no: 5.

Comparisons: *Polypodiisporites inangahuensis* is similar but exine is thicker (3–4.5 µm), grains are larger (57–82 µm), and verrucae are longer (2 µm), *Polypodiisporites specious* SAH 1967 and *Verrucatosporites speciosus* HARRIS 1965 have longer verrucae (0.5–2 µm long), *Verrucatosporites usmensis* (VAN DER HAMMEN 1956a) GERMERAAD et al. 1968 is gemmate.

Polypodiisporites pachyexinatus n. sp.

Plate 3, Figs. 19–21

Diagnosis: Monolete, mid-sized (39–48 µm), intexine 3 µm thick, proximal face laevigate, distal verrucate, verrucae flat, < 0.5 µm long, interverrucae wall scabrate.

Specimens: Holotype UFP 21, 8.2 × 92, pl. 3, figs. 19–21

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After the thick sporoderm.

Description: Spores single, symmetry radial, amb elliptic; monolete, margo 1 µm wide, produced by intexine fold, curvatura absent, laesura mid-sized, MLI 0.7, commisure irregular, ends pointed, indistinct; sporoderm 1-layered, intexine 3 µm thick, sporoderm very thick; sculpture verrucate, proximal surface laevigate, remainder of grain verrucate, verrucae 2–5 µm wide, 2–5 µm long, 0.5 µm long, 2–8 µm apart, polygonal with acute vertices, tip flat, distributed sparsely and irregularly, intexine interverrucae scabrate, scabrae < 0.5 µm long and wide, 1–2 µm apart. Dimensions: Equatorial diameter width 29 (32) 37 µm; equatorial diameter length 39 (44) 48 µm, equatorial diameter length/width 1.4, nm: 3; no: 3.

Comparisons: *Polypodiisporites specious* SAH 1967 has longer verrucae (0.5–2 µm long), densely distributed, *Verrucatosporites usmensis* (VAN DER HAMMEN 1956a) GERMERAAD et al. 1968 is gemmate.

Polypodiisporites aff. *specious* SAH 1967

Plate 3, Figs. 22–23

Diagnosis: Monolete, mid-sized (36–60 µm), proximal face laevigate, distal verrucate, verrucae irregular in shape and size, 0.5–2 µm long.

Specimens: UFP 48, 10.2 × 78.8

Description: Spores single, symmetry radial, reniform, amb elliptic; monolete, curvatura absent, laesura short-sized, MLI 0.5, commisure straight, ends pointed; sporoderm 1-layered, intexine 0.5–1.5 µm thick, thickening to 2–3 µm at proximal pole; sculpture verrucate, proximal surface laevigate, remainder of grain verrucate, verrucae 1–4 µm wide, 0.5–2 µm long, 0.5–1.5 apart, rounded to elongate to polygonal with vertices rounded, shaped irregularly, verrucae diminishing in width from distal pole toward proximal area. Dimensions: Equatorial diameter 36 (43) 60 µm, SD 7.1; polar diameter 20 (29.4) 40 µm, SD 4.6, equatorial/polar diameter 1.5, nm: 15; no: 370.

Comparisons: This is a morphological group that has a large intraspecific variation. Very similar to *Polypodiisporites specious* SAH 1967 although exine is thicker (2–3 µm), *Verrucatosporites speciosus* HARRIS 1965 has wider verrucae (2–7 µm). KHAN & MARTIN (1972) considers *Verrucatosporites* a junior synonym of *Polypodiisporites*. If this is the case, then *Verrucatosporites specious* HARRIS should be transferred to genus *Polypodiisporites*, and therefore, a new name should be assigned to *Polypodiisporites specious* SAH 1967.

Polypodiisporites sp. 1

Plate 4, Figs. 1–2

Diagnosis: Monolete, mid-sized (26–35 µm), verrucate 1–2 µm long, rounded in plain view, flat, rounded and/or even bacula-like in cross section.

Specimens: UFP 76, 14.8 × 110.7; UFP 82, 20 × 87

Description: Spores single, symmetry radial, plane-convex, amb elliptic; monolete, curvatura absent, laesura mid-sized, MLI 0.7, commisure indistinct; sporoderm 1-layered, intexine 1 µm thick; sculpture verrucate, verrucae 2–2.5 µm wide, 1–2 µm long, 1–5 µm apart, circular in plain view, flat, rounded or elongated in cross section, shaped unevenly, spaced widely and unevenly over entire body. Dimensions: Equatorial diameter 26 (31) 35 µm; polar diameter 24 (27) 30 µm, equatorial/polar diameter 1.1, nm: 3; no: 3.

Comparisons: *Verrucatosporites usmensis* (Van der Hammen 1956a) Germeraad et al. 1968 is larger (39–61 µm), and has gemmae spaced more widely and variable, *Polypodiisporites* aff. *specious* Sah 1967 is larger (36–60 µm), and proximal face is laevigate, *Polypodiisporites* sp. 3 is larger (30–50 µm), and verrucae are polygonal with sharp vertices, *Polypodiisporites minimus* (Couper 1960) emend. Khan & Martin 1971 has shorter verrucae (1 µm long), reduced on proximal side, and a thicker exine (2–3 µm).

Polypodiisporites sp. 2

Plate 4, Figs. 3–5

Diagnosis: Monolete, ellipsoid, mid-sized (42–43 µm), gemmate, gemmae 2–4 µm long, globular to mushroom-like, diminishing around laesura.

Specimens: UFP 49, 16.6 × 90

Description: Spores single, symmetry radial, reniform, amb elliptic; monolete, curvatura absent, laesura mid-sized, MLI 0.5, commisure irregular, indistinct; sporoderm 1-layered, intexine 2–4 µm thick; sculpture gemmate, gemmae 3–5 µm wide at tip, 1–2.5 µm wide at base, 2–4 µm long, < 0.5 µm apart, globular to mushroom-like, distributed densely over entire body, gemmae height diminishes to 0.5–1 µm around laesura. Dimensions: Equatorial diameter width 32 (35) 38 µm; equatorial diameter length 42 (42.5) 43 µm, equatorial diameter length/width 1.2, nm: 2; no: 2.

Comparisons: *Verrucatosporites usmensis* (Van der Hammen 1956a) Germeraad et al. 1968 has shorter gemmae (1.5–2.5 µm long), more widely spaced and variable.

Polypodiisporites sp. 3

Plate 4, Figs. 6–7

Diagnosis: Monolete, mid-sized (30–50 µm), verrucate, verrucae 2–5 µm wide, polygonal with sharp vertices, shaped and distributed irregularly, with bacula and gemmae scattered.

Specimens: UFP 6, 11.6 × 98.8

Description: Spores single, symmetry radial, plane-convex; monolete, curvatura absent, laesura indistinct, not clearly seen in lateral view, MLI 0.5; sporoderm 1-layered, intexine 1–1.5 µm thick; sculpture verrucate, verrucae 2–5 µm wide, 0.5–3 µm long, 0.5–1.5 µm apart, polygonal to rounded with sharp vertices, shaped and distributed irregularly, in some areas of grain loosely arranged, while in others form a negative reticula, scattered bacula and gemmae are also present, sculpturing has a very distinct dark color that contrast with light color of intexine, intexine sometimes micropitted to foveolate, lumina < 1.0 µm wide, this sculpturing may be product of grain degradation. Dimensions: Equatorial diameter 30 (37) 50 µm, SD 7.7; polar diameter 20 (26) 30 µm, SD 3.9, equatorial/polar diameter 1.4, nm: 5; no: 6.

Comparisons: *Polypodiisporites* aff. *specious* Sah 1967 has a laevigate proximal face, has verrucae with rounded vertices, and lacks gemmae or bacula, *Verrucatosporites usmensis* (Van der Hammen 1956a) Germeraad et al. 1968 is gemmate.

Genus *Pteridacidites* Sah 1967

Pteridacidites sp. 1

Plate 4, Figs. 8–10

Diagnosis: Trilete, mid-sized (40 µm), cingulate, laesura simple, proximal face laevigate, distal face verrucate, few verrucae very large.

Specimens: UFP 86, 15 × 88.4; UFP 87, 8.2 × 78.3

Description: Spores single, symmetry radial, plane-convex, amb triangular-obtuse-straight; trilete, curvatura absent, radii long, reaching equator without extending into cingulum, TLI 1, commisure straight, ends pointed; sporoderm 1-layered, intexine 1 µm thick, cingulate, cingulum 3–4 µm thick, laevigate; sculpture verrucate, proximal face laevigate, distal face verrucate, verrucae very large, 5–8 per grain, 2–3 µm wide, 3–6 µm long, 4–5 µm long, 2–3 µm apart, spoon-shaped, elongate in plain view, rounded in cross section, verrucae isolated or fused to each other at the base. Dimensions: Equatorial diameter width 30 (31) 32 µm; equatorial diameter length 40 (40) 40 µm, equatorial diameter length/width 1.3, nm: 2; no: 2.

Comparisons: *Pteridacidites africanus* Sah 1967 is larger (60–80 µm), and verrucae occur in proximal face.

Genus *Retitriletes* PIERCE 1961

Retitriletes sp. 1

Plate 4, Figs. 11–13

Diagnosis: Trilete, circular, mid-sized (40–60 µm), entire body reticulate, lumina 5–7 µm wide, hexagonal, muri thin, 2 µm long, produced by exoexine rise.

Specimens: UFP 46, 5.5 × 84.2

Description: Spores single, symmetry radial, pyramidal, amb triangular-obtuse-convex; trilete, margo < 0.5 µm wide, produced by muri parallel to commisure, curvatura absent, radii long reaching equator, TLI 1, commisure straight, ends pointed; sporoderm cavate, 1.5–2.0 µm thick, intexine 1.5–2 µm thick, exoexine < 0.5 µm thick, forming reticula; sculpture reticulate, reticula over entire body, lumina 5–7 µm wide, hexagonal, muri thin, 0.5 µm wide, 2 µm long, often forming a pseudocingulum, reticula caused by raised folds of exoexine. Dimensions: Equatorial diameter 40 (50) 60 µm, equatorial diameter length/width 1.1, nm: 3; no: 4.

Comparisons: *Zlivisporis blanensis* PACLTOVÁ 1961 has a laevigate proximal face. Here, we follow the opinion of KRUTZSCH 1963 that considers *Lycopodiumsporites* a nomen dubium, and suggests that all Tertiary forms that are reticulate and lycopodiaceoid should be assigned to *Retitriletes* PIERCE 1961 (JANSONIUS & HILLS 1976).

Genus *Scabramonoletes* RAMANUJAM 1966 (non VAN DER HAMMEN)

Scabramonoletes? sp. 1

Plate 4, Figs. 14–16

Diagnosis: Monolete, mid-sized (30 µm), granular, granules 1–2 µm wide, < 0.5 µm long, distributed sparsely and unevenly.

Specimens: UFP 5, 7.9 × 105

Description: Spores single, symmetry radial, amb elliptic; monolete, curvatura absent, laesura mid-sized, MLI 0.6, commisure straight, ends rounded; sporoderm 1-layered, intexine 1 µm thick; sculpture granular, granules 1–2 µm wide, < 0.5 µm long, 0.5–7 µm apart, circular to slightly elongated, distributed sparsely and unevenly over entire body. Dimensions: Equatorial diameter 30 µm, equatorial diameter length/width 1.1 nm: 1; no: 2.

Comparisons: These specimens have granular sculpturing very short and wide, sparsely distribute. This species cannot be placed satisfactorily in any existing genus and it is placed provisionally in *Scabramonoletes* RAMANUJAM 1966 that accommodates monolete spores with small sculptural projections that are densely distributed.

Genus *Tuberositriletes* DÖRING 1964

Tuberositriletes verrucatus n. sp.

Plate 4, Figs. 17–19

Diagnosis: Trilete, mid-sized (27–32 µm), verrucate, verrucae large, 2 µm long, well rounded in cross section.

Specimens: Holotype UFP 34, 10 × 94.9, pl. 4, figs. 17–19

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After verrucate sculpturing.

Description: Spores single, symmetry radial, amb triangular-obtuse-straight; trilete, margo 0.5 µm wide, 0.5 µm thick, produced by thickening of intexine, curvatura absent, radii long, almost reaching equator, TLI 0.9, commisure straight, ends pointed; sporoderm 1-layered, intexine 1 µm thick; sculpture verrucate, verrucae 3–4 µm wide, 2 µm long, 0.5–1.5 µm apart, circular to elongated, rounded in cross section, relatively even in shape and size, occasionally two fusing at base, distributed densely over entire body, forming negative reticula. Dimensions: Equatorial diameter 27 (30) 32 µm, SD 1.5, equatorial diameter length/width 1.1, nm: 9; no: 14.

Comparisons: *Tuberositriletes*? sp. 1 has smaller verrucae (0.5 µm long), more widely distributed, *Distaverrusporites* MULLER 1968 has a laevigate proximal face.

Tuberositriletes? sp. 1

Plate 4, Figs. 20–22

Diagnosis: Trilete, mid-sized (26 µm), intexine 1 µm thick, verrucate, verrucae 0.5 µm long, circular, tip rounded or flat, spaced widely and irregularly.

Specimens: UFP 32, 15 × 107.7

Description: Spores single, symmetry radial, amb circular; trilete, margo 0.5 µm wide, 0.5–1.0 µm thick, produced by thikkening of intexine, curvatura absent, radii long, almost reaching equator, TLI 0.9, commisure straight, ends pointed; sporoderm 1-layered, intexine 1 µm thick; sculpture verrucate, verrucae 0.5–1 µm wide, 0.5 µm long, 3–5 µm apart, circular, tip rounded or flat, spaced widely and irregularly over entire body. Dimensions: Equatorial diameter 26 µm, equatorial diameter length/width 1, nm: 1; no: 3.

Comparisons: These specimens are provisionally placed in *Tuberositriletes* DORING 1964 although the amb is circular rather than triangular, and verrucae density is lower than in *Tuberositriletes* type species.

Genus *Zlivisporis* PACLTOVÁ 1964

Zlivisporis blanensis PACLTOVÁ 1961

Plate 4, Figs. 23–24

Diagnosis: Trilete, circular, mid-sized (45–60 µm), proximal face laevigate, distal face reticulate, muri thin, produced by exoexine rise.

Specimens: UFP 17, 18.3 × 95.4

Description: Spores single, symmetry radial, amb circular; trilete, margo < 0.5 µm wide, produced by slight thickening of wall, curvatura absent, radii long, reaching equator, TLI 0.9, commisure straight, ends pointed; sporoderm cavate, 1.2 µm thick, intexine 0.5 – < 1.5 µm thick, exoexine < 0.5 µm thick, very thin, producing reticula; sculpture reticulate, proximal face laevigate, distal face reticulate, lumina 12–20 µm wide, hexagonal, muri thin, 0.5 µm wide, 1 µm long, often forming a pseudocingulum, reticula produced by raised folds of exoexine. Dimensions: Equatorial diameter 45 (53) 60 µm, SD 5, equatorial diameter length/width 1.1, nm: 6; no: 12.

4.2 Gymnosperm pollen

Genus *Araucariacites* COOKSON & COUPER 1953

Araucariacites sp. 1

Plate 5, Figs. 1–3

Diagnosis: Inaperturate, large-sized (66 µm), ellipsoidal, intectate 1.0–1.5 µm thick, rugulate, rugulae 1 µm wide, 3–5 µm long, < 0.5 µm long.

Specimens: UFP 19, 11.3 × 92.5

Description: Monad, radial, isopolar, amb elliptic; inaperturate; intectate, nexine 1.0–1.5 µm thick, exine mid-sized; sculpture rugulate, rugulae 1 µm wide, 3–5 µm long, < 0.5 µm long, covering the entire surface of grain. Dimensions: Equatorial diameter width 40 µm; equatorial diameter length 66 µm; equatorial diameter length/width 1.6, nm: 1; no: 2.

Comparisons: *Araucariacites australis* COOKSON 1947 is thinner at the poles and has microrugulate to granular sculpturing.

Araucariacites sp. 2

Plate 5, Figs. 4–5

Diagnosis: Inaperturate, mid to large-sized (40–70 µm), intectate very thin, 0.5 µm thick, scabrate densely.

Specimens: UFP 11, 14.5 × 104.7

Description: Monad, radial, isopolar, amb circular; inaperturate; intectate, nexine 0.5 µm thick, exine thin, grains always appear wrinkled and folded; sculpture scabrate, scabrae < 0.5 µm wide and long, distributed densely over entire surface. Dimensions: Equatorial diameter width 40 (44) 50 µm; equatorial diameter length 40 (55) 70 µm; equatorial diameter length/width 1.2, nm: 3; no: 3.

Comparisons: *Inaperturopollenites cursis* SARMIENTO 1992 is smaller and reticulate, *Araucariacites australis* COOKSON 1947 has a thicker exine (1–3 µm) and is commonly thinner at the poles.

Genus *Ephedripites* BOLKHOVITINA 1953 ex POTONIÉ 1958

Ephedripites vanegensis VAN DER HAMMEN & GARCIA 1966

Plate 5, Fig. 6

Diagnosis: Inaperturate, polyplicate, mid-sized (35–40 µm), atectate 0.5–1.0 µm thick, thicker at polar areas (1.2 µm), with zone smooth of about 3–6 µm at apocolpia, 18–35 plicae. Specimens: UFP 10, 4.9 × 86.7; UFP 9, 15.5 × 107

Description: Monad, radial, isopolar, prolate; inaperturate; atectate, nexine 0.5–1.0 µm thick, thicker at polar areas to < 1.5 µm producing a darker zone; sculpture polyplicate, 18–35 plicae, polar zone smooth, 3–6 µm wide, sometimes exine opening at plica simulating a colpus. Dimensions: Equatorial diameter 17 (21) 27 µm, SD 4.8; polar diameter 35 (37.5) 40 µm, SD 2.1, polar/equatorial diam. 1.8, nm: 4; no: 8.

Comparisons: *Ephedripites vanegensis* VAN DER HAMMEN & GARCIA 1966 has a larger number of plicae (30–50) as well as a larger smooth polar area (10 µm), however, these grains are included in *E. vanegensis* because they seem a continuous extension of its size range and plicae number.

Affinities: Similar to *Ephedra* pollen (VAN DER HAMMEN & GARCIA 1966).

Genus *Laevigatasporites* POTONIÉ & GELLETICH 1933

Laevigatasporites sp. 1

Plate 5, Figs. 7–8

Diagnosis: Inaperturate, large-sized (85–120 µm), elliptic, psilate, exine atectate 1 – < 2.0 µm thick.

Specimens: UFP 12, 8 × 81.5

Description: Monad, radial, isopolar, amb elliptic; inaperturate; atectate, nexine 1 – < 2.0 µm thick; sculpture psilate. Dimensions: Equatorial diameter width 40 (50) 62 µm, SD 9.1; equatorial diameter length 80 (96) 120 µm, SD 17.9; equatorial diameter length/width 1.9, nm: 4; no: 19.

Comparisons: *Araucariacites australis* COOKSON 1947 is thinner at the poles and has microrugulate to granular sculpturing.

4.3 Angiosperm pollen

Genus *Aglaoreidia* ERDTMAN 1960

Aglaoreidia? foveolata n. sp.

Plate 5, Figs. 9–11

Diagnosis: Monoporate, medium sized (42–43 µm), foveoreticulate, shape straight-convex, pore large, costate, foveolae 2 µm wide at equator gradually diminishing near poles.

Specimens: Holotype UFP 8, 14 × 111.2, pl. 5, figs. 9–11; paratype UFP 8, 17.9 × 90.1

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After foveolate sculpturing.

Description: Monad, bilateral, anisopolar, amb trapezoidal straight-convex; monoporate, ectopores simple, endopores costate, ecto and endopores of similar shape and coinciding, pores large, border not well defined, lolongate, 6–8 µm wide, 8–10 µm long, costae 4 µm wide, 1 µm thick; tectate, exine 3 µm thick, nexine 2.5 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, nexine decreasing toward equator to 0.5 µm and increasing near pore to 2.5 µm, columellae distinct, 1 µm wide, 0.5–1.5 µm apart, tectum very thin; sculpture foveoreticulate, lumina 2–2.5 µm wide near pore and at opposite pole gradually diminishing to 0.5 µm toward equator, rounded to elongated, muri 1 µm wide. Dimensions: Equatorial diameter 42 (42) 43 µm; polar diameter 23 (24) 25 µm, polar/equatorial diam. 0.5, nm: 3; no: 6.

Comparisons: *Aglaoreidia* ERDTMAN 1960 is the most similar genus to place this species, although *Aglaoreidia* is reticulate and lumina increase near the pore except in the immediate vicinity of the pore (JANSONIUS & HILLS 1976).

Affinities: A monocot.

Genus *Albertipollenites* SRIVASTAVA 1969

Albertipollenites? perforatus (GONZALEZ 1967) n. comb.

Plate 5, Figs. 12–14

Basionym = *Retitricolpites perforatus* GONZALEZ 1967, p. 33, pl. 4, figs. 4–4f

Diagnosis: Tricolpate, mid-sized (32 µm), reticulate-foveolate, lumina > 0.5–1 µm wide, > 0.5–2 µm long, uniform over entire surface.

Specimens: UFP 53, 14.5 × 109.5

Description: Monad, radial, isopolar, amb circular; tricolpate, colpi simple, CEi 0.5, mid-sized, simple, borders straight, ends pointed, polar area large, 12 µm wide, colpi membrane thin; semitectate, exine 1 µm thick, columellae distinct, 1 µm wide, 1 µm apart; sculpture reticulate-foveolate, lumina > 0.5–1 µm wide, > 0.5–2 µm long, circular or elongated, distributed uniformly and densely over entire grain, muri < 1 µm wide. Dimensions: Equatorial diameter 32 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Retitricolpites* (VAN DER HAMMEN 1956b) PIERCE 1961 is invalid and a later synonym of *Neea* (JANSONIUS & HILLS 1976, card 2401). This species has reticulate-foveolate sculpturing. This species cannot be placed satisfactorily in any existing genus. It is provisionally assigned to *Albertipollenites*, because of its lumina (> 1 µm wide) of uniform size over the entire surface.

Genus *Araliaceoipollenites* (POTONIÉ 1951) ex POTONIÉ 1960

Araliaceoipollenites? sp. 1

Plate 5, Figs. 15–17

Diagnosis: Scabratricolporate, prolate, mid-sized (32–44 µm), intectate, colpi long, costate, pores lalongate, costate, porecosta 2–3 µm wide, surrounding partially or entirely the pore.

Specimens: UFP 84, 10.5 × 91.5; UFP 76, 10.5 × 82.8; UFP 84, 14.2 × 103.9

Description: Monad, radial, isopolar, prolate, amb triangular-obtuse-convex; tricolporate, ectocolpi costate, CPi 0.9, colpi very long, borders straight, ends rounded, costae 1 µm wide, polar area small, 4 µm wide, endopores costate, lalongate, 6 µm wide, 4 µm long, costae 2–3 µm wide, 1 µm thick, sometimes developed only on the upper and lower pore margins and absent from equatorial pore ends; intectate, nexine 0.5–1.0 µm thick, thin; sculpture scabrate, scabrae < 0.5 wide, < 0.5 long, distributed densely. Dimensions: Equatorial diameter 25 (26) 27 µm; polar diameter 32 (38) 44 µm, polar/equatorial diam. 1.4, nm: 2; no: 3.

Comparisons: Specimens are intectate. This species cannot be placed satisfactorily in any existing genus. It is provisionally assigned to *Araliaceoipollenites*, because of its distinct granulate sculpturing. *Scabratricolporites platanensis* DUEÑAS 1980 has simple colpi and pores, *Araliaceoipollenites*? sp. 2 is tectate and costae of pores are narrower (1 µm).

Araliaceoipollenites? sp. 2

Plate 5, Figs. 18–19

Diagnosis: Scabratricolporate, small-sized (20–25 µm), tectate, colpi long, costate, pores lalongate, costate.

Specimens: UFP 41, 11.9 × 103

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi costate, CEi 0.95, colpi very long, borders straight, ends rounded, costae 1 µm wide, polar area small, 5 µm wide, endopores costate, lalongate, 7 µm wide, 4 µm long, costae 1 µm wide, 0.5–1.0 µm thick; tectate, exine > 1.0 µm thick, nexine increases near colpi and pore to < 1.0 µm, columellae > 0.5 µm thick, indistinct, only seen as a translucent layer between tectum and nexine; sculpture scabrate, scabrae < 1.0 wide, < 0.5 long, distributed densely, present also in colpi membrane. Dimensions: Equatorial diameter 25 (27) 30 µm, SD 2.0; equatorial diameter length/width 1, nm: 4; no: 4.

Comparisons: Specimens have costate ectocolpi. This species cannot be placed satisfactorily in any existing genus. It is provisionally assigned to *Araliaceoipollenites*, because of its distinct granulate sculpturing (FREDERIKSEN 1980). *Scabratricolporites platanensis* DUEÑAS 1980 has simple colpi and pores, *Araliaceoipollenites*? sp. 1 is intectate and costae of pores are wider (3 µm).

Genus *Arecipites* WODEHOUSE 1933, emend. NICHOLS et al. 1973

Arecipites regio (VAN DER HAMMEN & GARCIA 1966) n. comb.

Plate 5, Figs. 20–21

Basionym = *Retimonocolpites regio* VAN DER HAMMEN & GARCIA 1966, p. 106, pl. 1, fig. 4

1992 *Retimonocolpites regio* VAN DER HAMMEN & GARCIA, in SARMIENTO 1992, p. 74, pl. 5, fig. 5

Diagnosis: Monosulcate, mid-sized (30–53 µm), elliptic, sulcus long, slightly marginate, and tapering, tectate, margo sometimes indistinct, micropitted.

Specimens: UFP 4, 7.6 × 85.3

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus slightly marginate, CEi 0.90, sulcus long, borders straight, ends pointed, margo not well defined, sometimes indistinct, < 1.0 µm wide, polar area small, 2 µm wide; tectate, exine < 1.0 µm thick, exine thin, columellae indistinct, < 0.5 µm thick, ; sculpture micropitted, lumina < 1.0 µm wide, distributed evenly and densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter width 19 (25) 36 µm, SD 3.6; equatorial diameter length 30 (41) 53 µm, SD 5.3; equatorial diameter length/width 1.7, nm: 40; no: 81.

Comparisons: This species is transferred to *Arecipites* because *Retimonocolpites* has distinct reticula (JANSONIUS & HILLS 1987, card 4513). *Arecipites* has a colpus that tapers at the ends and a tectate exine, psilate to finely pitted (NICHOLS et al. 1973).

Affinities: Palmae.

Genus *Baculamonocolpites* SOLE DE PORTA 1971

Baculamonocolpites hammenii n. sp.

Plate 5, Figs. 22–25

Diagnosis: Baculamonosulcate, mid to large-sized (50–65 µm), intectate 2 µm thick, bacula 4–5 µm long, tip slightly wider, distributed sparsely to densely, surface interbacula psilate.

Specimens: Holotype UFP 38, 9.6 × 90.5, pl. 5, fig. 22–23; paratype UFP 43, 6.6 × 97.1, pl. 5, fig. 24–25

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After professor THOMAS VAN DER HAMMEN who contributed so much to development of palynology in Colombia.

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, sulcus indistinct; intectate, nexine 1–2 µm thick, homogeneous; sculpture baculate, bacula 4–5 µm long, 3 µm wide at tip, 2 µm wide at base, shaped homogeneously, distributed densely (> 200 bacula/grain) to sparsely (60 bacula/grain), surface interbacula psilate. Dimensions: Equatorial diameter width 40 (46) 50 µm, SD 4.9; equatorial diameter length 50 (58) 65 µm, SD 6.3; equatorial diameter length/width 1.3, nm: 6; no: 7.

Comparisons: *Racemonocolpites* GONZALEZ 1967 has sculpturing which is predominantly gemmate and more densely distributed, *Baculamonocolpites multispinosus* (VAN DER HAMMEN) SOLE DE PORTA 1971 is smaller (40–43 µm), nexine is thinner (1 µm), and bacula are distributed sparsely and not constricted at the base, *Bacumorphomonocolpites tausae* SOLE DE PORTA 1971 has longer bacula that bifurcate, *Baculamonocolpites* sp. 2 has smaller bacula not constricted at the base, *Papillamonocolpites splendens* GONZALEZ 1967 is larger, echinate to clavate, exine is thinner (1.5 µm), and sculptural elements are longer (6.5 µm long).

Baculamonocolpites sp. 1

Plate 5, Figs. 26–27

Diagnosis: Monosulcate, mid-sized (33 µm), marginate, margo 3 µm wide, baculate, bacula 1.5 µm long, 1–2 µm wide, sparsely distributed over the entire surface, base slightly wider than tip, surface interbacula micropitted to scabrate

Specimens: UFP 82 7.4 × 97.9

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus marginate, CEi 0.9, sulcus very long, marginate, margo produced by slight thickening of exine, 3 µm wide, surrounding the total length of the sulcus, toward the tip of sulcus is narrowed to 1 µm; tectate, exine < 1.0 µm thick, exine thin, thickness constant, columellae indistinct, < 0.5 µm thick; sculpture baculate, bacula 1.5 long, 1–2 µm wide, distributed sparsely over the surface, base slightly wider than tip, surface interbacula minutely micropitted to scabrate. Dimensions: Equatorial diameter width 28 µm; equatorial diameter length 33 µm; equatorial diameter length/width 1.2, nm: 1; no: 1.

Comparisons: *Baculamonocolpites multispinosus* (VAN DER HAMMEN) SOLE DE PORTA 1971 is smaller (40–43 µm), has a thinner exine, and shorter bacula, *Bacumorphomonocolpites tausae* SOLE DE PORTA 1971 is larger and bacula bifurcate, *Racemonocolpites* GONZALEZ 1967 has longer bacula.

Baculamonocolpites sp. 2

Plate 5, Figs. 28–30

Diagnosis: Monosulcate, mid-sized (40 µm), baculate, bacula (2–4 µm long), surface interbacula scabrate-microbaculate (< 1.0 µm long), tectate, columellae indistinct.

Specimens: UFP 38.7 × 98

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, sulcus indistinct; tectate, exine 1 µm thick, exine thickness constant, columellae indistinct, < 0.5 µm thick; sculpture baculate, bacula shape variable over surface of grain, some bacula thick, short (2 µm wide, 2 µm long), and some bacula long (4 µm long), with wide base (2.5 µm), and constriction at the tip (2 µm), tips rounded, surface interbacula scabrate to microbaculate (0.5 – < 1.0 µm long). Dimensions: Equatorial diameter width 28 µm; equatorial diameter length 40 µm; equatorial diameter length/width 1.4, nm: 1; no: 1.

Comparisons: *Echimorphomonocolpites* GONZALEZ 1967 has abundant spines, other *Baculamonocolpites* species do not have two types of sculptural elements (bacula and scabrate-microbacula).

Genus *Bacumorphomonocolpites* SOLE DE PORTA 1971

Bacumorphomonocolpites tausae SOLE DE PORTA 1971

Plate 6, Figs. 1–2

Diagnosis: Monosulcate, large-sized (90 µm), ellipsoidal, intectate (2 µm thick), baculate, bacula variable, 2–20 µm long in same grain, longer bacula branch apically

Specimens: UFP 74, 11.8 × 97.1

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, sulcus long, borders irregular, indistinct; intectate, nexine 2 µm thick; sculpture baculate, bacula large, distributed unevenly, shaped irregularly, 3–20 µm long, 3–4 µm wide, longest bacula branch apically, surface interbacula micropitted, lumina < 0.5 µm wide, rounded, muri < 0.5 µm wide. Dimensions: Equatorial diameter width 60 µm; equatorial diameter length 90 µm; equatorial diameter length/width 1.5, nm: 1; no: 1.

Genus *Bacutriporites* JAN DU CHÊNE, ONYIKE & SOWUNMI 1978

Bacutriporites echinatus n. sp.

Plate 6, Figs. 3–4

Diagnosis: Triporate, mid-sized (37 µm), triangular-obtuse-convex, baculate to echinate, 4 µm long, 2 µm wide, tip always rounded, surface interbacula slightly scabrate.

Specimens: Holotype UFP 41, 21.9 × 88.9, pl. 6, figs. 3–4

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After sculpturing that is transitional, baculate to echinate.

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; triporate, ecto and endopores of similar shape and coinciding, pores simple, lalongate, 6 µm wide, 3 µm long; tectate, exine < 1.0 µm thick, exine thin, columellae diffuse; sculpture baculate-echinate, bacula-spines 4 µm long, 2 µm wide at base, 1 µm wide at tip, densely arranged over the entire grain, tips always rounded, a few elements cylindrical (2 µm wide), surface interbacula slightly scabrate. Dimensions: Equatorial diameter 37 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: Unique in combination of aperture and sculpturing, *Echitriporites trianguliformis* VAN HOEKEN-KLINKENBERG 1964 is smaller and has shorter spines.

Genus *Bombacacidites* COUPER 1960, emend. KRUTZSCH 1970

Bombacacidites annae (VAN DER HAMMEN 1954) GERMERAAD et al. 1968

Plate 6, Figs. 5–7

Diagnosis: *Bombacacidites*-type, mid-sized (25–50 µm), triangular-obtuse-convex, reticulate, muri pluricolumellate, lumina 1–3 wide in apocolpia and around colpi, diminishing toward mesocolpia.

Specimens: UFP 6, 22.5 × 86.8; UFP 10, 9.5 × 104.9

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi costate, very short, CEi 0.3, colpi slightly protruding, costae 3 µm wide, endopore lalongate, pores indistinct; semitectate, exine 2 µm thick, nexine 0.5 µm thick, columellae 1 µm thick, tectum 0.5 µm thick, columellae distinct, long, present only under muri of reticulum, tectum reduced to reticula; sculpture reticulate, lumina 1–3 µm wide in apocolpial areas and surrounding the colpi, almost foveolate (lumina 0.5 µm wide) in mesocolpial areas, muri pluricolumellate, 1 µm wide, transition reticula to foveolae gradual although in short distance, sometimes a line separates foveolae from reticula. Dimensions: Equatorial diameter 25 (38.5) 50 µm, SD 4.9; equatorial diameter length/width 1.1, nm: 40; no: 244.

Affinities: Malvaceae sensu latu, very similar to *Bombax ceiba*, *B. rhodognaphalon*, and *B. pubescens* (GERMERAAD et al. 1968).

Bombacacidites brevis (DUEÑAS 1980) MULLER et al. 1987

Plate 6, Fig. 8

Diagnosis: *Bombacacidites*-type, mid-sized (26–40 µm), triangular-obtuse-convex to circular, costae thin, reticulate, lumina constant over the entire grain, 0.5 – < 1.0 µm wide, circular.

Specimens: UFP 39, 5.9 × 80; UFP 37, 15.2 × 96.8

Description: Monad, radial, isopolar, amb triangular-obtuse-convex to circular; tricolporate, ectocolpi costate, CEi 0.3, costae 0.5–1 µm wide, thin and sometimes inconspicuous, surrounding the entire length of the colpi, costae non protruding, endopores indistinct; semitectate, exine 1 µm thick, tectum restricted to columellae; sculpture reticulate, lumina 0.5 – < 1.0 µm wide,

circular, homogeneous over the entire grain. Dimensions: Equatorial diameter 26 (32) 40 µm, SD 3.6; equatorial diameter length/width 1, nm: 24; no: 54.

Bombacacidites fossureticulatus n. sp.

Plate 6, Figs. 12–13

Diagnosis: *Bombacacidites*-type, small to mid-sized (21–30 µm), triangular-obtuse-straight, fossulate at apocolpia and colpus margins, reticulate at mesocolpia.

Specimens: Holotype UFP 37, 13 × 98.5, pl. 6, figs. 12–13; paratype UFP 37, 14 × 112

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After fossulate to reticulate sculpturing.

Description: Monad, radial, isopolar, prolate, amb triangular-obtuse-straight; tricolporate, ectocolpi costate, CEi 0.8, colpi long, costae 1.0–1.5 µm wide, surrounding the entire colpi, slightly protruding, endopores indistinct; semitectate, exine 1.5 µm thick, nexine 0.5 µm thick, columellae < 1.0 µm thick, tectum < 0.5 µm thick, nexine slightly thickening around colpi, columellae 1 µm wide, tectum reduced to reticula, sexine absent in costae area; sculpture reticulate-fossulate, fossulae at apocolpia and colpi margins (0.5–1 µm wide) gradually changing to reticulate at mesocolpia (1–1.5 µm wide). Dimensions: Equatorial diameter 21 (27) 30 µm, SD 3.2; equatorial diameter length/width 1, nm: 6; polar diameter 42 µm, polar/equatorial diam. 1.7, nm: 1; no: 18.

Comparisons: *Bombacacidites foveoreticulatus* Muller et al. 1987 has shorter colpi, a thicker exine, larger lumina, and it is foveoreticulate, *Bombacacidites protofoveoreticulatus* n. sp. has fossulate-foveolate lumina even over the entire grain.

Bombacacidites foveoreticulatus Muller et al. 1987

Plate 6, Figs. 14–15

Diagnosis: *Bombacacidites*-type, mid-sized (35 µm), triangular-obtuse-straight, costae 3 µm wide, foveolate at apocolpia and colpus margins, reticulate at mesocolpia.

Specimens: UFP 49, 11.8 × 98.1

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; tricolporate, ectocolpi costate, CEi 0.5, colpi mid-sized, costae 3 µm wide, protruding, endopores indistinct; semitectate, exine 3 µm thick, nexine 1–1.5 µm thick, columellae < 1.0 µm thick, tectum 1 µm thick, exine thick, columellae distinct, 1 µm wide; sculpture reticulate-foveolate, foveolae at apocolpia, lumina 1–2.5 µm wide, reticula at mesocolpia, lumina 2.5–3 µm wide, muri 1 µm wide, pluricolumellate. Dimensions: Equatorial diameter 35 µm; equatorial diameter length/width 1.1, nm: 1; no: 2.

Bombacacidites gonzalezii n. sp.

Plate 6, Figs. 27–29

Diagnosis: *Bombacacidites*-type, mid-sized (30–50 µm), triangular-obtuse-straight, reticulate at apocolpia and near colpi, changing abruptly to psilate at mesocolpia.

Specimens: Holotype UFP 49, 14 × 91.4, pl. 6, figs. 27–28; paratype UFP 43, 3.3. × 113, pl. 6, fig. 29

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene. 116,7 ± 12,5 DIC

Etymology: After Dr. Enrique Gonzalez for his contribution to the Eocene pollen flora of Colombia.

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; tricolporate, ectocolpi costate, CEi 0.3, colpi short, costae 1 µm wide, entirely surrounding colpi, slightly protruding, endopores indistinct; semitectate, exine < 1.0 µm thick, exine thin, nexine thickening around colpi, columellae very thin at mesocolpia, 0.5 µm wide at apocolpia, tectum continuous at mesocolpia, restricted to reticula at apocolpia and equatorial areas surrounding colpi; sculpture reticulate-psilate, reticulate at apocolpia and equatorial areas surrounding the colpi, lumina < 1.0 µm wide, almost circular, muri 0.5 µm wide; sculpture changes to psilate at mesocolpia in a very short but gradual manner forming a triangle which vertices are 60 degrees

offset of grain vertices in polar view. Dimensions: Equatorial diameter 30 (39.5) 50 µm, SD 6.3; equatorial diameter length/width 1, nm: 6; no: 14.

Comparisons: *Bombacacidites psilatus* n. sp. is smaller (26–32 µm), has non-protruding costae, and lumina decrease gradually.

Bombacacidites grahamii n. sp.

Plate 6, Figs. 9–11

Diagnosis: *Bombacacidites*-type, mid-sized (36 µm), nexine thickening at mesocolpia, sculpture fossulate at apocolpia, foveolate at mid-latitudes, and psilate at mesocolpia.

Specimens: Holotype UFP 53, 21 × 99.3, pl. 6, figs. 9–11

Type locality: La Regadera Creek near La Donjuana, 72° 37′ W – 7° 42′ N, Colombia; Mirador Formation, early to middle Eocene.

Etymology: After professor ALAN GRAHAM in recognition of his contribution to palynology of Central America and the Caribbean.

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; tricolporate, ectocolpi costate, CEi 0.3, costae protruding, short, 3 µm wide, 2 µm thick, conspicuous, endopores indistinct; tectate, exine < 1.0 µm thick, columellae < 0.5 µm thick, nexine thickening to 3 µm at the middle of mesocolpial area; sculpture fossulate-psilate, fossulae at apocolpia 1–3 µm long, 0.5 µm wide, varying to foveolae at mid-latitude, 0.5 µm wide, and to psilate in equatorial intercolpate areas. Dimensions: Equatorial diameter µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: Differs from other *Bombacacidites* by its fossulate-psilate sculpturing and thickenings of the nexine at the mesocolpia.

Bombacacidites nacimientoensis (ANDERSON 1960) ELSIK 1968b

Plate 6, Figs. 16–17

1960 *Bombacacipites nacimientoensis* ANDERSON 1960, p. 23, pl. 18, fig. 13.
1968 *Bombacacidites nacimientoensis* (ANDERSON) ELSIK 1968b, p. 620, pl. 22, figs. 1–2, 4.
1969 *Bombacacidites bellus* FREDERIKSEN 1969, (unpublished name), p. 236–237, pl. 12, figs. 15–17.
1987 "*Bombacacidites bellus* FREDERIKSEN 1980" in MULLER et al. 1987, p. 45, pl. 4, fig. 5 (nomen nudum).

Diagnosis: *Bombacacidites*-type, mid-sized (31–63 µm), triangular-obtuse-straight, reticulate, pluricolumellate, lumina 2–4 µm wide at apocolpia and around colpi, diminishing toward mesocolpia.

Specimens: UFP 37, 18.6 × 100.3; UFP 34, 10.4 × 103

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; tricolporate, ectocolpi costate, CEi 0.4, colpi short, costae 1 µm thick, 2 µm wide, being constant around entire colpi, endopores lalongate, 9 µm wide, 6 µm long, pores generally indistinct; semitectate, exine 1.5–2 µm thick, nexine < 0.5 µm thick, columellae < 1.0 µm thick, tectum < 1.0 µm thick, columellae distinct, 0.5 µm wide, tectum reduced to reticula at apocolpia and around colpi, tectum more continuous at mesocolpia; sculpture reticulate, lumina 2–4 µm wide decreasing in size toward mesocolpia where sculpture is foveolate, 0.5 µm wide, muri pluricolumellate, 1 µm wide, transition reticula-foveolae although gradual occurs in a narrow zone surrounding each vertex of the grains, producing a shape triangular. Dimensions: Equatorial diameter 31 (43) 63 µm, SD 10.6; equatorial diameter length/width 1, nm: 8; no: 12.

Comparisons: *Bombacacidites annae* (VAN DER HAMMEN 1954) GERMERAAD et al. 1968 has a triangular-obtuse-convex shape, colpi are shorter, and costae are wider (3 µm), *Bombacacidites simplireticulatus* n. sp. has simplicolumellate muri.

Bombacacidites protofoveoreticulatus n. sp.

Plate 6, Figs. 18–23

Diagnosis: *Bombacacidites*-type, mid-sized (30–40 µm), triangular-obtuse-convex, costae 3 µm wide, fossulate-foveolate over entire grain.

Specimens: Holotype UFP 7, 8 × 98.9, pl. 6, figs. 21–23; paratypes UFP 7, 20 × 89.3, pl. 6, figs. 18–19; UFP 15, 18.3 × 95, pl. 6, fig. 20; UFP 9, 10.8 × 108.4

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After the similarity with *Bombacacidites foveoreticulatus*, an Eocene pollen species.

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, costate ectocolpi, CEi 0.4, colpi short, costae 3 µm wide, surrounding entire length of colpi, endopores indistinct; tectate, exine 2.5 µm thick, nexine 1 µm thick, columellae 1 µm thick, tectum 0.5 µm thick, columellae 1 µm wide; sculpture fossulate-foveolate over entire grain, fossulae 0.5 µm wide, 2–4.5 µm long, foveolae 0.5 µm wide/long, fossulae and foveolae mixed together, there is a tendency for fossulae to be at apocolpium while foveolae develops at mesocolpia. Dimensions: Equatorial diameter length 30 (35.5) 40 µm, SD 3.8; equatorial diameter length/width 1, nm: 7; no: 9.

Comparisons: *Bombacacidites foveoreticulatus* MULLER et al. 1987 is foveolate-reticulate, and has a thicker exine (3 µm), *Bombacacidites fossureticulatus* n. sp. is fossulate at apocolpia and colpus margins, reticulate at the mesocolpia.

Bombacacidites psilatus n. sp.

Plate 6, Figs. 24–26

Diagnosis: *Bombacacidites*-type, mid-sized (26–32 µm), triangular-obtuse-convex to straight, costae 1.5 µm wide, reticulate finely at apocolpia, lumina < 1.0 µm wide decreasing gradually toward mesocolpia where it is micropitted-psilate

Specimens: Holotype UFP 53, 18.5 × 110, pl. 6, figs. 25–26; paratypes UFP 83, 16.7 × 90.8, pl. 6, fig. 24; UFP 82, 11.4 × 97.4

Type locality: La Regadera Creek near La Donjuana, 72° 37′ W – 7° 42'N, Colombia; Mirador Formation, early to middle Eocene.

Etymology: After psilate sculpturing.

Description: Monad, radial, isopolar, amb triangular-obtuse-convex to straight; tricolporate, ectocolpi costate, CEi 0.3, costae 1.5 µm wide at equator decreasing in width to 1 µm toward polar end of colpi, non protruding, endopores indistinct; semitectate, exine < 1.0 µm thick, exine thin, columellae indistinct, < 0.5 µm thick, tectum continuous over mesocolpia; sculpture reticulate-psilate, reticulate at apocolpia, lumina < 1.0 µm wide, muri 0.5 µm wide, lumina decrease gradually toward mesocolpia changing to sculpture micropitted-psilate. Dimensions: Equatorial diameter width 22 (25) 30 µm, SD 2.9; equatorial diameter length 26 (29) 32 µm, SD 1.9; equatorial diameter length/width 1.2, nm: 7; no: 18.

Comparisons: *Bombacacidites brevis* (DUEÑAS 1980) MULLER et al. 1987 is more circular and has slightly larger lumina that is even over the entire grain, *Bombacacidites gonzalezii* n. sp. is larger (30–50 µm), has slightly protruding costae, and lumina decrease abruptly.

Bombacacidites simplireticulatus n. sp.

Plate 7, Figs. 1–2

Diagnosis: *Bombacacidites*-type, mid-sized (37–52 µm), triangular-obtuse-straight, colpi very short, reticulate, lumina 2–4 µm wide, sculpture abruptly changes to foveolate or psilate at vertices of grain, muri simplicolumellate.

Specimens: Holotype UFP 37, 12 × 95.5, pl. 7, figs. 1–2; paratype UFP 87, 10.7 × 103.5

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After muri simplicolumellate.

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; tricolporate, ectocolpi costate, CEi 0.15, colpi very short, slightly protruding, costae 2–4 µm wide, 1–1.5 µm thick, endopores lalongate, indistinct; semitectate, exine 2.5–3.0 µm thick, nexine < 1.0 µm thick, columellae 1.5 µm thick, tectum 0.5–1.0 µm thick, increasing with larger grain size, reduced to reticula at apocolpia and around colpi in mesocolpia, more continuous in vertices of intercolpate areas; sculpture reticulate, lumina 2–4 µm wide, muri 1 µm wide, simplicolumellate, sculpture abruptly changes to foveolate, lumina 0.5 µm wide, or psilate at vertices of mesocolpia. Dimensions: Equatorial diameter 37 (44.5) 52 µm; equatorial diameter length/width 1, nm: 2; no: 2.

Comparisons: *Bombacacidites nacimientoensis* (ANDERSON 1960) ELSIK 1968b has longer colpi (CIp 0.4), narrower costae (2 µm), and pluricolumellate muri.

Bombacacidites soleaformis MULLER et al. 1987
Plate 7, Figs. 3–4

Diagnosis: *Bombacacidites*-type, mid-sized (34–45 µm), triangular-obtuse-concave, costae horseshoe-shaped, micropitted, lumina constant over entire body.

Specimens: UFP 57, 15.5 × 93; UFP 49, 8.1 × 93.1

Description: Monad, radial, isopolar, amb triangular-obtuse-concave; tricolporate, ectocolpi costate, CEi 0.3, colpi short, shaped horseshoe-like, costae 4 µm wide, surrounding entire length of colpi, non protruding, endopores indistinct; tectate, exine 1 µm thick, columellae < 0.5 µm thick, nexine thickening up to 2 µm near colpi; sculpture micropitted, lumina < 0.5 µm wide, homogeneous over entire grain. Dimensions: Equatorial diameter 34 (40) 45 µm; equatorial diameter length/width 1.1, nm: 3; no: 3.

Bombacacidites sp. 1
Plate 7, Figs. 5–7

Diagnosis: *Bombacacidites*-type, mid-sized (45 µm), elliptic, costae thin, 1.0–1.5 µm wide, pores distinct, reticulate, lumina constant over the entire grain, > 0.5–1 µm wide

Specimens: UFP 9, 7.9 × 84.5

Description: Monad, radial, isopolar, amb elliptic; tricolporate, ectocolpi costate, CEi 0.3, costae 1.0–1.5 µm wide, decrease in width toward polar end of colpi where it is lacking, endopores lalongate, 7 µm wide, 3 µm long, very distinct; semitectate, exine 1.5–2.0 µm thick, nexine < 0.5 µm thick, columellae < 1.0 µm thick, tectum < 1.0 µm thick, columellae 0.5 µm wide, simplicolumellate?, tectum reduced to reticula; sculpture reticulate, lumina > 0.5–1 µm wide, homogeneous over entire grain, muri 0.5–1.0 µm wide. Dimensions: Equatorial diameter 45 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Bombacacidites brevis* (DUEÑAS 1980) MULLER et al. 1987 is smaller (<40 µm), pores are indistinct, and margo is thinner (< 1 µm wide), *Bombacacidites* sp. 4 is triangular-obtuse-convex, has wider costae (3 µm wide), and indistinct pores, *Bombacacidites* sp. 5 has wider lumina (> 1.0–2 µm).

Bombacacidites sp. 2
Plate 7, Figs. 8–9

Diagnosis: *Bombacacidites*-type, mid-sized (33–40 µm), triangular-obtuse-straight, exine thin (< 1 µm), costae 1–2 µm wide, reticulate, lumina > 0.5 – < 1.0 µm wide at apocolpia, 0.5 µm at mesocolpia, transition extremely gradual.

Specimens: UFP 15, 7.3 × 109.1; UFP 19, 4.5 × 89.5

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; tricolporate, ectocolpi costate, CEi 0.3, costae 1–2 µm wide, surrounding the entire colpi, endopores indistinct; semitectate, exine < 1 µm thick; sculpture reticulate, lumina > 0.5 – < 1.0 µm wide at apocolpia to 0.5 µm wide at equatorial intercolpate areas, transition extremely gradual, muri 0.5 – < 1.0 µm wide. Dimensions: Equatorial diameter 33 (38) 40 µm; equatorial diameter length/width 1.1, nm: 3; no: 3.

Comparisons: *Bombacacidites nacimientoensis* (ANDERSON 1960) ELSIK 1968b has larger lumina (2–4 µm wide), *Bombacacidites brevis* (DUEÑAS 1980) MULLER et al. 1987 has uniform lumina, narrower margines (< 1 µm), and a triangular-obtuse-convex to circular shape.

Bombacacidites sp. 3
Plate 7, Figs. 10–12

Diagnosis: *Bombacacidites*-type, mid-sized (40 µm), circular, costae very thin, reticulate-foveolate at apocolpia, reticulate at mesocolpia.

Specimens: UFP 49, 4.6 × 87

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi costate, CEi 0.2, colpi short, costae very thin and indistinct, 1 µm wide, surrounding entire colpi, non protruding, endopores costate, lalongate, 6 µm wide, 3 µm long, pores distinct, costae 1 µm wide and thick; semitectate, exine < 1.5 µm thick, nexine < 0.5 µm thick, columellae < 1.0 µm thick, tectum < 0.5 µm thick, nexine thickening around apertures, columellae 1 µm wide, pluricolumellate at apocolpia, simplicolumellate at mesocolpia, tectum restricted to columellae; sculpture reticulate, reticula-foveolae at apocolpia, lumina 0.5–1.0 µm wide, muri 1 µm wide, changing to more open reticula at mesocolpia including around colpi, lumina 2–2.5 µm, muri 0.5–1.0 µm wide. Dimensions: Equatorial diameter 40 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: Unique *Bombacacidites* in having lumina of reticula grading from foveolate at the apocolpia to reticulate at the mesocolpia, *Intratriporopollenites* PFLUG & THOMSON in THOMSON & PFLUG 1953 is vestibulate (JANSONIUS & HILLS 1976), *Rousea* SRIVASTAVA 1969 has long colpi, reaching the polar area, *Salixipollenites* SRIVASTAVA 1967 has long colpi, simple, and it is more or less deeply trilobate.

Bombacacidites sp. 4

Plate 7, Figs. 13–15

Diagnosis: *Bombacacidites*-type, mid-sized (46 µm), triangular-obtuse-convex, costae 3 µm wide, reticulate, lumina 1 µm wide constant over the entire grain.

Specimens: UFP 45, 21 × 109.9

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi costate, CEi 0.25, colpi short, costae 3 µm wide, entirely surrounding colpi, slightly protruding, endopores indistinct; semitectate, exine 1.5 µm thick, nexine 0.5 µm thick, columellae < 1.0 µm thick, tectum < 0.5 µm thick, nexine thickening around colpi, columellae 0.5–1.0 µm wide; sculpture reticulate, lumina 1 µm wide, homogeneous over the entire grain, muri > 0.5 – < 1.0 µm wide. Dimensions: Equatorial diameter 46 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Bombacacidites brevis* (Dueñas 1980) Muller et al. 1987 is smaller (<40 µm) and margo is thinner, < 1 µm wide, *Bombacacidites* sp. 1 is elliptic, costae are thinner (1.2 µm wide), and pores are distinct, *Bombacacidites* sp. 5 has wider lumina (> 1.0–2 µm)

Bombacacidites sp. 5

Plate 7, Figs. 16–17

Diagnosis: *Bombacacidites*-type, mid-sized (30–44 µm), triangular-obtuse-concave, colpi long, reticulate, lumina >1.0–2 µm wide, distributed over entire surface, simplicolumellate.

Specimens: UFP 49, 8.2 × 115.2; UFP 41, 18.7 × 109.5

Description: Monad, radial, isopolar, amb triangular-obtuse-concave; tricolporate, ectocolpi costate, CEi 0.45, costae 1–1.5 µm wide, surrounding colpi entirely, endopores indistinct; semitectate, exine 2 µm thick, nexine 0.5 µm thick, columellae 1.0 µm thick, tectum 0.5 µm thick, exine thick, nexine thickening around colpi, columellae 1 µm wide, only present under muri of reticula, tectum reduced to reticula; sculpture reticulate, lumina >1.0–2 µm wide, homogeneous over entire surface of grain, muri 0.5–1.0 µm wide, simplicolumellate. Dimensions: Equatorial diameter 30 (37) 44 µm; equatorial diameter length/width 1, nm: 2; no: 2.

Comparisons: *Bombacacidites ciriloensis* Muller et al. 1987 has pluricolumellate muri and shorter colpi (CIp: 0.3), *Bombacacidites brevis* (Dueñas 1980) Muller et al. 1987 has narrower lumina (<1.0 µm), *Bombacacidites* sp. 4 has narrower lumina (1 µm), and wider costae (3 µm), *Bombacacidites* sp. 1 is elliptic and has narrower lumina (< 1 µm).

Genus *Brevitricolpites* Gonzalez 1967

The definition of genus *Brevitricolpites* is very loose (tricolpate-tricolporate pollen grains, echinate, scabrate, clavate, or verrucate, with a short colpi). We think that it is a completely artificial genus as it stands now. We hope that future taxonomic revisions of this group will solve this problem.

Brevitricolpites macroexinatus n. sp.

Plate 7, Figs. 18–20

Diagnosis: Brevitricolporate, mid-sized (36 µm), micropitted, echinate, spines long (3 µm), exine tectate, thickening around pores and beneath spines

Specimens: Holotype UFP 49, 19.2 × 83.5, pl. 7, figs. 18–20

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After exine thickening around pores and beneath spines.

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi simple, CEi 0.2, very short, ends pointed, indistinct, endopores costate, costae protruding, 4–5 µm wide, 3 µm thick; tectate, exine 1 µm thick, nexine < 0.5 µm thick, columellae 0.5 µm thick, tectum < 0.5 µm thick, nexine increases around pores to 2.0–2.5 µm, and beneath spines to < 1.0 µm, columellae distinct, very thin; sculpture echinate, spines 3 µm long, 1.5 µm wide, tips pointed, ~ 30 spines, distributed sparsely over entire surface, massive, surface interspines finely reticulate, lumina < 1.0 µm wide, muri 0.5 µm wide. Dimensions: Equatorial diameter 36 µm; equatorial diameter length/width 1, nm: 1; no: 2.

Comparisons: *Brevitricolpites microechinatus* n. sp. is intectate, *Brevitricolpites* sp. 1 has smaller spines (< 1 µm), and exine does not thicken beneath the spines, *Brevitricolpites variabilis* Gonzalez 1967 is clavate to gemmate.

Brevitricolpites microechinatus n. sp.

Plate 8, Figs. 1–4

Diagnosis: Brevitricolporate, mid-sized (28–42 µm), intectate, poricostate, echinate, spines short.

Specimens: Holotype UFP 15, 14.1 × 87.5, pl. 8, figs. 1–3; paratypes UFP 15, 4.1 × 87, pl. 8, fig. 4; UFP 15, 6.5 × 86.7

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After short spines.

Description: Monad, radial, isopolar, amb circular; tricolporate, a few specimens 4-colporate, ectocolpi simple, CEi 0.25, colpi very short, ends pointed, endopores annulate, lalongate, 4–5 µm wide, 2–2.5 µm long, annuli 2 µm wide, 1.0–1.5 µm thick, slightly protruding; intectate, nexine < 0.5 µm thick, very thin, thickening around pores to 1.0–1.5 µm; sculpture echinate, spines 1 µm long, 0.5–1.0 µm wide, tips blunted, distributed sparsely, varying to bacula or verrucae of similar dimensions, surface interspines scabrate to micropitted. Dimensions: Equatorial diameter length 28 (33.5) 42 µm, SD 4.5; equatorial diameter length/width 1, nm: 20; no: 28.

Comparisons: *Brevitricolpites macroexinatus* n. sp. is tectate and has longer spines (3 µm), *Brevitricolpites* sp. 1 is tectate (1 µm thick), *Brevitricolpites variabilis* GONZALEZ 1967 is clavate to gemmate.

Brevitricolpites sp. 1

Plate 8, Figs. 5–7

Diagnosis: Brevitricolporate, inter-triangular, mid-sized (35 µm), tectate, poricostate, costae protruding, microechinate, spines conical, blunted, distributed sparsely.

Specimens: UFP 19, 20.4 × 102.8

Description: Monad, radial, isopolar, amb inter-triangular-obtuse-straight; tricolporate, ectocolpi simple, CEi 0.2, very short, margins straight, ends rounded, indistinct, endopores costate fastigiate, lalongate, 5 µm wide, 1 µm long, costae 4–5 µm wide, 2 µm thick, slightly protruding, fastigia 0.5 µm wide, 0.5 µm long; tectate, exine 1 µm thick, nexine thickening around pores to 2 µm, columellae indistinct; sculpture microechinate, spines < 1.0 µm wide, < 1.0 µm long, circular, conical, blunted, 2–4 µm apart, distributed sparsely, surface interspines micropitted, lumina < 0.5 µm wide. Dimensions: Equatorial diameter 35 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Brevitricolpites microechinatus* n. sp. is intectate, *Brevitricolpites macroexinatus* n. sp. has longer spines (3 µm), and exine thickens beneath the spines, *Brevitricolpites variabilis* GONZALEZ 1967 is clavate to gemmate.

Genus *Clavamonocolpites* GONZALEZ 1967 emend. MULLER et al. 1987

Clavamonocolpites sp. 1

Plate 8, Figs. 8–10

Diagnosis: Clavamonosulcate, mid-sized (42–45 µm), exine thick, tectate, sulcus costate, clavae 2 µm long, surface interclavae scabrate.

Specimens: UFP 47, 7.5 × 83.8

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus costate, CEi 0.4, mid-sized, costae 3 µm wide, surrounding entire sulcus; tectate, exine 2 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum 0.5–1.0 µm thick, exine thick, columellae indistinct; sculpture clavate, clavae large, shaped irregularly, 2 µm long, 1–1.5 µm wide, 1–2.5 µm long, surface interclavae scabrate, scabrae 0.5 µm long. Dimensions: Equatorial diameter width 35 (35.5) 36 µm; equatorial diameter length 42 (43.5) 45 µm; equatorial diameter length/width 1.2, nm: 2; no: 8.

Comparisons: Differs from other *Clavamonocolpites* in the nature of the clavate-scabrate sculpturing.

Affinities: Palmae?

Genus *Clavatricolpites* PIERCE 1961

Clavatricolpites densiclavatus n. sp.

Plate 8, Figs. 11–14

Diagnosis: Tricolpate, mid-sized (26–42 µm in polar view), intectate, nexine 0.5–1.0 µm thick, clavae short, distributed densely in rows, pseudocroton, or randomly.

Specimens: Holotype UFP 37, 4.2 × 88.2, pl. 8, figs. 11–12; paratypes UFP 41, 10.6 × 91, pl. 8, fig. 13; UFP 43, 15 × 111.6, pl. 8, fig. 14; UFP 41, 19.6 × 107.5; UFP 49, 12.5 × 80; UFP 53, 13 × 104.5

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After sculpturing that is clavate and densely distributed.

Description: Monad, radial, isopolar, prolate, amb circular; tricolpate, sometimes 4–5 colpate, ectocolpi simple, CEi 0.8, long, borders straight, ends pointed, colpi membrane generally absent, polar area small, 5–7 µm wide; intectate, nexine 0.5–1.0 µm thick, relatively thin; sculpture clavate, clavae 1–1.5 µm long, > 0.5–1 µm wide at tip, < 0.5 µm at base, 0.5 – < 1.0 µm long, in plane view circular to slightly elliptical, densely arranged sometimes in rows or in pseudocroton pattern but generally without a defined pattern, few gemmae and bacula also present. Dimensions: Equatorial diameter 26 (37) 42 µm; equatorial diameter length/width 1.1, nm: 33; no: 88.

Comparisons: *Clavatricolpites gracilis* GONZALEZ 1967 is marginate, *Crototricolpites protoannemariae* n. sp. has a well defined croton pattern, *Crototricolpites americanus* WIJMSTRA 1971 has digitate columellae.

Genus *Colombipollis* SARMIENTO 1992

Colombipollis tropicalis SARMIENTO 1992

Plate 8, Fig. 15

Specimens: UFP 11, 10.2 × 88.8

Description: Monad, radial, isopolar, amb triangular-acute-convex; tricolporate, Normapolles type; tectate, exine 1 µm thick, columellae very thin, indistinct; sculpture psilate. Dimensions: Equatorial diameter 52 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Genus *Corsinipollenites* NAKOMAN 1965

Corsinipollenites psilatus n. sp.

Plate 8, Figs. 16–18

Diagnosis: Triporate, mid-sized (28–40 µm), atectate < 1.0 µm thick, psilate, costae well developed, protruding.

Specimens: Holotype UFP 4, 16.5 × 100, pl. 8, figs. 16–17; paratypes UFP 7, 13.3 × 91.6, pl. 8, fig. 18; UFP 15, 6.2 × 82.3

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After psilate sculpturing.

Description: Monad, sometimes in tetrads, radial, isopolar, amb triangular-obtuse-convex; triporate, ecto and endopores of similar shape and coinciding, circular, 6–7 µm wide, 6–7 µm long, costate, costae well developed, 2–4 µm wide, 2 µm thick, protruding; atectate, nexine 0.5 – < 1.0 µm thick, very thin; sculpture psilate, folded usually at polar areas. Dimensions: Equatorial diameter 28 (34) 40 µm, SD 4.9; equatorial diameter length/width 1.1, nm: 9; no: 21.

Comparisons: *Corsinipollenites undulatus* (GONZALEZ 1967) n. comb. has a tectate exine that is thicker (>2.0 µm), and has psilate-rugulate sculpturing.

Corsinipollenites undulatus (GONZALEZ 1967) n. comb.

Plate 8, Fig. 19

Basionym = *Jussitriporites undulatus* GONZALEZ 1967, p.56, pl. 19, figs. 3–3b.

Diagnosis: Triporate, mid-sized (36–50 µm), exine 2 – < 3.5 µm thick, costae very well developed and protruding, with sculpture rugulate undulating.

Specimens: UFP 48, 17.3 × 87.9; UFP 43, 3.8 × 101.8; UFP 57, 20.5 × 113

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; triporate, ecto/endopores of similar shape and coinciding, circular, 5–9 µm wide, 5–9 µm long, costate, costae very well developed, 6 µm wide, 2 µm thick, pores protruding, usually there is a fold at apocolpia that initiates at pores and

fuses at poles; tectate, exine 2 – < 3.5 µm thick, nexine 1 µm thick, tectum 1 µm thick, exine composed of two layers, columellae absent, in some cases the two layers fuse at equatorial interporate areas and are separated near pores and apocolpia, in other grains there is constant separation (about 0.5–1.0 µm) between the two layers, in other grains, mostly psilate types, the two layers fuse given appearance of atectate exine 2–2.5 µm thick; sculpture psilate to rugulate, rugulae undulating, 2 µm wide, 1 µm thick. Dimensions: Equatorial diameter 36 (43) 50 µm, SD 5.8; equatorial diameter length/width 1.1, nm: 6; no: 9.

Comparisons: *Jussitriporites* GONZALEZ 1967 is a junior synonym of *Corsinipollenites* NAKOMAN 1965.

Affinities: Onagraceae, *Jussiaea* type.

Genus *Cricotriporites* LEIDELMEYER 1966

MULLER (1968) uses genus *Triorites* for triporate, psilate, atectate grains accepting description of COUPER in 1963 for the genus while rejecting the emendation of POTONIÉ in 1960. However, he does not consider the genus *Cricotriporites* LEIDELMEYER 1966. Here, we accept the POTONIÉ emendation for *Triorites* (JANSONIUS & HILLS 1976), and we use *Cricotriporites* for triporate, circular, atectate or tectate grains with indistinct columellae and thin exine, that are annulate or costate, finely scabrate, psilate, or micropitted, and lacking atrium or vestibulum.

Cricotriporites elongatoporus n. sp.

Plate 8, Figs. 27–29

Diagnosis: Psilatriporate, ellipsoid, mid-sized (26–35 µm), atectate, pores annulate, lalongate.

Specimens: Holotype UFP 45, 10.9 × 110, pl. 8, fig. 27–28; paratypes UFP 44, 16.3 × 113, pl. 8, fig. 29

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After lalongate pore.

Description: Monad, radial, isopolar, amb circular; triporate, pores annulate, lalongate, 6–8 µm wide, 3–4 µm long, annuli 2 µm wide, formed by slight thickening of nexine around the pores, pores slightly protruding; atectate, nexine > 0.5 – < 1.5 µm thick, thickening to 1.5 µm around pores; sculpture psilate. Dimensions: Equatorial diameter 26 (29) 35 µm, SD 3.7; equatorial diameter length/width 1.1, nm: 5; no: 5.

Comparisons: *Cricotriporites macroporus* n. sp. is larger, has circular pores, and a thinner exine, *Cricotriporites minutiporus* (MULLER 1968) n. comb. is smaller, *T. festatus* MULLER 1968 has smaller pores (3 µm wide), *T. tenuiaxis* MULLER 1968 has collar 3–4 µm long, *Cricotriporites guianensis* LEIDELMEYER 1966 is smaller and has smaller pores (2.5 × 2 µm).

Cricotriporites guianensis LEIDELMEYER 1966

Plate 8, Figs. 20–21

1966 *Cricotriporites guianensis* LEIDELMEYER 1966, p. 54, pl. 4, fig. 4.
1966 *Cricotriporites operculatus* VAN HOEKEN-KLINKENBERG 1966, p. 39, pl. 1, fig. 16.

Diagnosis: Psilatriporate, ellipsoid, small to mid-sized (24–32 µm), tectate (1 µm), pores costate, circular, operculate, operculum sometimes absent, psilate to finely scabrate.

Specimens: UFP 53, 19 × 111.9

Description: Monad, radial, isopolar, amb elliptic; triporate, ectopores and endopores of similar shape and coinciding, endopores costate, circular, 3–5 µm wide, 3–5 µm long, costae 2 µm wide, 0.5–1.0 µm thick, sometimes operculate; tectate, exine 1 µm thick, nexine thickening around pores to 1 µm, columellae indistinct, very thin; sculpture psilate to finely scabrate. Dimensions: Equatorial diameter 28 (30) 32 µm, SD 1.6; equatorial diameter length/width 1.1, nm: 4; no: 9.

Comparisons: No distinct morphological differences were found between *C. guianensis* and *C. operculatus* after examination of the holotypes of both species deposited at the University of Amsterdam palynological collection.

