

Appendix 1. Palynomorphs recovered in Colombia spinning Cretaceous to Neogene.

Plate 1

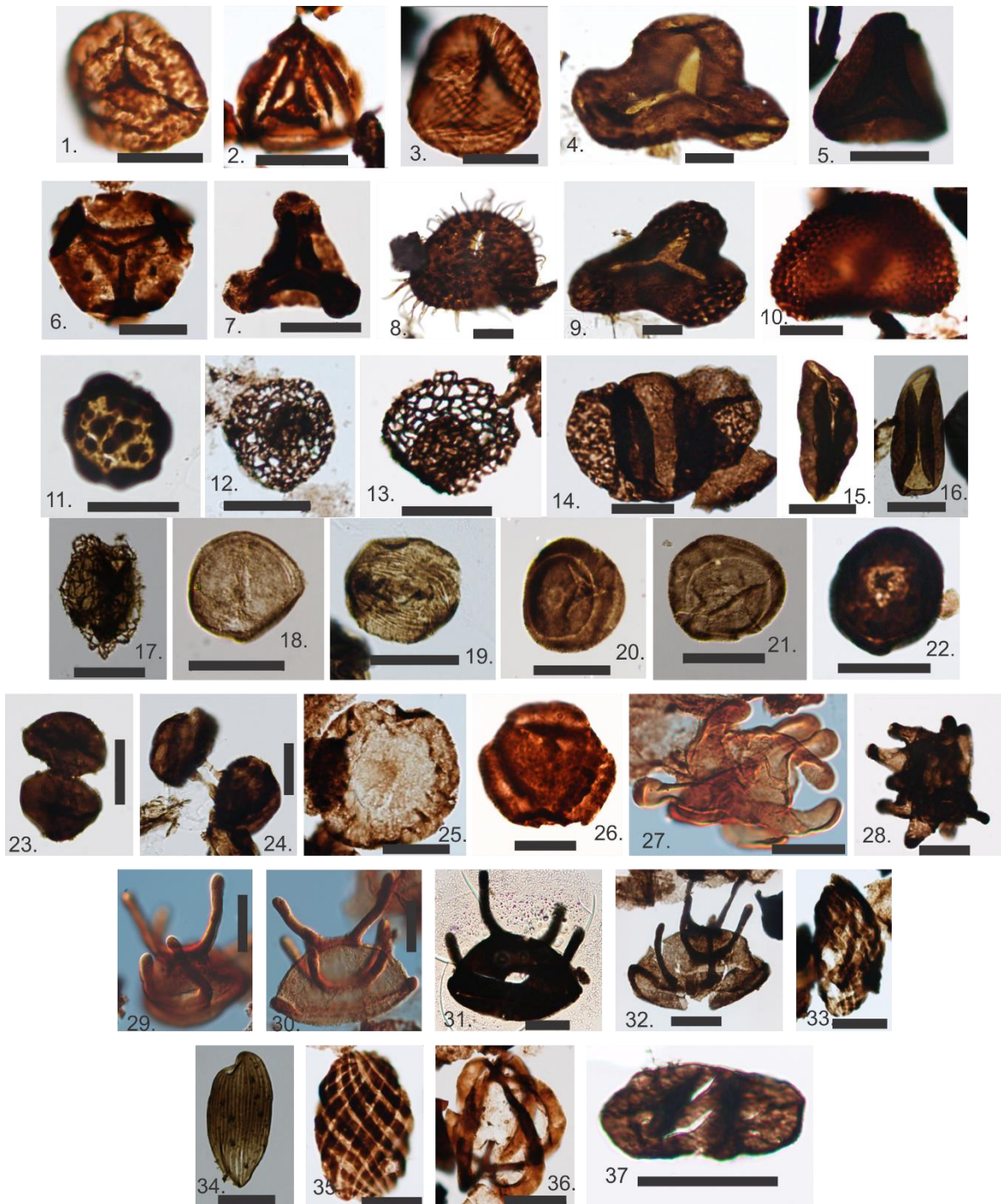


Plate 1. Berriasian-Albian Palynomorphs. Micrographs were taken at 100X. The bar represents 20 microns. The palynomorphs come from samples for palynology of Eastern Cordillera: Quebrada Lisgaura outcrop section, road to Vereda El Hato and San Andrés-Málaga, Tibú-Mercedes and Aguardiente formations; Quebrada San Antonio outcrop section, Une formation, and ANH-CON06-1X, ANH-CON07-1X wells. Cesar-Ranchería Basin: ANH-CR-Montecarlo-1X; ANH-CR- El Cerro -1X wells. Spores: 1. *Aequitriradites* sp. Helby et al. 1987; 2. *Appendicisporites problematicus* (Burger) Singh, 1971; 3. *Cicatricosisporites venustus* Deak, 1963; 4. *Deltoidospora* sp. Jan du Chene et al. 1978; 5. *Dictyophyllidites* sp. Couper, 1958; 6. *Gleicheniidites apilobatus* Brenner, 1963; 7. *Gleicheniidites aptianus* Llorens, 2008; 8. *Echinatisporis varispinosus* (Pocock) Srivastava, 1975; 9. *Impardecispora trioreticulosa* (Cookson and Dettmann) Venkatachala, Kar and Raza 1969; 10. *Microfoveolatosporites skottsbergii* (Selling, 1946) Srivastava, 1971; 11. *Verrucosisporites rotundus* Singh, 1964. Pollen: 12-13. *Afropollis jardinus* (Brenner, 1968) Doyle, Jardine and Doerekamp, 1982; 14. *Alisporites* spp. Daugherty, 1941; 15-16. *Bennettitaepollenites* sp. Thierngart, 1949; 17. *Brenneripollis* sp. Ward, 1989; 18-19. *Classopollis classoides* (Pflug, 1953) Pocock and Jansonius, 1961; 20-22. *Classopollis* sp. Brenner and Bickoff, 1992; 23-24. *Dicheiropollis etruscus* Trevisan, 1971; 25. *Callialasporites dampieri* (Balme) Dev, 1961; 26. *Callialasporites trilobatus* (Balme) Dev, 1961; 27-28. *Elaterocolpites castelaini* (Jardine and Magloire, 1965) Jardine, 1967; 29-32. *Elaterosporites klaszii* (Jardine and Magloire, 1965) Jardine, 1967; 33. *Ephedripites* cf. *Jansonii* (Pocock, 1964) Muller, 1968; 34. *Ephedripites* aff. *Regularis* Azema and Boltenhagen, 1974; 35. *Ephedripites torosus* Madler, 1964; 36. *Echisetosporites irregularis* (Herngreen 1973) de Lima 1980; 37. *Vitreisporites pallidus* (Reissinger) Brenner, 1963.

