

(Brenner, 1968), Lower Cretaceous to Upper Albian of Brazil (Regali et al., 1974a), Lower to Middle Albian of Venezuela (Sinanoglu, 1984), Upper Albian of Texas (Srivastava, 1977) and Valanginian–Hauterivian to Cenomanian offshore eastern United States (Bebout, 1981), Jurassic to Upper Albian of Alberta and western Canada (Pocock, 1962; Singh, 1971; Burden and Hills, 1989), Aptian–Cenomanian to Maastrichtian offshore South Africa (McLachlan and Pieterse, 1978), Kimmeridgian–Valanginian to Upper Albian of Libya (Thusu et al., 1988; Unwins and Batten, 1988), Hauterivian to Barremian of Israel (Brenner, 1974), Lower Albian of Spain (Arias and Doubinger, 1980), Hauterivian to Upper Albian of France (Fauconnier, 1979; de Ren ville and Rynaud, 1981), Lower Valanginian to Lower Aptian of Germany (Batten and Li, 1987) and Tithonian to Upper Albian of England (Norris, 1969; Kemp, 1970).

Callialasporites trilobatus (Balme 1957) Dev 1961

Plate 8, figure 2

1957 *Zonalapollenites trilobatus* Balme, p. 32. Plate 8, figures 91-92.

1961 *Callialasporites* (al. *Zonalapollenites*) *trilobatus* (Balme) Dev, p. 48-49.

1962 *Triangulopsis trilobatus* (Balme) D ring [pars], p. 114.

1962 *Triangulopsis discoidalis* D ring, p. 114.

1963 *Tsugaepollenites trilobatus* (Balme) Dettmann [pars], p. 100-101.

1964 *Applanopsipollenites trilobatus* (Balme) Levet-Carette [pars], p. 108.

Description. See Balme (1957), Filatoff (1975, p. 85) and Fensome (1983, p. 491-492)

Dimensions. Diameter: 26 μm (1 specimen).

Note. The single specimen observed has a triangular corpus that according to Filatoff (1975) and Fensome (1983), is the main distinguishing characteristic of this species. The small size might be indicative of an immature form of this species.

Occurrences. Only one specimen is observed in the Albian of well ALT-19X (sample 17421').

Callialasporites trilobatus has been reported from the Jurassic to Lower Cretaceous; Upper Jurassic to Aptian of Australia (Balme, 1957), Lower Cretaceous of Argentina (Gammero, 1965), Albian of Per  (Brenner, 1968), Aptian of Colombia (Pr ssl and

Vergara Streinesberger, 1993), Lower Cretaceous to Lower Aptian of Brazil (Regali et al., 1974a), Barremian to Albian of Maryland (Brenner, 1963) and Berriasian to Aptian offshore eastern United States (Bebout, 1981), Berriasian to Upper Albian of western Canada (Burden and Hills, 1989), Aptian to Cenomanian offshore South Africa (McLachlan and Pieterse, 1978), Lower Albian to Cenomanian offshore of Angola (Morgan, 1978), Jurassic to Middle Albian of Libya (Thusu et al., 1988; Uwins and Batten, 1988), Valanginian to Barremian of Israel (Brenner, 1974), Barremian of Spain (Doubinger and Mas, 1981), Lower Valanginian to Lower Aptian of Germany (Batten and Li, 1987), and Berriasian to Upper Albian of England (Norris, 1969; Kemp, 1970)

Callialasporites turbatus (Balme 1957) Schulz 1967

Plate 8, figure 1

1957 *Inaperturopollenites turbatus* Balme, p. 31-32. Plate 7, figures 85-86.

1961 *Callialasporites monoalaspurus* Dev, p. 48.

1962 *Pflugipollenites lucidus* Pocock, p. 73.

1963 *Tsugaepollenites* (al. *Pflugipollenites*) *lucidus* (Pocock) Dettmann, p. 99.

1963 *Tsugaepollenites* (al. *Callialasporites*) *monoalaspurus* (Dev Dettmann, p. 99.

1963 *Laricoidites turbatus* (Balme) de Jersey, p. 9.

1964 *Applanopsipollenites triangularis* Levet-Carette, p. 109.

1967 *Callialasporites turbatus* (Balme) Schulz, p. 593.

1974 *Callialasporites lucidus* (Pocock) Maheshwari, p. 37-38.

Description. See Schulz (1967), Filatoff (1975, p. 84) and Fesome (1983, p. 494).

Dimensions. Diameter: 50 (51) 52 μm (2 specimens).

Occurrences. This species is observed in two samples of the Albian of well ALT-19X (samples ALT-19X 17461' and ALT-19X 17439').

Callialasporites turbatus has been reported from the Jurassic to the Lower Cretaceous (Albian); Kimmeridgian to Aptian of Australia (Helby et al., 1987; Backhouse, 1988), Aptian of Colombia (Prössl and Vergara Streinsberger, 1993) and Albian of Egypt (Sultan, 1978 and 1987).

Callialasporites ? sp. A

Plate 8, figure 3

Description. Cavate, proximo-distally compressed. Inner exinal layer, 1.3 to 1.5 μm thick, finely granulate, forming a circular central body. Outer exinal layer, thin and extending equatorially, forming a cavation without foldings. Zona is less than 1/3 of the total diameter of the palynomorph. Trilete mark observed on the surface of the outer exinal layer.

Dimensions. Diameter: 24 to 31 μm (25 μm average) (7 specimens).

Note. As in the case of the specimen here attributed to *Callialasporites trilobatus*, these specimens might be immature forms of pollen of *Callialasporites*.

Occurrences. This species is observed only in two samples of the Barremian–Aptian of the Zea-Panamericana outcrop sections (samples 13-04-06 and 13-04-07).

CHEIROLEPIDACEAN POLLEN

Genus *Corollina* Malyavkina 1949 emend. Cornet & Traverse 1975

1949 *Corollina* Malyavkina, p. 123.

1953 *Classopollis* Pflug, p. 91.

1958 *Classopollis* Pflug emend. Couper, p. 156.

1960 *Corollina* Malyavkina emend. Klaus, p. 167.

1968 *Classopollis* Pflug emend. Boltenhagen, p. 29.

1970 *Classopollis* Pflug emend. Reyre, p. 311.

1975 *Corollina* Malyavkina emend. Cornet & Traverse, p. 16-17.

1976 *Classopollis* Pflug emend. Srivastava, p. 442-444.

Type Species. *Corollina compacta* Malyavkina 1949 (p. 124; plate 46, figure 10). Liassic, western Siberia, former USSR.

Remarks. The discussion about the validity of the generic names *Corollina* and *Classopollis* has been quite lengthy in the Mesozoic palynological literature. The original description of this genus by Malyavkina (1949) has been considered too vague and

inadequate for validation (Pocock and Jansonius, 1961). *Classopollis*, a genus described initially to include tricolate pollen grains by Pflug (1953), has been widely used to include the rimulate pollen and its description has been emended in order to incorporate new concepts derived from observations under the Scanning Electron Microscope (SEM) (Pettitt and Chaloner, 1964; Reyre, 1970).

Klaus (1960) emended the original description of *Corollina* and considered *Classopollis* as a taxonomic junior synonym of it. Cornet and Traverse (1975) reviewed this nomenclatural problem and concluded that the neotype designated by Klaus (1960) of *Corollina compacta* compared well with the exinal structure of *Classopollis*; a two layered exine comprising an inner structured layer (intrastructure) and an outer layer or tectum with relatively uniform sculpture. Therefore, Cornet and Traverse (1975) emended the original description of *Corollina* and considered *Classopollis* as a junior synonym. This approach is accepted here.

Corollina brasiliensis Herngreen 1975b comb. nov.

Plate 8, figure 4

1965 *Classopollis* sp. Jardiné & Magloire, p. 221. Plate 5, figure 11.

1973 *Classopollis jardinei* Herngreen, p. 544-545. Plate II, figures 2 and 6 [junior homonym].

1975b *Classopollis brasiliensis* Herngreen nomen novo pro *C. jardinei* Reyre et al., p. 197, p. 59.

Remarks. Herngreen (1975) pointed out that the epithet *jardinei* had already been used for other species of *Corollina*.

Description See Herngreen (1973).

Dimensions. Equatorial diameter: 37 (42) 48 μm (150 specimens).

Note. This species is differentiated from *Corollina torosa* (Reissinger 1950) Klaus 1960 emend. Cornet & Traverse 1974 by the larger size range and the absence of rimula, the latter being the main characteristics of this species according to Herngreen (1973).

Occurrences. This species is observed in the Aptian–Albian of the Zea-Panamericana and La Grita outcrop sections, wells CR-5, ALT-19X, ALP-6 and P-201. Its abundance in intervals assigned in this study to the Aptian is very low, whereas is the dominant miospore species in the Albian section of wells CR-5, ALT-19X and ALP-6.

The range of this species has been restricted to the Upper Albian to Cenomanian in Brazil (Pollen Zone II of Herngreen, 1973 and 1975b), Nigeria (Lawal and Moullade, 1986), Senegal (Jardiné and Magloire, 1965) and Egypt (Aboul Ela and Mahrous, 1992). This species is observed in this study in intervals characterized by the presence of *Reyrea polymorpha* Herngreen and *Afropollis zonatus* Doyle et al. and the absence of Upper Aptian–Albian markers, like *Afropollis jardinus* (Brenner) Doyle et al. and elater-bearing palynomorphs such as *Elaterosporites klaszi* Jardiné. Therefore, the stratigraphic range of this species is extended in this study into the Lower Aptian.

Corollina kieseri (Reyre 1970) comb. nov.

Plate 8, figures 6 and 7

1970 *Classopollis kieseri* Reyre, p. 313. Plate 54, figures 9-13, Plate 55, figures 1-10.

Description. See Reyre (1970).

Dimensions. Polar diameter: 21 (29) 37 μm (265 specimens).

Note. This species differs from and *Corollina brasiliensis* by the absence of striations in the equatorial area, the massive intrastructure and scabrate-microechinate ornamentation (Plate 8, figure 6). *Corollina noellii* (Reyre 1970) is characterized by the presence of well differentiated equatorial striations and microverrucate ornamentation.

Occurrences. This species is observed to be relatively very abundant in Aptian of the Zea-Panamericana outcrop section and in lower abundance in the Albian of the Zea-Panamericana, La Grita and Catatumbo outcrop sections, as well as wells CR-5, ALT-19X and ALP-6.

Corollina kieseri (Reyre) comb. nov. was reported from the Hettangian (Lower Jurassic) of France? by Reyre (1970).

Corollina torosa (Reissinger 1950) Klaus 1960 emend. Cornet & Traverse 1975

Plate 8, figure 5

- 1950 *Pollenites torosus* Reissinger, p. 115. Plate 14, figure 20.
 1953 *Classopollis classoides* Pflug, p. 91. Plate 16, figures 20-25 and 29-37.
 1953 *Classopollis declassis* Pflug, p. 92. Plate 16, figure 16-19.
 1953 *Circumpollis pharisaeus* Pflug, p. 92. Plate 16, figures 28-30.
 1953 *Circumpollis philosophus* Pflug, p. 92. Plate 17, figures 31-36.
 1957 *Classopollis* cf. *C. torosus* (Reissinger) Balme, p. 37.
 1958 *Classopollis torosus* (Reissinger) Couper, p. 156-157.
 1960 *Corollina torosus* (Reissinger) Klaus, p. 168.
 1961 *Classopollis classoides* Pflug emend. Pocock & Jansonius, p. 443-444.
 1965 *Classopollis torosus* (Reissinger) Balme emend. Burger, p. 65.
 1975 *Corollina torosus* (Reissinger) Klaus emend. Cornet & Traverse, p. 18.

Description. See Cornet and Traverse (1975).

Dimensions. Polar diameter: 21 (27) 33 μm (160 specimens).

Note. The specimens observed in this study are characterized by relatively small size and the type of scabrate-smooth ornamentation, characteristic of the *Corollina torosa*-*Corollina classoides* complex (Plate 8, figure 5). Cornet and Traverse (1975) discussed the similarities of *Corollina classoides* and *Corollina torosa*, concluding that they can not be differentiated because of the significant overlap in morphology. Fensome (1983) reached a similar conclusion, mentioning that the species *Corollina torosa*, *Corollina classoides* and *Corollina reclusa* (Thiergart 1949) Delcourt & Sprumont 1955 are closely comparable. He discussed the similarities of these species, proposing that *Corollina classoides* must be used for most of the smooth-walled forms of *Corollina*, leaving the use of *Corollina torosa* and *Corollina reclusa* to their type material.

The approach proposed by Cornet and Traverse (1975) is accepted in this study.

Occurrences. This species is found to be very abundant specially in the Aptian of the Zea-Panamericana outcrop section, wells CR-5, ALT-19X and ALP-6. The species is observed to be present in lower numbers in the Albian of La Grita outcrop section and of the previously mentioned sections.

In general this species has been widely reported in the Jurassic–Cretaceous on a worldwide basis. In the Lower Cretaceous selected occurrences are as follows: Albian of Venezuela (Sinanoglu, 1984), Lower Cretaceous to Cenomanian of Brazil (Regali et al., 1974a), Albian to Cenomanian of Peru (Brenner, 1968), Upper Jurassic to Lower Cretaceous of Louisiana (Rogers, 1987), Albian of Oklahoma (Hedlund and Norris, 1968), Berriasian to Cenomanian of eastern offshore United States (Bebout, 1981), Albian? to Cenomanian of Alberta (Norris, 1967), Berriasian to Upper Albian of western Canada (Burden and Hills, 1989), Kimmeridgian to Hauterivian in offshore northwest Africa (Williams and Bujak, 1980), Berriasian to Cenomanian of Israel (Brenner, 1974), Middle Albian to Cenomanian of Egypt (Aboul Ela and Mahrous, 1992), Lower Albian of Spain (Arias and Doubinger, 1980) and Jurassic to Lower Cretaceous of England (Couper, 1958).

CUPRESSACEAN/TAXACEAN/TAXODIACEAN POLLEN

Genus *Exesipollenites* Balme 1957

- 1957 *Exesipollenites* Balme, p. 39.
- 1958 *Spheripollenites* Couper, p. 158.
- 1962 *Spheripollenites* Couper emend. Jansonius, p. 81.
- 1963 *Exesipollenites* Balme emend. Brenner, p. 87.
- 1966 *Spheripollenites* Couper emend. Burger, p. 263.
- 1970 *Exesipollenites* Balme emend. Pocock, p. 99.

Type Species. *Exesipollenites tumulus* Balme 1957 (p. 39; plate 11, figure 123). Lower Jurassic, Australia.

Exesipollenites crassimarginatus Jain & Sah 1966 emend. nov.

Plate 8, figure 8 and 9

1966 *Exesipollenites crassimarginatus* Jain & Sah 1966, p. 112. Plate 1, figures 3, 16.

Emended diagnosis. A species of *Exesipollenites* with circular to ellipsoidal amb. Distal tenuitas, 7 to 15 μm across, poorly developed with irregular margins and without any

thickening surrounding it. Homogeneous exine, differentially thickened towards the equatorial area, up to 5.0 to 6.0 μm thick, psilate to finely scabrate. No trilete (?triradiate) mark or outer wall layer is observed.

Dimensions. Diameter: 25 (28) 35 μm (170 specimens).

Remarks. The above emendation of *Exesipollenites crassimarginatus* includes the presence of a distal tenuitas, poorly developed and with irregular margins. Jain and Sah (1966) reported the occurrence of a "central depression" and the absence of germinal apertures. Their illustration of the holotype from the Upper Jurassic of India (their Plate 1, figures 3 and 16) seems to suggest the presence of a tenuitas rather than a depression. Balme (1957) and Brenner (1963) reported the occurrence of "distal depression" in pollen of this genus, whereas Pocock (1970) referred to it as a leptoma (a thin walled area involved in forming an opening according to Kremp, 1965) and Fensome (1983) preferred the use of the term tenuitas (a thin, more or less aperturoid exinal area, not as distinct as a true aperture as defined by Erdtman, in Kremp, 1965). As stated by Fensome (1983), the term tenuitas is retained here for the sake of consistency. Filatoff (1975) and Fensome (1983) pointed out that the structure of the exine and the occurrence the distal tenuitas, depend on factors such as the preservation and degree of maturity of the pollen grains and the extent of alteration caused during the palynological maceration of the samples.

This species differs from *Exesipollenites tumulus* Balme 1957 in presenting thickening of the exine at the equatorial area rather than surrounding the distal tenuitas. It also differs from *Exesipollenites classopolloides* (Nilsson) Playford & Dettmann by having a psilate surficial wall rather than an "outer layer consisting of closely spaced projections which fuse to form a fine meshed surficial reticulum", as Playford and Dettmann (1965) reported for the latter.

Occurrences. This species is found to be abundant in in very few samples of the Aptian to Upper Aptian of the Zea-Panamericana and La Grita outcrop sections, and is rarely seen in wells CR-5, ALT-19X and ALP-6.

This species was described from the Upper Jurassic of Sri Lanka (formerly Ceylon) by Jain and Sah (1966) and reported in the Lower Cretaceous of India by Bose et al. (1982).

DIVISION CYCADOPHYTA BESSEY 1907

CYCADOPHYTE/BENETTITALEAN POLLEN

Genus *Cycadopites* Wodehouse 1933 ex Wilson & Webster 1946

1933 *Cycadopites* Wodehouse, p. 483.

1946 *Cycadopites* Wodehouse ex Wilson & Webster, p. 274.

Type Species. *Cycadopites follicularis* Wilson & Webster 1946 (p. 274; figure 7).
Paleocene, Montana, United States.

Cycadopites carpentieri (Delcourt & Sprumont 1955) Singh 1964

Plate 8, figure 10

1955 *Monosulcites carpentieri* Delcourt & Sprumont, p. 54. Figure 14.

1964 *Cycadopites carpentieri* (Delcourt & Sprumont) Singh, p. 104.

Description. See Singh (1964).

Dimensions. Length: 46 (61) 71 μm . Breadth: 16 (23) 25 μm (8 specimens).

Note. This species is characterized by the psilate exine and the broadening of the sulcus at the ends of the grain. The overall size observed in this study is larger than previously reported (Delcourt and Sprumont, 1965; Singh, 1964), which is especially significant considering that all the specimens observed in this study are broken or fragmented.

Occurrences. This species is rarely observed in samples of the Aptian–Albian of the Zea-Panamericana and La Grita outcrop sections, as in wells CR-5 and ALT-19X.

Cycadopites carpentieri has been reported in the Upper Albian of Utah (Tschudy et al., 1984), Berriasian to Upper Albian of western Canada (Burden and Hills, 1989), Aptian to Albian of Alberta (Singh, 1964), Middle Jurassic to Albian of the Sahara (Reyre, 1973), the Wealden of Belgium (Delcourt and Sprumont, 1955) and Middle Jurassic to Berriasian of England (Couper, 1958; Norris, 1969).

Cycadopites sp. cf. *C. nitidus* (Balme 1957) Norris 1969

Plate 8, figure 11

[cf.] 1969 *Cycadopites nitidus* (Balme) Norris, p. 599-600.

Description. Monosulcate pollen grains. Prolate with rounded apices. Exine, less than 1.3 μm thick. Psilate to finely scabrate sexine. Sulcus straight with smooth edges, broadening at the apices of the grain.

Dimensions. Length: 37 μm . Breadth: 16 (20) 22 μm (3 specimens).

Note. This species resembles *Cycadopites nitidus* in the overall shape, size and ornamentation. However, Norris (1969) also stated that the exine is "tectate and scabrate to infrapunctate". Because of the few specimens observed and their relatively bad preservation, these morphological features are not extensively characterized in the material from the Lower Cretaceous of Venezuela. Therefore, these specimens are compared with, rather than attributed to *Cycadopites nitidus*.

Occurrences. This species is observed in samples of the Upper Aptian-Albian of La Grita outcrop section (samples 09-04-04 and 09-04-10).

Cycadopites nitidus has been reported in the Lower Cretaceous from the Aptian of Colombia (Pons, 1988), Albian of Louisiana (Paden-Phillips and Felix, 1971b), Barremian to Albian of Maryland, eastern USA (Brenner, 1963), Berriasian to Upper Albian of western Canada (Burden and Hills, 1989), Aptian to Middle Albian of the Northwest Territories, Canada (Brideaux and McIntyre, 1975), Albian of Egypt (Sultan, 1987) and Barremian of Spain (Doubinger and Mas, 1981).