Cricotriporites macroporus n. sp.

Plate 8, Figs. 22–25

Diagnosis: Psilatriporate, ellipsoid, mid-sized (30–50 µm), intectate (0.5 µm), pores annulate (2 µm wide), circular (5–9 µm), micropitted, psilate, or scabrate.

Specimens: Holotype UFP 53, 18 × 101.1, pl. 8, fig. 23; paratypes UFP 48, 14.6 × 96.9, pl. 8, fig. 22; UFP 44, 13 × 105.7, pl. 8, fig. 24; UFP 34, 17 × 91, pl. 8, fig. 25

Type locality: La Regadera Creek near La Donjuana, 72° 37′ W – 7° 42′ N, Colombia; Mirador Formation, early to middle Eocene.

Etymology: After large pore size.

Description: Monad, radial, isopolar, amb circular, grain usually folded; triporate, pores annulate, circular, 5–9 µm wide, 5–9 µm long, annuli 2 µm wide, 1 µm thick, produced by slight thickening of nexine, pore slightly protruding; intectate, nexine 0.5 µm thick, very thin, thickening around the pores to 1 µm; sculpture micropitted to scabrate, lumina < 0.5 µm wide, homogeneous, distributed over entire grain inclusive over annulus, other grains scabrate, scabrae < 0.5 µm wide, homogeneous, distributed sparsely. Dimensions: Equatorial diameter 30 (42.5) 50 µm, SD 8.6; equatorial diameter length/width 1.1, nm: 4; no: 8.

Comparisons: *Cricotriporites minutiporus* (Muller 1968) n. comb. is smaller (25–30 µm) and pore is smaller (< 2 µm), *T. festatus* Muller 1968 has smaller pores (3 µm wide), *T. tenuiaxis* Muller 1968 has a collar 3–4 µm long, *Cricotriporites guianensis* Leidelmeyer 1966 is smaller, and has a thicker exine (1–2 µm).

Cricotriporites minutiporus (Muller 1968) n. comb.

Plate 8, Fig. 26

Basionym = *Triorites minutipori* Muller 1968, p. 14, pl. 3, fig. 9.

Diagnosis: Psilatriporate, small to mid-sized (25–30 µm), atectate, exine very thin (< 0.5 µm), pores costate, < 2 µm wide, psilate to finely scabrate.

Specimens: UFP 41, 7.1 × 82.5

Description: Monad, radial, isopolar, amb circular; triporate, pores annulate, circular, 3–5 µm wide, 2–4 µm long, annuli 1–2 µm wide, 0.5 µm thick, non protruding; atectate, nexine < 0.5 µm thick, very thin, nexine thickening around pores to 0.5–1.0 µm; sculpture psilate to finely scabrate. Dimensions: Equatorial diameter 27 (29) 30 µm, SD 1.5; equatorial diameter length/width 1.05, nm: 4; no: 4.

Comparisons: *Triorites* Erdtman 1947 ex Cookson 1950 emend. Potonié 1960 has a 4-layered exine (Jansonius & Hills 1976).

Genus *Crototricolpites* Leidelmeyer 1966

Crototricolpites cf. *annemariae* Leidelmeyer 1966

Plate 9, Fig. 1

Diagnosis: Tricolpate, mid-sized (48 µm), colpi simple, intectate 0.5–1.0 µm thick, clavate arranged in a croton pattern, clavae 1.5–2 µm long.

Specimens: UFP 76, 20.6 × 111

Description: Monad, radial, isopolar, amb circular; tricolpate, ectocolpi simple, CEi 0.6, mid-sized, borders indistinct, ends pointed, polar area large, 20 µm wide; intectate, nexine 0.5–1.0 µm thick; sculpture clavate, clavae 1.5–2 µm long, 1–1.5 µm wide at tip, < 0.5 µm at base, 1.5–2 µm long, in plane view triangular to elliptical, densely arranged in a croton pattern. Dimensions: Equatorial diameter 48 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Crototricolpites annemariae* Leidelmeyer 1966 has slightly larger clavae (2–3 µm long).

Crototricolpites protoannemariae n. sp.

Plate 9, Figs. 2–3

Diagnosis: Tricolpate, mid-sized (30–40 µm), intectate, clavate with croton pattern, clavae 2 µm long, croton highly variable, usually only distinctive in some areas of the grain.

Specimens: Holotype UFP 5, 13.3 × 97.3, pl. 9, figs. 2–3

Type locality: Piñalerita Creek near Sabanalarga, 73° 1' W – 4° 54' N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After the close resemblance to Eocene pollen grain *Crototricolpites annemariae*.

Description: Monad, radial, isopolar, prolate, amb circular; tricolpate, ectocolpi simple, CEi 0.5, colpus membrane very thin; intectate, nexine 0.5–1.0 µm thick, in many cases a circular body 12 µm wide × 12 µm long in the internal part of the grain is present; sculpture clavate, clavae 2 µm long, 1–1.5 µm wide, some elements are bacula or gemmae; sculpture arranges in distinctive croton pattern, although sometimes only in parts of the grain, sculpture height reduced around colpi in a band 1 µm wide. Dimensions: Equatorial diameter 30 (35) 40 µm, SD 3.7; equatorial diameter length/width 1.1, nm: 15; polar diameter 34 µm, polar/equatorial diam. 1.3, nm: 1; no: 48.

Comparisons: *Crototricolpites annemariae* Leidelmeyer 1966 is larger (~ 48 µm), tectate, and clavae are longer (3 µm), *Crototricolpites americanus* Wijmstra 1971 has digitate columellae.

Genus *Crusafontites* Sole De Porta 1971

Crusafontites megagemmatus n. sp.

Plate 11, Figs. 10–12

Diagnosis: Zonasulculate, gemmate, mid-sized (42 µm), intectate wall 0.5 µm thick increasing to 2 µm beneath gemmae, gemmae in two size-classes, 4–5 µm long, and 1–1.5 µm long.

Specimens: Holotype UFP 43, 18.8 × 87.1, pl. 11, figs. 10–12; paratype UFP 43, 5.2 × 111.4

Type locality: Piñalerita Creek near Sabanalarga, 73° 1' W – 4° 54' N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After large size of gemmae.

Description: Monad, bilateral, isopolar, amb elliptic; zonasulculate, sulculus divide grain in two almost equal parts, sulculus indistinct; intectate, nexine 0.5 µm thick, exine increasing to 2 µm beneath gemma and occasionally in areas without sculpturing; sculpture gemmate, gemmae highly variable and grouped in two size-classes, one group (7–13 gemma) 4–5 µm long, 4–5 µm wide, 7–6 µm long, constricted at base to 3 µm, the other group of gemmae (16–20 gemma) 1–1.5 µm long, 1–2 µm wide, 1–2 µm long. Dimensions: Equatorial diameter width 31 (32.5) 34 µm; equatorial diameter length 42 (42) 42 µm; equatorial diameter length/width 1.3, nm: 2; no: 2.

Comparisons: *Crusafontites grandiosus* Sole De Porta 1971 is verrucate.

Genus *Ctenolophonidites* Van Hoeken-Klinkenberg 1966

Ctenolophonidites cruciatus n. sp.

Plate 9, Figs. 4–5

Diagnosis: *Ctenolophonidites*-type, 4-colpate, mid-sized (50 µm), psilate, ridge cross-like.

Specimens: Holotype UFP 37, 18.4 × 111.5, pl. 9, figs. 4–5

Type locality: Piñalerita Creek near Sabanalarga, 73° 1' W – 4° 54' N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After cross-like ridge.

Description: Monad, radial, isopolar, amb circular; stephanocolpate, four-colpate, ectocolpi simple, CEi 0.6, long, borders irregular, ends pointed, polar area small, 15 µm wide; atectate, nexine 0.5 µm thick, exine increases to 1.5 µm into a pattern of radial costae meeting at poles and forming a cross-like ridge, ridge 5 µm wide, slightly protruding, < 0.5 µm long; sculpture psilate. Dimensions: Equatorial diameter 50 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Ctenolophonidites costatus* (Van Hoeken-Klinkenberg 1964) Van Hoeken-Klinkenberg 1966 is 6-colpate and has a ring-like ridge, *Ctenolophonidites lisamae* (Van der Hammen & Garcia 1966) Germeraad et al 1968 is smaller (17–31 µm) and scabrate.

Affinities: Ctenolophonaceae?

Genus *Curvimonocolpites* LEIDELMEYER 1966

Curvimonocolpites inornatus LEIDELMEYER 1966

Plate 9, Fig. 6

Diagnosis: Monosulcate, mid-sized (29–35 µm), concave-convex in polar view, tectate, psilate.

Specimens: UFP 4, 13.2 × 101.

Description: Monad, bilateral, anisopolar, amb elliptic, concave-convex; monosulcate, ectosulcus simple, long, extending along 2/3 parts of the equator line in the concave side of the grain; tectate, exine 1.0–1.5 µm thick, nexine 0.5 µm thick, columellae < 0.5 µm thick, tectum 0.5 µm thick, exine decreases to 1 µm near colpus ends by thinning of columellae; sculpture psilate to micropitted to finely scabrate. Dimensions: Equatorial diameter width 20 (22) 25 µm, SD 2; equatorial diameter length 29 (31) 35 µm, SD 1.9; equatorial diameter length/width 1.4, nm: 8; no: 16.

Genus *Duplotriporites* SARMIENTO 1992

Duplotriporites ariani SARMIENTO 1992

Plate 9, Figs. 9–10

Diagnosis: Pantoporate, mid to large-sized (55–65 µm), six pores arranged in two triplets, symmetrically located in both sides of the equatorial plane, annulate, baculate.

Specimens: UFP 76, 14.6 × 114.6; UFP 86, 16.9 × 103.8

Description: Monad, radial, isopolar, amb circular; pantoporate, number of pores six arranged in two triplets, symmetrically located in both sides of the equatorial plane, lalongate, 4 µm wide, 8 µm long, pores annulate, annuli produced by thickening of sexine, 2 µm wide, elongate in plain view, margin surrounded by 3–5 bacula slightly shorter than bacula in other areas of grain; tectate, exine 2–4 µm thick, nexine 2 µm thick, columellae 1 µm thick, tectum 1 µm thick, columellae very diffuse, tectum thickness include microbacula (0.5–1.0 µm long) because there is no clear distinction of tectum due to long density of microsculptural elements; sculpture baculate, two types of sculpture bacula large, distributed sparsely, 2 to 4 µm long, 2 µm wide, and microbacula, distributed densely, 0.5–1.0 µm long, 0.5–1.0 µm wide, bacula surrounding pores slightly shorter. Dimensions: Equatorial diameter 55 (60) 65 µm; equatorial diameter length/width 1.1, nm: 3; no: 4.

Comparisons: *Anacolosidites* COOKSON & PIKE 1954 is psilate to reticulate, and has a triangular-concave shape.

Genus *Echimonocolpites* VAN DER HAMMEN & GARCIA 1966

Echimonocolpites sp. 1

Plate 9, Figs. 11–12

Diagnosis: Monosulcate, small to mid-sized (24–35 µm), sulcus long, exine reticulate, echinate, spines small, elongate, conical, 2.5–3.5 µm long, < 0.5 µm wide.

Specimens: UFP 11, 11 × 103

Description: Monad, bilateral, anisopolar, amb circular; monosulcate, ectosulcus simple, CEi 0.8, long, borders irregular, ends pointed; tectate, exine > 0.5 – < 1.5 µm thick, nexine < 0.5 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, columellae distinct, < 0.5 µm wide, < 0.5 µm apart, covered by tectum finely reticulate; sculpture echinate, spines 2.5–3.5 µm long, < 0.5 µm wide, conical, tips pointed, 3–5 µm apart, scattered, surface interspines finely reticulate, lumina 0.5 µm wide, circular. Dimensions: Equatorial diameter 24 (29) 35 µm, SD 3.5; equatorial diameter length/width 1.1, nm: 7; no: 9.

Comparisons: *Mauritiidites franciscoi* VAN DER HAMMEN & GARCIA 1966 has spines inserted in the tectum producing depressions in the exine, *Spinizonocolpites* MULLER 1968 emend. MULLER et al. 1987 is zonasulculate.

Genus *Echiperiporites* VAN DER HAMMEN & WYMSTRA 1964, emend. ANZÓTEGUI 1996

Echiperiporites estelae GERMERAAD et al. 1968

Plate 9, Figs. 13–14

Diagnosis: Echipantoporate, mid-sized (45–60 µm), exine 1.5–2.0 µm thick, tectate, spines 4–7 µm long, surface interspines micropitted.

Specimens: UFP 37, 5.2 × 80.5; UFP 66, 18.9 × 96.1

Description: Monad, radial, isopolar, amb circular; pantoporate, pores annulate, circular, annuli 1.5–2 µm wide, 3–6 µm wide, pore number 20–25; tectate, exine 1.5–2.0 µm thick, nexine 0.5 µm thick, columellae < 1.0 µm thick, tectum < 0.5 µm thick, columellae < 0.5 wide µm, tectum thickened beneath base of spines to 0.5–1.0 µm; sculpture echinate, spines 4–7 µm long, 2–3 µm wide, conical, tips rounded, distributed moderately, surface interspines micropitted, lumina < 0.5 µm wide. Dimensions: Equatorial diameter width 37 (43) 50 µm, SD 5.7; equatorial diameter length 45 (52.5) 60 µm, SD 6.5; equatorial diameter length/width 1.2, nm: 4; no: 25.

Comparisons: *Malvacerumpollis* (NAGY) KRUTZSCH 1966 is stephanoporate (ANZÓTEGUI & CUADRADO 1996).

Affinities: Malvaceae sensu latu, similar to *Thespesia populnea*, *Hibiscus tiliaceus* (GERMERAAD et al. 1968).

Echiperiporites sp. 1

Plate 9, Figs. 15–16

Diagnosis: Echipantoporate, large-sized (90 µm), pores annulate, spines large, 3–4 µm long, scabrate.

Specimens: UFP 6, 12.1 × 110

Description: Monad, radial, isopolar, amb circular; pantoporate, ecto and endopores of similar shape and coinciding, annulate, circular, 10 µm wide, 10 µm long, annuli 2 µm wide, 1 µm thick, nonprotruding; tectate, exine 1.5 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum 0.5–1.0 µm thick, columellae short, 1 µm wide, < 0.5 µm apart, almost indistinct; sculpture echinate, spines 3–4 µm long, 3–4 µm wide, conical, tips rounded, solid, surface interspines scabrate, scabrae < 0.5 µm wide, < 0.5 µm long, distributed evenly, < 0.5 µm apart. Dimensions: Equatorial diameter width 40 µm; equatorial diameter length 90 µm; equatorial diameter length/width 2.2, nm: 1; no: 1.

Comparisons: *Echiperiporites estelae* GERMERAAD et al. 1968 has a micropitted tectum, and is smaller (45–60 µm).

Genus *Echitetracolpites* SONG et al. in QIAN et al. 1993

Echitetracolpites? tenuiexinatus n. sp.

Plate 9, Figs. 17–19

Diagnosis: Stephanocolporate, mid-sized (35–50 µm), colpi very short, echinate, two groups of spines: long (> 1.0–2 µm), and short (0.5 – < 1.0 µm), surface interspines micropitted.

Specimens: Holotype UFP 43, 4.7 × 94.5, pl. 9, figs. 17–18; paratypes UFP 41, 18.3 × 85, pl. 9, fig. 19; UFP 41, 15.7 × 104.5

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After thin exine.

Description: Monad, radial, isopolar, amb circular; stephanocolporate, ectocolpi simple, CEi 0.2, very short, indistinct in many instances, endopore costate, lalongate, 5–7 µm wide, 4–6 µm long, pores large, lined by minuscule spines, costae 1 µm wide, slightly thickened; tectate, exine 0.5–1.0 µm thick; sculpture echinate, two groups of spines: spines long, massive, tips rounded, > 1–2.0 µm long, > 1–2 µm wide, distributed sparsely, a second type of spines short, tips rounded, 0.5 – < 1.0 µm long, 0.5 – < 1.0 µm wide, distributed densely, surface interspines micropitted, lumina < 0.5 µm wide. Dimensions: Equatorial diameter 35 (41) 50 µm, SD 4.6; equatorial diameter length/width 1.1, nm: 14; no: 30.

Comparisons: Specimens are brevicolporates. This species cannot be placed in any existing genus, it is provisionally assigned to *Echitetracolpites* because of its very short colpi, echinate sculpturing, and small to mid-sized spines. *Echitetracolpites*?sp. 1 has a thicker exine (1.5 µm), only one class of spines, micropitting lumina are wider, costae are better developed, and colpi are more distinct, *Echitetracolpites jiangsuensis* SONG et al. (in QIAN et al. 1993) is colpate.

Echitetracolpites? sp. 1

Plate 9, Figs. 20–21

Diagnosis: Stephanocolporate, mid-sized (30–40 µm), exine 1.5 µm, colpi very short, echinate, spines long, 2 µm long, surface interspines micropitted.

Specimens: UFP 37, 18.9 × 105.5

Description: Monad, radial, isopolar, amb circular; stephanocolporate, four to six colporate, ectocolpi simple, CEi 0.2, very short, ends pointed, endopore costate, lalongate, costae 1.5 µm wide, 1.5–2.0 µm thick; tectate, exine 1.5 µm thick, nexine < 0.5 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, nexine thickening around pores, columellae very distinctive, < 0.5 µm wide; sculpture echinate, spines large, 2 µm long, 2 µm wide at the base of the spine, massive, tips blunted, distributed sparsely, surface interspines micropitted, lumina < 0.5 µm wide. Dimensions: Equatorial diameter 30 (36) 40 µm, SD 4.3; equatorial diameter length/width 1.1, nm: 5; no: 22.

Comparisons: Specimens are brevicolporates. This species cannot be placed satisfactorily in any existing genus, it is provisionally placed into *Echitetracolpites* because of its very short colpi, echinate ornamentation, and mid-sized spines. *Echitetracolpites ? tenuiexinatus* n. sp. has a thinner exine (< 1.0 µm), two classes of spines, and colpi are less distinct, *Echitetracolpites jiangsuensis* SONG et al. (in QIAN et al. 1993) is colpate.

Genus *Echitricolpites* REGALI et al. 1974

Echitricolpites sp. 1

Plate 9, Figs. 22–23

Diagnosis: Echitricolpate, mid-sized (50–60 µm), prolate, tectate, exine thin, colpi costate, intruding, lined by a row of spines, spines in longitudinal rows 5–6 µm apart.

Specimens: UFP 15, 4.1 × 82.3; UFP 17, 15 × 109

Description: Monad, radial, isopolar, prolate; tricolpate, ectocolpi costate, CPi 0.7, long, intruding, ends pointed, costae 3 µm wide, decreasing in width at polar ends of colpi, colpi lined by a row of spines; tectate, exine 0.5–1.0 µm thick; sculpture echinate, spines 0.5–1.0 µm long, tips pointed, slender, 0.5–1.0 µm wide, arranged in longitudinal rows, 5–6 µm apart, surface interspines micropitted, lumina < 0.5 µm wide. Dimensions: Equatorial diameter 35 (35.5) 36 µm; polar diameter 50 (55) 60 µm, polar/equatorial diam. 1.5, nm: 2; no: 4.

Comparisons: *Cristaecolpites echinatus* SCHRANK 1994 is smaller (33 µm), with two colpus-like furrows, and spines are longer (1.5–2.5 µm long).

Genus *Echitriporites* VAN DER HAMMEN 1956b ex VAN HOEKEN-KLINKENBERG 1964

Echitriporites trianguliformis var. *orbicularis* n. var.

Plate 10, Figs. 1–2

1987 *Echitriporites trianguliformis* forma A MULLER et al., p. 41, pl. 3, fig. 5.

Diagnosis: Echitriporate, small to mid-sized (22–32 µm), circular, pores costate, intectate 0.5–1.0 µm thick, spines > 0.5 – < 2.5 µm long, 0.5 µm wide at base, 0.5 µm apart.

Specimens: Holotype UFP 34, 7.3 × 83.5, pl. 10, figs. 1–2; paratypes UFP 34, 8 × 86.5; UFP 39, 15 × 83.8

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Description: Monad, radial, isopolar, amb circular; triporate, 4-porate or 6-porate in a few occasions, ecto and endopores of similar shape and coinciding, costate, circular, 2 µm wide, 2 µm long, costae 1.0–1.5 µm wide, 0.5–1.0 µm thick, slightly protruding; intectate, nexine 0.5–1.0 µm thick; sculpture echinate, spines > 0.5 – < 2.5 µm long, 0.5 µm at base, tips pointed or rounded, 0.5 µm apart. Dimensions: Equatorial diameter 22 (26) 32 µm, SD 2.1; equatorial diameter length/width 1.1, nm: 34; no: 77.

Comparisons: This variety is more rounded and with spines that are distributed more densely than grains of *Echitriporites trianguliformis* VAN HOEKEN-KLINKENBERG 1964 from Late Cretaceous strata.

Affinities: Proteaceae? (GERMERAAD et al. 1968).

Echitriporites variabilis n. sp.

Plate 10, Figs. 3–5

Diagnosis: Echitriporate, mid-sized (26–49 µm), triangular-acute-convex, pores costate, tectate, spines 1.5–3 µm long, tectum micropitted.

Specimens: Holotype UFP 42, 87.8 × 5.7, pl. 10, figs. 3–5; paratypes UFP 37, 14.1 × 105.1

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After large variation in spine density.

Description: Monad, radial, isopolar, amb triangular-acute-convex; triporate, ecto and endopores of similar shape and coinciding, costate, lalongate, 4–6 µm wide, 3–4 µm long, costae 1.5–2 µm wide, 0.5–1.0 µm thick, non-protruding; tectate, exine 1–1.5 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum 0.5–1.0 µm thick, columellae indistinct; sculpture echinate, spines density varies in relationship with grain size, larger grains with more and larger spines, 3 µm long, 2 µm wide, > 70 spines, smaller grains with less and shorter spines, 1.5 µm long, 1 µm wide, 30–50 spines, spines conical, massive, tips rounded, surface interspines micropitted. Dimensions: Equatorial diameter 26 (36) 49 µm, SD 7.4; equatorial diameter length/width 1, nm: 20; no: 37.

Comparisons: *Echitriporites nuriae* DUEÑAS 1980 has longer spines (up to 6 µm long), and a thinner exine (1 µm thick), *Echitriporites* sp. 2 is elliptic, has spines with tips pointed, and a finely reticulate tectum.

Echitriporites sp. 1

Plate 10, Figs. 6–7

Diagnosis: Echitriporate, mid-sized (29 µm), pores costate, tectate, spines small, 0.5–1.0 µm long, distributed sparsely over the entire grain.

Specimens: UFP 44, 7 × 91.5

Description: Monad, radial, isopolar, amb circular; triporate, ecto and endopores of similar shape and coinciding, costate, circular, 3 µm wide, 4 µm long, costae 2 µm wide, 1.5 µm thick, pores slightly protruding; tectate, exine 1.0–1.5 µm thick, nexine < 0.5 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, nexine thickening around pores, columellae distinct, long, thin; sculpture echinate, spines small, 0.5–1.0 µm long, 0.5 µm wide, distributed sparsely over the entire grain. Dimensions: Equatorial diameter 29 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Echitriporites triangulíformis* var. *orbicularis* n. var. is intectate and has narrower and thinner costae.

Echitriporites sp. 2

Plate 10, Fig. 8

Diagnosis: Echitriporate, mid-sized (30–37 µm), annulate, tectate, spines 2 µm long, distributed sparsely over entire grain, surface interspines finely reticulate.

Specimens: UFP 56, 7 × 88.6

Description: Monad, radial, isopolar, amb elliptic; triporate, pores annulate, lolongate, 2 µm wide, 4 µm long, annuli 2 µm wide, pore indistinct in some cases; tectate, exine 1.5 µm thick, nexine < 0.5 µm thick, columellae < 0.5 µm thick, tectum 0.5–1.0 µm thick; sculpture echinate, spines 2 µm long, 1.0–1.5 µm wide, tips pointed, distributed sparsely over the entire grain, surface interspines reticulate, lumina 0.5 – < 1.0 µm wide, circular. Dimensions: Equatorial diameter width 25 (28.5) 32 µm; equatorial diameter length 30 (33.5) 37 µm; equatorial diameter length/width 1.2, nm: 2; no: 2.

Comparisons: *Echitriporites nuriae* DUEÑAS 1980 is larger (38–47 µm), with longer spines (up to 6 µm long), and a thinner exine (1 µm thick), *Echitriporites variabilis* n. sp. is triangular-acute-convex, has spines with tips rounded, and a micropitted tectum.

Echitriporites sp. 3

Plate 10, Figs. 9–10

Diagnosis: Echitriporate, mid-sized (50 µm), annulate, annuli < 0.5 µm wide, intectate, exine 4 µm thick, spines 5 µm long.

Specimens: UFP 5, 18.4 × 94.2

Description: Monad, radial, isopolar, amb triangular-acute-convex; triporate, ectopores annulate, circular, 6 µm wide, 6 µm long, annuli 0.5 µm thick, < 0.5 µm wide, produced by thickening of exine, separated from remaining exine by fine layer or columellae-like structure restricted to pore margins, annuli slightly protruding; intectate, nexine 4 µm thick, exine very thick, massive, homogeneous; sculpture echinate, spines 5 µm long, 3 µm wide, subconical, blunt, distributed sparsely 4–6 µm apart. Dimensions: Equatorial diameter 50 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: Unique combination of echinate, triporate, and intectate pollen grain, with a very thick nexine.

Genus *Foveodiporites* VARMA & RAWAT 1963

Foveodiporites guianensis WIJMSTRA 1971

Plate 10, Figs. 11–12

Diagnosis: Diporate, rectangular, mid-sized (30–36 µm), foveolate, increasing in density near pores.

Specimens: UFP 4, 6.5 × 110.8

Description: Monad, radial, isopolar, amb rectangular; diporate, ecto and endopores of similar shape and coinciding, lalongate, 10 µm wide, 4 µm long, pores large, slightly sunken; atectate, nexine 1 µm thick, exine thin; sculpture foveolate, lumina 0.5 – < 1.0 µm wide, < 0.5 µm deep, circular, 7–8 µm apart, increasing in density in areas surrounding pores where they are 2–3 µm apart. Dimensions: Equatorial diameter width 23 (24) 25 µm; equatorial diameter length 30 (33) 36 µm; equatorial diameter length/width 1.4, nm: 2; no: 2.

Genus *Foveotricolpites* PIERCE 1961

Foveotricolpites perforatus VAN DER HAMMEN & GARCIA 1966

Plate 10, Figs. 13–14

Diagnosis: Tricolpate, prolate, mid-sized (30–50 µm), tectate 2–3 µm, foveolate, foveolae 1–2 µm wide, coarser on poles up to 5 µm.

Specimens: UFP 19, 15.9 × 88.2; UFP 10, 17.8 × 110.3

Description: Monad, radial, isopolar, subprolate; tricolpate, ectocolpi simple, CPi 0.5, borders straight, ends pointed, in some cases slightly costate, costae 0.5 µm wide; tectate, exine 2–3 µm thick, nexine 0.5–1 µm thick, columellae 0.5–1 µm thick, tectum 1.0–1.5 µm thick, columellae densely grouped in irregular pattern, < 1.0 µm wide; sculpture foveolate, lumina 1–2 µm wide at equator gradually increasing toward poles up to 5 µm wide, 3–5 µm apart, oval to circular, borders rounded. Dimensions: Equatorial diameter 22 (30.1) 42 µm, SD 6.3; polar diameter 30 (40.57) 50 µm, SD 6.6, polar/equatorial diam. 1.4, nm: 7; no: 10.

Foveotricolpites sp. 1

Plate 10, Figs. 15–17

Diagnosis: Tricolpate, mid-sized (33 µm), costae, foveolate, two sizes: large foveolae (3 µm wide), and small foveolae (1–2 µm wide).

Specimens: UFP 34, 4 × 100.5

Description: Monad, radial, isopolar, amb circular; tricolpate, ectocolpi costate, CEi 0.3, mid to short-sized, borders straight, ends rounded, costae 4 µm wide, polar area large, 15 µm wide; tectate, exine 2.5–3.0 µm thick, nexine 1 µm thick, columellae 0.5 µm thick, tectum 1.0–1.5 µm thick, columellae thin, < 0.5 µm wide, 0.5–1.0 µm apart; sculpture foveolate, two classes of foveolae: foveolae large, 3 µm wide, circular, rounded borders, and foveolae small, 1–2 µm wide, elongated and circular, both types of foveolae distributed over entire surface of grain. Dimensions: Equatorial diameter 33 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Foveotricolpites perforatus* Van der Hammen & Garcia 1966 has foveolae that is 1–2 µm wide increasing in width toward the poles.

Genus *Foveotricolporites* Pierce 1961

Foveotricolporites fossulatus n. sp.

Plate 10, Figs. 18–19

Diagnosis: Tricolporate, mid to large-sized (40–61 µm), thick nexine, colpi marginate, pores costate, fossulate/foveolate diminishing toward colpi margines where is micropitted.

Specimens: Holotype UFP 43, 7.9 × 89.9, pl. 10, figs. 18–19

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After fossulate sculpturing.

Description: Monad, radial, isopolar, subprolate; tricolporate, ectocolpi marginate, CPi 0.75, long, borders straight, ends pointed, margines 5 µm wide, formed by narrowing of sculpture lumina, endopores costate, lalongate-ovoid, 9 µm wide, 5 µm long, costae 2 µm wide, 2 µm thick, protruding, only present on upper and lower areas of pores and lacking from equatorial sides of pores; tectate, exine 3.5 µm thick, nexine 2 µm thick, columellae 0.5 µm thick, tectum 1 µm thick, nexine thickening to 4 µm around pores, columellae distinct, 0.5–1.0 µm wide, 1 µm apart, gradually decreasing in thickness toward colpi margines; sculpture fossulate, lumina 0.5 µm wide, 1–2 µm long, fusiform, diminishing in size toward colpi margines where lumina are circular and < 0.5 µm wide, muri 1 µm wide, pluricolumellate, some grains foveolate. Dimensions: Equatorial diameter 36 (47) 58 µm, SD 10.6; polar diameter 40 (51) 61 µm, SD 8.7, polar/equatorial diam. 1.1, nm: 4; no: 6.

Comparisons: *Retitricolporites quadrosi* Regali et al. 1974 has costate colpi and indistinct pores, *Foveotricolporites crassiexinatus* Van Hoeken-Klinkenberg 1966 is smaller (31 µm), and has homogeneous foveolae.

Foveotricolporites rugulatus n. sp.

Plate 10, Figs. 20–21

Diagnosis: Tricolporate, mid-sized (28–45 µm), tectate, tectum very thick, ectocolpi costate, fossulae branching, occasionally forming a rugulate-like pattern.

Specimens: Holotype UFP 34, 19.2 × 101, pl. 10, fig. 21; paratype UFP 66, 18.1 × 88.7 pl. 10, fig. 20

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After sculpturing that resembles rugulate.

Description: Monad, radial, isopolar, prolate, amb triangular-obtuse-convex; tricolporate, ectocolpi costate, CPi 0.8, colpi long, ends pointed, costae 2 µm wide, colpi membrane thin and psilate, endopores simple, lolongate, 6 µm wide, 10 µm long; tectate, exine 1.5 – < 2.0 µm thick, nexine < 0.5 µm thick, columellae < 0.5 µm thick, tectum 1.0–1.5 µm thick, columellae very thin, short, indistinct, tectum thicker than columellae and nexine combined; sculpture fossulate, lumina 2–5 µm long, 0.5 µm wide, 0.5 – < 1.0 µm deep, 1–4 µm apart, usually branching or making 60–70 degree turns, in some cases fossulae profusely fuse forming pattern rugulae-like. Dimensions: Equatorial diameter 30 (36) 45, SD 5.5 µm; equatorial diameter length/width 1, nm: 5; polar diameter 28 (34) 45 µm, SD 4.7, polar/equatorial diam. 1.3, nm: 13; no: 22.

Comparisons: *Foveotricolporites* sp. 4 is poricostate, *Foveotricolporites* sp. 3 has a thinner tectum, smaller fossulae (1–2 µm long), and surface interfossulae is micropitted.

Foveotricolporites sp. 1

Plate 10, Figs. 22–24

Diagnosis: Tricolporate, mid-sized (36 µm), tectate 1 µm, colpi short, endopore costate and fastigiate, foveolate, lumina decrease from poles to equator.

Specimens: UFP 34, 10 × 87

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi simple, CEi 0.3, short, borders straight, ends rounded, polar area large, 15 µm wide, endopores costate fastigiate, lalongate, 8 µm wide, 3 µm long, fastigia 2 µm long, costae 2 µm wide; tectate, exine 1 µm thick, columellae indistinct; sculpture foveolate, lumina in polar area 1 µm wide, slightly elongate, 0.5 µm apart; decreasing gradually toward equator where lumina are < 0.5 µm wide, circular, < 0.5 µm apart. Dimensions: Equatorial diameter width 31 µm; equatorial diameter length 36 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: Unique combination of short colpi, fastigiate endopores and foveolae that diminish in width toward the equator. *Retitribrevicolporites matanomadhensis* (Venkatachala & Kar 1969) Kar 1985 is similar but the sculpturing is reticulate and the exine is thicker (4 µm).

Foveotricolporites sp. 2

Plate 10, Figs. 25–26

Diagnosis: Tricolporate, mid-sized (30 µm), nexine thick, colpi marginate, fossulate, fossulae diminishing toward colpus margines and apocolpia where it is micropitted.

Specimens: UFP 43, 17.9 × 82.5

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi marginate, CEi 0.7, mid-sized, borders straight, ends pointed, margines 3 µm wide produced by narrowing of sculpture lumina, polar area 10 µm wide, endopores simple, lalongate, 8 µm wide, 1 µm long, pores distinct; tectate, exine 3 µm thick, nexine 2 µm thick, columellae 0.5 µm thick, tectum 0.5 µm thick, nexine very thick, columellae distinct, 0.5–1.0 µm wide, 1–1.5 µm apart, sexine gradually decreasing in thickness toward colpi margines; sculpture fossulate, lumina 0.5 µm wide, 1–2 µm long, fusiform, diminishing in size toward colpi margines and poles where lumina are < 0.5 µm wide and circular, muri 1–1.5 µm wide. Dimensions: Equatorial diameter 30 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Retitricolporites quadrosi* Regali et al. 1974 has costate colpi and indistinct pores, *Foveotricolporites crassiexinatus* Van Hoeken-Klinkenberg 1966 has uniform foveolae, *Foveotricolporites fossulatus* n. sp. is larger (40–61 µm) and poricostate, *Foveotricolporites voluminosus* Gonzalez 1967 has a thinner exine (< 2.0 µm), is poricostate, and foveolae are homogeneous.

Foveotricolporites sp. 3

Plate 10, Figs. 27–28

Diagnosis: Tricolporate, mid-sized (30 µm), prolate, colpi costate, tectate 1.0–1.5 µm thick, fossulate, surface interfossulae micropitted.

Specimens: UFP 32, 14.9 × 96.5

Description: Monad, radial, isopolar, prolate; tricolporate, ectocolpi costate, CPi 0.7, ends rounded, costae 1 µm wide, surrounding entire colpi, endopores simple, lolongate, 5 µm wide, 2 µm long; tectate, exine 1.0–1.5 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, columellae indistinct; sculpture fossulate, lumina 1–2 µm long, < 0.5 µm wide, surface interfossulae micropitted. Dimensions: Equatorial diameter 25 µm; polar diameter 30 µm, polar/equatorial diam. 1.2, nm: 1; no: 1.

Comparisons: *Foveotricolporites* sp. 4 is poricostate, *Foveotricolporites rugulatus* n. sp. has a thicker tectum (1 µm), longer fossulae (2–5 µm long), and surface interfossulae is psilate.

Foveotricolporites sp. 4

Plate 11, Figs. 1–2

Diagnosis: Tricolporate, mid-sized (36–40 µm), circular, tectate 2 µm thick decreasing toward colpi, endopores costate, fossulate.

Specimens: UFP 21, 5.7 × 99

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi simple, CEi 0.4, short, borders straight, ends rounded, polar area large, 15 µm wide, distance between colpi ends 20 µm, endopores costate, pore borders indistinct, costae 5 µm wide; tectate, exine 2 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5–1.0 µm thick, tectum 0.5–1.0 µm thick, columellae < 0.5 µm wide, 0.5–1.0 µm apart, sexine decreasing in thickness toward colpi margins where columellae are < 0.5 µm thick and tectum < 0.5 µm thick; sculpture fossulate, lumina 2–4 µm long, < 1.0 µm wide, < 0.5 µm deep, < 1.0 µm apart, distributed homogeneously over entire grain. Dimensions: Equatorial diameter 36 (38) 40 µm; equatorial diameter length/width 1.1, nm: 2; no: 2.

Comparisons: *Foveotricolporites* sp. 3 is colpicostate, *Foveotricolporites rugulatus* n. sp. has a thicker tectum (1 µm), and costate colpi.

Genus *Foveotriporites* Gonzalez 1967

Foveotriporites hammenii Gonzalez 1967

Plate 11, Fig. 3

Diagnosis: Triporate, mid to large-sized (42–75 µm), pore costate, tectate 3 µm thick, foveolate, lumina 1.5–3.5 µm wide.

Specimens: UFP 84, 13 × 96.5; UFP 47, 13.2 × 108.5

Description: Monad, radial, isopolar, amb elliptic; triporate, ecto and endopores of similar shape and coinciding, costate, circular, 6–10 µm wide, 6–10 µm long, costae 2–3 µm wide; tectate, exine 2–3 µm thick, nexine 1 µm thick, columellae 1 µm thick, tectum 1 µm thick; sculpture foveolate, lumina 1.5–3.5 µm wide, in some specimens sculpture is almost reticulate. Dimensions: Equatorial diameter 42 (54) 75 µm, SD 10.1; equatorial diameter length/width 1.1, nm: 13; no: 39.

Foveotriporites sp. 1

Plate 11, Figs. 4–7

Diagnosis: Triporate, mid-sized (50 µm), costae thick, tectate 1 µm thick, foveolate, lumina 0.5 µm wide.

Specimens: UFP 49, 16.3 × 105.5; UFP 49, 19.1 × 89.7

Description: Monad, radial, isopolar, amb circular; triporate, ectopores simple, endopores costate, lalongate, ectopores more elongated (10 × 6 µm) than endopores (7 × 6 µm), costae 5 µm wide, 5 µm thick; tectate, exine 1 µm thick, nexine thickening to 5 µm around pores, columellae indistinct; sculpture foveolate, lumina 0.5 µm wide, circular, rounded, > 0.5–1.0 µm apart, in some grains micropitted. Dimensions: Equatorial diameter width 40 µm; equatorial diameter length 50 µm; equatorial diameter length/width 1.2, nm: 1; no: 2.

Comparisons: *Foveotriporites hammeni* Gonzalez 1967 has a thicker exine (3 µm) and larger foveolae (1.5–3.5 µm).

Genus *Gemmamonocolpites* Van der Hammen & Garcia 1966

Gemmamonocolpites gemmatus (Van der Hammen 1954) Van der Hammen & Garcia 1966

Plate 11, Figs. 8–9

Diagnosis: Gemmamonosulcate, small to mid-sized (24–33 µm), intectate, gemmae < 0.5–1.5 µm long, distributed sparsely to moderately.

Specimens: UFP 8, 20 × 87.1; UFP 4, 7.8 × 100.5

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus simple, sulcus long, indistinct; intectate, nexine 0.5 µm thick, exine very thin; sculpture gemmate, gemmae < 0.5–1.5 µm long, grains with small gemmae are more abundant, distributed sparsely to moderately, in random pattern over entire surface of grain. Dimensions: Equatorial diameter width 20 (23.5) 28 µm, SD 3.2; equatorial diameter length 24 (27.5) 33, SD 3.1; equatorial diameter length/width 1.2, nm: 6; no: 6.

Gemmamonocolpites perfectus n. sp.

Plate 11, Figs. 13–14

Diagnosis: Gemmamonosulcate, mid-sized (40 µm), intectate, gemmae 1–2 µm long, distributed sparsely, surface intergemmae scabrate.

Specimens: Holotype UFP 43, 11 × 86.2, pl. 11, figs. 13–14

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After gemmae that are very well defined.

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus simple, CEi 0.6, indistinct; intectate, nexine 0.5 µm thick, exine very thin; sculpture gemmate, gemmae 1–2 µm long, 1–2 µm wide, long, circular in plane view and cross section, distributed sparsely, up to 40 gemma/grain, surface intergemmae scabrate, scabrae < 0.5 µm long, distributed densely. Dimensions: Equatorial diameter width 30 (32) 35 µm; equatorial diameter length 40 (40) 40 µm; equatorial diameter length/width 1.2, nm: 3; no: 3.

Comparisons: *Gemmamonocolpites* sp. 1 has less densely distributed gemmae and has densely distributed small clavae, *Gemmamonocolpites gemmatus* (Van de Hammen 1954) Van der Hammen & Garcia 1966 is smaller (24–28 µm), gemmae are smaller (< 1.5 µm), and lacks densely distributed scabrae, *Gemmamonocolpites* sp. 2 has mamiform-like gemmae and exine thickens beneath sculpturing elements, *Gemmamonocolpites macrogemmatus* Muller et al. 1987 has larger gemmae (up to 3 µm long), and a thicker exine (1 µm), *Racemonocolpites* Gonzalez 1967 has densely distributed gemmae.

Gemmamonocolpites sp. 1

Plate 11, Figs. 15–16

Diagnosis: Gemmamonosulcate, mid-sized (35–40 µm), intectate, gemmae large, mushroom-like, surface intergemmae clavate.

Specimens: UFP 84, 21 × 84.4

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus simple, long, obscured by sculpturing; intectate, nexine 0.5 µm thick, very thin; sculpture gemmate, gemmae large and wide, distributed sparsely in clusters (11 gemma/grain), shaped mushroom-like, 2 µm long, 2.5–3 µm long, 1.5–2 µm wide at tip, 0.5 µm at base, ellipsoidal in plane view, circular in cross section, surface intergemmae clavate, clavae small, distributed densely, 1 µm long, 0.5 wide and long, circular in plane view. Dimensions: Equatorial diameter width 20 (25) 30 µm, equatorial diameter length 35 (37.5) 40 µm; equatorial diameter length/width 1.5, nm: 2; no: 2.

Comparisons: *Gemmamonocolpites perfectus* n.sp. is more densely gemmate and surface intergemmae is scabrate, *Racemonocolpites* Gonzalez 1967 has densely distributed gemmae.

Gemmamonocolpites sp. 2

Plate 11, Figs. 17–18

Diagnosis: Gemmamonosulcate, mid-sized (32 µm), intectate, gemmae distributed sparsely, exine beneath gemmae rises giving the appearance of a mammary gland

Specimens: UFP 5, 11.5 × 94

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus simple, long, obscured by sculpturing; intectate, nexine 0.5–1.0 µm thick, exine variable in thickness, rising beneath gemmae looking like a mammary gland, there is not discontinuity between exine and gemmae; sculpture gemmate, gemmae 2 µm long, 1.5–2 wide, circular in plane and cross view, distributed sparsely. Dimensions: Equatorial diameter width 27 µm; equatorial diameter length 32 µm; equatorial diameter length/width 1.2, nm: 1; no: 1.

Comparisons: *Gemmamonocolpites perfectus* n. sp. has spherical gemmae and exine thickness is constant, *Gemmamonocolpites macrogemmatus* Muller et al. 1987 has larger gemmae (up to 3 µm long), and exine thickness is constant, *Racemonocolpites* Gonzalez 1967 has densely distributed gemmae.

Genus *Horniella* Traverse 1955

Retitricolporites (Van der Hammen 1956b) Van der Hammen & Wymstra 1964 is invalid and a later synonym of *Viburnum* (Jansonius & Hills 1976, card 2402). *Horniella* Traverse 1955 accommodates tricolporate pollen grains that are reticulate, prolate, with thin or lacking margines or costacolpi, and lalongate endopores (Frederiksen 1983).

Horniella sp. 1

Plate 11, Figs. 19–20

Diagnosis: Retitricolporate, large-sized (60 µm), colpi long, pores indistinct, tectate, nexine thick (2 µm), reticulate, lumina 3.5–4.5 µm wide, angular, uniform.

Specimens: UFP 49, 18.2 × 79.5

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi simple, CEi 0.8, long, slightly intruding, borders straight, ends pointed, polar area small, 7 µm wide, endopores lalongate, 15 µm wide, 5 µm long, pores indistinct; semitectate, exine 4 µm thick, nexine 2 µm thick, columellae 1 µm thick, tectum 1 µm thick, columellae distinct, 1 µm wide, 2 µm

apart, tectum reduced to reticulum; sculpture reticulate, lumina 3.5–4.5 µm wide, angular, uniform, distributed densely, muri 1 µm wide, simplicolumellate. Dimensions: Equatorial diameter 60 µm; equatorial diameter length/width 1, nm: 1; no: 2.

Comparisons: *Retitricolporites quadrosi* REGALI et al. 1974 has costate colpi, and it is reticulate-foveolate.

Horniella sp. 2

Plate 11, Figs. 21–23

Diagnosis: Tricolporate, small-sized (20–25 µm), reticula fine, ectocolpi simple, long, pore costate, columellae distinct.

Specimens: UFP 32, 11.6 × 107

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi simple, CEi 0.8 borders straight, ends pointed, polar area small, 5 µm wide, endopores costate, lalongate, 5 µm wide, 2 µm long, costae 1.5 wide, 0.5 µm thick; tectate, exine 1 µm thick, nexine slightly thickening around pores, columellae distinct, 0.5 µm wide, < 1.0 µm apart; sculpture reticulate, lumina 0.5–1.0 µm, rounded, uniform, distributed densely, muri 0.5–1.0 µm wide. Dimensions: Equatorial diameter 20 (23) 25 µm; equatorial diameter length/width 1, nm: 3; no: 3.

Comparisons: *Retitricolporites costatus* LEIDELMEYER 1966 has very short colpi, *Rhoipites cienagensis* (DUEÑAS 1980) n. comb. is colpimarginate, *Siltaria mariposa* (LEIDELMEYER 1966) n. comb. has columellae that are decreasing in thickness toward colpi, lumina are smaller (< 0.5 µm), exine is thicker (1.5 µm), and costae are narrower (1 µm).

Horniella sp. 3

Plate 11, Figs. 24–26

Diagnosis: Retitricolporate, mid-sized (23–40 µm), pores conspicuously costate and fastigiate, sculpture reticulate fine to psilate.

Specimens: UFP 21, 6.4 × 83.8

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi simple, CEi 0.7, long, borders straight, ends pointed, polar area small, 13 µm wide, endopore costate fastigiate, lalongate, 4 µm wide, 1 µm long, pores indistinct, costae conspicuous, 5 µm wide, fastigia 4 µm long, 6–10 µm wide; tectate, exine 1 µm thick, nexine separated from sexine in the equatorial zone around pores, columellae distinct, < 1.0 µm wide, < 1.0 µm apart; sculpture reticulate to psilate, lumina < 1.0 µm wide, rounded, uniform, distributed densely, muri < 1.0 µm wide, some grains psilate or micropitted. Dimensions: Equatorial diameter 23 (32) 40 µm, SD 5.1; equatorial diameter length/width 1, nm: 9; no: 10.

Comparisons: *Retitricolporites costatus* LEIDELMEYER 1966 is smaller (25 µm) and has uniform and very fine reticula, *Psilatricolporites marginatus* VAN DER KAARS 1983 has marginate colpi, smaller size (19–27 µm), and lacks vestibula.

Genus *Jandufouria* GERMERAAD et al. 1968

Jandufouria minor n. sp.

Plate 12, Figs. 1–3

Diagnosis: Stephanocolporate, mid-sized (26–36 µm), reticula fine, homogeneous, dense, lumina 0.5 µm wide, circular.

Specimens: Holotype UFP 45, 4.3 × 84, pl. 12. figs. 1–3

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After small grain-size.

Description: Monad, radial, isopolar, amb circular; stephanocolporate, 4–6 colporate, ectocolpi costate, CEi 0.4, mid-sized, borders straight, ends pointed, slightly costate, costae 0.5–1.0 µm wide, polar area 15 µm wide, endopores simple, lalongate, indistinct, faintly costate; semitectate, exine 1 µm thick, columellae < 0.5 µm wide, < 0.5 µm apart; sculpture reticulate, lumina < 1.0 µm wide, circular, distributed homogeneously and densely, muri 0.5 – < 1.0 wide. Dimensions: Equatorial diameter 26 (30) 36 µm, SD 3.1; equatorial diameter length/width 1.1, nm: 13; no: 23.

Comparisons: Very similar to *Jandufouria seamrogiformis* GERMERAAD et al. 1968 but *J. seamrogiformis* is consistently larger (range of 40–57 µm) and with a longer colpi, reaching half-way to the poles, *Retistephanocolpites williamsii* GERMERAAD et al. 1968 is larger (41–47 µm), 6–7 colpate, exine is thicker (2.5–4 µm), and columellae form spongy structure, *Retistephanocolpites angeli* LEIDELMEYER 1966 is larger (35–50), colpate, with thicker tectum (> 2.0 µm) and larger lumina that tends to be elongated and angular, *Retistephanocolpites tropicalis* DUEÑAS 1980 is 4-colpate and colpi are not costate, *Retistephanocolporites quadriporus* VAN DER HAMMEN & WYMSTRA 1964 has 4 pores and 4 colpi.

Genus *Ladakhipollenites* MATHUR & JAIN 1980

Ladakhipollenites rubinii (VAN DER HAMMEN 1954) n. comb.

Plate 12, Figs. 4–5

Basionym = *Tricolpites rubini* VAN DER HAMMEN, 1954, p. 93, pl. 8.

1992 "*Psilatricolpites rubini* (VAN DER HAMMEN) VAN DER HAMMEN & WYMSTRA 1964", in SARMIENTO 1992, p. 79, pl. 7, figs. 11–12 (nomen nudum)

Diagnosis: Psilatricolp(or)ate, small-sized (12–13 µm), tectate, colpi long, costae well defined.

Specimens: UFP 41, 4.6 × 103.2

Description: Monad, radial, isopolar, subprolate, amb circular; tricolpate, ectocolpi costate, CEi 0.7, long, borders straight, ends rounded, costae 0.5–1.0 µm wide, well defined, endopores present in some grains, pores simple, lalongate, 2 µm wide, 1 µm long, indistinct; tectate, exine 0.5–1.0 µm thick, columellae indistinct; sculpture psilate. Dimensions: Equatorial diameter 13 µm; equatorial diameter length/width 1, nm: 1; polar diameter 12 µm, polar/equatorial diam. 1.2, nm: 1; no: 4.

Comparisons: *Tricolpites* VAN DER HAMMEN 1954 is invalid and a junior synonym of *Bartsia* (JANSONIUS & HILLS 1976, card 2971).

Ladakhipollenites simplex (GONZALEZ 1967) n. comb.

Plate 12, Fig. 6

Basionym = *Psilatricolpites simplex* GONZALEZ 1967, p. 27, pl. 1, figs. 3–3a.

Diagnosis: Psilatricolpate, mid-sized (28–32 µm), prolate, nexine thick, columellae indistinct, colpi long, slightly marginate.

Specimens: UFP 62, 3.5 × 103.1

Description: Monad, radial, isopolar, prolate; tricolpate, colpi marginate, CPi 0.7, borders straight, ends pointed, margo 0.5 µm wide; tectate, exine 1.0–1.5 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, columellae indistinct; sculpture psilate. Dimensions: Equatorial diameter 20 (22) 25 µm; polar diameter 28 (30) 32 µm, polar/equatorial diam. 1.4, nm: 3; no: 4.

Comparisons: *Psilatricolpites* (VAN DER HAMMEN 1956b) PIERCE 1961 is an obligate junior synonym of *Tricolpites* VAN DER HAMMEN 1954, because they have same type species, as the latter is invalid and a junior synonym of *Bartsia*, so is *Psilatricolpites*, vide *Psilatricolpites* (JANSONIUS & HILLS 1976, card 2233).

Ladakhipollenites sp. 1

Plate 12, Figs. 7–8

Diagnosis: Psilatricolpate, mid-sized (30 µm), colpi membrane gemmate.

Specimens: UFP 53, 6.3 × 112.8

Description: Monad, radial, isopolar, amb circular; tricolpate, ectocolpi simple, CPi 0.54, long, borders straight, ends pointed, colpi membrane gemmate, polar area small, 4 µm wide; tectate, exine 0.5–1.0 µm thick, columellae indistinct; sculpture psilate, colpi membrane gemmate, gemmae < 1.0 µm wide and thick, distributed sparsely. Dimensions: Equatorial diameter 30 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: A gemmate colpi membrane is unusual in this genus.

Genus *Lakiapollis* VENKATACHALA & KAR 1969

Lakiapollis aff. *ovatus* VENKATACHALA & KAR 1969

Plate 12, Figs. 9–10

Diagnosis: Psilatricolporate, mid-sized (40 µm), colpi very short, tectate, poricostate conspicuously, at least one pore situated slightly above equator, micropitted.

Specimens: UFP 41, 12.3 × 112.5

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi simple, CEi 0.3, short, endopores costate, circular, 7 µm wide, 5 µm long, costae very distinctive, 3 µm wide, 1.0–1.5 µm thick; tectate, exine 1 µm thick, nexine thickening around pores, columellae very thin; sculpture micropitted, lumina < 0.5 µm wide, homogeneous over entire surface of grain. Dimensions: Equatorial diameter 40 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Lakiapollis ovatus* VENKATACHALA & KAR 1969 is very similar although sculpturing is psilate and exine is slightly thicker (1.5–2.5 µm), *Psilabrevitricolporites* sp. 1 is smaller and operculate.

Affinities: Malvaceae sensu latu, similar to *Durio* (VENKATACHALA et al. 1988).

Genus *Lanagiopollis* MORLEY, 1982

Lanagiopollis crassa (VAN DER HAMMEN & WYMSTRA 1964) FREDERIKSEN 1988

Plate 12, Fig. 11

Diagnosis: Psilatricolporate, mid-sized (33–55 µm), pore lalongate costate, tectum thick with columellae clearly distinct, sculpturing and thickness of the wall extremely variable.

Specimens: UFP 34, 12.3 × 84.5; UFP 34, 14.9 × 110

Description: Monad, radial, isopolar, spherical, amb circular; tricolporate, occasionally tricolpate, ectocolpi simple, CEi 0.5, mid-sized, borders straight, ends pointed, endopores costate, lalongate, 10 µm wide, 1 µm long, shaped slit-like, costae 2–3 µm wide, 2–3 µm thick; tectate, exine 2.5–3.0 µm thick, nexine 1 µm thick, columellae 0.5–1.0 µm thick, tectum 0.5–1.0 µm thick, columellae 0.5 µm thick, tectum easily corroded; sculpture psilate, extremely variable pseudosculpture produced by degree of tectum corrosion, from psilate to scabrate, micropitted, foveolate, reticulate, and rugulate. Dimensions: Equatorial diameter 33 (43) 55 µm, SD 6.2; equatorial diameter length/width 1.05, nm: 30; polar diameter 40 (47) 50 µm, polar/equatorial diam. 1.1, nm: 3; no: 319.

Affinities: Pellicieraceae, similar to extant mangrove *Pelliciera rhizophorae* (GERMERAAD et al. 1968).

Genus *Longapertites* VAN HOEKEN-KLINKENBERG 1964

Longapertites microfoveolatus ADEGOKE & JAN DU CHÈNE 1975

Plate 12, Figs. 12–13

Diagnosis: Longaperturate, mid-sized (42–53 µm), exine tectate, very thin 0.5–1.0 µm, micropitted.

Specimens: UFP 12, 18 × 81

Description: Monad, bilateral, anisopolar, oblate, amb elliptic, distal side concave and having a long colpus, proximal side flat or slightly convex; monosulcate, ectosulcus simple, long, borders straight, ends pointed, slightly intruding, longer than the length of grain; tectate, exine 0.5–1.0 µm thick, columellae visible near colpus where exine thickens to 1 µm; sculpture micropitted, lumina < 1.0 µm wide, fine, homogeneous, distributed evenly. Dimensions: Equatorial diameter width 22 (26) 31 µm; equatorial diameter length 42 (46) 53 µm; equatorial diameter length/width 1.8, nm: 3; no: 6.

Comparisons: *Longapertites vaneendenburgi* GERMERAAD et al. 1968, although very similar, is larger (59–83 µm), *Longapertites proxapertitoides* var. *proxapertitoides* VAN DER HAMMEN & GARCIA 1966 is foveolate and has a thicker exine.

Affinities: Palmae, very similar to *Eremospatha* (MULLER 1979).

Longapertites proxapertitoides var. *proxapertitoides* VAN DER HAMMEN & GARCIA 1966

Plate 12, Fig. 14

Diagnosis: Longaperturate, mid to large-sized (34–70 µm), tectate 1.5 µm thick, foveolate, lumina 0.5–2 µm.

Specimens: UFP 27, 13.4 × 93.5; UFP 27, 5.5 × 110.2; UFP 53,10.4 × 104.7

Description: Monad, bilateral, anisopolar, oblate, amb elliptic, distal side concave and having a long colpus, proximal side flat or convex; monosulcate, ectosulcus simple, long, borders straight, ends pointed, slightly intruding, longer than the length of grain, sometimes nearly zonasulculate, in other cases sulcus slightly shorter than the length of the grain; tectate, exine 1.5 µm thick, nexine 0.5 µm thick, columellae 0.5 µm thick, tectum 0.5 µm thick, columellae 0.5–1.0 µm wide, 0.5–1.0 µm apart; sculpture foveolate, lumina 0.5–2 µm wide, circular to ovoid, shaped irregularly, muri > 0.5–2 µm wide. Dimensions: Equatorial diameter width 20 (27) 40 µm, SD 4.6; equatorial diameter length 34 (44.) 70 µm, SD 8.1; equatorial diameter length/width 1.6, nm: 32; equatorial diameter 35 (42) 50 µm, SD 4.8, polar diameter 23 (26) 30 µm, SD 2.2, polar/equatorial diam. 0.6, nm: 8; no: 294.

Comparisons: *Longapertites proxapertitoides* var. *reticuloides* VAN DER HAMMEN & GARCIA 1966 has reticulate sculpturing, *Longapertites vaneendenburgi* GERMERAAD et al. 1968 has a finely perforated exine, *Longapertites marginatus* VAN HOEKEN-KLINKENBERG 1964 has a coarser reticulate pattern on the proximal side, *Longapertites klinkenbergii* RAO & RAMANUJAM 1978 has bacula that are free in the lumina.

Affinities: Palmae, similar to *Eremospatha* (MULLER 1979).

Longapertites proxapertitoides var. *reticuloides* VAN DER HAMMEN & GARCIA 1966

Plate 12, Fig. 15

Diagnosis: Longaperturate, mid to large-sized (35–50 µm), tectate 1.5–3 µm thick, reticulate, lumina 1–3 µm.

Specimens: UFP 27, 8 × 84.3; UFP 27, 5.6 × 108.2

Description: Monad, bilateral, anisopolar, oblate, amb elliptic, distal side concave and having a long colpus, proximal side flat or convex; monosulcate, ectosulcus simple, long, borders straight, ends pointed, slightly intruding, longer than length of grain, sometimes nearly zonosulculate, in other cases sulcus slightly shorter than the length of the grain; tectate, exine 1.5–3 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5–1.0 µm thick, tectum 0.5–1.0 µm thick, columellae 1 µm wide, 1 µm apart; sculpture

reticulate, lumina 1–3 µm wide, shaped irregularly, decreasing toward colpus in some grains, polygonal, vertices angular to rounded, muri 1–1.5 µm wide. Dimensions: Equatorial diameter width 21 (29) 37 µm, SD 6.94; equatorial diameter length 35 (43) 50 µm, SD 5; equatorial diameter length/width 1.5, nm: 6; equatorial diameter 40 µm, polar diameter 28 µm, polar/equatorial diam. 0.7, nm: 1; no: 303.

Affinities: Palmae, similar to *Eremospatha* (MULLER 1979).

Longapertites sp. 1

Plate 12, Figs. 16–18

Diagnosis: Longaperturate, mid-sized (40–45 µm), semitectate 1.5–1.0 µm thick, reticulate, lumina large, 4–6 µm wide, decreasing near colpus, simplicolumellate.

Specimens: UFP 43, 2.9 × 99.9

Description: Monad, bilateral, anisopolar, prolate, amb elliptic; monosulcate, sulcus simple, long, borders straight, ends rounded, slightly intruding, slightly longer than the length of the grain; semitectate, exine 1.5–2.0 µm thick, nexine < 0.5 µm thick, columellae 0.5–1.0 µm thick, tectum 0.5–1.0 µm thick, columellae 0.5–1.0 µm wide, 0.5 µm apart, tectum reduced to reticulum; sculpture reticulate, lumina large, 4–6 µm wide, decreasing toward colpus to 1 µm, polygonal, vertices angular to rounded, muri 0.5–1.0 µm wide, simplicolumellate. Dimensions: Equatorial diameter 40 (42.5) 45 µm; polar diameter 27 (29.5) 32 µm; polar/equatorial diam. 0.7, nm: 3; no: 5.

Comparisons: *Longapertites proxapertitoides var. reticuloides* VAN DER HAMMEN & GARCIA 1966 has narrower lumina (1–3 µm) and thicker muri (1–1.5 µm), *Longapertites marginatus* VAN HOEKEN-KLINKENBERG 1964 has coarser lumina on the proximal side.

Genus *Luminidites* POCKNALL & MILDENHALL 1984

Luminidites colombianensis n. sp.

Plate 12, Figs. 19–21

Diagnosis: Trichotomosulcate, large-sized (35–46 µm), exine semitectate, 1 µm thick, reticulate, lumina 1 µm at poles diminishing gradually toward radial equatorial areas.

Specimens: Holotype UFP 37, 11.9 × 106.8, pl. 12, figs. 19–21

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After Colombia.

Description: Monad, radial, anisopolar, amb triangular-obtuse-straight; trichotomosulcate, sulcus simple, branching radially in three arms, each arm reaching equator; semitectate, exine 1 µm thick, exine slightly decreasing in thickness toward radial region, columellae distinct, 0.5 µm wide, < 1 µm apart; sculpture reticulate, lumina > 0.5–1 µm wide, angular, polygonal to slightly elongated, gradually diminishing to 0.5 µm toward equatorial radial region, muri 1 µm wide, simplicolumellate. Dimensions: Equatorial diameter 35 (40.5) 46 µm; equatorial diameter length/width 1.1, nm: 2; no: 2.

Comparisons: *Syndemicolpites* VAN HOEKEN-KLINKENBERG 1964 is diplotrichotomosulcate, *Luminidites reticulatus* (COUPER 1960) POCKNALL & MILDENHALL 1984 has a thicker exine (1–2 µm), wider lumina (4.5–9 µm) that decrease toward the distal pole, and it is pluricolumellate.

Affinities: Palmae, similar to *Phytelephas microcarpa*.

Genus *Lymingtonia* ERDTMAN 1960

Lymingtonia? sp. 1

Plate 12, Figs. 22–24

Diagnosis: Pantocolpate, mid-sized (27 µm), intectate, echinate, spines 1–1.5 µm long, surface interspines micropitted.

Specimens: UFP 17, 16.1 × 111.8

Description: Monad, bilateral, anisopolar, amb circular; pantocolpate, nine colpi irregularly distributed over the entire grain, ectocolpi costate, CEi 0.4, short, costae 1 µm wide, indistinct, expressed as a tenuous darker coloration; intectate, nexine < 0.5 µm thick, exine very thin, slightly thickening around colpi; sculpture echinate, spines 1–1.5 µm long, 0.5–1 µm wide, tips pointed, distributed sparsely, surface interspines micropitted. Dimensions: Equatorial diameter 27 µm; Equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: This specimen is intectate and cannot be placed satisfactorily in any existing genus. The species is placed provisionally in *Lymingtonia* ERDTMAN 1960 because it is pantocolpate, and has an echinate-micropitted sculpturing.

Genus *Margocolporites* RAMANUJAM 1966 ex SRIVASTAVA 1969, emend. POCKNALL & MILDENHALL 1984

Margocolporites vanwijhei GERMERAAD et al. 1968

Plate 12, Fig. 25

Diagnosis: Retitricolporate, mid-sized (40–42 µm), colpicostate, margines wide.

Specimens: UFP 53, 6.9 × 107

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi costate marginate, CEi 0.3, costae 1.5 µm wide, surrounded by wide, finely baculate margins, 6 µm wide in equatorial view, endopores indistinct; semitectate, exine 1.5 µm thick, nexine 0.5 µm thick, columellae 0.5 µm thick, tectum 0.5 µm thick, columellae 0.5–1.0 µm wide, 1 µm apart, tectum lacking near colpi; sculpture reticulate, lumina 1–2 µm wide at equator gradually reducing to 0.5 µm at apocolpia, near colpi densely baculate. Dimensions: Equatorial diameter 40 (41) 42 µm; equatorial diameter length/width 1.1, nm: 3; no: 7.

Affinities: Leguminosae, similar to *Adipera*, *Brasilettia*, *Caesalpinia bondue*, *C. coriaria*, *Haematoxylon*, *Mezoneuron*, *Poincianella* (GERMERAAD et al. 1968).

Margocolporites sp. 1

Plate 12, Figs. 26–29

Diagnosis: Psilatricolporate, mid-sized (31 µm), colpi marginate, pores with two rings, sexine absent near colpi.

Specimens: UFP 41, 20.6 × 100.2

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi marginate, CEi 0.7, mid-sized, straight borders, ends pointed, margines 2 µm wide produced by the absence of sexine, polar area 5 µm wide, endopores costate, circular, 5 µm wide, 5 µm long, pores with unusual double ring, outer ring produced by thinning of nexine to 0.5 µm, inner ring produced by thickening of nexine to 1 µm; tectate, exine 2 µm thick, nexine 1 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, nexine gradually decreases in thickness near colpi where is lacking, nexine increases and decreases around pores forming two distinctive rings, columellae distinct, 0.5 µm wide, < 1 µm apart, tectum thin, translucent; sculpture psilate, columellae tips can easily be seen throughout thin tectum. Dimensions: Equatorial diameter 31 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: Double ring around pores has not been reported in any species of *Margocolporites*.

Margocolporites sp. 2

Plate 18, Figs. 25–27

Diagnosis: Retitricolporate, mid-sized (43–50 µm), ectocolpi marginate, lumina large (2 µm) at intercolpial equator, 1 µm wide at poles, and micropitted at margines.

Specimens: UFP 37, 6 × 106.5

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; tricolporate, ectocolpi marginate, CEi 0.8, long, borders straight, ends pointed, margines 5 µm wide produced by thinning of exine, polar area 10 µm wide, endopores simple, lalongate, 5 µm wide, 2 µm long, pores indistinct; tectate, exine 1.0–1.5 µm thick, nexine < 0.5 µm thick, columellae 0.5 µm thick, tectum 0.5 µm thick, exine decreases to 1 µm near colpi by thinning of sexine, columellae distinct, 0.5 µm wide, < 1 µm apart; sculpture reticulate, reticula large at mesocolpia, lumina 2 µm wide, angular, muri 1 µm wide, pluricolumellate, lumina gradually decrease toward margines where sculpturing is micropitted, and toward poles where lumina are 1 µm wide. Dimensions: Equatorial diameter 43 (46.5) 50 µm; equatorial diameter length/width 1.1, nm: 2; no: 2.

Comparisons: *Retitricolporites saskiae* GONZALEZ 1967 has finer reticula toward the mesocolpia, *Retitricolporites ellipticus* VAN HOEKEN-KLINKENBERG 1966 has costate colpi, *Retitricolporites quadrosi* REGALI et al. 1974 has costate colpi, and a thicker exine (3 µm), *Retitricolporites perpusillus* REGALI et al. 1974 is smaller (28–36 µm), has wider intercolpate lumina (3–4 µm) that abruptly decrease near the colpi margin.

Genus *Mauritiidites* VAN HOEKEN-KLINKENBERG 1964

Mauritiidites franciscoi var. *franciscoi* (VAN DER HAMMEN 1956a) VAN HOEKEN-KLINKENBERG 1964

Plate 13, Figs. 1–6

Diagnosis: Monosulcate, mid-sized (30–56 µm), intectate 1.0-<2.0 µm, echinate, spines rooted.

Specimens: UFP 6, 12 × 107.5; UFP 34, 3.3 × 104; UFP 34, 6.8 × 97.9; UFP 37, 11.1 × 89; UFP 40, 8 × 79; UFP 82, 13.1 × 78.8; UFP 40, 17.9 × 85.2

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, sulcus simple, CEi 0.8–1, long, borders irregular, ends rounded; intectate, nexine 1.0 - < 2.0 µm thick, sunken beneath spines 0.5 -1 µm deep; sculpture echinate, spines 1.5–5 µm long, 1–2 µm wide, massive, conical to subconical, tips rounded, distributed sparsely, deeply rooted in the exine, there is a great variation in size and shape of spines ranging from baculate to clavate to drop-like, the greatest variability seems to be in the early to middle Eocene. Dimensions: Equatorial diameter width 18 (27.5) 49 µm, SD 5.8; equatorial diameter length 30 (43) 56 µm, SD 6.4; equatorial diameter length/width 1.6, nm: 57; no: 391.

