LATE CRETACEOUS PALYNOLOGICAL ASSEMBLAGES FROM EL FURRIAL AREA WELLS

ARMANDO FASOLA E IRAIDA PAREDES DE RAMOS
Departamento de Ciencias de la Tierra
INTEVEP, S.A.

ABSTRACT: Partial results of a geological study carried out in the Maturín Sub-basin are presented. Emphasis is made on the formational nomenclature, since (from the biostratigraphic point of view) it has been confirmed that the ages determined in subsurface cores, do not correspond with those established for the formations in outcrops. The palynological studies carried out on well samples from El Furrial field have shown the presence of a Late Campanian to Early Maastrichtian sequence with terrestrial and marine assemblages containing pollen, spores and dinoflagellates. Towards the top, the sequence contains paleosols, and the palynomorphs are scarce and non determinant. The Cretaceous paleoenvironments vary from marine nearshore to subaereal. In one of the studied wells, a rather thick section of glauconitic sandstone was found where Tertiary palynomorphs have been found. Immediately above this glauconitic section, more abundant Oligocene palynomorphs and foraminifers are present, thus indicating an important time gap not completely determined as yet. The paleoenvironments suggested for this Tertiary sequence are marine, probably from the shelf on the neritic zone.

RESUMEN: Se presentan los resultados parciales de un estudio geológico realizado en la subcuenca de Maturín. Desde el punto de vista bioestratigráfico, se pudo constatar que las edades establecidas para muestras de núcleos de pozos no concuerdan con las edades de las formaciones en afloramientos. Por esta razón, se presenta la nomenclatura formacional utilizada en el subsuelo. Los estudios palinológicos realizados a muestras de pozos del campo El Furrial demostraron la presencia de una secuencia de edad Campaniense Tardío a Maestrichtiense Temprano con conjuntos de palinomorfos terrestres y marinos que contenían polen, esporas y dinoflagelados. Hacia el tope, la secuencia presenta paleosuelos, y los palinomorfos son escasos y no determinantes. Los paleoambientes Cretácicos varían desde marinos costeros a subaéreos. En uno de los pozos estudiados se encontró una gruesa sección de arenisca glauconítica, la cual contiene palinomorfos Terciarios. Inmediatamente sobre esta sección glauconítica se encuentran abundantes palinomorfos y foraminíferos de edad Oligoceno, lo cual indica la ausencia de un importante espacio de tiempo aun no determinado. Los paleoambientes sugeridos para esta secuencia Terciaria son marinos, probablemente de la plataforma en la zona nerítica.

1. INTRODUCTION

The northern part of Monagas State, where El Furrial field is located, has been the subject of analysis of several geological studies, due to the discovery of large amounts of hydrocarbons in deep structures, south of the mountain front (Fig. 1). Latest works concerning these deep reservoirs are scarce and can be summarized as follows:

-A synthesis of the exploration activities carried out by LAGOVEN, S.A. during the last decade is presented by Carnevalli [1]. In this paper, the author includes a geological and geochemical summary of the northern part of the Maturín Sub-basin.

-A detailed structural and tectonic analysis of the Serranía del Interior-Maturín Sub-basin, was presented by Subieta *et al.* [2]. These authors showed the tectonic-stratigraphic ev— lution of this foreland-type basin, from its origin through filling and the consequences implied on the generati— migration and entrapment of hydrocarbons.

-Campos *et al.* [3] worked out a model of the geologic evolution of the basin, mainly for the Oligocene-Miocene section, aimed at orienting the exploration and at defining structural or stratigraphic hydrocarbon prospects for CORPOVEN, S.A. In order to establish the necessary regional correlations, Campos *et al.* used sequence analysis according to Vail and others, major resistivity changes, and noticeable paleobathymetric changes observed in the biostratigraphic studies of the sequences involved.

Palynological studies referring to the Cretaceous of Venezuela are scarce. Palynological assemblages have been described from surface and subsurface sections in the western and in the eastern areas of the country [4-10]. On the other

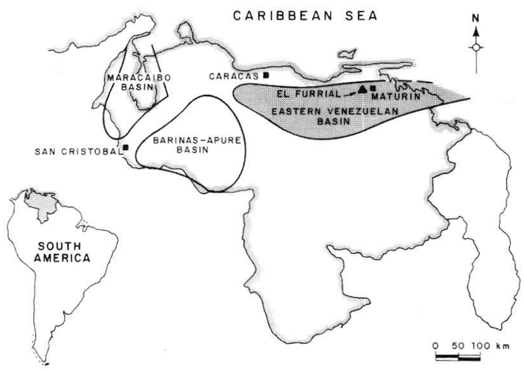

Fig. 1. Map of Venezuela showing the localities included in this study.

hand, there are also several unpublished internal reports of the oil companies describing characteristic palynomorph assemblages from different Cretaceous stages [11-15]. Reports of Cretaceous assemblages can be found in unpublished internal reports of INTEVEP, S.A. [16,17].

This article is aimed at presenting the biostratigraphic results obtained from the analysis of the Cretaceous sequence cut by wells FUL-6, FUL-12 and FUL-13. Emphasis is made on the palynological findings, to illustrate some of the most characteristic palynomorphs of the Cretaceous (Plates 1-3), and to compare the paleoenvironments suggested by palynomorphs and foraminifers in both the Cretaceous and the Tertiary sequences.

2. SECTION BETWEEN THE CARAPITA SHALE AND THE CRETACEOUS SEQUENCE

The formation names of subsurface geology in the area have been specially influenced by the stratigraphic nomenclature of the outcropping section to the north. Fig. 2 presents the formation names used in neighbouring areas on the northern and southern flanks of the Maturín Sub-basin.

During routine palynological studies carried out at INTEVEP, S.A. in the last few years, samples from wells of the Eastern Basin (Cuenca Oriental de Venezuela), containing assemblages of Cretaceous age, have been observed and described. These studies were complemented with the direct observation of the cores for sedimentological studies, and the use of petrophysical-petrographical tools. The information obtained has been reported in several internal reports such as those of wells COL-1, FUL-6, FUL-7, FUL-12 and FUL-13.