Plate 2.



Plate 2. Continued... Dinoflagellates: 1-2. *Circulodinium distinctum* (Deflandre and Cookson, 1955) Jansonius, 1986; 3. *Criboperidinium muderongense* (Cookson and Eisenack, 1958) Davey, 1969; 4-5. *Microdinium* sp. Helby et al. 1987; 6-7. *Muderongia endovata* Riding, 2000; 8-9. *Muderongia perforata* Alberti, 1961; 10. *Oligosphaeridium complex* (White, 1842) Davey and Williams, 1966; 11-12. *Oligosphaeridium pulcherrimum* (Deflandre and Cookson, 1955) Davey and Williams, 1966; 13. *Oligosphaeridium totum* Brideaux, 1971; 14-15. *Pseudoceratium securigerum* Davey and Verdier, 1974; 16-20. *Subtilisphaera* grupo (Incluye *S. senegalensis* Jain and Millepied, 1973; *S. Pirnaensis* (Alberti, 1959) Jain and Millepied, 1973); 21. *Tanyosphaeridium variecalamum* Davey and Williams, 1966.

Plate 3.

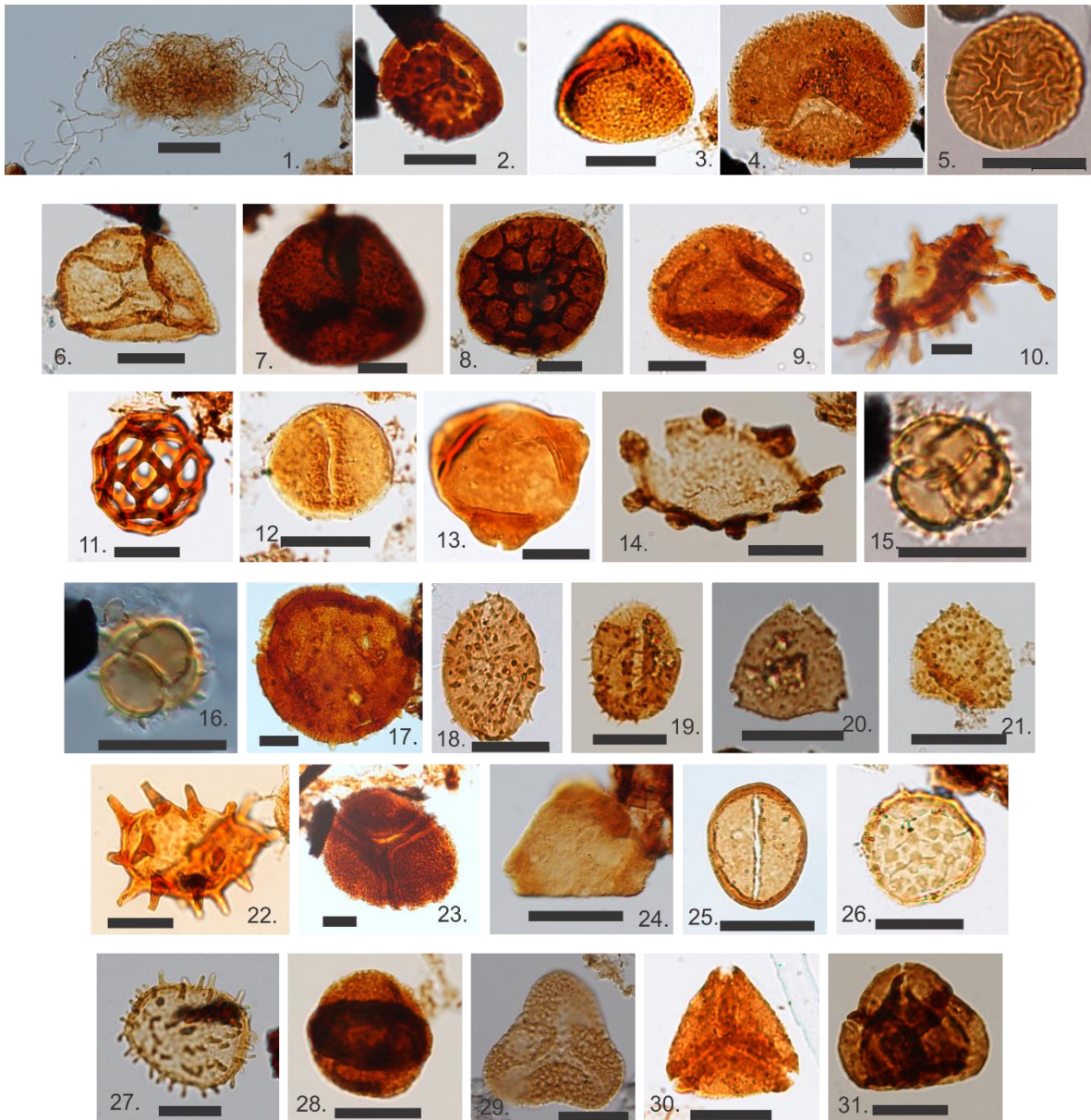


Plate 3. Late Cretaceous, Cenomanian-Maastrichtian palynomorphs. Micrographs were taken at 100X. The bar represents 20 microns. The palynomorphs come from samples for palynology of Upper Magdalena Valley (Olini Well); Eastern Cordillera (Quebrada san Antonio outcrop section and ANH-CON06-ST-S well); Cesar-Rancheria Basin (ANH-La Loma-1). Spores: 1. *Ariadnaesporites spinosus* Davey and Williams, 1966; 2. *Echitriletes intercolensis* Jaramillo et al. 2010; 3. *Foveotriletes margaritae* (van der Hammen, 1954) Germeraad et al. 1968; 4. *Gabonisporis*