DIVISION GNETOPHYTA

EPHEDRALEAN POLLEN

Genus *Equisetosporites* Daugherty 1941 emend. Singh 1964

1941 *Equisetosporites* Daugherty, p. 63.

1953 ?*Ephedripites* Bolkhovitina, p. 60.

- 1958 *Ephedracites* Malyavkina, p. 115.
 1960 *Ephedra* (Daugherty) Scott, p. 271 [pars].
 1961 *Striainaperturites* Pierce, p. 45.
 1964 *Equisetosporites* Daugherty emend Singh, p. 129-131.
 1965 *Equisetosporites* Daugherty emend. Pocock, p. 143-144.

Type Species. *Equisetosporites chinleanus* (Daugherty 1941) Scott 1960. Upper Triassic, Arizona.

Remarks. Most of the ephedralean pollen found in Mesozoic studies has been attributed to the genera *Ephedripites* or *Equisetosporites*. Singh (1964) concluded that *Ephedripites* was invalid because the affinity of the type species designated by Bolkhovitina (1953) is uncertain. Article 34.1 of the International Code of Botanical Nomenclature (Greuter et al., 1988) established that a name is not valid when "it is not accepted by the author in the original publication". In spite of the transfer of the type species of *Ephedripites* to the genus *Schizea* by Bolkhovitina, there is not a definite reason to declare *Ephedripites* as an invalid genus (see Jansonius and Hills, 1976).

Equisetosporites was erected by Daugherty (1941) to include spores with "wrapped elators". Scott (1960) re-examined this type material and concluded that the so-called "elators" were exine thickenings that became detached from the grain. Therefore, these forms were considered as morphologically similar to those of the extant genus *Ephedra*. Singh (1964) considered synonymizing *Ephedra* and *Ephedripites* was invalid and emended the description of *Equisetosporites* to allow species of ephedralean pollen similar to *Equisetosporites chinleanus* Daugherty and the *Ephedra* pollen type D (acolpate pollen) of Steeves and Barghoorn (1959), excluding forms with twisted or angular ridges that alternate with sinuous colpi (Types A, B, and C of Steeves and Barghoorn, 1959). Pocock (1965) emended this genus, describing the double layer structure of the exine of pollen of this genus and allowing the inclusion of all ephedralean pollen grains. Srivastava (1968) did not accept this approach, maintaining Singh's criteria.

Since the type material of *Equisetosporites* resembles most of the ephedralean pollen found in Mesozoic studies, this genus is used here to include species of ephedralean pollen. The emendation proposed by Singh (1964) is adopted for the purposes of this study, allowing only acolpate ephedralean pollen grains to be included in this genus.

Equisetosporites concinnus Singh 1964

Plate 8, figure 14

1964 *Equisetosporites concinnus* Singh, p. 132. Plate 17, figures 10-15.

Description. See Singh (1964).

Dimensions. Length: 60 (75) 89 μm . Breadth: 19 (23) 25 μm (4 specimens).

Note. This species differs from other species of *Equisetosporites* observed in this study in the large size.

Occurrences. This species is observed rarely in samples from the Upper Aptian–Albian of the Zea-Panamericana and La Grita outcrop sections.

This species has been reported in the Cretaceous; Lower Barremian to Upper Albian? of western Canada (Burden and Hills, 1989), Barremian? to Aptian of Alberta (Singh, 1964), Albian–Cenomanian to Maastrichtian offshore South Africa (McLachlan and Pieterse, 1978) and Albian of Egypt (Sultan, 1987).

Equisetosporites multicostatus (Brenner 1963) Norris 1967

Plate 9, figure 1

1963 *Ephedripites multicostatus* Brenner, p. 90. Plate 38, figures 1-2.

1967 *Equisetosporites multicostatus* (Brenner) Norris, p. 105.

1980 *Singhia multicostata* (Brenner) Lima, p. 30.

Description. See Brenner (1963).

Dimensions. Length; 39 (43) 45 μm . Breadth: 12 (16) 18 μm (17 specimens).

Occurrences. This species is observed in low abundances in samples of the Aptian–Albian of the La Grita, Zea-Panamericana and Catatumbo outcrop sections, and in lesser numbers in wells CR-5, ALT-19X and ALP-6

This species has been reported from the Lower Cretaceous (Barremian) to the Paleogene (Eocene); Lower to Middle Albian of Australia (Burger, 1980), Aptian–Albian of Brazil (Lima, 1980), Lower Cretaceous of Louisiana (Rogers, 1987), Albian of Oklahoma (Hedlund and Norris, 1968), Utah (Tschudy et al., 1984), Maryland (Brenner, 1963) and Barremian to Coniacian offshore eastern United States (Bebout, 1981), Berriasian to Upper Albian of western Canada (Burden and Hills, 1989), Albian of Alberta (Norris, 1967), Albian of Libya (Unwins and Batten, 1988), Albian to Lower Cenomanian of Egypt (Sultan, 1987), Barremian to Lower Albian of Spain (Arias and Doubinger, 1980; Doubinger and Mas, 1981) and Barremian to Lower Aptian of England (Kemp, 1970).

Equisetosporites sp. cf. *E. amabilis* Srivastava 1968

Plate 9, figure 2

[cf.] 1968 *Equisetosporites amabilis* Srivastava, p. 216-217. Figures 7-9.

Description. Acolpate pollen grains. Prolate outline with rounded longitudinal endings. Exine, less than 1.3 μm thick. 8 to 12 longitudinal ribs, up to 3.8 μm wide separated by 1.0 to 2.0 μm narrow grooves, psilate.

Dimensions. Length: 43 (47) 56 μm . Breadth: 12 (20) 25 μm (7 specimens).

Note. This species differs from *Equisetosporites multicostatus* in the number and width of the longitudinal ribs. It is similar to *Equisetosporites amabilis* in narrower ridges (2.0 to 3.0 μm in comparison to 3.0 to 5.0 μm according to the description provided by Srivastava, 1968).

Occurrences. This species is rarely observed in samples of the Aptian–Albian of the Zea-Panamericana and La Grita outcrop sections, as in wells CR-5 and ALT-19X.

Ephedripites amabilis has only been reported from the Maastrichtian of Alberta, Canada (Srivastava, 1968 and Snead, 1969).

Equisetosporites sp. cf. *E. dudarensis* (Deák 1964) Lima 1980

Plate 8, figure 13

[cf.] 1980 *Equisetosporites dudarensis* (Deák) Lima, p. 19. Plate 1, figure 3.

Description. See Deák (1964) and Lima (1980).

Dimensions. Length: 33 (34) 35 μm . Breadth: 18 (21) 25 μm (2 specimens).

Note. This species closely resembles *Equisetosporites dudarensis* in thickness of the exine and width and number of longitudinal ribs. However, the specimens observed in this study show a more circular or oblate outline.

Occurrences. Only two specimens are observed in the Aptian of the Zea-Panamericana (sample 13-04-05) and in the Upper Aptian of La Grita (sample 09-04-04) outcrop sections.

Equisetosporites dudarensis has been reported from the Albian of Peru (as *Equisetosporites chaloneri* by Brenner, 1968), Aptian of Colombia (Pons, 1988), Albian to Cenomanian of Brazil (Herngreen, 1973 and Lima, 1980) and Barremian to Albian of Egypt (Sultan, 1978 and 1987) and the Aptian of Hungary (Deák, 1964).

Equisetosporites sp. A

Plate 8, figure 12

Description. Acolpate pollen grain. Almost circular outline. Exine, less than 1.3 μm thick. Nexine, less than 0.5 μm thick. Sexine, about 0.7 μm thick, with 5-6 longitudinal ribs (up to 5.0 μm wide), curved or twisting, separated by 2.5 μm wide smooth grooves.

Dimensions. Length: 27 μm . Breadth: 23 μm (1 specimen).

Note. This species differs from others of the genus *Equisetosporites* observed in this study by the coarser ridges. Herngreen (1973) illustrated "*Ephedripites* sp. 4" from the Albian-Cenomanian of Brazil. He compared his species to *Equisetosporites strigatus* Brenner 1968, a species from the Albian of Peru. However, the latter has larger overall size and the outline is more prolate, rather than the circular to oblate outline observed in the specimen here reported.

Occurrences. It is observed in the Upper Aptian of La Grita outcrop section (sample 09-04-07).

DIVISION MAGNOLIOPHYTA CRONQUIST ET AL. 1966

DICOTYLEDONOUS ANGIOSPERM POLLEN

Genus *Rousea* Srivastava 1969

1969 *Rousea* Srivastava, p.52.

Type Species. *Rousea subtilis* Srivastava 1969 (p. 53; plate 1, figure 7). Maastrichtian, Alberta, Canada.

Rousea brenneri Singh 1983

Plate 9, figure 6

1962 *Retitricolpites* sp. 3 Groot & Groot, p. 166. Plate 9, figure 9.

1963 *Retitricolpites geranioides* (auct. non. Couper) Brenner, p. 91. Plate 38, Figure 8, Plate 39, figure 1.

1977 *Rousea geranioides* (auct. non. Couper) Srivastava, p.93.

1983 *Rousea brenneri* Singh, p. 76.

Description. See Srivastava (1977).

Dimensions. Diameter: 18 (23) 26 μm (22 specimens).

Note. Singh (1983) pointed out that specimens of *Tricolpites geranioides* Couper 1960 (from the Miocene of New Zealand) did not show the significant reduction in the size of the lumina as in the specimens described by Brenner (1963) from the Albian of Maryland. Therefore, Singh (1983) erected a new species that includes the specimens described by Brenner (1963) (one of which was designated as the holotype) and, subsequently, by other authors from the Lower and Upper Cretaceous.

Occurrences. This species is observed in low abundances in the Upper Aptian-Albian samples of La Grita and Zea-Panamericana outcrop sections and well ALT-19X.

This species has been reported from the Albian of Oklahoma (Hedlund and Norris, 1968; Srivastava, 1977) and Maryland (Brenner, 1963) and Middle Albian to Cenomanian of the Atlantic Coastal Plain of the United States (Doyle and Robbins, 1977) and Aptian to Cenomanian of Alberta (Norris, 1967; Singh, 1971 and 1983) and Upper Albian to Cenomanian of Ontario, Canada (Zippi and Bajc, 1990), Aptian of Africa (Doyle et al., 1977) and Upper Albian to Cenomanian of Portugal (Groot and Groot, 1962).

Genus *Striatopollis* Krutzsch 1959b

1959b *Striatopollis* Krutzsch, p. 142.

1962 *Striopollenites* Rouse, p. 212.

Type Species. *Striatopollis sarstedtensis* Krutzsch 1959b (p. 143; plate 34, figure 1). Lower Paleocene, Germany.

Striatopollis sp. cf. *S. paraneus* (Norris 1967) Singh 1971
Plate 9, figure 7

[cf.] 1971 *Striatopollis paraneus* (Norris) Singh, p. 206. Plate 32, figures 1-3.

Description. Tricolpate pollen grain of small size, with striate sexine. Circular to slightly ellipsoidal outline in equatorial view. Exine, 1.3 μm thick, undifferentiated, finely striate. Striae less than 0.5 μm across, without any evidence of reticulum and arranged in angles to the colpi. Colpi of equal size, straight with smooth margins and reaching the polar area.

Dimensions. Length: 25 (26) 26 μm . Breadth: 21 (22) 22 μm (4 specimens).

Note. Because of the small size of the observed specimens, it is impossible to obtain further characterization. As Penny (1988) discussed, the microstructure of the exine revealed by SEM studies might be useful to further characterize species of this genus. The specimens observed in this study are compared to *Striatopollis paraneus* because of the overall arrangement of the muri and overall outline of the pollen grain in equatorial view. They differ from the latter by the lack of a reticulum in areas between the striae.

In general, the species observed in this study differs from *Striatopollis reticulatus* Regali et al. 1974b by the smaller overall size of the observed specimens in this study. *Striatopollis sarstedtensis* has coarser muri parallel to the colpi (Penny, 1988).

Occurrences. This species is observed rarely in samples of the Upper Aptian–Albian of the Zea-Panamericana and La Grita outcrop sections and in well ALT-19X.

Striatopollis paraneus has been reported from the Albian to the Campanian; Albian of Oklahoma (Hedlund and Norris, 1968; Srivastava, 1977), Utah (Tschudy et al., 1984), Lower Campanian of New Mexico (Jameossanaie, 1987) and Upper Albian to Cenomanian of the eastern Atlantic Coastal Plain of the United States (Doyle and Robbins, 1977), Middle to Lower Albian of western Canada (Burden and Hills, 1989), Middle to Upper Albian of Alberta (Norris, 1967; Singh, 1971) and Upper Albian of Sudan (Schrank, 1990).

Genus *Tricolpites* Cookson 1947 ex Couper 1953 emend. Potonié 1960

1947 *Tricolpites* Cookson, p. 134 [nomen nudum].

1953 *Tricolpites* Cookson ex Couper, p. 61.

1960 *Tricolpites* Cookson ex Couper emend. Potonié, p. 95.

Type Species. *Tricolpites reticulatus* Cookson 1947 (p. 134; plate 15, figures 4-5). Tertiary, Kerguelen Archipelago, Indian Ocean.

Remarks. van der Hammen (1956) proposed the subgenus *Retitricolpites* to include tricolpate pollen grain and designated "*Retitricolpites*" *ornatus*, a species of the Recent, as the type species. Since this species belongs to a modern natural plant genus, it cannot be used as the type species of a fossil genus. Pierce (1961) raised *Retitricolpites* to the generic rank, designating *Retitricolpites vulgaris* Pierce 1961 as the type species. van der Hammen and Wijmstra (1964) proposed *Retitricolpites ovalis* van der Hammen & Wijmstra 1964 as the lectogenotype of the genus. Potonié (1966) also accepted *Retitricolpites* as a valid genus, designating the species *Retitricolpites vulgaris* as the lectogenotype. However, the validity of *Retitricolpites* is uncertain.

For the purposes of this study, tricolpate pollen grains with uniform reticulum, whose lumina is less than 2 μm , are included in the genus *Tricolpites*.

Tricolpites gritaensis sp. nov.

Plate 9, figure 5

Diagnosis. A species of *Tricolpites* characterized by prolate polar outline with rounded apices, colpi extending all the length of the grain. Relatively thin exine, 1.0 to 1.5 μm thick, finely scabrate and apparently tectate.

Etymology. With reference to the city of La Grita, Táchira State, western Venezuela.

Description. Tricolpate microreticulate pollen grains. Prolate polar outline with rounded apices. Exine, 1.0 to 1.5 μm thick. Nexine smooth and massive. Finely scabrate sexine, perhaps tectate (difficult to determine because of the preservation of the specimens). Colpi, relatively straight with smooth edges, almost extending to the polar areas, surrounded by thickened exine (1.5 μm thick).

Holotype. Plate 9, figure 5. Dimensions: 37 μm long x 25 μm broad. Exine, 1.5 μm thick. La Grita outcrop section. Sample; 09-04-05. Slide 1. Coordinates; 12.8 x 93.4. Aguardiente Formation. 3 km NW of the town La Grita, Táchira State, western Venezuela. Upper Aptian.

Dimensions. Length: 21 (33) 37 μm . Breadth: 15 (18) 25 μm (29 specimens).

Note. *Fraxinoipollenites venustus* Singh 1971 has a similar outline, but it has a reticulate ornamentation. *Tricolpites crassimurus* (Groot & Penny 1960) Singh 1971 has baculate ornamentation. The species observed in this study lack of the well-developed bacula reported and described by Singh (1971) for *Tricolpites crassimurus*.

Occurrences. This species is observed in low abundances in samples of the Upper Aptian and Albian of the Zea-Panamericana and La Grita outcrop sections, and more rarely in wells CR-5, ALT-19X and ALP-6.

Tricolpites sp. A

Plate 9, figure 4

Description. Tricolpate, microreticulate pollen grains. Prolate to oblate polar with relatively rounded apices. Exine 1.5 μm thick, undifferentiated. Very finely reticulate

with polygonal lumina less than 1.0 μm wide, evenly distributed. Apparently intectate. Colpi straight with thickened exine (1.0 to 1.5 μm), extending almost into the polar area.

Dimensions. Length: 40 (51) 62 μm . Breadth: 25 (31) 35 μm (7 specimens).

Note. In general, this species is characterized by relatively large grains, larger than reported for other species of *Tricolpites* of the Lower Cretaceous; *Tricolpites sagax* Norris 1967 shows fine striations, even though the sexine ornamentation is difficult to see under light microscope, and a double layered-exine. *Tricolpopollenites* sp. 4 of Groot and Groot (1962) is characterized by relatively large size and prolate outline. However its ornamentation is scabrate with closely-spaced projections. *Tricolpites crassimurus* has microreticulate ornamentation, with clavae (Singh, 1971) or finely scabrate (Groot and Penny, 1960). *Fraxinopollenites venustus* is smaller, and according to Singh (1971), has wider lumina in the polar areas.

Occurrences. This species is rarely observed in samples of the Upper Aptian and Albian of the Zea-Panamericana and La Grita outcrop sections, and in ALT-19X.

Tricolpites sp. B

Plate 9, figure 3a-b

Description. Tricolpate, reticulate prolate pollen grains. Circular polar view and ellipsoidal equatorial view. Exine, about 1.3 microns thick. Nexine, less than 0.5 μm thick, almost undifferentiated. Reticulate sexine, circular to rounded polygonal lumina of uniform size, 1.0 to 1.3 μm diameter. Muri connected to the nexine by simple bacula, less than 1.0 μm high. Tectate. Colpi, straight, extending almost into the polar areas, not very open or split in polar view.

Dimensions. Breadth: 28 (35) 42 μm . Length: 31.3 μm (only one specimen observed in equatorial view) (total of 4 specimens).

Note. "*Retitricolpites*" *vulgaris* Pierce 1961 does not have a tectate exine, according to Norris (1967) and Singh (1971). However, Srivastava (1977) concluded that this species has a tectate exine. "*Retitricolpites*" *maximus* Singh 1971 has clavae connecting the muri with the nexine and the muri are more sinuous. Overall lumina diameter is also larger than that reported for the species observed in this study. *Tricolpites virgeus* (Groot, Penny

& Groot 1961) Zippi & Bajc 1990 also has wider lumina and a more trilobate outline in polar view. This species is tectate with bacula connecting the muri to the nexine.

Occurrences. This species is observed rarely in Upper Aptian–Albian samples of La Grita and Zea-Panamericana outcrop sections, and in well ALT-19X.

Genus *Verrutricolpites* Pierce 1961

1961 *Verrutircolpites* Pierce, p. 24.

Type Species. *Verrutricolpites sphaeroides* Pierce 1961 (p. 50; plate 3, figure 103). Upper Cretaceous (Cenomanian), Minnesota, United States.

Verrutricolpites sp. A

Plate 9, figure 8

Description. Tricolpate, verrucate pollen grain of small size. Circular polar view. Exine, 1.3 μm thick, microverrucate. Verrucae of small size (less than 1.3 μm across), evenly distributed on the surface. Colpi extending into the polar areas.

Dimensions. Diameter: 26.3 μm (1 specimen).

Occurrences. It is observed in one sample of the Albian of the Zea-Panamericana outcrop section (sample 13-04-54).

ANGIOSPERM POLLEN OF UNCERTAIN AFFINITY

Genus *Afropollis* Doyle et al. 1982

1982 *Afropollis* Doyle et al., p. 3-4.

Type Species. *Afropollis jardinus* (Brenner 1968; p. 381; plate 7, figures 10-11) Doyle et al. 1982. Albian, Perú.

Afropollis zonatus Doyle et al. 1982

Plate 9, figure 9

1982 *Afropollis zonatus* Doyle et al., p. 48-49. Plates 9 and 10, Plate 8, figures 5-8.

Description. See Doyle et al. (1982).

Dimensions. Sexine diameter: 27 (28) 33 μm . Nexine diameter; 15 (17) 20 μm (25 specimens).

Occurrences. This species is observed in low numbers in Aptian samples of the Zea-Panamericana outcrop section and in wells CR-5, ALT-19X and ALP-6.