Comparisons: *Mauritiidites franciscoi* var. *pachyexinatus* VAN DER HAMMEN & GARCIA 1966 has a thicker exine (> 2 µm), *Mauritiidites franciscoi* var. *minutus* VAN DER HAMMEN & GARCIA 1966 is smaller and has shorter spines, and a thinner exine.

Affinities: Palmae, similar to *Mauritia* (GERMERAAD et al. 1968).

Mauritiidites franciscoi var. *minutus* VAN DER HAMMEN & GARCIA 1966

Plate 13, Fig. 7

Diagnosis: Monosulcate, mid-sized (25–33 µm), intectate 0.5-< 1.0 µm, echinate, spines rooted, 0.5–1.8 µm long.

Specimens: UFP 32, 7.6 × 80.5

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, sulcus simple, CEi 0.90, long, borders irregular, ends rounded; intectate, nexine 0.5 – < 1.0 µm thick, very thin, sunken 0.5 µm beneath spines; sculpture echinate, spines 0.5 – < 2.0 µm long, 0.5 µm wide, massive, conical to subconical, tips rounded, distributed sparsely, deeply rooted sunken in the exine. Dimensions: Equatorial diameter width 15 (24.5) 31 µm, SD 3.7; equatorial diameter length 25 (30) 33 µm, SD 2; equatorial diameter length/width 1.2, nm: 29; no: 81.

Comparisons: *Mauritiidites franciscoi* var. *franciscoi* VAN DER HAMMEN & GARCIA 1966 has longer spines (1.5–5 µm), a thicker exine (> 1.0 µm), and a larger size. This species seems to grade into *M. franciscoi* var *franciscoi* but is retained as separate because its size-range approaches a normal distribution.

Affinities: Palmae, *Mauritia* (GERMERAAD et al. 1968).

Mauritiidites franciscoi var. *pachyexinatus* VAN DER HAMMEN & GARCIA 1966

Plate 13, Fig. 8

Diagnosis: Monosulcate, mid to large-sized (40–60 µm), intectate 2–3 µm thick, echinate, spines rooted, 2.5–5 µm long, conical to subconical.

Specimens: UFP 40, 20.4 × 99.3; UFP 35, 8.4 × 87.3

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, sulcus simple, CEi 0.5–0.9, sulcus long to mid-sized, borders irregular, ends rounded; intectate, nexine 2–3 µm thick, very thick, sunken 1 µm beneath spines; sculpture echinate, spines 2.5–5 µm long, 1.5–2 µm wide, massive, conical to subconical, tips rounded, distributed sparsely, deeply rooted sunken in the exine. Dimensions: Equatorial diameter width 21 (43) 55 µm, SD 13; equatorial diameter length 40 (54) 60 µm, SD 8.5; equatorial diameter length/width 1.3, nm: 9; no: 12.

Affinities: Palmae, *Mauritia* (GERMERAAD et al. 1968).

Genus *Momipites* WODEHOUSE 1933, emend. NICHOLS 1973

Momipites africanus VAN HOEKEN-KLINKENBERG 1966

Plate 13, Figs. 9–10

Diagnosis: Psilatriporate, mid-sized (26–30 µm), triangular-obtuse-convex, atectate 1 µm thick, pores slightly protruding, atria slightly developed.

Specimens: UFP 5, 8.9 × 87.1; UFP 6, 7.1 × 87.1

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; triporate, pores atriate, slightly lolongate, 2 µm wide, 3 µm long, slightly protruding, atrium slightly developed, atectate, nexine 1 µm thick; sculpture psilate. Dimensions: Equatorial diameter width 22 (24) 26 µm; equatorial diameter length 26 (28) 30 µm; equatorial diameter length/width 1.2, nm: 2; no: 4.

Momipites sp. 1

Plate 13, Figs. 11–12

Diagnosis: Psilatriporate, mid-sized (38–46 µm), triangular-obtuse-convex, exine tectate thick (1.5 µm), columellae indistinct, atrium slightly developed, pore borders highly irregular.

Specimens: UFP 38, 16.1 × 97.6

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; triporate, pores atriate, circular, 3 µm wide, 3 µm long, pore borders irregular, not well defined, sometimes with low ridges produced by segmentation of exine radiating toward center of pore, atrium slightly developed; tectate, exine 1.5 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum 0.5–1.0 µm thick, exine thick, dense, columellae indistinct, < 0.5 µm wide, exine slightly thinning near pores; sculpture psilate. Dimensions: Equatorial diameter 38 (42) 46 µm, SD 3.1; equatorial diameter length/width 1.1, nm: 6; no: 10.

Comparisons: *Momipites africanus* VAN HOEKEN-KLINKENBERG 1966 is smaller (< 25 µm), polar shape is more triangular, and exine is atectate and thinner (< 1.5 µm), *Cricotriporites* LEIDELMEYER 1966 is circular or elliptic, and pores are annulate or costate.

Genus *Monocolpopollenites* PFLUG & THOMSON in THOMSON & PFLUG 1953, emend. NICHOLS et al. 1973

Monocolpopollenites ovatus n. sp.

Plate 13, Figs. 13–14

Diagnosis: Monosulcate, mid-sized (32–60 µm), trapezoidal with angular borders (egg-like), colpus long, ends widely rounded, tectate, micropitted densely, sometimes sparsely scabrate.

Specimens: Holotype UFP 10, 6.6 × 83.5, pl. 13. figs. 13–14

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After egg-shaped pollen grains.

Description: Monad, bilateral, anisopolar, amb elliptic, trapezoidal with angular borders, resembling an egg; monosulcate, sulcus simple, CEi 0.85, long, borders straight, ends widely rounded, polar area small, 3 µm wide; tectate, exine 1 µm thick, columellae 0.5 µm wide; sculpture micropitted, lumina < 1.0 µm wide, distributed evenly and densely, muri < 1 µm wide, some grains also sparsely scabrate, scabrae < 0.5 µm long and wide. Dimensions: Equatorial diameter width 20 (30) 50 µm, SD 5.9; equatorial diameter length 32 (42) 60 µm, SD 5.9; equatorial diameter length/width 1.4, nm: 63; no: 429.

Comparisons: *Arecipites regio* (Van der Hammen & Garcia 1966) n. comb. is ellipsoidal, has a margo, and sulcus end is pointed, *Retimonocolpites splendidus* Gonzalez 1967 is globular to ellipsoid, and the exine is thicker (2.5 µm).

Genus *Monoporopollenites* Meyer 1956

Monoporopollenites annulatus (Van der Hammen 1954) n. comb.

Plate 13, Figs. 15–16

Basionym = *Monoporites annulatus* Van der Hammen 1954, p. 90, pl. 6, fig. 4

1968 *Monoporites annulatus* Van der Hammen, in Germeraad et al. 1968, p. 294, pl. 3, fig. 3
1974 *Monoporites annulatus* Van der Hammen, in Regali et al. 1974, p. 273, pl. 16, fig. 7
1990 *Monoporites annulatus* Van der Hammen, in Salard-Cheboldaeff 1990, p. 10, pl. 5, fig. 14

Diagnosis: Monoporate, mid-sized (25–40 µm), tectate thin 0.5–1.0 µm, pore costate, slightly protruding, sculpture psilate.

Specimens: UFP 39, 18.2 × 82.4; UFP 32, 10.5 × 83.7

Description: Monad, bilateral, isopolar, spherical; monoporate, ecto and endopores of similar shape and coinciding, costate, circular, 2–4 µm wide, 2–4 µm long, costae 2–3 µm wide, 1–2 µm thick, slightly protruding; tectate, exine 0.5–1.0 µm thick, exine very thin, nexine thickening around pore, columellae indistinct; sculpture psilate to micropitted to slightly scabrate. Dimensions: Equatorial diameter 21 (28) 33 µm, SD 3; polar diameter 25 (32) 40 µm, SD 3.7, polar/equatorial diam. 1.1, nm: 21; no: 32.

Comparisons: *Monoporites* Van der Hammen 1954 is invalid and later synonym of *Chusquea* (Jansonius & Hills 1976, card 1705), *Monoporopollenites* Meyer 1956 includes monoporate and psilate grains (Jansonius & Hills 1976), *Monoporites parcus* Sarmiento 1992 has a simple aperture, and a thicker exine (1 µm), *Graminidites* Cookson ex Potonié emend. Krutzsch 1970 is finely reticulate to granulate (Thanikaimoni et al. 1984)

Affinities: Poaceae (Germeraad et al. 1968).

Genus *Multiporopollenites* Pflug in Thomson & Pflug 1953

Multiporopollenites pauciporatus n. sp.

Plate 13, Figs. 17–19

Diagnosis: Pantoporate, small to mid-sized (20–32 µm), pores 18–23, slightly annulate, micropitted.

Specimens: Holotype UFP 34, 13.5 × 87.2, pl. 13, figs. 17–19

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After the relative few number of pores.

Description: Monad, radial, isopolar, spherical, amb circular; pantoporate, 18–23 pores, 4–6 µm apart, pores slightly annulate, circular, 2 µm wide, 2 µm long, annuli < 0.5 µm wide, non protruding; tectate, exine 1 µm thick, columellae distinct, < 0.5 µm wide, tectum slightly thicker than nexine; sculpture micropitted, lumina < 0.5 µm, muri < 1 µm, distributed densely over entire grain, psilate at annuli.

Dimensions: Equatorial diameter 24 (27) 32 µm, SD 2.3; polar diameter 20 (27) 32 µm, SD 3.5, polar/equatorial diam. 1, nm: 10; no: 41.

Comparisons: *Psilaperiporites* REGALI et al. 1974 is an invalid name (JANSONIUS & HILLS 1990, card 4739), *Caryophyllidites* COUPER 1960 does not have annuli, *Polyporina* NAUMOVA 1939 ex POTONIÉ 1960 is granulate and have more pores, *Periporopollenites* PFLUG & THOMSON IN THOMSON & PFLUG 1953 is granulate and pore membrane is sculptured, *Chenopodipollis* KRUTZSCH 1966 has more pores (> 30), partly closed by a thin membrane, *Psilaperiporites robustus* REGALI et al. 1974 is larger (45–48 µm) and has 60–64 pores, *Scabraperiporites nativensis* REGALI et al. 1974 is scabrate.

Genus *Nothofagidites* POTONIÉ 1960

Nothofagidites huertasii n. sp.

Plate 13, Figs. 20–21

Diagnosis: Scabrastephanoporate, mid-sized (26–45 µm), intectate 0.5–1.0 µm, pore circular, annulate, scabrae < 1.0 µm long, distributed sparsely.

Specimens: Holotype UFP 46, 10 × 95, pl. 13, figs. 20–21; paratype UFP 46, 18.7 × 96.2

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After priest GUSTAVO HUERTAS for his contributions to the paleobotany of Colombia.

Description: Monad, radial, isopolar, amb polygonal; stephanoporate, 4–5-porate, pores annulate, circular, 4 µm wide, 4 µm long, annuli 1–1.5 µm wide, 1 µm thick; intectate, nexine 0.5 – < 1.0 µm thick, exine thickening to 1 µm around pores; sculpture scabrate, scabrae 0.5 µm wide, < 1.0 µm long, 1–1.5 µm apart, circular in plane view, conical to subconical to rounded, blunted to pointed, irregular in shape, distributed sparsely, in large grains several elements of the sculpture resemble spines but always < 1.0 µm long. Dimensions: Equatorial diameter width 24 (30) 40 µm, SD 6.1; equatorial diameter length 26 (35) 45 µm, SD 6.3; equatorial diameter length/width 1.2, nm: 7; no: 19.

Comparisons: *Echistephanoporites alfonsi* LEIDELMEYER 1966 is smaller (18–19 µm), and has clearly defined spines, 1 µm long, *Nothofagidites* sp. 1 has lolongate pores and wider annuli (2 µm), *Nothofagidites flemingii* (COUPER 1953) POTONIÉ 1960 has more pores (7–9), exine is thicker (1 µm), and annuli are thicker (2–3 µm), *Polyatriopollenites* PFLUG 1953 in THOMSON & PFLUG 1953 is atriate (JANSONIUS & HILLS 1976).

Nothofagidites sp. 1

Plate 13, Figs. 22–23

Diagnosis: Scabrastephanoporate, mid-sized (24–38 µm), intectate 0.5–1.0 µm, pore lolongate, annulate, scabrae < 0.5 µm long, distributed sparsely.

Specimens: UFP 65, 18 × 92.7

Description: Monad, radial, isopolar, amb circular; stephanoporate, 4–5 pores, pores costate, lolongate, 1 µm wide, 5 µm long, costae 2 µm wide, 1 µm thick; intectate, nexine 0.5 – < 1.0 µm thick, thickening to 1 µm around pores; sculpture scabrate, scabrae 0.5–1.0 µm wide, < 0.5 µm long, 0.5–1.0 µm apart, circular in plane view, rounded, blunted, uniform, distributed sparsely. Dimensions: Equatorial diameter 28 (33) 38 µm; equatorial diameter length/width 1.1, nm: 3; no: 3.

Comparisons: *Echistephanoporites alfonsi* LEIDELMEYER 1966 is smaller (18–19 µm), and has clearly defined spines, 1 µm long, *Nothofagidites huertasii* n. sp. has circular pores and more narrow annuli (1–1.5 µm), *Verrustephanoporites* sp. 1 has longer sculpturing (> 0.5 µm), *Polyatriopollenites* PFLUG 1953 is atriate, *Nothofagidites flemingii* (COUPER 1953) POTONIÉ 1960 is larger (37–54 µm), convex between pores, has more pores (7–9), and more spaced granules (2–3 µm apart).

Genus *Paleosantalaceaepites* BISWAS 1962 ex DUTTA & SHA 1970

Paleosantalaceaepites distinctus n. sp.

Plate 13, Figs. 24–25

Diagnosis: Retitricolporate, mid-sized (35–41 µm), endocingulum costate, meridional colpi very short and indistinct, lumina decreasing from equator to poles

Specimens: Holotype UFP 17, 18.2 × 85.2, pl. 13, figs. 24–25

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After unique reticulate sculpturing that decreases from the equator to the poles.

Description: Monad, radial, isopolar, prolate; tricolporate, ectocolpi simple, CPi 0.3, very short, indistinct, endocingulum costate, 2 µm wide, borders straight, costae 3 µm wide, 1 µm thick; tectate, exine 0.5–1.0 µm thick, columellae barely distinct, < 0.5 µm wide, < 1.0 µm apart; sculpture reticulate, lumina 1 µm wide, angular, gradually finer toward equator to < 0.5 µm, muri < 1 µm. Dimensions: Equatorial diameter 23 (29) 37 µm; polar diameter 35 (39) 41 µm polar/equatorial diam. 1.3, nm: 3; no: 3.

Comparisons: KAR (1985) states that *Zonocostites* GERMERAAD et al. 1968 is a junior synonym of *Paleosantalaceaepites* BISWAS 1962 ex DUTTA & SHA 1970. However, all species of *Zonocostites* are consistently smaller (< 20 µm), more spherical, and with shorter colpi than *Paleosantalaceaepites* species (21–102 µm, oval to prolate, long to short colpi, SAMANT & PHADTARE 1997). Therefore, we consider necessary to keep separate both genera. *Paleosantalaceaepites reticulatus* SAMANT & PHADTARE 1997 is smaller (24–25 µm), and has a thicker exine (1.5 µm), *Retitricolporites costatus* LEIDELMEYER 1966 is smaller (25 µm) and has uniform and very fine reticula, *Stephanocolpites costatus* VAN DER HAMMEN 1954 is spherical, 5–6 colpate, and colpi are longer.

Genus *Parsonsidites* COUPER 1960

Parsonsidites? sp. 1

Plate 13, Figs. 26–27

Diagnosis: Psilapantoporate, small-sized (22 µm), circular, atectate (1 µm), pores 9, 3 in equator, the other 6 opposite to each other half-way equator-pole, slightly annulate.

Specimens: UFP 1, 16.8 × 91.5

Description: Monad, radial, isopolar, amb circular; pantoporate, nine pores, three arranged on equatorial plane, and remaining six opposite to each other half-way between equator and poles, pores annulate, lolongate, 2 µm wide, 3 µm long, annuli slightly distinct, < 1 µm wide, < 0.5 µm thick, non protruding; atectate, nexine 1 µm thick, slightly thickened around pores to 1.0–1.5 µm; sculpture psilate with a low density micropitting, lumina < 0.5 µm wide, 1–2 µm apart. Dimensions: Equatorial diameter 22 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: The pore distribution and atectate exine of *Parsonsidites*? sp. 1 has not been described in literature. It is placed provisionally in the genus *Parsonsidites* COUPER 1960 because of its low number of annulate pores and psilate sculpturing, *Parsonsidites* sp. 2 has 12 pores, and it is tectate, *Anacolosidites luteoides* COOKSON & PIKE 1954 has six pores, is tectate, and subtriangular in polar view, *Cretacaeiporites mulleri* HERNGREEN 1973 is tectate, larger (24–40 µm), has a scabrate pore membrane, and randomly arranged pores.

Parsonsidites sp. 2

Plate 13, Figs. 28–29

Diagnosis: Pantoporate, small-sized (26 µm), nexine thick, sexine very thin, pores 12, annulate, psilate.

Specimens: UFP 47, 15 × 107

Description: Monad, radial, isopolar, amb circular; pantoporate, 12 pores, 8–10 µm apart, pores annulate, circular, 2–3 µm wide, 2–3 µm long, annuli 1 µm wide, non protruding; tectate, exine 1.0–1.5 µm thick, nexine 1 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, columellae indistinct; sculpture psilate. Dimensions: Equatorial diameter 26 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: In *Juglanspollenites* pores are often absent on proximal hemisphere, less numerous (6–8), and exine is thin and commonly folded (JANSONIUS & HILLS 1976, card 1374), *Multiporopollenites pauciporatus* n. sp. has 18–23 pores, and micropitted sculpturing.

Genus *Perfotricolpites* GONZALEZ 1967

Perfotricolpites digitatus GONZALEZ 1967

Plate 13, Fig. 30

Diagnosis: Tricolpate, mid-sized (38 µm), reticulate finely, columellae digitate.

Specimens: UFP 41, 9.2 × 96.5

Description: Monad, radial, isopolar, prolate, amb circular; tricolpate, ectocolpi simple, long, strongly intruding, borders straight, ends pointed; tectate, exine 2 µm thick, nexine 0.5 µm thick, columellae 1 µm thick, tectum 0.5 µm thick, columellae digitate; sculpture micropitted, finely reticulated to micropitted, lumina < 0.5 µm wide. Dimensions: Equatorial diameter width 32 µm; equatorial diameter length 38 µm; equatorial diameter length/width 1.2, nm: 1; no: 2.

Affinities: Convolvulaceae, similar to *Merremia glabra, M. umbellata* (GERMERAAD et al. 1968), and *M. microcalyx* (MULLER 1981).

Genus *Periretisyncolpites* KEISER & JAN DU CHÊNE 1979

Periretisyncolpites giganteus KEISER & JAN DU CHÊNE 1979

Plate 13, Fig. 31

Diagnosis: Syncolpate, large-sized (110 µm), tectate 8 µm thick, ectocolpi marginate, reticulate, lumina of variable shapes and sizes, 4 µm long, muri 3–4 µm wide.

Specimens: UFP 86, 10 × 81.2

Description: Monad, radial, isopolar, triangular-obtuse-convex, usually splitted into three segments along apertures; syncolpate, ectocolpi marginate, lined by a thickened continuous tectum; tectate, exine 8 µm thick, nexine 3 µm thick, columellae 3 µm thick, tectum 2 µm thick, nexine structure microfibrous, micropitted, columellae 2–3.5 µm wide, supporting incomplete tectum that is forming a reticulum; sculpture reticulate, lumina of diverse shape and size, 4 µm long, muri 3–4 µm wide. Dimensions: Equatorial diameter 110 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: This species is very common in Late Cretaceous strata, and has not been reported in Eocene strata. It may be a reworked specimen.

Periretisyncolpites sp. 1

Plate 13, Figs. 32–34

Diagnosis: Syncolpate, large-sized (110–120 µm), reticula formed by a large lumina surrounded by several smaller lumina.

Specimens: UFP 5, 7 × 97.6

Description: Monad, grains probably splitted apart into three segments along apertures, no complete grain was found; syncolpate?, ectocolpi marginate, margines produced by thickening of tectum, 5 µm wide, tectum along margines is supported by a row of columellae; tectate, exine 12 µm thick, nexine 4 µm thick, columellae 6 µm thick, tectum 2 µm thick, nexine structure microfibrous, micropitted, lumina < 0.5 µm wide, very few columellae 4–6 µm wide, isolated or supporting a tectum; sculpture reticulate, reticula with an unique pattern formed by a large lumina, 12–17 µm wide, polygonal with rounded angles, surrounded by several smaller lumina, 1–4 µm wide, circular to ovoid, muri 2–3 µm wide. Dimensions: Equatorial diameter width 50 (70) 90 µm; equatorial diameter length 110 (115) 120 µm; equatorial diameter length/width 1.7, nm: 2; no: 6.

Comparisons: *Periretisyncolpites giganteus* KEISER & JAN DU CHÊNE 1979 has more even lumina, columellae more abundant, and size is smaller, *Periretisyncolpites magnosagenatus* (VAN HOEKEN-KLINKENBERG) KEISER & JAN DU CHÊNE 1979 has homogeneous lumina.

Genus *Perisyncolporites* GERMERAAD et al. 1968

Perisyncolporites pokornyi GERMERAAD et al. 1968

Plate 14, Fig. 1

Diagnosis: Syncolporate, mid-sized (23–25 µm), tectate, colpi arranged in a complex pattern, pores number < colpi, psilate.

Specimens: UFP 65, 6 × 94.5; UFP 43, 5.7 × 84.5

Description: Monad, radial, isopolar, spherical, amb circular, sometimes seems angular because of apertures; syncolporate, number of pores less than number of colpi in most of grains, sometimes sexine is lost and grains appear pantoporate, ectocolpi marginate, arranged in complex pattern, highly variable, borders straight, margines 2 µm wide, 1 µm thick, endopores costate, circular, 4 µm wide, 4 µm long, costae 1 µm wide, 0.5 µm thick; tectate, exine 3 µm thick, nexine 2 µm thick, columellae 0.5 µm thick, tectum 0.5 µm thick, columellae < 0.5 µm wide, tectum thickening at colpi margins; sculpture psilate. Dimensions: Equatorial diameter 23 (29) 35 µm, SD 3.5; equatorial diameter length/width 1, nm: 30; no: 148.

Affinities: Malpighiaceae (GERMERAAD et al. 1968).

Genus *Poloretitricolpites* n. gen.

Type species: *Poloretitricolpites absolutus* (GONZALEZ 1967) n. comb.

Diagnosis: Pollen grains free, isopolar, prolate to subprolate, tricolpate, colpi short, costate, exine thick, tectate, sculpture psilate at mesocolpia gradually becoming fine reticulate to foveolate at apocolpia.

Etymology: After reticulate sculpturing that is coarser toward the poles.

Comparisons: *Poloretitricolpites* is a new genus proposed to accommodate tricolpate pollen grains with a short costate colpi, and a coarse reticulation at the apocolpia decreasing gradually toward the mesocolpia. *Rousea* SRIVASTAVA 1969 has fine sculpturing, and is reticulate at the apocolpia and near the colpi margin becoming coarser at the mesocolpia. *Tricolpites* COOKSON ex COUPER 1953 emend. JARZEN &

DETTMANN 1989, *Salixipollenites* SRIVASTAVA 1967, and *Albertipollenites* SRIVASTAVA 1969 have reticulate sculpturing with equidimensional lumina over the entire grain. *Retitrescolpites* SAH 1967 has coarser reticulation.

Poloretitricolpites absolutus (GONZALEZ 1967) n. comb.

Plate 14, Figs. 2–3

Basionym = *Retitricolpites absolutus* GONZALEZ 1967, p. 31, pl. 1, figs. 8–8f.

Diagnosis: Tricolpate, mid-sized (27 µm), subprolate, exine thick, tectate, colpi short, costate, psilate at equator, foveolate-reticulate at poles.

Specimens: UFP 44, 4.8 × 104.4

Description: Monad, radial, isopolar, subprolate; tricolpate, colpi costate, CPi 0.35, short, borders straight, ends rounded, costae 1.0–1.5 µm wide, polar area large; tectate, exine 1.0–1.5 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, columellae indistinct; sculpture reticulate, equatorial zone psilate, gradually changing to foveolate-reticulate toward poles, lumina 0.5–1 µm wide. Dimensions: Equatorial diameter 27 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Retitricolpites* (VAN DER HAMMEN 1956b) PIERCE 1961 is invalid and a later synonym of *Neea* (JANSONIUS & HILLS 1976, card 2401). *Poloretitricolpites* is a new genus proposed to accommodate tricolpate pollen with short colpi, costate, and coarse reticulation at the apocolpia decreasing gradually toward the mesocolpia.

Genus *Propylipollis* MARTIN & HARRIS 1975

Propylipollis pseudocostatus n. sp.

Plate 14, Figs. 4–6

Diagnosis: Psilatriporate, triangular-acute-straight, mid-sized (27 µm), reticulation very fine, distributed evenly, costae segmented.

Specimens: Holotype UFP 34, 12.6 × 113, pl. 14, figs. 4–6

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After elongated branching ridges that form a costae-like pattern.

Description: Monad, radial, isopolar, amb triangular-acute-straight; triporate, ecto and endopores of similar shape and coinciding, pores semicostate, circular, 2 µm wide, 2 µm long, costae 5 µm wide formed by partial thickening of nexine around the pores producing a series of elongated branching ridges that radiated from pores; tectate, exine 1 µm thick, columellae indistinct; sculpture reticulate, finely reticulate to micropitted, distributed evenly, lumina 0.5 µm wide, circular, muri 0.5 µm wide. Dimensions: Equatorial diameter 27 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Proteacidites dehaani* GERMERAAD et al. 1968 has larger reticula, coarser at interporate fields, and continuous costae, *Proteacidites miniporatus* VAN HOEKEN-KLINKENBERG 1966 is scabrate, *Propylipollis amolosexinus* (DETTMANN & PLAYFORD 1968) DETTMANN & JARZEN 1996 is larger (35–56 µm), and exine is thinner (2–3 µm thick).

Affinities: Proteaceae subfm. Grevilloideae, *Knightia*? (DETTMANN & JARZEN 1996).

Genus *Proxapertites* VAN DER HAMMEN 1956a, emend. SINGH 1975

Proxapertites cursus VAN HOEKEN-KLINKENBERG 1966

Plate 14, Fig. 7

Diagnosis: Zonasulculate, mid to large-sized (29–60 µm), reticulation coarse and homogeneous.

Specimens: UFP 10, 12.8 × 108.5

Description: Monad, radial, anisopolar, amb circular, sulculus dividing grain in two slightly unequal parts; zonasulculate, sulculus irregularly bordered by narrow margin of thinning of sexine; tectate, exine 2–4 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5–1.0 µm thick, tectum 0.5–1.0 µm thick, columellae rounded to oval in plane view, > 0.5–1.0 µm wide; sculpture

reticulate, reticula coarse, lumina < 2 µm wide, variable in shape and size from rounded to oval, muri 1–1.5 µm wide. Dimensions: Equatorial diameter width 29 (37) 52 µm, SD 7.9; equatorial diameter length 30 (44) 60 µm, SD 7.6; equatorial diameter length/width 1.2, nm: 12; no: 385.

Comparisons: *Proxapertites operculatus* (Van der Hammen 1954) Van der Hammen 1956a has smaller lumina and a thinner exine.

Affinities: Palmae (Germeraad et al. 1968).

Proxapertites humbertoides (Van der Hammen 1954) Sarmiento 1992

Plate 14, Figs. 8–9

Diagnosis: Zonasulculate, large-sized (73–121 µm), foveolate, lumina 2–6 µm wide.

Specimens: UFP 76, 21 × 81.5; UFP 11, 14.7 × 90; UFP 32, 8.2 × 89; UFP 34, 6.2 × 100.2

Description: Monad, radial, anisopolar, amb elliptic circular, usually broken, sulculus separate grain into two slightly unequal parts; zonasulculate, sulculus simple; tectate, exine 4–6 µm thick, nexine 1.5 µm thick, columellae 2 µm thick, tectum 2 µm thick, exine very thick, usually tectum and columellae found separated from nexine, columellae 1–1.5 µm wide, rounded in plain view, 1–3 µm apart, sometimes fuse forming a infraridge that supports muri; sculpture foveolate to fossulate, lumina 0.5–1.0 µm deep, 2–6 µm wide, 3–5 µm apart, shaped unevenly, circular to elongated to star-like varying in same grain, occasionally perforating the whole extent of the tectum, muri simplicolumellate. Dimensions: Equatorial diameter width 60 (76) 90 µm, SD 10.6; equatorial diameter length 73 (102) 121 µm, SD 17.1; equatorial diameter length/width 1.3, nm: 8; no: 37.

Comparisons: *Proxapertites tertiaria* Van der Hammen & Garcia 1966 is larger (130 µm), *Proxapertites magnus* Muller et al. 1987 has smaller foveolae (> 0.5–1.5 µm wide), *Matanomadhiasulcites* Kar 1985 has a long sulcus but it is not zonasulculate.

Affinities: Annonaceae, similar to *Malmea* tribe (Muller 1981).

Proxapertites magnus Muller et al. 1987

Plate 14, Figs. 10–11

Diagnosis: Zonasulculate, large-sized (60–95 µm), foveolate, lumina < 1.5 µm

Specimens: UFP 53, 23 × 100; UFP 12, 6.2 × 84.5; UFP 7, 20.2 × 98.1

Description: Monad, radial, anisopolar, amb elliptic to circular, usually broken, sulculus separate grain into two slightly unequal parts; zonasulculate, sulculus simple; tectate, exine 3–4 µm thick, nexine 0.5 µm thick, columellae 2 µm thick, tectum 1.3 µm thick, usually tectum and columellae are found separated from nexine, columellae either 1–1.5 µm wide, rounded in plain view, or 3 µm long, 1 µm wide, elongated in plain view, arranged in irregular pattern, 1–2 µm apart; sculpture foveolate, lumina 0.5–1.0 µm deep, > 0.5–1.5 µm wide, 3–5 µm apart, circular to elongated even in same grain, sometimes perforating the whole extent of tectum. Dimensions: Equatorial diameter width 40 (54) 85 µm, SD 14.5; equatorial diameter length 60 (74) 95 µm, SD 9.2; equatorial diameter length/width 1.4, nm: 17; no: 160.

Comparisons: *Proxapertites tertiaria* Van der Hammen & Garcia 1966 is larger (130 µm), *Proxapertites humbertoides* (Van der Hammen 1954) Sarmiento 1992 has larger lumina (3–5 µm wide), *Matanomadhiasulcites* Kar 1985 has s long sulcus but it is not zonasulculate.

Proxapertites operculatus (Van der Hammen 1956a) Germeraad et al. 1968

Plate 14, Fig. 12

Diagnosis: Zonasulculate, mid-sized, reticulation fine, even.

Specimens: UFP 10, 4.9 × 84.1

Description: Monad, radial, anisopolar, amb circular, sulculus dividing grain in two slightly unequal parts; zonasulculate, sulculus irregularly bordered by narrow margin of thinning of sexine; tectate, exine 1–2 µm thick, nexine 0.5 µm thick, columellae < 0.5 µm thick, tectum < 0.5, columellae indistinct, rounded in plane view; sculpture reticulate, finely reticulate, lumina 0.5–1 µm wide, decreasing along the sulculus margin, muri 0.5–1 µm wide. Dimensions: Equatorial diameter 30 (41) 56 µm, SD 7.3; equatorial diameter length/width 1, nm: 13; no: 235.

Comparisons: *Proxapertites cursus* Van Hoeken-Klinkenberg 1966 has wider and less even lumina, and a thicker exine.

Affinities: Palmae (Germeraad et al. 1968).

Proxapertites psilatus Sarmiento 1992

Plate 14, Figs. 13–14

Diagnosis: Zonasulculate, mid-sized (25–37 µm), exine thin, tectate, 0.5 – < 1.5 µm thick, sculpture psilate, scabrate to micropitted.

Specimens: UFP 32, 19.1 × 91.5; UFP 41, 5.5 × 100.5

Description: Monad, radial, anisopolar, amb circular, sulculus divide grain in two slightly unequal parts; zonasulculate, sulculus simple; tectate, exine 0.5 – < 1.5 µm thick, exine very thin, columellae indistinct; sculpture scabrate to psilate to micropitted, diameter of elements < 0.5 µm, distributed evenly. Dimensions: Equatorial diameter width 20 (26) 31 µm, SD 2.9; equatorial diameter length 25 (30) 37 µm, SD 3.1; equatorial diameter length/width 1.2, nm: 16; no: 23.

Comparisons: *Proxapertites cursus* VAN HOEKEN-KLINKENBERG 1966 and *P. operculatus* (VAN DER HAMMEN 1954) VAN DER HAMMEN 1956a are larger, lumina are wider, and exine is thicker, *Proxapertites minutus* DUEÑAS 1980 is scabrate-verrucate at the polar areas.

Proxapertites verrucatus SARMIENTO 1992

Plate 14, Figs. 15–16

Diagnosis: Zonasulculate, mid-sized (27–35 µm), verrucate.

Specimens: UFP 76, 14.8 × 102.9; UFP 75, 10.5 × 97.1

Description: Monad, radial, anisopolar, amb circular; zonasulculate, sulculus simple, continuous, equatorial, dividing grain in two slightly unequal parts, borders irregular; tectate, exine 1.0–1.5 µm thick, nexine < 0.5 µm thick, columellae < 0.5 µm thick, tectum 0.5 µm thick, columellae indistinct; sculpture verrucate, verrucae 2–3 µm wide, < 0.5 µm long, scattered over the entire surface, surface interverrucae micropitted to scabrate. Dimensions: Equatorial diameter 27 (32) 35 µm, SD 3.9; equatorial diameter length/width 1.1, nm: 4; no: 4.

Genus *Psilabrevitricolpites* VAN HOEKEN-KLINKENBERG 1966

Psilabrevitricolpites sp. 1

Plate 14, Figs. 17–18

Diagnosis: Psilatricolpate, mid-sized (30 µm), atectate 0.5–1.0 µm thick, colpi very short, costate, psilate.

Specimens: UFP 5, 9.8 × 104

Description: Monad, radial, isopolar, amb triangular-acute-convex; tricolpate, ectocolpi costate, CEi 0.3, very short, costae 2 µm wide, surrounding entire length of colpi, slightly protruding; atectate, nexine 0.5–1.0 µm thick, nexine thickens near colpi; sculpture psilate. Dimensions: Equatorial diameter 30 µm; equatorial diameter length/width 1, nm: 1; no: 10.

Comparisons: *Lakiapollis* VENKATACHALA & KAR 1969 is brevitricolporate.

Genus *Psilabrevitricolporites* VAN DER KAARS 1983

Psilabrevitricolporites simpliformis VAN DER KAARS 1983

Plate 14, Figs. 19–20

Diagnosis: Psilatricolporate, mid-sized (26–32 µm), triangular-acute-convex, atectate 0.5–1.0 µm thick, colpi very short, pore costate, psilate to finely scabrate.

Specimens: UFP 6, 12 × 107.1; UFP 6, 10 × 106.1; UFP 7, 12.5 × 100.5

Description: Monad, radial, isopolar, amb triangular-acute-convex; tricolporate, ectocolpi simple, CEi 0.3, very short, ends pointed, endopores costate, lalongate, costae 1–2 µm wide, slightly protruding; atectate, nexine < 0.5 µm thick, very thin, thickening around pores to 0.5–1.0 µm, and at apocolpium giving a darker triangular appearance to polar area; sculpture psilate to finely scabrate. Dimensions: Equatorial diameter 26 (29.5) 32 µm, SD 2.5; equatorial diameter length/width 1.1, nm: 4; no: 5.

Comparisons: *Psilabrevitricolporites annulatus* SARMIENTO 1992 is smaller and has thick annuli.

Psilabrevitricolporites triangularis (VAN DER HAMMEN & WYMSTRA 1964) n. comb.

Plate 14, Fig. 21

Basionym = *Psilatricolporites triangularis* VAN DER HAMMEN & WYMSTRA 1964, p. 237, pl. 3, figs. 7–8.

1968 *Psilatricolporites triangularis* VAN DER HAMMEN & WYMSTRA, in GERMERAAD et al. 1968, p. 339–340, pl. 18, figs. 1–2.
1974 *Psilatricolporites triangularis* VAN DER HAMMEN & WYMSTRA, in REGALI et al. 1974, p. 282, pl. 16, fig. 13.
1986 *Psilatricolporites triangularis* VAN DER HAMMEN & WYMSTRA, in LORENTE 1986, p. 198, pl. 21, figs. 8.

Diagnosis: Psilatricolporate, small-sized (20–25 µm), triangular-obtuse-convex in polar view, pores conspicuously costate.

Specimens: UFP 49, 10.9 × 87.6

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi simple, CEi 0.3, short, borders straight, ends rounded, endopores costate, lalongate, 3 µm wide, 2 µm long, costae thick, 5 µm wide, 2 µm thick, protruding, producing a triangular shape in polar view; tectate, exine 1.0–1.5 µm thick, nexine 0.5 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, nexine thickening to 2 µm around pores, columellae indistinct; sculpture psilate. Dimensions: Equatorial diameter 25 (25) 25 µm; equatorial diameter length/width 1.1, nm: 2; no: 3.

Comparisons: *Psilatricolporites* VAN DER HAMMEN 1956b ex PIERCE 1961 is an obligate later synonym of *Tricolporites* VAN DER HAMMEN, 1954 (non ERDTMAN 1949) because they have the same type species; as the latter is invalid and a later synonym of *Clethra*, so is *Psilatricolporites* (JANSONIUS & HILLS 1976, card 2234). *Psilabrevitricolporites* VAN DER KAARS 1983 accommodates tricolporate psilate pollen grains, that have short colpi and are poricostate.

Psilabrevitricolporites sp. 1

Plate 14, Figs. 22–23

Diagnosis: Psilatricolporate, small-sized (19 µm), colpi very short, pore costate, psilate.

Specimens: UFP 40, 16 × 100.5

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi operculate, CEi 0.4, short, opercula narrow, 1 µm wide at equator, similar to colpi margins, endopores costate, lalongate, 4 µm wide, 1 µm long, costae very distinctive, 2 µm wide; tectate, exine 1.0–1.5 µm thick, nexine < 0.5 µm thick, columellae 0.5 µm thick, tectum < 0.5 µm thick, columellae very thin, < 0.5 µm thick; sculpture psilate slightly micropitted. Dimensions: Equatorial diameter 19 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Ranunculacidites operculatus* (VAN DER HAMMEN & WYMSTRA 1964) n. comb. has longer and marginate colpi, and the operculum is wider (1.5 µm).

Psilabrevitricolporites sp. 2

Plate 14, Figs. 24–25

Diagnosis: Psilatricolporate, triangular-obtuse-convex, small-sized (25 µm), atectate thin (0.5 µm), colpi midsize, pores costate.

Specimens: UFP 41, 9.7 × 87.8

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi simple, CEi 0.5, mid-sized, borders straight, ends pointed, polar area large, 10 µm wide, endopores costate, lalongate, 10 µm wide, 4 µm long, costae 2 µm wide, 1 µm thick, pores well defined; atectate, nexine 0.5 µm thick, very thin, thickening around pores to 1 µm; sculpture psilate. Dimensions: Equatorial diameter width 25 µm; equatorial diameter length 30 µm; equatorial diameter length/width 1.2, nm: 1; no: 1.

Comparisons: *Psilatricolporites marginatus* VAN DER KAARS 1983 has a thicker exine, is tectate, and colpi are costate, *Tetracolporopollenites*? sp. 2 is tectate, and has longer colpi that are slightly marginate, *Psilabrevitricolporites simpliformis* VAN DER KAARS 1983 has shorter colpi and is more triangular.

Genus *Psilamonocolpites* VAN DER HAMMEN & GARCIA 1966

Psilamonocolpites grandis (VAN DER HAMMEN 1954) VAN DER HAMMEN & GARCIA 1966

Plate 14, Figs. 26–27

Diagnosis: Monosulcate, mid to large-sized (30–60 µm long), atectate, exine 1 µm thick, sculpture psilate to micropitted.

Specimens: UFP 4, 5.5 × 88.2

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, sulcus simple, CEi 0.85, long, borders straight to slightly irregular, ends rounded to slightly tapering; atectate, nexine 1 µm thick; sculpture psilate-micropitted. Dimensions: Equatorial diameter width 20 (32) 42 µm, SD 7.3; equatorial diameter length 30 (44) 60 µm, SD 7.6; equatorial diameter length/width 1.4, nm: 21; no: 77.

Comparisons: VAN DER HAMMEN & GARCIA (1966) separates *P. grandis* from other three species of *Psilamonocolpites* on the basis of size. An overlap in sizes was found between *P. medius* and *P. grandis*. *P. grandis* is retained here, however, because of its distinctive thick exine (1 µm), thicker than that of *P. medius* (< 0.5 µm).

Psilamonocolpites medius (VAN DER HAMMEN 1954) VAN DER HAMMEN & GARCIA 1966

Plate 14, Figs. 28–29

Diagnosis: Psilamonosulcate, mid-sized (29–50 µm), atectate, exine < 0.5 µm thick, sculpture psilate to micropitted.

Specimens: UFP 11, 14 × 112.1

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, sulcus simple, CEi 0.9, long, borders straight to slightly irregular, ends rounded to slightly tapering; atectate, nexine < 0.5 µm thick; sculpture psilate-micropitted. Dimensions: Equatorial diameter width 20 (25.5) 38 µm, SD 4.3; equatorial diameter length 29 (35) 50 µm, SD 6.0; equatorial diameter length/width 1.4, nm: 41; no: 142.

Comparisons: VAN DER HAMMEN & GARCIA (1966) separates *P. medius* from other three species of *Psilamonocolpites* on the basis of size. Here it was found that there is an overlap in size between *P. medius* and *P. grandis*. However, *P. medius* is retained here because its distinctive thin exine (< 0.5 µm).

Genus *Psilastephanocolpites* LEIDELMEYER 1966

The definition of genus *Psilastephanocolpites* is very loose (psilate, stephanocolpate pollen grains). We think that it is a completely artificial genus and a nomenclatural wastebasket as it stands now. We hope that future taxonomic revisions of this group solve this problem.

Psilastephanocolpites sp. 1

Plate 15, Figs. 1–3

Diagnosis: Psilastephanocolpate, mid-sized (53 µm), atectate 1 µm thick, colpi marginate.

Specimens: UFP 49, 15 × 105

Description: Monad, radial, isopolar, amb rectangular; stephanocolpate, 4-colpate, colpi marginate, CEi 0.4, mid-sized, borders irregular, ends pointed, margines 2 µm wide, produced by thinning of exine, polar area large, 26 µm wide; atectate, nexine 1 µm thick, exine thinning around colpi to < 0.5 µm, sculpture psilate. Dimensions: Equatorial diameter 53 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Psilastephanocolpites maia* LEIDELMEYER 1966 is tectate, has a thicker exine (1.8 µm), and is smaller (27 µm).

Psilastephanocolpites sp. 2

Plate 14, Figs. 30–31

Diagnosis: Stephanocolpate, small-sized (29 µm), tectate 0.5–1.0 µm thick, colpi very short, costate, micropitted densely.

Specimens: UFP 41, 15.5 × 110

Description: Monad, radial, isopolar, amb circular; stephanocolpate, colpi costate, CEi 0.2, very short, borders straight, ends rounded, costae 1 µm wide, 0.5 µm thick, non protruding; tectate, exine 0.5–1.0 µm thick, nexine thickening around colpi, columellae barely distinct, very thin; sculpture micropitted, lumina < 0.5 µm wide, distributed densely over entire grain, muri < 1.0 µm. Dimensions: Equatorial diameter 29 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Psilastephanocolpites maia* LEIDELMEYER 1966 has a thicker exine (> 1.5 µm), and longer colpi.

Genus *Psilastephanocolporites* LEIDELMEYER 1966

Psilastephanocolporites brevicolpatus n. sp.

Plate 15, Figs. 4–6

Diagnosis: Psilastephanocolporate, mid-sized (26–28 µm), tectate 0.5–1.0 µm thick, ectocolpi meridional, very short, 10–14, endocingulum costate.

Specimens: Holotype UFP 41, 6.9 × 109.5, pl. 15, figs. 4–5; paratype UFP 43, 8 × 90.9, pl. 15, fig. 6

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After short colpi.

Description: Monad, radial, isopolar, spherical to subprolate to suboblate, stephanocolporate, 10–14 colporate, ectocolpi meridional simple, CEi 0.35, short, borders straight, ends rounded, endocingulum costate, costae 6 µm wide, 0.5 µm thick, borders straight; tectate, exine 0.5–1.0 µm thick, nexine thickening around endocingulum, columellae thin, in some cases indistinct; sculpture psilate. Dimensions: Equatorial diameter 26 (27) 28 µm; equatorial diameter length/width 1, nm: 3; no: 4.

Comparisons: *Psilastephanocolporites fissilis* LEIDELMEYER 1966 has meridional colpi almost reaching the polar areas, and a thicker exine (2 µm), *Psilastephanocolpites globulus* VAN DER KAARS 1983 has only 4 colpi, costa is thicker (2 µm), and the exine is atectate, *Psilastephanocolporites globulus* VAN HOEKEN-KLINKENBERG 1966 does not have equatorial colpi.

Psilastephanocolporites fissilis LEIDELMEYER 1966

Plate 15, Figs. 7–9

Diagnosis: Psilastephanocolporate, mid-sized (22–32 µm), prolate, atectate 1.5–2.5 µm thick, ectocolpi meridional very long, endocingulum costate, costae 0.5–2 µm thick

Specimens: UFP 37, 11.6 × 108.2; UFP 35, 9.4 × 98.5; UFP 43, 12.4 × 109.5

Description: Monad, radial, isopolar, prolate, amb circular; stephanocolporate, 8–12 colporate, ectocolpi meridional simple, CPi 0.91, long, almost reaching poles, borders straight, ends pointed, polar area small, 6 µm wide, endocingulum costate, costae 5 µm wide, 0.5–2 µm thick; atectate, nexine 1.5–2.5 µm thick, thickening around endocingulum; sculpture psilate. Dimensions: Equatorial diameter 22 (27) 32 µm, SD 4.3; equatorial diameter length/width 1.1, nm: 4; polar diameter 35 (39) 41 µm, polar/equatorial diam. 1.7, nm: 3; no: 7.

Comparisons: *Psilastephanocolporites brevicolpatus* n. sp. has meridional colpi that are shorter, and a thinner exine (< 1 µm).
Affinities: Polygalaceae (LORENTE 1986).

Genus *Psilastephanoporites* REGALI et al. 1974 ex HOORN 1993

Psilastephanoporites sp. 1

Plate 15, Figs. 10–11

Diagnosis: Psilastephanoporate, large-sized (42 µm), atectate 1.2 µm thick, 4-porate, annulate.
Specimens: UFP 82, 16.2 × 86.9
Description: Monad, radial, isopolar, amb rectangular; stephanoporate, 4-porate, pores annulate, lolongate, 4 µm wide, 7 µm long, annuli 5 µm wide, 3 µm thick, protruding; atectate nexine 1.0–1.5 µm thick, thickening to 3 µm around pores; sculpture psilate. Dimensions: Equatorial diameter 42 µm; equatorial diameter length/width 1, nm: 1; no: 1.
Comparisons: *Psilastephanoporites caribiensis* DUEÑAS 1980 is smaller (26–31 µm) and tectate, *Psilastephanoporites stellatus* REGALI et al. 1974 has 6 pores in two groups of three, *Psilastephanoporites* sp. 2 has a thinner exine (0.5 µm), and annuli are narrower (2 µm), thinner (1 µm), and pores are intruding.

Psilastephanoporites sp. 2

Plate 15, Figs. 12–13

Diagnosis: Stephanoporate, mid-sized (31 µm), atectate (0.5 µm), 4-porate, pore intruding, annulate, scabrate in poles, psilate in equator.
Specimens: UFP 19, 10.5 × 101.2
Description: Monad, radial, isopolar, amb circular; stephanoporate, 4-porate, ecto and endopore of similar shape and coinciding, pores annulate, circular, 4 µm wide, 4 µm long, intruding, annuli 2 µm wide, 1 µm thick, non-protruding; atectate, nexine 0.5 µm thick, thickening to 1.5 µm around pores; sculpture psilate-scabrate, scabrae < 0.5 µm wide, < 0.5 µm long, distributed irregularly, densely at poles and decreasing toward equator where grain is psilate. Dimensions: Equatorial diameter 31 µm; equatorial diameter length/width 1, nm: 1; no: 1.
Comparisons: *Psilastephanoporites caribiensis* DUEÑAS 1980 is tectate, and exine is thicker (1.5 µm), *Psilastephanoporites stellatus* REGALI et al. 1974 has 6 pores in two groups of three, *Psilastephanoporites* sp. 1 has a thicker exine (1.0–1.5 µm), annuli are wider (5 µm), thicker (3 µm) and protruding, *Psilastephanoporites tesseroporus* REGALI et al. 1974 is larger (42–56 µm), pores are wider (8 µm), exine is thicker (1 µm) and psilate.

Genus *Psilasyncolporites* LEIDELMEYER ex GONZALEZ 1967

Psilasyncolporites sp. 1

Plate 15, Figs. 14–15

Diagnosis: Psilasyncolporate, mid-sized (29 µm), tectate 2 µm thick, sexine thick (1.0–1.5 µm), columellae indistinct, pores costate, fastigiate, apocolpial field 10 µm wide.
Specimens: UFP 57, 19.5 × 111.1
Description: Monad, radial, isopolar, amb triangular-acute-convex; syncolporate, ectocolpi simple, distinct, borders straight, polar area 10 µm wide, endopores costate fastigiate, lalongate, 6 µm wide, 2 µm long, pore borders indistinct, costae 3 µm wide, 1 µm thick, fastigia 6 µm wide, 2 µm long; tectate, exine 2 µm thick, nexine 1.0–1.5 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, exine slightly thickening toward colpi, columellae indistinct, fastigia formed by separation of endexine from foot layer; sculpture psilate faintly scabrate. Dimensions: Equatorial diameter 29 µm; equatorial diameter length/width 1, nm: 1; no: 3.
Comparisons: *Syncolporites poricostatus* VAN HOEKEN-KLINKENBERG 1966 has a thinner exine (1.2 µm) and it is smaller (14.5 µm).

Psilasyncolporites sp. 2

Plate 15, Figs. 16–17

Diagnosis: Psilasyncolporate, small-sized (13 µm), tectate 1 µm thick, columellae distinct, colpi costate, poricostate, apocolpial field absent.
Specimens: UFP 42, 12.8 × 89.5
Description: Monad, radial, isopolar, amb triangular-obtuse-convex; syncolporate, ectocolpi costate, straight, costae 0.5 µm wide, faint, apocolpial field absent, endopores costate, circular, 1.5 µm wide, 1.5 µm long, pore borders indistinct, costae 2 µm wide, 1 µm thick; tectate, exine 1 µm thick, nexine thickening to 1 µm around pores and colpi, columellae distinct, < 0.5 wide and apart; sculpture psilate. Dimensions: Equatorial diameter 13 µm; equatorial diameter length/width 1, nm: 1; no: 1.
Comparisons: *Syncolporites poricostatus* VAN HOEKEN-KLINKENBERG 1966 has fastigiate pores and simple colpi, *Syncolporites incomptus* VAN HOEKEN-KLINKENBERG 1964 is larger (20–23 µm) and apertures are simple, *Psilasyncolporites parcus* GONZALEZ 1967 has a thinner exine (< 1 µm) and simple pores.

Genus *Racemonocolpites* GONZALEZ 1967

Racemonocolpites facilis GONZALEZ 1967

Plate 15, Fig. 18

Diagnosis: Gemmamonosulcate, mid-sized (35–50 µm), intectate, gemmae 3–4 µm long, distributed densely over the entire grain, surface intergemmae slightly scabrate.

Specimens: UFP 84, 13.9 × 104.4; UFP 86, 13.5 × 83.5; UFP 46, 13.2 × 105.9

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus simple, CEi 0.9, long, often obscured by ornamentation; intectate, nexine 0.5 µm thick; sculpture gemmate, gemmae, 3–4 µm long, 3 µm wide and long, distributed densely, shaped irregularly, from gemmae perfect, to clavae short, to verrucae, to spines blunted, surface intergemmae slightly scabrate. Dimensions: Equatorial diameter width 23 (28) 33 µm, SD 3.7; equatorial diameter length 35 (43) 50 µm, SD 6.7; equatorial diameter length/width 1.5, nm: 5; no: 7.

Affinities: Palmae, *Iriartea* type (MULLER 1981).

Racemonocolpites racematus (VAN DER HAMMEN 1954) GONZALEZ 1967

Plate 15, Figs. 19–20

Diagnosis: Gemmamonosulcate, mid-sized (36–50 µm), intectate 0.5 µm thick, gemmae 1.5–2 µm long, distributed densely over entire grain.

Specimens: UFP 7, 8.2 × 85.7; UFP 53, 16.2 × 99.4; UFP 82, 14.7 × 111

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus simple, CEi 0.8, long, borders irregular, obscured by sculpture; intectate, nexine 0.5 µm thick; sculpture gemmate, gemmae small, 1.5–2 µm long, 1.5–2 µm wide, circular in plane view and cross section, distributed densely. Dimensions: Equatorial diameter width 22 (28) 34 µm; equatorial diameter length 36 (43) 50; equatorial diameter length/width 1.6, nm: 2; no: 2.

Affinities: Palmae, *Iriartea* type (MULLER 1981).

Racemonocolpites sp. 1

Plate 15, Figs. 21–22

Diagnosis: Gemmamonosulcate, mid-sized (43–50 µm), intectate 0.5 µm thick, sulcus costate, gemmae 1–1.5 µm long, distributed densely over the entire grain.

Specimens: UFP 32, 9.9 × 93.5; UFP 47, 9.3 × 106

Description: Monad, bilateral, anisopolar, amb elliptic; monosulcate, ectosulcus costate, CEi 0.35, costae 1 µm wide; intectate, nexine 0.5 µm thick, thickening around colpus; sculpture gemmate, gemmae small, 1.5–2 µm wide, 1.5–2 µm long, circular in plane view and cross section, distributed densely over the entire grain. Dimensions: Equatorial diameter width 30 (36) 48 µm; equatorial diameter length 43 (45) 50 µm; equatorial diameter length/width 1.3, nm: 3; no: 3.

Comparisons: *Racemonocolpites racematus* (VAN DER HAMMEN 1954) GONZALEZ 1967 is very similar but has a longer sulcus (CEi 0.8) that lacks costa.

Genus *Ranunculacidites* SAH 1967

Ranunculacidites operculatus (VAN DER HAMMEN & WYMSTRA 1964) n. comb.

Plate 15, Fig. 23

Basionym = *Psilatricolporites operculatus* VAN DER HAMMEN & WYMSTRA 1964, p. 236–237, pl. 1, fig. 13.

1968 *Psilatricolporites operculatus* VAN DER HAMMEN & WYMSTRA, in GERMERAAD et al. 1968, p. 328–330, pl. 15, fig. 3.
1974 *Psilatricolporites operculatus* VAN DER HAMMEN & WYMSTRA, in REGALI et al. 1974, p. 282, pl. 16, fig. 3.
1986 *Psilatricolporites operculatus* VAN DER HAMMEN & WYMSTRA, in LORENTE 1986, p. 196, pl. 21, fig. 3.

Diagnosis: Tricolporate, small-sized (18–21 µm), psilate-micropitted, operculate.

Specimens: UFP 40, 9.8 × 84.6

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi operculate, CEi 0.6, long, opercula 1 µm wide at equator, endopores simple, lalongate, pores distinct only in equatorial view; tectate, exine 1 µm thick; sculpture psilate-micropitted. Dimensions: Equatorial diameter 18 (18.5) 19 µm; equatorial diameter length/width 1, nm: 2; no: 2.

Comparisons: *Psilatricolporites* VAN DER HAMMEN 1956b ex PIERCE 1961 is an obligate later synonym of *Tricolporites* VAN DER HAMMEN 1954 (non ERDTMAN 1949) because they have the same type species; as the latter is invalid and a later synonym of *Clethra*, so is *Psilatricolporites* (JANSONIUS & HILLS card 2234). *Ranunculacidites* SAH 1967 accommodates small psilate tricolporate grains, with an operculum.

Affinities: Euphorbiaceae, similar to *Alchornea* (GERMERAAD et al. 1968).

Genus *Retibrevitricolpites* VAN HOEKEN-KLINKENBERG 1966

Retibrevitricolpites retibolus LEIDELMEYER 1966

Plate 15, Figs. 24–25

1966 *Retibrevitricolpites retibolus* LEIDELMEYER 1966, p. 53, pl. 2, fig. 4.
1967 *Retibrevitricolpites increatus* GONZALEZ 1967, p. 35, pl. 12, figs. 9–9a.
1967 *Retibrevitricolpites catatumbus* GONZALEZ 1967, p. 36, pl. 12, figs. 8–8b.

Diagnosis: Retibrevitricolp(or)ate, small (13–20 µm), tectate, pores costate, reticula uniform, lumina 0.5 µm wide.

Specimens: UFP 40, 8.5 × 111.7; UFP 40, 16 × 96

Description: Monad, radial, isopolar, spherical, amb circular; tricolporate or tricolpate, ectocolpi simple, CEi 0.2, very short, borders straight, ends pointed, polar area large, 12 µm wide, endopores costate, lalongate, 3 µm wide, 1 µm long, costae 1 µm wide, < 0.5 µm thick; semitectate, exine 1 µm thick, nexine thickening around pores, columellae distinct, < 1.0 µm wide; sculpture reticulate, lumina 0.5 µm, angular, uniform, distributed densely over entire grain, muri < 1.0 µm. Dimensions: Equatorial diameter 13 (14) 15 µm; equatorial diameter length/width 1, nm: 2; polar diameter 16 µm, polar/equatorial diam. 1, nm: 1; no: 6.

Comparisons: *Retibrevitricolpites increatus* GONZALEZ 1967 and *Retibrevitricolpites catatumbus* GONZALEZ 1967 are junior synonyms of *R. retibolus* LEIDELMEYER 1966

Retibrevitricolpites triangulatus VAN HOEKEN-KLINKENBERG 1966

Plate 15, Figs. 26–27

Diagnosis: Retibrevitricolp(or)ate, small-sized (17–26 µm), reticulate lumina decrease from equator to poles, colpi marginate, pores fastigiate.

Specimens: UFP 84, 10.6 × 92.9; UFP 38, 17.9 × 102.9

Description: Monad, radial, isopolar, amb triangular-acute-convex; tricolp(or)ate, ectocolpi marginate, CEi 0.2, very short, borders straight, ends pointed, margines 1 µm wide produced by thickening of tectum polar area large, 12 µm wide, endopores fastigiate, lalongate, 6 µm wide, 1 µm long, fastigia 4 µm wide, 1 µm long; semitectate, exine 1.5 µm thick, nexine 0.5 µm thick, columellae 0.5 µm thick, tectum 0.5 µm thick, columellae distinct, 0.5 µm wide, tectum thickening to 1 µm around colpi; sculpture reticulate, lumina 1.5 µm wide, angular, foveolate at apocolpia, 0.5 µm wide, muri 0.5 µm wide. Dimensions: Equatorial diameter 17 (19) 20 µm, SD 1; equatorial diameter length/width 1.1, nm: 6; no: 7.

Retibrevitricolpites? sp. 1

Plate 15, Figs. 28–29

Diagnosis: Retibrevitricolpate, mid-sized (29–33 µm), colpi costate, micropitted to finely reticulate, lumina 0.5 µm wide, uniform.

Specimens: UFP 49, 17.9 × 80.8

Description: Monad, radial, isopolar, amb circular; tricolpate, colpi costate, CEi 0.25, very short, borders straight, ends pointed, costae 3 µm wide, 1.5 µm thick, non-protruding, polar area large, 18 µm wide; tectate, exine 1.5 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, nexine thickening to 1.5–2.0 µm around colpi, columellae indistinct; sculpture micropitted to finely reticulate, lumina 0.5 µm wide, circular, uniform, distributed densely over entire body, muri < 1 µm wide. Dimensions: Equatorial diameter 29 (31) 33 µm; equatorial diameter length/width 1.1, nm: 2; no: 2.

Comparisons: This species cannot be placed satisfactorily in any existing genus. The species is placed provisionally in *Retibrevitricolpites* because of its very short colpi, but it is much larger than all of *Retibrevitricolpites* species. *Retibrevitricolporites speciosus* n. sp. does not have uniform lumina, *Retibrevitricolporites grandis* n. sp. has costate pores, and wider lumina (0.5 – < 1.0), *Retibrevitricolpites* sp. 2 has a thinner exine (1 µm), wider lumina (> 0.5–1.0 µm) and wider costae (3 µm).

Retibrevitricolpites sp. 2

Plate 15, Figs. 30–31

Diagnosis: Retibrevitricolpate, mid-sized (22–30 µm), tectate, exine slightly thinning near colpi, colpi costate, lumina of reticulum slightly increasing toward mesocolpia.

Specimens: UFP 58, 19.2 × 104; UFP 40, 3.2 × 114.5

Description: Monad, radial, isopolar, amb circular to triangular-obtuse-convex; tricolpate, ectocolpi costate, CEi 0.2, very short, borders indistinct, ends pointed, costae 3 µm wide, distinct, polar area large, 15 µm wide; tectate, exine 1 µm thick, columellae slightly distinct, sexine slightly thinning near colpi to 0.5–1.0 µm; sculpture reticulate, lumina > 0.5–1.0 µm wide, angular, slightly increasing toward mesocolpia, distributed densely, muri 0.5 µm wide. Dimensions: Equatorial diameter 22 (26) 30 µm; equatorial diameter length/width 1, nm: 2; no: 4.

Comparisons: *Retibrevitricolpites distinctus* VAN HOEKEN-KLINKENBERG 1966 is smaller (13 µm), and lumina decrease toward the mesocolpium, *Retibrevitricolpites triangulatus* VAN HOEKEN-KLINKENBERG 1966 has fastigiate pores, *Retibrevitricolpites retibolus* LEIDELMEYER 1966 is smaller (15–20 µm), and has costate pores.

Genus *Retibrevitricolporites* LEGOUX 1978

Retibrevitricolporites grandis n. sp.

Plate 15, Figs. 32–33

Diagnosis: Retibrevitricolporate, mid-sized (26–50 µm), pore costate, lumina 0.5–1.0 wide, uniform.

Specimens: Holotype UFP 33, 14.9 × 111.5, pl. 15, figs. 32–33; paratype UFP 49, 21.4 × 81

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After large grain-size.

Description: Monad, radial, isopolar, subprolate, amb elliptic to circular; tricolporate, ectocolpi simple, CEi 0.3, very short, borders straight, ends pointed, polar area large, 20 µm wide, endopores costate, lalongate, 2 µm wide, 1 µm long, pores indistinct, costae 4 µm wide, 2 µm thick; semitectate, exine 1 µm thick, nexine thickening to 2 µm around pores, columellae distinct, 0.5 µm wide; sculpture reticulate, lumina 0.5–1.0 µm wide, circular, uniform, distributed densely over entire body, muri < 1 µm wide, when grain is degraded sculpture appears scabrate or verrucate. Dimensions: Equatorial diameter length 26 (34) 50 µm, SD 5.4; equatorial diameter length/width 1.1, nm: 58; polar diameter 31 µm, polar/equatorial diam. 1.1, nm: 1; no: 127.

Comparisons: *Retibrevitricolporites speciosus* n. sp. does not have uniform lumina.

Retibrevitricolporites speciosus n. sp.

Plate 15, Figs. 34–36

Diagnosis: Retibrevitricolporate, small to mid-sized (21–30 µm), colpi marginate, pore costate, lumina decrease from equatorial intercolpial areas to poles and colpi, inner spherical body present.

Specimens: Holotype UFP 32, 3.9 × 82.1, pl. 15, figs. 34–36

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After splendid sculpture pattern.

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi marginate, CEi 0.25, very short, borders straight, ends pointed, margines 2 µm wide produced by thinning of columellae, polar area large, 19 µm wide, endopores costate, lalongate, 3 µm wide, 1 µm long, pores indistinct, costae 2 µm wide, 2 µm thick; semitectate, exine 1.0–1.5 µm thick, nexine thickening to 2 µm around pores, columellae distinct, 0.5–1.0 µm wide, most of grains posses an inner spherical body separated from exine; sculpture reticulate, lumina 1–2 µm wide, angular at mesocolpia, fine reticulate to foveolate at apocolpia and near colpi (0.5–1.0 µm wide), muri 1 µm wide, transition between both types of reticulation rather abrupt and forming a triangle. Dimensions: Equatorial diameter 21 (25.5) 30 µm, SD 2.2; equatorial diameter length/width 1, nm: 13; no: 17.

Comparisons: *Retibrevitricolpites distinctus* VAN HOEKEN-KLINKENBERG 1966 is smaller (13 µm), and tectum thickens around the colpi, *Retibrevitricolpites triangulatus* VAN HOEKEN-KLINKENBERG 1966 has vestibulate pores, and marginate colpi produced by thickening of the tectum.

Genus *Retidiporites* VARMA & RAWAT 1963

Retidiporites elongatus SARMIENTO 1992

Plate 16, Figs. 1–2

Diagnosis: Retidiporate, ellipsoid, mid-sized (30 µm), lumina of reticula decreasing toward pores.

Specimens: UFP 15, 7.4 × 79.5

Description: Monad, bilateral, isopolar, amb elliptic; diporate, ecto and endopores of similar shape and coinciding, pores circular, 10 µm wide, 8 µm long; semitectate, exine 1 µm thick, columellae distinct, 1 µm wide; sculpture reticulate, reticulation uneven, near pores finer, lumina variable in shape in same grain (circular, elongated, and polygonal with rounded borders), 1–2 µm wide in mid part of grain, 0.5–1 µm near pores, muri < 0.5–1 µm wide. Dimensions: Equatorial diameter 30 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Retidiporites magdalenensis VAN DER HAMMEN & GARCIA 1966

Plate 16, Fig. 3

Diagnosis: Retidiporate, ellipsoid, mid-sized (27–40 µm), tectate, pore simple, reticulate evenly.

Specimens: UFP 4, 18.6 × 95

Description: Monad, bilateral, isopolar, amb elliptic; diporate, ecto and endopores of similar shape and coinciding, pores simple, circular, 8 µm wide, 8 µm long; tectate, exine 1.0–1.5 µm thick, columellae distinct, < 0.5 wide; sculpture reticulate, lumina < 0.5–2 µm wide, muri < 0.5–1 µm wide, homogeneous, occasionally slightly finer near pores. Dimensions: Equatorial diameter width 19 (23) 32 µm, SD 3.05; equatorial diameter length 27 (31.5) 40 µm, SD 3.3; equatorial diameter length/width 1.3, nm: 21; no: 82.

Affinities: Proteaceae, similar to *Banksia collina*, *Dryanda longifolia* (GERMERAAD et al. 1968).

Retidiporites poricostatus n. sp.

Plate 16, Figs. 4–6

Diagnosis: Diporate, rectangular, mid-sized (41 µm), pore costate, foveoreticulate, lumina coarser near pores.

Specimens: Holotype UFP 8, 3.9 × 90.4, pl. 16, figs. 4–6

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After costae surrounding pore.

Description: Monad, bilateral, isopolar, amb rectangular; diporate, ecto and endopores of similar shape and coinciding, pores costate, lalongate, 11 µm wide, 8 µm long, border well defined, costae distinct, 6 µm wide, 1 µm thick; tectate, exine 0.5–1.0 µm thick, exine thickening near pores to < 1.5 µm, columellae indistinct, distinct near pores; sculpture foveoreticulate, lumina 1–1.5 µm wide near pores gradually diminishing to 0.5 µm at center of grain, shaped unevenly, elongated to circular, muri 0.5–1 µm wide. Dimensions: Equatorial diameter width 23 µm; equatorial diameter length 41 µm; equatorial diameter length/width 1.9, nm: 1; no: 1.

Comparisons: *Retidiporites magdalenensis* VAN DER HAMMEN & GARCIA 1966 has simple pore, and reticulum is evenly distributed, *Retidiporites elongatus* SARMIENTO 1992 has lumina that decreases near pores.

Genus *Retipollenites* GONZALEZ 1967

Retipollenites sp. 1

Plate 16, Figs. 7–8

Diagnosis: Inaperturate, mid-sized (40 µm), tectum 4 µm thick, reticulate, lumina 4–8 µm wide, nexine densely baculate.

Specimens: UFP 5, 14 × 82.7

Description: Monad, amb elliptic; inaperturate; semitectate, exine 4 µm thick, nexine 1 µm thick, columellae 2 µm thick, tectum 1 µm thick, columellae 1 µm wide, 2–4 µm apart, distributed sparsely; sculpture reticulate, lumina wide, 4–8 µm, muri 1.5 µm wide, simplicolumellate, nexine baculate, 1 µm long, bacula slender, distributed densely over entire grain. Dimensions: Equatorial diameter width 26 µm; equatorial diameter length 40 µm; equatorial diameter length/width 1.5, nm: 1; no: 1.

