Rev. Mus. Argentino Cienc. Nat., n.s.
8(2): 179-184, 2006
Buenos Aires, ISSN 1514-5158

Albian dinoflagellate cysts from the Kachaike Formation, Austral Basin, Southwest Argentina

M. Verónica GULER[1] & Sergio ARCHANGELSKY[2]

[1]Departamento de Geología, Universidad Nacional del Sur, CONICET. San Juan 670, (8000) Bahía Blanca. E-mail: vguler@criba.edu.ar. [2]Museo Argentino de Ciencias Naturales «Bernardino Rivadavia», CONICET. Angel Gallardo 470, C1405DJR Buenos Aires. E-mail:sarcang@fibertel.com.ar

Abstract: The palynological assemblages of the Kachaike Formation at the Bajo Comisión section, Austral Basin, Argentina, are mainly composed by pteridophyte and bryophyte spores, gymnosperm and angiosperm pollen, dinoflagellate cysts and other marine and freshwater algae. This study presents the dinoflagellate cyst assemblages recovered from the lower part of the section. The biostratigraphic index dinoflagellate cysts taxa suggest an early Albian age for the lower part of the Kachaike Formation and the assemblages are attributed to the *Muderongia tetracantha* Interval Zone (Helby). The dominance of well preserved pollen and spores together with the presence of dinoflagellate cysts, suggest that the lower levels of the Bajo Comisión section were deposited in marine shallow waters, in agreement with the sedimentary facies.

Key words: Dinoflagellate cysts, Albian, Austral Basin, Argentina

---

The Cretaceous deposits in the Austral Basin were grouped in three tecto-sedimentary cycles: Rio Mayer, Lago San Martin and Lago Viedma, ranging from the Berriasian to the Maastrichtian (Arbe, 2002). The Kachaike Formation was included in the Lago San Martin cycle (early Aptian – early Turonian), as the highstand phase within the late Albian – early Turonian Kachaike –Piedra Clavada subcycle. North of Lago San Martín, Cladera & Limarino (in prep.) analyzed exposures of the Kachaike Formation at the Bajo Comisión section (Fig. 1). The 280 m thick integrated sequence consists of sandstones, shales and conglomerates in a vertical arrangement of facies, passing from a marine-deltaic to a moderate to low sinuosity fluvial paleoenvironment (Fig. 2).

The age of the Kachaike Formation is debatable and ranges from late Aptian to early Cenomanian according to differente authors. Aguirre Urreta (2002) synthesized the information on lower Cretaceous invertebrate fossil records from Santa Cruz Province. Most of the age-diagnostic molluscan fossils found in the lago San Martin area indicate late Aptian-Albian ages for the formation.

Previous biostratigraphical studies based on megaflora and palynoflora, particularly at the Arroyo Caballo Muerto section (Fig. 1), proposed a late Aptian-early Albian age for the Kachaike Formation (Rebasa, 1982; Gamerro, 1982, unpublished report; Baldoni & Batten, 1991; Baldoni *et al*., 2001; Cúneo & Gandolfo, 2005). Other palynological analyses in the same section include the systematic study mainly of pollen and spores by Baldoni (1987) and Archangelsky & Llorens (2003; 2005).

In the Bajo Comision section, Passalía and Archangelsky (2002) recognized six levels bearing fossil remains of diverse gymnosperms and angiosperms, and two angiosperm leaf morphotypes were described by Passalía (2003). Age-diagnostic angiosperm leaves and fossil pollen in the upper part of the Bajo Comisión section suggest a late Albian-early Cenomanian age (Barreda & Archangelsky, 2006).

This study is focused on the lower part of the Kachaike Formation at the Bajo Comision section where dinoflagellate cysts are present. The biostratigraphical results are mainly compared with those from the Arroyo Caballo Muerto section presented by Baldoni *et al.* (2001).