This species was initially reported by Doyle et al. (1982) in the Lower Aptian of Gabon and has been reported in the Aptian-Albian of Colombia (Dueñas Jiménez, 1989), Barremian and Aptian of Libya (Thusu et al., 1988). Species similar to *A. zonatus* have also been reported in the Lower Aptian of western Canada (Burden and Hills, 1989) and the ?Lower Aptian of Maryland (Doyle, 1992), and the Aptian of Egypt (Schrank, 1983).

Afropollis sp. cf. *A. jardinus* (Brenner 1968) Doyle et al. 1982

Plate 9, figures 10 and 12

[cf.] 1982 *Afropollis jardinus* (Brenner) Doyle et al., p. 45-46. Plate 1, figures 1-6, Plate 2, figures 1-8.

Description Cryptoaperturate pollen grain. Subspherical, with circular to ellipsoidal outline. Exine, with a reticulate sexine of open lumina. Lumina diameter, 3 to 4 μm , decreasing towards the area where the nexine is attached to the sexine. Muri without columellae, relatively smooth and with clear finely granulate supratectal ornamentation (Plate 9, figure 12b). Nexine, psilate to granulate, up to half the radius of the sexine, not always present.

Dimensions. Diameter: 30 (35) 45 μm . Nexine diameter; 15 (18) 20 μm (120 specimens).

Note. The specimens observed in this study are similar under the light microscope to *Afropollis jardinus* (Brenner 1968) Doyle et al. 1982. However, the microgranulate

supractectal ornamentation observed in this study differs from the ridged or segmented muri shown by the specimens illustrated by Doyle et al. (1982) (their Plate 1, figure 6 and Plate 2, figure 5). *Afropollis* aff. *jardinus sensu* Doyle et al. (1982) shows coarser granulate (tiny microechinate?) ornamentation.

Occurrences. This species is observed quite abundantly in the Upper Aptian and Albian samples of La Grita and Zea-Panamericana outcrop sections, as well as in wells CR-5, ALT-19X, ALP-6 and P-201.

Afropollis jardinus has been reported from the Albian of Peru (Brenner, 1968), Albian to Cenomanian of Brazil (Regali et al., 1974a; Herngreen, 1973 and 1975b), Albian to Cenomanian of Colombia (Dueñas Jiménez, 1989), Lower Albian to Cenomanian offshore southwest Africa (Morgan, 1978), Upper Aptian to Cenomanian of Gondwana (Doyle et al., 1982), Albian of Senegal (Jardiné and Magloire, 1965), Upper Albian to Lower Cenomanian of Nigeria (Lawal and Moullade, 1986), Upper Albian to Lower Cenomanian of Sudan (Schränk, 1990), Albian to Cenomanian of Libya (Batten and Unwins, 1985) and Albian to Cenomanian of Egypt (Sultan, 1978 and 1987; Abou Ela and Mahrous, 1992).

Afropollis sp. B *sensu* Doyle et al. 1982

Plate 9, figure 11

1982 *Afropollis* sp. B Doyle et al., p. 50. Plate 13, figures 1-5, Plate 13, figures 1-5 and Plate 12, figures 5-7?

Description. Cryptoaperturate pollen grain. Spherical with circular outline. Exine, with reticulate sexine. Muri simplibaculate, thick, sinuous and very fragmented, without columellae. Polygonal lumina, 1.0 to 2.0 μm diameter.

Dimensions. Sexine diameter: 25 (27) 31 μm . Nexine diameter: 12 (14) 15 μm (3 specimens).

Note. The morphology of the observed specimens corresponds to that described by Doyle et al. (1982) for their *Afropollis* sp. B. Doyle et al. (1982) stated that this species was characterized by the thick, finely segmented muri also seen in the present study.

Occurrences. The three specimens are observed in three Aptian samples of the Zea-Panamericana outcrop section (samples 13-04-07, 13-04-16 and 13-04-22).

The species was described from Zone C-VIIc (Lower Aptian) of Doyle et al. (1977 and 1982).

Afropollis sp. C

Plate 10, figure 1a-b

Description. Spherical-circular zonosulcate? pollen grain. Reticulate sexine of open polygonal lumina, up to 4 μm across. Muri, relatively wide (1.0 to 1.5 μm) and thick, baculate, finely granulate and without columellae. Aperture is not very evident but might be zonoaperturate-operculate. No nexine is observed.

Dimensions. Diameter: 25 (32) 38 μm (6 specimens).

Note. This species differs from others previously described by the suggested aperture and the thickness of the muri. *Liliacidites peroreticulatus* (Brenner 1963) Singh 1971 has also a very coarse muri and open lumina. However, this species is monosulcate and possesses columellae joining the sexine with the nexine.

Occurrences. This species is observed only in low number in the Albian of La Grita outcrop section and well ALT-19X.

Afropollis sp. D

Plate 10, figure 2

Description. Cryptoaperturate spherical pollen grain with circular outline. Finely reticulate sexine with polygonal lumina, less than 1.3 μm wide. Muri, very thin and narrow, smooth or perhaps finely granulate and without columellae. Spherical smooth nexine, about 3/4 of the sexine diameter. Aperture is not evident.

Dimensions. Sexine diameter: 30 (33) 35 μm . Nexine diameter: 27 (31) 32 μm (4 specimens).

Note. This species differs from other species of *Afropollis* by the fine reticulum and from species of *Liliacidites* Couper 1953 by the lack of sulcus and columellae joining the nexine with the sexine.

Occurrences. This species is only observed in the Aptian of the Zea-Panamericana outcrop section (samples 13-04-16 and 13-04-17).

Afropollis sp. E

Plate 10, figure 3

Description. Cryptoaperturate pollen grain. Spherical palynomorph with ellipsoidal outline. Reticulate sexine of open polygonal (hexagonal) lumina, up to 6.0 to 7.0 μm across. Muri, relatively wide (1.0 to 1.5 μm), smooth and without columellae. Relatively large and thick nexine, granulate.

Dimensions. Nexine/sexine diameter: 47 x 27 μm (1 specimen).

Note. This species differs from other species of *Afropollis* by its wider lumina and the large granulate nexine, closely located to the sexine.

Occurrences. Only one specimen is observed in the Albian of well ALT-19X (sample ALT-19X 17461').

Afropollis sp. F

Plate 10, figure 4a-b

Description. Cryptoaperturate? spherical? pollen grain. Reticulate sexine of open polygonal (hexagonal) lumina, up to 3.0 to 4.0 μm across. Muri, relatively wide (1.0 to 1.5 μm), with supratectal short and very sharp echinae. Relatively thick nexine, granulate.

Dimensions. Sexine diameter: 45 μm . Nexine diameter: 25 μm (1 specimen).

Note. This species differs from others of the genus *Afropollis* by the echinate supratectal ornamentation.

Occurrences. It is observed in the Albian of the Catatumbo outcrop section (sample M-23).

Afropollis sp. G

Plate 10, figure 5a-b

Description. Small-sized, monosulcate pollen grain. Spherical with circular outline. Reticulate sexine, with open polygonal to slightly circular lumina, that increases in size away from the sulci (from about 1.3 μm to about 3.0 to 4.0 μm), without columellae. Straight sulci, in one of the faces of the grain, edged by thickened granulate sexine. Nexine, finely granulate to smooth, circular in outline, relatively thick, about 4/5 of the diameter of the sexine.

Dimensions. Sexine diameter: 21 μm . Nexine diameter: 18 μm (1 specimen).

Note. *Liliacidites peroreticulatus* has a similar reticulum. However, the species observed in this study clearly lack of any columellae joining the nexine and sexine.

Occurrences. It is observed in the Albian section of the Catatumbo outcrop section.

POLLEN OF UNKNOWN AFFINITY

Genus *Elaterosporites* Jardiné 1967

1963 *Galeacornea* Stover, p. 86.

1967 *Elaterosporites* Jardiné, p. 240.

Type Species. *Elaterosporites verrucatus* (Jardiné & Magloire 1965; p. 205; plate III, figures 26) Jardiné 1967. Albian–Cenomanian, Senegal.

Elaterosporites klazi (Jardiné & Magloire 1965) Jardiné 1967

Plate 10, figure 6

1963 *Galeacornea* sp. Stover, p. 89.

1965 *Galeacornea klaszi* Jardiné & Magloire, p. 205. Plate IV, figure 3 a-b.

1967 *Elaterosporites klaszi* (Jardine & Magloire) comb. nov. Jardiné, p. 246.

Description. See Jardiné (1967).

Dimensions. Central body: 38 (48) 62 μm . Projections length: 15 (17) 19 μm . Projections diameter: 5 to 7 μm . (10 specimens).

Occurrences. This species is observed in Albian samples of La Grita outcrop section and well ALT-19X.

Elaterosporites klaszi has been reported from the Albian to Cenomanian of Venezuela (Muller et al., 1987), Lower Albian to Cenomanian of Brazil (Regali et al., 1974a), Perú (Brenner, 1968), Lybia (Batten and Unwins, 1985; Unwins and Batten, 1988) and Egypt (Aboul Ela and Mahrous, 1992; Sultan, 1987). It has also been reported from the Upper Albian to Cenomanian of Senegal and Ivory Coast (Jardiné and Magloire, 1965) and Sudan (Schrank, 1990). Gregory and Hart (1992) reported the occurrence of four specimens of *E. klaszi* in the Paleocene–Eocene (Wilcox Formation) of Texas, specimens that they considered reworked.

Elaterosporites verrucatus (Jardiné & Magloire 1965) Jardiné 1967

Plate 10, figure 7

1965 *Galeacornea verrucata* Jardiné & Magloire, p. 205. Plate III, figure 26, Plate IV, figure 4 a-c.

1967 *Elaterosporites verrucatus* (Jardiné & Magloire) Jardiné, p. 244.

Description. See Jardiné (1967).

Dimensions. Central body: 48 (52) 59 μm . Projections length: 37 to 39 μm (3 specimens).

Occurrences. This species is only observed in three Albian samples of well ALT-19X (samples ALT-19X 17439', ALT-19X 17291' and ALT-19X 17244').

This species has been reported in the Albian to Cenomanian of Peru (Brenner, 1968), Upper Albian–Cenomanian of Colombia (Pons, 1988), Middle Albian to Cenomanian of Brazil (Herngreen, 1973; Regali et al., 1974a), middle Cretaceous of Surinam (Habib,

Brazil (Herngreen, 1973; Regali et al., 1974a), middle Cretaceous of Surinam (Habib, 1972), Middle Albian to Cenomanian of Senegal and Ivory Coast (Jardiné and Magloire, 1965) and Upper Albian of Egypt (Sultan, 1987; Aboul Ela and Mahrous, 1992).

Genus *Reyrea* Herngreen 1973

1973 *Reyrea* Herngreen, p. 546.

Type Species. *Reyrea polymorpha* Herngreen 1973 (p. 546; plate 2, figure 7). Upper–Middle Albian, Brazil.

Reyrea polymorpha Herngreen 1973

Plate 10, figure 9

1966 cf. *Pollen incertae sedis* (forme allongée) Reyre, p. 9-10. Plate 3, figures 41-43.

1973 *Reyrea polymorphus* [sic] Herngreen, p. 546, 548. Plate II, figure 7.

Description. See Herngreen (1973).

Dimensions. Length: 26 (33) 37 μm . Width: 17 (22) 26 μm (55 specimens).

Note. Just as Herngreen (1973) had noted in his original description of this species, most of the specimens found in the present study are broken.

Occurrences. This species is very abundant in some samples of the Aptian of the Zea-Panamericana outcrop section (basal part) and in lesser numbers in samples of the Aptian–Albian of La Grita outcrop section and well ALP-6.

This species has been reported from the Aptian–Albian of Venezuela (Muller et al., 1987), Albian to Cenomanian of Brazil (Herngreen, 1973; Regali et al., 1974a; Traverse, 1988), Aptian–Albian of Libya (Thusu and van der Eem, 1985) and Albian of Egypt (Sultan, 1987).

Genus *Sofrepites* Jardiné 1967

1967 *Sofrepites* Jardiné, p. 248.

Type Species. *Sofrepites legouxiae* Jardiné 1967 (p. 248; plate III, figures H-J) emend. Boltenhagen 1982. Upper Albian, Senegal.

Sofrepites legouxiae Jardiné 1967 emend. Boltenhagen 1983
Plate 10, figure 8a-b

1967 *Sofrepites legouxiae* Jardiné, p. 248. Plate III, figures H and J. Text-figure 5.
1983 *Sofrepites legouxiae* Jardiné emend. Boltenhagen, p. 150-151.

Description. See Jardiné (1967) and Boltenhagen (1983).

Dimensions. Body diameter: 36 (40) 43 μm . Projection length: 13 to 20 μm . Projection diameter: 6 to 7 μm (2 specimens).

Occurrences. Only two specimens are observed in the Albian of La Grita outcrop section (sample 09-04-10) and well ALP-6 (sample ALP-6 15740').

This species has been observed in the Albian to Cenomanian of Venezuela (Muller et al, 1987), Upper Albian to Cenomanian of Brazil (Herngreen, 1973; Regali et al., 1974a), Upper Albian to Lower Senonian of Egypt (Sultan, 1987) and Albian of Libya (Thusu and van der Eem, 1985).

3.4. Dinoflagellates

DIVISION DINOFLAGELLATA (BÜTSCHI 1885) FENSOME ET AL. 1993

SUBDIVISION DINOKARYOTA FENSOME ET AL. 1993

CLASS DINOPHYCEAE PASCHER 1914

SUBCLASS PERIDINIPHYCIDAE FENSOME ET AL. 1993

ORDER GONYAULACALES TAYLOR 1980

SUBORDER CLADOPYXIINEAE FENSOME ET AL. 1993

FAMILY CLADOPYXIACEAE STEIN 1883

Genus *Microdinium* Cookson & Eisenack 1960a emend. Stover & Evitt 1978

1960a *Microdinium* Cookson & Eisenack, p. 6

1966a *Microdinium* Cookson & Eisenack emend. Sarjeant, p. 148-149

1978 *Microdinium* Cookson & Eisenack emend. Stover & Evitt, p. 65-66

Type Species. *Microdinium ornatum* Cookson & Eisenack 1960 (p. 6; plate 2, figures 3-8). Albian-Turonian, Australia.

Remarks. Stover and Evitt (1978) emended the genus *Microdinium* stating the following tabulation formula; 1-4', 0-3a, 6-7'', 6c, 5-6''', 1p, 1''', 0-5s. These authors also stated that the operculum is formed of all 4 apical plates and in some cases, involves one of the intercalary plates.

Microdinium opacum Brideaux 1971

Plate 11, figure 1

1971 *Microdinium opacum* Brideaux, p. 76-77. Plate 21, figures 19-22. Text-figure 7 d-e.

1975 *Microdinium spinosum* Brideaux & McIntyre, p. 23-24. Plate 6, figures 3-5.

1987 *Phanerodinium opacum* (Brideaux) Below, p. 38

Description. See Brideaux (1971).

Dimensions. Autocyst: length, 18 (25) 28 μm . Breadth: 12 (15) 16 μm (55 specimens).

Note. This species is characterized by a finely perforate autophragm about 1.3 μm thick, with well developed parasutural ridges. Hypocysts larger than the epicyst. The reflected tabulation formula is determined to be 1'?, 6", 6c, 6"" and 1"". Plate 1"" is always offset in relation to the polar axis of the specimens. It is impossible to further characterize tabulation in the sulcal region, mainly because of the small size of the specimens and the preservation.

Occurrences. *Microdinium opacum* is observed in this study in low numbers in the southernmost section of Zea-Panamericana. It is present in low number in sections of the Aptian-Albian of wells CR-5, ALT-19X, ALP-6 and P-201. In Albian samples of the from the Catatumbo outcrop section, it is relatively common.

This species was initially described by Brideaux (1971) from the Middle to Upper Albian of Alberta, Canada. Later, Brideaux (1977) observed this species in the Lower Cretaceous (Hauterivian to Middle Albian) of the Northwest Territories of Canada. Lister and Batten (1988) also reported this species in the palynological assemblages of the Upper Aptian in England, mentioning that its occurrence in these assemblages might be an indicative of boreal or arctic influence. However, other authors have observed this species in low latitude assemblages; Hedlund and Norris (1986) in the Middle Albian of Oklahoma, Rogers (1987) in the Lower Cretaceous of Louisiana and Thusu et al. (1988) also reported this species in the Valanginian-Barremian of Lybia.

Microdinium sp. A

Plate 11, figure 4

Description. Acavate, proximate dinoflagellate cysts. Spherical autocyst, with ovoidal to polyhedral outline after dorsal-ventral compression. Autophragm thin (less than 1 μm thick), finely granulate, with low narrow smooth parasutural ridges. Inferred gonyaulacoid paratabulation, 1'?, 1a, 6", 6c, 6"", 1"". Plate 1"" slightly offset in relation to the polar axis. Epicyst smaller than hypocyst. Parasulcus depressed, delimited by parasutural ridges. Paracingulum also delimited by parasutural ridges, without major

offset, with six rectangular plates. Complex archeopyle involving the apical and perhaps intercalary series (tAaI?).

Dimensions. Autocyst: length: 37.5 μm . Breadth: 42.5 μm (1 specimen).

Note. The observed specimen differs from those of *Microdinium opacum* by the larger size and the more polyhedral outline. *Microdinium ornatum* is characterized by the occurrence of tubercles and the parasutural ridges are made of short and broad projections. *Microdinium setosum* Sarjeant 1966, *Microdinium distinctum* Davey 1969, *Microdinium variospinum* Davey 1969 and *Microdinium angularis* (Below 1987) Lentin and Williams 1990 have well developed spines along the parasutural ridges. *Microdinium dentatum* Vozzhennikova 1967 emend. Lentin & Williams 1990 has castellate parasutural ridges.

Occurrences. It is observed in the Albian of the Rosarito outcrop section.

Microdinium? sp. B

Plate 11, figure 5

Description. Small, proximate, acavate dinoflagellate cyst. Spherical brownish autocyst with circular dorso-ventral or lateral compression. Autophragm finely perforate-reticulate, with thick parasutural ridges (almost 1.3 μm high and wide). Descending cingulum and sulcus limited by thickened ridges. Details of the reflected tabulation not discernable because of poor preservation and orientation. Antapical plate clearly hexagonal, in contact with the sulcus in the ventral area. Apical archeopyle inferred.

Dimensions. Autocyst length: 18 (23) 25 μm . Breadth: 25 μm (10 specimens).

Note. The specimens observed in this study have been included within the genus *Microdinium* based mainly on the gross morphological features; parasutural ridges and small size. However, its definitive systematic position will depend on further characterization of the paratabulation and the nature of the archeopyle.

Microdinium variospinum shows more or less the same outline (circular in dorso-ventral or lateral view). The parasutural ridges of *Microdinium variospinum* are made of either echinae of variable shape or tubercles and the ridges are not continuous.

Occurrences. Observed in low abundances in samples of the Albian of the Catatumbo and Rosarito outcrop sections.

FAMILY PAREODINIACEAE GOCHT 1957

SUBFAMILY PAREODINIOIDEAE (AUTONYM)

Genus *Pareodinia* Deflandre 1947 emend. Stover & Evitt 1978

1947 *Pareodinia* Deflandre, p. 4.

1970 *Pareodinia* Deflandre emend. Gocht, p. 153-154.

1973 *Pareodinia* Deflandre emend. Johnson & Hills, p. 208.

1975 *Pareodinia* Deflandre emend. Wiggins, p. 102.

1978 *Pareodinia* Deflandre emend. Stover & Evitt, p. 116-117.

1990 *Pareodinia* Deflandre emend. Below, p. 64-65.

Type Species. *Pareodinia ceratophora* Deflandre 1947 emend. Below 1990. Jurassic, Germany.

Remarks. Most emendations to the description and diagnosis of this genus refer to the type of archeopyle. Gocht (1970) and Below (1990) limited the genus to species with a 2I archeopyle. Johnson and Hills (1973) stated that the archeopyle of *Pareodinia* might be 2I or 3I. Wiggins (1975) stated that the archeopyle was rather variable; I, 2I or 3I. Stover and Evitt (1978) stated that the genus was characterized by 2I or 3I archeopyles. These authors also referred to the absence of major prominent antapical horns and the lack of evidence of the reflected tabulation, except for the archeopyle. These concepts are accepted in this study. Stover and Evitt (1978) considered the genus *Paranetrelytron* Sarjeant as a junior synonym of *Pareodinia*. However, the specimens illustrated by Sarjeant (1966b) are clearly two-layered cysts. Therefore, their proposal regarding this latter genus is not accepted here.