Three of these wells, studied in this article, are very close together and reached Cretaceous sequences sampled with cores. They are FUL-6, FUL-12 and FUL-13, drilled on El Furrial anticline and located approximately 20 km west of Maturín. Fig. 3 shows the location with respect to the other wells drilled in the area.

Among these Cretaceous assemblages, those obtained from the section of FUL-13 are of particular importance. The reason is that it was the most extensively cored well in the area (see Figs. 4 and 5), with about 1600 ft of continuous conventional cores through the Cretaceous-Tertiary sequence. Besides the preservation, which indicates in situ deposition and the stratigraphic and tectonic implications of their presence in those horizons, FUL-12 and FUL-6 have been cored at relatively older sequences.

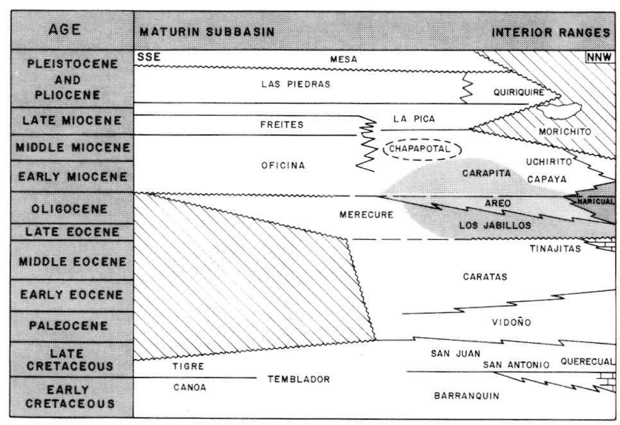

Fig. 2. Generalized stratigraphic column for the Maturín Sub-basin and the Interior Ranges (Modified from Carnevalli, 1988).

In the cored section of FUL-13 the first confirmed observation of Tertiary foraminifera, of Early Oligocene age range, occurred in a sandy-shaly sequence about 800 ft below the Carapita shale, where Truskowsky and Giffuni identified *Globigerina yeguaensis*, *Globorotalia increbescens*, *Cassigerinella chipolensis*, and *Globigerina* cf. *G. angustiumbilicata* [17]. Below this sequence, only fragments of microfossils of undetermined age were found.

Palynologically as well, Paredes and Terán report in this sandy-shaly sequence the first Tertiary palynomorphs, which suggest an age range of Eocene-Oligocene [17]. In the lowermost samples, there have been found, among others: *Polysphaeridium zoharyi*, *Hystrichokolpoma sp*, *Cicatricosisporites sp*, *Spirosyncolpites spiralis*, and *Homotrybilium sp*. The combined fossil content suggests marine paleoenvironments, with some terrestrial influence, probably located on the shelf on the neritic zone.

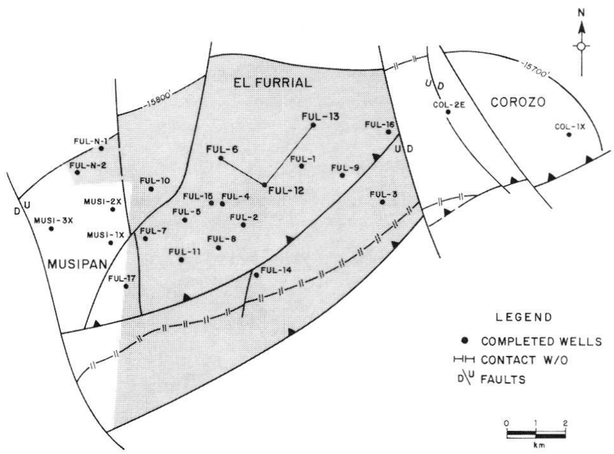

Fig. 3. Map of El Furrial field showing the location of the studied wells. The correlated section FUL-6, FUL-12, FUL-13 is indicated (Modified from Ghosh *et al.*, 1989).

The rest of the Tertiary sequence, upwards in the core, is considered Oligocene in age, with the subdivisions indicated in Fig. 4, based on the presence of palynomorphs like Tuberculodinium vancampoae [17] and species of foraminifera like Globigerina ciperoensis ciperoensis [17-18].

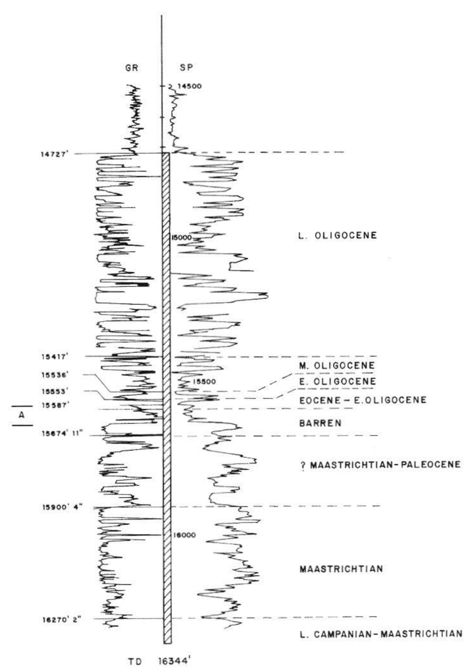

Fig. 4. Age determination resulting from palynological and micropaleontological analyses of the cored section (shaded in the graph) of well FUL-13. (A) Location of the condensed, glauconitic section in the core.

Sedimentologically, the Tertiary section seems to correspond to near shore bars and shale deposits of the shelf, built up on top of a condensed section with glauconite development [17].