The aim of this study is to present further evidences of marine components useful for a biostratigraphical analysis, in order to discuss the age of the Kachaike Formation. This is particularly relevant to contribute in the elucidation of palaeobiological events such as the origin and evolution of the angiosperms, since micro and megaflora components of this group in the Kachaike Formation are in constant study.

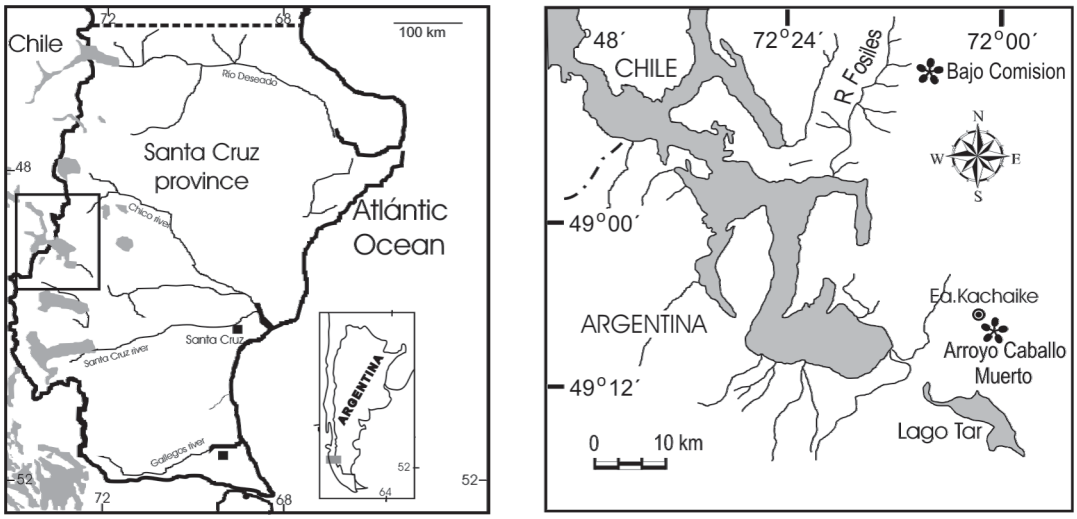

Fig. 1. Map showing location of the Bajo Comisión and Arroyo Caballo Muerto sections in the Lago San Martin area.

MATERIALS AND METHODS

Seventeen samples from the Kachaike Formation at the Bajo Comisión were processed for palynomophs. Treatment included hydrofluoric, hydrochloric acid and, for the dinoflagellate cysts, the organic residues were filtered with 25 μm mesh sieves. The residues were stained using Bismarck C and mounted in glycerine jelly.

Light microspcopy was undertaken using Nikon Eclipse 600 microscope serial number 772751. Images of specimes were captured by a Nikon Coolpix 950 digital camera. The nomenclature corresponds to Fensome and Williams (2004). Timescale corresponds to Gradstein *et al.* (2004).

PALYNOLOGICAL ASSEMBLAGES AND AGE

The palynoflora from Bajo Comision is mainly composed by pteridophytes, bryophytes, gymnosperms, angiosperms, dinoflagellate cysts and other remains of marine and freshwater algae. Statistical analysis indicates that the dinocyst / sporomorph ratio is variable throughout the section, and conforms three main intervals that reflect paleoenvironmental changes, from bottom to top: deltaic - marine conditions, subacueous to subaerial platform and subaerial to fluvial platform (Cladera & Limarino in prep; Archangelsky, personal observation). The transgressive pelites of the lower part of the Bajo Comision section (PBC10 to PBC15) yielded palynological assemblages with marine elements, mainly dinoflagellate cysts (Fig. 2). A complete list of taxa determined is given in the Appendix. The dinocyst assemblages are dominated by gonyaulacalean cysts, though peridinialeans are well represented. The abundance and diversity of dinocysts are variable, with highest frequencies in the four upper samples (PBC10 to PBC13), reaching up to 30% at PBC10 (Archangelsky, personal observation). The two lower levels bear extremely sparce, poorly-preserved assemblages, almost barren of dinocysts.