vigorousii Boltenhagen, 1967; 5. *Hamulatisporis caperatus* (van Hoeken-Klinkenberg, 1964) Schrank 1994; 6. *Scabratriletes granularis* Jaramillo et al. 2010; 7. *Verrutrilletes virueloides* Jaramillo et al. 2007; 8. *Zlivisporis blanensis* Pacltova, 1961. Polen: 9. *Araucariacites australis* Cookson, 1947; 10. *Bacumorphomonocolpites tausae* Sole de Porta, 1971; 11. *Buttinia andreevi* Boltenhagen, 1967; 12. *Clavatipollenites spheroidites* (Jardine and Magloire) Schrank, 2001; 13. *Colombipollis tropicalis* Sarmiento, 1992; 14. *Crusafontites grandiosus* Solé de Porta, 1971; 15-16. *Droseridites senonicus* Jardine and Magloire, 1965; 17. *Duplotriporites ariani* Sarmiento, 1992; 18-19. *Echimonocolpites protofranciscoi* Sarmiento, 1992; 20. *Echitriporites suescae* (van der Hammen, 1954) Cardenas, de la Parra and Espinoza-Campusano, 2019; 21. *Echitriporites trianguliformis* van Hoeken Klinkenberg, 1964; 22. *Echinoidites problematicus* Gonzalez, 1967; 23. *Periretisyncolpites giganteus* Kieser and Jan du Chene, 1979; 24. *Proteacidites dehaani* Germeraad et al. 1968; 25. *Proxapertites sulcatus* Jaramillo et al. 2010; 26. *Proxapertites verrucatus* Sarmiento, 1992; 27. *Spinizonocolpites baculatus* Muller, 1968; 28. *Stephanocolpites costatus* van der Hammen, 1954; 29. *Syndemicolpites typicus* van Hoeken-Klinkenberg, 1964; 30. *Syncolporites lisamae* van der Hammen, 1954; 31. *Tetradites umirensis* van der Hammen, 1954.

Plate 4.