This Tertiary sequence can be log correlated with wells FUL-6 and FUL-12 (Fig. 5). In well FUL-12 there are palynological and foraminiferal assemblages recovered from conventional cores, which suggest an Oligocene-Miocene age with foraminifera like Globigerina cf. G. venezuelana and G. praebulloides, and an Early-Middle Oligocene to Late Oligocene-Eary Miocene age containing palynomorphs, such as Cribroperidinium tenuitabulatum, Psilatricolporites crassus, Psilatricolporites triangularis, Operculodinium centrocarpum, Hystrichokolpoma rigaudae, Spirosyncolpites spiralis, Homotryblium floripes, Jandufouria seamrogiformis, Lingulodinium machaerophorum, Lejeunecysta sp, Polypodiisporites usmensis, Tuberculodinium vancampoae, and Perisyncolporites pokornyl.

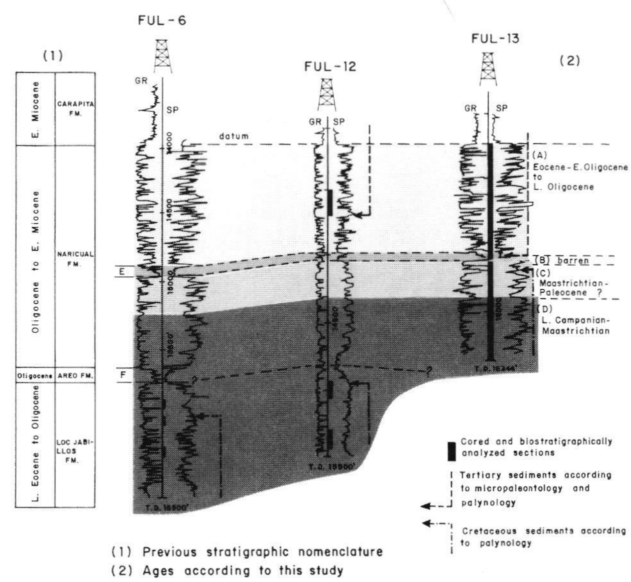

Fig. 5. Correlated GR and SP logs for the Cretaceous-Tertiary sequence in wells FUL-6. FUL-12 and FUL-13. (1) Subsurface stratigraphic nomenclature in use by the operating companies (Carnevalli, 1988). (2) Ages according to palynological and micro-paleontological studies. The most complete transitional sequence (well FUL-13) shows in (a): probable Eocene-Early Oligocene to Late Oligocene-Early Miocene foraminifera and palynomorph assemblages; in (b): absence of these groups of fossils; in (c): palynomorphs with known stratigraphic ranges from the Maastrichtian to the Paleocene, which might belong, as well, to a reworked flora; and in (d): a Late Campanian to Maastrichtian palynomorph assemblage. (e) and (f) indicate, respectively, the locations of the glauconitic section and the 150-feet shale referred in the text (Log correlation based on Ghosh *et al.*, 1989 and Sarzalejo de B. *et al.*, 1990).

3. THE LATE CRETACEOUS OBSERVED IN THE STUDIED CORES

It is difficult to locate precisely the Cretaceous-Tertiary unconformity, although it is apparently below the 60 ft thick condensed section in well FUL-13 (see Figs. 4 and 5).

The lower and middle parts of this condensed section are practically barren of palynomorphs, hindering the possibility of determining the age. Towards the upper part, however, abundant specimens of *Polysphaeridium zoharyi* were observed indicating a Tertiary age.

Below the condensed section there is an approximately 40 ft thick sequence, undetermined in age due to the absence of marker palynomorphs. Underlying this sequence, there is an interval with palynomorphs ranging in age from the Maastrichtian to the Paleocene. It is important to point out that Eocene or Oligocene palynomorphs were not found in these assemblages which, on the other hand, show a poor preservation. Due to this fact, the possibility of reworking cannot be discarded.

From this interval to total depth, the palynomorphs recorded are Late Cretaceous in age. The delimitation of the Cretaceous and the Tertiary through the study of other wells containing this sequence, is considered here of greatest importance.

In reference to other fossil groups, below the condensed section in FUL-13, no Cretaceous marker foraminifera were identified with certainty in assemblages mostly dominated by invertebrate fragments and other microfossils. Similarly, in the other two wells the studied samples were almost barren of foraminifera.

A selection of the palynomorphs which have helped in dating the Late Cretaceous sequence, is presented next. Illustrations of some of them are shown on Plates 1-3.

Andalusiella gabonensis
Ariadnaesporites spinosus
Buttinia andreevi
Cerodinium granulostriatum
Coronífera oceanica
Dinogymnium digitus
Dinogymnium euclaensis
Echitriporites trianguliformis
Ephedripites sp
Foveotrilletes margaritae
Icertae sedis
Perotriletes sp
Proxapertites cf. P. cursus
Proxapertites sp
Senegalinium sp
Spinizonocolpites baculatus
Spinizonocolpites echinatus
Zlivisporis blanensis

According to the literature, this assemblage restricts the age of the Cretaceous section to the latest Campanian - earliest Maastrichtian, even though some of the species range into earlier Cretaceous stages and others range into the Paleogene [4,6,18-23]. The forms of uncertain systematic position (Incertae sedis) illustrated in Plate. 2,. Figs. 9 and 11, have been previously observed by the authors in Maastrichtian samples from outcrops in the Western area of Venezuela [7] and is illustrated here in Plate 2, Fig. 12.

Starting at the base of the Cretaceous sequence studied in FUL-13, the variations of the observed paleoenvironments through time, as suggested by palynomorphs, begin with a marine-near shore facies, in which abundant and diverse dinoflagellates, together with terrestrial palynomorphs and terrestrial organic matter are present. This facies is followed by what has been suggested as marshes or lagoons, where dinoflagellates are almost absent and the terrestrial flora is scarce, with occasional predominance of fungal spores and hyphae. Next follows a terrestrial facies, partly subaereal, in which dinoflagellates are absent and sporomorphs are scarce and low in diversity. Observations of the core of FUL-13 clearly show paleosols and dessication structures at this depth. Finally, there is a facies with scarce palynomorphs, low in diversity. Dinoflagellates are also scarce, but their presence suggest marine incursions.