The dominance of well preserved pollen and spores together with the presence of dinocysts suggest that the lower deposits of the Bajo Comisión section accumulated in marine shallow waters near the shoreline.

The four lower samples of the Kachaike Formation at Bajo Comisión bearing dinocysts, indicate an early Albian age. The most important biostratigraphic index species are *Dinopterygium cladoides* (Fig. 3.O,P), *Muderongia tetracantha* (Fig. 3.J) and *Prolixosphaeridium conulum* (Fig. 3.K,L). The presence of *Muderongia tetracantha* indicates an age not younger than early Albian (Helby *et al*., 1987). The first appearance of *Prolixosphaeridium conulum* is at the mid Albian, according to Morgan (1980) and the base range of *Dinopterygium cladoides* (as *D. tuberculatum*) is considered to be mid Albian (Morgan, 1980; Helby *et al*. 1987). However, *D. tuberculatum* appears to be regularly present in Australia from the base of the Albian (Helby, pers. comm.). The occurrence of *P. conulum* may be a weak stratigraphic marker in these assemblages, since other strong mid Albian markers are

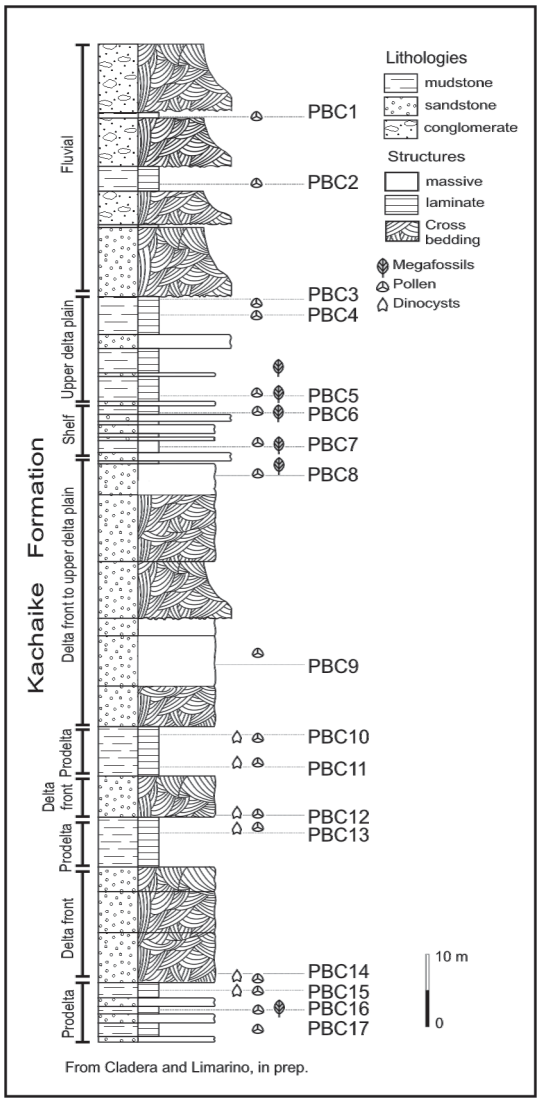

Fig. 2. Integrated stratigraphic section of the Kachaike Formation at the Bajo Comisión.

absent. Therefore, the samples are interpreted to be of early Albian age and attributed to the *Muderongia tetracantha* Interval Zone of Helby *et al*. (1987). However, a mid Albian age for the uppermost levels of the lower part of the section is not totally discarded.

DISCUSSION AND CONCLUSIONS

The Kachaike Formation in the Lago San Martin area appears to extend throughout the Albian based on palynomophs and other micro and mega fossils recovered at the Bajo Comisión and Arroyo Caballo Muerto sections. The diagnostic dinoflagellate cysts allow to propose an early age for the lower part of the Kachaike Formation.