Pareodinia sp. A

Plate 11, figure 3

Description. Proximochorate, acavate dinoflagellate cyst. Pear-shaped autocyst with ellipsoidal to nearly circular outline. Autophragm finely perforate-reticulate, with short hollow acuminate processes or echinae. Long and blunt apical horn. Antapical area rounded, without horns. No evidence of paratabulation except for 3I archeopyle.

Dimensions. Autocyst: length: 45 μm . Breadth: 56 μm . Horn length: 25 μm . Processes length: less than 1.3 μm (1 specimen).

Note. *Pareodinia ceratophora* has a 2I archeopyle and granulate autophragm. *Imbatodinium kondratjevii* (Vozzhennikova 1967) Wiggins 1975 emend. Below 1990 has a very long apical horn and weakly developed antapical bulges. *Pareodinia procerchagrinata* Below 1990 has very long apical horn (up to 2/3 of the size of the autocyst). *Pareodinia curvocervicata* Tasch 1964 has slender acuminate processes. *Pareodinia psilata* Jain & Millepied 1975 and *Pareodinia aphelia* Cookson & Eisenack 1958 have smooth to very finely granulate autophragm.

Ocurrences. This species is observed in the Upper Aptian section of the Zea-Panamericana outcrop section (sample 13-04-48).

SUBORDER GONYAULACINEAE (AUTONYM)

FAMILY GONYAULACACEAE LINDEMANN 1928

SUBFAMILY LEPTODINIOIDEAE FENSOME ET AL. 1993

Genus *Litosphaeridium* Davey & Williams 1966 emend. Lucas-Clark 1984

1966 *Litosphaeridium* Davey & Williams, p. 79-80

1973 *Litosphaeridium* Davey & Williams emend. Davey & Verdier, p. 193

1984 *Litosphaeridium* Davey & Williams emend. Lucas-Clark, p. 181-182

Type Species. *Litosphaeridium siphoniphorum* (Cookson & Eisenack 1958; p. 44; plate 11, figures 8-10) Davey & Williams 1966 emend. Lucas Clark 1984. Albian–Cenomanian, Australia.

Remarks. Davey and Verdier (1973) emended the description of the genus *Litosphaeridium*, allowing the inclusion of a new species (*Litosphaeridium conispinum* Davey & Verdier 1973). Lucas-Clark (1984), based on a detailed morphological analysis of species of this genus from North America, emended the description of the genus, including a more precise description of the reflected tabulation and wall relationships.

Litosphaeridium sp. A

Plate 11, figure 2

Description. Acavate, chorate dinoflagellate cyst. Spherical autocyst, with circular outline after compression. Autophragm, thin (less than 1.3 μm thick), finely granulate, forming 15-16 intratabular hollow tubular processes that are distally open and denticulate. Inferred gonyaulacoid paratabulation; 4', 6", 5-6''' and 1'''. Apical archeopyle with zig-zag margins.

Dimensions. Autocyst diameter: approximately 42 μm . Processes length: 12-13 μm (1 specimen).

Note. The observed specimen shows some resemblance to the types of processes of *Litosphaeridium bacar* Lucas-Clark 1984 (her plate 3, Figures 1-12), that are distally denticulate. However, the length of the processes reported by Lucas-Clark (1984) is shorter than the range observed in this study.

Occurrences. Only one complete specimen, badly preserved, is observed in one sample of well ALT-19X (sample ALT-19X 17421'), within the Albian. A possible fragment is observed also in sample ALT-19X 17412'.

Genus *Oligosphaeridium* Davey & Williams 1966 emend. Davey 1982

1966 *Oligosphaeridium* Davey & Williams, p. 70-71.

1982 *Oligosphaeridium* Davey & Williams emend. Davey, p. 13.

Type Species. *Oligosphaeridium complex* (White 1842, p. 39; plate 4, figure 11) Davey & Williams 1966. Upper Cretaceous (Senonian), England.

Oligosphaeridium albertense (Pocock 1962) Davey & Williams 1969

Plate 11, figures 6 and 7

1962 *Hystriospheridium albertense* Pocock, p. 82. Plate 15, figures 226-227.

1969 *Oligosphaeridium albertense* (Pocock) Davey & Williams, p. 5.

For a more extensive synonymy, see Below (1982).

Description. See Brideaux (1977, p. 27-28).

Dimensions. Autocyst diameter: 43 (48) 62 μm . Processes length: 11 (15) 21 μm (100 specimens).

Note. This species is the most common representative of the genus observed in this study. Brideaux (1977) described the variability of the shape and terminations of the processes (secate to aculeate). In the specimens observed, postcingular and antapical processes tend to be wider at the base (up to 10 μm) than the precingular and apical processes (3 to 6 μm). Although Brideaux (1977) did not report this difference, it is observed in some of the specimens he illustrated (his plate 11, figures 4 and 5).

This species is differentiated from *Oligosphaeridium complex* by shorter and wider processes with more irregular endings.

Occurrences. This species is common in samples of the Aptian-Albian samples in most of the studied sections, although occurred in very low numbers in the southernmost sections of La Grita and Zea-Panamericana, whereas they are more abundant in sediments of the Albian in wells CR-5, ALT-19X and the outcrop sections of Catatumbo and Rosarito.

This species has been reported from the Valanginian-Barremian of Australia (Burger, 1982), Turonian to Coniacian of Colombia (Prössl, 1992), Middle Albian of Oklahoma (Hedlund and Norris, 1986), Albian of Kansas (Tasch et al., 1964), Barremian to Cenomanian of Alberta, Canada (Pocock, 1962; Davey, 1969; Brideaux and McIntyre,

1975; Singh, 1983), Albian to Cenomanian of offshore southeast Canada (Bujak and Williams, 1978), Hauterivian to Albian of Morocco (Below, 1981) and Aptian to Cenomanian of offshore northwest Africa (Below, 1984) and Barremian to Albian of Germany (Prössl, 1990)

Oligosphaeridium complex (White 1842) Davey & Williams 1966

Plate 11, figure 8

1842 *Xanthidium tubiferum* var. *complex* White, p. 39. Plate 4, figure 11.

1946 *Hystriosphæridium complex* (White) Deflandre, 11.

1966 *Oligosphaeridium complex* (White) Davey & Williams, p. 71. Plate 7, figures 1-2, Plate 10, figure 3. Text-figure 14.

For a more extensive synonymy, see Lejeune-Carpentier and Sarjeant (1983) and Harker and Sarjeant (in Harker et al., 1990).

Description. See Davey and Williams (1966).

Dimensions. Autocyst diameter: 43 (47) 62.5 μm . Processes length: up to 27.5 μm (20-21 μm average) (10 specimens).

Occurrences. The poorly preserved specimens observed in this study are found in very low abundance in samples of the Aptian-Albian of wells CR-5 and ALT-19X.

This is a long-ranging species (Berriasian to Eocene according to Williams and Bujak, 1985) and has been reported in different localities in the Lower Cretaceous on a worldwide basis; Valanginian to Upper Cretaceous (Senonian) of Australia (Deflandre and Cookson, 1955, Cookson and Eisenack, 1961; Burger, 1980 and 1982), Lower Aptian of Argentina (Pöthe de Baldi and Ramos, 1983), Albian of Brazil (Arai, 1992), Turonian to Coniacian of Colombia (Prössl, 1992), Albian of Mexico (Helenes, 1984b), Hauterivian to the Cenomanian offshore Bahamas (Habib and Drugg, 1983), Lower Cretaceous of Louisiana (Rogers, 1987), Middle Albian of Oklahoma (Hedlund and Norris, 1986), Campanian to Maastrichtian of Wyoming and Texas (Harker et al. 1990; Srivastava, 1991), Hauterivian-Albian of Alberta, Canada (Brideaux, 1971 and 1977; Singh, 1971), Valanginian to Campanian in the the southeast offshore Canada (Bujak and Williams, 1978), Aptian-Albian of Senegal (Jain and Millepied, 1975), Hauterivian-

Cenomanian of Morocco (Below, 1982 and 1984), Berriasian–Cenomanian of Lybia (Batten and Unwins, 1985; Thusu et al., 1988; Unwins and Batten, 1988), Valanginian to Upper Cretaceous (Lower Campanian) in France (Habib and Warren, 1973; Davey and Verdier, 1974; Foucher, 1979), Hauterivian to Turonian of Germany (Prössl, 1990), Hauterivian to Turonian of England (Davey, 1969, Duxbury, 1977, Harding, 1986, Jarvis et al., 1988) and Lower Cretaceous in the Middle East (Ashraf, 1979), for example. The oldest occurrence of this species was reported in the Berriasian of Libya (Thusu et al, 1988) whereas the youngest has been reported from the Eocene of France (Auffret and Gruas-Cavagnetto, 1975) and India (Sakar and Singh, 1988).

Oligosphaeridium sp. cf. *O. pulcherrimum* (Deflandre and Cookson 1955) Davey & Williams 1966
Plate 11, figure 9

[cf.] 1966 *Oligosphaeridium pulcherrimum* (Deflandre & Cookson) Davey & Williams, p. 75. Plate 10, figure 9, Plate 11, figure 5.

Description. See Davey and Williams (1966).

Dimensions. Autocyst diameter: about 50 μm . Processes length: up to 19 μm (1 specimen).

Note. Only one fragmented and poorly preserved specimen is observed. It differs from other species of *Oligosphaeridium* by the open mesh or fenestrate pattern in the aculeate tips of the processes. Davey and Williams (1966) stated that the fenestrate nature of the tips of the processes is a distinctive feature of this species. However, Brideaux (1977) reported that some of the processes of *Oligosphaeridium albertense* might be fenestrate. Since only a single specimen shows fenestrate termination of the processes and other specimens that are clearly assigned to *Oligosphaeridium albertense* did not show this feature, the specimen observed in this study is compared with *Oligosphaeridium pulcherrimum*.

Occurrences. The only specimen is observed in the Albian section of well ALT-19X (sample ALT-19X 17339').

SUBFAMILY CRIBROPERIDIOIDEAE FENSOME ET AL. 1993

Genus *Cribroperidinium* Neale & Sarjeant 1962 emend. Helenes 1984a

1962 *Cribroperidinium* Neale & Sarjeant, p. 443.

1969 *Cribroperidinium* Neale & Sarjeant emend. Davey, p. 125.

1982 *Cribroperidinium* Neale & Sarjeant emend. Sarjeant, p. 40.

1984a *Cribroperidinium* Neale & Sarjeant emend. Helenes, p. 112.

Type Species. *Cribroperidinium sepimentum* Neale & Sarjeant 1962 (p. 443; plate 19, figure 4). Lower Cretaceous (Hauterivian), England.

Remarks. Davey (1969) emended the diagnosis of the genus, drawing the attention to the fact that anterior and posterior plates were not always distinguishable. He proposed the following reflected tabulation formula: ?6', (1-5a), 8-9", 0c, 9", 1p, 1-3 pv and 0""(-2""?). Sarjeant (1982) emended the diagnosis of the genus, stating the occurrence of preapical plates and establishing a more detailed description of the relation between contacts of different plates. He proposed the following reflected tabulation formula: 0-2pa, 3-4', 0-2?a, 6', 6-7c, 6-6", 1p, 1"". Helenes (1984a) offered a more detailed description, especially of the post apical plates, proposing the following reflected tabulation formula: 1pa, 4a, 6", 6c, 5s, 6", 1p, 1"" and pointed out that the species of the genus are acavate and possess only one preapical plate. The emendation proposed by Helenes (1984a) is accepted herein.

Cribroperidinium orthoceras (Eisenack 1958a) Davey 1969 emend. Sarjeant 1985

Plate 12, figure 1a-b

1958a *Gonyaulax orthoceras* Eisenack, p. 388. Plate 21, figures 3-11, Plate 24, figure 1.
Text-figures 2-3.

1969 *Cribroperidinium orthoceras* (Eisenack) emend. Davey, p. 128.

1985 *Cribroperidinium orthoceras* (Eisenack) Davey emend. Sarjeant, p. 51, 53.

For more extensive synonymy, see Sarjeant (1985).

Description. See Sarjeant (1985) and comments by Helenes (1984a).

Dimensions. Autocyst length (including apical horn): 81 (87) 92 μm . Breadth: 69 (72) 75 μm wide. Apical horn length: 15 (16) 18 μm . Echinae: less than 2.5 μm long (10 specimens).

Note. This species is characterized by the low relief and narrow parasutural ridges with echinae. Sarjeant (1985) referred to tubercles on the wall of the holotype, but this character is not observed in the specimens observed in this study. Helenes (1984a) pointed out that this species along with *Cribroperidinium edwardsii* (Cookson & Eisenack 1958) Davey 1969 and *Cribroperidinium muderogense* (Cookson & Eisenack 1958) Davey 1969 belong to a morphological complex, identified mainly by the dimensions of the ornament along the parasutural ridges.

Occurrences. This species is sporadic in the Aptian–Albian samples of most of the studied sections.

Cribroperidinium orthoceras was initially described from the Aptian of Germany. It has also been reported in the Albian–Cenomanian of offshore Bahamas (Habib, 1970), Barremian to Aptian of the Northwest Territories, Canada (Brideaux, 1977) and the Albian of Alberta (Singh, 1971), Hauterivian to Cenomanian offshore southeast Canada (Bujak and Williams, 1978), Aptian to Albian of Senegal (Jain and Millepied, 1975), Barremian to Aptian of Libya (Unwins & Batten, 1988), Valanginian to Albian offshore northwest Africa (Williams, 1978) and Albian to Cenomanian of France (Davey and Verdier, 1971; Fauconnier, 1979).

Genus *Florentinia* Davey & Verdier 1973 emend. Duxbury 1980

1973 *Florentinia* Davey & Verdier, p. 185–186.

1976 *Silicisphaera* Davey & Verdier, p. 320, 321.

1980 *Florentinia* Davey & Verdier emend. Duxbury, p. 119–120.

Type Species. *Florentinia laciniata* Davey & Verdier 1973 (p. 186–187; plate 2, figures 1,3). Albian–Cenomanian, France.

Remarks. Duxbury (1980) emended the original description of the genus, considering the genus *Silicisphaera* Davey and Verdier as a junior synonym. Duxbury (1980) proposed

that the presence or absence of a well differentiated antapical process is intrageneric and should not be considered as a distinctive feature for differentiating these two genera.

Florentinia laciniata Davey & Verdier 1973

Plate 12, figure 2

1973 *Florentinia laciniata* Davey and Verdier, p. 186-187. Plate 2, figures 3-4, 6-7 and 9.

Description. See Davey and Verdier (1973).

Dimensions. Autocyst diameter: 43 (47) 53 μm . Processes length: 12 (15) 18 μm . Antapical process length: 18 (20) 23 μm . Breadth: 10 μm (6 specimens).

Note. This species is characterized by a granulate autophragm and distally split processes, ending in short, truncated tubules. Postcingular processes are relatively larger than those in the epicyst. Combination archeopyle (tAaP₃").

Occurrences. This species is observed in low numbers in the Aptian-Albian sediments of the Zea-Panamericana and Catatumbo outcrop sections and in wells CR-5, ALT-19X, ALP-6 and P-201.

This species has been reported from Upper Albian to Cenomanian of Australia (Morgan, 1980), Cenomanian of the Gulf of Mexico (Riley and Fenton, 1984), Aptian to Cenomanian eastern offshore Canada (Bujak and Williams, 1978), Upper Albian to Cenomanian of Libya (Uwins and Batten, 1988) and Aptian to Cenomanian of France (Davey and Verdier, 1971 and 1974; Fauconnier, 1977),

Florentinia sp. cf. *F. verdieri* Singh 1983

Plate 12, figures 3 and 4

[cf.] 1983 *Florentinia verdieri* Singh, p. 149. Plate 53, figures 5-10, Plate 54, figures 1-2.

Description. Cavate, skolochorate dinoflagellate cyst. Spherical to slightly ellipsoidal endocyst. Endophragm, 1.3 μm thick, smooth. Pericyst slightly ellipsoidal after compression. Periphragm, less than 1.3 μm thick, smooth to very finely granulate, tightly

appressed against the endophragm except at the base of the process. Periphragm forming two types of processes; 1) a well differentiated, tubular-cylindrical hollow and relatively wide distally-closed antapical process; and 2) hollow and distally open processes that may or may not branch, perhaps two or more per paraplate. Combination (tAP₃-) and precingular (P₃-) archeopyle.

Dimensions. Autocyst diameter: 47 (55) 70 μm . Processes length: 8 (15) 18 μm . Antapical process length: 15 (16) 18 μm long. Breadth: 18 (21) 25 μm (8 specimens).

Note. These specimens show some resemblance to those of *Florentinia verdieri*, from the Cenomanian of Kansas and Alberta, especially by the occurrence of unbranched and fine processes. However, the distal branching is less differentiated in the specimens observed in this study. They differ from other species of this genus, such as *Florentinia laciniata* by the almost the complete absence of complexes of intratabular processes. The number of processes per paraplate seems to be larger than one. *Florentinia resex* Davey & Verdier 1976 also has more than one process per paraplate, but they are not distally branched.

Occurrences. This species is observed in samples of the Aptian and Albian of wells ALT-19X (quite common in the Albian), CR-5, ALP-6 and P-201, as well as in the Zea-Panamericana and Catatumbo outcrop sections (in low abundance)

This species was described from the Cenomanian of Alberta by Singh (1983).

SUBFAMILY GONYAULACOIDEAE (AUTONYM)

Genus *Achomosphaera* Evitt 1963a

1963a *Achomosphaera* Evitt, p. 163.

Type Species. *Achomosphaera ramulifera* (Deflandre 1937; p. 74; plate 74, figure 5) Evitt 1963a. Late Cretaceous, France.

Remarks. May (1980) and Duxbury (1983) considered *Achomosphaera* a junior synonym of *Spiniferites* Mantell 1850 emend. Sarjeant 1970. May (1980) considered that specimens with *Spiniferites* like processes, but without parasutural ridges, must be

considered *Spiniferites* variants and should be included in the latter genus. Davey and Williams (1966) pointed out that the paratype of *Achomosphaera ramulifera*, the type species of *Achomosphaera*, showed faint indications of perisutural ridges, that might have been obscured in the holotype by the embedding flint. Based on this fact, Duxbury (1983) agreed with synonymizing both genera and retained *Spiniferites*.

It is clear that the morphology of species of these genera is very similar and its separation, based solely on the presence of parasutural ridges, might not be diagnostic at the generic level. However, by considering these two genera as a synonyms, a significant taxonomic problem arises. These two genera contain a large number of species and establishing the proper synonymy between them requires an extensive and detailed taxonomic task that is beyond the scope of this study. Therefore, I prefer to retain *Achomosphaera* and *Spiniferites* as separate genera, pending future studies.

Achomosphaera triangulata (Gerlach 1961) Davey & Williams 1969

Plate 13, figure 1

1961 *Baltisphaeridium triangulatum* Gerlach, p. 194. Plate 29, figure 1.

1969 *Achomosphaera triangulata* (Gerlach) Davey & Williams, p. 4.

Description. Acavate, skolochorate dinoflagellate cyst. Spherical autocyst with circular outline. Thin autophragm, less than 1.3 μm thick, smooth. Two type of processes differentiated; slender solid gonol processes, generally distally branched (at about 2/3 of the length of these processes) and one of the branches is distally branched and bifid. Intergonal processes, solid, slender distally bifurcate and closed. Both types of similar length. Ratio length of the processes to main body diameter, approximately 1:4. Descending cingulum indicated by alignment of processes. Reflected tabulation: 4', 6", 6''' and 1'''. Precingular (P_3) archeopyle.

Dimensions. Main body diameter: 40 (43) 45 μm . Processes length: 10 (11) 12 μm (15 specimens).

Note. This species is characterized by the slender processes and by the distal branching of the gonol processes and their bifid terminations. Below (1982) illustrated the typical pattern of branching of this species in the Lower Cretaceous of Morocco.

Occurrences. This species is observed in relatively low numbers in the Aptian–Albian sections in wells CR-5, ALT-19X, ALP-6, P-201 and the Rosarito and Catatumbo outcrop sections.