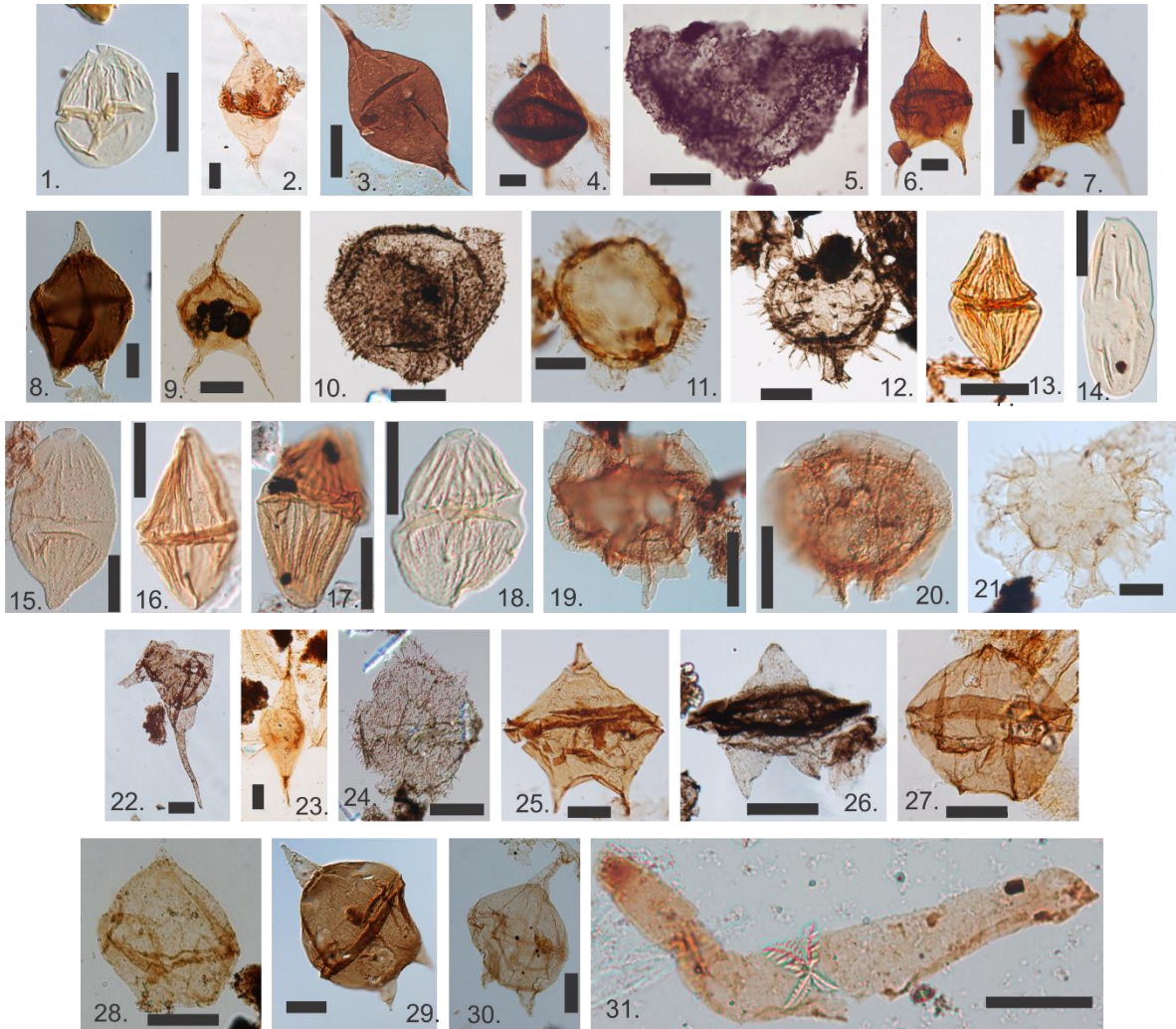


Plate 4. Continued... Dinoflagellates: 1. *Alisogymnium euclaense* (Cookson and Eisenack 1970) Lentin and Vozzhennikova, 1990; 2. *Andalusiella gabonensis* (Stover and Evitt, 1978) Wrenn and Hart, 1988; 3. *Andalusiella mauthei* Riegel 1974, Emend. Riegel and Sarjeant, 1982, Emend. Masure et al. 1996; 4. *Andalusiella romboides* (Boltenhagen 1977) Lentin and Williams, 1980, Emend. Masure et al. 1996; 5. *Canningia senonica* Clarke and Verdier, 1967; 6-7. *Cerodinium diebelii* (Alberti, 1959b) Lentin and Williams, 1987; 8. *Cerodinium granulostriatum* (Jain and Millepied, 1973) Lentin and Williams, 1987; 9. *Cerodinium pannuceum* (Stanley, 1965) Lentin and Williams, 1987; 10. *Circulodinium distinctum* (Deflandre and Cookson, 1955) Jansonius, 1986; 11. *Cordosphaeridium fribrospinosum* Davey and Williams, 1966. Emend. Davey, 1969; 12. *Coronifera oceanica* Cookson and Eisenack, 1958, Emend. May, 1980; 13. *Dinogymnium acuminatum* Evitt et al. 1967; 14. *Dinogymnium digitus* (Deflandre 1935) Evitt et al. 1967; 15. *Dinogymnium lamarense* Jaramillo and Yepes 1994; 16. *Dinogymnium microgranulosum* Clarke and Verdier, 1967; 17. *Dinogymnium undulosum* Cookson and Eisenack, 1970; 18. *Dinogymnium westralium* (Cookson and Eisenack, 1958) Evitt et al. 1967, Emend. May, 1977; 19-20. *Dinopterygium cladoides* Deflandre, 1935; 21. *Glaphyrocysta perforata* Hultberg and Malmgren, 1985; 22. *Odontochitina operculata* (Wetzel, 1933) Deflandre and Cookson, 1955; 23. *Palaeocystodinium lidiae* (Gorka, 1963) Davey, 1969b; 24. *Palaeohystrichophora infusorioides* Deflandre 1935; 25-26. *Phelodinium tricuspe* (Wetzel, 1933a) Stover and Evitt, 1978; 27-28. *Senegalinium laevigatum* (Malloy, 1972) Bujak and Davies, 1983; 29-30. *Senegalinium bicavatum* Jain and Millepied, 1973; 31. *Yolkinigymnium lanceolatum* (May, 1977) Lentin and Vozzhennikova, 1990.

Plate 5.



Plate 5. Paleogene (Paleocene-Eocene-Oligocene) palynomorphs. Micrographs were taken at 100X. The bar represents 20 microns. The palynomorphs come from samples for palynology of Sinú-San Jacinto Basin (Colombian Caribbean): ANH-Piedras blancas-1X, ANH-Mohambo-1X, ANH-San Antero-1X, ANH-San Jacinto-1, ANH-La X-1A, ANH-San Cayetano-1, and ANH-La Estrella-1X Wells. Cesar-Ranchería Basin: ANH-Cañaboba-1, ANH-Carretalito-1, ANH-La Estación-1, and ANH-La Loma-2. Spores: 1-2- *Cicatricosisporites dorogensis* Potonie and Gelletich, 1933; 3. *Cicatricosisporites eocenicus* (Selling, 1944) Jansonius and Hills, 1976; 4. *Concavissimisporites fossulatus* Dueñas, 1980; 5-6. *Foveotriletes concavoides* Jaramillo et al. 2007; 7. *Foveotriletes ornatus* Regali et al. 1974; 8. *Ischyosporites problematicus* Jaramillo and Dilcher, 2001; 9. *Magnastriatites grandiosus* (Kedves and Sole de Porta, 1963) Dueñas, 1980; 10-11. *Polypodiaceoisporites fossulatus* Jaramillo and Dilcher, 2001; 12. *Polypodiisporites pachyexinatus* Jaramillo and Dilcher, 2001; 13. *Polypodiisporites usmensis* (van der Hammen, 1956a) Khan and Martin, 1972; 14. *Retitriletes sommeri* Regali et al. 1974. Pollen: 15. *Baculamonocolpites hammenii* Jaramillo and Dilcher, 2001; 16. *Bombacacidites annae* (van der Hammen, 1954) Leidelmeyer, 1966; 17. *Bombacacidites echinatus* Jaramillo et al. 2010; 18. *Bombacacidites gonzalezii* Jaramillo and Dilcher, 2001; 19. *Bombacacidites nacimientoensis* (Anderson, 1960) Elsik, 1968; 20. *Bombacacidites protofoveoreticulatus* Jaramillo and Dilcher, 2001; 21. *Bombacacidites simplireticulatus* Jaramillo and Dilcher, 2001; 22. *Bombacacidites soleaformis* Muller et al. 1987; 23. *Brevitricolpites macroexinatus* Jaramillo and Dilcher, 2001; 24. *Brevitricolpites microechinatus* Jaramillo and Dilcher, 2001; 25. *Corsinipollenites psilatus* Jaramillo and Dilcher, 2001; 26. *Corsinipollenites undulatus* (González) Jaramillo and Dilcher, 2001; 27. *Cricotriporites minutiporus* (Muller, 1968) Jaramillo and Dilcher, 2001; 28. *Clavatricolpites protoannemariae* Jaramillo and Dilcher, 2001; 29. *Ctenolophonidites lisamae* (van der Hammen and García) Germeraad et al. 1968; 30. *Cyclusphaera scabrata* Jaramillo and Dilcher, 2001.

Plate 6.