Similarly, sedimentological studies of the Cretaceous part of the core of FUL-13 confirm the palynological results, with the following observed sequences of sedimentary environments through time, starting at the base: bay deposits, amalgamated estuarine channels fill, bay deposits and near shore bars, estuarine channels fill, and development of near shore bars [17].

The section of FUL-13 just analyzed can be followed by and correlated with sections of approximately the same thickness, which developed above a 150 ft shale marker bed (see Fig. 5), in wells FUL-12 and FUL-6, and for which no sedimentological or biostratigraphic data are available.

Below the shale, however, palynological studies have demonstrated the presence of similar Late Cretaceous assemblages of predominantly terrestrial origin. They are slightly different from those of FUL-13 and they are thought to be slightly older in age due to stratigraphic position (see Fig. 5).

Age marker palynomorphs identified in the Cretaceous section of FUL-6 and FUL-12 are:

Andalusiella gabonensis
Arcellites sp
Ariadnaesporites sp
Ariadnaesporites spinosus

Biretisporites sp
Cerodinium sp
Concavissimisporites sp
Echitriporites trianguliformis
Ephedripites cf E. ambiguus
Ephedripites spp
Gabonisporis vigourouxii
Matonisporites sp
Matthesisporites sp
Perotriletes sp
Proxapertites cf P. cursus
Spinizonocolpites echinatus
Spinizonocolpites sp
Undulatisporites sp

The age suggested by this assemblage, specially by Andalusiella gabonensis, Ariadnaesporites spinosus, Echitriporites trianguliformis, and Spinizonocolpites echinatus, is Early to Middle Maastrichtian [18, 19, 21, 22, 23] (see Fig. 6).

The associations of palynomorphs present in this section, obtained from one core and cutting samples in the case of FUL-l2 and from two discontinuous cores in FUL-6, suggest a clear predominance of terrestrial origin as the source. Actually, in FUL-6 there is an abundance of plant material of terrestrial origin, and fungal spores and hyphae. Pollen and spores are variable in diversity and abundance. Freshwater forms such as Pediastrum, although very low in numbers, appear along the section.

Species present in the section, although in low numbers,

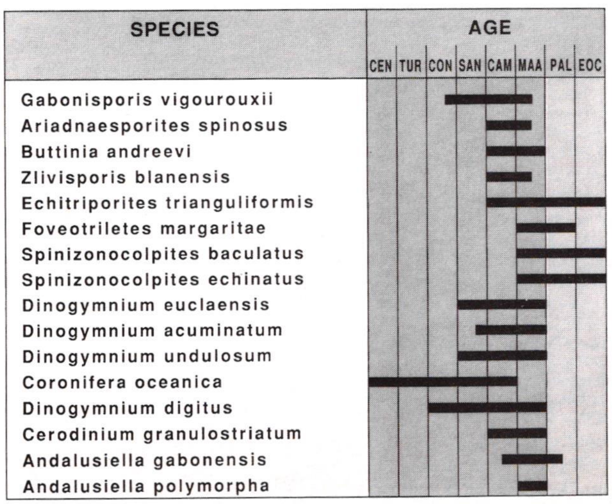

Fig. 6. Documented ranges of some of the palynomorph species present in the assemblages studied in FUL-13 and other wells of the Maturín Sub-basin. (Based on the works of Malloy, 1972; Jain and Millepied, 1973 [24]; Regali *et al.*, 1974; Williams and Bujak, 1985; Muller *et al.*, 1987).

such as Arcellites sp, Ariadnaesporites spp and Chomotriletes sp, have been suggested in the literature as belonging to plants of water habitats, and Echitriporites trianguliformis and Spinizonocolpites echinatus as representing an association of coastal environments [4, 25-27].

In well FUL-12, dinoflagellates and other marine forms of the microplankton have been found in small numbers in the core and in the last three cutting samples. This suggests terrestrial or strongly terrestrially influenced environments for the upper part, and marine, near shore paleoenvironments for the lower part of the Cretaceous section.

Sedimentological interpretations of the cores of these two wells demonstrate the presence, in FUL-6, of near shore to fluvial environments [16] and, in FUL-l2, of estuarine deposits [28].

In the three wells the palynological studies indicate that the paleoenvironments become slightly more marine towards the upper part of the Cretaceous section.

4. COMPARISONS WITH THE WESTERN AREA OF VENEZUELA. INDICATIONS OF SUBTROPICAL PALEOLATITUDES

The Cretaceous palynological assemblages from FUL-13, FUL-12 and FUL-6 wells, compare quite well with those observed in surface samples from sections of the Navay Formation of the western part of Venezuela.

Samples previously observed from sections at La Vueltosa on the Caparo River and Borde Seco on the Camburito River in the Andes region (Fig. 1), present a number of species in common with these subsurface samples in the Maturín Sub-basin.

The following species in La Vueltosa and Borde Seco sections can be mentioned:

Andalusiella gabonensis
Andalusiella polymorpha
Ariadnaesporites sp
Cerodinium granulostriatum
Cerodinium obliquipes
Cycloneophelium distinctum
Deltoidospora sp
Dinogymnium acuminatum
Dinogymnium cooksoniae
Dinogymnium digitus
Dinogymnium undulosum
Dinogymnium vozzhennikovae
Dinogymnium sp
Foveotriletes margaritae
Incertae sedis
Senegalinium bicavatum

Senegalinium laevigatum
Senegalinium microspinosum
Spinizonocolpites echinatus

According to the literature, the age suggested by these predominantly marine assemblages is Maastrichtian [7].

The Cretaceous marine microplankton of El Furrial wells, and those of the Navay Formation, belong to the Malloy Suite of dinoflagellates, present in Late Cretaceous sediments of North America, the mid Atlantic and northern South America.