In an unpublished report, Gamerro (1982) stated that the Kachaike Formation at the Arroyo Caballo Muerto section was of late Aptian-early Albian age. The author described nine palynologically productive samples and two of them yielded dinoflagellate cysts (98/81and 689/81); these two dinocyst assemblages were re-studied in Guler and Archangelsky (2003). The lower sample (98/81) bears a scarce and poorly diverse dinocyst assemblage, with long ranging species that impede to state an age for the base of the section. Sample 689/81, from the middle part of the section, contains dinoflagellate cysts with Albian affinities for which a late Albian age was proposed. However, regarding the lack of continuity of the dinocyst records the age of these assemblages must be confirmed in future studies.

Baldoni and Batten (1991) analyzed the megaspores recovered from the Kachaike Formation at the Arroyo Caballo Muerto and proposed a late Aptian- early Albian age. Later, Baldoni *et al*. (2001) stated for the same section, a late Aptian-early Albian (probable early Albian) age, based on the spores, pollen, megaspores and microplancton recovered in 12 of the 14 samples analyzed (2012 to 2015, 2112 to 2119 and a plant level). They stated a minimun early Albian age for the whole section by the presence of the key dinocyst taxon *Muderongia tetracantha* and the absence of angiosperm tricolpate pollen. However, according to the range chart presented in Baldoni *et al*. (2001) *Muderongia tetracantha* is only present in two samples from the lower part of the section. This fact allows to correlate the lower levels of the Kachaike Formation in both Bajo Comisión and Arroyo Caballo Muerto section. Therefore, dinocyst assemblages from the lower part of the Kachaike Formation in both sections would indicate an early Albian age, and suggest at the same time a correlation with the *Muderongia tetracantha* Interval Zone of Helby *et al*. (1987). Otherwise, angiosperm pollen and megaflora recovered from the upper levels of the Bajo Comisión section suggest a younger late Albian age for the upper Kachaike Formation (Barreda & Archangelsky, 2006). The lack of dinocyst records in these continental deposits does not add further support for this dating.

ACKNOWLEDGEMENTS

The authors thank R. Guerstein and M. Borel for comments which improved the original