Comparisons: *Spirosyncolpites spiralis* GONZALEZ 1967 has a scabrate nexine and apertures, *Retipollenites confusus* GONZALEZ 1967 lacks a densely baculate nexine.

Retipollenites sp. 2

Plate 16, Figs. 9–10

Diagnosis: Inaperturate, large-sized (100 µm), tectum very thick, nexine micropitted, reticulate, simplicolumellate, lumina 8–13 µm wide.

Specimens: UFP 16, 12.3 × 110.5

Description: Monad, amb elliptic; inaperturate; semitectate, exine 8.5 µm thick, nexine 1.5 µm thick, columellae 5 µm thick, tectum 2 µm thick, columellae very sparse supporting tectum, most columellae free from tectum standing like isolated bacula, and rarely gemmae; sculpture reticulate, lumina broad, 8–13 µm wide, muri 3 µm wide, simplicolumellate, nexine micropitted, lumina < 0.5 µm wide. Dimensions: Equatorial diameter width 70 µm; equatorial diameter length 100 µm; equatorial diameter length/width 1.4, nm: 1; no: 1.

Comparisons: *Spirosyncolpites spiralis* GONZALEZ 1967 is smaller and nexine is scabrate, *Retipollenites confusus* GONZALEZ 1967 is smaller (48–85 µm), and exine is thinner (5 µm) (VENKATACHALA et al. 1988).

Genus *Retistephanocolpites* LEIDELMEYER 1966

Retistephanocolpites angeli LEIDELMEYER 1966

Plate 16, Figs. 11–12

Diagnosis: Retistephanocolpate, mid-sized (40–58 µm), colpi short, costate, reticula uniform, lumina 1–1.5 µm wide.

Specimens: UFP 7, 20.3 × 101.2

Description: Monad, radial, isopolar, amb circular; stephanocolpate, ectocolpi costate, CEi 0.3, short, borders straight, ends pointed, costae 3 µm wide, 1 µm thick, polar area large, 35 µm wide; semitectate, exine 2 µm thick, nexine 0.5 µm thick, columellae 1 µm thick, tectum 0.5 µm thick, nexine thickening around colpi to 1 µm, columellae distinct, 0.5–1.0 µm wide; sculpture reticulate, lumina 1–1.5 µm wide, angular, elongated, uniform, distributed densely, muri < 1.0 µm. Dimensions: Equatorial diameter 40 (49) 58 µm, SD 6.7; equatorial diameter length/width 1.1, nm: 5; no: 10.

Retistephanocolpites fossulatus n. sp.

Plate 16, Figs. 13–15

Diagnosis: Retistephanocolpate, mid-sized (30–55 µm), 6–8 colpate, colpi very short, sculpture reticulate-foveolate at poles, fossulate at equator.

Specimens: Holotype UFP 39, 15 × 94, pl. 16, figs. 13–15; paratype UFP 41, 5.4 × 92.8

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After fossulate sculpturing.

Description: Monad, radial, isopolar, amb polygonal-obtuse-convex; stephanocolpate, six to eight colpate, ectocolpi simple, CEi 0.2, very short, indistinct, polar area very large, 44 µm wide; tectate, exine 6 µm thick, nexine 2–3 µm thick, columellae 2.0–2.5 µm thick, tectum 0.5–1.0 µm thick, exine very thick, columellae distinct, 1.0–1.5 µm wide; sculpture reticulate reticulate-foveolate at apocolpia, lumina 0.5–1.0 µm wide, circular, muri 1–2 µm wide, sculpture changes gradually to fossulate at equatorial areas, lumina 0.5–1.0 µm wide, 1–2 µm long, muri 1–2 µm wide. Dimensions: Equatorial diameter 30 (43) 55 µm, SD 6.7; equatorial diameter length/width 1.1, nm: 22; no: 37.

Comparisons: *Retistephanocolpites angeli* LEIDELMEYER 1966 has longer colpi, *Retistephanocolpites williamsi* GERMERAAD et al. 1968 has a spongy exine, *Retistephanocolporites festivus* GONZALEZ 1967 has protruding costae, and uniform lumina, *Retistephanocolpites finalis* GONZALEZ 1967 has a thinner tectum (2.5 µm), and uniform lumina, *Polybrevicolporites indistinctus* SAMANT & PHADTARE 1997 has a crescent-shaped nexinal thickening at colpal ends, and it is smaller (28–33 µm).

Retistephanocolpites sp. 1

Plate 16, Figs. 16–17

Diagnosis: Retistephanocolpate, mid-sized (38 µm), colpi costate, lumina decrease gradually from equator (1 µm) toward poles (< 0.5 µm).

Specimens: UFP 41, 20 × 110

Description: Monad, radial, isopolar, amb circular; stephanocolpate, ectocolpi costate, CEi 0.6, borders straight, ends pointed, costae 1 µm wide, 1 µm thick, decreasing toward colpi ends where it is lacking; semitectate, exine 1 µm thick, nexine thickening around colpi at mesocolpia, columellae distinct, 1 µm wide; sculpture reticulate, lumina 1 µm wide at equator, angular, decreasing gradually toward poles where is < 0.5 µm, muri 0.5–1 µm wide. Dimensions: Equatorial diameter 38 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons; *Retistephanocolpites angeli* LEIDELMEYER 1966 has uniform lumina (1–1.5 µm), *Retistephanocolpites williamsi* GERMERAAD et al. 1968 has a spongy exine, *Retistephanocolporites festivus* GONZALEZ 1967 has protruding costae, and smaller and uniform lumina, *Retistephanocolpites finalis* GONZALEZ 1967 has a thicker tectum (2.5 µm).

Retistephanocolpites sp. 2

Plate 16, Figs. 18–19

Diagnosis: Retistephanocolpate, mid-sized (30 µm), colpi short, costate, lumina large (2–4 µm), angular, uniform.

Specimens: UFP 43, 22.3 × 80.3

Description: Monad, radial, isopolar, amb circular; stephanocolpate, ectocolpi costate, CEi 0.3, colpi short, borders straight, ends pointed, costae 1.5 µm wide, 0.5–1.0 µm thick, non-protruding, polar area large, 22 µm wide; tectate, exine 1 µm thick, nexine thickening around colpi, columellae distinct, 1 µm wide, tectum reduced to reticulum; sculpture reticulate, lumina large, 2–4 µm

wide, angular, uniform, muri 0.5–1.0 µm wide, simplicolumellate. Dimensions: Equatorial diameter 30 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Retistephanocolpites angeli* LEIDELMEYER 1966 has smaller lumina (1–1.5 µm), *Retistephanocolpites williamsi* GERMERAAD et al. 1968 has a spongy exine, *Retistephanocolporites festivus* GONZALEZ 1967 has protruding costae, and smaller and uniform lumina (< 1.0 µm), *Retistephanocolpites finalis* GONZALEZ 1967 has a thicker tectum (2.5 µm), and smaller lumina (< 1.5 µm wide).

Genus *Retistephanocolporites* VAN DER HAMMEN & WYMSTRA 1964

Retistephanocolporites festivus GONZALEZ 1967

Plate 16, Figs. 20–21

Diagnosis: Stephanocolporate, mid-sized (26–50 µm), tectate, thin exine, colpi very short, pore costate, costae thick and protruding, reticulate, lumina 0.5–1 µm wide.

Specimens: UFP 41, 19.7 × 98.2; UFP 39, 7.6 × 111.4

Description: Monad, radial, isopolar, amb circular; stephanocolporate, 4–6 colporate, a few grains 3-colporate, ectocolpi simple, CEi 0.3, very short, borders straight, ends pointed, endopores costate, circular, 2–6 µm wide, 2–6 µm long, costae 4 µm wide, 2 µm thick, slightly protruding; tectate, exine 1.0–1.5 µm thick, nexine thickening around pores, columellae distinct, < 0.5 µm wide; sculpture reticulate, lumina 0.5 µm-1.0 wide, circular, distributed densely over entire grain, muri 1–1.2 µm. Dimensions: Equatorial diameter 26 (40) 50 µm, SD 6; equatorial diameter length/width 1.1, nm: 18; no: 26.

Retistephanocolporites fossulatus n. sp.

Plate 16, Figs. 22–25

Diagnosis: Retistephanocolporate, mid-sized (24–28 µm), tectate 1.5 µm thick, colpi very short, pore indistinct, costae non-protruding, reticulate/foveolate/fossulate in same grain.

Specimens: Holotype UFP 37, 7.8 × 97.7, pl. 16, figs. 22–25

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After fossulate sculpturing.

Description: Monad, radial, isopolar, amb circular; stephanocolporate, 4-colporate, ectocolpi simple, CEi 0.3, very short, borders straight, ends pointed, endopores costate, lalongate, 2 µm wide, 1 µm long, pores indistinct, costae 1.5 µm wide, 0.5 µm thick, non-protruding; semitectate, exine 1.5 µm thick, nexine < 0.5 µm thick, columellae 0.5–1.0 µm thick, tectum 0.5 µm thick, nexine thin, slightly thickening around pores, columellae distinct, 1 µm wide; sculpture reticulate, reticulate-foveolate-fossulate, lumina extremely variable on same grain, 1–2 µm long, 0.5 µm-1.0 wide, circular to elongated to triangular with rounded borders, distributed densely over entire grain, muri 1–2 µm wide. Dimensions: Equatorial diameter 24 (26) 28; equatorial diameter length/width 1, nm: 3; no: 4.

Comparisons: *Retistephanocolporites festivus* GONZALEZ 1967 has protruding costae, and smaller and uniform lumina, *Retistephanocolpites finalis* GONZALEZ 1967 has a thicker tectum (2.5 µm), larger size (41–51 µm), and uniform lumina.

Genus *Retistephanoporites* GONZALEZ 1967

Retistephanoporites angelicus GONZALEZ 1967

Plate 16, Figs. 26–27

Diagnosis: Retistephanoporate, mid-sized (30 µm), pores simple, reticula uniform, circular, dense, lumina < 1.0 µm wide.

Specimens: UFP 44, 11 × 113.5

Description: Monad, radial, isopolar, amb circular; stephanoporate, 5–6 porate, ecto and endopores of similar shape and coinciding, circular, 3 µm wide, 3 µm long; semitectate, exine 1.5 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5 µm thick, tectum < 0.5 µm thick, columellae distinct, 0.5 µm wide; sculpture reticulate, lumina < 1.0 µm wide, circular, uniform, distributed densely, muri < 1 µm wide. Dimensions: Equatorial diameter 25 (32.5) 40 µm, SD 4.2; equatorial diameter length/width 1.1, nm: 23; no: 76.

Retistephanoporites crassiexinatus n. sp.

Plate 16, Figs. 28–29

Diagnosis: Retistephanoporate, hexagonal, mid-sized (37 µm), exine semitectate thick (3.0 µm), nexine thick.

Specimens: Holotype UFP 37, 5.2 × 85.6, pl. 16, figs. 28–29

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After thick exine.

Description: Monad, radial, isopolar, amb hexagonal; stephanoporate, ecto and endopores of similar shape and coinciding, simple, circular, 5 µm wide, 5 µm long, pores large, borders well defined; semitectate, exine 3.0 µm thick, nexine 1.5 µm thick, columellae 0.5 µm thick, tectum 1.0 µm thick, columellae distinct, 1 µm wide, angular, sexine peel off in some areas of the grain; sculpture reticulate, lumina 1–1.5 µm wide, angular, muri 1–1.5 µm wide. Dimensions: Equatorial diameter 37 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Retistephanoporites angelicus* GONZALEZ 1967 has a thinner exine (1.7 µm), and a sexine that is thicker than the nexine, *Retistephanoporites minutiporus* n. sp. has smaller pores (1 µm), and a thinner exine (1.5 µm).

Retistephanoporites minutiporus n. sp. = R. angelicus de Milton Ro

Plate 17, Figs. 1–2

Diagnosis: Retistephanoporate, mid-sized (26–35 µm), pores small, costate, reticula uniform, dense, lumina 0.5–1 µm wide.

Specimens: Holotype UFP 37, 11.4 × 98.1, pl. 17, figs. 1–2

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After small pores.

Description: Monad, radial, isopolar, amb circular; stephanoporate, ecto and endopores of similar shape and coinciding, costate, circular, 1 µm wide, 1 µm long, pores small, borders indistinct, costae 2 µm wide, 0.5 thick; semitectate, exine 1.5 µm thick, nexine < 0.5 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, nexine thickening around pores to 0.5–1.0 µm, columellae distinct, long, 1 µm wide; sculpture reticulate, lumina 0.5–1 µm wide, circular, uniform, distributed densely, muri 1–1.5 µm wide. Dimensions: Equatorial diameter 26 (31) 37 µm, SD 2.8; equatorial diameter length/width 1, nm: 24; no: 42.

Comparisons: *Retistephanoporites angelicus* GONZALEZ 1967 has simple pores, *Retistephanoporites crassiexinatus* n. sp. has a thicker exine (3.0 µm).

Retistephanoporites sp. 1

Plate 17, Figs. 3–4

Diagnosis: Stephanoporate, mid-sized (30 µm), exine thin 0.5–1.0 µm, columellae indistinct, pores lolongate, costate, reticula dense, lumina < 0.5 µm wide.

Specimens: UFP 86, 12.7 × 107.9

Description: Monad, radial, isopolar, amb circular; stephanoporate, ectopores costate, lolongate, 3 µm wide, 6 µm long, costae distinct, 2 µm wide, < 0.5 µm thick; tectate, exine 0.5–1.0 µm thick, columellae indistinct; sculpture micropitted to finely reticulate, lumina < 0.5 µm wide, circular, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 30 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Retistephanoporites angelicus* GONZALEZ 1967 has a thicker exine (> 1.5 µm), *Retistephanoporites crassiexinatus* n. sp. has a thicker exine (3.0 µm), and wider lumina (1–1.5 µm).

Genus *Retisyncolporites* GONZALEZ 1967

Retisyncolporites angularis GONZALEZ 1967

Plate 17, Fig. 5

Diagnosis: Syncolporate, mid-sized (40–46 µm), thick exine (3.5 µm), fossulate-verrucate.

Specimens: UFP 66, 5.5 × 100; UFP 65, 21.8 × 87.2

Description: Monad, radial, isopolar, spherical, amb triangular-obtuse-convex; syncolporate, ectocolpi simple, connected with adjacent colpi at polar area forming a triangular piece of exine bounded by colpi, colpus borders straight, endopores simple, lalongate, 12 µm wide, 2 µm long, borders well defined; tectate, exine 3.5 µm thick, nexine 1.0–1.5 µm thick, columellae 1 µm thick, tectum 1.0–1.5 µm thick, columellae distinct, 1.0–1.5 µm wide, < 0.5 µm apart; sculpture fossulate-verrucate, lumina < 0.5 µm wide,

1–2 µm long, fading away toward the poles, muri 2–4 µm wide, verrucae 1 µm wide, < 0.5 µm long, sparsely distributed and indistinct. Dimensions: Equatorial diameter 46 µm; equatorial diameter length/width 1.1, nm: 1; polar diameter 40 µm, polar/equatorial diam. 1, nm: 1; no: 2.

Retisyncolporites sp. 1

Plate 17, Figs. 6–7

Diagnosis: Retisyncolporate, mid-sized (30 µm), tectate, colpi marginate by thinning of exine, poricostate, lumina of reticula < 1.0 µm decreasing toward colpi.

Specimens: UFP 49, 3.1 × 95.1

Description: Monad, radial, isopolar, amb triangular-obtuse-straight, syncolporate, ectocolpi marginate, indistinct, intruding, borders straight, margines 1 µm wide, produced by thinning of exine, margines psilate and darker in color, colpi membrane dark, distinct, apocolpial field absent, endopores costate, lalongate, 6 µm wide, 3 µm long, pores large, costae 2 µm wide, 1 µm thick; tectate, exine 1.0–1.5 µm thick, nexine thickening to 1 µm around pores, sexine thinning toward colpi to 0.5 µm, columellae distinct, < 0.5 µm wide, < 1.0 µm apart, tectum thin, segmented at mesocolpium where grain is semitectate; sculpture reticulate, lumina 0.5–1.0 µm wide, circular, diminishing toward colpi where sculpture is psilate, muri < 1.0 µm wide, grains degraded sometimes appear baculate at mesocolpium because of the tectum lacking. Dimensions: Equatorial diameter 30 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Syncolporites marginatus* Van Hoeken-Klinkenberg 1964 has fossulae that are perpendicular to the colpi and circular in polar view, *Psilasyncolporites aureus* Gonzalez 1967 has reticula that diminish toward the poles, and simple colpi.

Retisyncolporites sp. 2

Plate 17, Figs. 8–10

Diagnosis: Retisyncolporate, mid-sized (40–50 µm), marginate 2–4 µm wide, pores large, simple, lumina decrease toward margines.

Specimens: UFP 34, 5 × 100.9; UFP 32, 11.6 × 85.3

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; syncolporate, ectocolpi marginate, colpi meet at poles, slightly intruding, borders straight, margines 2–4 µm wide, produced by thinning of columellae and thickening of nexine, endopores simple, circular, 10 µm wide, 8 µm long, pores large, borders well defined; tectate, exine 1 µm thick, columellae distinct, 0.5 µm wide, 1 µm apart, nexine thickening to 1 µm near colpi while columellae gradually decrease in thickness disappearing near colpi; sculpture micropitted, lumina 1 µm wide, 1–1.5 µm long, rounded to elongated, irregular, lumina gradually decrease toward colpus margines where sculpturing is psilate, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 40 (45) 50; equatorial diameter length/width 1, nm: 2; no: 2.

Comparisons: *Syncolporites marginatus* Van Hoeken-Klinkenberg 1964 is smaller (20 µm), poricostate, and has uniform lumina, *Retisyncolporites angularis* Gonzalez 1967 is fossulate-verrucate, and has a thicker exine (3.5 µm).

Genus *Retitrescolpites* Sah 1967

Retitrescolpites baculatus n. sp.

Plate 17, Figs. 11–14

Diagnosis: Tricolpate, mid to large-sized (50–70 µm), tectate, exine 8 µm thick, reticulate, tectum usually lacking given appearance of very dense bacula.

Specimens: Holotype UFP 11, 13.8 × 82.1, pl. 17, figs. 11–13; paratypes UFP 49, 18.1 × 111.6, pl. 17, fig. 14; UFP 34, 6.5 × 106; UFP 42, 13.2 × 83.2.

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After sculpturing that resembles bacula.

Description: Monad, radial, isopolar, prolate, amb elliptic; tricolpate, ectocolpi simple, CPi 0.85, long, indistinct; semitectate, exine 8 µm thick, nexine 1 µm thick, columellae 6 µm thick, tectum 1 µm thick, nexine indistinct, columellae 1 µm wide, very tall, narrow, some of them ending in a tip rounded constricted, grains in younger sediments tend to have columellae wider (up to 2 µm wide), and are more connected by tectum forming a tectum rather distinct supported by many isolated columellae; sculpture reticulate, most of the cases tip of columellae are not connected by a tectum given appearance of very dense bacula, when tectum is present, lumina 5–8 wide, muri 1.5 µm wide, younger grains have reticula defined with muri being present over most of the surface. Dimensions: Equatorial diameter width 35 (46) 62 µm, SD

11.6; equatorial diameter length 50 (56) 70, SD 9.6; equatorial diameter length/width 1.2, nm: 4; polar diameter 60 (67.5) 75 µm, polar/equatorial diam. 1.2, nm: 2; no: 14.

Comparisons: *Spirosyncolpites spiralis* GONZALEZ 1967 has well defined muri, and shorter columellae that have lower density, *Retitrescolpites saturum* (GONZALEZ 1967) n. comb. is smaller (40–47 µm), exine is thinner (< 3.5 µm), and lumina are narrower (< 3.5 µm).

Retitrescolpites? irregularis (VAN DER HAMMEN & WYMSTRA 1964) n. comb.

Plate 18, Fig. 20

Basionym = *Retitricolporites irregularis* VAN DER HAMMEN & WYMSTRA 1964, p. 235, pl. 3, figs. 9–10.

1968 *Retitricolporites irregularis* VAN DER HAMMEN & WYMSTRA, in GERMERAAD et al. 1968, p. 338–339, pl. 17, figs. 4–5.
1970 *Retitricolporites irregularis* VAN DER HAMMEN & WYMSTRA, in SCHULER & DOUBINGER 1970, p. 446, pl. 7, figs. 1–3.
1974 *Retitricolporites irregularis* VAN DER HAMMEN & WYMSTRA, in REGALI et al. 1974, p. 283, pl. 13, fig. 6.

Diagnosis: Retitricolporate, mid-sized (23–30 µm), circular, colpi and pores costate, curvimurate, simplicolumellate.

Specimens: UFP 32, 7.3 × 103.8

Description: Monad, radial, isopolar, amb spherical, circular; tricolporate, ectocolpi costate, CEi 0.4, strongly intruding, borders straight, ends pointed, costae 2 µm wide, 2 µm thick, polar area small, 5 µm wide, endopores slightly costate, lalongate, 3 µm wide, 1 µm long, costae 2 µm wide, 0.5 µm thick; tectate, exine 1.5–2.0 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, columellae distinct, 0.5–1.0 µm wide; sculpture reticulate, lumina 3–5 µm wide, irregular, angular, finer toward colpi, muri 0.5–1.0 µm wide, curvimurate, simplicolumellate. Dimensions: Equatorial diameter 23 (27) 30 µm, SD 2.5; equatorial diameter length/width 1, nm: 12; polar diameter 25 µm, polar/equatorial diam. 1, nm: 1; no: 19.

Comparisons: *Retitricolporites* (VAN DER HAMMEN 1956b) VAN DER HAMMEN & WYMSTRA 1964 is invalid and a later synonym of *Viburnum* (JANSONIUS & HILLS 1976, card 2402). This species cannot be placed satisfactorily in any existing genus. It is provisionally placed in *Retitrescolpites* WODEHOUSE 1933 because of its reticulate sculpturing, but *Retitrescolpites? irregularis* is tricolporate rather than tricolpate.

Affinities: Euphorbiaceae, similar to *Amanoa oblongifolia*, and *Pseudolachnostylis glauca* (GERMERAAD et al. 1968).

Retitrescolpites magnus (GONZALEZ 1967) n. comb.

Plate 17, Figs. 15–16

Basionym = *Retitricolpites magnus* GONZALEZ 1967, p. 34, pl. 5, figs. 2–2c.

Diagnosis: Retitricolpate, mid-sized (38–55 µm), colpi simple, long, lumina 3–4 m wide, uniform, dense, muri thin, simplicolumellate.

Specimens: UFP 38, 19.4 × 88.8

Description: Monad, radial, isopolar, amb prolate, circular; tricolpate, ectocolpi simple, CPi 0.8, long, borders straight, ends pointed, polar area small, 8 µm wide; tectate, exine 3.5 µm thick, nexine 1 µm thick, columellae 1 µm thick, tectum 1.5 µm thick, columellae distinct, 0.5–1.0 µm wide, 2 µm apart; sculpture reticulate, lumina 3–4 µm wide, angular, uniform, distributed densely, muri 0.5–1.0 µm, simplicolumellate. Dimensions: Equatorial diameter 20 (29) 38 µm, SD 6.4; polar diameter 38 (46) 55 µm, SD 6.3, polar/equatorial diam. 1.6, nm: 6; no: 73.

Comparisons: *Retitricolpites* (VAN DER HAMMEN 1956b) PIERCE 1961 is invalid and a later synonym of *Neea* (JANSONIUS & HILLS 1976, card 2401). *Retitrescolpites* SAH 1967 is a genus restricted to tricolpate grains with coarsely reticulate to retipila(ria)te sculpturing.

Retitrescolpites peculiaris n. sp.

Plate 17, Figs. 17–21

Diagnosis: Retitricolpate, mid-sized (38–55 µm), colpi costate, short, lumina large 6–10 m wide, muri thin, simplicolumellate, sometimes muri are reticulate.

Specimens: Holotype UFP 9, 17 × 101.6, pl. 17, figs. 17–19; paratypes UFP 9, 22 × 91, pl. 17, fig. 20; UFP 9, 11.5 × 96.5, pl. 17, fig. 21

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After singular reticula.

Description: Monad, radial, isopolar, prolate, amb triangular-obtuse-convex; tricolpate, colpi costate, CEi 0.3, short, borders straight, ends rounded, costae 2 µm wide, 2 µm thick, polar area large, 35 µm wide; semitectate, exine 3 µm thick, nexine 1 µm thick, columellae 1 µm thick, tectum 1 µm thick, nexine thickening around colpi to 2 µm, columellae distinct, 1 µm wide, 1 µm apart, tectum reduced to reticulum; sculpture reticulate, lumina 6–10 µm wide, angular, muri 0.5–1.0 µm wide, simplicolumellate, muri also reticulate in some parts of the reticula, lumina 1–2 µm wide, angular to rounded, muri 0.5–1.0 µm wide, intrareticulation is not always present. Dimensions: Equatorial diameter 36 (45) 50 µm, SD 5.5; equatorial diameter length/width 1.1, nm: 7; no: 14.

Comparisons: *Retitricolpites marginatus* Van Hoeken-Klinkenberg 1966 has smaller lumina (3.5 µm) that decrease near the colpi, *Retitricolporites elegans* Wijmstra 1971 has pores, and lumina decrease toward poles and near the colpi, *Retitriporites amplireticulatus* n. sp. is porate, and muri are slightly wider (1 µm), *Retitrescolpites catenatus* Pocknall & Nichols 1996 is smaller (24–33 µm), has longer colpi extending almost to the poles, and a thinner exine (2 µm), other species of *Retitrescolpites* Sah 1967 have retipila(ria)te exine.

Retitrescolpites saturum (Gonzalez 1967) n. comb.

Plate 18, Figs. 1–2

Basionym = *Retitricolpites saturum* Gonzalez 1967, p. 33–34, pl. 4, figs 5–5c.

Diagnosis: Retitricolpate, mid-sized (40–47 µm), columellae tall (1.5 µm), reticulate, lumina 3 µm wide, muri thin, undulating, tectum sometimes lacking in parts of grain that then seems baculate.

Specimens: UFP 15, 7.3 × 88.7

Description: Monad, radial, isopolar, subprolate, amb triangular-obtuse-convex; tricolpate, colpi costate, CEi 0.75, long, borders straight, ends pointed, costae 1 µm wide, < 0.5 µm thick, polar area small, 11 µm wide; semitectate, exine 3.0–3.5 µm thick, nexine 1 µm thick, columellae 1.5 µm thick, tectum 0.5–1.0 µm thick, columellae distinct, long, 1 µm wide, 1 µm apart, sculpture reticulate, lumina 3 µm wide, angular, distributed densely, muri 0.5–1.0 µm wide, undulating, simplicolumellate, tectum sometimes lacking in some areas of grain, then sculpture appears baculate. Dimensions: Equatorial diameter 40 µm; equatorial diameter length/width 1, nm: 1; polar diameter 47 µm, polar/equatorial diam. 1.2, nm: 1; no: 2.

Comparisons: *Retitricolpites* (Van der Hammen 1956b) Pierce 1961 is invalid and a later synonym of *Neea* (Jansonius & Hills 1976, card 2401). *Retitrescolpites* Sah 1967 is a genus restricted to tricolpate grains, with coarsely reticulate to retipila(ria)te sculpturing.

Genus *Retitriporites* Ramanujam 1966

Retitriporites amplireticulatus n. sp.

Plate 18, Figs. 3–5

Diagnosis: Triporate, triangular-obtuse-convex, mid-sized (40 µm), exine semitectate (2.5–3.0 µm thick), columellae distinct, pores indistinct, reticula large, simplicolumellate.

Specimens: Holotype UFP 15, 6.9 × 97.3, pl. 18, figs. 3–5

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After large lumina.

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; triporate, ecto and endopores of similar shape and coinciding, simple, circular, 5 µm wide, 4 µm long, indistinct; semitectate, exine 2.5–3.0 µm thick, nexine 0.5–1.0 µm thick, columellae 1 µm thick, tectum 1 µm thick, columellae < 0.5 µm wide, < 0.5 µm apart, present only under muri of reticula, tectum reduced to reticula; sculpture reticulate, lumina large, 6–8 µm wide, hexagonal to pentagonal, muri simplicolumellate, 1 µm wide. Dimensions: Equatorial diameter 40 µm; equatorial diameter length/width 1, nm: 1; no: 2.

Comparisons: *Retitriporites variabilis* MULLER 1968 has indistinct columellae which tips fuse to form a structureless and narrow band, muri < 1 µm wide, *Retitrescolpites peculiaris* n. sp. is colpate.

Retitriporites poricostatus n. sp.

Plate 18, Figs. 6–7

Diagnosis: Retitriporate, mid-sized (25–35 µm), costae distinct, slightly protruding, 3 µm thick, 4 µm wide, reticula uniform, angular, 1.5–2 µm wide, muri simplicolumellate.

Specimens: Holotype UFP 47, 18.1 × 82, pl. 18, figs. 6–7

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After costae surrounding pores.

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; triporate, ecto and endopores of similar shape and coinciding costate, circular, 4 µm wide, 4 µm long, costae 4 µm wide, 3 µm thick, slightly protruding, pores slightly intruding; semitectate, exine 1 µm thick, nexine thickening around pores to 3 µm, columellae distinct, < 0.5 µm wide, < 1 µm apart, tectum reduced to reticulum; sculpture reticulate, lumina 1.5–2 µm wide, angular, uniform, muri < 1.0 µm wide, simplicolumellate. Dimensions: Equatorial diameter 25 (32) 35 µm; equatorial diameter length/width 1, nm: 3; no: 3.

Comparisons: *Retitriporites federicii* GONZALEZ 1967 has larger lumina (3 µm), a thicker exine (2.3 µm), and broader muri (2 µm).

Retitriporites sp. 1

Plate 18, Figs. 8–9

Diagnosis: Retitriporate, triangular-obtuse-convex, mid-sized (38 µm), semitectate, 1.5 µm thick, annulate, annuli distinct, reticula uniform.

Specimens: UFP 7, 20 × 96.5

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; triporate, ecto and endopores of similar shape and coinciding, annulate, circular, 1 µm wide, 1 µm long, annuli 4 µm wide, 2 µm thick, slightly protruding; semitectate, exine 1.5 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, exine thickening near pore to 2 µm becoming undifferentiated, columellae distinct, < 1 µm wide, < 1 µm apart, tectum very thin; sculpture reticulate, lumina < 1 µm wide, < 1.5 µm long, circular to elongated, uniform, distributed densely, muri < 1 µm wide. Dimensions: Equatorial diameter width 30 µm; equatorial diameter length 38 µm; equatorial diameter length/width 1.3, nm: 1; no: 1.

Comparisons: *Proteacidites dehaani* GERMERAAD et al. 1968 has larger reticula, coarser in interporate fields, and continuous costae, *Propylipollis pseudocostatus* n. sp. is triangular-acute straight, and costae are segmented, *Retitriporites tilburgii* GONZALEZ 1967 is smaller (26 µm), and annuli are narrower (1 µm).

Retitriporites sp. 2

Plate 18, Figs. 10–11

Diagnosis: Retitriporate, small-sized (27 µm), circular, tectate 1.5–2.0 µm thick, poricostate, pores lolongate.

Specimens: UFP 41, 4.9 × 93.1

Description: Monad, radial, isopolar, amb circular; triporate, ecto and endopores of similar shape and coinciding, costate, lolongate, 3 µm wide, 4 µm long, costae 1 µm wide, 1 µm thick, pores slightly intruding; tectate, exine 1.5–2.0 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, nexine thickening around pores to 1.5 µm, columellae barely

distinct, < 0.5 µm wide, < 0.5 µm apart, tectum thin; sculpture reticulate, lumina 0.5–1.0 µm wide, circular, uniform, muri < 1.0 µm wide. Dimensions: Equatorial diameter 27 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Retitriporites tilburgii* GONZALEZ 1967 has a thinner exine (< 1.5 µm), and pores smaller and circular (2 µm).

Retitriporites sp. 3

Plate 18, Figs. 12–13

Diagnosis: Retitriporate, mid-sized (40 µm), semitectate, 2 µm thick, sexine diminishing toward pores, annulate, reticula irregular, lumina diminishing from poles toward pores

Specimens: UFP 39, 5.6 × 84.5

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; triporate, ecto and endopores of similar shape and coinciding, simple, lalongate, 6 µm wide, 4 µm long, annuli 1 µm wide, 1 µm thick; semitectate, exine 2 µm thick, nexine 0.5 µm thick, columellae 1 µm thick, tectum 0.5 µm thick, exine undifferentiated around pores, 1 µm thick near pores, columellae distinct, < 1 µm wide, < 1 µm apart, gradually diminishing toward pores; sculpture reticulate, lumina 1 µm wide, 1–1.5 µm long, circular to elongated, irregular, diminishing from poles and interpose areas toward pores where is psilate, muri < 1 µm wide. Dimensions: Equatorial diameter 40 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Retitriporites typicus* GONZALEZ 1967 is smaller (27–33 µm), spheroidal, and lumina diminish toward the equator.

Retitriporites sp. 4

Plate 18, Figs. 14–15

Diagnosis: Triporate, mid-sized (29 µm), tectate, exine thick (2 µm), pore costate and protruding, micropitted at equator, foveolate/fossulate to reticulate at poles.

Specimens: UFP 43, 5 × 87.5

Description: Monad, radial, isopolar, subprolate; triporate, ecto and endopores of similar shape and coinciding, costate, circular, 1 µm wide, 1 µm long, costae 2 µm wide, 1 µm thick, protruding; tectate, exine 2 µm thick, nexine 0.5 – < 1.0 µm thick, columellae 0.5–1.0 µm thick, tectum 0.5–1.0 µm thick, nexine thickening around pores to 1 µm, columellae distinct, 0.5 µm wide, thickening at the poles to 1.5 µm; sculpture micropitted-foveolate-reticulate, micropitted at equator and mid latitudes, lumina < 0.5 µm, uniform, circular, distributed densely, changes abruptly to foveolate-fossulate-reticulate at apocolpia, lumina 1–2 µm wide, 1 µm long, muri 1–2 µm wide. Dimensions: Equatorial diameter 27 µm; polar diameter 29 µm; polar/equatorial diam. 1.1, nm: 1; no: 1.

Comparisons: *Retitriporites simplex* VAN DER KAARS 1983 has uniform lumina and simple pores, *Retitriporites typicus* GONZALEZ 1967 has larger lumina (> 1.0 µm) that gradually decrease toward equator, sometimes sculptural elements are not fused.

Genus *Rhoipites* WODEHOUSE 1933

Rhoipites cienagensis (DUEÑAS 1980) n. comb.

Plate 18, Fig. 16

Basionym = *Retitricolporites cienagensis* DUEÑAS 1980, p. 322, pl. 2, figs. 3–4

Diagnosis: Tricolporate, mid-sized (26–31 µm), ectocolpi marginate, endopores costate, reticulate, lumina decrease toward margines where is psilate, exine thickness decreases toward colpi.

Specimens: UFP 39, 21 × 110

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi marginate, CEi 0.9, long, borders straight, ends pointed, margines 1.5–4 µm wide at equator decreasing toward colpi ends, polar area small, 3 µm wide, endopores costate, lalongate, 4 µm wide, 1 µm long, costae distinct, 1.5 µm wide, 1 µm thick; tectate, exine 1 µm thick, exine decreases toward colpi by thinning of columellae, nexine thickening to 1 µm around pores, columellae distinct, 0.5 µm wide, 1 µm apart; sculpture reticulate, lumina < 1.0 µm wide, rounded, gradually decrease toward margines where sculpturing is psilate, muri 0.5–1.0 µm wide. Dimensions: Equatorial diameter 26 (28) 31 µm; equatorial diameter length/width 1.1, nm: 3; no: 3.

Comparisons: *Retitricolporites* (VAN DER HAMMEN 1956b) VAN DER HAMMEN & WYMSTRA 1964 is invalid and a later synonym of *Viburnum* (JANSONIUS & HILLS 1976, card 2402). *Rhoipites* WODEHOUSE 1933 accommodates tricolporate pollen grains that are reticulate, prolate, with marginate/costate colpi (POCKNALL & CROSBIE 1982, FREDERIKSEN 1983).

Rhoipites guianensis (VAN DER HAMMEN & WYMSTRA 1964) n. comb.

Plate 18, Figs. 17–18

Basionym = *Retitricolporites guianensis* VAN DER HAMMEN & WYMSTRA 1964, p. 235, pl. 3, figs. 1–2.

1968 *Retitricolporites guianensis* VAN DER HAMMEN & WYMSTRA, in GERMERAAD et al. 1968, p. 336–338, pl. 17, figs. 8–9.
1974 *Retitricolporites guianensis* VAN DER HAMMEN & WYMSTRA, in REGALI et al. 1974, p. 283, pl. 17, fig. 2.
1986 *Retitricolporites guianensis* VAN DER HAMMEN & WYMSTRA, in LORENTE 1986, p. 202, pl. 23, fig. 6.

Diagnosis: Retitricolporate, mid-sized (28–40 µm), columellae distributed regularly, reticula loose-meshed, 3–4 µm wide, diminishing toward colpi.

Specimens: UFP 38, 9.8 × 91

Description: Monad, radial, isopolar, amb prolate; tricolporate, ectocolpi marginate, CPi 0.8, long, intruding, borders straight, ends pointed, margines 2 µm wide produced by decreasing of sculpture lumina, endopores simple, lolongate, 1 µm wide, 1 µm long, pores indistinct; tectate, exine 1.5 µm thick, nexine 0.5 µm thick, columellae 0.5 µm thick, tectum 0.5 µm thick, columellae distinct, 0.5 µm wide, 1 µm apart, distributed regularly; sculpture reticulate, lumina 3–4 µm wide, angular, slightly elongated, diminishing toward colpi, muri 0.5 µm wide, pluricolumellate. Dimensions: Equatorial diameter 18 (23) 28 µm, SD 2.7; polar diameter 26 (34) 40 µm, SD 4.3 polar/equatorial diam. 1.5, nm: 23; no: 109.

Comparisons: see above, p. 157.

Affinities: Similar to *Firmiania* and *Hildegardia* (GERMERAAD et al. 1968), genus of the paraphyletic family Sterculiaceae, that is now lumped into Malvaceae sensu latu (Angiosperm Phylogeny Group 1998).

Rhoipites hispidus (VAN DER HAMMEN & WYMSTRA 1964) n. comb.

Plate 18, Fig. 19

Basionym = *Retitricolporites hispidus* VAN DER HAMMEN & WYMSTRA 1964, p. 235–236, pl. 1, fig. 12.

1974 *Retitricolporites hispidus* VAN DER HAMMEN & WYMSTRA, in REGALI et al. 1974, p. 283, pl. 19, fig. 4.

Diagnosis: Retitricolporate, mid-sized (22–36 µm), prolate, exine thick (2 µm), pores and colpi costate, lumina < 1.0 µm.

Specimens: UFP 40, 17.6 × 105

Description: Monad, radial, isopolar, prolate, amb circular; tricolporate, ectocolpi costate, CPi 0.8, long, borders straight, ends pointed, costae 1 µm wide, 2 µm thick at equator decreasing toward the colpi ends, polar area small, 8 µm wide, endopores costate, lalongate, 10 µm wide, 2 µm long, costae 3 µm wide, 1 µm thick; tectate, exine 2 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5 µm thick, tectum 0.5–1.0 µm thick, exine thick, endexine thickens at equatorial area to 1–2 µm; sculpture reticulate, reticulate to foveolate, lumina < 1.0 µm, muri 1 µm. Dimensions: Equatorial diameter 13 (18) 24 µm, SD 2.8; polar diameter 22 (28) 36 µm, SD 3.6, polar/equatorial diam. 1.5, nm: 10; no: 15.

Comparisons: see above, p. 157.

Rhoipites squarrosus (VAN DER HAMMEN & WYMSTRA 1964) n. comb.

Plate 18, Figs. 21–22

Basionym = *Retitricolporites squarrosus* VAN DER HAMMEN & WYMSTRA 1964, p. 236, pl. 3, figs. 4–5.

Diagnosis: Tricolporate, small-sized (26 µm), subprolate, exine thick (2 µm), ectocolpi costate, pore simple, reticula fine, lumina 0.5–1.0 µm wide.

Specimens: UFP 39, 12.5 × 104.1

Description: Monad, radial, isopolar, subprolate; tricolporate, ectocolpi costate, CPi 0.7, long, borders straight, ends pointed, costae 2 µm wide at equator, 1.5 µm at colpi ends, 2 µm thick, polar area small, 6 µm wide, endopores simple, lalongate, 2 µm wide, 4 µm long, pores indistinct; tectate, exine 2 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5 µm thick, tectum 0.5–1.0 µm thick, nexine thickens around colpi to 2 µm, columellae distinct, 0.5 wide, < 1 µm apart; sculpture reticulate, lumina 0.5–1.0 µm, rounded,

uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 23 µm; polar diameter 26 µm, polar/equatorial diam. 1.1, nm: 1; no: 1.

Comparisons: see above, p. 157.

Rhoipites sp. 1

Plate 18, Figs. 23–24

Diagnosis: Retitricolporate, mid-sized (40 µm), nexine thick (2 µm), columellae distinct, thinning near colpi, colpi long, pores circular, distinct, large (6 µm), reticula fine.

Specimens: UFP 44, 7.3 × 89.5

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi marginate, CEi 0.95, long, borders straight, ends pointed, margines 2 µm wide produced by thinning of columellae, polar area small, 2 µm wide, endopores simple, circular, 6 µm wide, 6 µm long, pores large, distinct; tectate, exine 3 µm thick, nexine 2 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, nexine very thick, columellae distinct, < 0.5 µm wide, < 1 µm apart, thinning near colpi to < 0.5 µm, tectum very thin; sculpture reticulate, lumina 0.5–1.0 µm wide, rounded, distributed densely, muri 1.0 µm wide. Dimensions: Equatorial diameter 40 µm; equatorial diameter length/width 1, nm: 1; no: 2.

Comparisons: *Rhoipites* sp. 2 has a thicker nexine (3 µm) that diminishes near colpi, and indistinct pores.

Rhoipites? sp. 2

Plate 18, Figs. 28–29

Diagnosis: Retitricolporate, mid-sized (25–36 µm), nexine very thick (3 µm) thinning near colpi, sexine thin, columellae indistinct, reticula fine.

Specimens: UFP 41, 15.8 × 98.4

Description: Monad, radial, isopolar, amb triangular-obtuse-straight; tricolporate, ectocolpi costate, CEi 0.8, long, borders straight, ends pointed, costae 3 µm wide produced by thinning of nexine to 1 µm, polar area small, 4 µm wide, endopores simple, lalongate, 9 µm wide, 4 µm long, barely distinct; tectate, exine 4 µm thick, nexine 3 µm thick, columellae < 0.5 µm thick, tectum 0.5–1.0 µm thick, nexine very thick diminishing to 1 µm near colpi, columellae indistinct; sculpture reticulate, lumina 0.5–1.0 µm wide, 0.5–1.5 µm long, rounded to elongated, irregular, distributed densely, muri 1.0 µm wide. Dimensions: Equatorial diameter 25 (32) 36 µm, SD 4.8; equatorial diameter length/width 1, nm: 5; no: 5.

Comparisons: This species cannot be placed satisfactorily in any existing genus because of its thick endexine. The species is placed provisionally in *Rhoipites* WODEHOUSE 1933 that accommodates reticulate grains with marginate colpi (POCKNALL & CROSBIE 1982, FREDERIKSEN 1983). *Rhoipites* sp. 1 has a thinner exine (2 µm) that does not diminish near the colpi, has distinct pores, and uniform lumina.

Genus *Rousea* SRIVASTAVA 1969

Rousea florentina (GONZALEZ 1967) n. comb.

Plate 19, Figs. 1–2

Basionym = *Retitricolpites florentinus* GONZALEZ 1967, p. 33, pl. 4, figs. 1–1b

Diagnosis: Retitricolpate, mid-sized (40 µm), prolate, lumina 1–1.5 µm wide at equator decreasing gradually to 0.5 µm at poles.

Specimens: UFP 49, 9.1 × 89.1

Description: Monad, radial, isopolar, prolate; tricolpate, ectocolpi simple, CPi 0.75, borders straight, ends pointed, polar area small, 5 µm wide; semitectate, exine 1 µm thick, columellae distinct, 0.5–1.0 µm wide, 0.5–1.5 µm apart, tectum continuous at apocolpia; sculpture reticulate, lumina 1–1.5 µm wide, angular, distributed densely, muri 0.5 µm wide, decreasing gradually toward poles where sculpture is micropitted, lumina 0.5 µm wide, muri < 1 µm wide. Dimensions: Equatorial diameter 25 µm; polar diameter 40 µm, polar/equatorial diam. 1.6, nm: 1; no: 1.

Comparisons: *Retitricolpites* (VAN DER HAMMEN 1956b) PIERCE 1961 is invalid and a later synonym of *Neea* (JANSONIUS & HILLS 1976, card 2401). *Rousea* SRIVASTAVA 1969 is a genus restricted to retitricolpate pollen grains with lumina > 1 µm wide at the mesocolpia decreasing gradually toward the apocolpia.

Genus *Rugotricolporites* GONZALEZ 1967

Rugotricolporites felix GONZALEZ 1967

Plate 19, Figs. 3–4

Diagnosis: Tricolporate, mid-sized (31 µm), prolate, colpi marginate, rugulate, rugulae short, curved.

Specimens: UFP 37, 17.7 × 81.5

Description: Monad, radial, isopolar, prolate; tricolporate, ectocolpi marginate, CPi 0.7, long, borders straight, ends pointed, margines 1.5 µm wide, polar area small, 6 µm wide, endopores simple, circular, 3 µm wide, 3 µm long, indistinct; tectate, exine 1.0 µm thick, columellae indistinct; sculpture rugulate, rugulae short, curved, < 1 µm wide, 1–4 µm long, < 0.5 µm long. Dimensions: Equatorial diameter 25 µm; polar diameter 31 µm, polar/equatorial diam. 1.2, nm: 1; no: 1.

Genus *Scabrastephanocolpites* VAN DER HAMMEN & GARCIA 1966

Scabrastephanocolpites sp. 1

Plate 19, Figs. 5–6

Diagnosis: Scabrastephanocolporate, mid-sized (40 µm), intectate 0.5 µm thick, colpi short, marginate.

Specimens: UFP 27, 20 × 102

Description: Monad, radial, isopolar, amb elliptic; stephanocolpate, 4-colporate, colpi marginate, CEi 0.35, short, borders straight, ends pointed, margines 1.5 µm wide decreasing to 1 µm toward colpi ends, 1.0 µm thick, polar area large, 24 µm wide; intectate, nexine 0.5 µm thick, thickening around colpi to 1.0 µm; sculpture scabrate, scabrae < 0.5 µm wide, < 0.5 µm long, 1–2 µm apart, rounded, uniform, distributed moderately. Dimensions: Equatorial diameter 40 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Scabrastephanocolpites vanegensis* VAN DER HAMMEN & GARCIA 1966 has longer colpi and less distinct margines, *Scabrastephanocolpites scabratus* VAN DER HAMMEN & GARCIA 1966 is tectate, *Scabrastephanocolpites guaduensis* (VAN DER HAMMEN 1954) SARMIENTO 1992 has a thicker exine (2 µm), *Nothofagidites* POTONIÉ 1960 is echinate, generally has more than 4 colpi, and colpi are shorter (ROMERO 1977).

Genus *Scabratriporites* VAN DER HAMMEN 1956b ex VAN HOEKEN-KLINKENBERG 1964

Scabratriporites sp. 1

Plate 19, Figs. 7–8

Diagnosis: Triporate, mid-sized (36 µm), atectate (0.5 µm), annulate, annuli 3–4 µm wide, 2 µm thick, scabrae < 0.5 µm wide/long.

Specimens: UFP 66, 5.1 × 98.2

Description: Monad, radial, isopolar, amb elliptic; triporate, ecto and endopores of similar shape and coinciding, annulate, lalongate, 4 µm wide, 1 µm long, annuli slightly protruding, 3–4 µm wide, 2 µm thick; intectate, nexine 0.5 µm thick, thickening around pores to 2 µm; sculpture scabrate, scabrae < 0.5 µm wide, < 0.5 µm long, circular, blunted, 1 µm apart, distributed sparsely. Dimensions: Equatorial diameter width 31 µm; equatorial diameter length 36 µm; equatorial diameter length/width 1.2, nm: 1; no: 1.

Comparisons: *Scabratriporites simpliformis* VAN HOEKEN-KLINKENBERG 1966 is smaller (21 µm), annuli are thinner (1.2 µm), and amb is triangular-convex, *Cricotriporites macroporus* n. sp. has circular pores, wider (5–9 µm) and thinner annuli (1 µm).

Genus *Siltaria* TRAVERSE 1955

Siltaria mariposa (LEIDELMEYER 1966) n. comb.

Plate 19, Figs. 9–11

Basionym = *Retitricolporites mariposus* LEIDELMEYER 1966; p. 55, pl. 5, fig. 5.

Diagnosis: Tricolporate, mid-sized (28 µm), triangular-acute-convex, exine thinner near colpi, ectocolpi intruding, pores slightly costate, micropittted.

Specimens: UFP 27, 13.7 × 109.1

Description: Monad, radial, isopolar, amb triangular-acute-convex; tricolporate, ectocolpi simple, CEi 0.8, intruding, borders straight, ends pointed, polar area small, 5 µm wide, endopores slightly costate, circular, 5 µm wide, 4 µm long, pores well defined, costae 1 µm wide, 0.5 µm thick; tectate, exine 1.5 µm thick in intercolpi areas decreasing to 1 µm near colpi by shortening of columellae, nexine 0.5 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, columellae distinct, < 0.5 µm wide, < 0.5 µm apart; sculpture micropitted, lumina < 0.5 µm wide, rounded, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 28 (28) 28 µm; equatorial diameter length/width 1, nm: 2; no: 2.

Comparisons: See discussion of *Retitricolporites* in comparisons of *R. cienagensis*, p. 157. *Siltaria* TRAVERSE 1955 accommodates tricolporate punctate pollen grains (FREDERIKSEN 1983).

Siltaria media (GONZALEZ 1967) n. comb.

Plate 19, Fig. 12

Basionym = *Retitricolporites medius* GONZALEZ 1967, p. 40, pl. 10, figs. 3–3e

1970 *Retitricolporites medius* GONZALEZ, in SCHULER & DOUBINGER 1970, p. 446, pl. 6, figs. 9–11.

Diagnosis: Tricolporate, small to mid-sized (19–30 µm), subprolate, exine 1–1.5 µm, columellae distinct, ectocolpi intruding, pore simple, micropitted 0.5 µm wide.

Specimens: UFP 32, 7.5 × 109.3; UFP 38, 19 × 91.5

Description: Monad, radial, isopolar, subprolate, amb circular; tricolporate, ectocolpi simple, CPi 0.9, slightly intruding, borders straight, ends pointed, polar area small, 4 µm wide, endopores simple, lalongate, 3 µm wide, 1 µm long, pores distinct; tectate, exine 1–1.5 µm thick, columellae distinct, 0.5 µm wide, < 1.0 µm apart; sculpture micropitted, lumina 0.5 µm wide, rounded, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 15 (18) 20 µm, SD 2.1; polar diameter 20 (22.5) 25 µm, SD 2.1, polar/equatorial diam. 1.2, nm: 4; no: 12.

Comparisons: See discussion of *Retitricolporites* in comparisons of *R. cienagensis*, p. 157.

Siltaria sp. 1

Plate 19, Figs. 13–14

Diagnosis: Tricolporate, mid-sized (30–36 µm), prolate, ectocolpi costate, pore simple, micropittted at poles, psilate at equator.

Specimens: UFP 41, 8.3 × 78.5

Description: Monad, radial, isopolar, prolate; tricolporate, ectocolpi costate, CPi 0.8, long, borders straight, costae 1.5 µm wide, 1 µm thick, polar area small, 6 µm wide, endopores simple, lalongate, 8 µm wide, 4 µm long, distinct; tectate, exine 2 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5–1.0 µm thick, tectum 0.5–1.0 µm thick, nexine thickening around colpi to 1.5 µm, columellae distinct at apocolpia, indistinct at equator, < 0.5 µm wide, < 1 µm apart; sculpture micropitted, micropitted at apocolpia, lumina 0.5 µm wide, rounded, diminishing gradually toward equator where sculpturing is psilate, muri < 0.5 µm wide. Dimensions: Equatorial diameter 19 (23) 27 µm; polar diameter 30 (33) 36 µm, polar/equatorial diam. 1.4, nm: 2; no: 3.

Comparisons: Unique sculpturing in *Siltaria* group.

Siltaria sp. 2

Plate 19, Figs. 15–16

Diagnosis: Tricolporate, mid-sized (28–35 µm), tectate thin, columellae indistinct, spherical, pore costate, lalongate, conspicuous, colpi simple, micropitted.

Specimens: UFP 43, 11 × 91.5

Description: Monad, radial, isopolar, spherical; tricolporate, ectocolpi simple, CPi 0.6, mid-sized, borders straight, ends pointed, very thin, polar area 10 µm wide, endopores costate, lalongate, 11 µm wide, 2 µm long, pores distinct, costae 5 µm wide decreasing toward the equatorial ends of the pores, 1 µm thick; tectate, exine 1 µm thick, nexine thickening near pores to 1.5 µm, columellae indistinct; sculpture micropitted, lumina < 0.5 µm wide, rounded, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 26 (30.5) 35 µm, SD 3.7; polar diameter 28 (33) 35 µm, SD 3.3, polar/equatorial diam. 1.1, nm: 4; no: 5.

Comparisons: *Tetracolporopollenites maculosus* (REGALI et al. 1974) n. comb. has continuous equatorial costae, *Tetracolporopollenites spongiosus* n. sp. is subprolate, costae equatorial is very thick, and tectum is spongy, *Tetracolporopollenites transversalis* (DUEÑAS 1980) n. comb. is subspherical, has shorter and indistinct colpi, protruding pores, and psilate sculpturing, *Horniella* sp. 2 has wider lumina (> 0.5 µm) and distinct columellae.

Siltaria sp. 3

Plate 19, Figs. 17–18

Diagnosis: Tricolporate, mid-sized (40–52 µm), tectate thin, columellae indistinct, colpi marginate, pores costate, fastigiate, micropitted.

Specimens: UFP 53, 12.8 × 113

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolporate, ectocolpi marginate, CEi 0.8, long, slightly intruding, borders straight, ends rounded, margines 1.5 µm wide, 1 µm thick, polar area small, 8 µm wide, endopores costate, fastigiate, circular, 5 µm wide, 4 µm long, pores distinct, costae 2 µm wide, 2 µm thick, fastigia 4 µm wide, 2 µm thick; tectate, exine 1 µm thick, nexine thickening around pore to 2 µm, columellae indistinct, tectum and columellae seem to fuse near colpi producing margo; sculpture micropitted, lumina 0.5 µm wide, rounded, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 40 (47) 52 µm; equatorial diameter length/width 1, nm: 3; no: 3.

Comparisons: *Psilatricolporites marginatus* VAN DER KAARS 1983 is smaller (19–27 µm), and lacks fastigia, *Horniella* sp. 3 is smaller (23–40 µm), has simple colpi, and distinct columellae.

Siltaria sp. 4

Plate 19, Figs. 19–20

Diagnosis: Tricolporate, small to mid-sized (21–30 µm), subprolate, columellae barely distinct, ectocolpi costate, pore simple, micropittted.

Specimens: UFP 40, 6.9 × 110.5

Description: Monad, radial, isopolar, subprolate, amb triangular-obtuse-convex; tricolporate, ectocolpi costate, CPi 0.7, borders straight, ends pointed, costae 1.5 µm wide at equator, 1 µm at colpi ends, 1 µm thick, polar area small, 6 µm wide, endopores simple, circular, 3 µm wide, 3 µm long, pores distinct; tectate, exine 1 µm thick, nexine thickening around colpi to 1.5 µm, columellae barely distinct; sculpture micropitted, lumina 0.5 µm wide, rounded, uniform, distributed densely, muri < 0.5 µm wide. Dimensions: Equatorial diameter 11 (18) 24 µm; polar diameter 21 (25) 30 µm, polar/equatorial diam. 1.4, nm: 3; no: 10.

Comparisons: *Siltaria media* (GONZALEZ 1967) n. comb. has simple colpi, *Rhoipites squarrosus* (VAN DER HAMMEN & WYMSTRA 1964) n. comb. has a thicker exine (2 µm), distinct columellae, and wider lumina (> 0.5 µm).

Siltaria sp. 5

Plate 19, Figs. 21–24

Diagnosis: Retitricolporate, mid-sized (24–30 µm), columellae reduced near colpi, colpi costate, costae reduced at equator, pores indistinct, micropitted.

Specimens: UFP 11, 7.2 × 106.5; UFP 11, 6.5 × 85

Description: Monad, radial, isopolar, spherical, amb triangular-obtuse-convex; tricolporate, ectocolpi costate, CPi 0.8, long, borders straight, ends pointed, costae 2 µm wide, 2 µm thick, highly reduced at equator, polar area small, 7 µm wide, endopores simple, lalongate, 3 µm wide, 1 µm long, indistinct; tectate, exine 1 µm thick, columellae distinct, 0.5 µm wide, 0.5–1.0 µm apart, decreasing in thickness toward colpi at mesocolpia; sculpture micropitted, lumina < 0.5 µm, circular, uniform, distributed densely, muri < 1 µm. Dimensions: Equatorial diameter 24 (27.5) 30 µm, SD 2.1; equatorial diameter length/width 1.1, nm: 6; polar diameter 24 µm, polar/equatorial diam. 1, nm: 2; no: 14.

Comparisons: *Retitricolporites crassicostatus* VAN HOEKEN-KLINKENBERG 1966 has uniform costae, columellae thickness is constant, and has exopores.

Genus *Spinizonocolpites* MULLER 1968

Spinizonocolpites aff. *baculatus* MULLER 1968

Plate 19, Figs. 25–26

Diagnosis: Zonasulculate, mid-sized (55 µm), tectate thick (3 µm thick), columellae barely distinct, tectum micropitted, bacula 4–6 long, 2–6 µm apart.

Specimens: UFP 82, 17.5 × 92.3

Description: Monad, radial, anisopolar, amb elliptic, grain separated by a continuous equatorial sulculus into two slightly unequal parts; zonasulculate, sulculus marginate, borders irregular, indistinct, margo produced by thinning of exine; tectate, exine 2.5–3.0 µm thick, nexine 2 µm thick, columellae 0.5 µm thick, tectum < 0.5 µm thick, columellae barely distinct; sculpture baculate, bacula 4–6 µm long, 2–6 µm apart, 2–3 µm wide, tips rounded, straight, slightly curved or subconical in same grain, surface interbacula micropitted, lumina < 0.5 µm, rounded, muri < 1.0 wide. Dimensions: Equatorial diameter width 40 µm; equatorial diameter length 55 µm, equatorial diameter length/width 1.3, nm: 1; no: 1.

Comparisons: These specimens are probably reworked from Upper Cretaceous or lower Paleocene sediments. *Spinizonocolpites baculatus* MULLER 1968 is very similar but the exine is thinner (1–2 µm) and bacula are longer (7–13 µm), *Spinizonocolpites* cf. *baculatus* MULLER 1968 has a thinner tectum (1–2 µm), finely reticulate, and bacula are more scattered (7–12 µm apart).

Affinities: Palmae, similar to *Nypa* (GERMERAAD et al. 1968).

Spinizonocolpites cf. *baculatus* MULLER 1968

Plate 19, Figs. 27–28

Diagnosis: Zonasulculate, mid-sized (32–50 µm), tectate (1–2 µm thick), tectum finely reticulate, lumina < 1 µm, baculate, bacula 3.5–6 µm long, 7–12 µm apart, straight or slightly curved, tips rounded or slightly pointed.

Specimens: UFP 76, 14 × 108.5; UFP 76, 21.5 × 97

Description: Monad, radial, anisopolar, suboblate, amb elliptic, grain separated by a continuous equatorial sulculus into two slightly unequal parts; zonasulculate, sulculus marginate, borders irregular, margo produced by thinning exine, thin, indistinct; tectate, exine 1–2 µm thick, nexine 0.5 µm thick, columellae 0.5 µm thick, tectum < 0.5 µm thick, columellae distinct, tectum thin; sculpture baculate, bacula 3.5–6 µm long, 2–4 µm wide, 5–10 µm apart, scattered, massive, tips rounded or slightly pointed, straight or slightly curved, surface interbacula reticulate, lumina < 1 µm, rounded, muri 0.5 µm wide. Dimensions: Equatorial diameter width 25 (34) 45 µm; equatorial diameter length 32 (39) 45 µm; equatorial diameter length/width 1.2, nm: 8; no: 15.

Comparisons: These specimens are probably reworked from Late Cretaceous or Paleocene sediments. *Spinizonocolpites baculatus* MULLER 1968 is practically identical but has bacula consistently longer (7–13 µm), *Spinizonocolpites* aff. *baculatus* MULLER 1968 has a thicker exine (3 µm), a micropitted tectum, and bacula that are more densely distributed (2–4 µm).

Spinizonocolpites breviechinatus n. sp.

Plate 19, Figs. 29–31

Diagnosis: Zonasulculate, mid to large-sized (40–65 µm), tectate (1 µm thick), tectum micropitted, echinate, spines 2–4 µm long, 1–2 µm wide, 3–5 µm apart, cylindrical to subconical.

Specimens: Holotype UFP 15, 14.8 × 110.2, pl. 19, figs. 29–30; paratype UFP 11, 8.2 × 95, pl. 19, fig. 31

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After small spines.

Description: Monad, radial, anisopolar, amb elliptic, grain separated by a continuous equatorial sulculus into two slightly unequal parts; zonasulculate, sulculus simple, borders irregular; tectate, exine 1 µm thick, columellae barely distinct; sculpture echinate, spines 2–4 µm long, 1–2 µm wide, 3–6 µm apart, scattered, subconical to cylindrical, tips tapering, blunted to pointed, surface interspines micropitted, lumina < 0.5 µm wide, rounded, muri < 0.5 wide. Dimensions: Equatorial diameter width 30 (39.5) 50 µm, SD 6.9; equatorial diameter length 40 (55.5) 65 µm, SD 8.4 equatorial diameter length/width 1.4, nm: 7; no: 12.

Comparisons: *Spinizonocolpites echinatus* MULLER 1968 is very similar but spines are significantly longer (5–7 µm), wider, more spaced from each other, and conical with slightly expanded base, *Spinizonocolpites spinulosus* RAMANUJAM 1987 is smaller (23–28 µm), *Spinizonocolpites grandis* n. sp. has wider (3–4 µm wide), longer (4–5 µm long), and conical spines.

Spinizonocolpites grandis n. sp.

Plate 20, Figs. 1–3

Diagnosis: Zonasulculate, large-sized (70–85 µm), tectate (1 µm thick), tectum finely reticulate, echinate, spines 4–5 µm long, 3–4 µm wide, 5–10 µm apart (3–5/100 sq µm), conical.

Specimens: Holotype UFP 34, 11.4 × 111.2, pl. 20, figs. 1–3

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After large grain-size.

Description: Monad, radial, anisopolar, amb elliptic, grain separated by a continuous equatorial sulculus into two slightly unequal parts; zonasulculate, sulculus simple, borders irregular; tectate, exine 0.5–1.0 µm thick, nexine < 0.5 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, columellae distinct, < 0.5 µm wide, < 1.0 µm apart, tectum fine; sculpture echinate, spines 4–5 µm long, 3–4 µm wide, 5–10 µm apart, scattered, conical, tips blunted to pointed, sometimes expanded at the base, surface interspines reticulate, lumina < 1.0 µm wide, slightly angular, muri < 1.0 wide. Dimensions: Equatorial diameter width 40 (47) 57 µm, SD 6.1; equatorial diameter length 70 (77) 85 µm, SD 4.9, equatorial diameter length/width 1.6, nm: 7; no: 62.

Comparisons: *Spinizonocolpites echinatus* MULLER 1968 is smaller (33–43) and has longer spines (5–7 µm), *Spinizonocolpites breviechinatus* n. sp. has narrower spines (1–2 µm wide), shorter (2–4 µm long), and subconical to cylindrical, *Spinizonocolpites thanikaimonii* SAMANT & PHADTARE 1997 has more densely placed spines (8–12 spines/100 sq µm).

Spinizonocolpites pachyexinatus n. sp.

Plate 20, Figs. 4–5

Diagnosis: Zonasulculate, large-sized (70–80 µm), tectate (3–5 µm thick), tectum micropitted to finely reticulate, echinate, spines 7–10 long, 10–20 µm apart.

Specimens: Holotype UFP 21, 13 × 108, pl. 20, figs. 4–5

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After thick exine.

Description: Monad, radial, anisopolar, amb elliptic, grain separated by a continuous equatorial sulculus into two slightly unequal parts; zonasulculate, sulculus marginate, borders irregular, indistinct, margo produced by thinning of exine, thin; tectate, exine 3–5 µm thick, nexine 2 µm thick, columellae 0.5–1.0 µm thick, tectum < 0.5 µm thick, columellae distinct, < 1.0 µm wide, < 1.0 µm apart, tectum fine; sculpture echinate, spines 7–10 µm long, 5–6 µm wide, 10–20 µm apart, 14–15 spines, conical, blunted, with lower part slightly expanded, hollow, slightly micropitted to psilate, surface interspines micropitted to finely reticulated, lumina < 1.0 µm, rounded, muri < 1.0 µm wide, lumina sometimes increase inside spine bases. Dimensions: Equatorial diameter width 30 (44) 50 µm, SD 8.2; polar diameter length 60 (72) 80 µm, SD 8.3, equatorial diameter length/width 1.7, nm: 5; no: 7.

Comparisons: *Spinizonocolpites echinatus* MULLER 1968 is similar but the exine is thinner (2 µm) and the spines are shorter (5–7 µm).

Genus *Spirosyncolpites* GONZALEZ 1967, emend. LEGOUX 1978

Spirosyncolpites spiralis GONZALEZ 1967

Plate 20, Figs. 6–8

1967 *Spirosyncolpites spiralis* GONZALEZ, 1967, p. 45, pl. 16, figs. 1–1c.
1974 *Retitricolpites amapaensis* REGALI et al., 1974, p 280, pl. 17, fig. 4.

Diagnosis: Retitricolpate, mid to large-sized (32–85 µm), colpi often indistinct, exine tectate 9 µm thick, reticulate, lumina 8–14 µm wide, simplicolumellate, nexine scabrate.

Specimens: UFP 49, 17.9 × 104.5; UFP 38, 19 × 101.8

Description: Monad, radial, isopolar, amb circular; tricolpate, colpi rarely seen, grains syncolpate were not observed; semitectate, exine 9 µm thick, nexine 1 µm thick, columellae 5–6 µm thick, tectum 2–3 µm thick, columellae 2–3 µm wide, tectum and columellae usually found detached from main body; sculpture reticulate, lumina variable, 8–14 µm wide, muri thick, 1.0–1.5 µm wide, simplicolumellate, nexine scabrate. Dimensions: Equatorial diameter 32 (47) 85, SD 10.5; equatorial diameter length/width 1.1, nm: 31; no: 128.

Comparisons: The holotype of *Retitricolpites amapaensis* REGALI et al. 1974 was observed and corresponds to this species. LEGOUX (1978) expanded the definition of genus *Spirosyncolpites* to include tricolpate forms. GONZALEZ (1967) described this species as having a syncolpate aperture. However, the aperture in the specimens studied was rarely distinct, but when observed it was tricolpate, syncolpate grains were not observed. The holotype of *S. spiralis* is damaged and cannot be observed.

Genus *Striatopollis* KRUTZSCH 1959b

Striatopollis catatumbus (GONZALEZ 1967) TAKAHASHI & JUX 1989

Plate 20, Figs. 9–10

Diagnosis: Striatricolp(or)ate, prolate, mid-sized (37–53 µm), colpi simple, pore indistinct, muri subparallel to slightly anastomosing.

Specimens: UFP 46, 15.6 × 108.5

Description: Monad, radial, isopolar, prolate; tricolpate, sometimes tricolporate, ectocolpi simple, CPi 0.85, long, intruding, borders straight, ends pointed, polar area small, 10 µm wide, endopores simple, circular, 4 µm wide, 4 µm long, absent or indistinct; tectate, exine 2.5 µm thick, nexine 1 µm thick, columellae 0.5 µm thick, tectum 1 µm thick, columellae distinct, 0.5 µm wide, 0.5 µm apart, slightly longer at apocolpia, linearly arranged underneath muri of striation; sculpture striate, striae 1 µm wide, muri 1–1.5 µm wide, 1 µm long, subparallel to slightly anastomosing, tectum within striae very thin, sometimes perforated. Dimensions: Equatorial diameter 18 (26) 39 µm, SD 5.7; polar diameter 37 (42.6) 53 µm, SD 3.9, polar/equatorial diam. 1.7 nm: 19; no: 45.