Achomosphaera triangulata was described by Gerlach (1961) from the Miocene of Germany. Below (1982) reported this species from the Hauterivian through the Cenomanian of Morocco. Prössl (1990) reported this species from the Lower Albian to the Turonian in Germany.

Achomosphaera sp. A

Plate 12, figure 6

Description. Cavate, skolochorate dinoflagellate cyst. Spherical cyst with circular outline. Endophragm, less than 1.3 μm thick, smooth. Thin periphragm (less than 1.3 μm thick), tightly appressed against the thin endophragm, except at the base of the processes. Two types of processes are differentiated; gonol processes, generally distally trifurcate and closed, and intergonal processes distally bifurcate and closed as well. Both types of processes of similar length. Periphragm is observed to extend up to 1/3 of the length of processes surrounding the cingulum and up to the full length of the apical process. Ratio length of the processes to main body diameter, approximately 1:4. Descending cingulum indicated by alignment of processes. Inferred tabulation: 4', 6", 6''' and 1'''. Precingular (P_3'') archeopyle.

Dimensions. Main body diameter: 40 μm . Processes length: 11–15 μm (1 specimen).

Occurrences. It is observed in this study in the Albian section of well ALT-19X (sample ALT-19X 17461')

Achomosphaera sp. B

Plate 12, figure 7

Description. Acavate, skolochorate dinoflagellate cyst. Spherical autocyst with circular outline after compression. Autophragm about 1.3 μm thick, granulate. Two type of processes are differentiated; solid gonol processes, generally distally trifurcate and closed, and intergonal processes distally bifurcate and closed as well. Both types of processes of

similar length. Ratio length of the processes to cyst diameter, approximately 1:5 to 1:8. Descending cingulum indicated by alignment of processes. No archeopyle is observed.

Dimensions. Autocyst diameter; 40 μm (40 μm average). Processes length; 5 to 8 μm (7 μm average) (5 specimens).

Ocurrences. Rare specimens are observed in samples of the Aptian to Albian in wells CR-5, ALT-19X, ALP-6 and the Catatumbo outcrop section.

Genus *Spiniferites* Mantell 1850 emend. Sarjeant 1970

1850 *Spiniferites* Mantell, p. 191.

1970 *Spiniferites* Mantell emend. Sarjeant, p. 75.

For a more extensive generic synonymy, see Sarjeant (1970).

Type Species. *Spiniferites ramosus* (Ehrenberg 1838; plate 1, figure 5) Mantell 1854. Upper Cretaceous, Germany.

Spiniferites twistringiensis (Maier 1959) Fensome et al. 1990.

Plate 13, figure 2

1959 *Galea twistringiense* Maier, p. 308-309. Plate 30, figures 3-4.

1964 *Baltisphaeridium twistringiense* (Maier) Sarjeant, p. 176.

1966 *Hystriosphera ramosa* var. *multibrevis* Davey & Williams, p. 35-37. Plate 1, figure 4, Plate 4, figure 6. Text-figure 9.

1969 *Aeroligera twistringiensis* (Maier) Davey et al., p. 15.

1970 *Achomosphaera cambra* Sah et al., p. 144. Plate 1, figure 3.

1982 *Spiniferites multibrevis* (Davey & Williams) stat. nov. Below, p. 35

1990 *Spiniferites twistringiensis* (Maier) Fensome et al., p. 639.

For extensive synonymy, see Below (1982) and Sarjeant (1983).

Description. See Davey and Williams (1966).

Dimensions. Main body diameter: 31 (37) 40 μm . Processes length: 3 (6) 10 μm (30 specimens).

Occurrences. This species is observed to occur in low abundances in both Aptian and Albian sections of wells CR-5, ALT-19X, CR-5, ALP-6 and Zea-Panamericana, La Grita and Rosarito outcrop sections.

This species has been reported under its various names from the Valanginian to Barremian of Australia (Burger, 1982), ?Cenomanian of the Gulf of Mexico (Riley and Fenton, 1984), Middle Albian of Oklahoma (Hedlund and Norris, 1986), Cenomanian to Maastrichtian in Texas (Srivastava, 1991), Middle to Upper Albian (Singh, 1971), Aptian to Albian of Senegal (Jain and Millepied, 1975), ?Aptian to basal Cenomanian offshore northwest Africa (Below, 1984), Valanginian to Hauterivian of Morocco (Below, 1982), Lower to Upper Albian of Libya (Unwins and Batten, 1988), Aptian to Albian of the Bay of Biscay (eastern Atlantic Ocean) (Davey, 1979a), Aptian to Campanian of France (Davey and Verdier, 1971 and 1973; Foucher, 1979), Valanginian to Albian of England (Duxbury, 1977; Lister and Batten, 1988).

Spiniferites sp. A

Plate 13, figure 3

Description. Suturocavate, skolochorate dinoflagellate cyst. Spherical cyst with circular outline after compression. Endophragm about 1.3 μm thick, finely reticulate-perforate, tightly appressed against the thin smooth periphragm (less than 1.3 μm thick), except at the parasutural ridges and at the base of some processes. Solid short gonol processes, usually distally trifurcate and closed. Intergonal processes, short, solid and distally bifurcate and closed. Parasutural ridges of low relief, formed by the periphragm, that in the case of the antapical processes, extends their full length. Two antapical process, wider (3.0 to 4.0 μm) than the rest of the process, with rather aculeate? termination. Ratio of process length to main body diameter is 1/5. Reflected tabulation: 4', 6, 6'', 1'''. Descending cingulum evidenced from the alignment of processes. Archeopyle is not observed.

Dimensions. Main body diameter: 35 μm . Processes length: 7 to 8 μm long (1 specimen).

Note. *Pterodinium cingulatus* (Wetzel 1933) Sarjeant 1970 also has very short processes. However, this species is characterized by parasutural ridges with high relief, formed by the periphragm that extends to the full length of all the processes.

Occurrences. It is observed in the Albian section of well ALT-19X (sample ALT-19X 17412').

Spiniferites sp. B

Plate 13, figure 5

Description: Suturocavate, skolochorate dinoflagellate cyst. Spherical cyst, with circular to ellipsoidal outline after compression. Endophragm about 1.3 μm thick, finely granulate, tightly appressed against the thin smooth periphragm (less than 1.3 μm thick), except at the parasutural ridges and at the base of some processes. Fibrous complex processes with multifurcate terminations. Ratio of process length to cyst diameter; 1:3. Archeopyle is not observed.

Dimensions. Main body diameter: 37 μm . Processes length: 12 to 13 μm long (1 specimen)

Note. The only specimen of this species that is observed in this study is partially covered which hinders any further morphological characterization of this species.

Occurrences. It is observed in the Albian section of well ALT-19X (sample ALT-19X 17291').

SUBFAMILY UNCERTAIN (Family Gonyaulacaceae)

Genus *Coronifera* Cookson & Eisenack 1958 emend. Mao and Norris 1988

1958 *Coronifera* Cookson & Eisenack, p. 45.

1974 *Coronifera* Cookson & Eisenack emend. Davey, p. 47.

1980 *Coronifera* Cookson & Eisenack emend. May, p. 48.

1988 *Coronifera* Cookson & Eisenack emend. Mao Shaozhi and Norris, p. 36-36.

Type Species. *Coronifera oceanica* Cookson & Eisenack 1958 (p. 45, plate 12, figure 6) emend. May 1980. Albian, Australia.

Remarks. Davey (1969) emended the original description of the genus by stating that the archeopyle type is apical, describing also the characteristics of the apical and antapical processes. Davey (1974) pointed out that the processes of species of this genus were distally closed and that the archeopyle is precingular. May (1980) pointed out that this genus was characterized by combination archeopyle, involving the apical and precingular series (3").

Mao Shaozhi and Norris (1988) finally described the full variations of archeopyle of the genus by stating that it can be; (1) precingular (P_3''), (2) combination of all four apical plates and the third precingular forming a polyplacoid operculum either compound; $tA + P_3''a$ or $(tA)a + P_3''$ or simple $(tA + P_3'')$. I follow this emendation.

Coronifera oceanica Cookson & Eisenack 1958 emend. May 1980

Plate 13, figure 4

1958 *Coronifera oceanica* Cookson & Eisenack, p. 45. Plate 12, figures 5-6.

1978 *Coronifera monstrosa* (Tasch in Tasch et al. 1964) Stover & Evitt, p. 148.

1980 *Coronifera oceanica* Cookson & Eisenack emend. May, p. 48-49.

For a more extensive synonymy, see Harker and Sarjeant (in Harker et al., 1990).

Description. See May (1980).

Dimensions. Main body diameter: 35 (43) 65 μm . Processes length: 12 (14) 15 μm . Antapical processes length: 12 (13) 15 μm long. Breadth: 12 (13) 15 μm width (25 specimens)

Occurrences. This species is observed to be rather common in Aptian-Albian sections in well ALT-19X and occurred in less abundances in samples of well, CR-5, P-201 and in the Zea-Panamericana and Catatumbo outcrop sections.

This species have been commonly reported in sediments of the Lower Cretaceous worldwide; Albian-Cenomanian of Australia (Morgan, 1980), Albian of Brazil (Azevedo

et al., 1987 and Arai, 1992), Albian of Kansas (Tasch et al. 1964), Cenomanian to Campanian of the USA (Harker et al., 1990; Srivastava, 1991), Hauterivian–Barremian of the Northwest Territories, Canada (Brideaux, 1977) and Lower Cenomanian of Alberta (Singh, 1983), Berriasian to Coniacian of offshore southeast Canada (Bujak and Williams, 1978), Aptian in the offshore southwest Africa (Davey, 1978), Hauterivian to Cenomanian of Morocco (Below, 1982), Hauterivian to Cenomanian of Libya (Thusu and van der Eem, 1985; Thusu et al., 1988; Uwins and Batten, 1988), Aptian to Albian in the Bay of Biscay (eastern Atlantic Ocean; Davey, 1979a), Aptian to Campanian of France (Davey and Verdier, 1971, 1973 and 1974; Foucher, 1979), Barremian to Turonian of Germany (Prössl, 1990), Hauterivian to Cenomanian of England (Clarke and Verdier, 1967; Davey 1969 and 1974; Duxbury, 1977 and 1980).

Genus *Hystrichodinium* Deflandre 1935 emend. Clarke & Verdier 1967

1935 *Hystrichodinium* Deflandre, p. 229-230.

1961 *Heliodinium* Alberti, p. 33.

1966a *Hystrichodinium* Deflandre emend. Sarjeant, p. 140.

1967 *Hystrichodinium* Deflandre emend. Clarke & Verdier, p. 37-38.

Type species. *Hystrichodinium pulchrum* Deflandre 1935 (p. 229-230; plate 5, figure 1, text-figures 9-11). Upper Cretaceous (Senonian), France.

Remarks. The emendation proposed by Clarke and Verdier (1967) stated that the genus must include all the species with signs of tabulation (formerly included in the genus *Heliodinium* Alberti 1961) or lacking them (as defined by Deflandre, 1935 and Sarjeant, 1966a). The emendation of Clarke and Verdier (1967) is accepted in this study.

Hystrichodinium pulchrum Deflandre 1935

Plate 13, figure 9

1935 *Hystrichodinium pulchrum* Deflandre, p. 229-230. Plate 5, figure 1. Text-figures 9-11.

For a more extensive synonymy, see Harker and Sarjeant (in Harker et al., 1990).

Description. See Sarjeant (1966a) and Clarke and Verdier (1967).

Dimensions. Main body diameter: 45-46 μm . Processes length: 10-12.5 μm (1 specimen).

Note. This species is characterized by the numerous hollow distally acuminate processes, formed by the periphragm.

Occurrences. This species is observed only in one sample of the Albian section in well ALT-19X (sample ALT-19X 17291').

Williams and Bujak (1985) proposed that the stratigraphic range of this species extends from the Berriasian to the Maastrichtian. This species have been commonly reported in sediments of the Lower Cretaceous; Barremian to Cenomanian of Australia (Morgan, 1980; Stover & Helby, 1987b), Albian of Brazil (Arai, 1992), Berriasian to Cenomanian-Turonian in the western Atlantic (Habib and Drugg, 1987), ?Portlandian to Lower Maastrichtian of offshore southeast Canada (Bujak and Williams, 1978), Aptian to Senonian of offshore southwest of Africa (Davey, 1978), Valanginian to Lower Cenomanian offshore northwestern Africa (Williams, 1978), Valanginian to Lower Hauterivian of Morocco (Below, 1982), Hauterivian to Upper Albian of Libya (Unwins and Batten, 1988), Aptian to Albian of the Bay of Biscay (eastern Atlantic Ocean) (Davey, 1979a), Aptian to Campanian of France (Davey and Verdier, 1973 and 1974; Foucher, 1979), Hauterivian to Turonian of Germany (Prössl, 1990) and Barremian to Senonian of England (Davey, 1974, Duxbury, 1977 and 1983; Lister and Batten, 1988).

Genus *Kiokansium* Stover & Evitt 1978 emend. Duxbury 1983

1978 *Kiokansium* Stover & Evitt, p. 167.

1979a *Bacchidinium* Davey, p. 555.

1983 *Kiokansium* Stover & Evitt emend. Duxbury, p. 48-49.

Type Species. *Kiokansium unituberculatum* (Tasch in Tasch et al. 1964; p. 194; plate 3, figure 8) Stover & Evitt 1978. Albian, Kansas.

Kiokansium unituberculatum (Tasch in Tasch et al. 1964) Stover & Evitt 1978
Plate 13, figure 8

1964 *Hystriosphærdium unituberculatum* Tasch in Tasch et al., p. 194. Plate 3, figure 8.

1978 *Kiokansium unituberculatum* (Tasch in Tasch et al.) Stover & Evitt, p. 267.

For a complete synonymy, see Stover and Evitt (1978).

Description. See Stover and Evitt (1978).

Dimensions. Main body diameter: 37 (43) 47 μm . Processes length: 6 (8) 11 μm (100 specimens).

Note. This species is characterized by the numerous non-tabular slender solid process with trifurcate or multifurcate endings and 2P archeopyle.

Occurrences. This species is observed to be present in most of the studied sections, in low numbers in the sections located to the south (Zea-Panamericana and La Grita) and in higher numbers in wells CR-5, ALT-19X, ALP-6 and the Catatumbo outcrop section. The species is found to be more common in Albian sediments in these subsurface and outcrop sections located to the north and central areas of the Maracaibo Basin.

Kiokansium unituberculatum was initially described under its synonyms from the Albian of Kansas (Tasch et al., 1964). The species has also been reported in the Neocomian–Cenomanian of Australia (Morgan, 1980), Middle Albian of Colombia (Prössl, 1992), Middle Albian of Oklahoma (Hedlund and Norris, 1986), Valanginian to Albian offshore Bahamas (Habib & Drugg, 1983), Barremian to Albian of the Northwest Territories and Alberta, Canada (Singh, 1971; Brideaux and McIntyre, 1975; Brideaux, 1977), Barremian to Cenomanian of southeast offshore Canada (Bujak and Williams, 1978), Turonian of offshore southwest Africa (Davey, 1978), Aptian of Morocco (Below, 1982), Aptian to Turonian of France (Foucher, 1979), Hauterivian to Albian of Germany (Prössl, 1990), Hauterivian to Albian of England (Duxbury, 1977 and 1983).

Kiokansium? sp. A

Plate 13, figure 7

Description. Acavate, proximochorate dinoflagellate cysts. Ovoidal autocyst with ellipsoidal outline. Autophragm, light brownish color; thin (less than 1.3 μm thick), finely perforate-reticulate. Numerous short, non-tabular, solid-hollow processes, generally distally closed and capitate. No evidence of paratabulation. Archeopyle is not observed.

Dimensions. Main body diameter: 45 (54) 65 μm . Processes length: 6 (9) 12 μm (50 specimens).

Note. This species is included within the genus *Kiokansium* because of the nature and characteristics of the processes. Since it is impossible to characterize the archeopyle, further studies will be needed to establish a definite generic assignment for this species. It differs from *Kiokansium unituberculatum* by the larger diameter of the main body, its fine reticulation-perforation and the shorter capitate processes, that are not clearly trifurcate or multifurcate as those of *Kiokansium unituberculatum*.

Occurrences. This species is observed in the Upper Aptian and Albian sections of wells CR-5, ALT-19X, ALP-6 and P-201, and in larger numbers in samples of the Catatumbo outcrop section.

Kiokansium? sp. B

Plate 13, figure 6

Description. Acavate, skolochorate dinoflagellate cysts. Spherical autocyst with circular to slightly circular outline. Autophragm thin (less than 1.3 μm thick), smooth to finely granulate. Numerous non-tabular, hair-like hollow processes; distally multifurcate. No evidence of paratabulation except for a precingular archeopyle (P_3 ?) is observed.

Dimensions. Main body diameter: 37 (39) 43 μm (39 μm average). Processes length: 10 (11) 12 μm (4 specimens).

Note. This species is included within the genus *Kiokansium* because of the nature and characteristics of the processes. However further characterization is needed to establish a definite generic assignment. It differs from other species of *Kiokansium* observed in this

study by the almost smooth autophragm and hair-like processes (longer than those observed for *Kiokansium unituberculatum*).

Occurrences. This species is observed in samples of the Albian section in wells CR-5 and ALT-19X and Catatumbo outcrop section.

Genus *Protoellipsodinium* Davey & Verdier 1971

1971 *Protoellipsodinium* Davey & Verdier, p. 28.

Type Species. *Protoellipsodinium spinocristatum* Davey & Verdier 1971 (p. 28-29; plate 5, figure 2). Albian, France.

Protoellipsodinium sp. A

Plate 12, figure 5

Description. Acavate, skolochorate-proximochorate dinoflagellate cysts. Spherical autocyst with circular outline. Autophragm, thin (less than 1.3 μm thick), finely granulate. Numerous short, non-tabular hollow processes; distally capitate or acuminate. No evidence of paratabulation. ?Precingular archeopyle.

Dimensions. Main body diameter: 36 (37) 43 μm . Processes length: 6 (8) 10 μm (10 specimens).

Note. This species has been attributed to the genus *Protoellipsodinium* because of the overall outline and the numerous distally closed processes. Further characterization of the archeopyle will allow definite generic assignment of this species. The specimens observed in this study resemble *Protoellipsodinium* sp. of Harding (1990), but the latter has larger processes, showing some alignment. *Protoellipsodinium spinocristatum* Davey & Verdier 1971 has low longitudinally aligned ridges joining the base of adjacent processes. *Protollipsodinium spinosum* Davey & Verdier 1971 has similar longitudinal alignment of the processes, but without the low ridges of *Protoellipsodinium spinocristatum*. "*Protoellipsodinium rarispinum*" Prössl 1990 has shorter processes. *Protoellipsodinium densispinum* Morgan 1980 has numerous processes, that are shorter than those of the species observed in this study. *Protoeellipsodinium seghiris* Below 1981

has very short processes whereas *Protoellipsodinium touilis* Below 1981 has larger processes.

Occurrences. This species is observed in low numbers in samples of the Upper Aptian and Albian of the La Grita outcrop section, as well as in samples of well ALT-19X.

FAMILY AREOLIGERACEAE EVITT 1963

Genus *Circulodinium* Alberti 1961

1961 *Circulodinium* Alberti, p. 28.

Type Species. *Circulodinium hirtellum* Alberti 1961 (p. 28; plate 4, figure 20). Lower Cretaceous (Valanginian to Hauterivian), Germany.

Circulodinium colliveri (Cookson & Eisenack 1960a) Helby 1987

Plate 13, figure 10

1960a *Canningia colliveri* Cookson & Eisenack, p. 251. Plate 38, figures 3-4.

1987 *Circulodinium colliveri* (Cookson & Eisenack) Helby, p. 324-325.

1988 *Canninginiopsis colliveri* (Cookson & Eisenack) Backhouse, p. 77.

Description. See Cookson and Eisenack (1960a).

Dimensions. Autocyst diameter: 37 (41) 47 μm . Processes length: less than 1.3 μm (6 specimens).