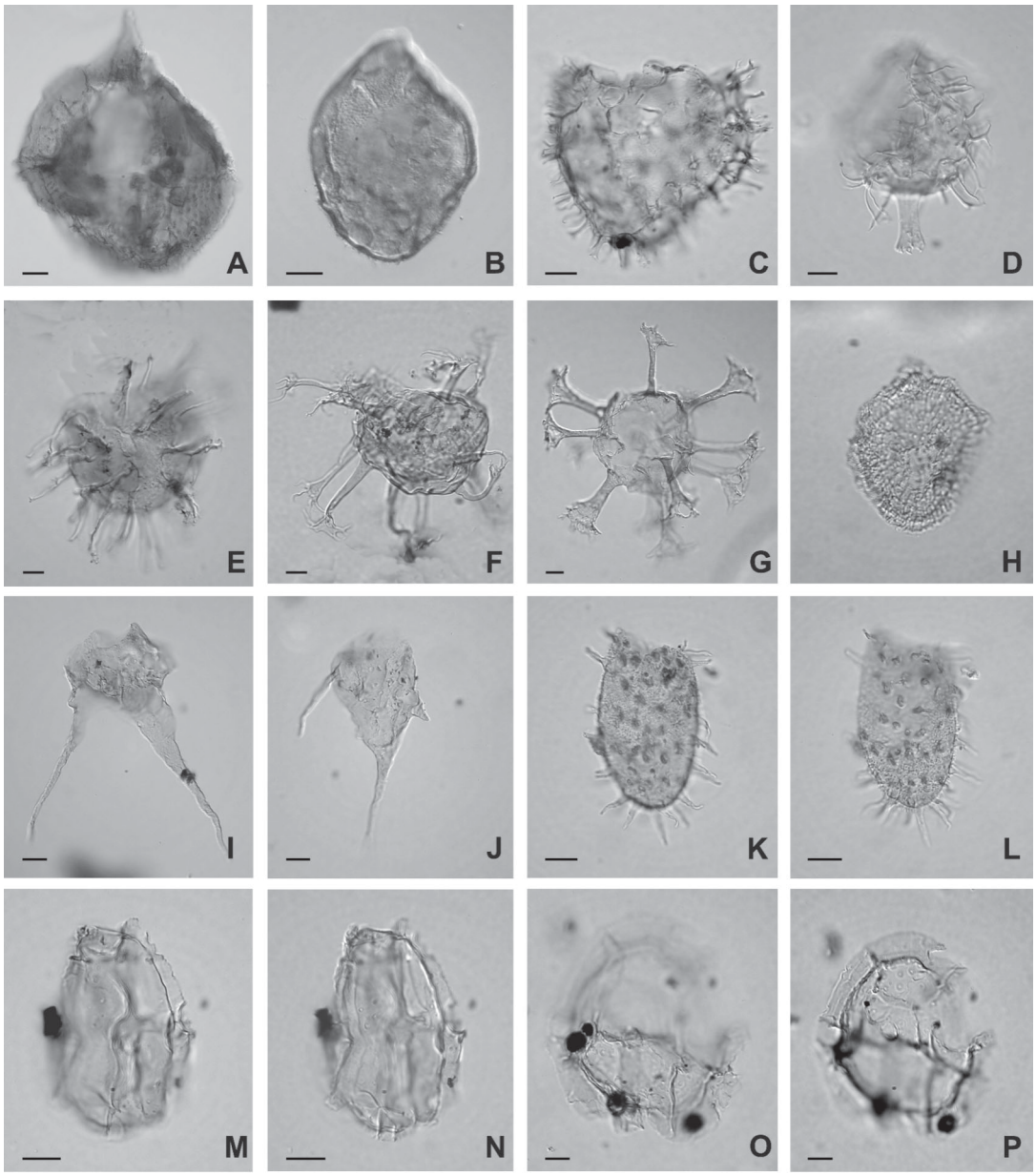

Fig. 3. **A**, *Cribroperidinium orthoceras* (Eisenack) Davey, PBC10E 51,2/103,5; dorsal view, intermediate focus. **B**, *Batiacasphaera* sp. cf. *B. granulosa* Cookson & Eisenack, PBC11C 40/107; dorsal view, low focus. **C**, *Circulodinium distinctum* (Deflandre & Cookson) Jansonius, PBC11C 43/108; dorsal view, low focus. **D**, *Coronifera oceanica* Cookson & Eisenack *emend.* May, PBC11C 36,5/111; right lateral view; high focus. **E,** *Systematophora cretacea* Davey, PBC11E 36,5/113; general view, intermediate focus. **F,** *Oligosphaeridium* sp., PBC12E 25,5/101,1; dorsal view, intermediate focus. **G**, *Oligosphaeridium pulcherrimun* (Deflandre & Cookson) Davey & Williams, PBC10D 46/99,8; oblique apical view, high focus. **H,** *Chlamidophorella nye* Cookson & Eisenack 1958, PBC11C 35/105; general view. **I**, *Odontochitina operculata* (Wetzel) Deflandre & Cookson, PBC10C 27,5/109; dorsal view, high focus. **J**, *Muderongia tetracantha* (Gocht) Alberti *emend.* Monteil, PBC10C 37/109; ventral view, high focus. **K, L,** *Prolixosphaeridium conulum* Davey, PBC13C 33/105; dorsal view; **K**, low focus; **L,** high focus. **M, N,** *Carpodinium granulatum* Cookson & Eisenack emend. Leffingwell & Morgan, 1977, PBC11D 50,5/104,5; dorsal view; **M,** intermediate focus; **N**, low focus. **O, P** *Dinopterygium cladoides* (Eisenack & Cookson) Stover & Evitt, PBC13B 34/104,5; apical-antapical view; **O**, high focus; **P**, low focus.

version of the manuscript. The financial support was given by grants from CONICET PIP 5093. Sample processing was carried out in the Museo Argentino de Ciencias Naturales «Bernardino Rivadavia» by Orlando Cárdenas.