In fact, the Late Cretaceous peridiniacean dinocysts exhibit a distinctive biogeographic distribution pattern which permits the delineation of several suites [29]. One of them, the Malloy peridiniacean suite, was named by Lentin and Williams [29] for Campanian assemblages containing characteristic species of genera such as *Andalusiella, Cerodinium, Lejeunecysta* and *Senegalinium* and, according to these authors, extends into Southern Spain, Senegal, Gabon, Brazil and Venezuela. The Malloy Suite was presumably restricted to tropical to subtropical paleolatitudes within the vicinity of the Campanian paleoequator.

5. FINAL REMARKS

The areal representation of the contact surface between the Cretaceous and the Tertiary, the nature of that surface considered as a physical barrier or transfer passage of hydrocarbons, and the petrophysical parameters of the Cretaceous sequence, are of interest in exploration.

If our assumptions are correct, the geometries and the strikes of the sedimentary sequences might have drastically changed during the 30 million years of the hiatus. This change becomes of extreme importance to establish the continuities of the sand bodies in the case of reservoirs.

Some of the palynological assemblages occur in what has been preliminary correlated in the field with the Tertiary Areo and Naricual Formations [30]. This view, however, contradicts the Cretaceous age of the assemblages in the subsurface section (see Fig. 5). Undoubtedly, it could be predicted that paleontological and sedimentological studies will become of considerable importance in the near future.

As a corollary of the biostratigraphic analysis, a revision of the subsurface stratigraphy in the area is needed, since the ages of the sequences, as determined from the present study, do not agree with the ages established for the formations in outcroping areas to the north.

AKNOWLEDGEMENTS

We would like to thank our colleagues Argenis Rodríguez, Andreína Isea and Wolfgang Scherer for their suggestions which helped to improve this paper, and Solángel Alfonzo for her help in preparing the plates.

REFERENCES

1. CARNEVALLI, J. Venezuela nor-oriental: exploración en frente de montaña. In *III Simposio Bolivariano, Exploración Petrolera de las Cuencas Subandinas*, Caracas, 1:69-89. 1988.
2. SUBIETA, T.; CARNEVALLI, J.; HUNTER, V. Evolución tectonoestratigráfica de la Serranía del Interior y de la Subcuenca de Maturín. In *III Simposio Bolivariano, Exploración Petrolera de las Cuencas Subandinas*, Caracas; 2:548-578. 1988.
3. CAMPOS, V.; DE JANVRY, H.C.; DAAL, A.; MONTES, G.B.; GONZALEZ, A.; HERNANDEZ, J.; PINZON, J. Síntesis tectónico-estratigráfica del Norte de Anzoátegui-Monagas y su aplicación en la exploración de hidrocarburos. In *III Simposio Bolivariano, Exploración Petrolera de las Cuencas Subandinas*, Caracas;1:376-400. 1988.
4. GERMERAAD, J.H.; HOPPING, C. A.; MULLER, J. Palynology of Tertiary sediments from tropical areas. *Review of Palaeobotany and Palynology*, 6:189-348. 1968.
5. SINANOGLU, E. Early Cretaceous palynomorphs from the Zuata area, eastern Venezuela. *Bol. Inst. Geociencias U.S.P.*, 15:116 128. 1985.
6. MULLER, J.; DI GIACOMO, E.; VAN ERVE, A.W. A palynological zonation for the Cretaceous, Tertiary and Quaternary of northern South America. *American Association of Stratigraphic Palynologists Contribution Series*, 19:7-76. 1987.
7. FASOLA, A.; PAREDES, I. Palynological study of Cretaceous sections in western Venezuela. Abstracts of Proceedings XIX Annual Meeting American Association Stratigraphic Palynologists. *Palynology*, 11: 226. 1987.
8. FASOLA, A. Mid and Late Cretaceous dinoflagellate assemblages of Venezuela. In *7th International Palynological Congress*, Brisbane; Abstracts: 48. 1988.
9. PAREDES, I; FASOLA, A. Cretaceous Palynology of Venezuela. In *Second Geological Conference, the Geological Soc. of Trinidad and Tobago*, Port of Spain; Programme and Abstracts:10. 1990.
10. DI CROCE, J.; TRUSKOWSKI, I.; FASOLA, A.; GHOSH, S.; LAMBERTINI, R. *Estudio geológico del pozo COL-1*, Norte de Monagas. Inf. Técn. Nº. INT-EPCT-00004,90. INTEVEP. S.A. Los Teques, 1990.

11. VAN ERVE, A. *Esporomorfos del Cretácico de Venezuela.* Informe N° EPC-7886, Maraven, S.A. Caracas. 418 p. 1985.

12. PAREDES DE RAMOS, I. *The stratigraphy, palynology and palaeoenvironments of selected core samples from the MERST-1, MERCEDES-I and MERCEDES-194 wells, Cuenca Oriental de Venezuela.* Report N°. 2669P/F. Robertson Research Intl. Ltd. Llandudno, England. 1981.

13. PAREDES DE RAMOS, I. *Estudios palinológicos de los pozos MCH-3-5X y MCH-2-4X, area Machete.* lnf. Técn. N°. INT-00868,83. INTEVEP, S.A. Los Teques, 1983.

14. FASOLA, A.; MACQUHAE, M. DE; P. DE RAMOS, I. *Bioestratigrafía de la sección muestreada con núcleos en el pozo 27-ME-124, campo Melones.* Inf. Técn. N°. INT-00690,83. INTEVEP, S.A. Los Teques, 1983.

15. MAGUREGUI, J.; EURIBE, A. *Estudio geológico del núcleo del pozo MCH-6-3X, área Machete, Faja Petrolífera del Orinoco.* Inf. Técn. N°. INT-01031,84. INTEVEP, S.A. Los Teques, 1984.

16. GHOSH, S.; ISEA, A.; TRUSKOWSKI, I.; AGUADO, B.; FASOLA, A.; DE RAMOS, I.; COLMENARES, O.; DI CROCE, J.; GIFFUNI, G.; TERAN, L.; DE MACQUHAE, M.; PEREZ, C. *Proceso-respuesta sedimentaria. Estudio sedimentológico-bioestratigráfico de las áreas El Furrial-Musipán-Carito, norte de Monagas.* lnf-Técn. N° INT-02033,89. INTEVEP, S.A. Los Teques, 1989.