Affinities: Fabaceae, similar to *Crudia*, *Anthonotha*, *Isoberlinia*, *Macrolobium bifilium* (GERMERAAD et al. 1968).

Striatopollis minor (WIJMSTRA 1971) n. comb.

Plate 20, Fig. 11

Basionym = *Striatricolpites minor* WIJMSTRA 1971, p. 50, pl. 3, figs. 11–12.

1992 *Striatricolpites minor* WIJMSTRA, in SARMIENTO 1992, p. 82–83, pl. 8, fig. 18.

Diagnosis: Striatricolpate, subprolate, small-sized (15–18 µm), tectate, exine thin, colpi simple, pores absent or indistinct, muri subparallel to colpi.

Specimens: UFP 17, 11.9 × 115.1

Description: Monad, radial, isopolar, subprolate; tricolpate, sometimes tricolporate, ectocolpi simple, CPi 0.8, long, borders straight, ends pointed, polar area small, 6 µm wide, endopores absent or indistinct; tectate, exine 0.5–1.0 µm thick, columellae indistinct; sculpture striate, striae < 0.5 µm wide, muri < 0.5 µm wide, < 0.5 µm long, subparallel to colpi. Dimensions: Equatorial diameter 18 µm; polar diameter 18 µm, polar/equatorial diam. 1, nm: 1; no: 1.

Comparisons: *Striatricolporites* (VAN DER HAMMEN 1956b) GONZALEZ 1967 is invalid and a later synonym of *Acer*. *Striatopollis* KRUTZSCH 1959b accommodates tricolpate pollen grains that are tectate, subprolate-prolate, and striate.

Striatopollis? tenuistriatus n. sp.

Plate 20, Figs. 12–14

Diagnosis: Striatricol(por)ate, prolate, mid-sized (36–45 µm), exine thin, colpi costate, striae and muri 0.5 µm wide, muri < 0.5 µm long, meridionally elongated.

Specimens: Holotype UFP 58, 15.6 × 95.2, pl. 20, figs. 12–13; paratype UFP 84, 17.8 × 89.4, pl. 20, fig. 14

Type locality: La Regadera Creek near La Donjuana, 72° 37′ W – 7° 42′ N, Colombia; Mirador Formation, early to middle Eocene.

Etymology: After thin and indistinct striae.

Description: Monad, radial, isopolar, prolate, amb circular; tricolpate, sometimes tricolporate, ectocolpi costate, CPi 0.9, long, slightly intruding, borders straight, ends pointed, costae 1–2 µm wide, 0.5–1 µm thick, polar area small, 3–5 µm wide, endopores costate, lolongate, 2 µm wide, 7 µm long, costae 1 µm wide; tectate, exine 0.5–1.0 µm thick, columellae indistinct; sculpture striate, striae 0.5 µm wide, muri 0.5 µm wide, < 0.5 µm long, elongated longitudinally, deflected and bifurcated at equator. Dimensions: Equatorial diameter 22 (28.5) 36 µm, SD 4.5; polar diameter 35 (41) 45 µm, SD 3.7, polar/equatorial diam. 1.5, nm: 13; no: 13.

Comparisons: Specimens have very faint striations and cannot be placed satisfactorily in any existing genus. It is provisionally assigned to *Striatopollis* KRUTZSCH 1959b because of its tricolpate, tectate, prolate, and striate characteristics. *Striatricolpites semistriatus* GONZALEZ 1967 has a thicker exine (1.5 µm) and striae that bifurcate at poles, *Striatricolpites saramacensis* WIJMSTRA 1971 has a thicker exine (2–3 µm) and distinct columellae, *Striatricolporites tenuissimus* DUEÑAS 1980 is reticulate within striae (lumina 0.5–1.0 µm wide), *Striatricolporites agustinus* GONZALEZ 1967 is smaller (19–23 µm).

Striatopollis sp. 1

Plate 20, Figs. 15–16

Diagnosis: Striatricolpate, prolate, mid-sized (35–41 µm), colpi simple, tectum thin, muri parallel to colpi, tectum reticulate within striae.

Specimens: UFP 11, 5 × 96.6

Description: Monad, radial, isopolar, prolate; tricolpate, ectocolpi simple, CPi 0.8, long, borders straight, ends pointed, polar area small, 11 µm wide; tectate, exine 1 µm thick, columellae indistinct; sculpture striate, striae 0.5–1.0 µm wide, muri 0.5–1.0 µm wide, < 0.5 µm long, parallel to colpi, tectum within striae reticulate, lumina 0.5–1.0 µm wide, rounded. Dimensions: Equatorial diameter 20 (23) 26 µm; polar diameter 35 (38) 41 µm, polar/equatorial diam. 1.7, nm: 2; no: 2.

Comparisons: *Striatopollis catatumbus* (GONZALEZ 1967) TAKAHASHI & JUX 1989 has a thicker exine (3 µm) and wider muri (1–1.5 µm), *Striatricolpites semistriatus* GONZALEZ 1967 has bifurcating muri at poles, *Striatricolpites saramacensis* WIJMSTRA 1971

has a thicker exine (2–3 µm), *Striatricolporites tenuissimus* DUEÑAS 1980 has costate colpi, *Striatricolporites agustinus* GONZALEZ 1967 is smaller (19–23 µm), *Striatricolporites pimulis* LEIDELMEYER 1966 has annulate endopores and exine diminishes near colpi.

Genus *Striatricolporites* LEIDELMEYER 1966

Striatricolporites digitatus n. sp.

Plate 20, Figs. 17–18

Diagnosis: Striatricolporate, prolate, mid-sized (35 µm), exine tectate, columellae distinct, colpi costate, long, pore indistinct, muri pattern resembles a finger print.

Specimens: Holotype UFP 6, 16 × 101.9, pl. 20, fig. 17–18 106 x14.5

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After sculpturing that resembles a finger-print.

Description: Monad, radial, isopolar, prolate; tricolporate, ectocolpi costate, CPi 0.80, long, borders straight, ends pointed, costae 0.5 µm wide, 2 µm thick at equator, thinning toward colpi ends, polar area small, 6 µm wide, endopores simple, lalongate, 5 µm wide, 3 µm long, pores indistinct; tectate, exine 1 µm thick, sexine thicker at poles (1.0 µm), columellae distinct, 0.5–1.0 µm wide, 0.5 µm apart; sculpture striate, striae 0.5 µm wide, muri 1 µm wide, 0.5 µm long, tectum within striae irregularly perforated, elongated, lumina 0.5–1.0 µm long, < 0.5 µm wide, muri pattern resembles a finger-print, with scattered convolutions and bifurcations. Dimensions: Equatorial diameter 21 µm; polar diameter 35 µm, polar/equatorial diam. 1.7, nm: 1; no: 1.

Comparisons: *Striatricolpites semistriatus* GONZALEZ 1967 has bifurcating muri at the poles, *Striatricolporites tenuissimus* DUEÑAS 1980 is reticulate within striae, *Striatricolporites pimulis* LEIDELMEYER 1966 has annulate endopores, and exine decreases near colpi, *Dactylopollis* MULLER 1968 is colpate, foveolate-reticulate in intercolpate equatorial areas and curved-striate along colpi and near poles.

Striatricolporites sp. 1

Plate 20, Figs. 19–20

Diagnosis: Striatricolpate, prolate, mid-sized (25–36 µm), exine thick (1.5–2 µm), colpi costate, striations very faint and randomly organized, overlying a tectum finely reticulate.

Specimens: UFP 19, 19 × 91

Description: Monad, radial, isopolar, prolate; tricolporate, ectocolpi costate, CPi 0.7, mid-sized, borders straight, ends pointed, costae 2 µm wide, 1 µm thick, polar area small 10 µm wide, endopores costate, lalongate, ovoid, 8 µm wide, 4 µm long, costae 1 µm wide, 1.5 µm thick; tectate, exine 1.5–2 µm thick, nexine 0.5–1.0 µm thick, columellae 0.5 µm thick, tectum 0.5–1.0 µm thick, columellae distinct, < 1.0 µm wide and apart, sexine thickening to 1 µm around colpi; sculpture striate-reticulate, striations very fine, striae < 0.5 µm wide, muri < 1.0 µm wide, < 0.5 µm long, distributed randomly, surface within striations reticulate, lumina 0.5–1.0 µm wide, angular to slightly elongated, uniform, distributed densely, muri < 0.5 µm wide. Dimensions: Equatorial diameter 20 (23) 29 µm, SD 3.9; polar diameter 25 (30.5) 36 µm, SD 4.5, polar/equatorial diam. 1.3, nm: 4; no: 5.

Comparisons: *Striatopollis catatumbus* (GONZALEZ 1967) TAKAHASHI & JUX 1989 has a thicker exine (3 µm) and longer muri (1 µm), *Striatricolporites tenuissimus* DUEÑAS 1980 has a thinner exine (1 µm) and simple pores, *Striatricolporites pimulis* LEIDELMEYER 1966 has a exine that diminishes near colpi, *Striatopollis* sp. 1 has a thinner exine (< 1.0 µm) and reticula are less uniform.

Genus *Syncolporites* VAN DER HAMMEN 1954

Syncolporites lisamae VAN DER HAMMEN 1954

Plate 20, Figs. 21–22

Diagnosis: Syncolporate, small-sized (16–21 µm), intectate (< 0.5 µm thick), pore annulate, apocolpial field absent, scabrate, psilate in annuli zone.

Specimens: UFP 12, 11.4 × 84.1

Description: Monad, radial, isopolar, triangular-obtuse-convex; syncolporate, ectocolpi simple, borders straight, apocolpial field absent, endopores annulate, circular, 1 µm wide, 1 µm long, pores indistinct, annuli 2 µm wide, < 1 µm thick; intectate, nexine < 0.5 µm thick, thickening around pores to 1 µm; sculpture scabrate, scabrae < 0.5 µm wide, < 0.5 µm long, < 1.0 µm apart, circular, uniform, distributed densely, absent at annuli where sculpture is psilate. Dimensions: Equatorial diameter 16 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Affinities: Myrtaceae (MULLER 1981).

Syncolporites marginatus VAN HOEKEN-KLINKENBERG 1964

Plate 20, Figs. 23–24

Diagnosis: Retisyncolporate, small-sized (18 µm), colpi marginate, pore costate, lumina 0.5–1.0 µm wide, dense, uniform.

Specimens: UFP 56, 11.5 × 109.4

Description: Monad, radial, isopolar, amb circular; syncolporate, ectocolpi marginate, borders straight, connecting with other colpi at pole, margines 1.5 µm wide, endopores costate, lalongate, 3 µm wide, 1 µm long, costae 2.5 µm wide, 0.5 µm thick; tectate, exine 1 µm thick, columellae distinct, 0.5 µm wide; sculpture reticulate, lumina 0.5–1.0 µm wide, circular, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 18 µm; equatorial diameter length/width 0.9, nm: 1; no: 1.

Syncolporites sp. 1

Plate 20, Figs. 25–26

Diagnosis: Syncolporate, small-sized (17 µm), colpi simple, pores annulate, verrucate, verrucae 1–1.5 µm wide, 1 µm long.

Specimens: UFP 21, 12.2 × 114

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; syncolporate, ectocolpi simple, indistinct, borders straight, in some areas colpi lined by a ridge verrucate, apocolpial field absent, endopores annulate, circular, 1 µm wide, 1 µm long, borders indistinct, annuli distinct, 2 µm wide, 3 µm thick; intectate, nexine 0.5 µm thick, thickening around pores; sculpture verrucate, verrucae 1–1.5 µm wide, 1 µm long, 0.5–1.5 µm apart, uniform, distributed densely, absent from costae. Dimensions: Equatorial diameter 17 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Syncolporites lisamae* VAN DER HAMMEN 1954 is scabrate to microverrucate (< 0.5 µm long).

Genus *Tetracolporites* COUPER 1963

Tetracolporites pachyexinatus n. sp.

Plate 20, Figs. 27–28; Plate 21, Figs. 1–2

Diagnosis: Psilastephanocolporate, mid-sized (45–53 µm), tectate 4–5 µm thick, nexine very thick, colpi large, marginate by thinning of nexine.

Specimens: Holotype UFP 44, 13.5 × 85.1, pl. 20, figs. 27–28; paratypes UFP 37, 8.1 × 97.6, pl. 21, figs. 1–2; UFP 37, 11.9 × 98

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After thick exine.

Description: Monad, radial, isopolar, subprolate, amb circular; stephanocolporate, 3–4 colporate, ectocolpi marginate, CEi 0.7, long, borders straight, ends pointed, margines 4 µm wide produced by thinning of nexine, endopores costate, lalongate, 12 µm wide, 4 µm long, costae 1 µm wide, 0.5 µm thick; tectate, exine 4–5 µm thick, nexine 3.0–3.5 µm thick, columellae < 0.5 µm thick, tectum 0.5–1.0 µm thick, nexine very thick, thinning around colpi, columellae indistinct; sculpture psilate. Dimensions: Equatorial diameter 45 (48) 51 µm; equatorial diameter length/width 1.1, nm: 2; polar diameter 52 µm, polar/equatorial diam. 1.3, nm: 1; no: 5.

Comparisons: *Tetracolporites spectabilis* POCKNALL & MILDENHALL 1984 has simple colpi and a thinner exine (2–3 µm), *Tetracolporites psilatus* n. sp. has shorter colpi, and a thinner exine (< 2 µm), *Tamilipollenites grandis* SINGH & MISRA 1991 is larger (60–112 µm), and has a thicker exine (10–16 µm), *Meliapollis* SAH & KAR 1970 has simple colpi.

Affinities: Meliaceae?.

Tetracolporites psilatus n. sp.

Plate 21, Figs. 3–4

Diagnosis: Psilastephanocolporate, mid-sized (30–53 µm), tectate (1.5–2 µm), nexine very thick, colpi short to mid-sized, marginate by thinning of nexine, poricostate.

Specimens: Holotype UFP 49, 14 × 91.5, pl. 21, figs. 3–4; paratype UFP 49, 17.8 × 110.8

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After psilate sculpturing.

Description: Monad, radial, isopolar, amb circular; stephanocolporate, 4–6 colporate, ectocolpi marginate, CEi 0.3, short, in few grains colpi larger, reaching half-way between equator and pole, borders straight, ends pointed, margines 3 µm wide produced by thinning of nexine, endopore costate, lalongate, 12 µm wide, 3 µm long, costae distinct, 3 µm wide, 2 µm thick; tectate, exine 1.5–2.0 µm thick, nexine 1.0–1.5 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, nexine (possibly foot layer) very thick, thinning around colpi, forming thick poricostae, in some grains there is a slight thickening of exine at apocolpia forming distinct darker circular shape, columellae indistinct; sculpture psilate. Dimensions: Equatorial diameter 30 (42) 53 µm, SD 7.4; equatorial diameter length/width 1, nm: 13; no: 13.

Comparisons: *Tetracolporites spectabilis* POCKNALL & MILDENHALL 1984 has simple colpi and a thicker exine (2–3 µm), *Tetracolporites pachyexinatus* n. sp. has longer colpi, and a thicker exine (4–5 µm), *Meliapollis* SAH & KAR 1970 has simple colpi.

Affinities: Meliaceae?

Genus *Tetracolporopollenites* PFLUG & THOMSON in THOMSON & PFLUG 1953

Tetracolporopollenites maculosus (REGALI et al. 1974) n. comb.

Plate 21, Figs. 5–6

Basionym = *Psilatricolporites maculosus* REGALI et al. 1974, p. 282–283, pl. 16, fig. 1.

1986 *Psilatricolporites maculosus* REGALI et al., in LORENTE 1986, p. 195, pl. 21, fig. 11.

Diagnosis: Psilatricolporate, prolate, small to mid-sized (24–36 µm), colpi short to mid-sized, costa equatorial conspicuous, pores lalongate.

Specimens: UFP 48, 20 × 87

Description: Monad, radial, isopolar, prolate; tricolporate, ectocolpi simple, CPi 0.2–0.4, short to mid-sized, borders straight, ends pointed, endopores costate, lalongate, 1 µm wide, 5 µm long, costae well developed, 5 µm wide, 1 µm thick, forming a continuous equatorial band; tectate, exine 1 µm thick, nexine < 0.5 µm thick gradually thickening to 1 µm at equator, columellae thin, indistinct; sculpture psilate. Dimensions: Equatorial diameter 20 (24) 35 µm, SD 3.3; polar diameter 24 (30) 36 µm, SD 3.7, polar/equatorial diam. 1.2, nm: 29; no: 54.

Comparisons: *Psilatricolporites* VAN DER HAMMEN 1956b ex PIERCE 1961 is an obligate later synonym of *Tricolporites* VAN DER HAMMEN 1954 (non ERDTMAN 1949) because they have the same type species; as the latter is invalid and a later synonym of *Clethra*, so is *Psilatricolporites* (JANSONIUS & HILLS 1976, card 2234). *Tetracolporopollenites* PFLUG & THOMSON in THOMSON & PFLUG 1953 accommodates pollen grains that are 3–4 colporate with morphology similar to Sapotaceae (JANSONIUS & HILLS 1976, card 2860, FREDERIKSEN 1988).

Affinities: Sapotaceae, similar to *Chrysophyllum argenteum* (LORENTE 1986).

Tetracolporopollenites spongiosus n. sp.

Plate 21, Figs. 7–8

Diagnosis: Psilatricolporate, subprolate, mid-sized (30–41 µm), tectum spongy, colpi long, costae equatorial very thick.

Specimens: Holotype UFP 19, 6.2 × 93, pl. 21, figs. 7–8

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After spongy exine.

Description: Monad, radial, isopolar, subprolate, amb circular; tricolporate, ectocolpi simple, CPi 0.7, borders straight, ends pointed, endopores costate, lalongate, 7 µm wide, 5 µm long, costae very well developed forming a continuous equatorial band 5 µm wide, 3 µm thick at equator decreasing gradually toward poles, sometimes costae are not well defined and thickening is restricted to around pores; tectate,

exine 1.5–2.0 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum 0.5–1.0 µm thick, exine thick, not very well differentiated, spongy structure, nexine thickening to 3 µm at equator; sculpture psilate. Dimensions: Equatorial diameter 26 (29) 35 µm, SD 2.5; polar diameter 30 (34) 41 µm, SD 3.4, polar/equatorial diam. 1.1, nm: 10; no: 24.

Comparisons: *Tetracolporopollenites maculosus* (Regali et al. 1974) n. comb. is very similar but exine is thinner (1.2 µm) and not spongy, colpi are shorter (up to half-way pole-equator), and costae are thinner (1 µm), *Tetracolporopollenites transversalis* (Dueñas 1980) n. comb. has shorter and indistinct colpi, and tectum is not spongy.

Tetracolporopollenites transversalis (Dueñas 1980) n. comb.

Plate 21, Fig. 9

Basionym = *Psilatricolporites transversalis* Dueñas 1980, p. 319, pl. 2, figs. 10–11.

1986 *Psilatricolporites transversalis* Dueñas, in Lorente 1986, p. 198, pl. 21, figs. 12.

Diagnosis: Psilatricolporate, subprolate, mid-sized (26–40 µm), costae highly protruding surrounding pores lalongate, colpi very short, indistinct, equatorial band of endexine thickening.

Specimens: UFP 43, 9.7 × 110.4; UFP 18, 19.2 × 111.3

Description: Monad, radial, isopolar, subprolate; tricolporate, ectocolpi simple, CPi 0.1–0.25, short and very narrow, indistinct, endocolpi costate, lalongate, 4 µm wide, 2 µm long, costae highly protruding, 2 µm wide, elongated meridionally, 3 µm thick, in some grains there is an endocingulum very narrow; tectate, exine 0.5–1.0 µm thick, nexine < 0.5 µm thick gradually thickening toward equator to < 1.0 µm where it forms a continuous band, also thickening around pores up to 3 µm forming a highly protruding costae, columellae indistinct; sculpture psilate. Dimensions: Equatorial diameter 20 (24) 31 µm, SD 3.3; polar diameter 26 (31) 40 µm, SD 4.0, polar/equatorial diam. 1.3, nm: 16; no: 20.

Comparisons: See above, p. 168. *Tetracolporopollenites maculosus* (Regali et al. 1974) n. comb. lacks highly protruding costae, and colpi are distinct.

Tetracolporopollenites sp. 1

Plate 21, Figs. 10–12

Diagnosis: Psilatricolporate, mid-sized (30 µm), exine thick (2 µm), columellae distinct and tall, costae 1.2 µm thick forming belt at equator and decreasing gradually toward poles.

Specimens: UFP 43, 5.5 × 112

Description: Monad, radial, isopolar, prolate; tricolporate, ectocolpi costate, CPi 0.8, long, almost reaching poles, borders straight, ends pointed, costae surrounding entire grain in equatorial region, 1.0–1.5 µm thick at equator decreasing gradually toward ends of colpi where disappears, endopores simple, lalongate, 5 µm wide, 2 µm long, pores distinct; tectate, exine 2 µm thick, nexine 0.5 µm thick, columellae 1 µm thick, tectum 0.5 µm thick, nexine gradually thickening toward equatorial region, columellae 1 µm wide, sculpture psilate. Dimensions: Equatorial diameter 23 µm; polar diameter 34 µm, polar/equatorial diam. 1.5, nm: 1; no: 1.

Comparisons: *Psilatricolporites obscurus* Gonzalez 1967 has a thicker exine (4.8 µm), and an equatorial colpus, *Psilatricolporites optimus* Gonzalez 1967 has a micropitted tectum and costae are lacking.

Tetracolporopollenites? sp. 2

Plate 21, Figs. 13–15

Diagnosis: Psilatricolporate, mid-sized (25–33 µm), tectate, colpi long, slightly marginate, pores circular, costate.

Specimens: UFP 58, 20 × 93.7

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi marginate, CEi 0.8, long, borders straight, ends pointed, polar area small, 3 µm wide, margines 2 µm wide produced by a slight thinning of exine, endopores costate, circular, 3 µm wide, 3 µm long, costae 2 µm wide, 1 µm thick, pores well defined; tectate, exine 1 µm thick, nexine < 0.5 µm thick, thickening to 1 µm around the pores, columellae distinct, < 0.5 µm wide; sculpture psilate. Dimensions: Equatorial diameter 24 (27) 33 µm; equatorial diameter length/width 1, nm: 3; no: 6.

Comparisons: These specimens have long colpi that are slightly marginate, and cannot be place satisfactorily in any existing genus. It is placed provisionally in *Tetracolporopollenites* Pflug & Thomson in Thomson & Pflug 1953 because of its psilate sculpturing, and costate pores. *Lakiapollis* aff. *ovatus* Venkatachala & Kar 1969 has shorter and simple colpi.

Genus *Tricolpites* COOKSON ex COUPER 1953, emend. JARZEN & DETTMANN 1990

Tricolpites antonii (GONZALEZ 1967) n. comb.

Plate 21, Figs. 16–17

Basionym = *Retitricolpites antonii* GONZALEZ 1967, p. 32, pl. 3. figs. 2–2a.

Diagnosis: Retitricolpate, small-sized (26 µm), prolate, tectate 1.5 µm thick, columellae barely distinct, colpi long, simple.

Specimens: UFP 38, 14.2 × 107.9

Description: Monad, radial, isopolar, prolate; tricolpate, colpi simple, CPi 0.8, long, borders straight, ends pointed, polar area small, 4 µm wide; tectate, exine 1.5 µm thick, nexine 0.5 µm thick, columellae 0.5 µm thick, tectum 0.5 µm thick, columellae barely distinct; sculpture reticulate, lumina < 1.0 µm wide, rounded, uniform, distributed densely. Dimensions: Equatorial diameter 15 µm; polar diameter 26 µm, polar/equatorial diam. 1.7, nm: 1; no: 2.

Comparisons: *Retitricolpites* (VAN DER HAMMEN 1956b) PIERCE 1961 is invalid and a later synonym of *Neea* (JANSONIUS & HILLS 1976, card 2401). *Tricolpites* is a genus restricted to tricolpate forms with fine lumina (< 1 µm wide), equidimensional over entire surface of the grain (JARZEN & DETTMANN 1989).

Tricolpites clarensis (GONZALEZ 1967) n. comb.

Plate 21, Fig. 18

Basionym = *Retitricolpites clarensis* GONZALEZ 1967, p. 32, pl. 3, figs. 3–3c.

1966 *Retitricolpites clarensis* GONZALEZ, in VAN HOEKEN-KLINKENBERG 1966, p. 41. pl. 1, fig. 12.
1971 *Retitricolpites clarensis* GONZALEZ, in WIJMSTRA 1971, p. 49. pl. 3, fig. 8.
1994 *Retitricolpites clarensis* GONZALEZ, in AWAD 1994, p. 110. pl. 14, fig. 17.

Diagnosis: Retitricolpate, small to mid-sized (29–44 µm), tectate, columellae distinct, colpi simple, long, reticulate finely, lumina 0.5–1 µm wide.

Specimens: UFP 38, 12.4 × 97.6; UFP 27, 18.2 × 95.6; UFP 32, 7.5 × 89

Description: Monad, radial, isopolar, amb circular; tricolpate, ectocolpi simple, CEi 0.6, borders slightly irregular, ends pointed, polar area small, 12 µm wide, colpi membrane usually lost; tectate, exine 1.0–1.5 µm thick, columellae distinct; sculpture reticulate, lumina 0.5–1 µm, equidimensional, distributed densely over entire grain, muri < 1.0 µm wide, sculpture appears fossulate when grain is deteriorated. Dimensions: Equatorial diameter 30 (35) 44 µm, SD 4.7; equatorial diameter length/width 1.1, nm: 11; no: 9.

Comparisons: See above, p. 170.

Tricolpites protoclarensis n. sp.

Plate 21, Figs. 19–20

Diagnosis: Tricolpate, small to mid-sized (22–45 µm), circular, tectate, thin exine (< 1 µm), columellae indistinct, colpi simple, long, micropitted densely (lumina < 1.0 µm).

Specimens: Holotype UFP 17, 15 × 91.8, pl. 21, figs. 19–20

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After the close resemblance to Eocene pollen grain *Tricolpites clarensis.*

Description: Monad, radial, isopolar, amb circular; tricolpate, colpi simple, CEi 0.65, borders irregular, ends pointed, polar area small, 8 µm wide; tectate, exine 0.5–1.0 µm thick, columellae indistinct; sculpture micropitted, lumina < 0.5 µm wide, distributed densely over entire grain, equidimensional, muri < 1.0 µm wide. Dimensions: Equatorial diameter 25 (35) 45 µm, SD 4.9; equatorial diameter length/width 1.1, nm: 19.

Comparisons: *Tricolpites clarensis* (GONZALEZ 1967) n. comb. is very similar but exine is thicker (1 µm), columellae are distinct, and lumina are wider (0.5–1 µm).

Tricolpites sp. 1

Plate 21, Figs. 21–22

Diagnosis: Retitricolpate, mid-sized (44 µm), columellae indistinct, colpi costate, micropitted densely (lumina < 0.5 µm).

Specimens: UFP 47, 9.7 × 99.2

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolpate, ectocolpi costate, CEi 0.55, mid-sized, borders straight, ends pointed, costae 2 µm wide, 0.5 µm thick, polar area 15 µm wide; tectate, exine 1 µm thick, nexine slightly thickening around colpi, columellae indistinct; sculpture micropitted, lumina < 0.5 µm wide, circular, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 44 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Tricolpites clarensis* (Gonzalez 1967) n. comb. has an uniform exine and simple colpi, *Retitricolpites belskii* (Belsky et al. 1965) Sarmiento 1992 has interangular colpi, a dark stain in polar area, and is smaller (~25 µm), *Tricolpites* sp. 2 is marginate, and columellae are distinct.

Tricolpites sp. 2

Plate 21, Figs. 23–24

Diagnosis: Retitricolpate, mid-sized (37 µm), colpi costate and marginate, micropitted densely (lumina < 0.5 µm).

Specimens: UFP 35, 11.9 × 115.7

Description: Monad, radial, isopolar, amb circular; tricolpate, ectocolpi costate, marginate, CEi 0.6, borders slightly irregular, ends pointed, costae 5 µm wide at equator reducing gradually to 2 µm at colpi end, 0.5 µm thick, margines 5 µm wide produced by thinning of columellae, polar area small, 7 µm wide; tectate, exine 2 µm thick, nexine 0.5 µm thick, columellae 1 µm thick, tectum 0.5 µm thick, exine decreases to 1 µm toward colpi by shortening of columellae, nexine slightly thickening around colpi, columellae distinct, < 1.0 µm wide, < 0.5 µm apart; sculpture micropitted, lumina < 0.5 µm wide, circular, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter 37 µm; equatorial diameter length/width 1, nm: 1; no: 1.

Comparisons: *Tricolpites* sp. 1 is not marginate, and columellae are indistinct.

Genus *Triporopollenites* Pflug & Thomson in Thomson & Pflug 1953, emend. Potonié 1960

Triporopollenites? tenuiexinatus n. sp.

Plate 21, Figs. 25–26

Diagnosis: Psilatriporate, triangular-acute-convex, mid-sized (29–31 µm), atectate, exine very thin (0.5 µm), annulate, annuli narrow and thin.

Specimens: Holotype UFP 76, 12.3 × 106.2, pl. 21, figs. 25–26

Type locality: Rio Negro river, near Uribe, 7° 20N – 73° 20W, Colombia; La Paz Formation, early to middle Eocene.

Etymology: After thin exine.

Description: Monad, radial, isopolar, amb triangular-acute-convex; triporate, ecto and endopores of similar shape and coinciding, annulate, circular, 3 µm wide, 3 µm long, annuli 0.5–1.0 µm wide, 0.5 µm thick; atectate, nexine 0.5 µm thick, exine very thin, slightly thickening around pores; sculpture psilate. Dimensions: Equatorial diameter 29 (30) 31; equatorial diameter length/width 1.1, nm: 2; no: 2.

Comparisons: *Triporopollenites? tenuiexinatus* n. sp. lacks well developed aspides but it is placed provisionally in *Triporopollenites* Pflug & Thomson in Thomson & Pflug 1953 emend. Potonié 1960, the closest genus available in the literature. This genus is restricted to pollen grains that are psilate, triangular with faintly convex sides, triporate, and aspidate (Pocknall & Nichols 1996). *Proteacidites dehaani* Germeraad et al. 1968 is reticulate, *Proteacidites miniporatus* Van Hoeken-Klinkenberg 1966 is scabrate and exine is thicker, *Propylipollis pseudocostatus* n. sp. is reticulate.

Genus *Ulmoideipites* Anderson 1960

Ulmoideipites krempii (Anderson 1960) Elsik 1968b

Plate 21, Fig. 27

Diagnosis: Stephanoporate, 3–5-porate, mid-sized (26–35 µm), exine thin, tectate, annulate, arcuate (arci faint to distinct), verrucate.

Specimens: UFP 19, 18.6 × 96.9

Description: Monad, radial, isopolar, amb polygonal, stephanoporate, 3–5-porate, pores annulate arcuate, lolongate, 3 µm wide, 1.5 µm long, annuli 2 µm wide, 1.5 µm thick, protruding, arci faint to distinct, pores sometimes located slightly above equatorial plane; tectate, exine 0.5–1.0 µm thick, thickening around pores to 1.5 µm, sexine slightly thickening in a sweeping band

from one aperture to the other, columellae indistinct; sculpture verrucate, verrucae 1–2 µm long, 1–2 µm wide, 0.5 µm long, rounded to slightly elongate, homogeneous, distributed densely. Dimensions: Equatorial diameter 26 (31) 35 µm, SD 3.2; equatorial diameter length/width 1.1, nm: 11; no: 20.

Affinities: Ulmaceae, *Ulmus* type (MULLER 1981).

Genus *Venezuelites* MULLER et al. 1987

Venezuelites? distinctus n. sp.

Plate 21, Figs. 28–29

Diagnosis: Psilastephanoporate, small to mid-sized (26–40 µm), rhombic, pores annulate, protruding and above equator.

Specimens: Holotype UFP 43, 11.2 × 85.6, pl. 21, figs. 28–29

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After unique wall structure and shape.

Description: Monad, radial, anisopolar, amb rhombic; stephanoporate, ectopores annulate, operculate, circular, 3 µm wide, 3 µm long, pores located above equatorial zone, annuli 2 µm wide, 2–2.5 µm thick, protruding, operculum 2.5–3.0 µm wide with a similar structure as annuli; tectate, exine 1.5 µm thick, nexine 0.5–1.0 µm thick, columellae < 0.5 µm thick, tectum < 0.5 µm thick, exine thickening around pores to 2–2.5 µm, columellae indistinct; sculpture psilate to sparsely micropitted, lumina < 0.5 µm wide. Dimensions: Equatorial diameter length 25 (29.4) 35 µm, SD 4; equatorial diameter width 27 (32) 40 µm, SD 5.1, polar/equatorial diam. 0.9, nm: 5; no: 5.

Comparisons: Very similar to genus *Venezuelites* MULLER et al. 1987 although annuli are thinner. *Venezuelites globoannulatus* MULLER et al. 1987 has thicker annuli (9 µm), and a thicker exine (2.5 µm), *Fibulapolllis* CHLONOVA 1961 has wing-like structures, *Doualaidites* LEGOUX et al. 1971 has three archs parallel to the polar arch.

Genus *Verrustephanocolpites* VAN DER HAMMEN & GARCIA 1966

Verrustephanocolpites rugulatus n. sp.

Plate 21, Figs. 30–31

Diagnosis: Stephanocolpate, mid-sized (34–38 µm), intectate, colpi short, surrounded by 2 ridges, 1.5–2.5 µm high, verrucate to rugulate.

Specimens: Holotype UFP 27, 18.2 × 109.2, pl. 21, figs. 30–31

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Arcillas de El Limbo Formation, late Paleocene.

Etymology: After rugulate sculpturing.

Description: Monad, radial, isopolar, amb circular; stephanocolpate, five-colpate, ectocolpi marginate, CEi 0.25, colpi short, indistinct, borders straight, ends rounded, margines composed of 2 concentric ridges that are surrounding colpi, inner ridge 2–3 µm wide, 2.5 µm thick, outer ring 2–3 µm wide, 1.5 µm thick, ridges 0.5–1 µm apart; intectate, nexine 1 µm thick; sculpture verrucate to rugulate, verrucae 1.5 µm wide, 1.5–3 µm high, 0.5–1.0 µm long, elongated to rounded, sometimes two or more verrucae fuse forming short ridges. Dimensions: Equatorial diameter 34 (36) 38 µm; equatorial diameter length/width 1.1, nm: 2; no: 2.

Comparisons: *Ctenolophonidites* VAN HOEKEN-KLINKENBERG 1966 has endexinous thickenings fusing at poles to form a ring, *Cristatricolpites* LEIDELMEYER 1966 has distinct columellae, and it is psilate.

Genus *Verrustephanoporites* LEIDELMEYER 1966

Verrustephanoporites sp. 1

Plate 22, Figs. 1–2

Diagnosis: Stephanoporate, small-sized (29 µm), tectate, columellae indistinct, pore costate, lalongate, microverrucae densely, microgemmae, microbacula, and microclavae scattered.

Specimens: UFP 43, 4.3 × 104

Description: Monad, radial, isopolar, amb circular; stephanoporate, 5-porate, pores costate, lalongate, 4 µm wide, 2 µm long, costae 2 µm wide, 1 µm thick; tectate, exine 0.5–1.0 µm thick, exine thin, nexine thickens around pore to 1.5 µm, columellae indistinct; sculpture microverrucate with scattered microgemmae, microbacula, and microclavae, all elements < 1.0 µm long, 0.5–1.0 µm wide, 0.5–1.5 µm apart, circular, distributed densely, elements slightly larger (microbacula and microclavae) near pores. Dimensions: Equatorial diameter 29 µm; equatorial diameter length/width 1.1, nm: 1; no: 2.

Comparisons: *Gemmastephanoporites breviculus* GONZALEZ 1967 is larger (34–40 µm), gemmae are longer (1.1 µm) and wider (1.1–1.3 µm), and tectum is reticulate, *Verrutricolporites reticulatus* n. sp. is larger (31–57 µm), has very short colpi, verrucae 1–1.5 wide/0.5 long, and dense micropitting, *Nothofagidites* sp. 1 has lolongate pores, and sculpturing is shorter (< 0.5 µm).

Genus *Verrutricolpites* PIERCE 1961

Verrutricolpites sp. 1

Plate 22, Figs. 3–4

Diagnosis: Verrutricolpate, mid-sized (33 µm), colpi very long, marginate, margines protruding, verrucae rounded to angular, irregularly shaped, 0.5 µm long.

Specimens: UFP 49, 8.8 × 87.2

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; tricolpate, ectocolpi marginate, CEi 0.97, very long, borders straight, ends pointed, margines protruding, 3 µm wide, 2 µm thick, polar area small, 3 µm wide; tectate, exine 1 µm thick, exine barely differentiated, thickening near colpi to 2 µm, columellae indistinct; sculpture verrucate, verrucae 1.5–3 µm wide, < 1.0 µm long, < 1.0 µm apart, distributed densely, angular to rounded to elongated, shaped irregularly, occasionally two verrucae fuse. Dimensions: Equatorial diameter 33 µm; equatorial diameter length/width 1.1, nm: 1; no: 1.

Comparisons: *Verrutricolpites isolatus* LEIDELMEYER 1966 has simple colpi and longer verrucae (3–3.5 µm).

Genus *Verrutricolporites* VAN DER HAMMEN & WYMSTRA 1964, emend. LEGOUX 1978

Verrutricolporites reticulatus n. sp.

Plate 22, Figs. 5–7

Diagnosis: Verrutricolporate or verrutriporate, mid-sized (31–57 µm), colpi often lacking, pore costate, large (4–10 µm wide), verrucae 1.5–2 wide, 0.5–1 µm long, micropitted densely to reticulate finely.

Specimens: Holotype UFP 43, 10.5 × 98, pl. 22, figs. 5–6; paratypes UFP 49, 7.6 × 105.5, pl. 22, fig. 7; UFP 46, 21.5 × 104; UFP 49, 19 × 103

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After reticulate sculpturing.

Description: Monad, radial, isopolar, amb triangular-obtuse-convex; triporate, tricolporate, or 4-colporate, ectocolpi simple, CEi 0.2–0.4, sometimes lacking, indistinct, borders straight, ends pointed, polar area large, 17 µm wide, endopores costate, lalongate, 4–10 µm wide, 3–6 µm long, pores large, borders irregular, costae distinct, 4 µm wide, 1.5–2 µm thick; tectate, exine 1 µm thick, nexine < 0.5 µm thick thickening around colpi to 2 µm, columellae distinct, 0.5 µm wide; sculpture verrucate, verrucae 1.5–2 µm wide, 0.5–1 µm long, sparsely distributed, surface interverrucae micropitted to finely reticulate, lumina < 1.0 µm wide, circular, distributed densely. Dimensions: Equatorial diameter 31 (40.5) 57 µm, SD 6.9; equatorial diameter length/width 1, nm: 35; no: 59.

Comparisons: *Gemmastephanoporites breviculus* GONZALEZ 1967 is gemmate, *Retistephanoporites festivus* GONZALEZ 1967 is very similar but lacks verrucae.

Genus *Wilsonipites* SRIVASTAVA 1969

Wilsonipites margocolpatus MULLER et al. 1987

Plate 22, Fig. 8

Diagnosis: Tricolporate, mid-sized (30 µm), colpi very long, almost syncolpate, marginate, micropittted.

Specimens: UFP 57, 6.4 × 102.3

Description: Monad, radial, isopolar, amb circular; tricolporate, ectocolpi marginate, CEi 0.9, very long, almost syncolpate, borders straight, ends rounded, margines 2 µm wide, polar area very small, 2 µm wide; endopores simple, circular, 2 µm wide, 2 µm long, pores indistinct; tectate, exine 1 µm thick, columellae barely distinct, < 1.0 µm wide, < 0.5 µm apart; sculpture micropitted, lumina < 0.5 µm, rounded, uniform, distributed densely, muri < 1.0 µm wide. Dimensions: Equatorial diameter width 26 µm; equatorial diameter length 30 µm; equatorial diameter length/width 1.2, nm: 1; no: 1.

Genus *Zonocostites* GERMERAAD et al. 1968

Zonocostites minor n. sp.

Plate 22, Figs. 9–11

Diagnosis: Psilatricolporate, small-sized (12–15 µm), prolate to subprolate, aperture equatorial elongated to fused, costate, slightly fastigiate, micropitted to almost psilate at equator.

Specimens: Holotype UFP 90, 6.5 × 97.9, pl. 22, fig. 10; paratypes UFP 90, 8.4 × 92, pl. 22, fig. 9; UFP 91, 15.4 × 97.5, pl. 22, fig. 11

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; San Fernando Formation, middle Eocene.

Etymology: After small grain-size.

Description: Monad, radial, isopolar, prolate to subprolate, amb triangular-obtuse-convex; tricolporate, ectocolpi simple, mid-sized, borders straight, ends pointed, endocolpus elongated equatorially to zonate, costate, costae 0.5 µm wide, 0.5–1.0 µm thick, distinct, slightly fastigiate in polar view; tectate, exine 0.5–1.0 µm thick, columellae slightly distinct; sculpture micropitted, often almost psilate at equator. Dimensions: Equatorial diameter width 14.5 µm; equatorial diameter length 16 µm; equatorial diameter length/width 1.1, nm: 1; equatorial diameter 10 (11) 12 µm, SD 0.7; polar diameter 12 (13) 15 µm, SD 1, polar/equatorial diam. 1.2, nm: 11; no: 12.

Comparisons: *Zonocostites ramonae* GERMERAAD et al. 1968 is very similar but consistently larger (16–19 µm) and subprolate to circular, *Zonocostites duquensis* DUEÑAS 1980 has a distinct reticulation.

4.4 Dinoflagellate cysts and other algae

Phylum **Pyrrhophyta** PASCHER 1914

Class Dinophyceae FRITSCH 1929

Order Peridiniales HAECKEL, 1894

Genus *Achomosphaera* EVITT 1963

Achomosphaera sp. 1

Plate 22, Fig. 12

Specimens: UFP 34, 6.4 × 94

Description: Body spherical, apiculocavate, skolochorate, processes parasutural, gonal and intergonal; primary bifurcations generally are trifurcated one time, bifurcate in intergonal, trifurcate in gonal positions, no septa connecting process bases, occasionally a parasutural septa connects two adjacent process bases, processes 7–10 µm long, < 1 µm wide, 6–8 µm apart, hollow, closed distally, tips 3–5 µm long, paratabulation could not be determined, cyst wall psilate. Dimensions: Length 56 (54) 60 µm, SD 4.8; width 40 (49) 59 µm, SD 6.6; length/width 1.1, nm: 4; no: 12.

Comparisons: This genus has a large intraspecific morphological variation.

Genus *Cordosphaeridium* EISENACK 1963

Cordosphaeridium inodes (KLUMPP 1953) EISENACK 1963 emend. MORGENROTH 1968

Plate 22, Figs. 13–17

Diagnosis: *Cordosphaeridium*-type, processes intratabular, fibrous, open distally, wall finely reticulate. Dimensions: Length 65 (77.5) 100 µm, SD 12.5; width 50 (72.5) 100 µm, SD 17.2; length/width 1.1, nm: 6; no: 36.

Specimens: UFP 42, 20.6 × 95.7; UFP 34, 4 × 95.2; UFP 34, 10.5 × 102.5

Genus *Coronifera* COOKSON & EISENACK 1958

Coronifera sp. 1

Plate 22, Fig. 18

Specimens: UFP 21, 13.1 × 80

Description: Cyst spheroid, skolochorate, multiple nontabular processes closed distally and a single large antapical process, no parasutural features, antapical process single, large, wide, open distally, 10 µm wide, 10 µm long, cylindrical, entire, other processes are > 60, nontabular, 7–8 µm long, 0.5–1.0 µm wide, 1.5–3 µm apart, distributed densely, tapering, hollow, closed distally, acuminate, cyst wall psilate, archeopyle precingular. Dimensions: Length 50 µm; width 40 µm; length/width 1.3, nm: 1; no: 1.

Comparisons: Cyst preservation precludes species assignment.

Genus *Glaphyrocysta* STOVER & EVITT 1978

Glaphyrocysta sp. 1

Plate 22, Figs. 19–21

Specimens: UFP 39, 18.4 × 104.3

Description: Cyst marginate, body lenticular, apiculocavate, process complexes not clearly defined, arcuate penitabular each with many branched stalks, joined to one another by a simple, slender trabeculae, process complexes absent from midventral and middorsal areas, wall between processes finely reticulate, lumina < 0.5 µm, parasulcal notch offset, archeopyle apical, type (tA), operculum free, paratabulation given by process complexes is not clear, paracingulum indicated by 3 slender processes. Dimensions: Width 70 (70) 70 µm; length 55 (57.5) 60 µm; length/width 0.8, nm: 2; no: 2.

Comparisons: Large intraspecific variation within this genus.

Genus *Homotryblium* DAVEY & WILLIAMS 1966

Homotryblium floripes (DEFLANDRE & COOKSON 1955) STOVER 1975

Plate 22, Figs. 22–24

Diagnosis: Skolochorate, AP: A(3A)6P, processes long, intratabular. Dimensions: Length 70 (85.5) 100 µm, SD 11.1; width 65 (73.4) 82 µm, SD 7.26; length/width 1.2, nm: 5; no: 65.

Specimens: UFP 37, 11.3 × 90.1

Genus *Hystrichokolpoma* KLUMPP 1953

Hystrichokolpoma sp. 1

Plate 23, Figs. 1–4

Specimens: UFP 37, 12 × 107; UFP 43, 20 × 80.8

Description: Cyst spherical, skolochorate, processes intratabular, processes 12–17 µm long, 3–4 µm wide, 8–10 µm apart, tubiform, hollow, open distally, patulate to aculeate to digitate, wall between processes micropitted, parasulcus and paracingulum indicated by intratabular processes, AP (tA), 6″ 6c 6‴ 1⁗ Dimensions: Length 60 µm; width 65 µm; length/width 0.9, nm: 1; no: 2, this measure does not include apical plates, because archeopyle was detached.

Comparisons: This type of process shape has not been reported in any *Hystrichokolpoma* species.

Genus *Lingulodinium* WALL 1967

Lingulodinium cf. *sicula* (DRUGG 1970) WALL & DALE in WALL et al. 1973

Plate 23, Figs. 5–6

Diagnosis: *Operculodinium*-type, processes nontabular, subconical, closing distally, acuminate to evexate. Dimensions: Length 50 (55) 60 µm; width 40 (46.5) 53 µm; length/width 1.1, nm: 2; no: 3.

Specimens: UFP 39, 10.3 × 92.2; UFP 43, 15.7 × 103

Comparisons: Cysts very similar to *L. sicula* although archeopyle type could not be determined.

Genus *Nematosphaeropsis* DEFLANDRE & COOKSON 1955

Nematosphaeropsis sp. 1

Plate 23, Figs. 7–9

Specimens: UFP 34, 18.6 × 82

Description: Cyst spheroidal, acavate, skolochorate, parasutural, processes 12–15 µm long, < 1 µm wide, flared, hollow, open distally, tips of adjacent processes connected by a complex network of ribbon-like trabeculae, in some sectors of the grain trabeculae form a sheet-like layer with elongated perforations, wall between processes finely reticulate, lumina < 1.0 µm wide. Dimensions: Length 60 (76.5) 90 µm; width 55 (72) 80 µm; length/width 1.1, nm: 3; no: 3.

Comparisons: Preservation of cysts precludes species assignment

Genus *Polysphaeridium* DAVEY & WILLIAMS 1966

Polysphaeridium subtile DAVEY & WILLIAMS 1966 emend. BUJAK et al. 1980

Plate 23, Figs. 10–11

Diagnosis: Skolochorate, AP: A(3A)6P, processes long, narrow, cylindrical and nontabular. Dimensions: length 55 (61) 68 µm, SD 4.6; width 40 (56) 66 µm, SD 9.7; length/width 1.1, nm: 5; no: 74.

Specimens: UFP 34, 6.1 × 114.9

Genus *Spiniferites* MANTELL 1850

Spiniferites sp. 1

Plate 23, Figs. 12–13

Specimens: UFP 34, 17.8 × 98.9

Description: Cyst *Spiniferites*-type, processes 10–12 µm long, 1–2 µm wide, tapering, hollow, open distally, bifurcate intergonal and trifurcate gonal, sometimes two or more joined at the bases by a ridge, wall between processes reticulate, lumina < 1.0 µm wide. Dimensions: Length 60 µm; width 56 µm; length/width 1.1, nm: 1; no: 7.

Comparisons: Large intraspecific variation in this genus.

Genus *Systematophora* KLEMENT 1960

Systematophora? sp. 1

Plate 23, Figs. 14–15

Specimens: UFP 37, 12.5 × 83.6

Description: Cyst lenticular, proximochorate, processes 5–6 µm long, distributed densely, > 60, 5–6 µm long, 0.5–1 µm wide, 3–4 µm apart, subconical to tapering, hollow, open to close distally, acuminate to slightly aculeate, occasionally two or more processes joined at the base by a ridge seeming arcuate penitabular complexes, wall between processes finely reticulate, lumina < 1.0 µm. Dimensions: Length 53 µm; width 42 µm; length/width 0.8, nm: 1, measure does not include apical plates because archeopyle is detached; no: 1.

Comparisons: The archeopyle type could not be determined, also it is not clear if the processes are grouped in arcuate penitabular complexes. These data would confirm its affinity to *Systematophora* KLEMENT 1960.

4.5 Incertae sedis

Genus *Cyclusphaera* ELSIK 1966

Cyclusphaera scabrata n. sp.

Plate 9, Figs. 7–8

Diagnosis: Elliptic grain, mid-sized (25–60 µm), two symmetric large openings lined by a thickening of grain wall, scabrate-verrucate.

Specimens: Holotype UFP 32, 5.9 × 89.2, pl. 9, figs. 7–8; paratype UFP 49, 3.6 × 113

Type locality: Piñalerita Creek near Sabanalarga, 73° 1′ W – 4° 54′ N, Colombia; Areniscas de El Limbo Formation, early to middle Eocene.

Etymology: After scabrate sculpturing.

Description: Monad, radial, isopolar, amb elliptic; two symmetric large openings, width 1/3 of grain diameter, lined by thickening of grain wall, thickening 0.5–1 µm wide; wall 0.5 to 2 µm thick, thicker at the equator and around openings; sculpture scabrate-verrucate, scabrae < 0.5 µm wide, verrucae 1 µm wide, very few; sculpture restricted to area above equator and below openings, in some grains sculpturing is produced by fragmentation of wall, tendency upsection to increase range of grain size, also there is a trend in reducing size of sculpturing and width of thickening lining aperture. Dimensions: Equatorial diameter width 22 (28) 40 µm, SD 5.1; equatorial diameter length 25 (39) 60 µm, SD 8.4; equatorial diameter length/width 1.4, nm: 24; no: 61.

Comparisons: *Cyclusphaera euribei* ELSIK 1966 does not exhibit a thickening of the wall surrounding aperture, wall is psilate, and openings are wider, *Cyclusphaera doubingeri* SALARD-CHEBOLDAEFF 1978 is reticulate/perforate.

Incertae sedis sp. 1

Plate 22, Figs. 25–26

Specimens: UFP 41, 23 × 95.4

Description: Rhombic psilate grain, with a thin wall that thickens at the vertices of the grain, wall 0.5–1.5 µm thick. Dimensions: Length 50 (54) 60 µm; width 45 (50) 54 µm; length/width 1.1, nm: 3; no: 3.

Affinities: Probably a type of Zygnemataceae (green algae), genus *Mougeotia*.

5. Biostratigraphy

Pollen and spore biostratigraphers should not expect many widespread synchronous first and last occurrences in the stratigraphic record. Many variables like migration, non preservation, geographic barriers, and local extinctions can truncate the geological range of a taxon (MANN & LANE 1995). Pollen and spore distributions in tropical environments are strongly controlled by the geographic distribution of the plants from which they are produced. However, this fact has not been fully considered in the previous palynological zonations proposed for the Paleocene-Eocene interval in northern South America (VAN DER HAMMEN 1957a, b, LEIDELMEYER 1966, GONZALEZ 1967, GERMERAAD et al. 1968, REGALI et al. 1974, MULLER et al. 1987). For example, some zones have been based on pollen produced by mangrove elements (*Psilatricolporites crassus* zone, GERMERAAD et al. 1968). A zone like that clearly would be controlled by facies, and would lead to the recognition of a false "hiatus" in continental areas where mangrove vegetation was not present. This may be one of the reasons for the many hiatuses proposed during the Eocene in the Colombian-Venezuela region (COLMENARES & TERÁN 1993).

In this study, the pollen and spore distribution of upper Paleocene-Eocene strata was analyzed using the technique of graphic correlation (SHAW 1964). For a detailed explanation of this technique see EDWARDS (1984, 1989). This method dismisses narrative-type scenarios and produces alternative hypothesis that can be expressed in testable forms (MANN & LANE 1995). Graphic correlation does not make the a priori assumption that first and last appearances in a section, record speciation and extinction events. By combining the information of multiple sections, the method allows the true stratigraphic range of a taxon to be determined; therefore, the use of an "index" fossil is not necessary because the whole assemblage is being compared. This approach also produces a biostratigraphic framework that can be challenged constantly as new information (more sections) becomes available. On the contrary, "traditional" zonations such as the ones currently used in northern South America, are static and authoritative, strongly relying upon one biostratigrapher's interpretation of the chronostratigraphic importance of a few given taxa. Graphic correlation has been successfully used by many authors and specially by Amoco researchers for many years (CARNEY & PIERCE 1995).

Using the graphic correlation technique, a Composite Section (CS) was developed based on the stratigraphic distribution of pollen, spores, and dinoflagellate cysts of the three sections studied (see range charts in Tables 1–4, and Text-figs. 2–5, the tables also are available as Excel spreadsheets upon request from first author) and two additional sections, the only ones available from literature with palynomorph range charts and samples referenced to a stratigraphic position in a measured section (Tibui section in Catatumbo area after GONZALEZ 1967, and well T1 in Maracaibo Basin after RULL 1997). Eighty-four palynomorph taxa were selected to be used in this graphic correlation. This selection was based upon common occurrence in all or most of the sections and their chronostratigraphic potential based on experience of previous zonations (GERMERAAD et al. 1968, REGALI et al. 1974, MULLER et al. 1987). The Piñalerita section was chosen as the Reference Section, because it had the most complete sampling encompassing from the upper Paleocene to the Middle Eocene. Five rounds of correlation were performed on the five stratigraphic sections in order to produce a Composite Section (Text-figs. 6–9). The first and last appearance datums of the taxa in the final Composite Section (CS) are shown in Table 5. The general sequence of events, first appearance datums (FAD) and last appearance datums (LAD), of the Composite Section (CS) is similar to those of previous zonations (Table 5 for datums, c.u. indicates composite unit, Text-figs. 6–9). The sequence of *Foveotricolpites perforatus* FAD (81 composite units c.u.); *Retibrevitricolpites triangulatus* FAD (245 c.u.); *Foveotricolpites perforatus* LAD (310 c.u.); *Ephedripites vanegensis* LAD (312 c.u.); *Retidiporites magdalenensis* LAD (312 c.u.); *Bombacacidites annae* LAD (325 c.u.); *Cricotriporites guianensis* FAD (475.2 c.u.); *Foveotriporites hammeni* FAD (490 c.u.); *Monoporopollenites annulatus* FAD (568 c.u.); *Cicatricosisporites dorogensis* FAD (605 c.u.); *Perisyncolporites pokornyi* FAD (612 c.u.); *Lanagiopollis crassa* FAD (637 c.u.); and *Rugotricolpites felix* LAD (725 c.u.) mostly agrees with previous zonations.

There are some discrepancies with the zonation of GERMERAAD et al. (1968) and MULLER et al. (1987) specially within the Eocene. Taxa, which according to these zonations should not be overlapping, do overlap (e.g., *Cicatricosisporites dorogensis* and *Rugotricolpites felix*, see Table 5). Most of the taxa ranges in

Table 1. Palynomorph distribution in samples from the Piñalerita section. See Table 4 for stratigraphic position of the samples.

Taxa / Sample code UFP	1	4	5	6	7	8	9	10	11	12	15	16	17	18	19	21	25	26	27	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Aglaoreidia ? foveolata						6																															
Apiculatasporites obscurus			1								3				1	1																		1		1	
Apiculatasporites ? cingulatus																															2						
Araliaceoipollenites ? sp. 2																													1	1	1		1				
Araucariacites sp. 1															1																						
Araucariacites sp. 2					1				1														1														
Arecipites regio		3	9	18	16	5	5	6	10	3	3			1					1																		
Baculamonocolpites hammenii																										1			3		1						
Baculamonocolpites sp. 2																										1											
Baculatisporites sp. 1																													1							1	
Baculatisporites sp. 2																													1								
Bacutriporites echinatus																													1								
Bombacacidites annae			34	70	4	18	5	9	3		29	3	60		6	3																					
Bombacacidites brevis																									1		1		1		2	1	9	7	7	4	19
Bombacacidites fossureticulatus																									3	8	3	2	1		1						
Bombacacidites foveoreticulatus																																					1
Bombacacidites gonzalezii																															1	6					7
Bombacacidites nacimientoensis																						1			1		1		3	1	1	1				2	
Bombacacidites protofoveoreticulatus			1		2		1		2		2	1																									
Bombacacidites simplireticulatus																									1												
Bombacacidites soleaformis																																					1
Bombacacidites sp. 1							1																														
Bombacacidites sp. 2									1		1				1																						
Bombacacidites sp. 3																																					1
Bombacacidites sp. 4																																	1				
Bombacacidites sp. 5																													1								1
Brevitricolpites macroexinatus																																		1			1
Brevitricolpites microechinatus													1																								
Brevitricolpites sp. 1															1																						
C. dorogensis subsp. *minor* forv. *rugulatearis*																						2			1									1			1
Chomotriletes minor																								2		1											
Cicatricosisporites dorogensis																						10			1	4	7	6	5	15	4	22	26	64	15	89	14
Cicatricosisporites sp. 1			1																																		
Cicatricososporites decussatus																																1					
Cicatricososporites eocenicus																									1						3	3	2		1		1
Clavamonocolpites sp. 1																																			4	1	3
Clavatisporites mutisii										1																											
Clavatricolpites densiclavatus																						3			2	15	9	8	13	2	6	4		4	2	1	4
Colombipollis tropicalis									1																												
Corsinipollenites psilatus	3	1	1	1	1		2			1	2	1	8																								
Corsinipollenites undulatus																						1									2			1		1	
Cricotriporites elongatoporus																																1	1		2	1	
Cricotriporites guianensis																			1																		
Cricotriporites macroporus																				1												1		1		4	

Table 1. (continued)

Taxa / Sample code UFP	1	4	5	6	7	8	9	10	11	12	15	16	17	18	19	21	25	26	27	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Crusafontites megagemmatus																															2						
Cricotriporites minutiporus																													1								
Crototricolpites protoannemariae			1	6				3	1		2		4		31																						
Ctenolophonidites cruciatus																									1												
Curvimonocolpites inornatus		5	2	2	1	4		2																													
Cyclusphaera scabrata																				6		1			1		1				1	6	1	6	2	2	15
Echimonocolpites sp. 1					1				4	1					3																						
Echinatisporis brevispinosus																						1										4	5			1	4
Echiperiporites estelae																									2					1	1	2		3	5	10	
Echiperiporites sp. 1				1																																	
Echitetracolpites ? sp. 1																									1	1			6		1	1	1		1	1	3
Echitetracolpites ? tenuiexinatus																													5		4	1	1	1		2	5
Echitricolpites sp. 1											2		2																								
Echitriporites sp. 1																																1					
Echitriporites sp. 3			1																																		
Echitriporites trianguliformis var. orbicularis																						6			2	4	8	3	7	2	12	4	4	2	3		1
Echitriporites variabilis																						1			3	1	1	3	1	1	1	4			3		16
Ephedripites vanegensis						1	1	4	2																												
Foveodiporites guianensis		2																																			
Foveotricolpites perforatus							1	1		2			4		2																						
Foveotricolpites sp. 1																						1															
Foveotricolporites fossulatus																									2				1		3						
Foveotricolporites rugulatus																						1												1	2	3	11
Foveotricolporites sp. 1																						1															
Foveotricolporites sp. 2																															1						
Foveotricolporites sp. 3																				1																	
Foveotricolporites sp. 4																2																					
Foveotriletes margaritae (RW?)																										1							1				
Foveotriletes sp. 1																															1						1
Foveotriporites hammenii																						12			2				2	2	3	2			1	3	
Foveotriporites sp. 1																																					2
Gemmamonocolpites gemmatus		5				1																															
Gemmamonocolpites perfectus																									1		1				1						
Gemmamonocolpites sp. 2			1																																		
Horniella sp. 1																															1						1
Horniella sp. 2																				1										1							
Horniella sp. 3																2			1				1					1				1			1		2
Ischyosporites problematicus											4	1							1																		
Jandufouria minor																								1							1	4	8		2	1	6
Kirchheimerisporites tenuiradiatus																																3					
L. proxapertitoides var *reticuloides*																			*246*	*1*								*1*	*5*	*2*	*2*	*3*	*1*			*1*	
L. proxapertitoides var. *proxapertitoides*								1					1		1	1			148	1						1											
Ladakhipollenites rubinii																													1	1		2					
Ladakhipollenites simplex																											2	1									

Table 1. (continued)

Taxa / Sample code UFP	1	4	5	6	7	8	9	10	11	12	15	16	17	18	19	21	25	26	27	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Laevigatasporites sp. 1				1					2		5		9		1																						
Laevigatosporites sp. 1							1																														
Laevigatosporites sp. 2																									1												
Laevigatosporites tibuensis				1		2		1	2		25	6	9		13	3				8		22	1	4	4	48	126	169	186	39	65	39	72	52	27	41	57
Lakiapollis aff. *ovatus*																													1								
Lanagiopollis crassa																						31	3		11	36	34	2	13	7	63	4	1	3	1	6	17
Longapertites microfoveolatus									4	2																											
Longapertites sp. 1																											1		2		1						1
Luminidites colombianensis																									1								1				
Lymingtonia ? sp. 1													1																								
M. franciscoi var. *minutus*			1		1			1	3	2	1		4		2	1				5		1				5	7	13	10	1	2	1			3	2	1
M. franciscoi var. *pachyexinatus*																							2				3	3	1	1							
Margocolporites sp. 1																													1								
Margocolporites sp. 2																									1	1											
Mauritiidites franciscoi var. *franciscoi*	1	11	8	6	3	43	17	35	2	15	7		14		17	1			1	1		9	1	3	1	32	10	22	22	6	5	15	4	5	6	7	7
Microfoveolatosporis skottsbergii																																					1
Momipites africanus			2	2																																	
Momipites sp. 1																										1			4		1					2	2
Monocolpopollenites ovatus						20		9		3	180		33		25	14			1	1		4	1		4	9	8	3	6	2	7	7	5	5	2	8	12
Monoporopollenites annulatus																				6		1			1	1	1			1	2	3	3	1	3	3	
Multiporopollenites pauciporatus																						6			3	10	9	1	6	2	1		1		2		
Nothofagidites huertasii																																		5	13		
Osmundacidites minor																																	4	2			
Paleosantalaceaepites distinctus											1		2																								
Parsonsidites sp. 2																																			1		
Parsonsidites ? sp. 1	1																																				
Perfotricolpites digitatus																									1				1								
Periretisyncolpites sp. 1			3		2								1																								
Perisyncolporites pokornyi																						6			4	3	1	1	4	3	10	13	9	14	11	49	7
Planisporites sp. 2																									1												
Planisporites ? sp. 1																							1	1	1												
Poloretitricolpites absolutus																																1					
Polypodiaceoisporites ? *fossulatus*							1		2											1					1				1		2	2	6			3	
Polypodiisporites aff. *specious*																						1			2	33	32	35	13	22	31	21	86	12	12	15	14
Polypodiisporites echinatus									1																												
Polypodiisporites pachyexinatus																3																					
Polypodiisporites sp. 2																																					1
Polypodiisporites sp. 3				1				1		1	1				1	1																					
Propylipollis pseudocostatus																						1															
Proxapertites cursus		1	2	1	1	97	1	253		8	6	4	6				2									1	1										
Proxapertites humbertoides			13	1					1	1	2		10							2	1	1										2			1		
Proxapertites magnus		2		16	6	12	16	5	6	6	18	6	57		4	2	1								1			1									
Proxapertites operculatus			1	1	1	61	4	61	1	21	4	4	26	2	25	4	1	2				1					1				2					1	
Proxapertites psilatus					1				1											2	3	1			2			1	4	1	2						3

Table 1. (continued)

Taxa / Sample code UFP	1	4	5	6	7	8	9	10	11	12	15	16	17	18	19	21	25	26	27	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Psilabrevitricolpites sp. 1			1								9																										
Psilabrevitricolporites simpliformis				1	2								1		1																						
Psilabrevitricolporites sp. 1																												1									
Psilabrevitricolporites sp. 2																													1								
Psilabrevitricolporites triangularis																										1					1						1
Psilamonocolpites grandis		57	4	3	2		6	1				1	2			1																					
Psilamonocolpites medius		8	4	15	5	4	2	8	3	1	2		6		3	2	1			4		3		5	1	6		1			5	4	8	6	3	4	3
Psilastephanocolpites sp. 1																																					1
Psilastephanocolpites sp. 2																													1								
Psilastephanocolporites brevicolpatus																						1			1				1		1						
Psilastephanocolporites fissilis																							1		1						2				2	1	
Psilastephanoporites sp. 2															1																						
Psilasyncolporites sp. 2																														1							
Racemonocolpites facilis																				1		1												1			1
Racemonocolpites racematus					1																																
Racemonocolpites sp. 1																				1																1	
Ranunculacidites operculatus																												1									
Retibrevitricolpites retibolus																												6									
Retibrevitricolpites sp. 2																												1									
Retibrevitricolpites triangulatus																										1	1	3									
Retibrevitricolpites ? sp. 1																																					2
Retibrevitricolporites grandis																				9	1	2	1		2	5			1		2	3	1	4	30	12	38
Retibrevitricolporites speciosus																				1								10	2		3						
Retidiporites elongatus											1																										
Retidiporites magdalenensis		33			2	38	2	5							2																						
Retidiporites poricostatus						1																															
Retipollenites sp. 1			1																																		
Retipollenites sp. 2												1																									
Retistephanocolpites angeli					2				1		2		2		1	2																					
Retistephanocolpites fossulatus																											1		1		1	6	6	1	8	2	9
Retistephanocolpites sp. 1																													1								
Retistephanocolpites sp. 2																															1						
Retistephanocolporites festivus																									1		2		1		1		4	3	2		3
Retistephanocolporites fossulatus																									3							1					
Retistephanoporites minutiporus																									1	1	2	3	11	3	16	5					
Retistephanoporites angelicus																																1	19	12	7	12	4
Retistephanoporites crassiexinatus																									1												
Retisyncolporites sp. 1																																					1
Retisyncolporites sp. 2																				1		1															
Retitrescolpites baculatus									1													1							2	2	1					2	5
Retitrescolpites magnus																						1			6	28	15	4	9	4	4	1		1			
Retitrescolpites peculiaris							4				1		2		7																						
Retitrescolpites saturum											1				1																						
Retitrescolpites ? *irregularis*																				1		1			1		3		1		1	2		1		2	3

Table 1. (continued)

Taxa / Sample code UFP	1	4	5	6	7	8	9	10	11	12	15	16	17	18	19	21	25	26	27	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Retitriletes sp. 1																																		2		2	
Retitriporites amplireticulatus											2																										
Retitriporites poricostatus																									1										1		
Retitriporites sp. 1					1																																
Retitriporites sp. 2																													1								
Retitriporites sp. 3																											1										
Retitriporites sp. 4																															1						
Rhoipites cienagensis																											1							2			
Rhoipites guianensis																						3			3	19	17	9	4	17	12	10		1	5	8	1
Rhoipites hispidus																												5	1	1	1	1					6
Rhoipites sp. 1																																2					
Rhoipites squarrosus																											1										
Rhoipites ? sp. 2																													1						1		2
Rousea florentina																																					1
Rugotricolporites felix																									1												
Scabramonoletes ? sp. 1			2																																		
Scabrastephanocolpites sp. 1																			1																		
Siltaria mariposa																			1																		
Siltaria media																				4	1					3											4
Siltaria sp. 1																													3								
Siltaria sp. 2																															1	1	1				
Siltaria sp. 3																																					
Siltaria sp. 4																											1	2				2	1	1	2		1
Siltaria sp. 5									10	2					2																						
Spinizonocolpites breviechinatus			1	2		1			1	1	2				4																						
Spinizonocolpites grandis																						20	3		5	7	9	2	6	6	4						
Spinizonocolpites pachyexinatus																	5																				
Spirosyncolpites spiralis																				15		3	4	2	1	3	1	1	1			9		5	8	5	25
Striatopollis catatumbus																				2		2			1				1		1	6	3	3	2	3	9
Striatopollis minor													1																								
Striatopollis sp. 1									1			1																									
Striatricolporites digitatus				1																																	
Striatricolporites sp. 1															1	1				1		1										1					
Syncolporites lisamae										1																											
Syncolporites sp. 1																1																					
Tetracolporites pachyexinatus																									2		2					1					
Tetracolporites psilatus																															1			1	4	2	4
Tetracolporopollenites maculosus																										2			2	3	4	2	5	3	3	5	4
Tetracolporopollenites sp. 1																															1						
Tetracolporopollenites spongiosus				4					2		3				14	1																					
Tetracolporopollenites transversalis														1						2			2		4	1	1	4	1		1						
Tetracolporopollenites ? sp. 2																													1								
Tricolpites antonii																										2											
Tricolpites clarensis																			3			1	1			1		1			1						1

Table 1. (continued)

Taxa / Sample code UFP	1	4	5	6	7	8	9	10	11	12	15	16	17	18	19	21	25	26	27	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Tricolpites protoclarensis		2	1	3	3				2	1	3		2		2																						
Tricolpites sp. 1																																			1		
Tricolpites sp. 2																							1														
Tuberositriletes verrucatus																						1										2	3		2	2	3
Tuberositriletes ? sp. 1									2											1																	
Ulmoideipites krempii		1													1																						
Venezuelites ? *distinctus*																															1	1	1	1			
Verrustephanocolpites rugulatus																			1							1											
Verrustephanoporites sp. 1																															1	1					
Verrutricolpites sp. 1																																					1
Verrutricolporites reticulatus																				1	1	1			2	2	3				7	36		1			4
Zlivisporis blanensis													11			1																					
Zonocostites minor																															7	1	2	1			
Achomosphaera sp. 1																						6			1		1		1	2	1						
Cordosphaeridium inodes																						30							1	1	4						
Coronifera sp. 1																1																					
Glaphyrocysta sp. 1																											2										
Homotryblium floripes																									1	3	3	1	10	44	3						
Hystrichokolpoma sp. 1																									1						1						
Lingulodinium cf. *sicula*																											1		1		1						
Nematosphaeropsis sp. 1																						3															
Polysphaeridium subtile																						52		1		1	2		2	4	2	5					
Spiniferites sp. 1																						7															
Systematophora ? sp. 1																									1												
Incertae sedis sp. 1																													1			1			1		

Table 2. Palynomorph distribution in samples from the La Regadera section. See Table 4 for stratigraphic position of the samples.