REFERENCES

Aguirre Urreta, M. B. 2002. Invertebrados del Cretácico inferior. In: M.J. Haller (ed.), *Geología y Recursos Naturales de Santa Cruz*. Relatorio del XV Congreso Geológico Argentino, pp. 439-459.

Arbe, H. A. 2002. Análisis estratigráfico del Cretácico de la cuenca Austral. In: M.J. Haller (ed.), *Geología y Recursos Naturales de Santa Cruz*. Relatorio del XV Congreso Geológico Argentino, pp. 103-128.

Archangelsky, A. & M. Llorens. 2003. Palinología de la Formación Kachaike, Cretácico inferior de la cuenca Austral, provincia de Santa Cruz. I. Esporas lisas y cinguladas. *Ameghiniana*. 40: 71-80.

- 2005. Palinología de la Formación Kachaike, Cretácico inferior de la cuenca Austral, provincia de Santa Cruz. II. Esporas. *Ameghiniana*. 42: 311-328.

Baldoni, A. M. 1987. Dos nuevas especies de megaspores de la Formación Kachaike, Cretácico inferior de la Provincia de Santa Cruz, Argentina. *Anais do 10 Congreso Brasileiro de Paleontología*, Río de Janeiro, pp. 669-689.

Baldoni, A. M. & D. J. Batten. 1991. Megaspores from the Lower Cretaceous Kachaike Formation, Santa Cruz Province, Argentina. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* 162: 377-393.

Baldoni, A. M., R. A. Askin & D. Ragona. 2001. Palynology of the Lower Cretaceous Kachaike Formation, Santa Cruz Province, Argentina. In: D.K. Goodman & R. T. Clark (eds.), *Proceedings of the IX International Palynological Congress, AASP*: 191-200.

Cúneo, R. & M. A. Gandolfo. 2005. Angiosperm leaves from the Kachaike Formation, Lower Cretaceous of Patagonia, Argentina. *Review of Paleobotany and Palynology* 136: 29-47.

Fensome, R. A. & G. L. Williams. 2004. The Lentin and Williams Index of fossil dinoflagellates. 2004 edition. *American Association of Stratigraphic Palynologists Contributions Series* 42: 909 pp.

Gamerro, J. C. 1982. Informe palinológico del Perfil Arroyo Caballo Muerto, Santa Cruz. Y.P.F., Buenos Aires. Unpublished Report.

Guler, M. V. & S. Archangelsky. 2003. Quistes de dinoflagelados de la Formación Kachaike (Cretácico inferior), provincia de Santa Cruz, Argentina. *VIII Congreso Argentino de Paleontología y Bioestratigrafía. Abstracts,* p. 75.

Gradstein, F. M., J. G. Ogg, A. G. Smith, F. P. Agterberg, W. Bleeker, R. A. Cooper, V. Favydov, P. Gibbard, L. Hinnov, M. R. House, L. Lourens, H-P. Luterbacher, J. McArthur, M. J. Melchin, L. J. Robb, J. Shergold, M. Velleneuve, B. R. Wardlaw, J. Ali, H. Brinkhuis, F. J. Hilgen, J. Hooker, R. J. Howarth, A. H. Knoll, J. Laskar, S. Monechi, J. Powell, K. A. Plumb, I. Raffi, U. Röhl, A. Sanfilippo, B. Schmitz, N.J. Shackleton, G. A. Shields, H. Strauss, J. Van Dam, J. Veizer, Th. Van Kolfschoten and D. Wilson. 2004. A Geologic Time Scale. *Cambridge University Press*, 500 pp.