Note. This species was included in the genus *Circulodinium* Alberti by Helby (1987), based on the lack of indications of parasutural arrangement of the ornamentation. Cookson & Eisenack (1960a), in their original description of the species, did not make any reference to indication of paratabulation given by the ornamentation, except for a faint indication of the girdle (paracingulum). Backhouse (1988) included this species in the genus *Canninginiopsis* Cookson & Eisenack 1962 emend. Marshall 1990. However, this assignment is not followed in this study since the description of the genus *Canninginiopsis* clearly indicates the parasutural arrangement of the ornamentation. The specimens observed in this study have two antapical bulges of more or less equal size.

The ornamentation consists of fine spines or short acuminate processes. Apical archeopyle with zig-zag margins.

Occurrences. This species is observed in Aptian and Albian samples of wells CR-5 and ALP-6.

This species have been reported in the Hauterivian to Cenomanian of Australia (Cookson & Eisenack, 1960a; Burger, 1980 and 1982; Morgan 1980; Helby et al., 1987), Albian of Oklahoma (Hedlund and Norris, 1986) and Alberta, Canada (Singh, 1964 and 1971; Brideaux, 1971), Berriasian to Valanginian of offshore southeast Canada (Williams, 1975), Aptian offshore southwest Africa (Davey, 1978), Upper Aptian of the Bay of Biscay (Davey, 1979a), Aptian to Santonian of France (Davey and Verdier, 1971, 1973 and 1974; Foucher, 1979) and Cenomanian to Santonian of England (Clarke and Verdier, 1967).

Circulodinium distinctum (Deflandre & Cookson 1955) Jansonius 1986

1955 *Cyclonephelium distinctum* Deflandre & Cookson, p. 285-286. Plate 2, figure 14.
Text-figures 47-48.

1986 *Circulodinium distinctum* (Deflandre & Cookson) Jansonius, p. 204.

For more extensive synonymy, see Harker and Sarjeant (in Harker et al., 1990; p. 80-82, as *Cyclonephelium distinctum*).

Circulodinium distinctum subsp. *distinctum* Autonym

Plate 14, figure 1

Description. This species is characterized by numerous short, bifid hollow processes, evenly distributed on the surface of the autophragm. No evidence of reflected tabulation is observed, except for the apical archeopyle margin with low angle zig-zag margins.

Dimensions. Autocyst diameter: 43 (47) 55 μm . Processes length: 1-2 μm (45 specimens).

Occurrences. This subspecies is observed in samples of the Aptian and Albian of the La Grita, Zea-Panamericana, CR-5, ALT-19X, ALP-6, P-201 and Catatumbo Quarry outcrop section, in some cases being very abundant.

This species has been commonly reported in the Lower Cretaceous; Neocomian to Cenomanian of Australia (Cookson and Eisenack, 1962 and 1971; Morgan, 1980), Albian of Brazil (Arai, 1992), Berriasian to Valanginian in the western north Atlantic Ocean (Habib and Warren, 1973; Habib, 1975), Middle to Upper Albian of Alberta, Canada (Singh, 1971), Hauterivian to Albian of the Northwest Territories, Canada (Brideaux and McIntyre, 1975; Brideaux, 1977), Berriasian to Maastrichtian of offshore southeast Canada (Bujak and Williams, 1978), Valanginian to Cenomanian offshore northwest Africa (Williams, 1978), Hauterivian to Cenomanian of Morocco (Below, 1981), Kimmeridgian to Barremian of Libya (Thusu et al., 1988), Aptian to Cenomanian of France (Davey, 1969; Davey and Verdier, 1971, 1973 and 1974), Hauterivian to Turonian of Germany (Prössl, 1990) and Barremian to Campanian of England (Clarke & Verdier, 1967; Davey, 1969, 1974; Duxbury, 1977 and 1980).

Circulodinium distinctum subsp. *longispinatum* (Davey 1978) Lentin & Williams 1989

Plate 14, figure 4

1978 *Cyclonephelium distinctum* subsp. *longispinatum* Davey, p. 894. Plate 3, figures 4, 7, 8.

1989 *Circulodinium distinctum* subsp. *longispinatum* (Davey) Lentin & Williams, p. 63.

Description. See Davey (1978).

Dimensions. Autocyst diameter; 43-62 μm (average 54 μm). Processes length; 5 to 6 μm (6 specimens).

Occurrences. This subspecies is observed in Aptian-Albian samples of the Zea-Panamericana outcrop section and in wells CR-5, ALT-19X, ALP-6 and P-201.

Davey (1978) reported this subspecies in Turonian sediments of Site 361 of the D.S.D.P. Leg 40, offshore southwest Africa. Arai (1992) reported this species from the Albian of Brazil.

Circulodinium sp. A

Plate 14, figure 2

Description. Large acavate, proximochorate dinoflagellate cyst. Lenticular autocyst after dorso-ventral compression. Autophragm 1.3 μm thick, finely reticulate. Two assymetrical antapical bulges, one being incipient and barely discernible whereas the one located to the left side of the cyst is more prominent and rounded. Numerous short, solid and acuminate nontabular processes, evenly distributed over the surface of the cyst. No evidence of the paratabulation, except for the apical archeopyle with relatively small offset sulcal notch.

Dimensions. Autocyst length: 52 μm . Breadth: 70 μm . Processes length: less than 2.5 μm (1 specimen).

Note. This species differs from *Circulodinium colliveri* by its large size.

Occurrences. It is observed in the Aptian of the Zea-Panamericana (sample 13-04-18).

Circulodinium sp. B

Plate 14, figure 3

Description. Acavate, proximochorate dinoflagellate cyst. Spherical autocyst with lenticular outline after dorso-ventral compression. Autophragm 1.3 μm thick, finely reticulate-perforate without antapical knobs. Numerous short, solid and blunt nontabular echinae, evenly distributed over the surface of the cyst. No evidence of the paratabulation, except for the apical archeopyle with zig-zag margins and offset sulcal notch.

Dimensions. Autocyst; length 49 μm , width 56 μm . Echinae length less than 2.5 μm (1 specimen).

Note. This species differs from *Circulodinium colliveri* in the larger size of the cyst and from *Circulodinium* sp. A in having echinae rather than processes. *Canningia minor* Cookson & Hughes 1960 has granulate to scabrate ornamentation rather than blunt echinae, as the specimen observed in this study.

Occurrences. A single specimen is observed in the Aptian of the Zea-Panamericana outcrop section (sample 13-04-27).

Genus *Cyclonephelium* Deflandre & Cookson 1955 emend. Dörhöfer and Davies 1980

1955 *Cyclonephelium* Deflandre & Cookson, p. 285.

1962 *Cyclonephelium* Deflandre & Cookson emend. Cookson & Eisenack, p. 493.

1966 *Cyclonephelium* Deflandre & Cookson emend. Williams & Downie, p. 223.

1976 *Cyclonephelium* Deflandre & Cookson emend. Ioannides et al., p. 450.

1978 *Cyclonephelium* Deflandre & Cookson emend. Sarjeant & Stover, p. 51.

1978 *Cyclonephelium* Deflandre & Cookson emend. Stover & Evitt, p. 35.

1980 *Cyclonephelium* Deflandre & Cookson emend. Dörhöfer and Davies, p. 41.

Type Species. *Cyclonephelium compactum* Deflandre & Cookson 1955 (p. 285; plate 2, figure 12). Lower to Upper Cretaceous, Australia,

Remarks. Williams and Downie (1966) and Ioannides et al. (1976) made specific reference to the apical archeopyle and to the restricted distribution of the ornamentation to the peripheral area, ornamentation made up by processes of variable length, distally joined in some cases. Sarjeant and Stover (1978) and Stover and Evitt (1978) largely followed the previously noting emendations, mentioning the acavate nature of the cysts and the lenticular shape of the autophragm. Dörhöfer and Davies (1980) drew the attention to the "apteate" nature of the ornamentation; capitate spines or baculae that might or might not be fused distally and restricted to the circumferential area. These authors also proposed the following inferred tabulation formula: 4', 6", 5-6c, 6", 1p and 1"". Since most of these emendations are similar, the one proposed by Dörhöfer and Davies (1980) is accepted since it incorporates the inferred tabulation of the genus.

Cyclonephelium vannophorum Davey 1969

Plate 14, figures 6 and 7

1969 *Cyclonephelium vannophorum* Davey, p. 168-170. Plate 9, figure 3, Plate 11, figures 11-12. Text-figure 16E)

Description. See Davey (1969).

Dimensions. Autocyst length: 60 (63) 70 μm . Breadth: 70 (72) 75 μm . Processes length: 3 to 5 μm (7 specimens).

Note. This species is characterized by lenticular autocysts after dorso-ventral compression. Relatively thin autophragm (about 1.3 μm thick), finely reticulate-perforate, with one antapical bulge. Numerous hollow and bifid non-tabular processes, showing in cases preferred alignment (see Plate 14, figure 6), distally joined.

Occurrences. This species is rarely observed only in samples of the Upper Aptian-Albian of wells CR-5, ALT-19X and ALP-6.

Cyclonephelium vannophorum has been observed in the Cenomanian to Turonian of Alberta, Canada (Singh, 1983; Sweet and McIntyre, 1988), Hauterivian to Coniacian of offshore southeast Canada (Bujak and Williams, 1978), Aptian to Lower Cenomanian of Morocco (Below, 1981), Albian to Cenomanian of France (Davey and Verdier, 1973; Fauconnier, 1979) and Cenomanian of England (Davey, 1969).

SUBORDER CERATIINEAE FENSOME ET AL. 1993

FAMILY CERATIACEAE WILLEY & HICKSON 1909

Genus *Odontochitina* Deflandre 1935 emend. Bint 1986

1935 *Odontochitina* Deflandre, p. 234.

1970 *Odontochitina* Deflandre emend. Davey, p. 354.

1986 *Odontochitina* Deflandre emend. Bint, p. 138.

Type Species. *Odontochitina operculata* (Wetzel 1933; p. 170; plate 2, figures 21-22, text-figure 3) Deflandre & Cookson 1955. Upper Cretaceous (Senonian), Baltic Flint Boulders.

Remarks. Davey (1970) emended the description of the genus by stating that its species were cavate and with one apical horn and two shorter antapical horns. Bint (1986) made a more detailed description of the genus and concluded that the species are cornucavate (rather than cavate) and that horns are apical, antapical and right lateral postcingular, with

variable shape. This latter emendation seems to illustrate well the variability of species of this genus and it is accepted in this study.

Odontochitina operculata (Wetzel 1933) Deflandre & Cookson 1955

Plate 14, figure 8

1933 *Ceratium* (*Euceratium*) *operculata* Wetzel, p. 170. Plate 2, figures 21-22.

1935 *Odontochitina silicorum* Deflandre, p. 234. Plate 9, figures 8-10.

1955 *Odontochitina operculata* Deflandre & Cookson, p.291. Plate 3, figures 5-6.

For more extensive synonymy, see Harker and Sarjeant (in Harker et al., 1990)

Description. See Bint (1986).

Dimensions. Pericyst length: 90 (108) 126 μm . Breadth: 30 (37) 43 μm . Apical horn length: 30 (33) 37 μm (only 2 opercula observed). Antapical horn length: 40 (43) 45 μm . Postcingular horn length: 18 (19) 23 μm . Endocyst diameter: 37 (41) to 43 μm (35 specimens).

Note. In general the observed specimens are large cornucavate proximate cysts, always incomplete, the operculum being detached from the main body. The periphragm is finely granulate to smooth.

Occurrences. This species is observed in the Aptian-Albian section of wells CR-5, ALT-19X, ALP-6, P-201, and the Rosarito and the Catatumbo outcrop sections in low to moderate numbers.

Williams and Bujak (1985) suggested a Middle Barremian to Lower Maastrichtian stratigraphic range for this species. It has been widely reported in the Lower Cretaceous worldwide; Barremian to Cenomanian of Australia (Burger, 1980; Morgan, 1980; Stover & Helby, 1987b), Albian of Brazil (Arai, 1992), Middle Albian of Colombia (Prössl, 1992) and México (Helenes, 1984b), Hauterivian to Cenomanian-Turonian in the northwest Atlantic Ocean (Habib, 1972; Habib and Drugg, 1983 and 1987), Middle Albian of Oklahoma (Hedlund and Noris, 1986), Albian of Kansas (Bint, 1986), Albian to Cenomanian of Alberta, Canada (Singh, 1964 and 1971; Brideaux, 1971), Hauterivian to Middle Albian of the Northwest Territories, Canada (Brideaux, 1977), Upper Albian to

Cenomanian of Ontario, Canada (Zippi and Bajc, 1990), Barremian to Campanian of offshore southeast Canada (Bujak and Williams, 1978), Aptian to Turonian of the offshore southwest Africa (Davey, 1978), Hauterivian to Cenomanian offshore northwest Africa (Williams, 1978; Below, 1984), Aptian to Albian of Senegal (Jain and Millepied, 1975), Barremian to Cenomanian of Libya (Thusu et al., 1988; Unwins and Batten, 1988), Aptian to Albian of the Bay of Biscay (Davey, 1979a), Barremian to Campanian of France (Davey, 1970; Davey and Verdier, 1971, 1973 and 1974; Foucher, 1979), Hauterivian to Barremian of Germany (Prössl, 1990) and Barremian to Cenomanian of England (Clarke and Verdier, 1967; Davey, 1970 and 1974; Duxbury, 1980 and 1983; Lister and Batten, 1988).

Genus *Pseudoceratium* Gocht 1957 emend Helby 1987

1957 *Pseudoceratium* Gocht, p. 166.

1966b *Doidyx* Sarjeant 1966, p. 205.

1980 *Pseudoceratium* Gocht emend. Dörhöfer & Davies, p. 39.

1986 *Pseudoceratium* Gocht emend. Bint, p. 144.

1987 *Pseudoceratium* Gocht emend. Helby, p. 313-315.

Type Species. *Pseudoceratium pelliferum* Gocht 1957 (p. 166-168; plate 18, figure 18, text-figures 1-3) emend. Dörhöfer & Davies 1980. Valanginian, Germany.

Remarks. Dörhöfer and Davies (1980) emended this genus pointing out the "apteate" ornamentation of the species, as well as the three long horns; apical, antapical and postcingular and the presence of anterior intercalary plates. Bint (1986) did not accept the emendation proposed by Dörhöfer and Davies (1980), in regard to the occurrence of intercalary anterior plates, and included in the genus *Pseudoceratium* species with shorter horns and well developed ectophragm, formerly included in the genus *Aptea* Eisenack 1958 emend. Davey & Verdier 1974 Helby (1987) took a similar approach to that of Bint (1986). However, he retained the species with shorter horns in the genus *Aptea*, limiting the genus *Pseudoceratium* to species with relatively long horns. Even though Monteil (1991) mentioned that paleoenvironmental controls might affect the development of horns and ornamentation in ceratioid cysts, it is not clear if species of these two genera can be merged into only one. Therefore, the emendation proposed by Helby is accepted in this study, pending further studies on the distribution and paleoecology of these two genera.

Pseudoceratium sp. A

Plate 14, figure 5

Description. Acavate, proximochorate dinoflagellate cyst. Autocyst, ellipsoidal after compression with elongated and sharp antapical horn and at least one short postcingular-cingular horn. Autophragm, 1.3 μm thick, smooth bearing numerous slender, short, acuminate-capitate, nontabular solid processes, evenly distributed over the surface, including the horns. No evidence of paratabulation except for the apical archeopyle with offset sulcal notch.

Dimensions. Autocyst length: 44 μm . Antapical horn length: 20 μm . Postcingular horn length: 15 μm . Processes length: 2.5 μm (1 specimen).

Note. This species differs from *Pseudoceratium interiorensense* Bint 1986 by the lack of an ectophragm and by the dense arrangement of simpler processes on the autophragm surface. *Pseudoceratium gochtii* Neale & Sarjeant 1962 has larger processes, whose arrangement reflects the tabulation. *Pseudoceratium iehiense* Helby & May in Helby 1987 has a well developed ectophragm and *Pseudoceratium aulaeum* Harding 1990 has intratabular processes. *Pseudoceratium expolitum* Brideaux 1971 has finely granulate ornamentation with faint narrow low muri.

Occurrences. It is observed in the Albian section of well ALT-19X (sample ALT-19X 17439').

Genus *Xenascus* Cookson & Eisenack 1969 emend. Stover & Helby 1987a

1969 *Xenascus* Cookson & Eisenack, p. 7.

1981 *Xenascus* Cookson & Eisenack emend. Yun, p. 60

1987a *Xenascus* Cookson & Eisenack emend. Stover & Helby, p. 127-128.

Type Species. *Xenascus australiensis* Cookson & Eisenack 1969 (p. 7; figures 1 I-J). Albian-Cenomanian, Australia.

Remarks. Yun (1981) made reference to the occurrence of one lateral horn and the distribution of processes in five longitudinal series in the central body. Stover and Helby

(1987a) emended the description of the genus, indicating that processes on the central body surface occupy broad penitabular and /or parasutural positions. Since this latter emendation seems to represent better the variability of the genus, it is accepted in this study.

Xenascus plotei Below 1981

Plate 14, figure 9

1981 *Xenascus plotei* Below, p. 21-22. Plate 2, figures 8-9, Plate 8, figures 20-21, Plate 14, figure 15. Text-figure 10.

Description. See Below (1981).

Dimensions. Pericyst length (including the apical and antapical horns): 90 (105) 120 μm . Apical and antapical horns length: 23 μm . Endocyst diameter: 43 (45) 50 μm (45 specimens).

Note. The processes or spines are solid, acuminate at the bases of the apical and antapical horns. The processes located in the equatorial part of the cyst, on the other hand, are hollow and complex, distally branched. The cysts are large, cornucavate and proximochorate with a spherical, smooth thin-walled endocyst, longer than the apical and antapical horns. Smooth and thin periphragm forming a pericyst with elongated and sharp apical and shorter antapical horns and one short postcingular-cingular horn. Apical horn wider at the base than the antapical horn. Apical archeopyle with offset sulcal notch, usually attached.

Occurrences. This species is found to be abundant in the Albian section of wells CR-5 and ALT-19X and in lesser numbers in wells ALP-6 and P-201 and in the Catatumbo outcrop section.

Below (1981) described this species in the Upper-Aptian-Albian to Cenomanian of Morocco. It has also been reported in the Albian of Kansas (Bint, 1986), Middle Albian of Oklahoma (Hedlund and Norris, 1986), Upper Albian to Cenomanian of the Bahamas (Herbin et al., 1987) and Albian to Cenomanian of Libya (Uwins and Batten, 1988).

SUBORDER UNCERTAIN (Order Gonyaulacales)

FAMILY UNCERTAIN (Order Gonyaulacales, Suborder Uncertain)

Genus *Chlamydothorella* Cookson & Eisenack 1958 emend. Duxbury 1983

1958 *Chlamydothorella* Cookson & Eisenack, p. 56.

1983 *Chlamydothorella* Cookson & Eisenack emend. Duxbury, p. 41.

Type Species. *Chlamydothorella nyei* Cookson & Eisenack 1958 (p. 56; plate 11, figure 1). Aptian to Lower Turonian, Australia.

Chlamydothorella nyei Cookson & Eisenack 1958

Plate 15, figure 7

1958 *Chlamydothorella nyei* Cookson & Eisenack, p. 56. Plate 11, figures 1-3.

Description. See Cookson and Eisenack (1958) and Singh (1971).

Dimensions. Autocyst length (including apical horn): 43 μm . Breadth: 35 μm . Apical horn length: 15-16 μm . Process length: 5 to 7 μm (1 specimen).

Note. This species is characterized by a reticulate-perforate thin autophragm, with short solid processes that terminate in a thin finely perforate ectophragm, which is more visible in the epicyst, near the apical horn.

Occurrences. Only one specimen is observed in the Albian section of well ALT-19X (sample ALT-19X 17461').

Chlamydothorella nyei has been reported from Albian to Cenomanian of Australia (Cookson and Eisenack, 1970), Hauterivian to Albian of Alberta, western Canada (Davey, 1969; Brideaux, 1971 and 1977; Singh, 1971), Aptian to Cenomanian? offshore South Africa (McLachlan and Pieterse, 1978), Aptian of France (Davey and Verdier, 1974) and Hauterivian to Turonian (Prössl, 1990).

Genus *Dapsilidinium* Bujak et al. 1980

1980 *Dapsilidinium* Bujak et al., p. 27.