Regadera Taxa sample code UFP	50	52	53	56	57	58	59	62	63	64	65	66
Albertipollenites? perforatus			1									
Apiculatasporites ? cingulatus			3	1								
Araucariacites sp. 1				1								
Baculamonocolpites hammenii												1
Bombacacidites foveoreticulatus										1		
Bombacacidites grahamii			1									
Bombacacidites psilatus			1									
Bombacacidites soleaformis					1							
Brevitricolpites microechinatus			2									
C. dorogensis subsp. *minor* forv. *rugulatearis*												1
Cicatricosisporites dorogensis										2	33	90
Clavatricolpites densiclavatus			7	2	2						3	1
Corsinipollenites undulatus				1	1	2						
Cricotriporites guianensis			2	3								
Cricotriporites macroporus			1									
Cyclusphaera scabrata			1	2	2						1	2
Echinatisporis brevispinosus			1		1							
Echiperiporites estelae												1
Echitetracolpites ? sp. 1											3	3
Echitetracolpites ? tenuiexinatus											7	4
Echitriporites sp. 2				2								
Echitriporites trianguliformis var. *orbicularis*											13	
Foveotricolporites rugulatus											3	1
Foveotriporites hammenii				2	2	4						
Horniella sp. 3						1						
L. proxapertitoides var. *proxapertitoides*		145		1		1						
Ladakhipollenites simplex								1				
Ladakhipollenites sp. 1			1									
Laevigatasporites sp. 1				1								
Laevigatosporites tibuensis			3	1	7	131					19	25
Lanagiopollis crassa											2	85
Longapertites proxapertitoides var *reticuloides*			25									1
Margocolporites vanwijhei			7									
Mauritiidites franciscoi var. *franciscoi*			4	2	3	5				2	10	14
Mauritiidites franciscoi var. *minutus*				1	2	2						
Mauritiidites franciscoi var. *pachyexinatus*			1									
Microfoveolatosporis skottsbergii			1									
Monocolpopollenites ovatus			7	2	2	3		7		1		
Monoporopollenites annulatus				2	2	1					1	
Nothofagidites huertasii										1		
Nothofagidites sp. 1											3	
Perisyncolporites pokornyi											6	7
Polypodiisporites aff. *inangahuensis*					1						1	
Polypodiisporites aff. *specious*								4		7	7	16
Polypodiisporites echinatus			11		1							
Proxapertites magnus			1									
Proxapertites operculatus										3	1	
Psilamonocolpites medius			14		1	1					3	1
Psilasyncolporites sp. 1			1		1							
Retibrevitricolpites sp. 2						3						
Retibrevitricolporites grandis			10	1	2							
Retistephanocolpites fossulatus						1						1
Retistephanocolporites festivus				1	6							
Retistephanoporites angelicus											6	15
Retisyncolporites angularis											1	1
Retitrescolpites ? irregularis					1						2	

Table 2. (continued)

Regadera Taxa sample code UFP	50	52	53	56	57	58	59	62	63	64	65	66
Scabratriporites sp. 1												1
Siltaria mariposa					1							
Siltaria sp. 2					1							
Siltaria sp. 3			1									
Spirosyncolpites spiralis			11	3	7						1	
Striatopollis catatumbus				3	1			1				
Striatopollis ? tenuistriatus			2			1						
Syncolporites marginatus				1								
Tetracolporites psilatus								1				
Tetracolporopollenites maculosus								1			5	12
Tetracolporopollenites transversalis				1	1							
Tetracolporopollenites? sp. 2						1						
Ulmoideipites krempii			12									
Venezuelites? distinctus											1	
Verrutricolporites reticulatus											1	
Wilsonipites margocolpatus					1							
Polysphaeridium subtile											1	4

Table 3. Palynomorph distribution in samples from the Uribe section. See Table 4 for stratigraphic position of the samples.

Uribe Taxa sample code UFP	74	75	76	78	79	80	81	82	83	84	85	86	87
Apiculatasporites obscurus												1	1
Apiculatasporites ? cingulatus									1	1			
Araliaceoipollenites ? sp. 1			1							2			
Baculamonocolpites hammenii					1								
Baculamonocolpites sp. 1								1					
Baculatisporites sp. 2	1						1						
Bacumorphomonocolpites tausae	1												
Bombacacidites brevis									2				
Bombacacidites nacimientoensis									1				
Bombacacidites psilatus								15	1			1	
Bombacacidites simplireticulatus													1
Brevitricolpites microechinatus			4			1						2	18
Camarozonosporites sp. 1										1			2
Chomotriletes minor					2		1	8	5				
Cricotriporites guianensis										3			
Crototricolpites cf. *annemariae*			1										
Cyclusphaera scabrata			1						2	1		3	4
Duplotriporites ariani			1					1				2	
Echinatisporis brevispinosus					2								
Echitriporites trianguliformis var. *orbicularis*									6				
Echitriporites variabilis								2					
Foveotriporites hammenii										2		2	
Gemmamonocolpites sp. 1										2			
L. proxapertitoides var. *proxapertitoides*			1					1					
Laevigatosporites tibuensis	2		1				1	2		51		13	14
Longapertites proxapertitoides var *reticuloides*								5	1				
Mauritiidites franciscoi var. *franciscoi*					1		1	4	1	7			
Mauritiidites franciscoi var. *minutus*			7						1	1			
Mauritiidites franciscoi var. *pachyexinatus*										1			
Monocolpopollenites ovatus	1		9		2			17	1	7		1	
Polypodiaceoisporites ? fossulatus										3		11	16
Polypodiisporites aff. *inangahuensis*										1		1	1

Table 3. (continued).

Uribe Taxa sample code UFP	74	75	76	78	79	80	81	82	83	84	85	86	87
Polypodiisporites aff. *specious*								2		5			
Polypodiisporites echinatus			11										
Polypodiisporites sp. 1			2					1					
Polypodiisporites sp. 2												1	
Proxapertites cursus								1					
Proxapertites humbertoides			2										
Proxapertites operculatus										5			
Proxapertites psilatus							2						
Proxapertites verrucatus	1	1	1										
Psilamonocolpites medius							1	3	1				
Psilastephanoporites sp. 1								1					
Pteridacidites sp. 1												1	1
Racemonocolpites facilis										1		1	1
Racemonocolpites racematus								1					
Racemonocolpites sp. 1			1										
Retibrevitricolpites triangulatus										2			
Retibrevitricolporites grandis			1							2			
Retibrevitricolporites speciosus										1			
Retistephanocolporites festivus									2				
Retistephanoporites sp. 1												1	
Retitriporites poricostatus												1	
Siltaria sp. 2							1						
Siltaria sp. 3										1			
Spinizonocolpites aff. *baculatus* (RW)								1					
Spinizonocolpites cf. *baculatus* (RW)	1		10					3				1	
Spirosyncolpites spiralis	1		1		1		3	1	3	3		10	
Striatopollis catatumbus	3						1	1		1			1
Striatopollis? tenuistriatus					1		1			8			
Tetracolporopollenites maculosus					1							2	
Tetracolporopollenites? sp. 2			3						1				
Triporopollenites? tenuiexinatus			1				1						
Tuberositriletes verrucatus												1	
Ulmoideipites krempii			6										

Germeraad's and Muller's zonations end or begin abruptly at time boundaries (Paleocene/Eocene, lower/middle Eocene, and middle/late Eocene). In the Composite Section (CS), the first and last occurrence events are tied to stratigraphy (Table 5, Text-figs. 6–9). This produces a higher time resolution and non-congruence in single stratigraphic horizons of most of the first appearance datums (FAD) and last appearance datums (LAD). Therefore, many of the FAD and LAD sequence of events in the CS do not exactly agree with the GERMERAAD et al. (1968) and MULLER et al. (1987) zonations where taxa appear in pseudo-bursts of speciation events (e.g., Paleocene/Eocene boundary with 25 new taxa in the zonation of MULLER et al. 1987). The CS has low sample resolution between 330 and 460 c.u. and between 500 and 600 cu. due to the sterile nature of most of the samples in the Piñalerita section (upper Arcillas de El Limbo, lower Areniscas de El Limbo Formations, Table 1, Text-fig. 3), in the La Regadera section (upper Cuervos, lower Mirador, Table 2, Text-fig. 4), and in the Uribe section (upper Lisama, lower La Paz Formations, Table 3, Text-fig. 5). Information for the sterile interval was supplied by palynological record from the Tibui section (Text-fig. 7, GONZALEZ 1967). Correlations of these sections, and three additional sections from literature (GERMERAAD et al. 1968, GUERRERO & SARMIENTO 1996) against the composite, indicate that there is not a significant hiatus associated with the Mirador/Cuervos, La Paz/Lisama, or Arcillas de El Limbo/Areniscas de El Limbo contacts, in the localities studied (Text-fig. 10). Many authors since the 1950s have associated this

Table 4. Stratigraphic position of samples studied.

Piñalerita section

sample	stratigraphic meters above base of Arcillas de El Limbo Fm.
UFP 1	–5.4
UFP 4	5.4
UFP 5	30.6
UFP 6	37.0
UFP 7	46.8
UFP 8	79.2
UFP 9	81.0
UFP 10	105.3
UFP 11	131.4
UFP 12	154.
UFP 15	196.2
UFP 16	203,4
UFP 17	214.2
UFP 18	234.0
UFP 19	266.4
UFP 21	311.4
UFP 25	432.0
UFP 26	455.4
UFP 27	475.2
UFP 32	636.6
UFP 33	639.0
UFP 34	660.6
UFP 35	673.8
UFP 36	682.2
UFP 37	689.4
UFP 38	696.6
UFP 39	702.9
UFP 40	710.8
UFP 41	715.6
UFP 42	724.9
UFP 43/90/91*	733.7
UFP 44	738.3
UFP 45	752.6
UFP 46	758.6
UFP 47	766.8
UFP 48	775.6
UFP 49	784.8

* 3 slides made from this level

Regadera section

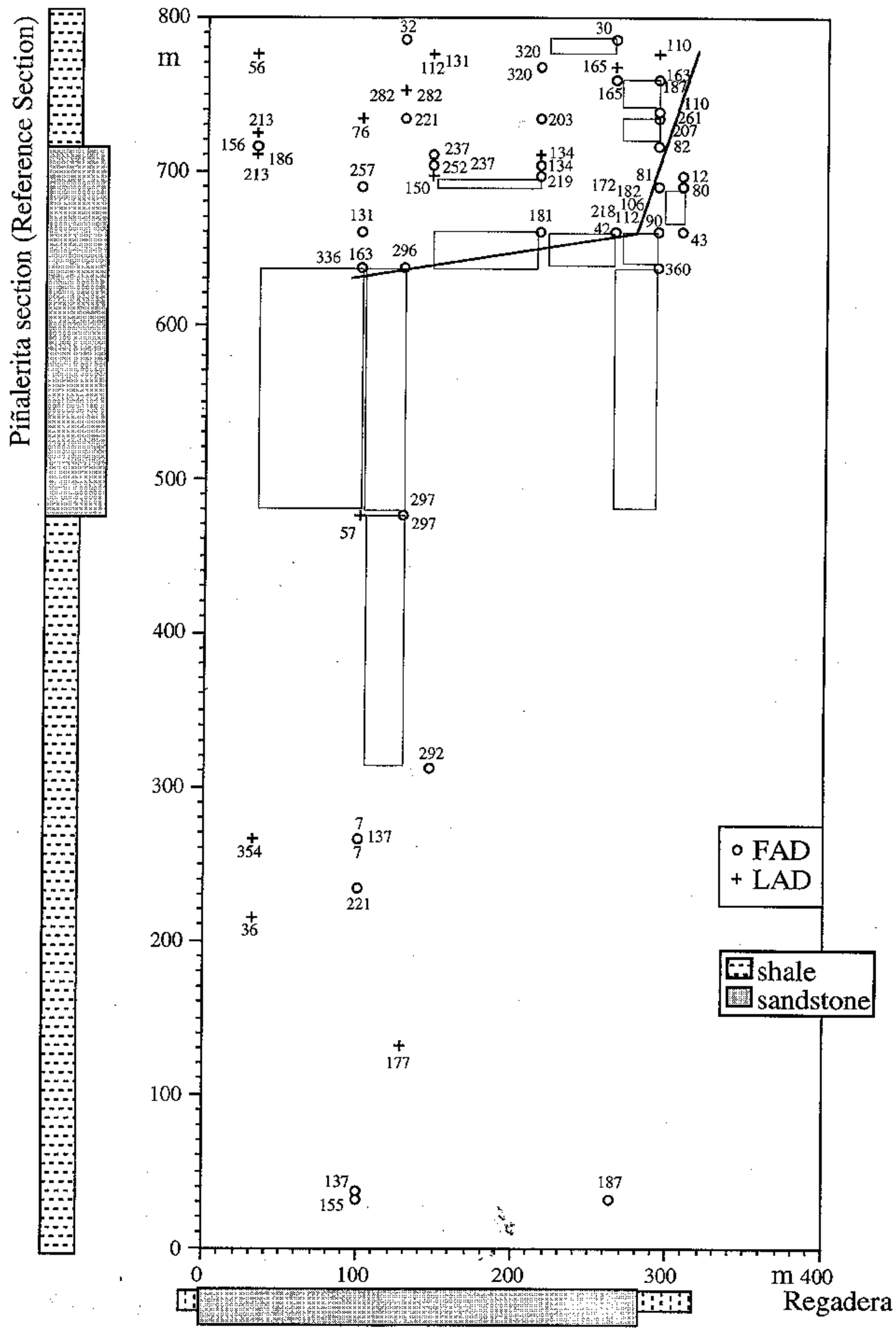
sample	stratigraphic meters above base of Mirador Fm.
UFP 50	–12
UFP 52	4.3
UFP 53	31.2
UFP 56	99
UFP 57	127.5
UFP 58	145.2
UFP 59	159
UFP 62	214.6
UFP 63	259.5
UFP 64	263.5
UFP 65	291.4
UFP 66	306.3

Uribe section

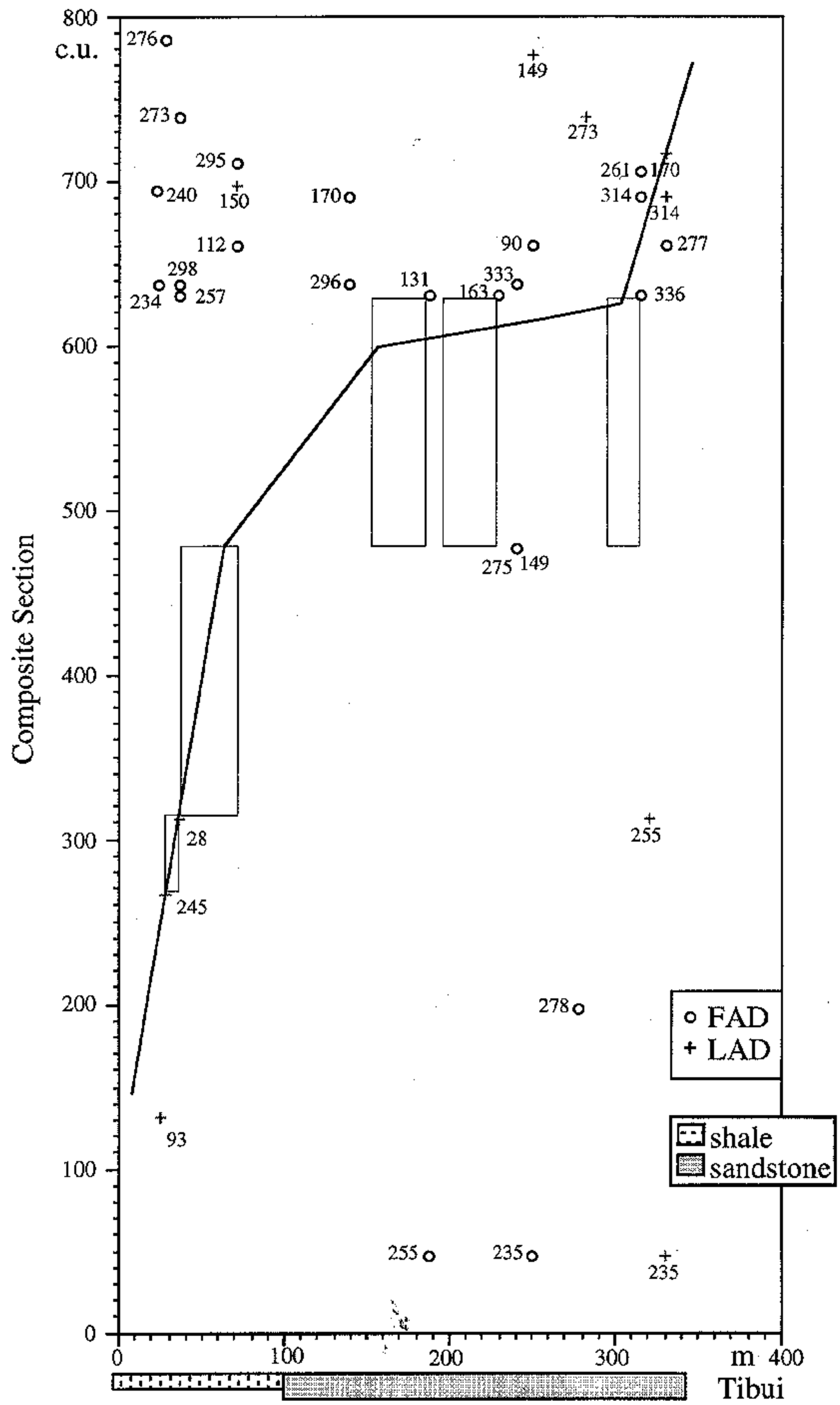
sample	stratigraphic meters above base of La Paz Fm.
UFP 74	180
UFP 75	187.5
UFP 76	224.7
UFP 78	244.5
UFP 79	361
UFP 80	385.1
UFP 81	418
UFP 82	470.5
UFP 83	500.7
UFP 84	547
UFP 85	602.5
UFP 86	712
UFP 87	886

Table 5. Fossil events of Composite Section. Events are in composite units (c.u.). FAD = first appearance datums, LAD = last appearance datums. Paleocene-Eocene boundary: 420 c.u; early-middle Eocene boundary: 640 c.u. The code indicates the number used for each species during the graphic correlation.

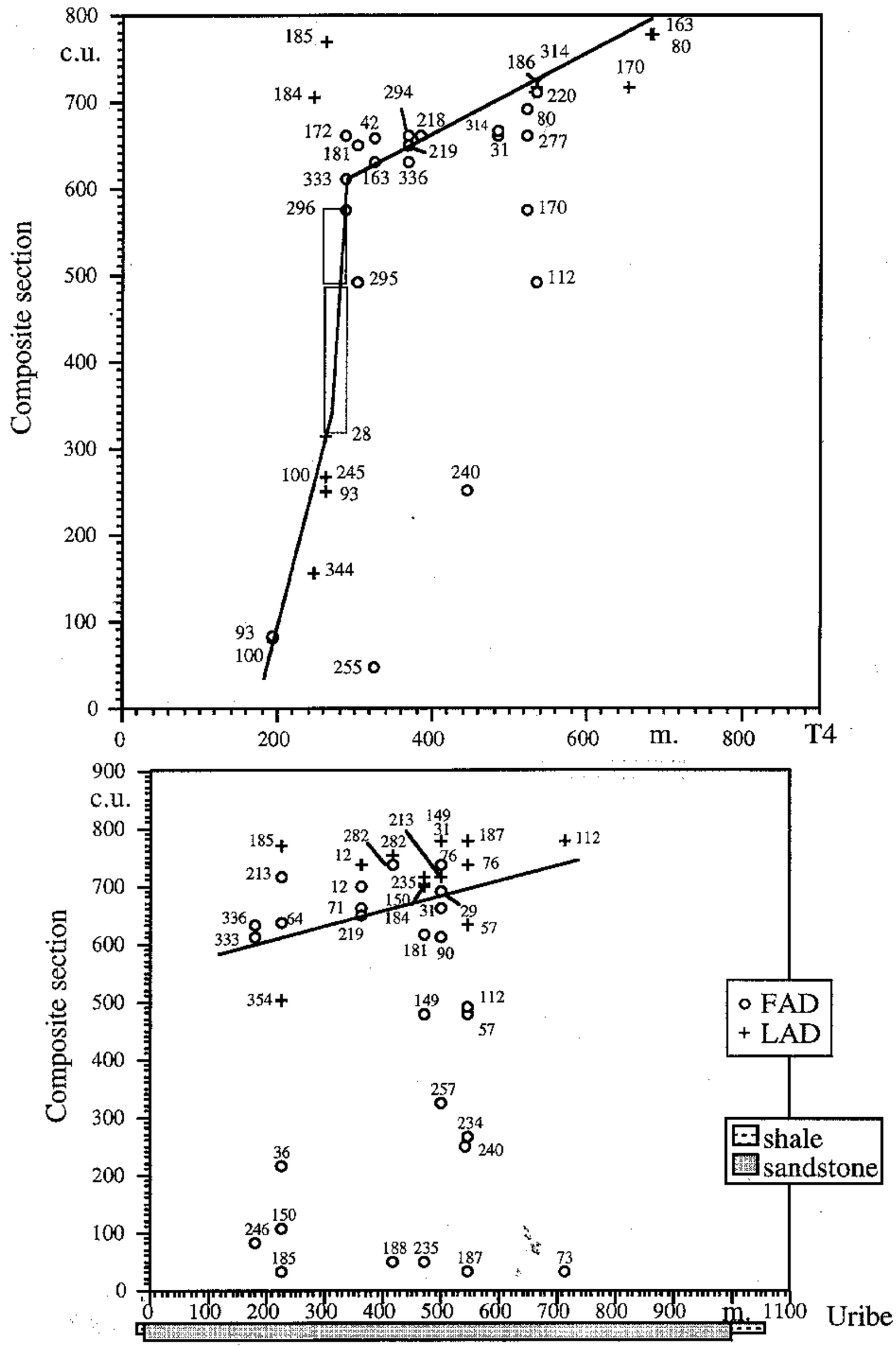
taxa	code	FAD c.u.	LAD c.u.	taxa	code	FAD c.u.	LAD c.u.
Apiculatasporites ? cingulatus	76	680	733.7	*Proxapertites cursus*	184		702.9
Apiculatasporites obscurus	73	30.6	775.6	*Proxapertites humbertoides*	185	30.6	766.8
Arecipites regio	247		475.2	*Proxapertites magnus*	186		725
Baculamonocolpites hammenii	12	640	733.7	*Proxapertites operculatus*	187	30.6	775.6
Bombacacidites annae	28	30.6	325	*Proxapertites psilatus*	188	46.8	
Bombacacidites brevis	29	661		*Psilabrevitricolporites simpliformis*	193	37	266.4
Bombacacidites foveoreticulatus	30	640		*Psilabrevitricolporites triangularis*	222	696.6	
Bombacacidites nacimientoensis	31	660.6	775.6	*Psilamonocolpites grandis*	194		311.4
Bombacacidites soleaformis	32	595		*Psilastephanocolporites fissilis*	204	673.8	775.6
Brevitricolpites microechinatus	36	214.2	502	*Racemonocolpites facilis*	234	265	
Cicatricosisporites dorogensis	42	605		*Racemonocolpites racematus*	235	46.8	715
Corsinipollenites undulatus	131	548	775.6	*Ranunculacidites operculatus*	220	705	710.8
Cricotriporites guianensis	57	475.2	730	*Retibrevitricolpites* sp. 2	237	600	710.8
Cricotriporites macroporus	56	580	775.6	*Retibrevitricolpites triangulatus*	240	245	
Cricotriporites minutiporus	58	715.6	715.6	*Retidiporites magdalenensis*	245		312
Curvimonocolpites inornatus	63		105.3	*Retistephanocolpites angeli*	255	46.8	685
Cyclusphaera scabrata	64	565		*Retistephanocolporites festivus*	257	322	
Echimonocolpites sp. 1	67	46.8	266.4	*Retistephanoporites angelicus*	261	650	
Echinatisporis brevispinosus	71	640		*Retitrescolpites ? irregularis*	296	522	
Echiperiporites estelae	80	668		*Retitrescolpites magnus*	277	660.6	758.6
Echitriporites trianguliformis var. *orbicularis*	90	588		*Retitrescolpites saturum*	278	196.2	266.4
Ephedripites vanegensis	93	79.2	312	*Rhoipites guianensis*	294	650	
Foveodiporites guianensis	98		5.4	*Rhoipites hispidus*	295	490	
Foveotricolpites perforatus	[illegible]	[illegible]	310	*Rousea florentina*	276	265	
Foveotricolporites fossulatus	103	689.4	[illegible]3.7	*Rugotricolporites felix*	314	665	725
Foveotriporites hammenii	112	490	791	*Siltaria mariposa*	297	475.2	475.2
Ladakhipollenites rubini	133	715.6	738.3	*Siltaria media*	298	322	
Ladakhipollenites simplex	134	625	710.8	*Siltaria* sp. 2	282	590	752.6
Lanagiopollis crassa	218	637		*Spinizonocolpites breviechinatus*	329	30.6	266.4
Longapertites proxapertitoides var. *reticuloides*	149	475.2	775.6	*Spirosyncolpites spiralis*	333	560	
L. proxapertitoides var. *proxapertitoides*	150	105.3	696.6	*Striatopollis catatumbus*	336	562	
Momipites africanus	162	30.6	758.6	*Syncolporites lisamae*	344	154.8	255
Monocolpopollenites ovatus	246	79.2		*Tetracolporites psilatus*	203	625	
Monoporopollenites annulatus	163	568		*Tetracolporopollenites maculosus*	219	621	
Multiporopollenites pauciporatus	198	660.6	766.8	*Tetracolporopollenites spongiosus*	217	131.4	311.4
Nothofagidites huertasii	165	640	766.8	*Tetracolporopollenites transversalis*	221	232	733.7
Perfotricolpites digitatus	170	522	780	*Tetracolporopollenites*? sp. 2	213	505	715.6
Perisyncolporites pokornyi	172	612		*Tricolpites antonii*	274	696.6	696.6
Planisporites ? sp. 1	72	673.8	689.4	*Tricolpites clarensis*	275	475.2	
Poloretitricolpites absolutus	273	322	738.3	*Ulmoideipites krempii*	354		610
Polypodiisporites aff. *specious*	181	615		*Venezuelites ? distinctus*	207	650	758.6
Polysphaeridium subtile	182	650	738.3	*Verrutricolporites reticulatus*	360	580	



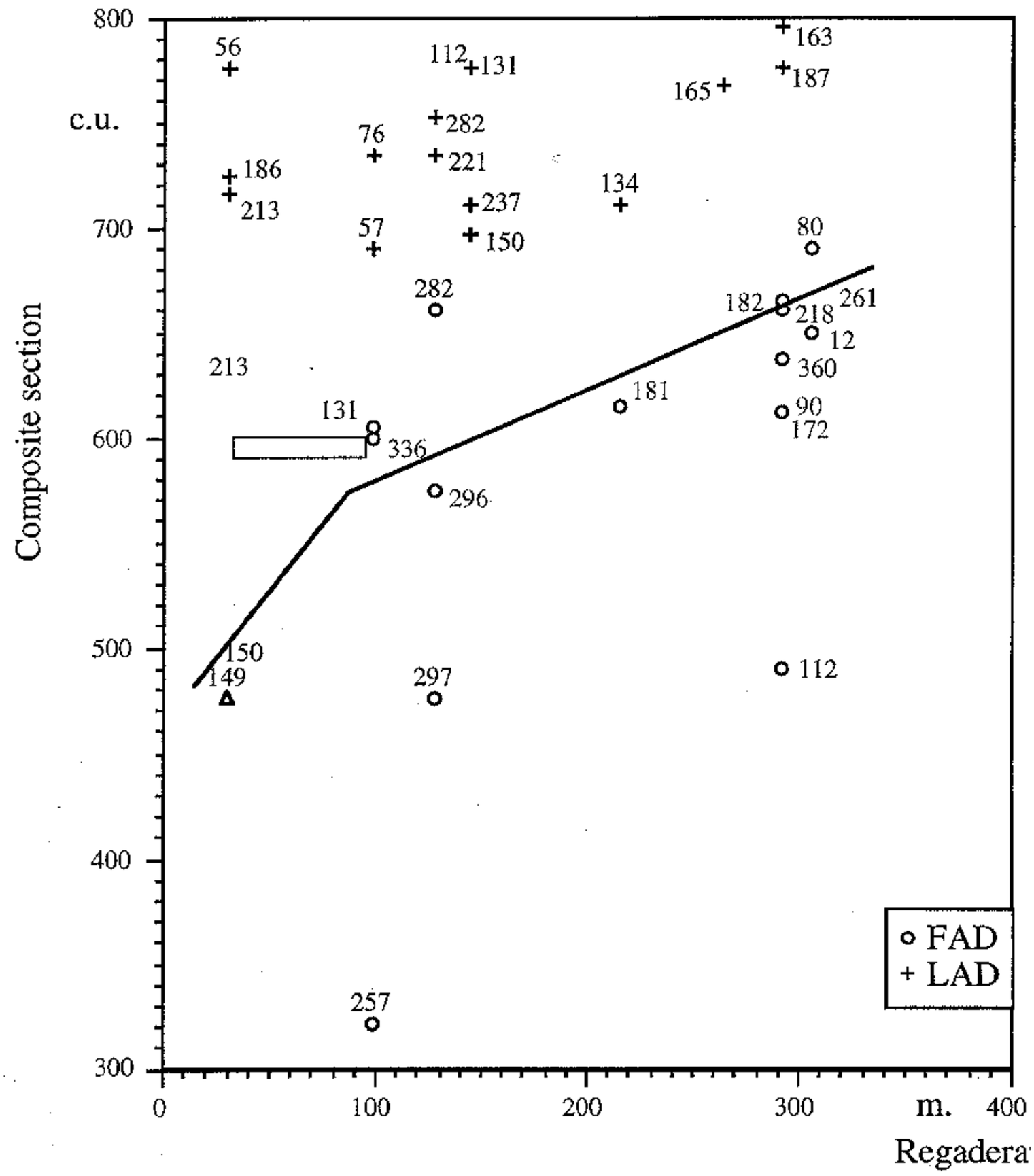
Text-fig. 6. First round of correlation. Piñalerita (Reference Section) versus La Regadera. See Table 5 for the names of the taxa used in graphic correlation. Boxes indicate strata down to next lower sample for first appearance datums (FAD) and up to next higher sample for last appearance datums (LAD) to take into account large gaps in sample interval.



Text-fig. 7. First round of correlation. Composite Section versus Tibui. Tibui section after GONZALEZ (1967). See Table 5 for the names of the taxa used in graphic correlation. c.u. = composite units. Boxes indicate strata down to next lower sample for first appearance datums (FAD) and up to next higher sample for last appearance datums (LAD) to take into account large gaps in sample interval.

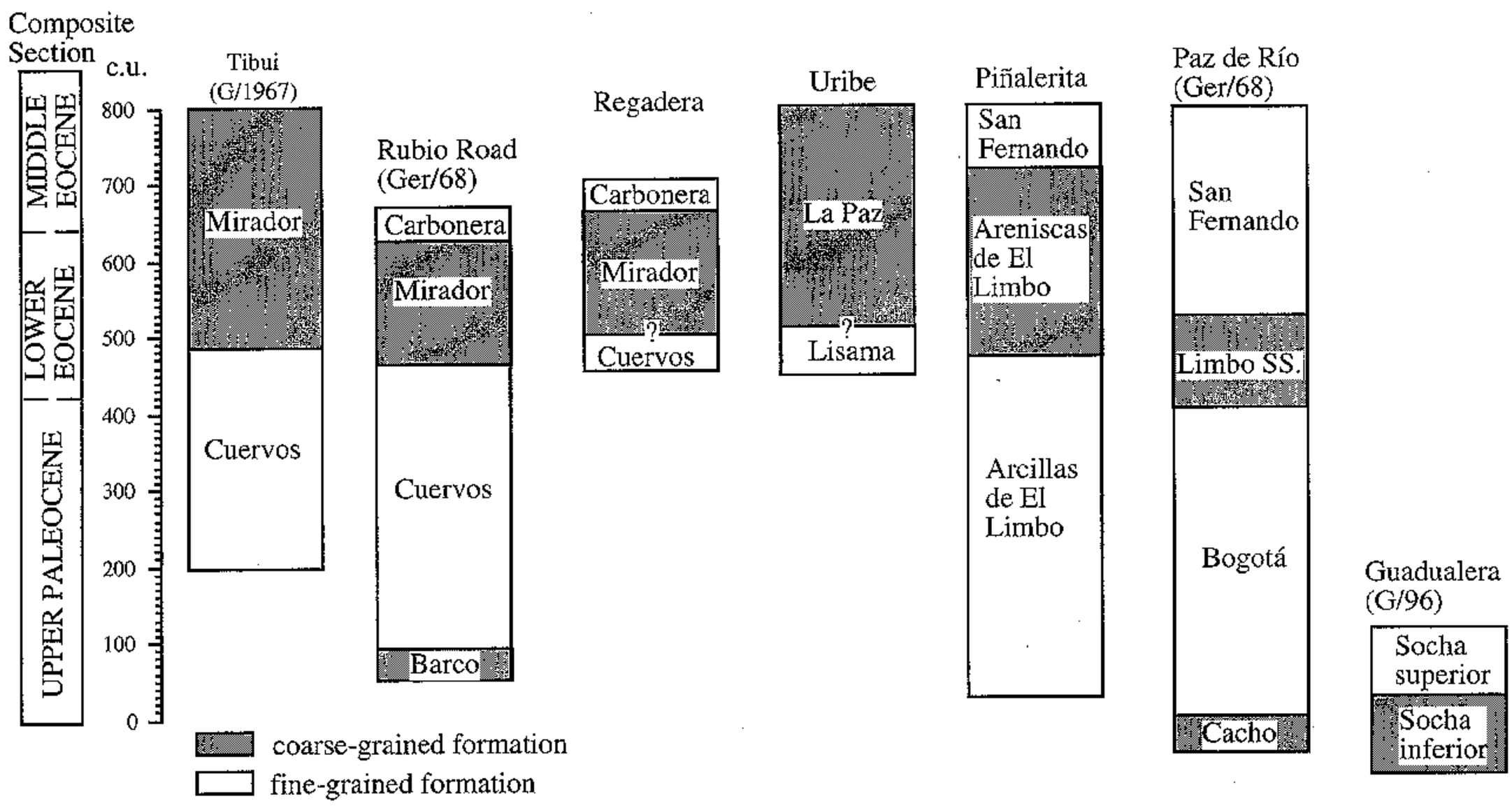


Text-fig. 8. First round of correlation. Composite Section versus T4 and Uribe sections. T4 after RULL (1997). See Table 5 for the names of the taxa used in graphic correlation. c.u. = composite units. Boxes indicate strata down to next lower sample for first appearance datums (FAD) and up to next higher sample for last appearance datums (LAD) to take into account large gaps in sample interval.



Text-fig. 9. Second round of correlation. Composite Section versus Regadera. See Table 5 for the names of the taxa used in graphic correlation. c.u. = composite units. Datums of Composite Section derived from Regadera are excluded. First appearance datums = FAD, last appearance datums = LAD.

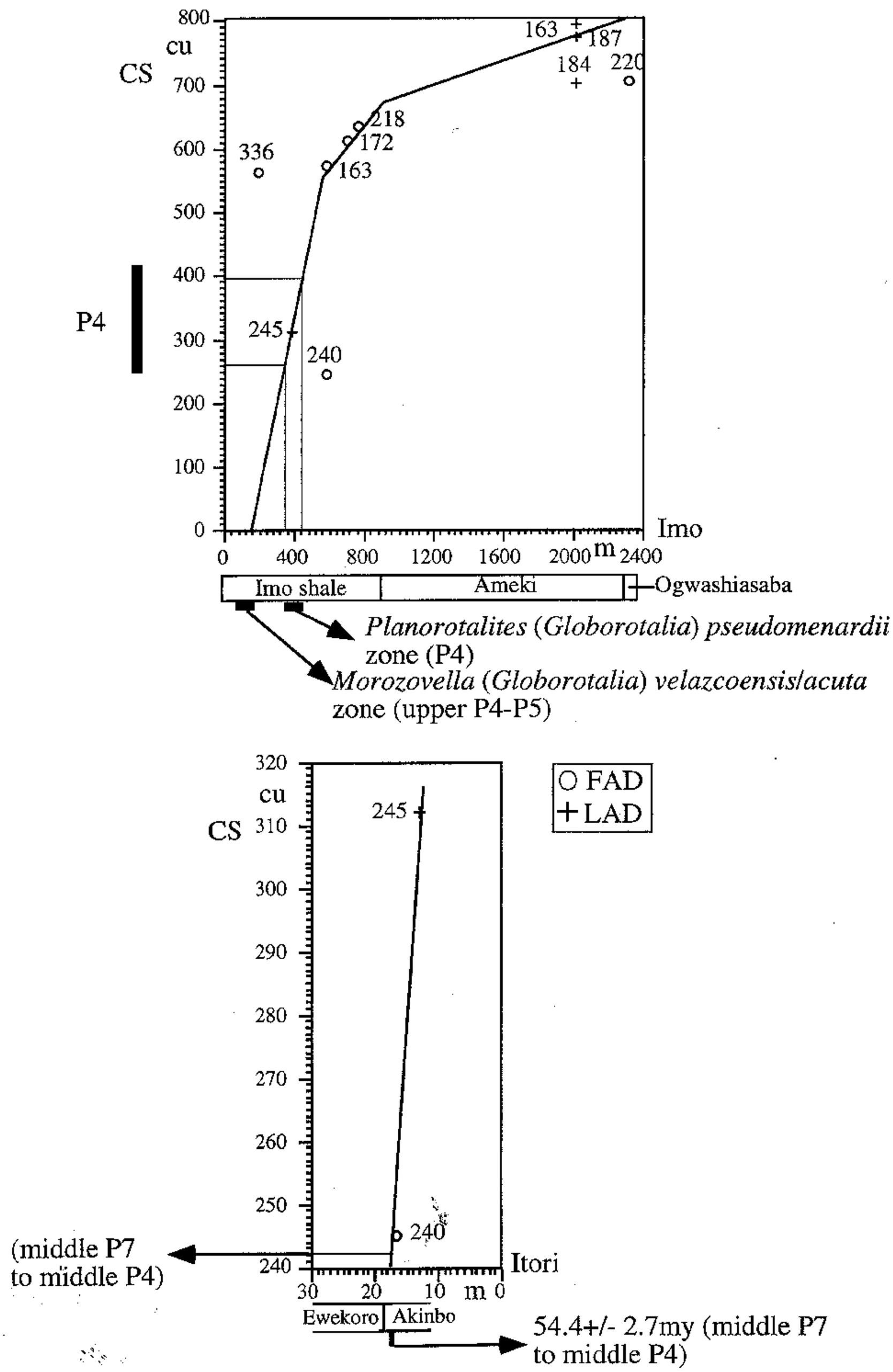
contact in Colombia with a major hiatus that would encompass 16 million years, the entire early to middle Eocene (Morales 1958, Schamel 1991, Dengo & Covey 1993, Cooper et al. 1995, Ramon & Cross 1997, Suarez 1997a, b, Villamil & Restrepo-Pace 1998). This idea is deeply rooted in the literature about this interval in Colombia. However, an intensive literature search has not produced a single locality with fully documented paleontological information supporting this hypothesis. Localities with good palynological information have not registered this hiatus (Gonzalez 1967 in Catatumbo area, and Colmenares & Terán 1993 in Maracaibo Basin). Files of oil companies may contain some evidence supporting this hiatus; however, the graphic correlation of the Piñalerita section and the Tibui, Rubio and Paz de Rio sections (Jaramillo 1999) does not indicate a major hiatus encompassing 16 million years (Text-fig. 10). Julivert (1961) also pointed out the lack of paleontological evidence supporting this hiatus in the middle Magdalena area and concludes that the time-gap, where present, would be isochronous with the accumulation of the Lisama Formation (Paleocene), because the Lisama Formation is absent from the anticline axis, and it is in angular unconformity above Cretaceous sediments on the anticline flanks. The time-gap would not be between La Paz-Lisama Formations as previously assumed but during the accumulation of Lisama. It



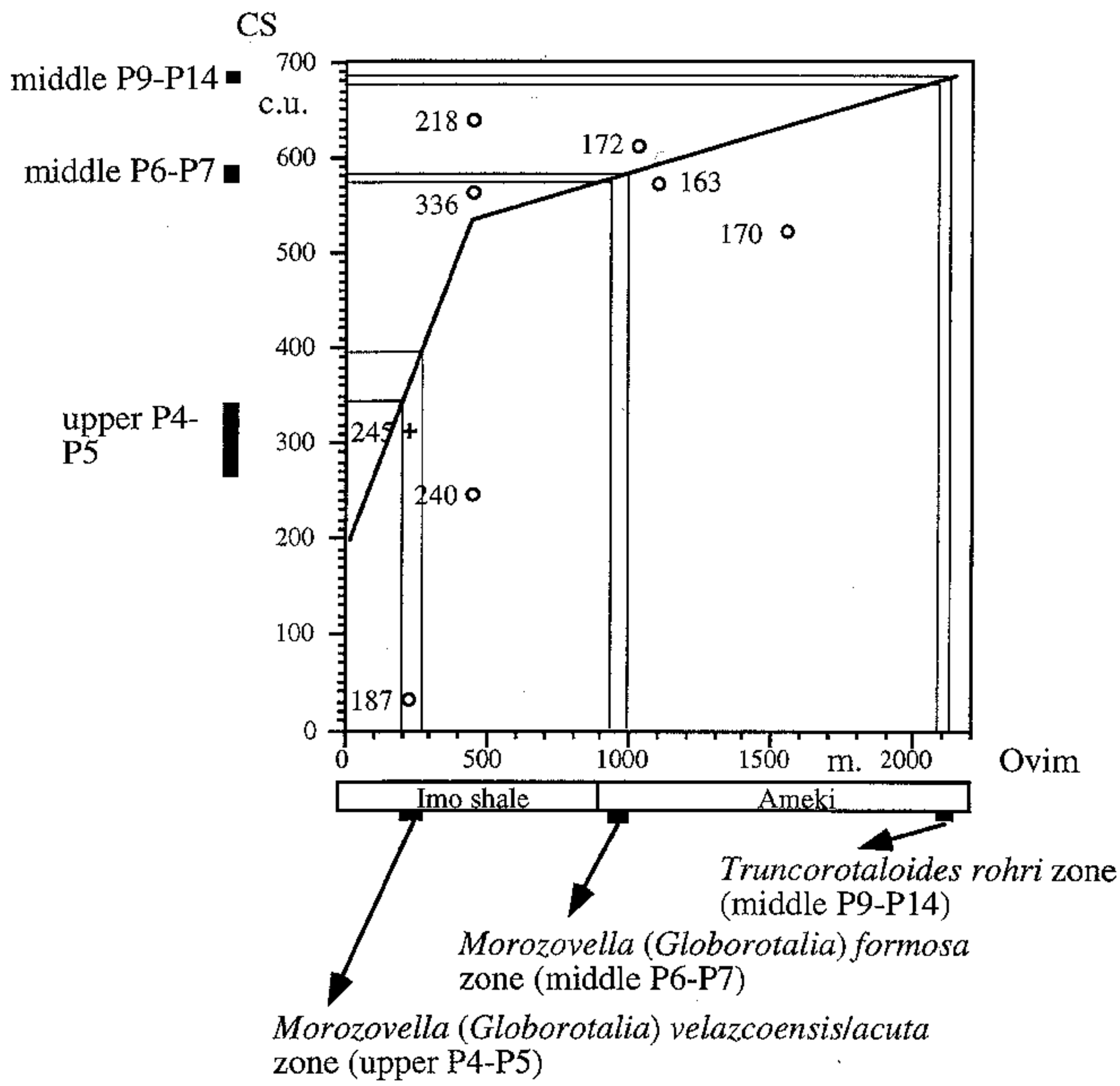
Text-fig. 10. Lithostratigraphy of all available sections with palynological information for the late Paleocene-Eocene interval in Colombia and western Venezuela. (G/67 = GONZALEZ 1967, Ger/68 = GERMERAAD et al. 1968, G/96 = GUERRERO & SARMIENTO 1996).

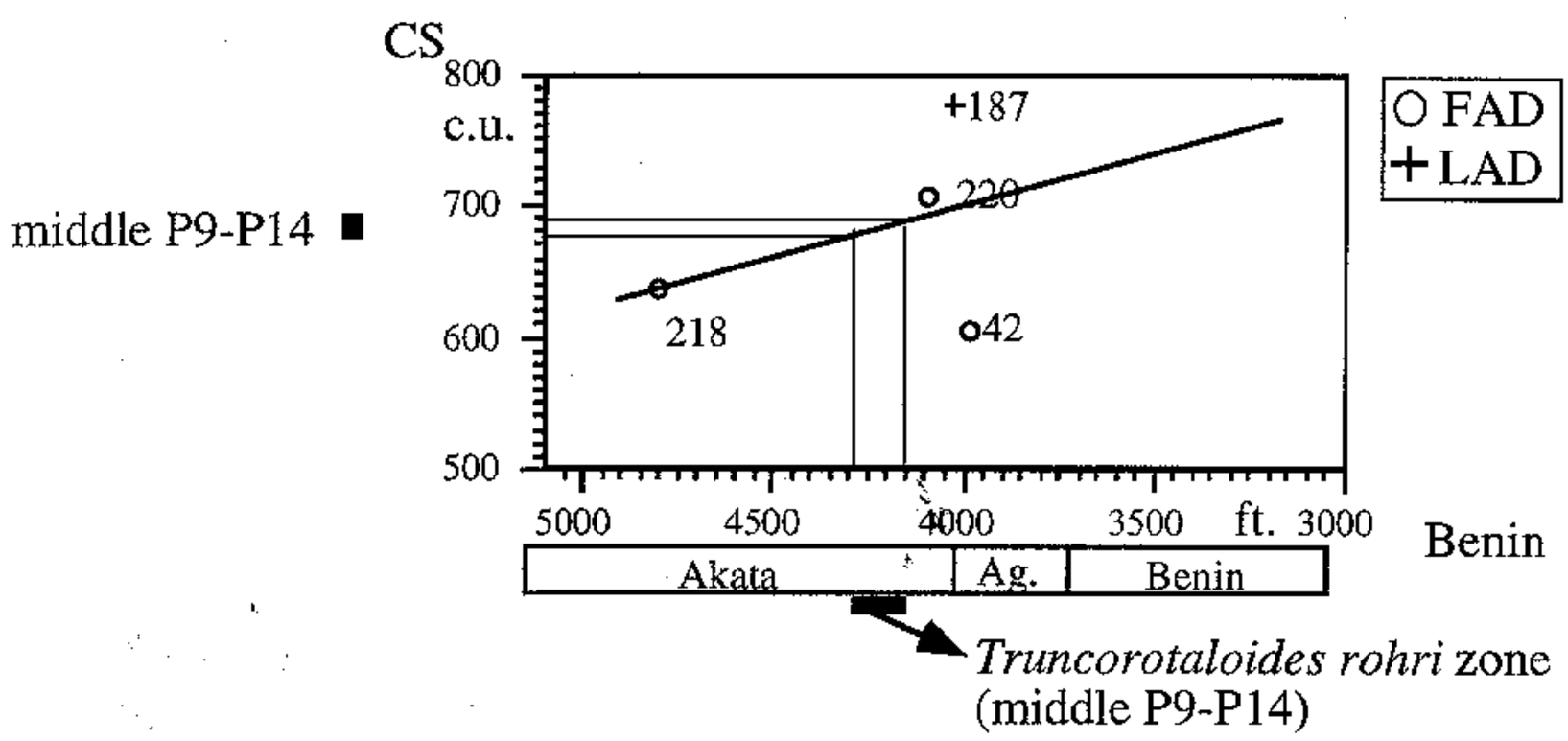
could be argued that one of the reasons producing the perception of this hiatus is that samples above and below the assumed hiatus are generally sterile of palynomorphs. This would produce an artificial gap in time because of the absence of traditional pollen zones present within the sampling gap. The possibility of an important hiatus is, however, still an open question.

One of the most difficult tasks in biostratigraphy is calibrating the Composite Section (CS) with the geologic time scale. The Paleocene and Eocene epochs and their ages are defined by planktonic foraminifera, calcareous nannoplankton and magnetic polarities. The chronostratigraphy of BERGGREN et al. (1995) for the late Paleocene and Eocene is followed here. The planktonic foraminifera zonation is that of BERGGREN et al. (1995). Most of the epoch/series and stage/age boundaries of the late Paleocene and Eocene are relatively well established with the exception of the Paleocene/Eocene boundary that still does not have a Global Stratotype Section and Point (GSSP). The Paleocene and Eocene series terms were first defined in 1874 and 1833, respectively (BERGGREN & AUBRY 1998). The boundary awaits determination of a GSSP within the 2 million years time span between the top of the Thanetian Stage and the base of the Ypresian Stage. The difficulties in defining the boundary are caused by the multitude of unconformities and facies changes at the base of the type section of Ypresian Stage in Belgium (the base of Ieper Clay of the Belgian Basin is equivalent to the base of the London Clay Formation in the London/Hampshire Basin). The base of the Ypresian Stage/Series in these two localities is separated from the top of the Thanetian Stage/Series (Thanet Beds, London Basin) by a stratigraphic interval where the Paleocene/Eocene boundary would be located (BERGGREN & AUBRY 1998). This interval encompasses from nannoplankton zone NP10a/b boundary, base of Ypresian (54.37 my) to the top of the Thanetian (56.6 my). Several events within this interval are suggested to denote the Paleocene/Eocene boundary (BERGGREN & AUBRY 1998). Planktonic foraminifera P5/P6 boundary (54.48 my), N9/N10 boundary (55 my), benthic foraminiferal extinction (55.5 my), and delta^{13}C isotopic excursion (55.5 my). Here, the planktonic foraminifera P5/P6 boundary (54.48 my) is chosen as the Paleocene/Eocene boundary because foraminifera data are available to calibrate the Composite Section.

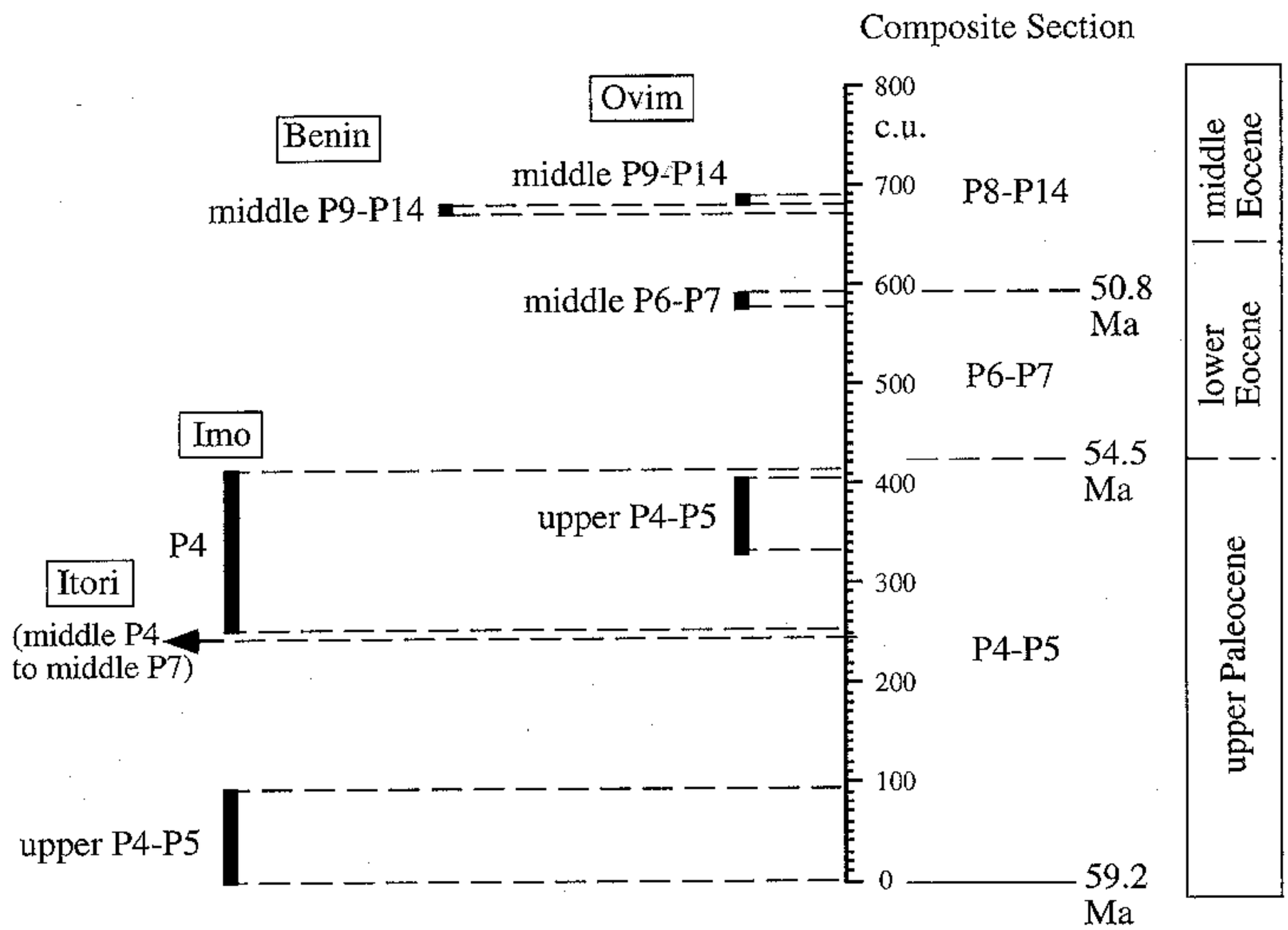


Text-fig. 11. Line of correlation for Imo section (GERMERAAD et al. 1968) and Itori well (ADEGOKE et al. 1970 and JAN DU CHÊNE et al. 1978a) versus Composite Section (CS). See Table 5 for names of the taxa used in graphic correlation. FAD = first occurrence datum; LAD = last occurrence datums. P are planktonic foraminifera zones of BERGGREN et al. (1995).





Text-fig. 12. Line of correlation for Ovim and Benin section (GERMERAAD et al. 1968) versus Composite Section. See Table 5 for names of the taxa used in graphic correlation. FAD = first occurrence datum; LAD = last occurrence datums. P are planktonic foraminifera zones of BERGGREN et al. (1995).



Text-fig. 13. Summary of calibration datums for the Composite Section. See Text-figs 11 and 12 for source of information. P = planktonic foraminifera zones of BERGGREN et al. (1995), c.u. = composite units of the Composite Section.

Few elements are available to calibrate the Composite Section (Text-figs. 11–13). GERMERAAD et al. (1968) have a number of foraminifera taxa recorded from sections in Colombia and Venezuela. Unfortunately, the paper did not indicate the precise stratigraphic position of any of those foraminifera taxa. Therefore, they cannot be used in the graphic correlation methodology. GERMERAAD et al. (1968) only presented stratigraphic positions of foraminifera from sections in Nigeria (Imo, Itori, Ovim, and Benin sections). These were the informations used to calibrate the CS developed in this study. GERMERAAD et al. (1968) and subsequent research in Nigeria (ADEGOKE & JAN DU CHÊNE 1975, JAN DU CHÊNE & SALAMI 1978, JAN DU CHÊNE et al. 1978a, SALAMI 1985, AWAD 1994) have noticed floristic similarities between northern South-America and tropical Africa during Paleocene and Eocene times. These authors also have used, to some extent, the GERMERAAD et al. (1968) zonation. Therefore, correlations with the Nigerian sections (Imo, Itori, Ovim, and Benin sections) probably would provide a general idea of the timing of pollen and spore succession in northern South America until further research in the area is done.

The Imo and Ovim sections (after GERMERAAD et al. 1968) contain the *Planorotalites (Globorotalia) pseudomenardii* zone that is equivalent to P4 zone of BERGGREN et al. (1995), and the *Morozovella velascoensis/Morozovella acuta* zone that is equivalent to the upper P4 to P5 zones of BERGGREN et al. (1995) (taxonomy after TOURMANKINE & LUTERBACHER 1985, taxa ranges after TOURMANKINE & LUTERBACHER 1985 and BERGGREN et al. 1995). When projected in the CS, the foraminifera indicate that the interval P4-P5 is located between composite units (c.u.) 0 to 420 (Text-figs. 11–13). The position of the Paleocene/Eocene boundary is then tentatively located at c.u. 420, although it could be located in an interval between 420 and 475, because the sample at 477 meters in the Piñalerita section (c.u. 475) contains an assemblage that lacks typical late Paleocene taxa as *Foveotricolpites perforatus*, *Retidiporites magdalenen-*

sis, and *Bombacacidites annae*. This late Paleocene age given to the 0–420 c.u., is also supported by the radiometric dating of a bentonite (ADEGOKE et al. 1970, JAN DU CHÊNE et al. 1978a) that yielded an age of 54.4 ± 2.7 million years equivalent to middle P7 to middle P4 planktonic zones (Text-fig. 11, 13). The early Eocene is recognized by the projection in the CS of the *Morozovella formosa* zone of GERMERAAD et al. (1968) (Text-fig. 12, 13). They did not state how this zone was identified, therefore, we consider the total range of *M. formosa-formosa*, (middle P6 to P7 after BERGGREN et al. 1995), as the chronostratigraphic significance of GERMERAAD et al. (1968) *M. formosa* zone. Therefore, the early Eocene (zones P5 to P7) would be represented between composite units 420 to 590 (Text-fig. 13). The uppermost early Eocene and middle Eocene are recognized by the GERMERAAD et al. (1968) *Truncorotaloides rohri* zone. They did not state how this zone was recognized. We consider, then, the whole range of *T. rohri* (middle P9 to P14 after TOURMANKINE & LUTERBACHER 1985) to denote the chronostratigraphic significance of the "*T. rohri* zone". In this scenario the latest early Eocene to early middle Eocene interval would be present between 590 to 670 c.u. (Text-fig. 13). Calibration above 670 c.u. is not possible due to the lack of foraminifera data. The early-middle Eocene boundary (49 my) is tentatively located at composite unit 640 (Text-fig. 13). Both boundaries, however, need a better resolution.

An alternative hypothesis would be to consider the *T. rohri* of GERMERAAD equivalent to *T. rohri-M. spinulosa* Partial Range Zone (P14) of BERGGREN et al. (1995). This hypothesis would indicate an extensive time condensation (~ 10.8 my), between c.u. 590 and 670, top of P7 to base of P14 (Text-fig. 13). This level in the Piñalerita section, that is the Reference Section, is associated with a sterile interval overlain by strata with good palynomorph recovery associated to a transgressive surface and probably some time condensation (Text-fig. 3, 11, JARAMILLO 1999). Therefore, the possibility of an upper lower to middle middle Eocene condensation of the Composite Section between composite units 590 to 670 still exists but further research is necessary to address this specific issue.

6. Floristic comparison with other contemporaneous deposits

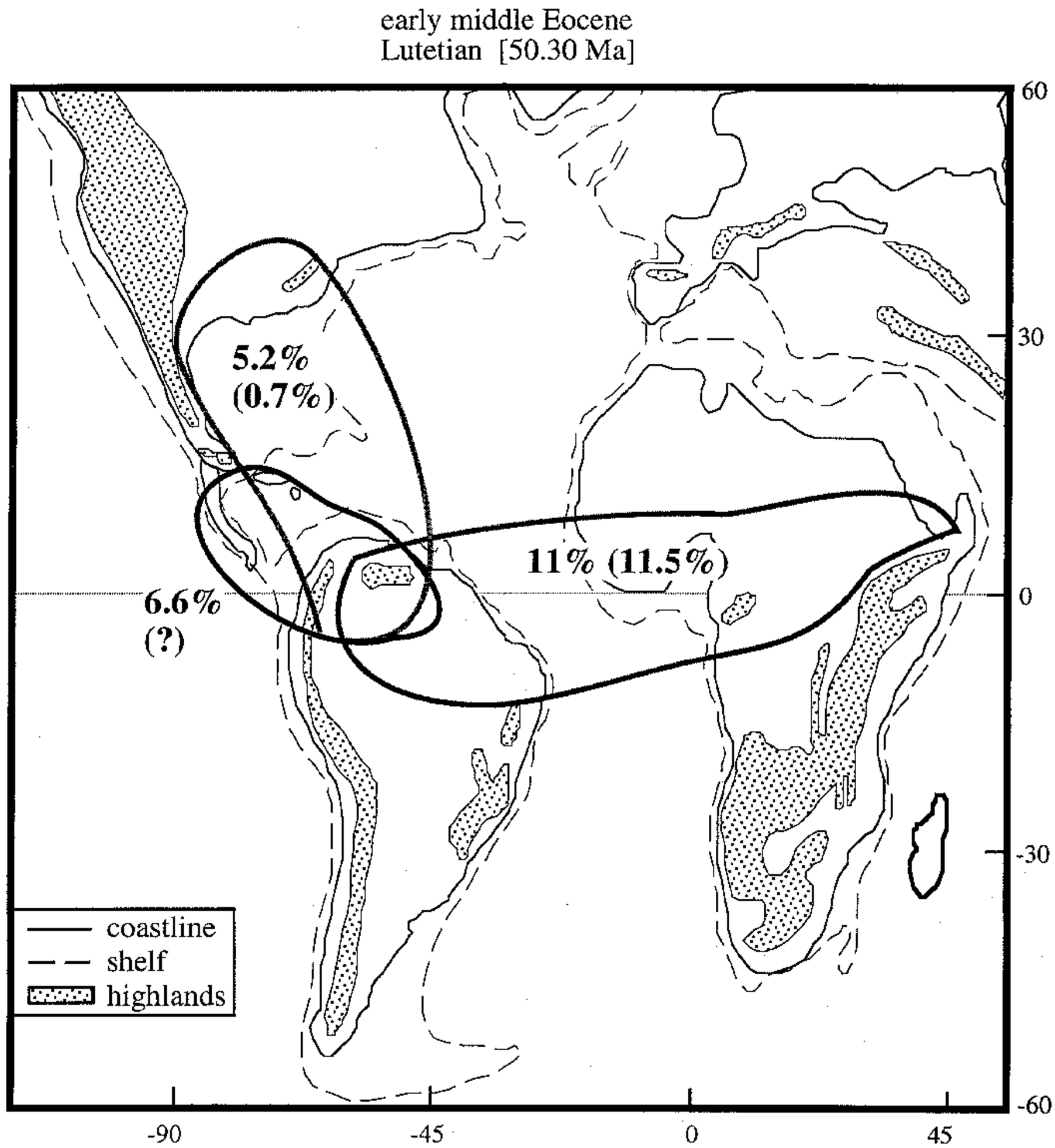
The palynoflora studied was compared with contemporaneous fossil assemblages from the U.S. Gulf Coast, Caribbean, Central America and tropical Africa. Published papers were used as the main sources of this comparative study (VAN HOEKEN-KLINKENBERG 1966, GERMERAAD et al. 1968, ELSIK 1968a, b, 1978, GRAHAM & JARZEN 1969, SRIVASTAVA 1972, TSCHUDY 1973, ELSIK 1974, ELSIK & DILCHER 1974, ADEGOKE & JAN DU CHÊNE 1975, POTTER 1976, GRAHAM 1977, 1985, 1993, 1995, JAN DU CHÊNE & SALAMI 1978, SALARD-CHEBOLDAEFF 1978, 1979, 1990, JAN DU CHÊNE et al. 1978a, b, FREDERIKSEN 1980, MARTÍNEZ-HERNÁNDEZ et al. 1980, POTTER & DILCHER 1980, MEDUS 1982, TOMASINI-ORTIZ & MARTÍNEZ-HERNÁNDEZ 1984, MEBRADU et al. 1985, SALAMI 1985, SCHRANK 1987, FREDERIKSEN 1988, VENKATACHALA et al. 1988, WESTGATE & GEE 1990, OLOTO 1992, AWAD 1994, EL BEIALY 1998).

Table 6 summarizes taxa that are shared by northern South America and Gulf Coast, Caribbean/Central America, and tropical Africa during the Paleocene and Eocene. In Table 6, only taxa with first appearances within the Paleocene or Eocene are included. The percentages calculated indicate the proportion of the northern South America palynoflora that is shared with another region at a specific time (Text-fig. 14).

Zero-point-seven percent of Northern South American taxa are shared with the Gulf Coast in the Paleocene and 5.2 % in the Eocene. Six-point-six percent of taxa are shared in the Eocene with the Caribbean and Central America (Text-fig. 14). Paleocene sediments in the Caribbean and Central America have not been studied. Similar results were found by GRAHAM (1992) who noted an Eocene Caribbean-South America similarity of 2.6 % (using an unnamed similarity index = (a/(b+(c-a))*100, a = number of common species, b = species in Caribbean, c = species in South America). A large percentage of those shared taxa (30 %) have coastal plain preferences (Table 6), including *Spinizonocolpites* (Palmae), *Lanagiopollis crassa* (Pellicieraceae), *Proxapertites* (Palmae), and *Brevitricolpites*. Thirty-five percent of the taxa shared with the Caribbean region are also present in the Gulf Coast, 25 % are in the Gulf Coast but absent in the Caribbean, and 40 % are in the Caribbean and absent from the Gulf Coast. This low percentage of shared taxa suggests a very limited exchange of floras between northern South America and the Caribbean/Gulf

Table 6. Sporomorph species shared by Africa, Gulf Coast, and Caribbean/Central America with the Colombian Paleocene/Eocene. A = tropical Africa, GC = Gulf Coast, C = Caribbean/Central America, P = Paleocene, E = Eocene. This list includes only taxa with first appearances in the Paleocene or Eocene.