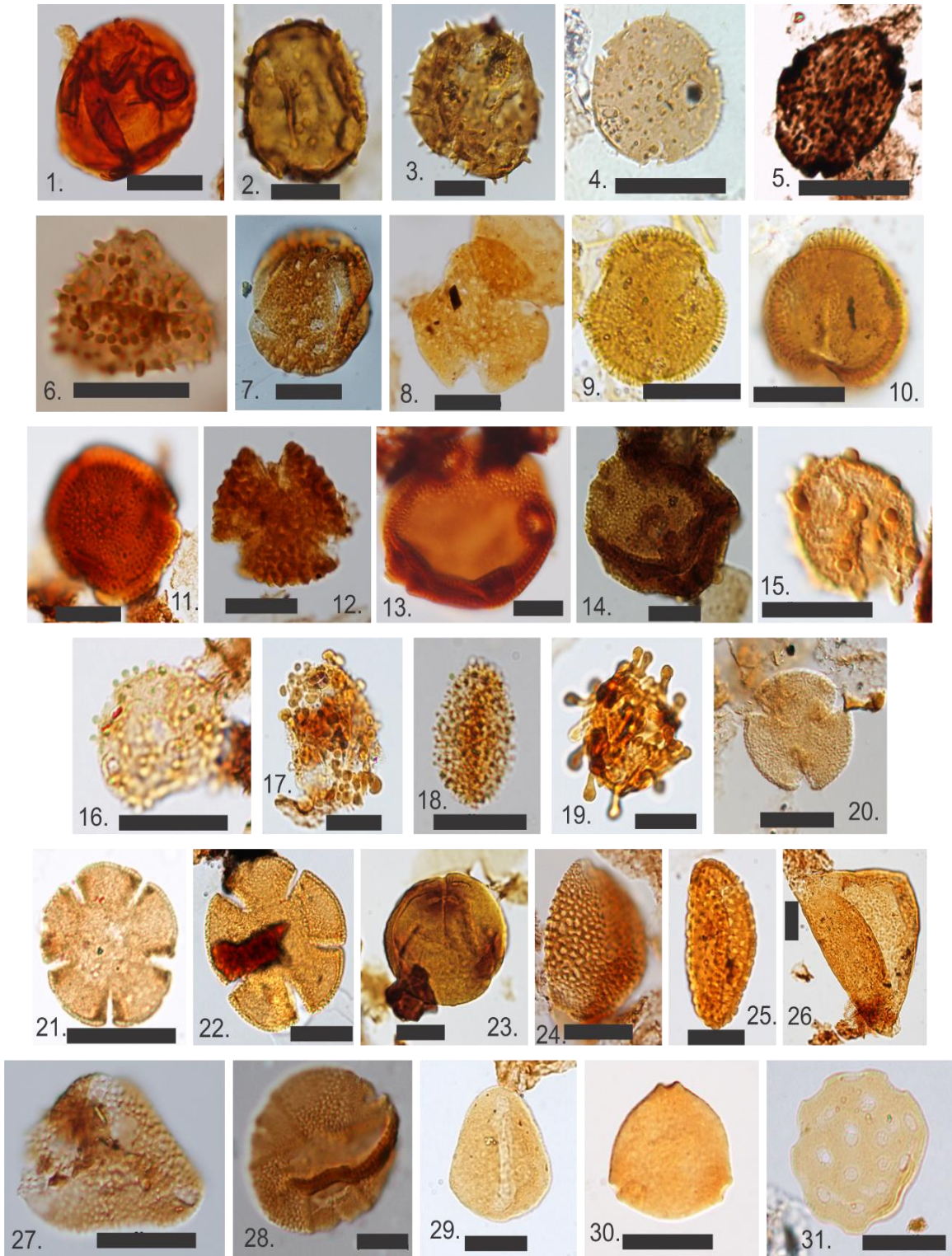


Plate 6. Continued... 1. *Diporopollis assamica* Dutta et al. 1970; 2. *Echimorphomonocolpites gracilis* González, 1967; 3. *Echimorphomonocolpites solitarius* González, 1967; 4-5. *Echitriporites trianguliformis* var. *Orbicularis* Jaramillo and Dilcher, 2001; 6. *Echitriporites variabilis* Jaramillo and Dilcher, 2001; 7-8. *Foveotricolpites perforatus* van der Hammen and García, 1966; 9-10. *Foveotricolporites etayoi* Jaramillo et al., 2010; 11. *Foveotricolporites fossulatus* Jaramillo and Dilcher, 2001; 12. *Foveotricolporites rugulatus* Jaramillo and Dilcher, 2001 ; 13. *Foveotriporites hammenii* González, 1967; 14. *Gemmastephanoporites polymorphus* Gonzalez, 1967; 15. *Gemmamonocolpites amicus* González, 1967; 16. *Gemmamonocolpites barbatus* González, 1967; 17. *Gemmamonocolpites dispersus* Sarmiento, 1992; 18. *Gemmamonocolpites gemmatus* (van der Hammen, 1954) van der Hammen and García, 1966; 19. *Grimsdalea minor* Dueñas, 1986; 20. *Horniella lunarensis* Jaramillo et al. 2007; 21. *Jandufouria minor* Jaramillo and Dilcher, 2001; 22. *Jandufouria seamrogiformis* Germeraad et al. 1968; 23. *Lanagiopollis crassa* (van der Hammen and Wymstra, 1964) Frederiksen, 1988; 24. *Longapertites proxapertitoides* var. *Proxapertitoides* van der Hammen and García, 1966; 25. *Longapertites proxapertitoides* var. *Reticulooides* van der Hammen and García, 1966; 26. *Longapertites vaneendenburgi* Germeraad et al. 1968; 27. *Luminidites colombianensis* Jaramillo and Dilcher, 2001; 28. *Margocolporites vanwijhei* Germeraad et al. 1968; 29. *Monocolpopollenites ovatus* Jaramillo and Dilcher, 2001; 30. *Momipites africanus* van Hoeken Klinkenberg, 1966; 31. *Multiporopollenites pauciporatus* Jaramillo and Dilcher, 2001.

Plate 7.



Plate 7. Continued... 1. *Nothofagidites huertasii* Jaramillo and Dilcher, 2001; 2-3. *Perfotricolpites digitatus* González, 1967; 4. *Perisyncolporites pokorny* Germeraad et al. 1968; 5. *Poloretitricolpites absolutus* (Gonzalez, 1967) Jaramillo and Dilcher, 2001; 6. *Proxapertites cursus* van Hoeken Klinkenberg, 1966; 7. *Proxapertites magnus* Muller et al. 1987; 8. *Proxapertites operculatus* (van der Hammen, 1954) van der Hammen, 1956; 9. *Psilabrevitricolporites simpliformis* van der Kaars, 1983; 10. *Psilatricolporites pachydermatus* Lorente, 1986; 11. *Racemonocolpites facilis* González, 1967; 12. *Racemonocolpites racematus* (van der Hammen, 1954) González, 1967; 13. *Retibrevitricolpites triangulatus* van Hoeken Klinkenberg, 1966; 14. *Retibrevitricolporites grandis* Jaramillo and Dilcher, 2001; 15. *Retibrevitricolporites speciosus* Jaramillo and Dilcher, 2001; 16. *Retistephanocolpites angeli* Leidelmeyer, 1966; 17. *Retistephanocolpites angelicus* Gonzalez, 1967; 18. *Retistephanocolporites festivus* González, 1967; 19. *Retistephanoporites crassiannulatus* Lorente, 1986; 20. *Retistephanoporites minutiporus* Jaramillo and Dilcher, 2001; 21. *Retitrescolpites baculatus* Jaramillo and Dilcher, 2001; 22-23. *Retitrescolpites? Irregularis* (van der Hammen and Wymstra, 1964) Jaramillo and Dilcher, 2001; 24. *Retitrescolpites magnus* (González, 1967) Jaramillo and Dilcher, 2001; 25. *Retitrescolpites saturum* (González, 1967) Jaramillo and Dilcher, 2001; 26. *Retitricolpites simplex* Jaramillo et al. 2014; 27. *Retitriporites poricostatus* Jaramillo and Dilcher, 2001; 28. *Rhoipites cienaguensis* (Dueñas, 1980) Barreda, 1997; 29. *Rhoipites guianensis* (van der Hammen and Wymstra, 1964) Jaramillo and Dilcher, 2001.