17. ISEA. A.; AGUADO, B.; PARNAUD, F.; PASCUAL, J.C.; P. DE RAMOS, I.; TERAN, L.; TRUSKOWSKI, I.; GIFFUNI, G. *Caracterización del yacimiento en el área El Furrial-Musipán: sección Oligocena.* Inf. Técn. N°. INT-EPCT-00001,90. INTEVEP, S.A. Los Teques, 1990.

18. HERNGREEN, G.F.W. Palynology of middle and Upper Cretaceous strata on Brazil. *Mededdelingen Rijks Geologische Dienst*, 26: 39-91. 1975.

19. HERNGREEN, G.F.W.; CHLONOVA, A.F. Cretaceous microfloral provinces. *Pollen et Spores*, 23:441-555. 1981.

20. MALLOY, R.E. An Upper Cretaceous dinoflagellate cyst lineage from Gabon, West Africa. *Geoscience and Man*, 4:57-65. 1972.

21. WILLIAMS, G. L.; BUJAK, J.P. Mesozoic and Cenozoic dinoflagellates. In *Plankton Stratigraphy.* H.M. Bolli *et al.* (Ed). Cambridge, England; 847-964. 1985.

22. REGALI, M. S. P.; UESUGUI, N.; SANTOS, A.S. Palinologia dos sedimentos meso-cenozóicos do Brasil (I). *Boletim Técnico Petrobras*, 17: 177-190.1974

23. REGALI, M.S.P.; UESUGUI, N.; SANTOS, A.S. Palinologia dos sedimentos meso-cenozóicos do Brasil (II). *Boletim Técnico Petrobras*, 17: 263-301. 1974.

24. JAIN, K.P.; MILLEPIED, P. Cretaceous microplankton from Senegal Basin, N.W. Africa. 1. Some new genera, species and combinations of dinoflagellates. *Palaeobotanist*, 20:22-32. 1973.

25. HUGHES, N.F. Jurassic and Early Cretaceous pollen and spores. In *Aspects of Palynology.* R. H. Tschudy and R.A. Scott (Eds). New York; Wiley lnterscience, 1969. 311-329.

26. GUNTHER, P.; HILLS. L.V. Heterospory In Arladnaesporites. *Pollen et Spores*, 12:123-130. 1970.

27. ROSSIGNOL, M. Analyse pollinique de sediments marins Quaternaires en Israel. II. Sediments Pleistocenes. *Pollen et Spores*, 4:121-148. 1962.

28. SARZALEJO DE BAUDUHIN, S.; PAREDES DE RAMOS, I.; GIFFUNI., G. *Evaluación geológica de los núcleos del pozo Ful-12, norte de Monagas.* lnf. Técn. No. INT-EPCT-00003,90. INTEVEP, S.A. Los Teques. 1990.

29. LENTIN, J.K.; WILLIAMS, G.L. Dinoflagellate provincialism, with emphasis on Campanian Peridiniaceans. A.A.S.P. *Contribution Series*, 7:1-47. 1980.

30. GONZALEZ DE JUANA, C.; ITURRALDE, J.M.; PICARD, C.X. *Geología de Venezuela y sus cuencas petrolíferas*; Caracas, Ediciones Foninves, 1980. 1031 p.