	A		GC		C			
Taxa	P	E	P	E	E	affinities	paleoecology	
Anacolosidites luteoides	×	×		×		Olacaceae		
Annutriporites iversenni	×							
Arecipites regio					×	Palmae	alluvial	(*Retimonocolpites* in C)
Bombacacidites annae		×				Malvaceae s.l.	alluvial	
Bombacacidites nacimientoensis			×	×	×	Malvaceae s.l.		
Brevitricolpites variabilis					×		coastal plain	
Buttinia andreevi	×							
Cicatricosisporites dorogensis		×	×	×		Schizaeaceae	coastal plain	
Corsinipollenites spp.				×	×	Onagraceae		
Cricotriporites operculatus		×						
Echiperiporites estelae		×			×	Malvaceae s.l.	alluvial/coastal	
Echitriporites trianguliformis	×					Proteaceae	coastal plain	
Gemmastephanocolpites gemmatus		×						
Lanagiopollis crassa		×			×	Pellicieraceae	coastal plain	
Longapertites microfoveolatus	×					Annonaceae		
Longapertites proxapertitoides				×		Annonaceae } Palmae		(*Longapertites* sp. in GC)
Longapertites vaneendenburgi	×	×				Annonaceae		
Margocolporites vanwijhei	×	×				Fabaceae		
Mauritiidites franciscoi					×	Palmae		
Momipites africanus		×						
Monoporopollenites annulatus		×		×	×	Poaceae		(*G. gramineoides* in GC)
Perfotricolpites digitatus		×				Convolvulaceae		
Perisyncolporites pokornyi		×				Malphigiaceae	coastal plain	
Proxapertites cursus		×		×	×	Palmae	coastal plain	(*Proxapertites* spp. in GC)
Proxapertites humbertoides	×						coastal plain	
Proxapertites operculatus	×	×				Palmae	coastal plain	
Proxapertites tertiaria		×						
Psilamonocolpites medius	×					Palmae		
Psilatricolpites minutus		×						
Racemonocolpites racematus	×	×						
Ranunculacidites operculatus		×			×	Euphorbiaceae		
Retibrevitricolpites triangulatus	×	×					coastal plain	
Retidiporites magdalenensis	×					Proteaceae	coastal plain	
Retitrescolpites ? irregularis		×				Euphorbiaceae		
Retitricolpites americana		×						
Spinizonocolpites spp.	×	×		×	×	Palmae	coastal plain	(*Nypa* in GC)
Spironsyncolpites spiralis		×					alluvial	
Striatopollis catatumbus	×	×		×	×	Fabaceae	alluvial	(aff. *Crudia* in GC)
Syncolporites marginatus	×							
Syncolporites poricostatus	×	×		×				(*Myrtaceadites* sp. in GC)
Tetracolporopollenites maculosus				×	×	Sapotaceae	alluvial	
Tetracolporopollenites transversalis					×	Burseraceae		(cf. *Protium* in C)
Tricolpites clarensis	×							
Ulmoideipites krempii			×	×		Ulmaceae		
Verrucatosporites usmensis		×				Polypodiaceae		
Zonocostites ramonae					×	Rhizophoraceae	coastal plain	



Text-fig. 14. Percentage of shared similarities during the Eocene and Paleocene between northern South America and tropical Africa, Caribbean/Central America, and the Gulf Coast. Percentages in parenthesis indicate similarities during the Paleocene. Paleocene data for Caribbean/Central America are not published. Paleogeographic map of the early middle Eocene after SCOTESE (1992).

Coast regions during the Paleocene-Eocene as was previously suggested by GRAHAM (1992). Most of this change was limited to coastal plain environments. Migration seems to occur in two opposite directions. The first runs from north to south in taxa as *Cicatricosisporites dorogensis* (Schizaeaceae), *Ulmoideipites krempii* (Ulmaceae) and *Bombacacidites nacimientoensis* (Malvaceae sensu latu) which first appearances occur in the Paleocene in Gulf Coast, and in the Eocene in northern South America. The second runs from south to north. These migrations occur mostly with coastal plain elements as *Proxapertites* (Palmae), *Spinizonocolpites* (Palmae), *Brevitricolpites*, *Lanagiopollis crassa* (Pellicieraceae), and *Zonocostites ramonae* (Rhizophoraceae). Also other non-coastal plain elements migrated toward the north as *Mauritiidites* (Palmae), *Longapertites* (Palmae), *Syncolporites poricostatus* (Myrtaceae), and *Striatopollis catatumbus* (Fabaceae). Most of this migration probably occurred during the Eocene, as all of those taxa have first appearances in the Eocene

of the Gulf Coast and Caribbean while they have their first appearances during the Paleocene and early Eocene in northern South America. This northward migration could be correlated with the Eocene Thermal Maximum that expanded tropical zones into previously subtropical areas (SLOAN & REA 1995). PITMAN et al. (1993) proposed possible intermittent arcuate connections between Central America and South America during the Campanian to middle Eocene interval. Data presented here suggest that at least during the Paleocene this corridor did not exist, or at least was not used for floral elements to migrate south or northward. During the Eocene, however, a corridor may have existed allowing limited floral interchange enhanced by expanded tropical zones.

Tropical Africa and tropical South America shared 11.5 % of their taxa in the Paleocene (Text-fig. 14). Thirty-one percent of this shared flora are coastal plain elements such as *Proxapertites* (Palmae), *Spinizonocolpites* (Palmae), and *Retidiporites* (Proteaceae) among others (Table 6). However, the direction of migration is still uncertain due to the lack of chronostratigraphic resolution in both areas. During the Eocene the shared taxa decreased slightly to 11 % (Table 6, Text-fig. 14). Sixty-four percent of those 11 % shared taxa have their first appearances, both in Africa and South America, during the Eocene. Thirty-three percent of them are coastal plain elements such as *P. pokornyi* (Malphigiaceae), *L. crassa* (Pellicieraceae), and *E. estelae* (Malvaceae sensu latu). Others are alluvial plain elements such as *Ranunculacidites operculatus* (Euphorbiaceae), *Retitrescolpites? irregularis* (Euphorbiaceae), *Monoporopollenites annulatus* (Poaceae), *Momipites africanus*, *Perfotricolpites digitatus* (Convolvulaceae). These phytogeographic patterns indicate that floral interchange between eastern and western Gondwana, that was occurring into the late Cretaceous (COETZEE 1993), continued during the Paleogene in spite of the increasing distance between these two continents, that started to split apart in the early Cretaceous (PITMAN et al. 1993; ~2000 km in the middle Eocene, 3300 km today). The importance of this continuing Paleocene-Eocene floral interchange has not been recognized by many authors (e. g., COETZEE 1993, ROMERO 1993). RAVEN & AXELROD (1974) and DILCHER (2000) recognized the possibility of direct migration during or before Paleocene. This Paleogene interchange has been recognized in other groups like chiclid, nandid, synbranchid, and cyprinodontiform fresh-water fishes (LUNDBERG 1993), most reptile families (BAUER 1993), and coccyzine birds (VUILLEUMIER & ANDORS 1993). The phytogeographic patterns also indicate that latitudinal control of vegetation distribution is stronger than distances between continents, thus, while the Gulf Coast/Caribbean were 1200km apart from northern South America during Eocene (PITMAN et al. 1993), Africa was 2000 km apart from northern South America (SCOTESE 1992) and still had a stronger floral interchange with South America. This lateral distribution of mainly coastal plain floras also could be further enhanced by the current patterns of the southern Tethys Sea. There is another plausible explanation for those shared taxa between tropical Africa and the Neotropics during the Paleocene and Eocene. Those taxa could have speciated in subtropical areas during the late Cretaceous when the two continents were still close to each other. Then, because of the Paleocene/Eocene climatic change, they migrated into tropical regions and consequently appeared in the tropical fossil record. However, those shared taxa have not been found in subtropical areas during the late Cretaceous. Therefore, at this time, this hypothesis has only weak support.

7. Conclusions

The analysis of palynomorph distributions in three stratigraphic sections in the Eastern Andes of Colombia yielded a rich palynoflora of 276 palynomorph species that were fully described and illustrated (38 spores, 225 pollen, 11 dinoflagellate cysts, and 2 incertae sedis). One new genus *Poloretitricolpites*, 69 new species (57 pollen, 11 spores, 1 incertae sedis), and 28 new combinations are proposed.

A biostratigraphic framework is constructed for the late Paleocene-middle Eocene interval, using the technique of graphic correlation. This framework consists of a Composite Section (CS) that has the earliest first appearance and latest last appearance datums for the most common and/or stratigraphically important taxa found in this study (Table 5). Previous palynological zonations for the area (GERMERAAD et al. 1968, REGALI et al. 1974, MULLER et al. 1987) have inconsistencies and have a poor resolution for the late Paleocene-Eocene interval. On the contrary, the CS produced in this study, has a higher resolution, and

constitutes a hypothesis that can be continuously tested as further information is gathered from surrounding areas. The CS was calibrated using foraminifera data and radiometric ages from tropical Africa. Unfortunately, this type of information from northern South America has not been published. Composite unit 0 of the CS is still within the late Paleocene, the Paleocene/Eocene boundary (54.5 my) is defined at composite unit 420, while the early-middle Eocene boundary (49 my) is tentatively located at composite unit 640 (Text-fig. 13). The Paleocene/Eocene boundary is defined by the P5/P6 foraminiferal boundary. Absolute ages, epoch boundaries, and foraminifera zonation followed BERGGREN et al. (1995), and BERGGREN & AUBRY (1998). Calibration of this CS, however, is still poorly resolved, and there is a need for studies involving planktonic foraminifera and magnetic stratigraphy in northern South America strata during this time interval.

Paleocene and Eocene palynofloras from northern South America have 11 % and 11.5 % similarities, respectively, with those from tropical Africa (Text-fig. 14). A third part of those shared taxa are coastal plain elements. These taxa appear during the Paleocene and others during the Eocene, indicating that African-South America interchange was still continuing in the Eocene, and did not stop at the end of the Cretaceous or Paleocene as previous authors had suggested (RAVEN & AXELROD 1974, COETZEE 1993, ROMERO 1993).

Similarities during the Eocene between northern South America and Central American/Caribbean and Gulf coast palynofloras are relatively low (6.6 and 5.2 %, respectively, Text-fig. 14). Paleocene data from the Caribbean are unpublished whereas data from Gulf Coast indicate a 0.7 % similarity with northern South America palynofloras. One third of the Eocene shared taxa are coastal plain elements. Migration took place in two opposite directions and was restricted to the Eocene, probably relating to the expansion of tropical zones during the Eocene warming. These two phytogeographic patterns indicate that latitudinal control on the distribution of vegetation was a stronger influence on floristic similarities than proximity of continents, as distance Africa-South America was longer than Caribbean/Gulf Coast-South America during the Paleogene.

8. Acknowledgments

Thanks to D. MAI, M. BOULTER, and an anonymous reviewer for their useful comments. Thanks to D. HODELL, D. JONES, W. JUDD, S. MANCHESTER, and N. OPDYKE for their continuous support. We are grateful to G. BAYONA for his assistance during the field season. Thanks D. JARZEN, and R. HOLDO for discussions about palynological and statistical matters. The Corporación Geológica Ares provided valuable logistic support. This study was funded by the National Science Foundation (INT-9724122), Colciencias, the Fundación para la Promoción de la Investigación y la Tecnología Banco de la República, the Geological Society of America, the American Association of Petroleum Geologists, the American Association of Stratigraphic Palynologists, the University of Florida's College of Liberal Arts and Sciences (Gerson Dissertation Fellowship), the Department of Geology, and the Florida Museum of Natural History. Our gratitude goes to R. DINO, H. HOOGHIEMSTRA, R. VERREUSSEL, and E. DIGIACOMO for allowing CJ to visit their palynological collections. G. WILLIAMS and J. BUJAK helped with the dinocyst identifications. We are also grateful to all the people who helped during the field season in the towns of Sabanalarga, Uribe-Uribe, and Cúcuta. Thanks to G. J. GASTONY for correcting latinization of new species and combinations. Special thanks go to MARIA INÉS BARRETO for her continuos support.

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10. Explanation of plates

One scale bar is given on each plate for pollen and spore sizes, exceptions for large grains are noted when necessary.

Plate 1

Figs. 1–3.	*Baculatisporites* sp. 1, three foci, UFP 48, 4.6 × 85.5.
Figs. 4–6.	*Baculatisporites* sp. 2, three foci, UFP 41, 5.6 × 109.7.
Figs. 7–9.	*Camarozonosporites* sp. 1, three foci, UFP 84, 13.9 × 112.1.
Fig. 10.	*Chomotriletes minor* (KEDVES 1961) POCOCK 1970, UFP 36, 17.9 × 86.5.
Figs. 11–13.	*Cicatricosisporites dorogensis* POTONIÉ & GELLETICH 1933, three foci, UFP 37, 8.1 × 88.5.
Figs. 14–16.	*C. dorogensis* subsp. *minor* forv. *rugulatearis* KEDVES 1961, three foci, UFP 37, 12 × 101.7.
Figs. 17–19.	*Cicatricosisporites* sp. 1, three foci, UFP 5, 4 × 86.7.
Figs. 20–22.	*Cicatricososporites decussatus* n. sp., Holotype, three foci, UFP 44, 5.4 × 92.3.

Plate 2

Figs. 1, 2.	*Cicatricososporites eocenicus* (SELLING 1944) JANSONIUS & HILLS 1976. 1: lateral view, UFP 43, 6 × 102.6; 2: proximal view, UFP 37, 17.6 × 110.
Figs. 3–4.	*Clavatisporites mutisii* (VAN DER HAMMEN 1954) comb. nov., two foci, UFP 12, 14.1 × 85.5.
Figs. 5–6.	*Echinatisporis brevispinosus* n. sp., Holotype, two foci, UFP 49, 9.4 × 84.5.
Figs. 7–9.	*Apiculatasporites ? cingulatus* n. sp., Holotype, three foci, UFP 43, 7.4 × 81.5.
Figs. 10–11, 12.	*Apiculatasporites obscurus* n. sp. 10–11: Holotype, two foci, UFP 15, 21.2 × 92.1; 12: Paratype, UFP 15, 3.6 × 91.9
Figs. 13–15.	*Planisporites*? sp. 1, three foci, UFP 35, 19.1 × 88.2.
Figs. 16–18.	*Planisporites* sp. 2, three foci, UFP 37, 5.2 × 87.1.
Figs. 19–20.	*Foveotriletes margaritae* (VAN DER HAMMEN 1954) GERMERAAD et al. 1968, two foci, UFP 45, 17.6 × 106.
Figs. 21–22, 23–24.	*Foveotriletes* sp. 1. 21–22: two foci, UFP 49, 12.2 × 111.8; 23–24: two foci, UFP 43, 5 × 82.3.
Figs. 25–27, 28.	*Ischyosporites problematicus* n. sp. 25–27: Holotype, three foci, UFP 27, 12 × 114; 28: Paratype, UFP 15, 13.9 × 85.6.
Figs. 29–30.	*Kirchheimerisporites tenuiradiatus* n. sp., Holotype, two foci, UFP 44, 5.1 × 99.5.
Fig. 31.	*Laevigatosporites tibuensis* (VAN DER HAMMEN 1956a) comb. nov., UFP 6, 6.6 × 91.
Figs. 32–34.	*Laevigatosporites* sp. 1, three foci, UFP 9, 10 × 108.1.

Plate 3

Figs. 1–3.	*Laevigatosporites* sp. 2, three foci, UFP 37, 15.5 × 93.
Figs. 4, 5.	*Microfoveolatosporis skottsbergii* (SELLING 1946) SRIVASTAVA 1971. 4: UFP 53, 6.8 × 92.3; 5: UFP 49, 13.2 × 112.
Figs. 6–8.	*Osmundacidites minor* n. sp., Holotype, three foci, UFP 45, 14.8 × 87.4.
Figs. 9–11, 12.	*Polypodiaceoisporites? fossulatus* n. sp. 9–11: Holotype, three foci, UFP 87, 20.7 × 80.5; 12: Paratype, UFP 43, 6.7 × 112.
Figs. 13–15.	*Polypodiisporites echinatus* n. sp., Holotype, three foci, UFP 11, 15.5 × 108.5.

Figs. 16–18. *Polypodiisporites* aff. *inangahuensis* (COUPER 1953) POTONIÉ 1956 emend. POCKNALL & MILDENHALL 1984, three foci, UFP 86, 17.6 × 106.5.
Figs. 19–21. *Polypodiisporites pachyexinatus* n. sp., Holotype, three foci, UFP 21, 8.2 × 92.
Figs. 22–23. *Polypodiisporites* aff. *specious* SAH 1967, three foci, UFP 48, 10.2 × 78.7.

Plate 4

Figs. 1–2. *Polypodiisporites* sp. 1, two foci, lateral view, UFP 76, 14.8 × 110.7.
Figs. 3–5. *Polypodiisporites* sp. 2, three foci, proximal view, UFP 49, 16.6 × 90.
Figs. 6–7. *Polypodiisporites* sp. 3, two foci, lateral view, UFP 6, 11.6 × 98.8.
Figs. 8, 9–10. *Pteridacidites* sp. 1. 8: UFP 86, 15 × 88.4; 9–10: two foci, UFP 87, 8.2 × 78.3.
Figs. 11–13. *Retitriletes* sp. 1, three foci, UFP 46, 5.5 × 84.2.
Figs. 14–16. *Scabramonoletes*? sp. 1, three foci, UFP 5, 7.9 × 105.
Figs. 17–19. *Tuberositriletes verrucatus* n. sp., Holotype, three foci, UFP 34, 10 × 94.9.
Figs. 20–22. *Tuberositriletes*? sp. 1, three foci, UFP 32, 15 × 107.7.
Figs 23, 24. *Zlivisporis blanensis* PACLTOVÁ 1961, UFP 17, 18.3 × 95.4. 23: proximal view, mid focus; 24: detail reticula and exine.

Plate 5

Figs. 1–3. *Araucariacites* sp. 1, UFP 19, 11.3 × 92.5. 1–2: two foci; 3: detail sculpture rugulate.
Figs. 4–5. *Araucariacites* sp. 2, UFP 11, 14.5 × 104.7. 4: mid focus; 5: detail exine thin, sculpture scabrate.
Fig. 6. *Ephedripites vanegensis* VAN DER HAMMEN & GARCIA 1966, UFP 10, 4.9 × 86.7.
Figs. 7–8. *Laevigatasporites* sp. 1, UFP 12, 8 × 81.5. 7: mid focus; 8: detail exine atectate and sculpture psilate.
Figs. 9–11. *Aglaoreidia*? *foveolata* n. sp., Holotype, three foci, UFP 8, 14 × 111.2.
Figs. 12–14. *Albertipollenites*? *perforatus* (GONZALEZ 1967) comb. nov., three foci, UFP 53, 14.5 × 109.5.
Figs. 15–16, 17. *Araliaceoipollenites*? sp. 1. 15–16: equatorial view, two foci, UFP 84, 10.5 × 91.5; 17: polar view, UFP 76, 10.5 × 82.8.
Figs. 18–19. *Araliaceoipollenites*? sp. 2, two foci, UFP 41, 11.9 × 103.
Figs. 20–21. *Arecipites regio* (VAN DER HAMMEN & GARCIA 1966) comb. nov., two foci, UFP 4, 7.6 × 85.3.
Figs. 22–23, 24–25. *Baculamonocolpites hammenii* n. sp. 22–23. Holotype, UFP 38, 9.6 × 90.5; 22: polar view; 23. detail sculpture baculate. 24–25. Paratype, UFP 43 6.6 × 97.1; 23: polar view; 24: detail exine intectate. Scale bar for Fig. 23 is 10 µm.
Figs. 26–27. *Baculamonocolpites* sp. 1, two foci, UFP 82, 7.4 × 97.9.
Figs. 28–30. *Baculamonocolpites* sp. 2, three foci, UFP 38, 7 × 98.

Plate 6

Figs. 1–2. *Bacumorphomonocolpites tausae* SOLE DE PORTA 1971. 1: polar view; 2: detail bacula branching apically, UFP 74, 11.8 × 97.1. Scale bar for Fig. 1 is 10 µm.
Figs. 3–4. *Bacutriporites echinatus* n. sp., Holotype, two foci, UFP 41, 21.9 × 88.9.
Figs. 5–6, 7. *Bombacacidites annae* (VAN DER HAMMEN 1954) GERMERAAD et al. 1968. 5–6: two foci, UFP 6, 22.5 × 86.8; 7: UFP 10, 9.5 × 104.9.
Fig. 8. *Bombacacidites brevis* (DUEÑAS 1980) MULLER et al. 1987, UFP 39, 5.9 × 80.
Figs. 9–11. *Bombacacidites grahamii* n. sp., Holotype, three foci, UFP 53, 21 × 99.3.
Figs. 12–13. *Bombacacidites fossureticulatus* n. sp., Holotype, two foci, UFP 37, 13 × 98.5.
Figs. 14–15. *Bombacacidites foveoreticulatus* MULLER et al. 1987, two foci, UFP 49, 11.8 × 98.1.
Figs. 16, 17. *Bombacacidites nacimientoensis* (ANDERSON 1960) ELSIK 1968b. 16: polar view, high focus, UFP 37, 18.6 × 100.3; 17: detail colpore and reticula, UFP 34, 10.4 × 103.
Figs. 18–19, 20. *Bombacacidites protofoveoreticulatus* n. sp. 18–19: Paratype, two foci, UFP 7, 20 × 89.3; 20: Paratype, detail colpore, UFP 15, 18.3 × 95.
Figs. 21–23. *Bombacacidites protofoveoreticulatus* n. sp., Holotype, three foci, UFP 7, 8 × 98.9.
Figs. 24, 25–26. *Bombacacidites psilatus* n. sp. 24: Paratype, UFP 83, 16.7 × 90.8; 25–26: Holotype, two foci, UFP 53, 18.5 × 110.
Figs. 27–28, 29. *Bombacacidites gonzalezii* n. sp. 27–28: Holotype, two loci, UFP 49, 14 × 91.4; 29: Paratype, UFP 43, 3.3. × 113.

Plate 7

Figs. 1–2. *Bombacacidites simplireticulatus* n. sp., Holotype, two foci, UFP 37, 12 × 95.5.
Figs. 3, 4. *Bombacacidites soleaformis* MULLER et al. 1987. 3: UFP 57, 15.5 × 93.4, UFP 49, 8.1 × 93.1.
Figs. 5–7. *Bombacacidites* sp. 1, three foci, UFP 9, 7.9 × 84.5.

Figs. 8–9. *Bombacacidites* sp. 2, two foci, UFP 15, 7.3 × 109.1.
Figs. 10–12. *Bombacacidites* sp. 3, three foci, UFP 49, 4.6 × 87.
Figs. 13–15. *Bombacacidites* sp. 4, three foci, UFP 45, 21 × 109.9.
Figs. 16–17. *Bombacacidites* sp. 5, two foci, UFP 49, 8.2 × 115.2.
Figs. 18–20. *Brevitricolpites macroexinatus* n. sp., Holotype, three foci, UFP 49, 19.2 × 83.5.

Plate 8

Figs. 1–3, 4. *Brevitricolpites microechinatus* n. sp. 1–3: Holotype, three foci, UFP 15, 14.1 × 87.5; 4: Paratype, detail short colpus, UFP 15, 4.1 × 87.
Figs. 5–7. *Brevitricolpites* sp. 1, three foci, UFP 19, 20.4 × 102.8.
Figs. 8–10. *Clavamonocolpites* sp. 1, three foci, UFP 47, 7.5 × 83.8.
Figs. 11–12. *Clavatricolpites densiclavatus* n. sp., Holotype, two foci, UFP 37, 4.2 × 88.1.
Figs. 13, 14. *Clavatricolpites densiclavatus* n. sp. 13: Paratype, equatorial view, UFP 41, 10.6 × 91; 14: Paratype, polar view, four-colporate, UFP 43, 15 × 111.6.
Fig. 15. *Colombipollis tropicalis* SARMIENTO 1992, UFP 11, 10.2 × 88.8.
Figs. 16–17, 18. *Corsinipollenites psilatus* n. sp. 16–17: Holotype, two foci, UFP 4, 16.5 × 100; 18: Paratype, UFP 7, 13.3 × 91.6.
Fig. 19. *Corsinipollenites undulatus* (GONZALEZ 1967) comb. nov., UFP 48, 17.3 × 87.9.
Figs. 20–21. *Cricotriporites guianensis* LEIDELMEYER 1966, two foci, UFP 56, 19 × 111.9.
Figs. 22, 23, 24, 25. *Cricotriporites macroporus* n. sp. 22: Paratype, UFP 48, 14.9 × 96.9; 23: Holotype, UFP 53, 18 × 101.1; 24: Paratype, UFP 48, 13 × 105.7; 25: Paratype, detail pore, UFP 34, 17 × 91.
Fig. 26. *Cricotriporites minutiporus* (MULLER 1968) comb. nov., UFP 41, 7.1 × 82.5.
Figs. 27–28, 29. *Cricotriporites elongatoporus* n. sp. 27–28: Holotype, two foci, UFP 45, 10.9 × 110; 29: Paratype, UFP 44, 16.3 × 113.

Plate 9

Fig. 1. *Crototricolpites* cf. *annemariae* LEIDELMEYER 1966, UFP 76, 20.6 × 111.
Figs. 2–3 *Crototricolpites protoannemariae* n. sp., Holotype, two foci, UFP 5, 13.3 × 97.3.
Figs. 4–5. *Ctenolophonidites cruciatus* n. sp., Holotype, two foci, UFP 37, 18.4 × 111.5.
Fig. 6. *Curvimonocolpites inornatus* LEIDELMEYER 1966, UFP 4, 13.2 × 101.
Figs. 7–8. *Cyclusphaera scabrata* n. sp., Holotype, two foci, UFP 32, 5.9 × 89.2.
Figs. 9–10. *Duplotriporites ariani* SARMIENTO 1992, UFP 76, 14.6 × 114.6. 9: polar view; 10: detail exine tectate and sculpture baculate.
Figs. 11–12. *Echimonocolpites* sp. 1, two foci, UFP 11, 11 × 103.
Figs. 13–14. *Echiperiporites estelae* GERMERAAD et al. 1968, two foci, UFP 37, 5.2 × 80.5.
Figs. 15–16. *Echiperiporites* sp. 1, UFP 6, 12.1 × 110. 15: whole grain; 16: detail bacula and tectum echinate-scabrate. Scale bar for Fig. 15 is 10 µm.
Figs. 17–18, 19. *Echitetracolpites? tenuiexinatus* n. sp. 17–18: Holotype, two foci, UFP 43, 4.7 × 94.5; 19: Paratype, UFP 41, 18.3 × 85.
Figs. 20–21. *Echitetracolpites?* sp. 1, two foci, UFP 37, 18.9 × 105.5.
Figs. 22–23. *Echitricolpites* sp. 1, two foci, UFP 15, 4.1 × 82.3.

Plate 10

Figs. 1–2. *Echitriporites trianguliformis* var. *orbicularis* n. var., Holotype, two foci, UFP 34, 7.3 × 83.5.
Figs. 3–5. *Echitriporites variabilis* n. sp., Holotype, three foci, UFP 42, 87.8 × 5.7.
Figs. 6–7. *Echitriporites* sp. 1, two foci, UFP 44, 7 × 91.5.
Fig. 8. *Echitriporites* sp. 2, UFP 56, 7 × 88.6.
Figs. 9–10. *Echitriporites* sp. 3, UFP 5, 18.4 × 94.2. Scale bar for Fig. 10 is 10 µm.
Figs. 11–12. *Foveodiporites guianensis* WIJMSTRA 1971, two foci, UFP 4, 6.5 × 110.8.
Figs. 13–14. *Foveotricolpites perforatus* VAN DER HAMMEN & GARCIA 1966, two foci, UFP 19, 15.9 × 88.2.
Figs. 15–17. *Foveotricolpites* sp. 1, UFP 34, 4 × 100.5.
Figs. 18–19. *Foveotricolporites fossulatus* n. sp., Holotype, two foci, UFP 43, 7.9 × 89.9.
Figs. 20, 21. *Foveotricolporites rugulatus* n. sp. 20: Paratype, polar view, UFP 66, 18.1 × 88.7; 21: Holotype, equatorial view, UFP 34, 102.2 × 101.
Figs. 22–24. *Foveotricolporites* sp. 1, three foci, UFP 34, 10 × 87.
Figs. 25–26. *Foveotricolporites* sp. 2, two foci, UFP 43, 17.9 × 82.5.
Figs. 27–28. *Foveotricolporites* sp. 3, two foci, UFP 32, 14.9 × 96.5.

Plate 11

Figs. 1–2. *Foveotricolporites* sp. 4, two foci, UFP 21, 5.7 × 99.
Fig. 3. *Foveotriporites hammenii* GONZALEZ 1967, UFP 84, 13 × 96.5.
Figs. 4–6, 7. *Foveotriporites* sp. 1. 4–6: three foci, UFP 49, 16.3 × 105.5; 7: detail pore costate, UFP 49, 19.1 × 89.7.
Figs. 8–9. *Gemmamonocolpites gemmatus* (VAN DER HAMMEN 1954) VAN DER HAMMEN & GARCIA 1966, two foci, equatorial view, UFP 8, 20 × 87.1.
Figs. 10–12. *Crusafontites megagemmatus* n. sp., Holotype, three foci, polar view, UFP 43, 18.8 × 87.1.
Figs. 13–14. *Gemmamonocolpites perfectus* n. sp., Holotype, two foci, polar view, UFP 43, 11 × 86.2.
Figs. 15–16. *Gemmamonocolpites* sp. 1, two foci, polar view, UFP 84, 21 × 84.4.
Figs. 17–18. *Gemmamonocolpites* sp. 2, two foci, UFP 5, 11.5 × 94.
Figs. 19–20. *Horniella* sp. 1, two foci, UFP 49, 18.2 × 79.5.
Figs. 21–23. *Horniella* sp. 2, three foci, UFP 32, 11.6 × 107.
Figs. 24–26. *Horniella* sp. 3, three foci, UFP 21, 6.4 × 83.8.

Plate 12

Figs. 1–3. *Jandufouria minor* n. sp., Holotype, three foci, UFP 45, 4.3 × 84.
Figs. 4–5. *Ladakhipollenites rubinii* (VAN DER HAMMEN 1954) comb. nov., two foci, UFP 41, 4.6 × 103.2.
Fig. 6. *Ladakhipollenites simplex* (GONZALEZ 1967) comb. nov., UFP 62, 3.5 × 103.1.
Figs. 7–8. *Ladakhipollenites* sp. 1, two foci, UFP 53, 6.3 × 112.8.
Figs. 9–10. *Lakiapollis* aff. *ovatus* VENKATACHALA & KAR 1969, two foci, UFP 41, 12.3 × 112.5.
Fig. 11. *Lanagiopollis crassa* (VAN DER HAMMEN & WYMSTRA 1964) FREDERIKSEN 1988, UFP 34, 12.3 × 84.5.
Figs. 12–13. *Longapertites microfoveolatus* ADEGOKE & JAN DU CHENE 1975, two foci, UFP 12, 18 × 81.
Fig. 14. *Longapertites proxapertitoides* var. *proxapertitoides* VAN DER HAMMEN & GARCIA 1966, UFP 27, 13.4 × 93.5.
Fig. 15. *Longapertites proxapertitoides* var. *reticuloides* VAN DER HAMMEN & GARCIA 1966, UFP 27, 8 × 84.3.
Figs. 16–18. *Longapertites* sp. 1, three foci, UFP 43, 2.9 × 99.9.
Figs. 19–21. *Luminidites colombianensis* n. sp., Holotype, three foci, UFP 37, 11.9 × 106.8.
Figs. 22–24. *Lymingtonia*? sp. 1, three foci, UFP 17, 16.1 × 111.8.
Fig. 25. *Margocolporites vanwijhei* GERMERAAD et al. 1968, UFP 53, 6.9 × 107.
Figs. 26–29. *Margocolporites* sp. 1, four foci, UFP 41, 20.6 × 100.2.

Plate 13

Figs. 1, 2, 3. *Mauritiidites franciscoi* var. *franciscoi* (VAN DER HAMMEN 1956a) VAN HOEKEN-KLINKENBERG 1964. 1: whole grain, UFP 6, 12 × 107.5; 2: spine, UFP 34, 3.3 × 104; 3. spine, UFP 34, 6.8 × 97.9.
Figs. 4, 5, 6. *Mauritiidites franciscoi* var. *franciscoi* (VAN DER HAMMEN 1956a) VAN HOEKEN-KLINKENBERG 1964. 4: spine, UFP 44, 6.6 × 93; 5: spine, UFP 37, 11.1 × 89; 6: spine, UFP 82, 13.1 × 78.8.
Fig. 7. *Mauritiidites franciscoi* var. *minutus* VAN DER HAMMEN & GARCIA 1966, UFP 32, 7.6 × 80.5.
Fig. 8. *Mauritiidites franciscoi* var. *pachyexinatus* VAN DER HAMMEN & GARCIA 1966, UFP 40, 20.4 × 99.3.
Figs. 9–10. *Momipites africanus* VAN HOEKEN-KLINKENBERG 1966, two foci, UFP 5, 8.9 × 87.1.
Figs. 11–12. *Momipites* sp. 1, two foci, UFP 38, 16.1 × 97.6.
Figs. 13–14. *Monocolpopollenites ovatus* n. sp., Holotype, two foci, UFP 10, 6.6 × 83.5.
Figs. 15, 16. *Monoporopollenites annulatus* (VAN DER HAMMEN 1954) comb. nov. 15: lateral view, UFP 39, 18.2 × 82.4; 16: distal view, UFP 32, 10.5 × 83.7.
Figs. 17–19. *Multiporopollenites pauciporatus* n. sp., Holotype, two foci, UFP 34, 13.5 × 87.2.
Figs. 20–21. *Nothofagidites huertasii* n. sp., Holotype, two foci, UFP 46, 10 × 95.
Figs. 22–23. *Nothofagidites* sp. 1, two foci, UFP 65, 18 × 92.7.
Figs. 24–25. *Paleosantalaceaepites distinctus* n. sp., Holotype, two foci, UFP 17, 18.2 × 85.2.
Figs. 26–27. *Parsonsidites*? sp. 1, two foci, UFP 1, 16.8 × 91.5.
Figs. 28–29. *Parsonsidites* sp. 2, two foci, UFP 47, 15 × 107.
Fig. 30. *Perfotricolpites digitatus* GONZALEZ 1967, UFP 41, 9.2 × 96.5.
Fig. 31. *Periretisyncolpites giganteus* KEISER & JAN DU CHÊNE 1979, UFP 86, 10 × 81.2. Scale bar for Fig. 31 is 10 µm.
Figs. 32–34. *Periretisyncolpites* sp. 1, UFP 5, 7 × 97.6. 32: whole grain; 33–34: two foci, detail reticula. Scale bar for Fig. 32 is 10 µm.

Plate 14

Fig. 1. *Perisyncolporites pokornyi* GERMERAAD et al. 1968, UFP 65, 6 × 94.5.
Figs. 2–3. *Poloretitricolpites absolutus* (GONZALEZ 1967) comb. nov., two foci, UFP 44, 4.8 × 104.4.
Figs. 4–6. *Propylipollis pseudocostatus* n. sp., Holotype, three foci, UFP 34, 12.6 × 113.

Fig. 7. *Proxapertites cursus* VAN HOEKEN-KLINKENBERG 1966, UFP 10, 12.8 × 108.5.
Figs. 8–9. *Proxapertites humbertoides* (VAN DER HAMMEN 1954) SARMIENTO 1992, UFP 76, 21 × 81.5. 8: polar view; 9: detail sculpture foveolate to fossulate. Scale bar for Fig. 8 is 10 µm.
Figs. 10, 11. *Proxapertites magnus* MULLER et al. 1987. 10: polar view, UFP 53, 23 × 100; 11: detail columellae, UFP 12, 6.2 × 84.5. Scale bar for Fig. 10 is 10 µm.
Fig. 12. *Proxapertites operculatus* (VAN DER HAMMEN 1956a) GERMERAAD et al. 1968, UFP 10, 4.9 × 84.1.
Figs. 13, 14. *Proxapertites psilatus* SARMIENTO 1992. 13: UFP 41, 5.5 × 100.5; 14: UFP 32, 19.1 × 91.5.
Figs. 15, 16. *Proxapertites verrucatus* SARMIENTO 1992. 15: UFP 76, 14.8 × 102.9; 16: UFP 75, 10.5 × 97.1.
Figs. 17–18. *Psilabrevitricolpites* sp. 1, two foci, UFP 5, 9.8 × 104.
Figs. 19–20. *Psilabrevitricolporites simpliformis* VAN DER KAARS 1983, two foci, UFP 6, 12 × 107.1.
Figs. 21. *Psilabrevitricolporites triangularis* (VAN DER HAMMEN & WYMSTRA 1964) comb. nov., UFP 49, 10.9 × 87.6.
Figs. 22–23. *Psilabrevitricolporites* sp. 1, two foci, UFP 40, 16 × 100.5.
Figs. 24–25. *Psilabrevitricolporites* sp. 2, two foci, UFP 41, 9.7 × 87.8.
Figs. 26–27. *Psilamonocolpites grandis* (VAN DER HAMMEN 1954) VAN DER HAMMEN & GARCIA 1966, two foci, UFP 4, 5.5 × 88.2.
Figs. 28–29. *Psilamonocolpites medius* (VAN DER HAMMEN 1954) VAN DER HAMMEN & GARCIA 1966, two foci, UFP 11, 14 × 112.1.
Figs. 30–31. *Psilastephanocolpites* sp. 2, two foci, UFP 41, 15.5 × 110.

Plate 15

Figs. 1–3. *Psilastephanocolpites* sp. 1, three foci, UFP 49, 15 × 105.
Figs. 4–5, 6. *Psilastephanocolporites brevicolpatus* n. sp. 4–5: Holotype, two foci, UFP 41, 6.9 × 109.5; 6: Paratype, UFP 43, 8 × 90.9.
Figs. 7, 8, 9. *Psilastephanocolporites fissilis* LEIDELMEYER 1966. 7: UFP 43, 12.4 × 109.5; 8: UFP 37, 11.6 × 108.2; 9: UFP 35, 9.4 × 98.5.
Figs. 10–11. *Psilastephanoporites* sp. 1, two foci, UFP 82, 16.2 × 86.9.
Figs. 12–13. *Psilastephanoporites* sp. 2, two foci, UFP 19, 10.5 × 101.2.
Figs. 14–15. *Psilasyncolporites* sp. 1, two foci, UFP 57, 19.5 × 111.1.
Figs. 16–17. *Psilasyncolporites* sp. 2, two foci, UFP 42, 12.8 × 89.5.
Fig. 18. *Racemonocolpites facilis* GONZALEZ 1967, UFP 84, 13.9 × 104.4.
Figs. 19, 20. *Racemonocolpites racematus* (VAN DER HAMMEN 1954) GONZALEZ 1967. 19: UFP 7, 8.2 × 85.7; 20: UFP 53, 16.2 × 99.4.
Figs. 21–22. *Racemonocolpites* sp. 1, two foci, UFP 32, 9.9 × 93.5.
Fig. 23. *Ranunculacidites operculatus* (VAN DER HAMMEN & WYMSTRA 1964) comb. nov. 1967, UFP 40, 9.8 × 84.6.
Figs. 24–25. *Retibrevitricolpites retibolus* LEIDELMEYER 1966, two foci, UFP 40, 8.5 × 111.7.
Figs. 26–27. *Retibrevitricolpites triangulatus* VAN HOEKEN-KLINKENBERG 1966, two foci, UFP 84, 10.6 × 92.9.
Figs. 28–29. *Retibrevitricolpites* sp. 1, two foci, UFP 49, 17.9 × 80.8.
Figs. 30, 31. *Retibrevitricolpites* sp. 2. 30: UFP 58, 19.2 × 104; 31: UFP 40, 3.2 × 114.5.
Figs. 32–33. *Retibrevitricolporites grandis* n. sp., Holotype, two foci, UFP 33, 14.9 × 111.5.
Figs. 34–36. *Retibrevitricolporites speciosus* n. sp., Holotype, three foci, UFP 32, 3.9 × 82.1.

Plate 16

Figs. 1–2. *Retidiporites elongatus* SARMIENTO 1992, two foci, UFP 15, 7.4 × 79.5.
Fig. 3. *Retidiporites magdalenensis* VAN DER HAMMEN & GARCIA 1966, UFP 4, 18.6 × 95.
Figs. 4–6. *Retidiporites poricostatus* n. sp., Holotype, three foci, UFP 8, 3.9 × 90.4.
Figs. 7–8. *Retipollenites* sp. 1, two foci, UFP 5, 14 × 82.7.
Figs. 9–10. *Retipollenites* sp. 2, UFP 16, 12.3 × 110.5. 9: whole grain; 10: detail reticula. Scale bar for Fig. 9 is 10 µm.
Figs. 11–12. *Retistephanocolpites angeli* LEIDELMEYER 1966, two foci, UFP 7, 20.3 × 101.2.
Figs. 13–15. *Retistephanocolpites fossulatus* n. sp., Holotype, three foci, UFP 39, 15 × 94.
Figs. 16–17. *Retistephanocolpites* sp. 1, two foci, UFP 41, 20 × 110.
Figs. 18–19. *Retistephanocolpites* sp. 2, two foci, UFP 43, 22.3 × 80.3.
Figs. 20, 21. *Retistephanocolporites festivus* GONZALEZ 1967. 20: UFP 41, 19.7 × 98.2; 21: UFP 39, 7.6 × 111.4.
Figs. 22–25. *Retistephanocolporites fossulatus* n. sp., Holotype, three foci, UFP 37, 7.8 × 97.7.
Figs. 26–27. *Retistephanoporites angelicus* GONZALEZ 1967, two foci, UFP 44, 11 × 113.5.
Figs. 28–29. *Retistephanoporites crassiexinatus* n. sp., Holotype, two foci, UFP 37, 5.2 × 85.6.

Plate 17

Figs. 1–2. *Retistephanoporites minutiporus* n. sp., Holotype, two foci, UFP 37, 11.4 × 98.1.
Figs. 3–4. *Retistephanoporites* sp. 1, two foci, UFP 86, 12.7 × 107.9.
Fig. 5. *Retisyncolporites angularis* GONZALEZ 1967, UFP 66, 5.5 × 100.
Figs. 6–7. *Retisyncolporites* sp. 1, two foci, UFP 49, 3.1 × 95.1.
Figs. 8–9, 10. *Retisyncolporites* sp. 2. 8–9: two foci, UFP 34, 5 × 100.9; 10: UFP 32, 11.6 × 85.3.
Figs. 11–13, 14. *Retitrescolpites baculatus* n. sp. 11–13: Holotype, three foci, UFP 11, 13.8 × 82.1; 14: Paratype, detail reticula, UFP 49, 18.1 × 111.6.
Figs. 15–16. *Retitrescolpites magnus* (GONZALEZ 1967) comb. nov., two foci, UFP 38, 19.4 × 88.8.
Figs. 17–19, 20, 21. *Retitrescolpites peculiaris* n. sp. 17–18: Holotype, UFP 9, 17 × 101.6, polar view; 19: Holotype, detail reticula; 20: Paratype, detail reticula, UFP 9, 22 × 91; 21: Paratype, UFP 9, 11.5 × 96.5.

Plate 18

Figs. 1–2. *Retitrescolpites saturum* (GONZALEZ 1967) comb. nov., two foci, UFP 15, 7.3 × 88.7.
Figs. 3–5. *Retitriporites amplireticulatus* n. sp., Holotype, three foci, UFP 15, 6.9 × 97.3.
Figs. 6–7. *Retitriporites poricostatus* n. sp., Holotype, two foci, UFP 47, 18.1 × 82.
Figs. 8–9. *Retitriporites* sp. 1, two foci, UFP 7, 20 × 96.5.
Figs. 10–11. *Retitriporites* sp. 2, two foci, UFP 41, 4.9 × 93.1.
Figs. 12–13. *Retitriporites* sp. 3, two foci, UFP 39, 5.6 × 84.5.
Figs. 14–15. *Retitriporites* sp. 4, two foci, UFP 43, 5 × 87.5.
Fig. 16 *Rhoipites cienagensis* (DUEÑAS 1980) comb. nov., UFP 39, 21 × 110.
Figs. 17–18. *Rhoipites guianensis* (VAN DER HAMMEN & WYMSTRA 1964) comb. nov., two foci, UFP 38, 9.8 × 91.
Fig. 19. *Rhoipites hispidus* (VAN DER HAMMEN & WYMSTRA 1964) comb. nov., UFP 40, 17.6 × 105.
Fig. 20. *Retitrescolpites? irregularis* (VAN DER HAMMEN & WYMSTRA 1964) comb. nov., UFP 32, 7.3 × 103.8.
Figs. 21–22. *Rhoipites squarrosus* (VAN DER HAMMEN & WYMSTRA 1964) comb. nov., two foci, UFP 39, 12.5 × 104.1.
Figs. 23–24. *Rhoipites* sp. 1, two foci, UFP 44, 7.3 × 89.5.
Figs. 25–27. *Margocolporites* sp. 2, three foci, UFP 37, 6 × 106.5.
Figs. 28–29. *Rhoipites?* sp. 2, two foci, UFP 41, 15.8 × 98.4.

Plate 19

Figs. 1–2. *Rousea florentina* (GONZALEZ 1967) comb. nov., two foci, UFP 49, 9.1 × 89.1.
Figs. 3–4. *Rugotricolporites felix* GONZALEZ 1967, two foci, UFP 37, 17.7 × 81.5.
Figs. 5–6. *Scabrastephanocolpites* sp. 1, two foci, UFP 27, 20 × 102.
Figs. 7–8. *Scabratriporites* sp. 1, two foci, UFP 66, 5.1 × 98.2.
Figs. 9–11. *Siltaria mariposa* (LEIDELMEYER 1966) comb. nov., three foci, UFP 27, 13.7 × 109.1.
Fig. 12. *Siltaria media* (GONZALEZ 1967) comb. nov., UFP 32, 7.5 × 109.3.
Figs. 13–14. *Siltaria* sp. 1, two foci, UFP 41, 8.3 × 78.5.
Figs. 15–16. *Siltaria* sp. 2, two foci, UFP 43, 11 × 91.5.
Figs. 17–18. *Siltaria* sp. 3, two foci, UFP 53, 12.8 × 113.
Figs. 19–20. *Siltaria* sp. 4, two foci, UFP 40, 6.9 × 110.5.
Figs. 21–22, 23–24. *Siltaria* sp. 5. 21–22: two foci, UFP 11, 7.2 × 106.5; 23–24: two foci, UFP 11, 6.5 × 85.
Figs. 25–26. *Spinizonocolpites* aff. *baculatus* MULLER 1968, two foci, UFP 82, 17.5 × 92.3. Scale bar for Figs. 25–26 is 10 µm.
Figs. 27, 28. *Spinizonocolpites* cf. *baculatus* MULLER 1968. 27: UFP 76, 14 × 108.5; 28: UFP 76, 21.5 × 97.
Figs. 29–30, 31. *Spinizonocolpites breviechinatus* n. sp. 29–30: Holotype, two foci, UFP 15, 14.8 × 110.2; 31: Paratype, UFP 11, 8.2 × 95.

Plate 20

Figs. 1–3. *Spinizonocolpites grandis* n. sp., Holotype, UFP 34, 11.4 × 111.2. 1: polar view; 2: detail tectum finely reticulate; 3: detail spines.
Figs. 4–5. *Spinizonocolpites pachyexinatus* n. sp., Holotype, two foci, UFP 21, 13 × 108.
Figs. 6–7, 8. *Spirosyncolpites spiralis* GONZALEZ 1967. 6–7: two foci, UFP 49, 17.9 × 104.5; 8: colpus, UFP 38, 19 × 101.8.
Figs. 9–10. *Striatopollis catatumbus* (GONZALEZ 1967) TAKAHASHI & JUX 1989, two foci, UFP 46, 15.6 × 108.5.
Fig. 11. *Striatopollis minor* (WIJMSTRA 1971) comb. nov., UFP 17, 11.9 × 115.1.
Figs. 12–13, 14. *Striatopollis? tenuistriatus* n. sp. 12–13: Holotype, two foci, UFP 58, 15.6 × 95.2; 14: Paratype, UFP 84, 17.8 × 89.4
Figs. 15–16. *Striatopollis* sp. 1, two foci, UFP 11, 5 × 96.6.

Figs. 17–18. *Striatricolporites digitatus* n. sp., Holotype, two foci, UFP 6, 16 × 101.9.
Figs. 19–20. *Striatricolporites* sp. 1, two foci, UFP 19, 19 × 91.
Figs. 21–22. *Syncolporites lisamae* VAN DER HAMMEN 1954, two foci, UFP 12, 11.4 × 84.1.
Figs. 23–24. *Syncolporites marginatus* VAN HOEKEN-KLINKENBERG 1964, two foci, UFP 56, 11.5 × 109.4.
Figs. 25–26. *Syncolporites* sp. 1, two foci, UFP 21, 12.2 × 114.
Figs. 27–28. *Tetracolporites pachyexinatus* n. sp., Holotype, two foci, UFP 44, 13.5 × 85.1.

Plate 21

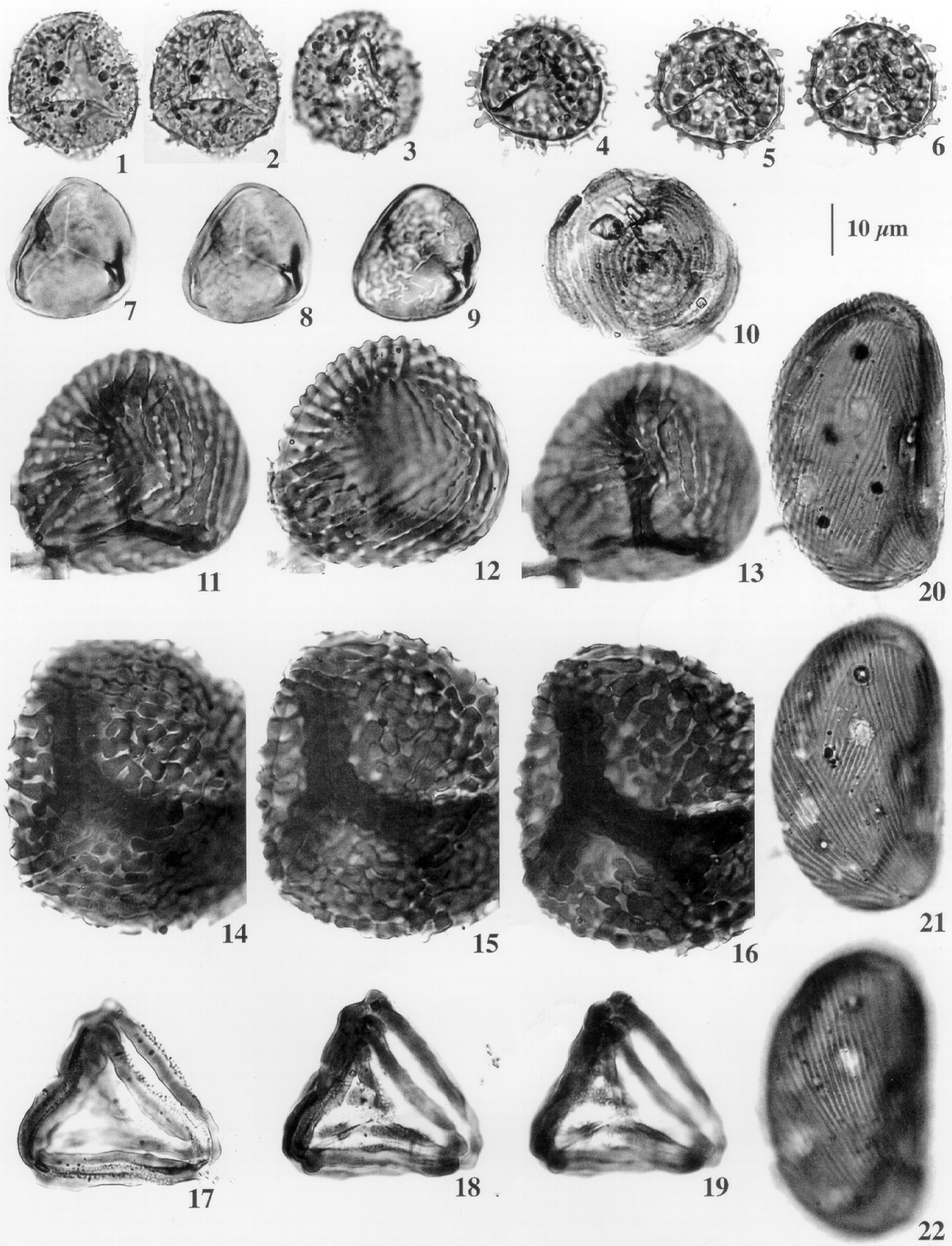
Figs. 1–2. *Tetracolporites pachyexinatus* n. sp., paratype, two foci, UFP 37, 8.1 × 97.6.
Figs. 3–4. *Tetracolporites psilatus* n. sp., Holotype, two foci, UFP 49, 14 × 91.5.
Figs. 5–6. *Tetracolporopollenites maculosus* (REGALI et al. 1974) comb. nov., two foci, UFP 48, 20 × 87.
Figs. 7–8. *Tetracolporopollenites spongiosus* n. sp., Holotype, two foci, UFP 19, 6.2 × 93.
Fig. 9. *Tetracolporopollenites transversalis* (DUEÑAS 1980) comb. nov., UFP 43, 9.7 × 110.4.
Figs. 10–12. *Tetracolporopollenites* sp. 1, three foci, UFP 43, 5.5 × 112.
Figs. 13–15. *Tetracolporopollenites*? sp. 2, three foci, UFP 58, 20 × 93.7.
Figs. 16–17. *Tricolpites antonii* (GONZALEZ 1967) comb. nov., two foci, UFP 38, 14.2 × 107.9.
Fig. 18. *Tricolpites clarensis* (GONZALEZ 1967) comb. nov., UFP 38, 12.4 × 97.6.
Figs. 19–20. *Tricolpites protoclarensis* n. sp., Holotype, two foci, UFP 17, 15 × 91.8.
Figs. 21–22. *Tricolpites* sp. 1, two foci, UFP 47, 9.7 × 99.2.
Figs. 23–24. *Tricolpites* sp. 2, two foci, UFP 35, 11.9 × 113.7.
Figs. 25–26. *Triporopollenites*? *tenuiexinatus* n. sp., Holotype, two foci, UFP 76, 12.3 × 106.2.
Fig. 27. *Ulmoideipites krempii* (ANDERSON 1960) ELSIK 1968b, UFP 19, 18.6 × 96.9.
Figs. 28–29. *Venezuelites*? *distinctus* n. sp., Holotype, two foci, UFP 43, 11.2 × 85.6.
Figs. 30–31. *Verrustephanocolpites rugulatus* n. sp., Holotype, two foci, UFP 27, 18.2 × 109.2

Plate 22

Figs. 1–2. *Verrustephanoporites* sp. 1, two foci, UFP 43, 4.3 × 104.
Figs. 3–4. *Verrutricolpites* sp. 1, two foci, UFP 49, 8.8 × 87.2.
Figs. 5–6, 7. *Verrutricolporites reticulatus* n. sp. 5–6: Holotype, two foci, UFP 43, 10.5 × 98; 7:Paratype, UFP 49, 7.6 × 105.5.
Fig. 8. *Wilsonipites margocolpatus* MULLER et al. 1987, UFP 57, 6.4 × 102.3.
Figs. 9–11. *Zonocostites minor* n. sp. 9: Paratype, UFP 90, 8.4 × 92; 10: Holotype, UFP 90, 6.5 × 97.9; 11: Paratype, UFP 91, 15.4 × 97.5.
Fig. 12. *Achomosphaera* sp. 1, UFP 34, 6.4 × 94.
Figs. 13–15, 16, 17. *Cordosphaeridium inodes* (KLUMPP 1953) EISENACK 1963 emend. MORGENROTH 1968. 13–15: UFP 42, 20.6 × 95, 13–14: ventral view; 15: detail process fibrous; 16: detail operculum, UFP 34, 4 × 95.2; 17: UFP 34, 10.5 × 102.5. Scale bar for Figs. 13–14, 17 is 10 µm.
Fig. 18. *Coronifera* sp. 1, UFP 21, 13.1 × 80.
Figs. 19–21. *Glaphyrocysta* sp. 1, UFP 39, 18.4 × 104.3. 19–20: ventral view; 21: detail process complexes not clearly defined joined to one another by a trabeculae. Scale bar for Figs. 19–20 is 10 µm.
Figs. 22–24. *Homotryblium floripes* (DEFLANDRE & COOKSON 1955) STOVER 1975, UFP 37, 11.3 × 90.1. 22–23: two foci; 24: detail process long, intratabular. Scale bar for Figs. 22–23 is 10 µm.
Figs. 25–26. Incertae sedis sp. 1, UFP 41, 23 × 95.4.

Plate 23

Figs. 1–4. *Hystrichokolpoma* sp. 1, four foci, UFP 37, 12 × 107. Scale bar for Fig. 4 is 10 µm.
Figs. 5, 6. *Lingulodinium* cf. *sicula* (DRUGG 1970) WALL & DALE in WALL et al. 1973. 5: UFP 39, 10.3 × 92.9; 6: UFP 43, 15.7 × 103. Scale bar for Fig. 5–6 is 10 µm.
Figs. 7–9. *Nematosphaeropsis* sp. 1, UFP 34, 18.6 × 82. 7–8: two foci; 9: detail processes falred, connected by a complex network of ribbon-like trabeculae. Scale bar for Figs. 7–8 is 10 µm.
Figs. 10–11. *Polysphaeridium subtile* DAVEY & WILLIAMS 1966 emend. BUJAK et al. 1980, two foci, UFP 34, 6.1 × 114.9.
Figs. 12–13. *Spiniferites* sp. 1, two foci, UFP 34, 17.8 × 98.9. Scale bar for Fig. 12 is 10 µm.
Figs. 14–15. *Systematophora*? sp. 1, two foci, UFP 37, 12.5 × 83.6.



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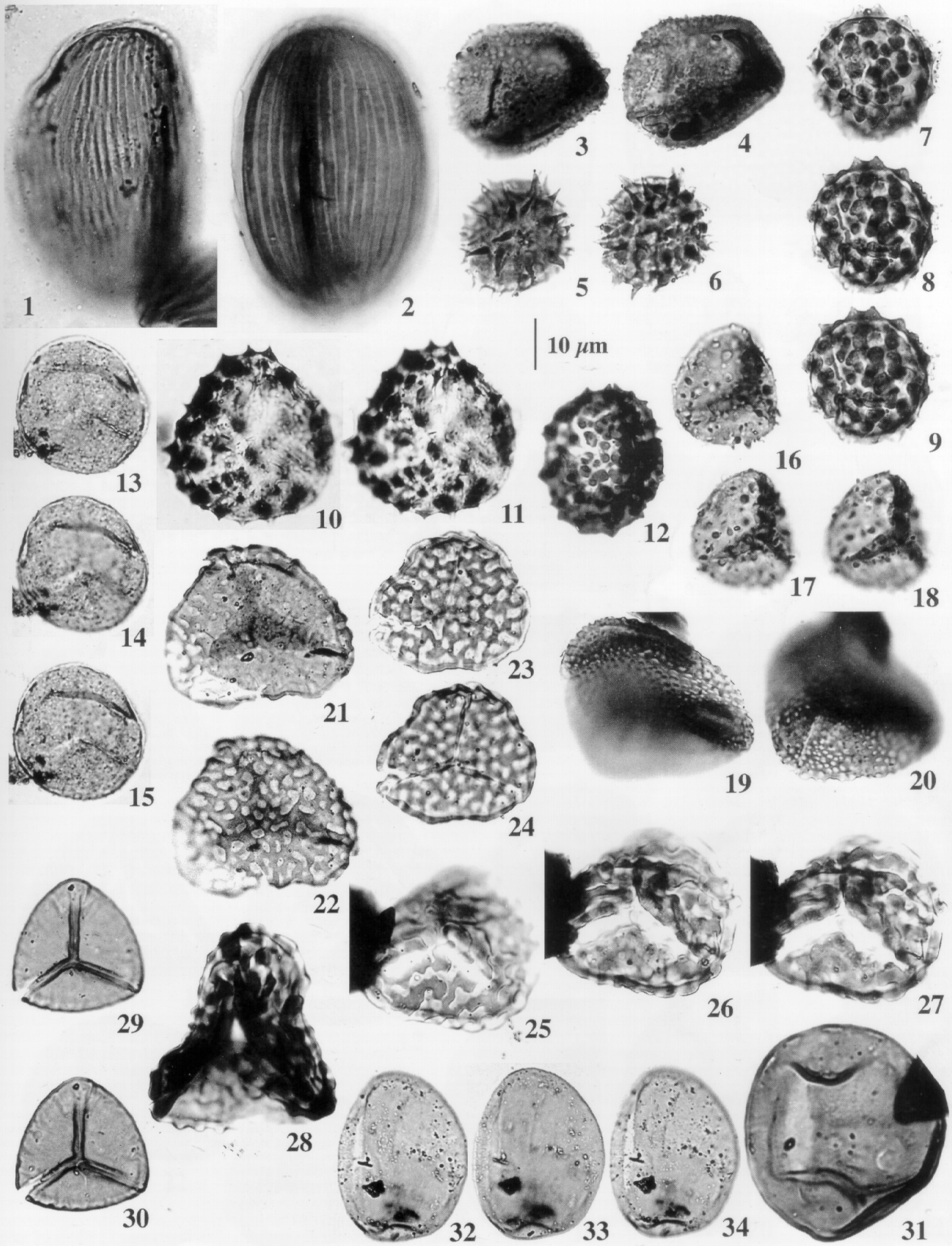

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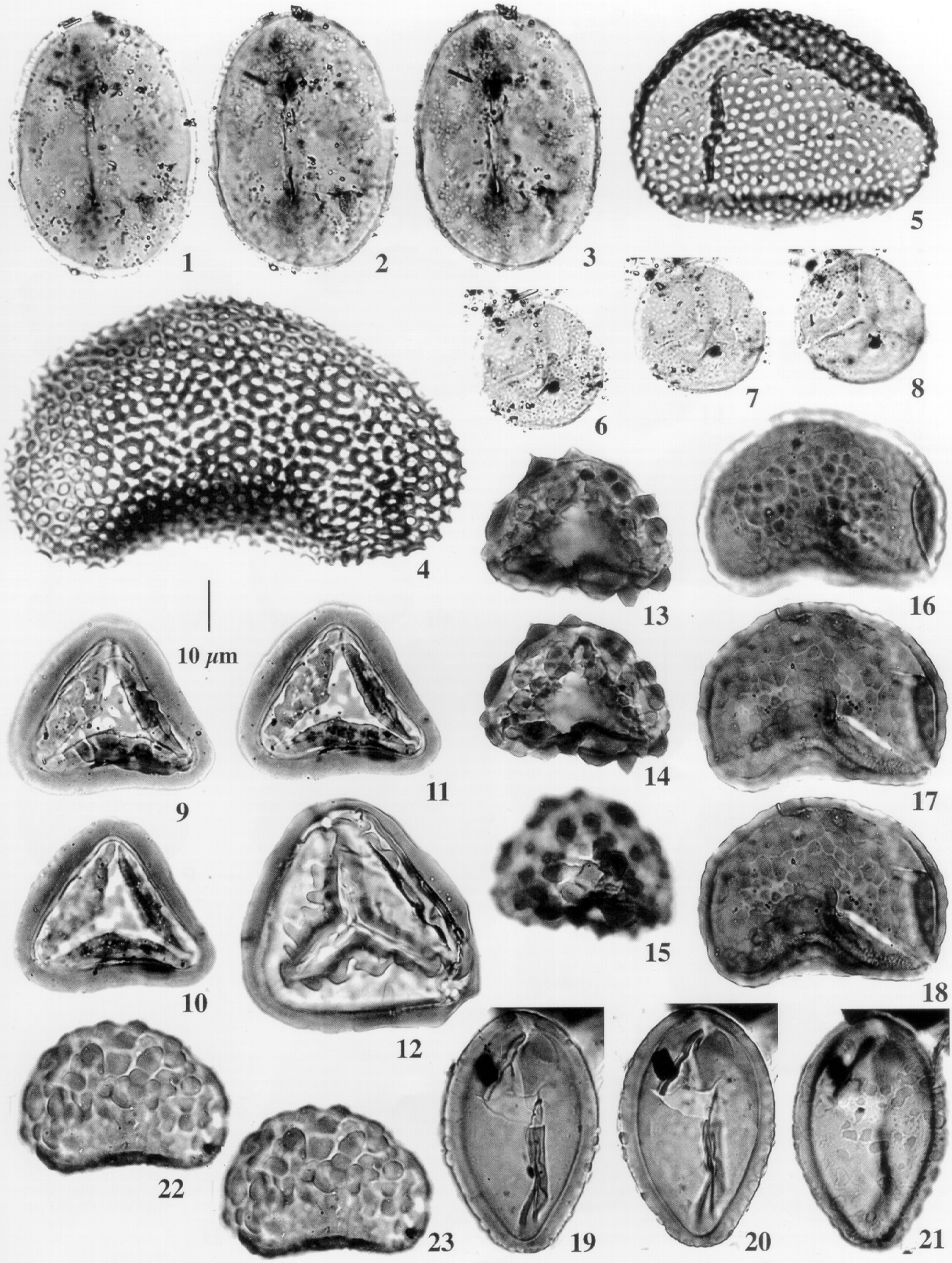

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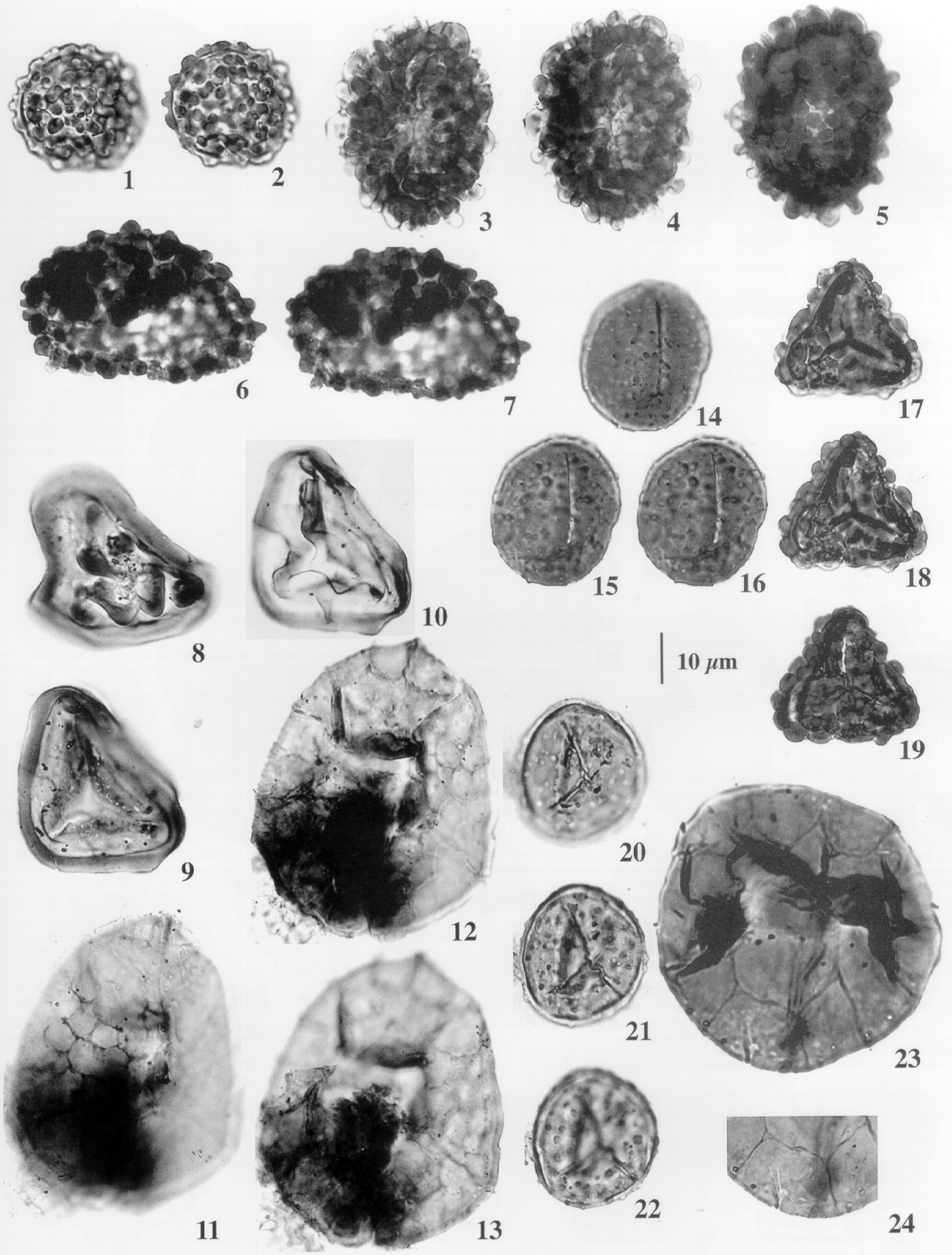