Type Species. *Dapsilidinium pastielsii* (Davey & Williams 1966, p. 92-93; plate 11, figure 10) Bujak et al. 1980. Lower Eocene, England.

Dapsilidinium sp. A

Plate 15, figure 1

Description. Acavate, skolochorate dinoflagellate cysts. Spherical autocyst with circular outline after compression. Autophragm, thin (less than 1.3 μm thick), densely granulate or with tubercles about 0.5 μm diameter that are uniformly distributed on the surface. Numerous non-tabular hollow processes; distally digitate and open. Ratio of process length to main body diameter is 1:2 to 1:3. No evidence of paratabulation except for the apical archeopyle.

Dimension. Main body diameter: 31 (33) 37 μm . Processes length: 12 (13) 15 μm (5 specimens).

Occurrences. This species is found in very low abundances in samples of La Grita outcrop section and wells CR-5 and ALT-19X.

Dapsilidinium sp. B

Plate 15, figure 2

Description. Acavate, skolochorate dinoflagellate cyst. Spherical autocyst with circular to ellipsoidal outline. Autophragm, thin (less than 1.3 μm thick), finely granulate. Numerous non-tabular tubular solid processes; distally buccinate? and opened. Ratio of process length to main body diameter is 1:4. No evidence of paratabulation except for the apical archeopyle with zig-zag margins.

Dimensions. Main body diameter: 38.8 μm . Processes length: up to 10 μm (1 specimen).

Note. This species differs from *Dapsilidinium granulosum* (Jain & Millepied 1975) Lentin & Williams 1990 by the over all cyst diameter and the longer processes.

Occurrences. It is observed in the Albian section of well CR-5 (sample CR-5 14196').

Dapsilidinium sp. C

Plate 15, figure 3

Description. Acavate, skolochorate dinoflagellate cysts. Spherical autocyst with circular outline. Autophragm, thin (less than 1.3 μm thick), finely granulate. Numerous non-tabular, tubiform, hollow processes and distally opened. Ratio process length to main body diameter is about 1:3 to 1:4. No evidence of paratabulation except for the apical archeopyle.

Dimensions. Main body diameter: 37 (48) 56 μm . Processes length: 12 (15) 18 μm (3 specimens).

Note. This species differed from *Dapsilidinium granulosum* by lacking the double-layered wall.

Occurrences. This species is observed only in samples of the Albian section in well ALT-19X.

Genus *Exochosphaeridium* Davey et al. 1966

1966 *Exochosphaeridium* Davey et al., p. 165.

Type Species. *Exochosphaeridium phragmites* Davey et al. 1966 (p. 165; plate 2, figures 9-10). Cenomanian, England.

Exochosphaeridium phragmites Davey et al. 1966

Plate 15, figure 8

1966 *Exochosphaeridium phragmites* Davey et al., p. 165. Plate 2, figures 8-10.

Description. See Davey et al. (1966).

Dimensions. Main body diameter: 43 x 37 μm . Processes length: 11-12 μm (1 specimen).

Note. This species is characterized by the fibrous hollow and capitate processes with a complex (branched) process in the apical region and the 2P archeopyle.

Occurrences. It is observed in the Albian section of well ALT-19X (sample ALT-19X 17421').

Exochosphaeridium phragmites has been reported from the Aptian to Cenomanian of Australia (Burger, 1980), Middle Albian (?) of Colombia (Prössl, 1992), Aptian to Cenomanian offshore northwest Africa (Below, 1984), Hauterivian to Albian of Morocco (Below, 1982), Barremian to Cenomanian of France (Davey, 1969; Davey and Verdier, 1971, 1973 and 1974; de Renéville and Raynaud, 1981), Hauterivian to Turonian of Germany (Prössl, 1990) and Barremian to Cenomanian of England (Davey, 1969 and 1974; Lister and Batten, 1988).

Genus *Xiphophoridium* Sarjeant 1966a

1966a *Xiphophoridium* Sarjeant, p. 146-147.

Type Species. *Xiphophoridium alatum* (Cookson & Eisenack 1962; p. 487-488; plate 2, figures 1-4) Sarjeant 1966b. Albian to Cenomanian, Australia.

Xiphophoridium sp. A

Plate 15, figure 4a-b and Plate 16, figure 1

Description. Murochorate, suturocavate dinoflagellate cyst. Roughly pentagonal lateral and dorsal-ventral outline, circular apical-antapical outline. Endophragm and periphragm, less than 1.3 μm thick, tightly appressed to each other except at the parasutural margins; endophragm relatively thicker, with intratabular ring-shaped tubercles (variable in number, approximately 2.0 to 4.0 μm diameter). Periphragm thin, finely granulate, seen mainly as parasutural flanges. The parasulcal flange well developed, projecting from the cyst. Paracingulum delimited by double flanges of relatively low relief, 1.0 to 2.0 μm high. Simple (tA) or combination archeopyle: apical with some precingulars involved (undetermined if A+P or AP) or epicystal.

Dimensions. Cyst diameter; 43 (54) 75 μm (60 specimens).

Note. The taxonomic treatment of species belonging to the genera *Xiphophoridium* *Dinopterygium* Deflandre 1935 emend. Stover & Evitt 1978 and "*Oodnadattia*" Eisenack & Cookson 1960 (considered as a junior synonym of *Dinopterygium* by Stover and Evitt, 1978 and Lentin and Williams, 1993) has been confusing and in some cases, contradictory.

Deflandre (1935) referred in his description of *Dinopterygium* to the typical outline (like a medieval helmet) and the presence of flanges, fine membranes and (intratabular) punctuations. Stover and Evitt (1978) emended the description of the genus, indicating the gonyaulacoid paratabulation formula and a combination epicystal archeopyle (tAtP). Eisenack and Cookson (1960) described the genus *Oodnadattia*, pointing out the membranaceous wings that delimited the cyst plates, paracingulum and parasulcus. These authors believed that the low membranaceous parasutural ridges distinguished *Oodnadattia* from *Dinopterygium*. Norris and Sarjeant (1965) and Clarke and Verdier (1967) disregarded this difference and proposed that *Oodnadattia* and the species *Oodnadattia tuberculata* Eisenack & Cookson 1960 were junior synonyms of *Dinopterygium* Deflandre and *Dinopterygium cladoides* Deflandre 1935 respectively.

Below (1981) emended the genus *Oodnadattia*, pointing out that this genus was characterized by the apical archeopyle, that distinguished it from *Dinopterygium*, that showed epicystal archeopyle. By doing this, Below (1981) proposed that *Xiphophoridium* had to be considered a junior synonym of *Oodnadattia*. Morgan (1980) considered *Oodnadattia* and *Dinopterygium* to be separate genera, pointing out the need for more detailed morphological studies of *Dinopterygium cladoides* in order to establish a definite taxonomic criteria.

Below (1981) pointed out that Sarjeant (1966a) established that specimens of "*Oodnadattia*" *tuberculata* "often separated along the equatorial line", whereas this separation was not observed in specimens of *Dinopterygium cladoides*. Specimens observed in this study of the Lower Cretaceous of western Venezuela show variability in regard to the nature of the archeopyle, the apical archeopyle being the dominant type observed, but with more complex archeopyles involving the precingular plates also

observed. Similar inferences were made by Below (1981) for specimens that he considered were "*Oodnadattia*" *tuberculata* of the Early Cretaceous of Morocco.

The holotype of "*Oodnadattia*" *tuberculata* illustrated by Cookson and Eisenack (1960, plate 2, figures 10-14) seems to show an epicystal archeopyle, rather than apical as suggested by Below (1981). However, Cookson and Eisenack (1960) did not elaborate on the variability of this feature. If the archeopyle is demonstrated to be epicystal, the emendation proposed by Below (1981) would be contradictory. Therefore, it is proposed here in that the observed species from western Venezuela are to be included within the genus *Xiphophoridium*, that was defined for specimens showing apical archeopyles. The validity and extent of the overlap of the genera *Oodnadattia* and *Dinopterygium* are beyond the scope of this study, but further studies are necessary to clarify the definite systematic relationships of this complex of three genera.

Occurrences. This species is observed in relatively large numbers in samples of the Albian in wells CR-5, ALT-19X and the Catatumbo Quarry outcrop section, and in low numbers in wells ALP-6 and P-201.

ORDER PERIDINIALES HAECKEL 1894

SUBORDER PERIDINIINEAE (AUTONYM)

FAMILY PERIDINIACEAE EHRENBERG 1831

SUBFAMILY PALAEOPERIDINIOIDEAE (VOZZHENNIKOVA 1961) BUJAK & DAVIES 1983

Genus *Chichaouadinium* Below 1981

1981 *Chichaouadinium* Below, p. 122-123.

Type Species. *Chichaouadinium arabicum* Below 1981 (p. 123-124; plate 10, figures 13 a-c, text-figure 81h). Albian, Morocco.

Chichaouadinium boydii (Morgan 1975) Bujak & Davies 1983

Plate 15, figure 6

1975 *Spinidinium boydii* Morgan, p. 159. Plate 1, figure 3 a-d.

1983 *Chichaouadinium boydii* (Morgan) Bujak & Davies, p. 173. Plate 5, figure 17.

Description. See Morgan (1975).

Dimensions. Autocyst: length 38 (41) 52 μm . Breadth: 30 (35) 37 μm . Echinae, less than 1.3 μm long (6 specimens).

Note. This species is characterized by an autocyst with ellipsoidal outline after dorso-ventral compression. Delicate echinae form the parasutural ridges on the finely granulate or smooth periphragm. The apical horn is short and blunt, whereas the antapical horn is very short and sharp when visible. The archeopyle is formed by plate 2a (steno deltaform, according to the nomenclature of Bujak and Davies, 1983) and incipient accessory sutures on plates 3", 4" and 5".

Occurrences. This species is observed in very low numbers only in samples of the Upper Aptian to Albian of wells ALT-19X and CR-5.

This species was described by Morgan (1975) in the Aptian to Albian of the Great Australian Basin and has also been reported in the Aptian to Albian of Australia (Burger, 1980; Helby et al., 1987) and Albian to Cenomanian of Germany (Prössl, 1990).

Genus *Dioxya* Cookson & Eisenack 1958 emend. Morgan 1977

1958 *Dioxya* Cookson & Eisenack, p. 59.

1977 *Dioxya* Cookson & Eisenack emend. Morgan, p. 131.

Type Species. *Dioxya armata* Cookson & Eisenack 1958 (p. 59; plate 11, figure 11, text-figure 20). Albian, Australia.

Dioxya sp. A
Plate 15, figure 5

Description. Acavate, proximochorate dinoflagellate cysts. Ovoidal to spherical autocyst with ellipsoidal outline and a very short apical horn. Finely granulate autophragm. Numerous non-tabular solid bifid-trifid processes (2.5 to 4.0 μm long), apparently evenly distributed on the surface. No evidence of paratabulation or archeopyle is observed.

Dimensions. Autocyst length: 45 (48) 52 μm . Breadth: 30 (38) 47 μm . Process length: 3 to 6 μm (2 specimens).

Note. This species differs from other reported in this genus by the occurrence of bifid-trifid processes rather than simple processes as in *Dioxya villosa* Cookson & Eisenack 1958 or short and blunt spines as *Dioxya armata* Cookson & Eisenack 1958.

Occurrences. This species is observed only in Upper Aptian of well ALT-19X (samples ALT-19X 17600' and ALT-19X 17639').

Genus *Ginginodinium* Cookson & Eisenack 1960a emend. Lentin & Williams 1976

1960a *Ginginodinium* Cookson & Eisenack, p. 7.

1976 *Ginginodinium* Cookson & Eisenack emend. Lentin & Williams, p. 95-96.

Type Species. *Ginginodinium spinulosum* Cookson & Eisenack 1960a (p. 7; plate 12, figure 9). ?Upper Albian–Cenomanian, Australia.

Ginginodinium? sp. A
Plate 16, figure 2

Description. Proximate, acavate? dinoflagellate cyst. Spherical autocyst with circular to ellipsoidal outline. Autophragm, 1.3 to 1.5 μm thick, finely granulate and bearing short parasutural echinae (less than 0.5 μm long) with a short apical and two short antapical horns. In certain cases, the observed specimens seemed to have differentiated endo- and pericysts, showing only endocoel at the horns (cornucavate). Reflected tabulation is not inferred since most of the specimens are folded. Laevorotatory cingulum, about 1.0 μm wide, and sulcal areas marked by rows of aligned processes. Archeopyle is not observed.

Dimension. Autocyst length: 43 (45) 50 μm . Breadth: 37 (39) 43 μm (15 specimens).

Note. This species is attributed to the genus *Ginginodinium* based on the overall shape of the autocyst and the parasutural bands of short echinae. However, its definite generic assignment will depend on further studies that might reveal the characteristics of the archeopyle and the reflected tabulation. In terms of the ornamentation and overall shape, this species differs from *Ginginodinium ornatum* (Felix & Burbridge 1973) Lentin & Williams 1976 by having short and sharp echinae rather than tubercles along the plate boundaries and from *Ginginodinium spinulosum*, by the smaller size and more circular or ellipsoidal outline. *Ginginodinium evittii* Singh 1983 has short echinae (0.5 μm long) and is cornucavate, but its periphragm seems to be thinner than the one of the species observed in this study.

Ocurrences. This species is observed in low proportions in Albian sediments of the Zea-Panamericana and La Grita outcrop sections, as well as in wells CR-5, ALT-19X and ALP-6.

Genus *Subtilisphaera* Jain & Millepied 1973 emend. Lentin & Williams 1976

1973 *Subtilisphaera* Jain & Millipied, p. 26-27.

1976 *Subtilisphaera* Jain & Millepied emend. Lentin & Williams, p. 117-119.

Type Species. *Subtilisphaera senegalensis* Jain & Millepied 1973 (p. 27-28; plate 3, figure 31). Aptian, Senegal.

Subtilisphaera cheit Below 1981

Plate 16, figure 3

1981 *Subtilisphaera cheit* Below, p. 126-127. Plate 9, figures 23-24.

Description. See Below (1981).

Dimensions. Pericyst length: 48 (56) 62 μm . Breadth: 35 (38) 45 μm . Endocyst length: 37 (39) 48 μm . Breadth: 28 (32) 35. Apical and antapical horns length: 3.0 to 4.0 μm . Processes length: 2.5 to 5.0 μm (6 specimens).

Note. The specimens observed are characterized by cysts with a thin and granulate periphragm, bearing numerous simple hair-like processes. Circular endocyst and polyhedral pericyst. Pericyst with epicyst and hypocyst of equal length. Specimens are circumcavate to cornucavate. The periphragm and endophragm are rather thin (less than 1.3 μm thick). Apical and left antapical horns are approximately of the same length, 3–4 μm . Cingulum, faintly indicated in a depressed area of the periphragm, less than 1.0 μm wide. No archeopyle is detected.

Ocurrences. This species is observed in low numbers in the Upper Aptian and Albian samples of La Grita outcrop section and in wells ALT-19X and ALP-6.

This species was originally described by Below (1981) in the Aptian–Vraconian (uppermost Albian) of Morocco and has also been reported in the Turonian–Coniacian of Colombia (Prössl, 1992), Vraconian to Cenomanian offshore east of the United States (Herbin et al., 1987), Hauterivian to Cenomanian of Libya (Batten and Unwins, 1985; Thusu et al., 1988; Unwins and Batten, 1988), Aptian to Albian of Egypt (Omran et al., 1990) and Barremian of Portugal (Berthou and Leereveld, 1986) and Albian to Cenomanian of Germany (Prössl, 1990).

Subtilisphaera deformans (Davey & Verdier 1973) Stover & Evitt 1978

Plate 16, figure 4

1971 *Deflandrea asymmetrica* Davey & Verdier, p. 39. Plate 2, figures 4, 6.

1973 *Deflandrea deformans* Davey & Verdier nom.nov.pro *D. asymmetrica* Davey & Verdier, p. 197.

1978 *Subtilisphaera deformans* (Davey & Verdier) Stover & Evitt, p. 239.

Description. See Davey and Verdier (1971).

Dimensions. Pericyst length: 56 (62) 72 μm . Breadth: 43 (45) 50 μm . Endocyst diameter: 43 (45) 56 μm . Apical horn length: 5.0 to 8.0 μm . Antapical horn length: 7.0 to 12.0 μm (45 specimens).

Note. The observed specimens are characterized by a smooth, thin endophragm (less than 1.0 μm thick). Periphragm, about 1.0 μm thick, finely granulate. Ellipsoidal endocyst,

elongated along the apical-antapical axis of the cyst. Pericyst ellipsoidal after lateral or in dorso-ventral and lateral compressions. Endocyst attached against the pericyst only in the ventral area. Descending cingulum, approximately 1.0 to 1.3 μm wide, indicated by thickened periphragm ridge (1.3 μm thick). Archeopyle is not observed.

Occurrences. This species is commonly observed in Aptian–Albian sections of Zea-Panamericana and La Grita outcrop sections, wells CR-5, ALP-19X ALP-6 and P-201. Its abundance is larger in Albian samples of wells ALT-19X and CR-5.

This species was described from the Middle Albian of France (Davey and Verdier, 1971) and has been reported in Cenomanian of Alberta (Singh, 1983), Albian offshore southeast Canada (Bujak and Williams, 1978), Aptian of offshore northwest Africa (Below, 1984) and Barremian to Albian of Portugal (Berthou and Leereveld, 1986).

Subtilisphaera senegalensis Jain & Millepied 1973

Plate 16, figure 5

1973 *Subtilisphaera senegalensis* Jain & Millepied, p. 27-28. Plate 3, figure 31-33.

Description. See Jain and Millepied (1973).

Dimensions. Pericyst length: 45 (51) 57 μm . Breadth: 31 (33) 35 μm . Endocyst diameter: 31 (45) 40 μm (25 specimens).

Note. Circumcavate to cornucavate dinoflagellate cyst. Circular to ellipsoidal endocyst. Ellipsoidal pericyst with epicyst and hypocyst of about the same length. Short and sharp apical and antapical horns, 1.0 to 3.0 μm long. Endophragm relatively thick (1.3 μm thick) and granulate. Periphragm (less than 1.0 μm thick), finely granulate. Descending cingulum marked by ridges formed by thickened periphragm (about 1.0 to 1.3 μm thick) in a depressed area, 1.0 to 1.5 μm wide. In some cases, the granulation on the periphragm indicates faint indications of the tabulation.

Occurrences. This species is found in the Aptian–Albian in the studied sections; in low proportions of Zea-Panamericana and La Grita outcrop section, and more abundantly in wells ALT-19X, ALP-6 and P-201.

The species was originally described by Jain and Millepied from the Aptian of Senegal. *Subtilisphaera senegalensis* has also been reported from the Hauterivian to Cenomanian of Morocco (Below, 1981), Aptian of offshore northwest Africa (Below, 1984), Barremian to Albian of Portugal (Berthou and Lereveld, 1986) and Hauterivian to Barremian of Libya (Thusu et al., 1988).

Subtilisphaera zawia Below 1981

Plate 16, figure 6

1981 *Subtilisphaera zawia* Below, p. 128-129. Plate 9, figures 21-22. Text-figure 82.

Description. See Below (1981).

Dimensions. Pericyst length: 43 (45) 48 μm . Breadth: 37 (38) 42 μm . Endocyst diameter: 31 (34) 36 μm (9 specimens).

Note. Cavate to circumcavate cysts. The general outline of the pericyst is polyhedral to polygonal, with the epicyst typically triangular and bearing an apical horn, 1.0 to 1.3 μm long. Some specimens do not show the apical horn observed by Below (1981). Hypocyst almost polygonal, with two short antapical horns (0.5 to 0.7 μm long), approximately equal. The antapex is concavely curved to the interior. Endocyst, in general of ellipsoidal outline, very rarely circular. Periphragm finely granulate and thin (less than 1.0 μm). Endophragm, 1.3 μm thick, smooth.

Occurrences. This species is rarely observed in samples of the Upper Aptian of the La Grita outcrop section (samples 09-04-05 and 09-04-06).

Below (1981) described this species from the Albian of Morocco and has also been reported in the Albian of Mexico (Helenes, 1984b), Vraconian (uppermost Albian) to Cenomanian of Libya (Uwins and Batten, 1988) and from the Upper Barremian of Portugal (Berthou and Leereveld, 1986).