Plate 8.



Plate 8. Continued... 1. *Rhoipites hispidus* (van der Hammen and Wymstra, 1964) Jaramillo and Dilcher, 2001; 2. *Rhoipites perprolatus* Rodríguez et al. 2012; 3. *Rhoipites planipolaris* Jaramillo et al., 2010; 4. *Scabraperiporites asymmetricus* Dueñas, 1980; 5. *Scabratricolporites planetensis* Dueñas, 1980; 6. *Spinizonocolpites breviechinatus* Jaramillo and Dilcher, 2001; 7. *Spinizonocolpites grandis* Jaramillo and Dilcher, 2001; 8. *Spirosyncolpites spiralis* González, 1967; 9. *Striatopollis catatumbus* (González, 1967) Takahashi and Jux, 1989; 10. *Striatopollis tenuistriatus* Jaramillo and Dilcher, 2001; 11. *Striatricolporites digitatus* Jaramillo and Dilcher, 2001; 12. *Tetracolporopollenites maculosus* (Regali et al. 1974) Jaramillo and Dilcher, 2001; 13. *Tetracolporopollenites transversalis* (Dueñas, 1980) Jaramillo and Dilcher, 2001; 14. *Ulmoideipites krempii* (Anderson, 1960) Elsik, 1968; 15. *Verruperiporites denseverrucatus* Dueñas, 1986; 16. *Verruperiporites paucumverrucatus* Dueñas, 1986; 17. *Zonocostites duquensis* Dueñas, 1980; 18. *Zonocostites minor* Jaramillo and Dilcher, 2001; 19. *Zonocostites ramonae* Germeraad et al. 1968.

Plate 9.

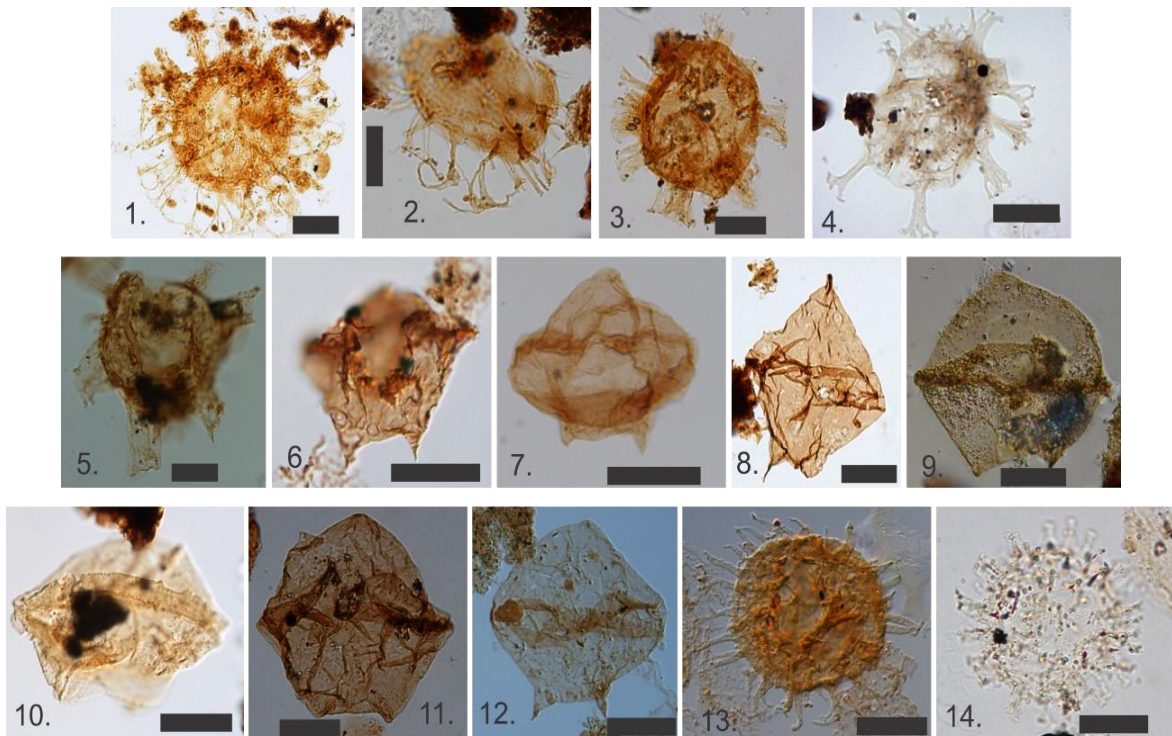


Plate 9. Continued... Dinoflagellates: 1. *Adnatosphaeridium multispinosum* Williams and Downie, 1966; 2. *Areosphaeridium arcuatum* Eaton, 1971; 3. *Cordosphaeridium fibrospinosum* Davey and Williams, 1966. Emend. Davey, 1969; 4. *Homotryblum floripes* (Deflandre and Cookson, 1955) Stover, 1975; 5. *Hystrichokolpoma rigaudiae* Deflandre and Cookson, 1955; 6. *Lejeunecysta beninensis* Biffi and Grignani, 1983; 7. *Lejeunecysta brassensis* Biffi and Grignani, 1983; 8. *Lejeunecysta communis* Biffi and Grignani, 1983; 9. *Lejeunecysta globosa* Biffi and Grignani, 1983; 10. *Lejeunecysta granosa* Biffi and Grignani, 1983; 11. *Lejeunecysta lata* Biffi and Grignani, 1983; 12. *Lejeunecysta pulchra* Biffi and Grignani, 1983; 13. *Lingulodinium (machaerophorum) polyedra* (Stein) Dodge, 1989; 14. *Polysphaeridium subtile* Davey and Williams, 1966 emend. Bujak et al. 1980.