Helby, R., R. Morgan & A. D. Partridge. 1987. A palynological zonation of the Australian Mesozoic. In: P.A. Jell (ed.), *Studies in Australian Mesozoic palynology.* Association of Australasian Palaeontologists, Memoir 4 : 1-85.

Morgan, R. 1980. Palynostratigraphy of the Australian Early and Middle Cretaceous. Memoirs of the Geological Survey of New South Wales. *Palaeontology* 18 : 1-153.

Rebasa, M. 1982. Análisis estratigráfico y paleoambiental de la Formación Kachaike, aflorante en la barranca epónima, Provincia de Santa Cruz. Unpublished thesis, University of Buenos Aires, 52 pp.

Passalía, M. 2003. Hojas de angiospermas del Cretácico inferior del Bajo Comisión, Santa Cruz, Argentina. *XII Simposio Argentino de Paleobotánica y Palinología, Abstracts*, p. 45.

Passalía, M. & S. Archangelsky. 2002. La flora cretácica del Bajo Comisión, Lago San Martin, provincial de Santa Cruz. *VIII Congreso Argentino de Paleontología y Bioestratigrafía. Abstracts*, p.71.

Recibido: 10-X-2006
Aceptado: 8-XI-2006

Appendix

List of the dinoflagellate cysts encountered in this study. The following species are fully referenced by Fensome & Williams., 2004

Apteodinium granulatum Eisenack, 1958 *emend.* Lucas-Clark, 1987

Apteodinium sp.

Batiacasphaera sp. cf. B.granulosa Cookson & Eisenack, 1974. Fig. 3 B

Carpodinium granulatum Cookson & Eisenack 1962b *emend.* Leffingwell & Morgan, 1977. Figs. 3 M, N

Chichauoadininium boydii (Morgan 1975) Bujak & Davies, 1983

Chlamydophorella «ambigua» (Deflandre, 1937) Stover & Helby, 1987

Chlamydophorella nye Cookson & Eisenack 1958. Fig. 3 H

Circulodinium distinctum (Deflandre & Cookson, 1955) Jansonius, 1989 Fig. 3 C

Coronifera oceanica Cookson & Eisenack, 1958 *emend.* May 1980. Fig. 3 D

Cribroperidinium orthoceras (Eisenack, 1958) Davey 1969. Fig. 3 A

Cribroperidinium sp.

Dinopterygium cladoides (Eisenack & Cookson 1960) Stover & Evitt 1978. Figs. 3 O, P

Florentinia laciniata Davey & Verdier, 1973
Florentinia mantellii (Davey & Williams 1966) Davey & Verdier, 1973
Kiokansium unituberculatum (Tasch in Tasch *et al*. 1964) Stover & Evitt, 1978
Muderongia tetracantha (Gocht, 1957) Alberti, 1961 *emend*. Monteil, 1991. Fig. 3 J
Odontochitina operculata (Wetzel, 1933) Deflandre & Cookson, 1955. Fig. 3 I
Odontochitina shinghii Morgan, 1980
Odontochitina sp
Oligosphaeridium complex (White, 1842) Davey & Williams, 1966
Oligosphaeridium pulcherrimun (Deflandre & Cookson, 1955) Davey & Williams, 1966. Fig. 3 G
Oligosphaeridium sp. Fig. 3 F
Prolixosphaeridium conulum Davey 1969. Figs. 3 K, L
Prolixosphaeridium parvispinium (Deflandre, 1937b) Davey *et al.,* 1969
Spiniferites ramosus (Ehremberg, 1838) Mantel, 1954
Stephodinium sp.
Systematophora cretacea Davey 1979b. Fig. 3 E
Trichodinium castanea Deflandre, 1935