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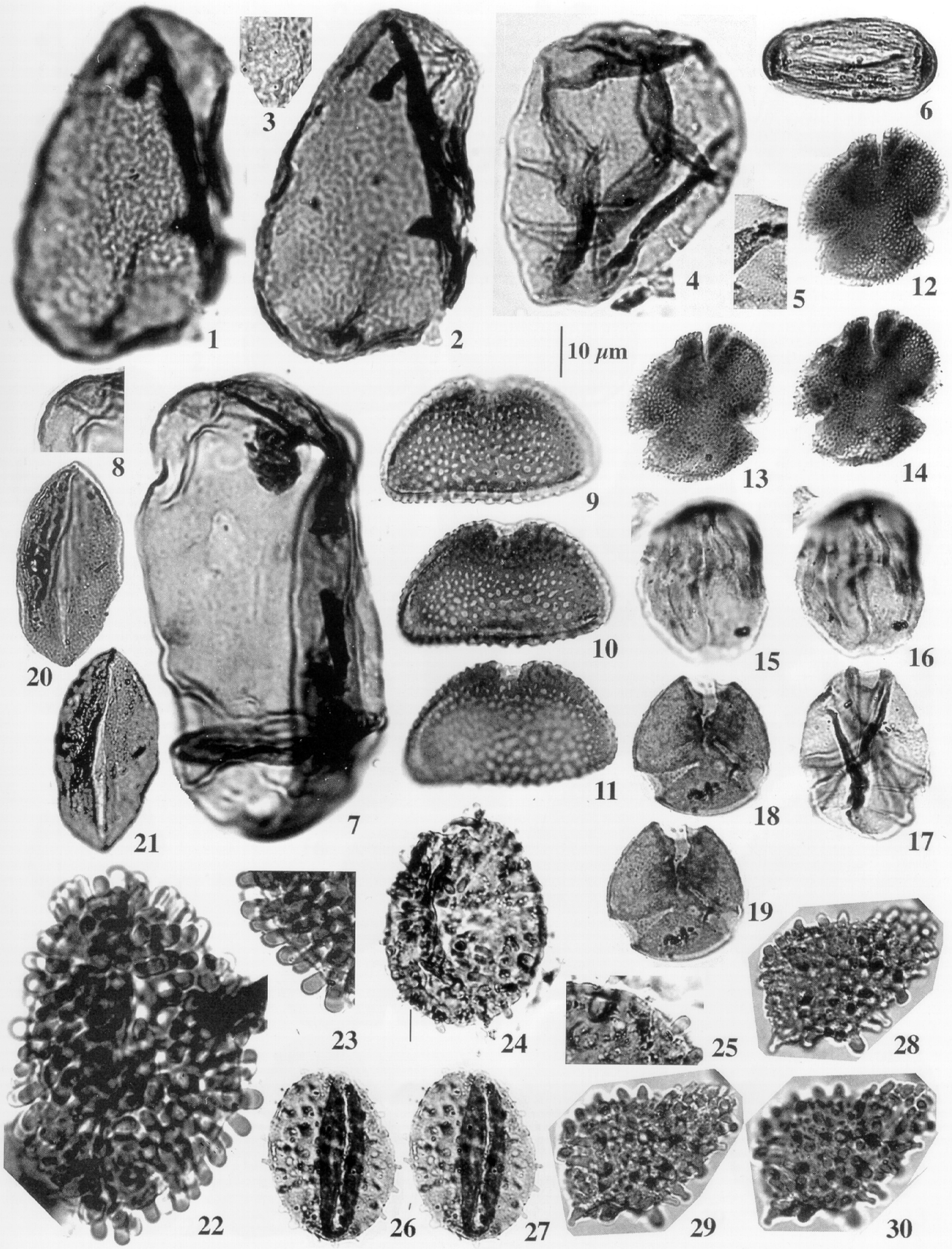

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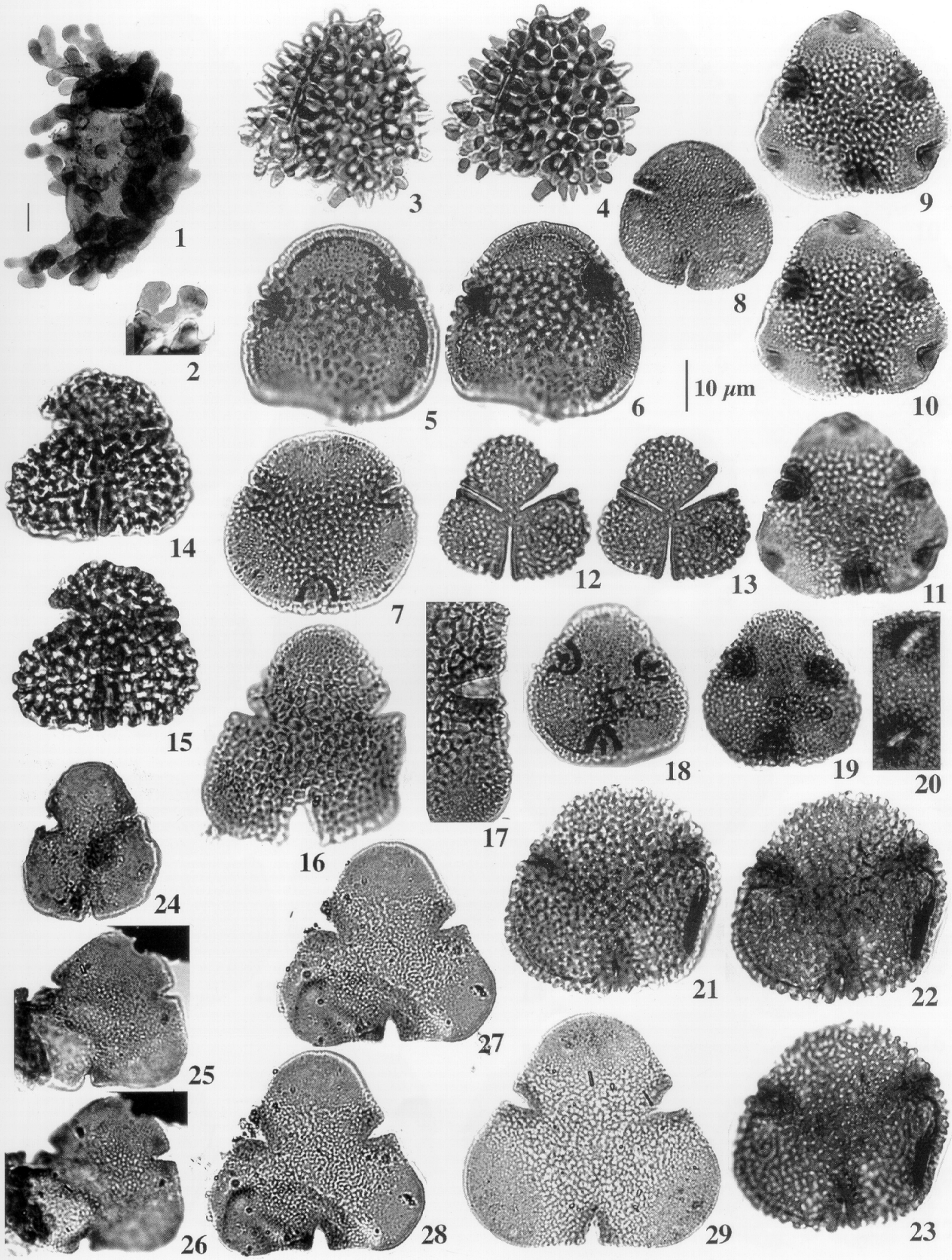

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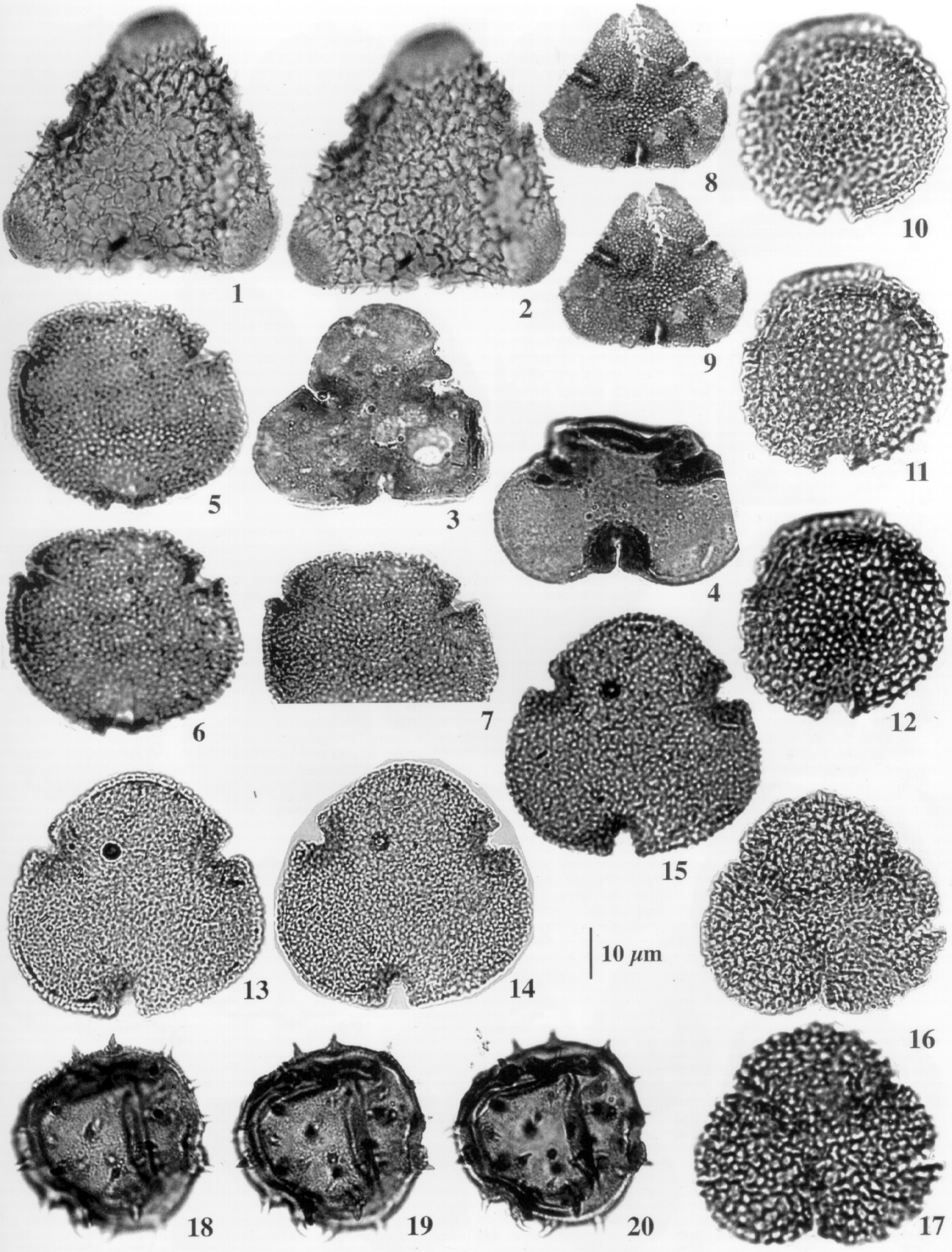

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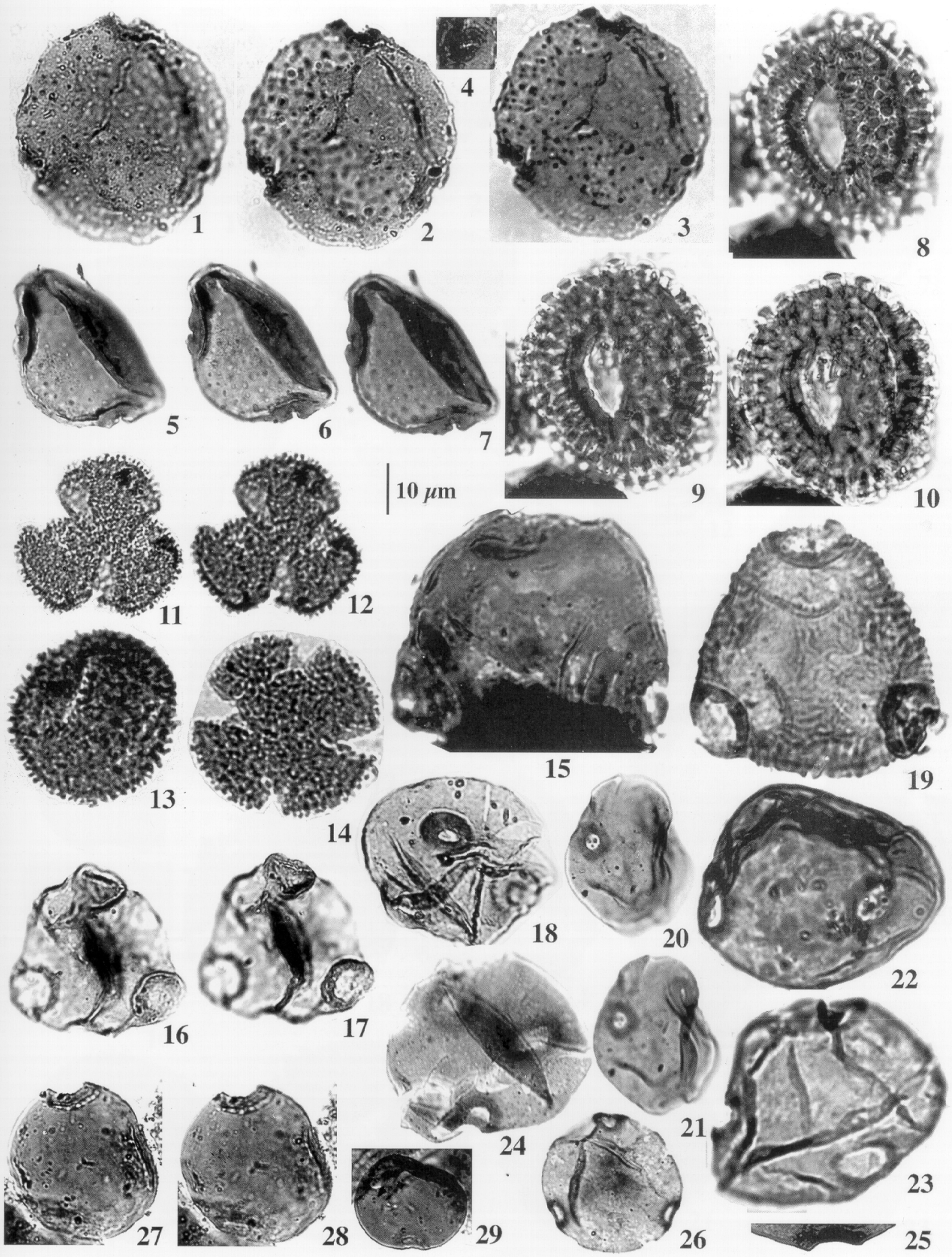

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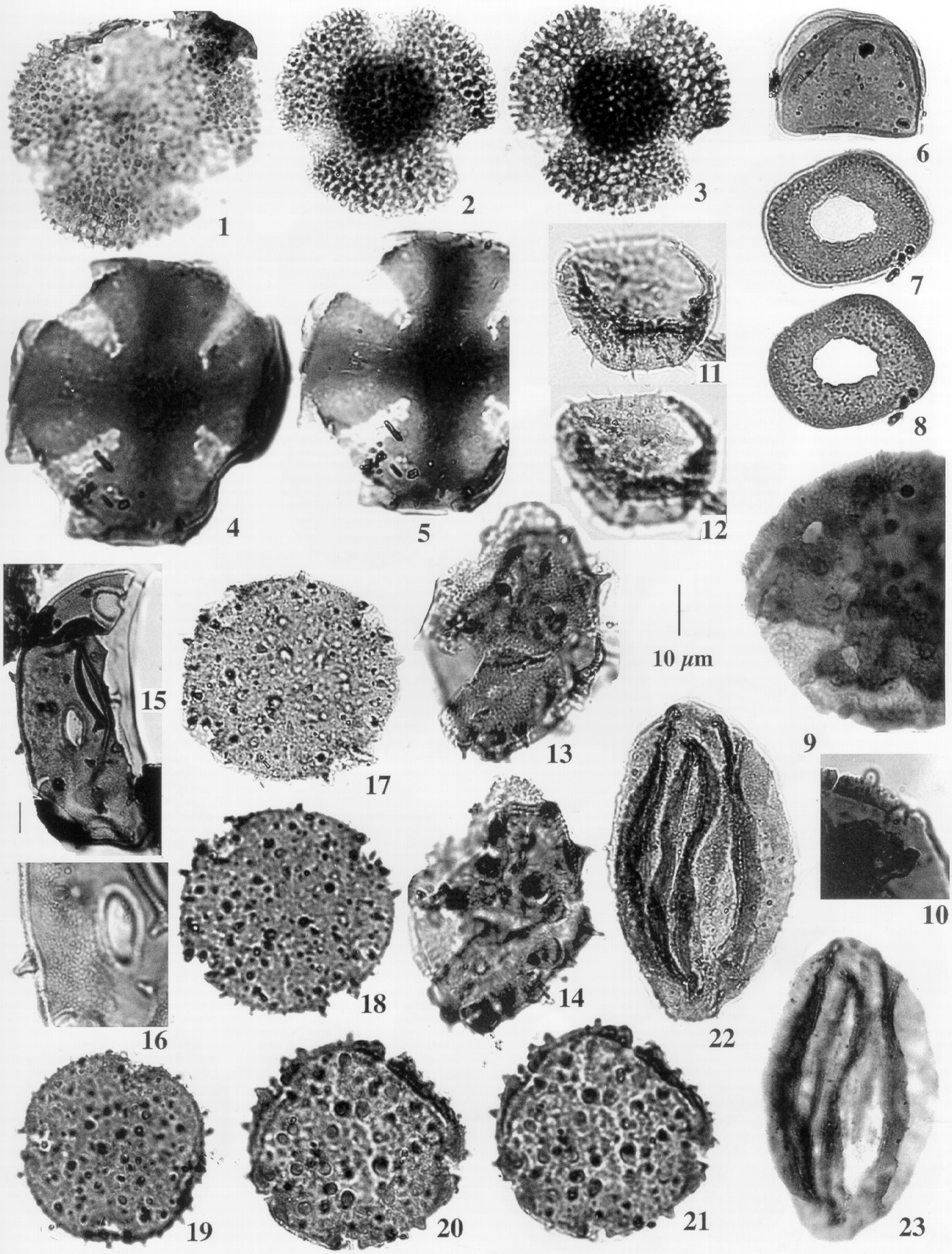

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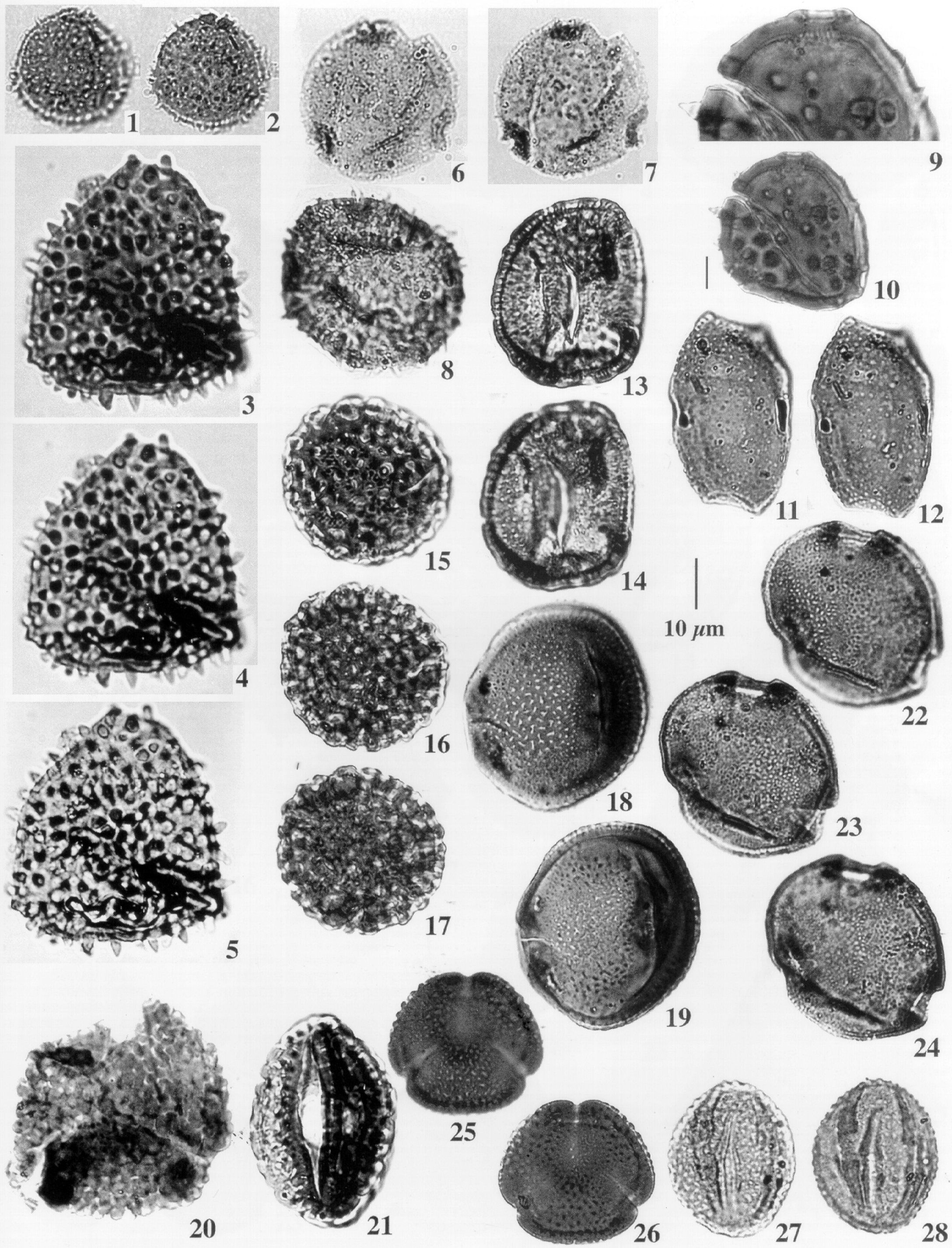

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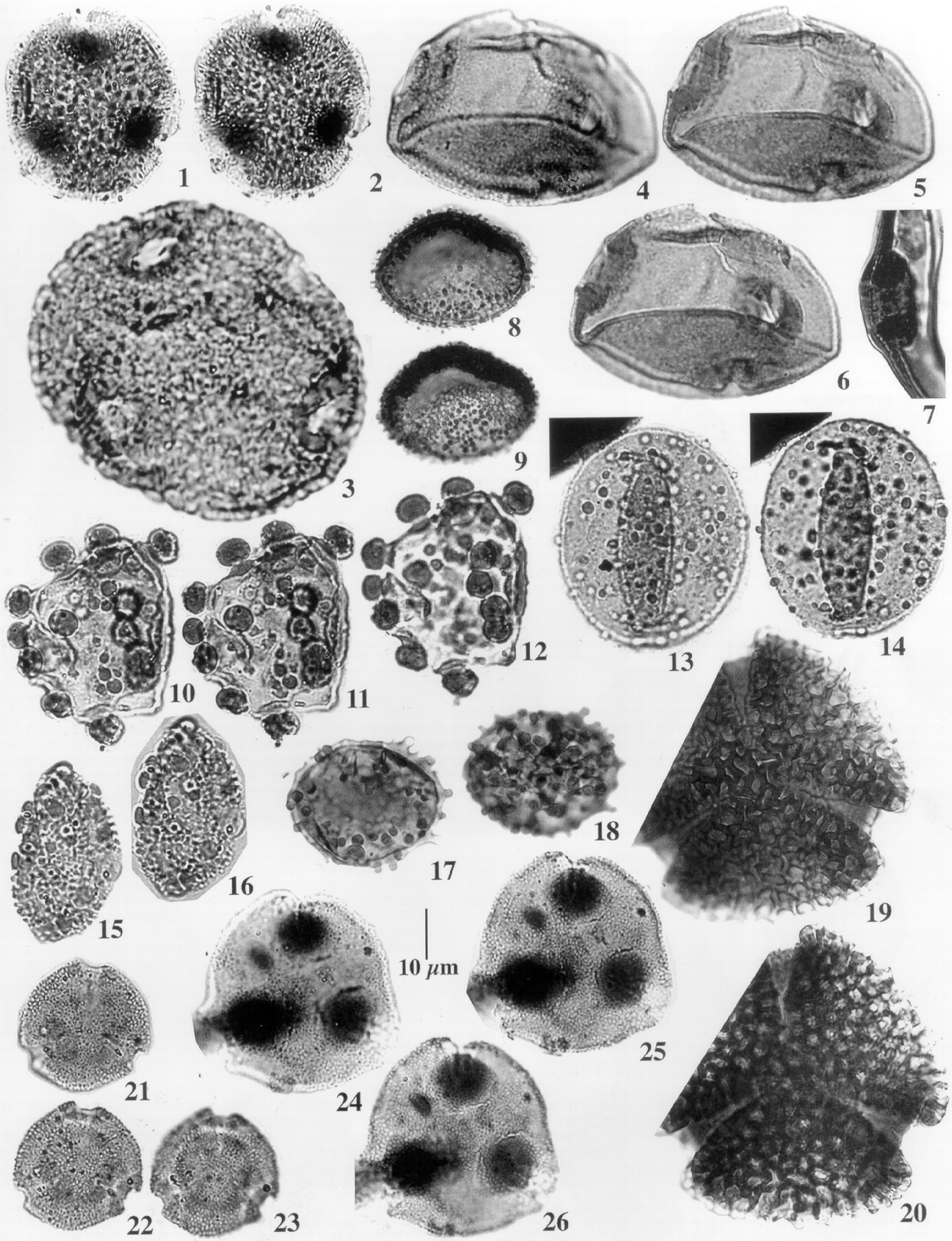

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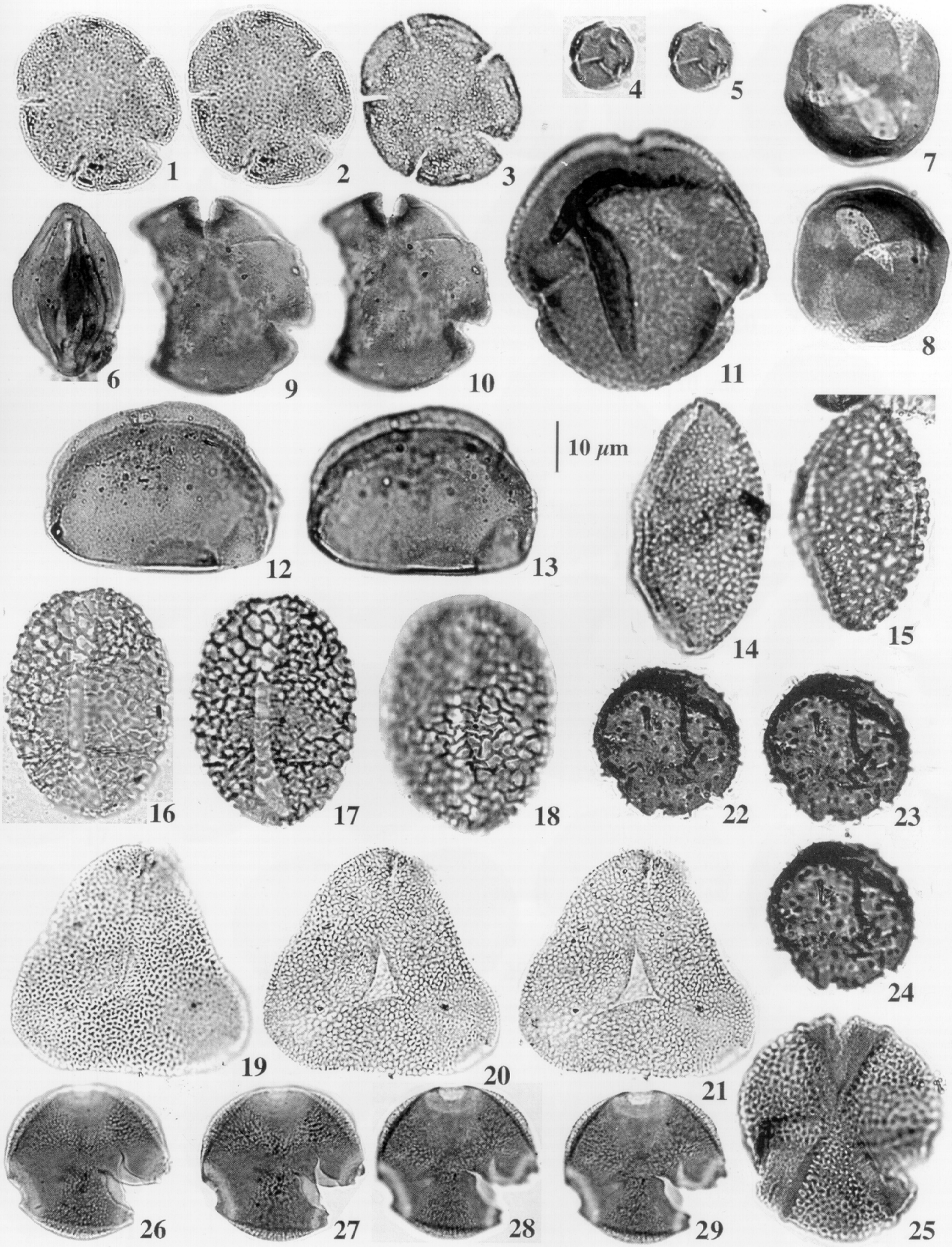

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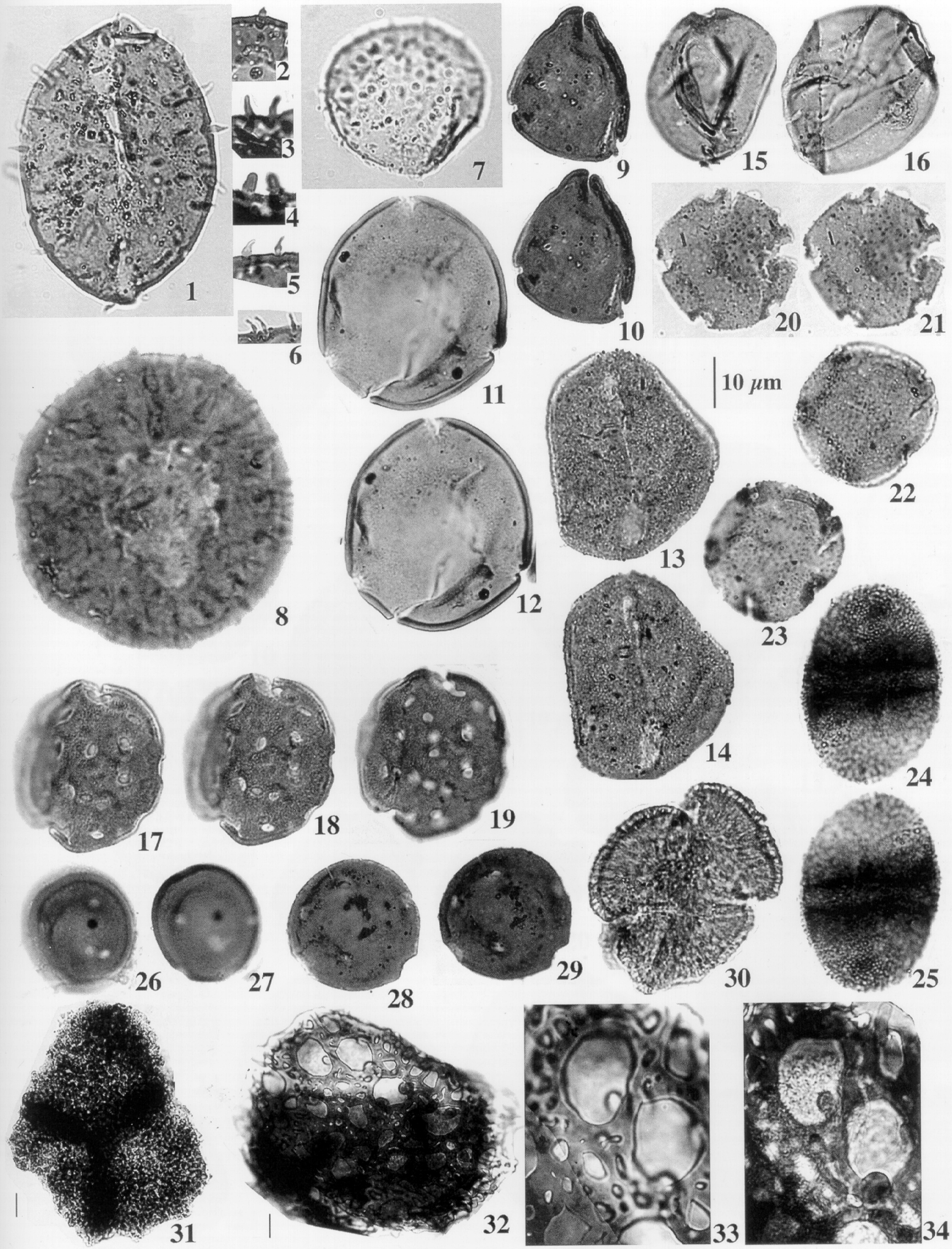

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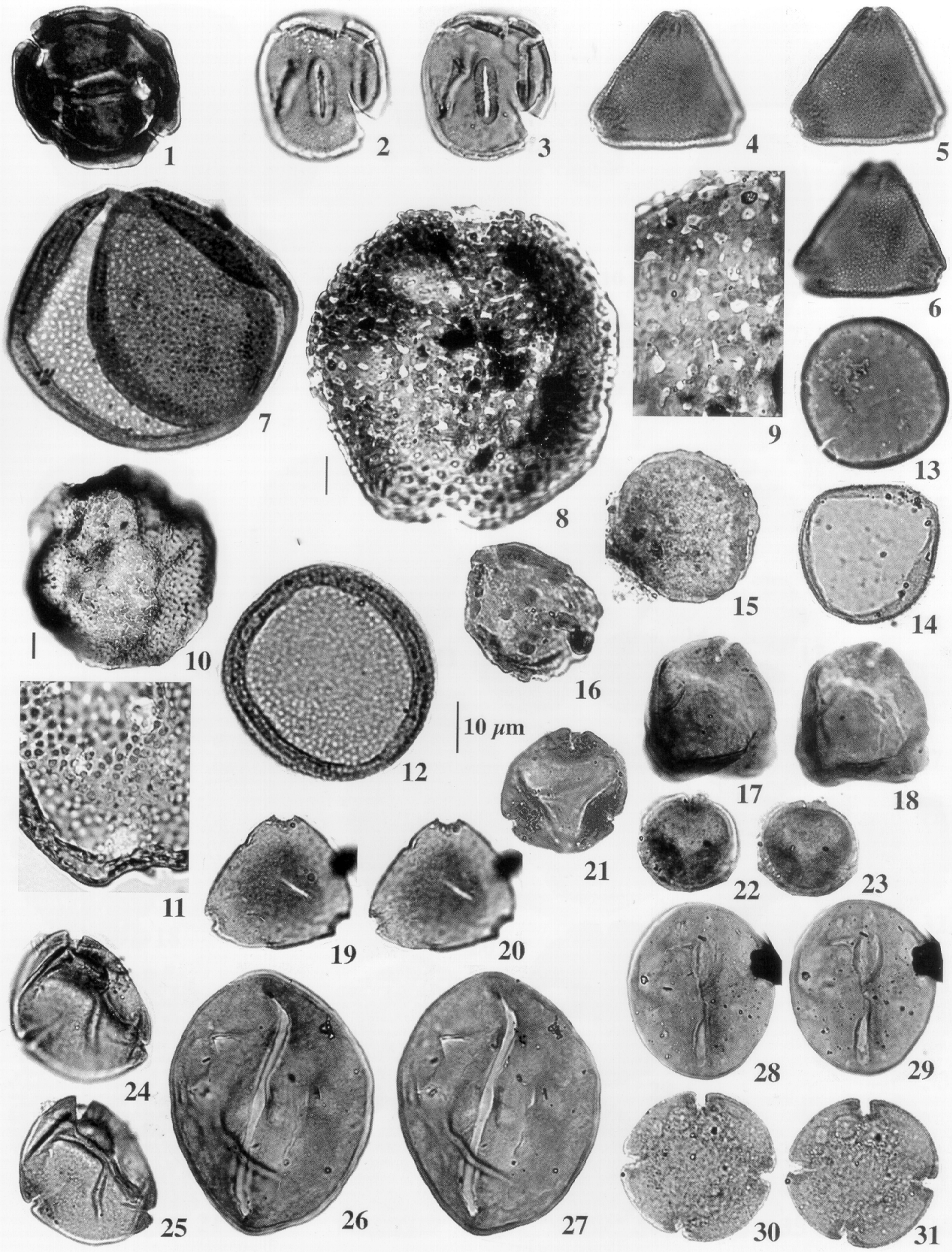

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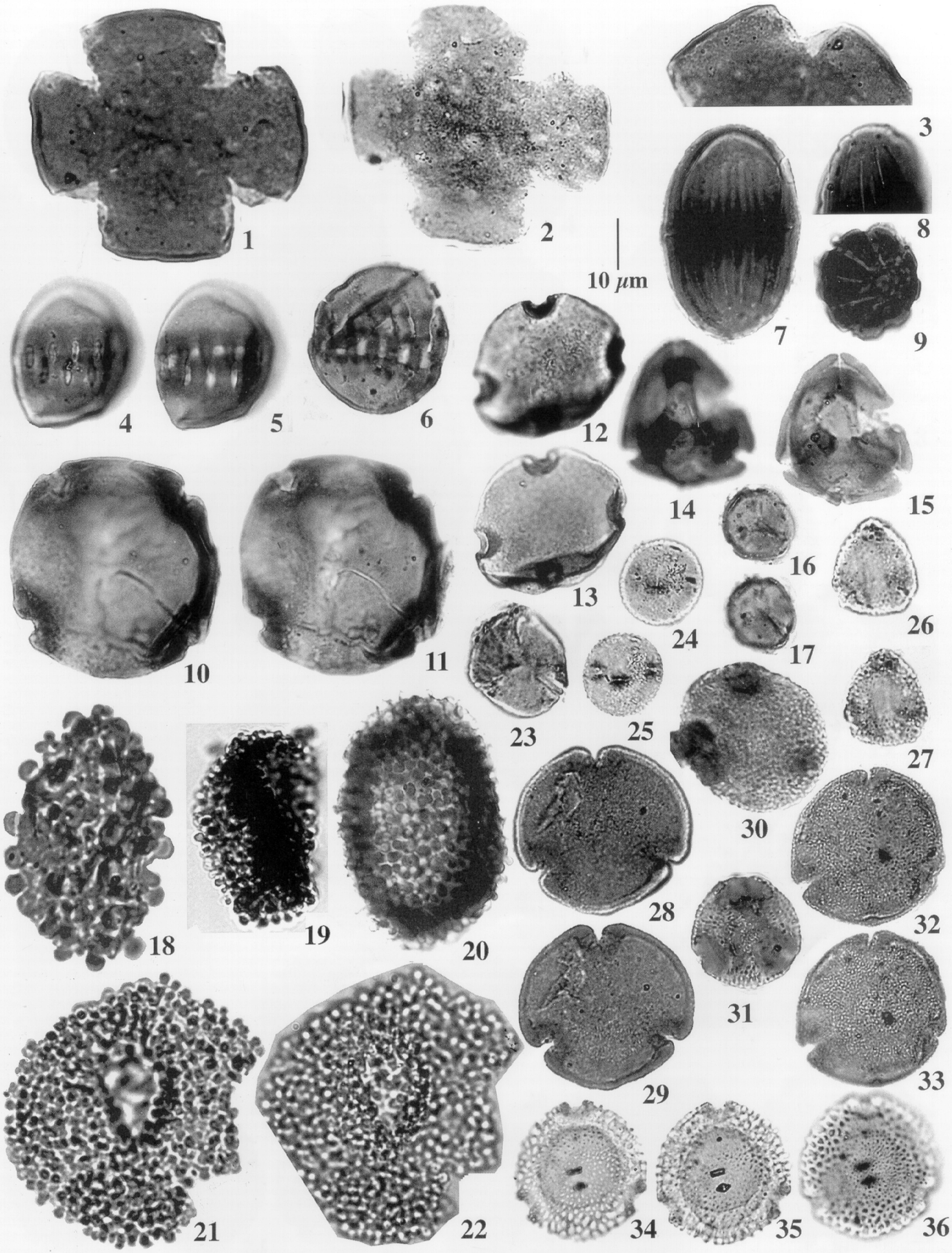

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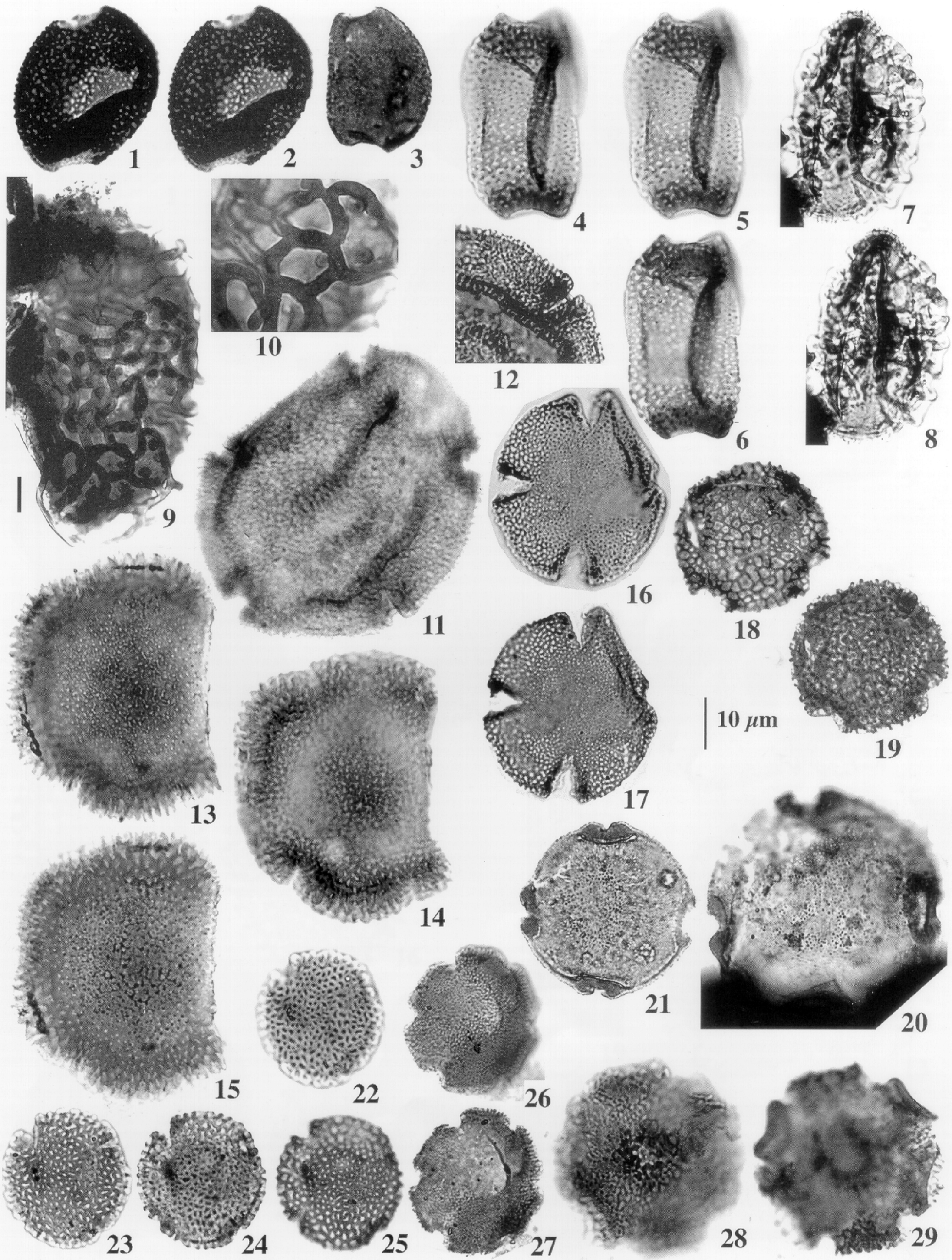

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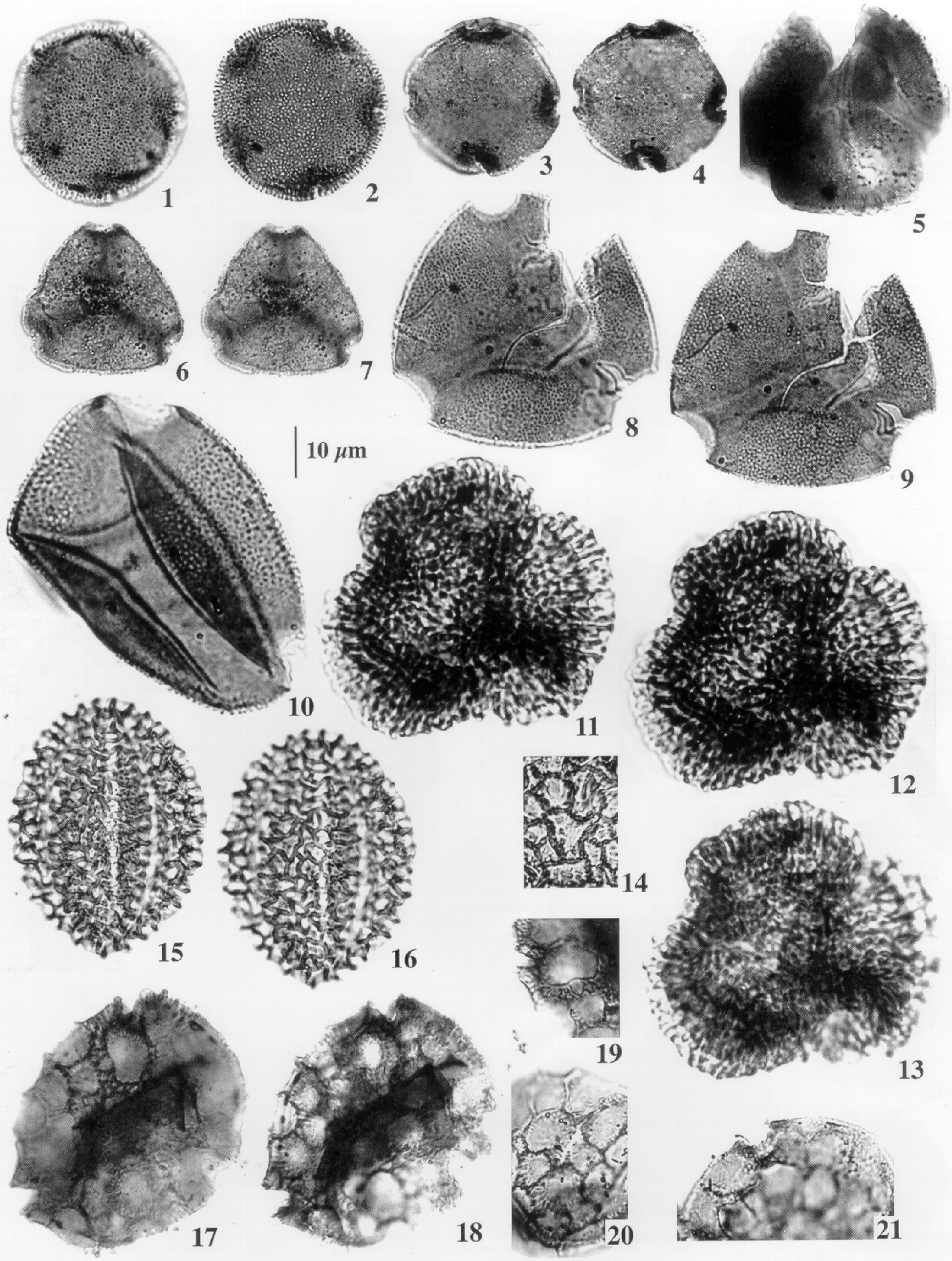

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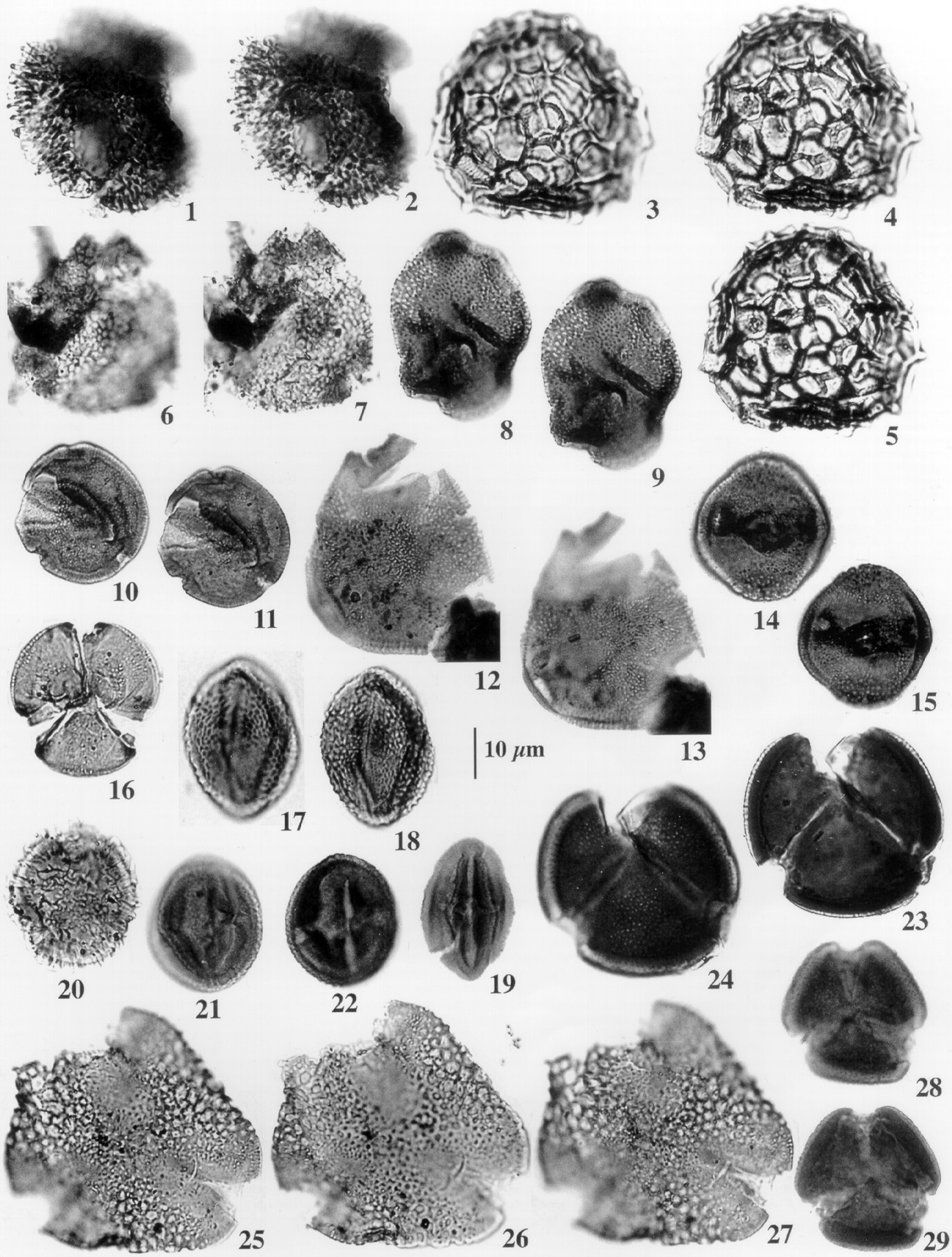

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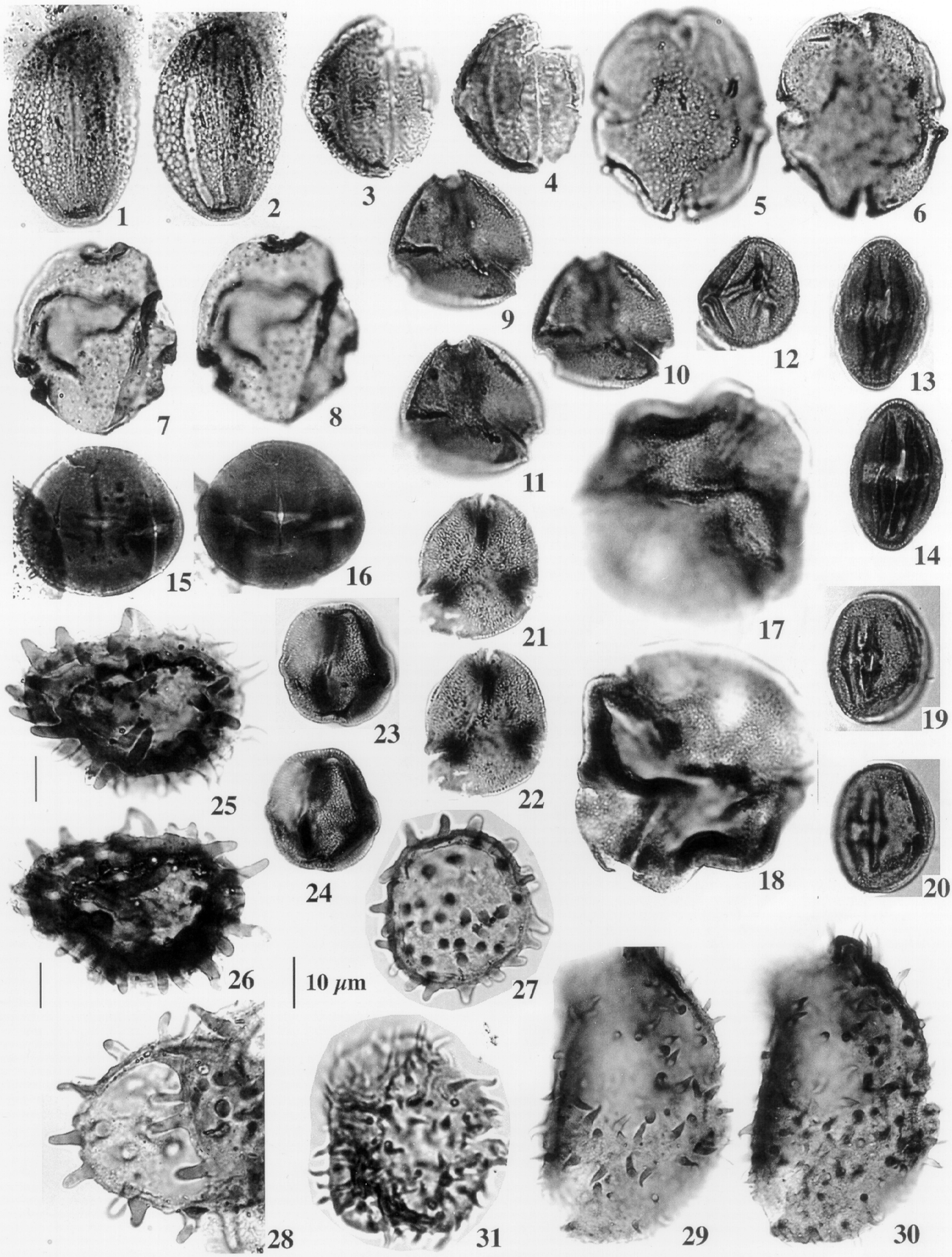

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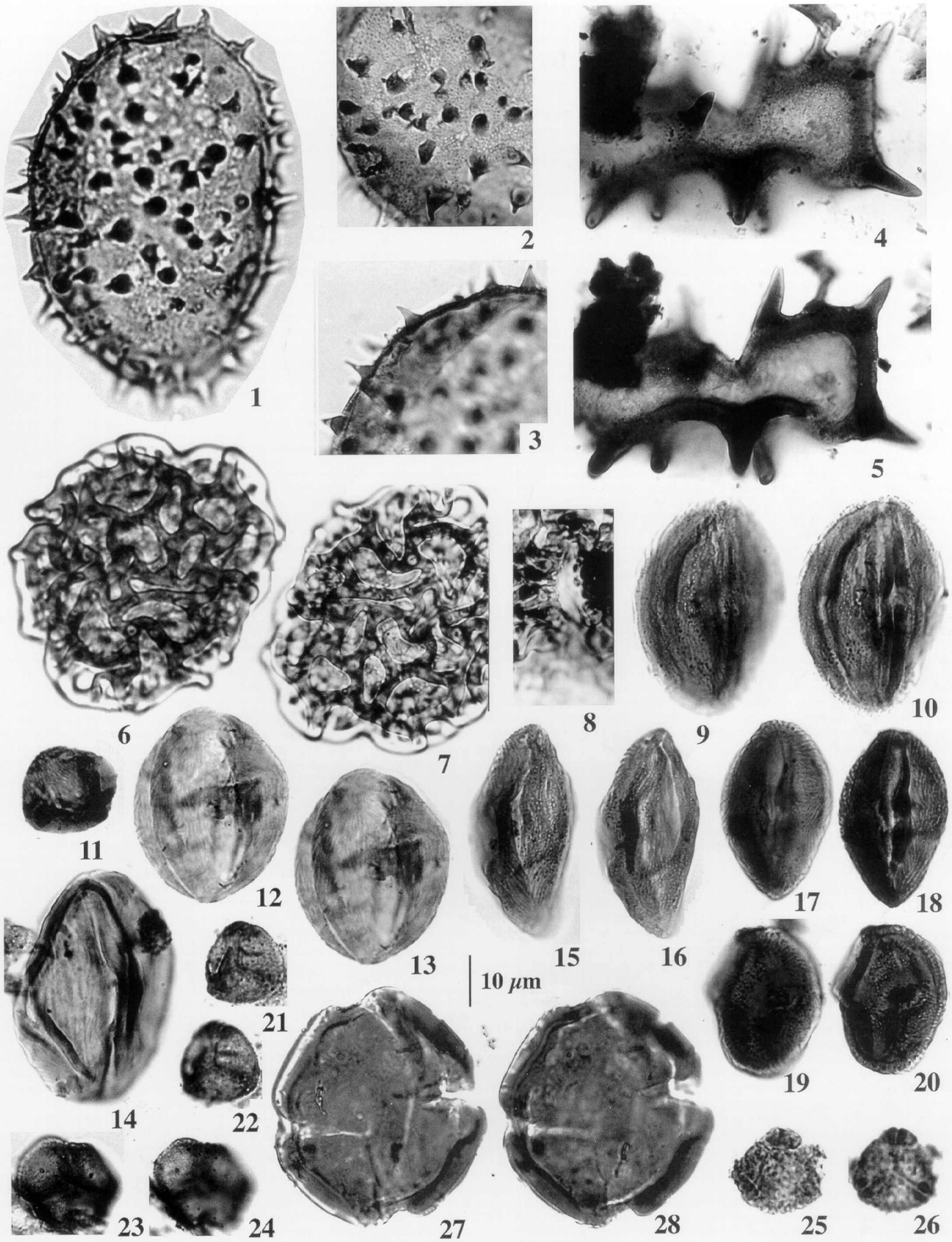

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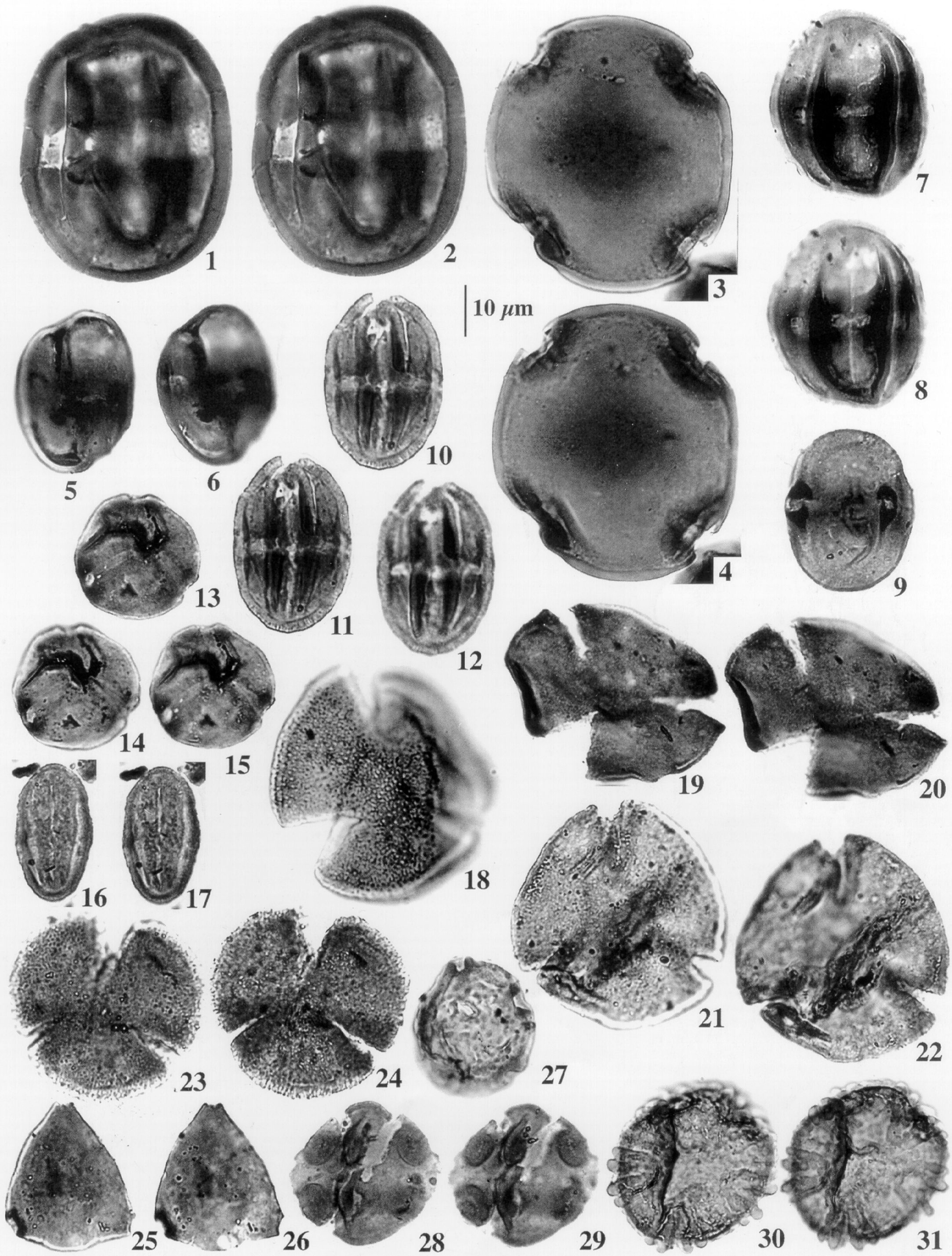

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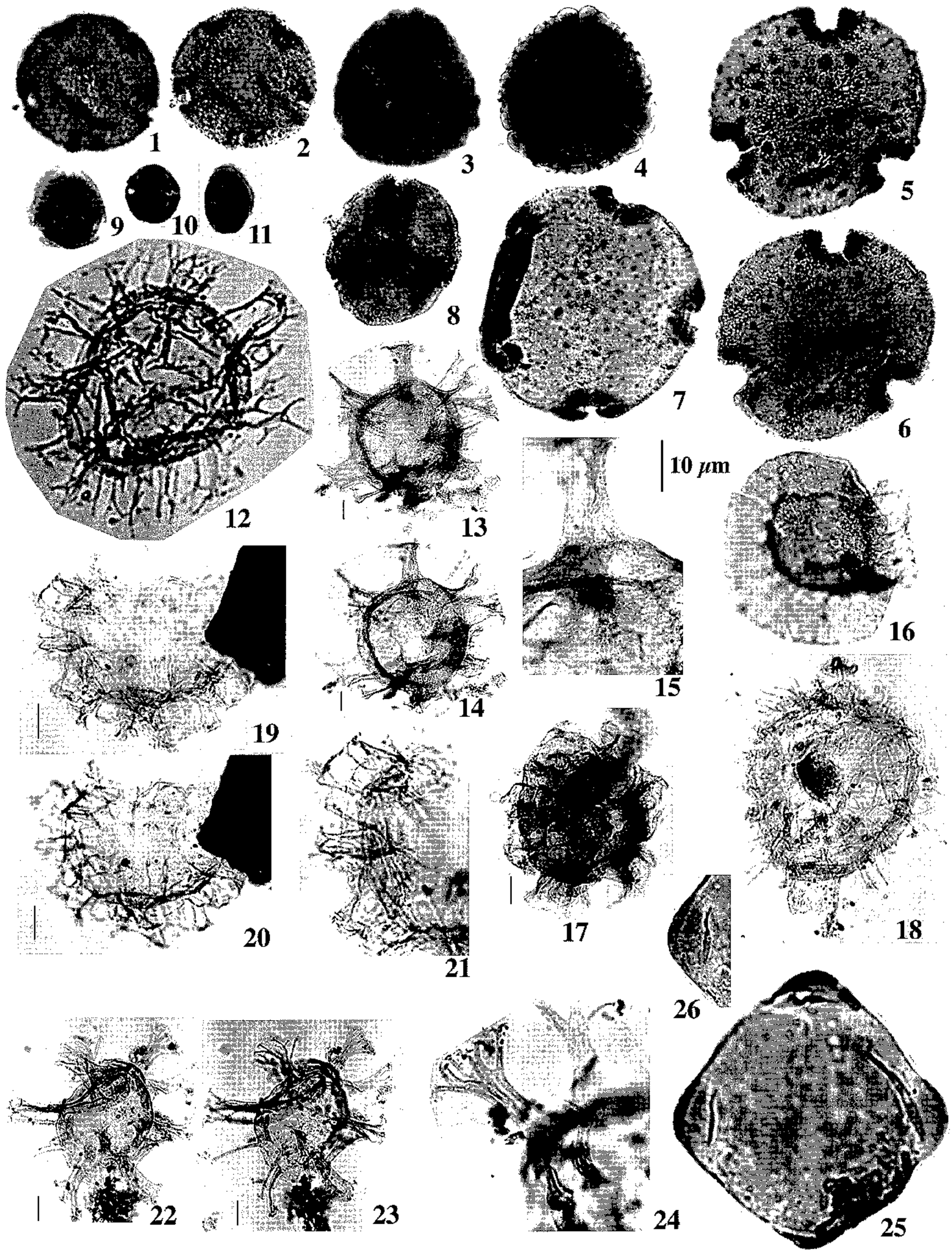

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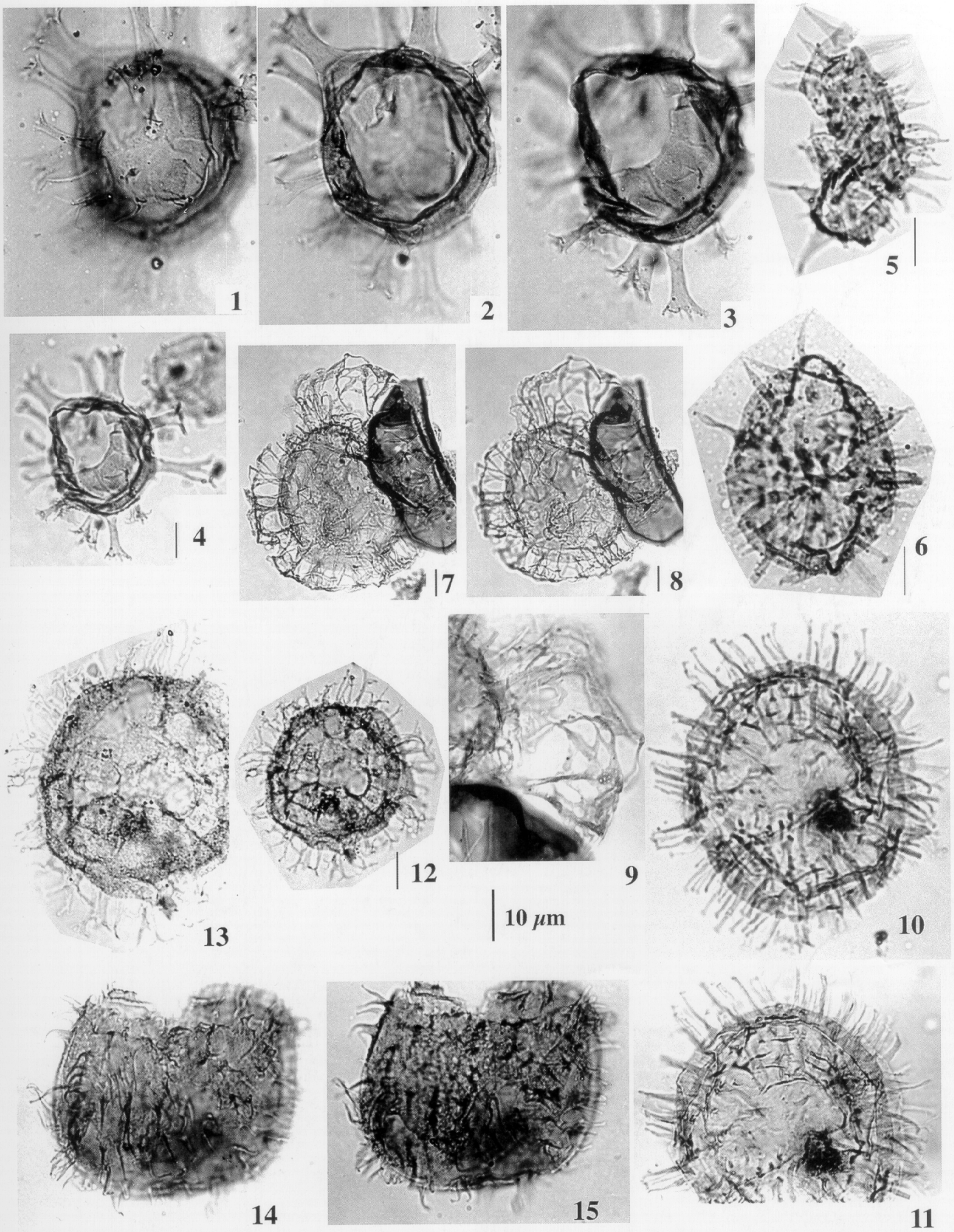

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