Plate 10.

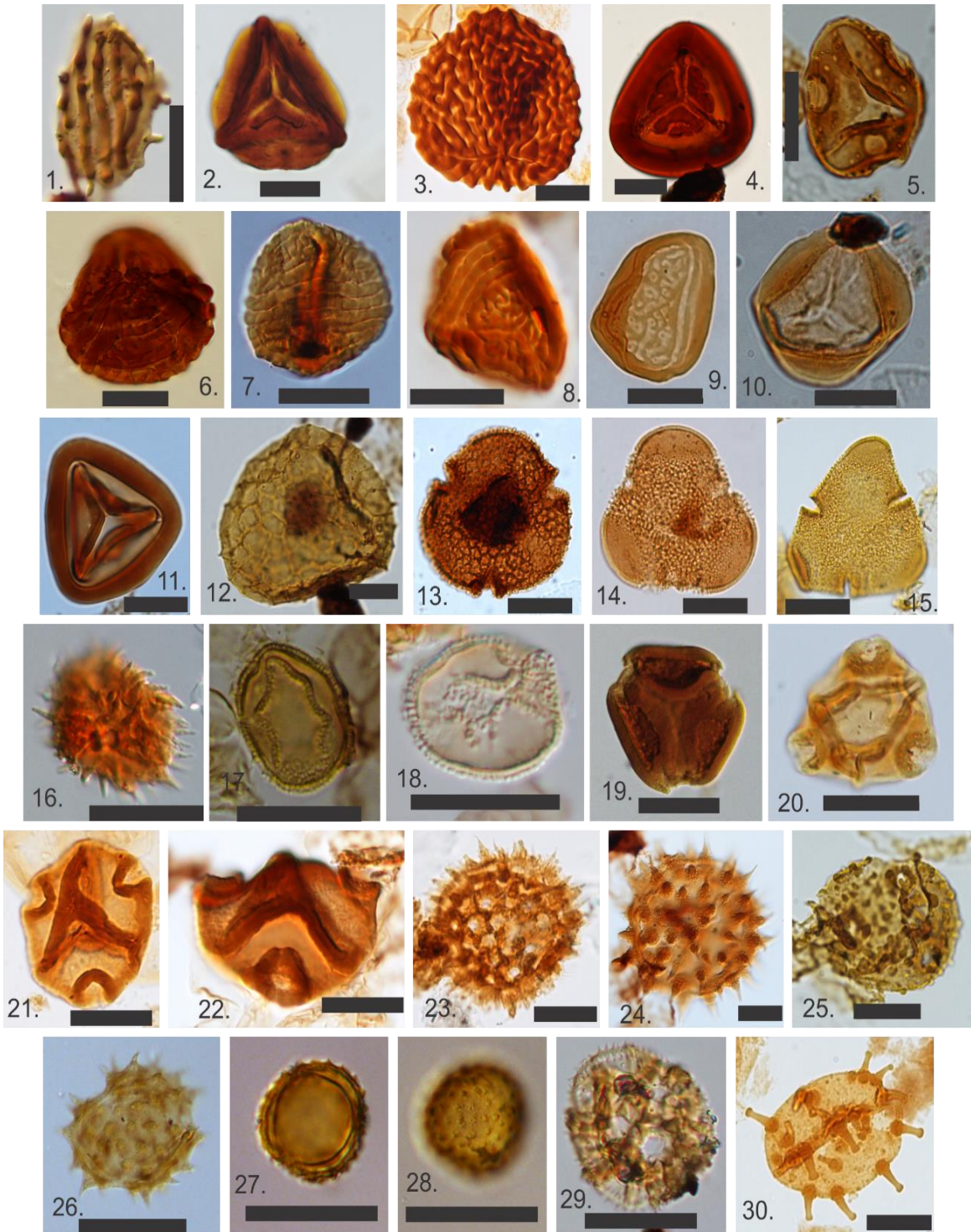


Plate 10. Neogene (Miocene-Pliocene) palynomorphs. Micrographs were taken at 100X. The bar represents 20 microns. The palynomorphs come from samples for palynology of Sinú-San Jacinto Basin (Colombian caribbean): ANH-Los Pajaros-1X, ANH-La Cantera-1, and P18 wells. Cesar-Ranchería Basin: ANH-Los Cerezos-1X.

Spores. 1. *Cicatricosisporites baculatus* Regali et al. 1974; 2. *Cingulatisporites laevigatus* Silva-Caminha et al. 2010; 3. *Crassoretitriletes vanraadshooveni* Germeraad et al. 1968; 4. *Cyatheacidites annulatus* Cookson, 1967; 5. *Kuylisporites waterbolkii* Potonie, 1956; 6-8. *Nijssenosporites fossulatus* Lorente, 1986; 9. *Polypodiaceoisporites? Amazonensis* Silva-Caminha et al. 2010; 10. *Psilatritriletes lobatus* Hoorn, 1994b; 11. *Psilatritriletes peruanus* Hoorn, 1994b; 12. *Retitriletes altimuratus* Silva-Caminha et al. 2010. Pollen. 13. *Bombacacidites araracuarensis* Hoorn, 1994; 14. *Bombacacidites baculatus* Muller et al. 1987; 15. *Bombacacidites muinaneorum* Hoorn, 1993; 16. *Cichoreacidites longispinosus* (Lorente, 1986) Silva-Caminha et al. 2010; 17-18. *Clavainaperturites microclavatus* Hoorn, 1994b; 19. *Crassiectoapertites columbianus* (Dueñas) Lorente, 1986; 20. *Corsinipollenites collaris* Silva-Caminha et al. 2010; 21. *Corsinipollenites oculusnoctis* (Thiergart, 1940) Nakoman, 1965; 22. *Corsinipollenites scabratus* Silva-Caminha et al. 2010; 23-24. *Echiperiporites lophatus* (Silva-Caminha et al. 2010) Leite et al. 2020; 25. *Echitriporites cricotriporatiformis* Jaramillo et al. 2010; 26. *Echitricolporites spinosus* van der Hammen, 1956; 27-28. *Echitricolporites mcneilly* Germeraad et al. 1968; 29. *Fenestrites spinosus* van der Hammen, 1956; 30. *Grimsdalea magnaclavata* Germeraad et al. 1968

Plate 11.