PLATE 1

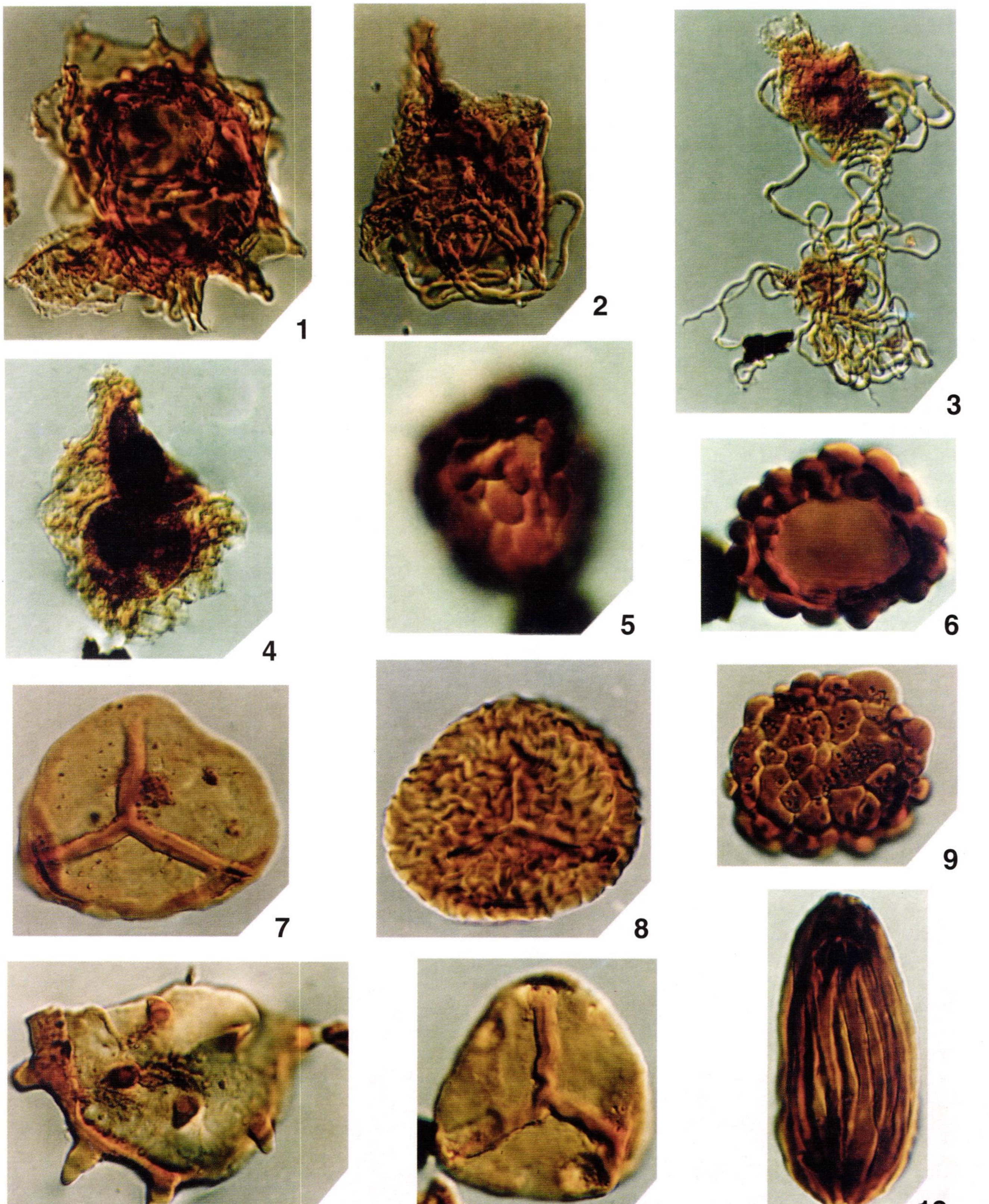

PLATE 2

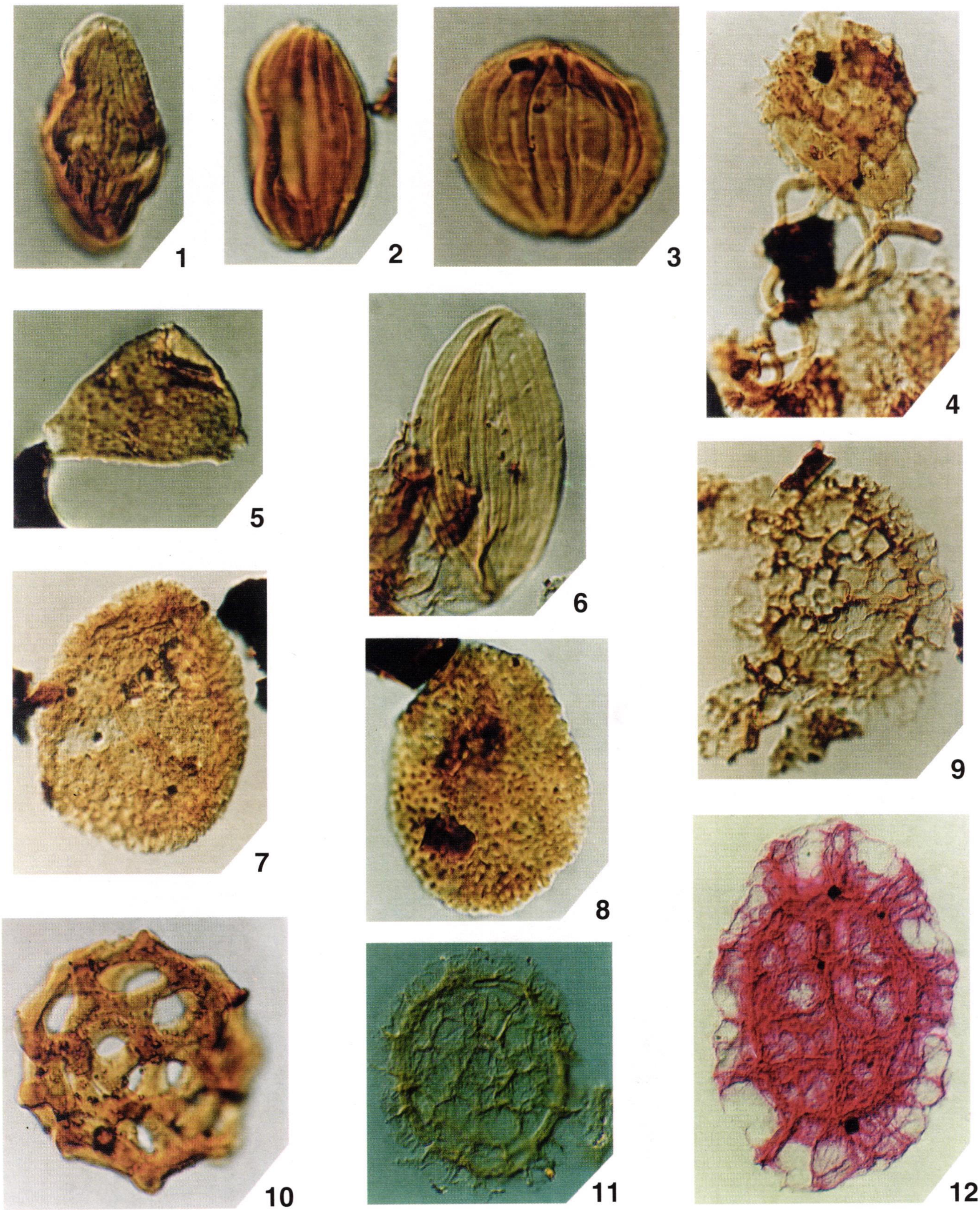

PLATE 3

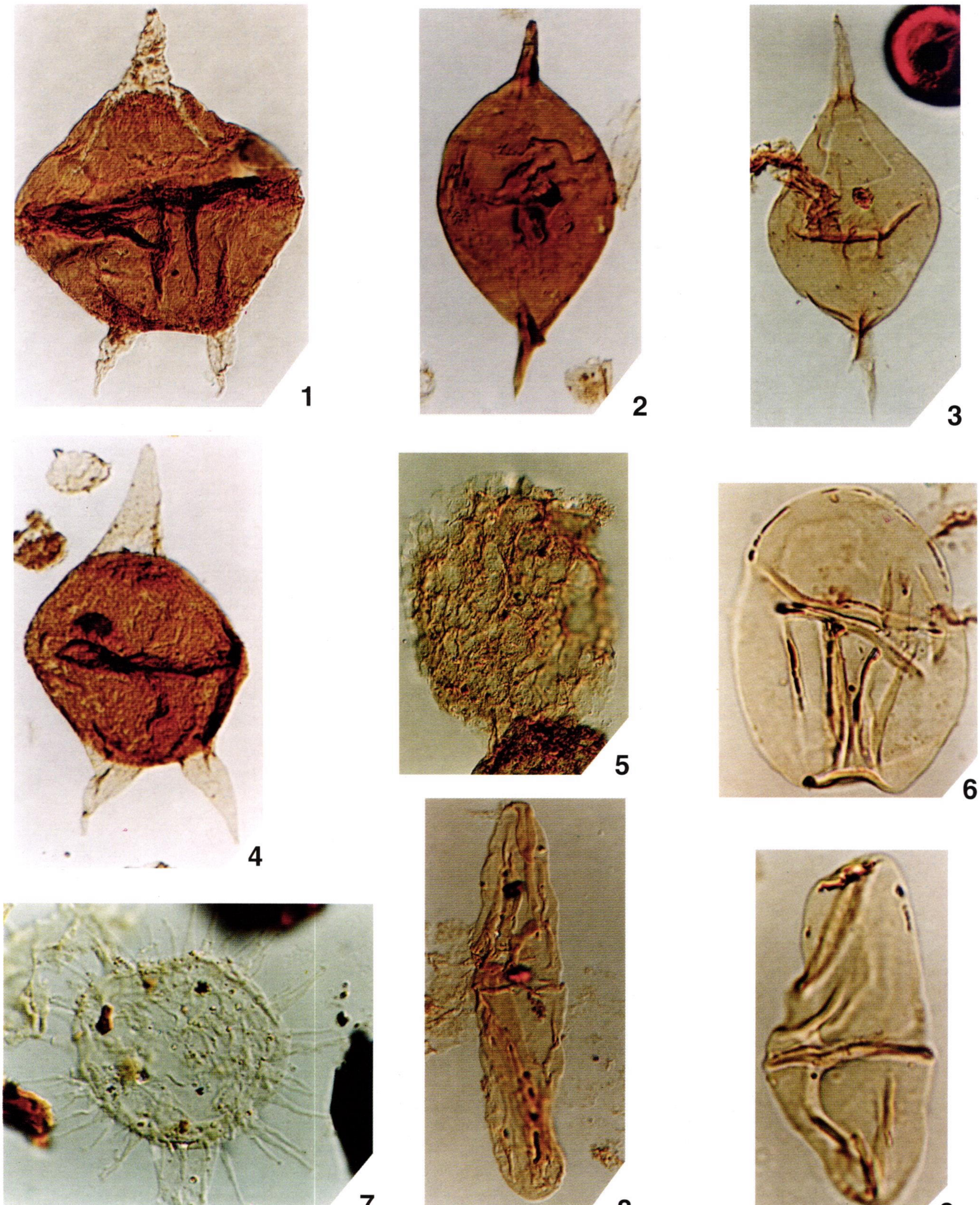

PLATE 1

1 Arcellites sp; well FUL-12, 14993, 820X

2 Ariadnaesporites spinosus (Elsik) Hills; well FUL-12, 15374'6", 820X

3 Ariadnaesporites spinosus (Elsik) Hills; well FUL-6, 16232', 540X

4 Arcellites sp; well FUL-6, 16004'5", 540X

5, 6 Matthesisporites sp; well FUL-6, 16197', 1320X

7 Biretisporites sp; well FUL-12, 15067'6", 1320X

8 Rugulatisporites sp; well FUL-6, 16189'9", 1320X

9 Matthesisporites sp; well FUL-12, 15330'7", 1320X

10 Spinizonocolpites echinatus Muller; well FUL-6, 16232'. 1320X

11 Undulatisporites sp; well FUL-6, 16232', 1320X

12 Ephedripites sp; well FUL-12, 15330'7", 1320X

PLATE 2

1 Ephedripites ambiguus Hedlund; well FUL-6, 16232', 1320X

2 Ephedripites sp; well FUL-12, 14993'. 1320X

3 Ephedripites sp; well FUL-12, 15374'6", 1320X

4 Ariadnaesporites spinosus (Elsik) Hills; well FUL-13, 16308'9", 920X

5 Echitriporites trianguliformis Van der Hammen; well FUL-6, 16195', 1320X