SUBCLASS UNCERTAIN (Class Dinophyceae)

ORDER UNCERTAIN (Class Dinophyceae, Subclass uncertain)

FAMILY UNCERTAIN (Class Dinophyceae, Subclass uncertain, Order uncertain)

Genus *Prolixosphaeridium* Davey et al. 1966 emend. Davey 1969

1966 *Prolixosphaeridium* Davey et al., p. 171.

1969 *Prolixosphaeridium* Davey et al. emend. Davey, p.160.

Type Species. *Prolixosphaeridium deirense* Davey et al. 1966 (p. 171-172; plate 3, figure 2, text-figure 45) emend. Harding 1990. Middle Barremian, England.

Prolixosphaeridium sp. A

Plate 16, figure 8

Description. Small, acavate, proximo-chorate dinoflagellate cysts. Ovoidal autocyst with ellipsoidal outline. Autophragm thin (less than 1.3 μm thick), finely granulate. Numerous solid processes, possibly latitudinally aligned; distally closed with very short trifurcate terminations. Position of the paracingulum given by alignment of processes, 1.0 μm wide. Probably small apical archeopyle.

Dimensions. Main body length: 40 μm . Main body breadth: 23 μm . Processes length, up to 9 μm (2 specimens).

Occurrences. This species is observed in the Lower Aptian of the Zea-Panamericana (sample 13-04-06) and the Albion of La Grita (sample 09-04-11) outcrop sections.

3.5 Algae

DIVISION CHLOROPHYTA PASCHER 1914

CLASS CHLOROPHYCEAE KÜTZING 1843

ORDER CHLOROCOCCALES MARCHAND 1885

FAMILY CHLORELLACEAE (WILLE) BRUNNTHALER 1913

Genus *Tetraedron* Kützing 1854

Tetraedron sp. A

Plate 17, figure 1

Description. Cell solitary, tetrahedral with polyhedral outline after compression. Straight to slightly concave sides. Cell wall rather thin, less than 1.0 μm thick, granulate (perhaps related to preservational artifacts). Four solid rod-like appendages are observed at the corner of the cell wall.

Dimensions. Cell diameter: 25 μm . Projection length: 2-5 μm (1 specimen).

Note. This species resembles *Tetraedron paraincus* Batten & Lister 1988 from the Wealden of England. However, morphological features such as the presence of thickened rims at the corners of the cell wall and the separation and communication of the projections with the cell interior are not assessed because of preservation of the only specimen observed. Further studies are needed to establish a definite morphological characterization of this species.

Occurrences. Only one specimen is observed in the Albian of La Grita outcrop section (sample 09-04-10).

Family HYDRODICTYACEAE (GRAY) DUMORTIER 1829

Genus *Pediastrum* Moyen 1829

Remarks. The fossil record of this genus extends back to the Lower Cretaceous (Evitt, 1963b, Batten and Lister, 1988).

Pediastrum sp. A

Plate 17, figure 3

Description. Coenobium ovate, non-perforate with no major differentiation of the interior and outer cells (perhaps related to preservational artifacts). Outer cells, emarginate with simple and relatively long projections (7-9 μm long), gradually tapering and distally truncated, perhaps two per outer cell.

Dimensions. Coenobium diameter; approximately 56 μm (1 specimen).

Note. The specimen observed in this study does not show any differentiation of the interior and outer cell walls and, therefore, it is impossible to determine their shape, dimensions and arrangement. Zippi (1992) illustrated specimens of *Pediastrum boryanum* (Turpin) Meneghini, characterized by deeply emarginate outer cells with two projections per outer cell. The overall morphology of this species and the one observed in western Venezuela is similar, but the lack of differentiation of the inner and outer cells hinders any possible comparison.

Occurrences. This species is observed in the Albian of La Grita outcrop section (samples 09-04-11 and 09-04-12).

ORDER PTerosPERMATALES SCHILLER 1925

FAMILY TASMANATACEAE (SOMMER 1956) TAPPAN 1980

Genus *Pterospermella* Eisenack 1972

1972 *Pterospermella* Eisenack, p. 597.

Type Species. *Pterospermella aureolata* (Cookson & Eisenack 1958; p. 49, figure 11) Eisenack 1972. Cenomanian–Turonian, Australia.

Pterospermella australiensis (Deflandre & Cookson 1955) Eisenack & Cramer 1973
Plate 17, figure 4

1954 *Pterospermopsis australiensis* Deflandre & Cookson, p. 1236. Text-figures 13-14.
[nomen nudum]

1955 *Pterospermopsis australiensis* Deflandre & Cookson, p. 286. Plate 3, figure 4. Text-figures 52-53.

1959 *Pterospermopsis helios* Sarjeant, p. 342. Plate 13, figure 9.

1973 *Pterospermella australiensis* (Deflandre & Cookson) Eisenack & Cramer, p. 959.

Description. Discoidal test, with circular outline after compression. Smooth central body, about 1.3 μm thick. Equatorial lamellae less than 1.0 μm thick, finely granulate and presenting 10 to 14 folds at regular intervals. Ratio of the diameter of the central body to the total diameter of the test is about 1:2.

Dimensions. Overall test diameter: 30 (33) 37 μm . Central body diameter 13 (14) 15 μm . Equatorial lamella width: 17 (18) 20 μm (6 specimens).

Occurrences. This form is observed in very low numbers the Aptian–Albian of La Grita outcrop section and in wells CR-5, ALT-19X, ALP-6 and P-201.

Pterospermella australiensis has been reported from the Lower Valanginian to the Cenomanian of Australia (Cookson and Eisenack, 1971; Burger, 1980; Backhouse, 1988), Cenomanian of the Gulf of Mexico (Riley and Fenton, 1984), Albian of Alberta,

western Canada (Brideaux, 1971; Singh, 1971). This species has reported from the Jurassic (Sarjeant, 1959) to the Oligocene (Weyns, 1970).

Pterospermella sp. A

Plate 17, figure 5

Description. Discoidal test, with circular outline after compression. Smooth central body, about 1.5 to 2.0 μm thick. Equatorial lamellae 1.3 μm thick, granulate and presenting 10 to 15 folds at irregular intervals. Folds did not reach the equatorial margin. Ratio of the diameter of the central body to the total diameter of the test is about 2:3.

Dimensions. Overall test diameter: 56 μm . Central body diameter 20 (21) 21 μm . Equatorial lamella width: 35 (36) 36 μm (2 specimens).

Note. This species resembles *Pterospermella hartii* (Sarjeant 1960) Eisenack & Cramer 1973. However, the folding of the equatorial lamellae reaches the equatorial margin in *Pterospermella hartii*. *Pterospermella barbarae* (Gorka 1963) Eisenack & Cramer 1973 has a larger overall diameter (more than 160 μm).

Occurrences. This species is observed in two samples the Lower Aptian of the Zea-Panamericana outcrop section (samples 13-04-02 and 13-04-06).

Pterospermella sp. B

Plate 17, figure 6

1977 *Penetetrapites mollis* Hedlund & Norris; Srivastava, p. 103. Plate 48, figures 15-19 [auct. non].

Description. Discoidal test, with circular outline after compression. Smooth central body, about 1.3 μm thick. Equatorial lamellae, 1.3 μm thick, granulate, without radial folds. Ratio of the diameter of the central body to the total diameter of the test is almost 1:1.

Dimensions. Overall test diameter: 25 (30) 36 μm . Central body diameter 21 (25) 30 μm . Equatorial lamella width: 35 (36) 36 μm (3 specimens).

Note. Srivastava (1977) illustrated a specimen that he considered an acritarch (p. 103, Plate 48, figures 15-19) which he attributed to *Penetetrapites mollis*. Illustrations presented by Hedlund and Norris (1968, their plate VII, figures 6-12) show specimens completely different from the one shown by Srivastava. However, the specimen illustrated by Srivastava is similar to those reported in this study, except that it has a wider equatorial lamellae.

Occurrences. This species is observed in very low abundances the Albian of the La Grita outcrop section (sample 09-04-10).

3.6 Acritarchs

GROUP ACRITARCHA EVITT 1963

Genus *Chomotriletes* Naumova 1939

1939 *Chomotriletes* Naumova, p. 355.

1962 *Concentriystes* Rossignol, p. 134-135.

1962 *Pseudoschizaea* Thiegart & Frantz, p. 84.

Type Species. *Chomotriletes vedugensis* Naumova 1953 (p. 58; plate 7, figures 21-22). Devonian, U.S.S.R.

Remarks. Species of the genus *Circulosporites* de Jersey 1962 emend. Kedves 1977 are characterized by being heteropolar; that is, only one of the faces of the test shows the concentric striae (Kedves, 1977). Therefore *Circulosporites* is considered different from *Chomotriletes*, that is characterized by species with isopolar tests. Playford and Dring (1981) made the first reference to this genus as an acritarch.

Chomotriletes minor (Kedves 1961) Pocock 1970

Plate 17, figure 8

1961 *Schizaeoisporites minor* Kedves, p. 129. Plate 16, figures 11-12.

1962 *Chomotriletes fragilis* Pocock, p. 39. Plate 3, figures 30-32.

1970 *Chomotriletes minor* (Kedves) Pocock, p. 61.

Description. Vesicle of circular outline, isopolar, 1.5 μm thick. Both sides or faces distinctively and regularly sculptured with concentrically arranged continuous smooth ridges, 0.5 to 1.0 μm wide and high, separated by narrow smooth canals, less than 0.5 μm wide.

Dimensions. Vesicle diameter: 28 (32) 36 μm (6 specimens).

Occurrences. The observed specimens are reported from the Aptian–Albian of the Zea-Panamericana and La Grita outcrop sections and from wells CR-5 and ALP-6.

Chomotriletes minor has been reported from the Aptian of Colombia (Pons, 1988), Berriasian to Maastrichtian of Maryland, eastern U.S.A. (Bebout, 1981), Jurassic to Upper Albian of western Canada (Pocock, 1962 and 1970; Burden and Hills, 1989), Upper Albian to Cenomanian of Sudan (Schrack, 1990), Neocomian to Albian of Libya (Thusu and van der Eem, 1985), Middle Albian of Egypt (Aboul Ela and Mahrous, 1992) and Berriasian to Valanginian of Germany (Dörhöfer and Norris, 1977).

Genus *Goniosphaeridium* Eisenack 1969 emend. Turner 1984

1969 *Goniosphaeridium* Eisenack, p. 256.

1971 *Goniosphaeridium* Eisenack emend. Kjellstrom, p. 43.

1984 *Goniosphaeridium* Eisenack emend. Turner, p. 15-16.

Type Species. *Goniosphaeridium polygonale* (ex *Ovum hispidum polygonale*) (Eisenack 1931) Eisenack 1969. Lower Silurian, Germany. Neotype: Paris and Deunff (1970; plate 1, figure 14).

Remarks. Kjellstrom (1971) emended the diagnosis of the genus, including species with spherical vesicles. Turner (1984) rendered *Goniosphaeridium sensu* Kjellstrom a partial synonym of *Solisphaeridium* Staplin et al. and preferred to restrict the genus *Goniosphaeridium* to those species with polygonal vesicles. This proposal is accepted in this study.

Goniosphaeridium polygonale (Eisenack 1938) Eisenack 1969

Plate 17, figure 9

- 1931 *Ovum hispidum polygonale* Eisenack, p. 113. Plate 4, figure 18-19. [*pars*]
 1938 *Hystriosphæridium splendens* (Eisenack) Eisenack, p. 12.
 1959 *Baltisphaeridium polygonale* (Eisenack) Eisenack, p. 199. Plate 16, figures 6-8.
 1963 *Veryhachium polygonale* (Eisenack) Eisenack, p. 209.
 1969 *Goniosphaeridium polygonale* (Eisenack) Eisenack, p. 257.
 1984 *Goniosphaeridium splendens* (Eisenack) Turner, p. 113-114.

Description. See Turner [1984, p. 114 under *Goniosphaeridium splendens* (Eisenack 1938) Turner 1984].

Dimensions. Vesicle diameter: 22 (23) 25 μm . Processes length: 10-11 μm (2 specimens).

Note. Turner (1984) proposed to restrict the use of the epithet *polygonale* only to the material related to the neotype designated by Eisenack (1959). However, article 7.10 of the International Code for Botanical Nomenclature (Greuter et al., 1988) establishes that a neotype may be designated in order to preserve the previous usage. According to Turner (1984) the neotype designated by Eisenack (1959) is different from the original description. However, *Goniosphaeridium splendens* is a junior synonym of *Goniosphaeridium polygonale*.

Occurrences. Only two specimens are observed in the Albian of La Grita outcrop section (sample 09-04-11) and in the Aptian of well CR-5 (sample 14401').

Genus *Leiosphaeridia* Eisenack 1958b emend. Turner 1984

- 1958b *Leiosphaeridia* Eisenack, p. 2-5.
 1963 *Leiosphaeridia* Eisenack emend. Downie & Sarjeant, p. 94-95.
 1984 *Leiosphaeridia* Eisenack emend. Turner, p. 116.

Type Species. *Leiosphaeridia baltica* Eisenack 1958 (p. 8; plate 2, figure 5). Ordovician, Germany.

Remarks. Turner (1984) largely followed the emendation proposed by Downie and Sarjeant (1963), but stated that the wall thickness might be variable and included species with thicker wall (more than 0.5 μm). This approach is accepted in this study.

Leiosphaeridia sp. A

Plate 17, figure 7

Description. Spherical thin-walled vesicle, with circular to ellipsoidal outline after compression, wall about 1.0 μm thick, of relatively large size and generally finely granulate. No pylome is observed.

Dimensions. Vesicle diameter: 51 (63) 70 μm (10 specimens).

Note. *Leiosphaeridia major* (Staplin 1961) Downie & Sarjeant 1965 has similar outline and wall thickness, but the wall is laevigate or smooth. It is unknown if the observed granulation in the specimens from western Venezuela might be related to preservational factors.

Occurrences. This species shows quite sporadic occurrences in most of the studied section, in general with very poor preservation.

Genus *Micrhystridium* Deflandre 1937 emend. Sarjeant & Stancliffe 1994

1937 *Micrhystridium* Deflandre, p. 79-80.

1963 *Micrhystridium* Deflandre emend. Downie & Sarjeant, p. 83-84.

1961 *Micrhystridium* Deflandre emend. Staplin, p. 408.

1970 *Micrhystridium* Deflandre emend. Lister, p. 77.

1994 *Micrhystridium* Deflandre emend. Sarjeant & Stancliffe, p. 12-13.

Type Species. *Micrhystridium inconspicuum* (Deflandre 1935, p. 233, plate 9; figures 11-12) Deflandre 1937 emend. Deflandre & Sarjeant 1970. Upper Cretaceous, France.

Remarks. Staplin (1961) proposed to include species having spherical to subspherical vesicles with uniform and distally closed spines, regardless of the size or dimensions of the vesicle. Downie and Sarjeant (1963) proposed to restrict this genus to species whose

vesicle have a mean and modal diameter less than 20 μm . Lister (1970) emended the description of this genus, citing the presence of an excystment cryptosuture. According to Turner (1984) this type of structure has rarely been observed in species of this genus. Sarjeant and Stancliffe (1994) emended the description of this genus by incorporating major details of the characteristic of the wall (eilyma) and discriminating the generic assignment based on the number of spines (9 to 35) and the characteristics of the termination of the spines. These authors do not consider that the vesicle opening is a diagnostic feature, as suggested by Lister (1970).

Micrhystridium sp. A

Plate 17, figure 10

Description. Hollow spherical vesicle, thin wall (less than 1.3 μm), smooth, bearing 8-10 short slender cylindrical homomorphic processes that are distally acuminate.

Dimensions. Vesicle diameter: 18 μm . Processes length: 4 to 5 μm (2 specimens).

Note. This species resembles *Micrhystridium inusitatum* Wicander 1974 in the general overall size and shape of the vesicle. However, it differs from the latter in the number of process, that is significantly lower than that reported for *Micrhystridium inusitatum* (18-21). *Micrhystridium parvum* Stockmans & Williere 1966 has similar shape, size and number of processes, but the later have a broader base than those observed in the specimens in this study.

Occurrences. Only one specimen is observed in the Albian of La Grita outcrop section (sample 09-04-10).

Incertae Sedis A

Plate 16, figure 9

Description. Small suturocavate proximate dinoflagellate? cyst. Circular to polygonal outline after apical-antapical compression. Endocyst circular in outline. Endophragm tightly appressed against the periphragm except at the parasutures. Pericyst with polygonal outline (see Plate 16, figure 9), with perisutural ridges.Periphragm finely perforate-reticulate. Parasutural ridges made of thin periphragm, about 1.3 μm high and easily folded. Undetermined tabulation. No archeopyle is observed.

Dimensions. Cyst diameter: 25 (26) 31 μm (20 specimens).

Note. The thin wall, poor preservation and small size of these forms precluded detailed morphological characterization. The specimens are generally oriented as shown in Plate 9, figure 6. I believe that this particular orientation might be related to compression along the apical-antapical axis and that the polygonal outline of the cysts might be related to the parasutural ridges associated to the limits of the cingulum. In general the parasutural ridges suggest the presence of 6 fields, perhaps representative of six plates, but because of the easy way the periphragm folds, it is difficult to ascertain this pattern. Further studies, especially using SEM will be useful in order to resolve the characteristics of this species.

Occurrences. This species is observed quite abundantly in Albian samples of the Catatumbo outcrop section and in low numbers in the Late Aptian-Albian of well ALT-19X.

Incertae Sedis B

Plate 16, figure 7

Description. Relatively large proximate-proximochorate dinoflagellate? cysts. Ovoidal autocyst with ellipsoidal outline. Autophragm granulate to smooth, with solid aculeate? processes that terminate in a thin ectophragm, with polygonal areas (coarse reticulum?). No evidences of paratabulation or archeopyle are observed.

Dimensions. Cyst length: 66 (73) 80. Cyst breadth: 43 (47) 56 μm . Autocyst length: 52 (63) 73 μm . Autocyst breadth: 35 (42) 45 μm . Processes length: 6 to 7 μm (15 specimens).

Note. Harker and Sarjeant (in Harker et al., 1990) showed specimens of *Cassiculosphaeridia ovalis* Harker & Sarjeant 1990 (their plate 2, figures 7, 8, 11 and 12 and text-figure 19) that resemble the outline and the coarse reticulum of the specimens observed in this study. However, further studies are needed to characterize the material from the Lower Cretaceous of Venezuela in order to determine its definite morphology and taxonomy.

Occurrences. This species is found to be present in low to moderate abundances in Aptian–Albian (especially in the latter) of wells CR-5 and ALT-19X.

Incertae sedis C

Plate 17, figure 2

Description. Spherical body with roughly circular outline. Thick wall, 2.5 to 3.0 μm , characteristically reticulate with polygonal lumina, approximately 2.5 μm across.

Dimensions. Diameter: approximately 75 μm (broken specimen).

Note. The overall thickness of the wall resembles that of species of the genus *Crassosphaera* described by Cookson and Manun (1960). However, the species of this genus, as well as other genera of the Family Tasmanaceae, are characterized by having projections that are open and form minute perforations in the test wall. These structures are not observed in the specimen observed in this study.

This species also differs from the genus *Schizosporis* Cookson & Dettmann 1959b emend. Pierce 1976 by lacking the double-layered wall, with the external layer of closely packed cell-like units and the lack of a equatorial suture that divides the individuals in almost equal halves.

Occurrences. Only broken specimens are observed in the samples of the Zea-Panamericana outcrop section and in well ALT-19X.

Incertae sedis D

Plate 17, figure 11

Description. Reticulate, large palynomorph, with rounded ellipsoidal outline. Exine; 2.5 microns thick, reticulate. Lumina polygonal to circular, less than 1.3 μm across, muri 1.3 μm wide.

Dimensions. Diameter: 57 (60) 62 μm (2 specimens).

Note. This species differs from species of the genus *Schizosporis* described by Cookson and Dettmann (1959b) by lacking the complex structured wall and the equatorial suture (Pierce, 1976). Species of *Schizophacus* Pierce 1976 also have an equatorial suture that is not observed in the case of the species observed in this study.

Occurrences. Several broken specimens are observed in the Aptian-Albian of the Zea-Panamericana outcrop section and in wells C ALT-19X, ALP-6 and P-201.