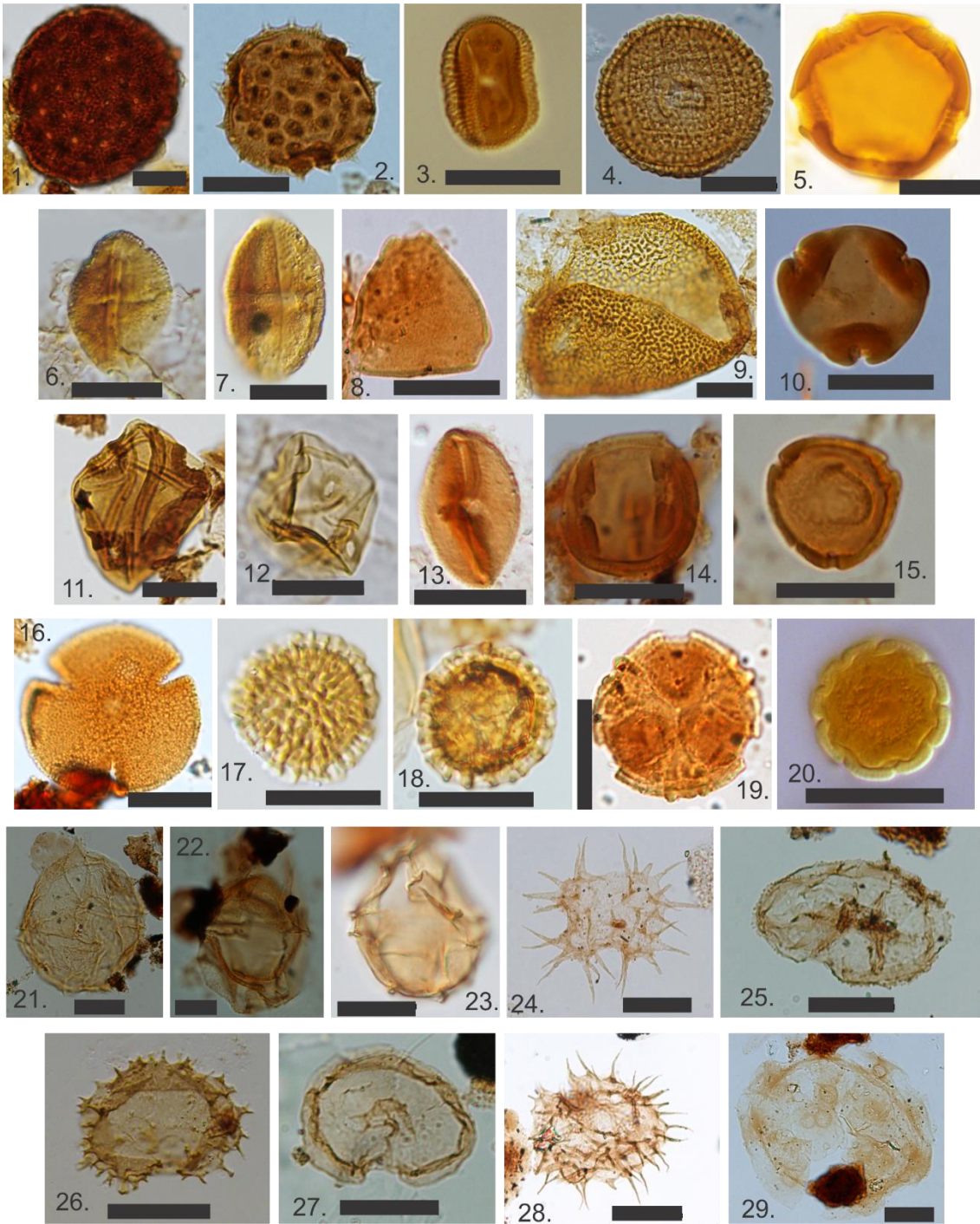


Plate 11. *Continued...* 1. *Magnaperiporites spinosus* González, 1967; 2. *Malvacipolloides maristellae* (Muller et al. 1987) Silva-Caminha et al. 2010; 3. *Multiareolites formosus* (van der Hammen, 1956) Germeraad et al. 1968; 4. *Multimarginites vanderhammeni* Germeraad et al. 1968; 5. *Pachydermites diderixi* Germeraad et al. 1968; 6-7. *Paleosantalaceaepites cingulatus* Jaramillo et al. 2010; 8. *Proteacidites triangulatus* Lorente, 1986; 9. *Proxapertites tertiaria* van der Hammen and Garcia, 1966; 10. *Psilabrevitricolporites triangularis* (van der Hammen and Wymstra, 1964) Jaramillo and Dilcher, 2001; 11. *Psilastephanoporites herngreenii* Hoorn, 1993; 12. *Psilastephanoporites tesseroporus* Regali et al. 1974; 13. *Ladakhipollenites? caribbiensis* (Muller et al., 1987) Silva-Caminha et al 2010; 14-15. *Psilabrevitricolporites devriesii* (Lorente, 1986) Silva-Caminha et al 2010; 16. *Retitricolpites caquetanus* Hoorn, 1994; 17-18. *Retitriporites crotonicolumellatus* (Jaramillo et al., 2010) D'Apolito et al. 2020; 19. *Rugutricolporites intensus* Jaramillo et al. 2010; 20. *Stephanocolpites evansii* Muller et al. 1987. Dinoflagellates: 21. *Cribopteridinium tenuitabulatum* (Gerlach, 1961) Helenes, 1984, emend. Sarjeant 1984; 22. *Hystrichosphaeropsis obscura* Habib, 1972; 23. *Impagidinium patulum* (Wall, 1967) Stover and Evitt, 1978; 24. *Quadrina? condita* de Verteuil and Norris, 1992; 25. *Selenopemphix brevispinosa* Head et al. 1989; 26. *Selenopemphix dionaecysta* Head et al., 1989; 27. *Selenopemphix nephroides* (Benedek 1972) Benedek and Sarjeant, 1981; 28. *Selenopemphix quanta* (M. R. Bradford) Matsuoka, 1985; 29. *Tuberculodinium vancampoae* (Rossignol) Wall, 1967.