6 Ephedripites sp; well FUL-6, 16194', 1320X

7 Gabonisporis sp; well FUL-6, 16232', 820X

8 Proxapertites cf P. cursus Van der Hammen; well FUL-12, 15372'6", 1320X

9 Incertae sedis; well FUL-13, 16335', 820X

10 Buttinia andreevi Boltenhagen; well FUL-13, 15944'8", 1320X

11 Incertae sedis; surface sample Navay Fm., 820X

12 Incertae sedis; surface sample Navay Fm., 820X

PLATE 3

1 Cerodinium granulostriatum (Jain and Millepied) Lentin and Williams; surface sample Navay Fm., 820X

2 Andalusiella gabonensis (Stover and Evitt) Wrenn and Hart; well FUL-13, 16331'4", 600X

3 Andalusiella gabonensis (Stover and Evitt) Wrenn and Hart; surface sample Navay Fm., 820X

4 Cerodinium granulostriatum (Jain and Millepied) Lentin and Williams; well FUL-13, 16343'9", 600X

5 Incertae sedis; well FUL-13, 16319', 820X

6 Dinogymnium euclaense Cookson and Eisenack; well FUL-13, 16332', 1450X

7 Coronifera oceanica Cookson and Eisenack; well FUL-13, 16308'9", 1120X

8 Dinogymnium digitus (Deflandre) Evitt *et al.*; surface sample Navay Fm., 920X

9 Dinogymnium digitus (Deflandre) Evitt *et al.*; well FUL-13, 16332', 1840X