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DEVONIAN SPORES FROM THE PERTNJARA FORMATION AMADEUS BASIN, NORTHERN TERRITORY.

by

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CONTENTS

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SUMMARY

A spore assemblage from a cuttings sample of the Pertnjara Formation in the Exoil Mereenie Water Bore No.2 is described. It consists of only a few spores but these include diagnostic ones such as Geminospora lemurata, Radiospora sp. and Ancyrospora spp. which indicate that the sample is of Devonian age. The spores are compared with similar forms from Australia and overseas and their value in determining the position of the sample in relation to the standard Devonian succession is discussed.

INTRODUCTION

After the failure to obtain an adequate supply of water from the first water bore drilled in the Mereenie Sandstone near Exoil Mereenie No.1 Well, Amadeus Basin, Northern Territory, a second bore was drilled several miles to the east at latitude 23°59'25"S, longitude 133°33'06"E to a total depth of 720 feet. The well commenced in a siltstone in the lower part of the Pertnjara Formation and finished in a water-bearing sandstone thought to be that sandstone which contains Middle or Upper Devonian Bothriolepis remains (J.G. Tomlinson, pers. comm.) in outcrop above the Mereenie Sandstone.

OBSERVATIONS

All available cuttings from the Mereenie Water Bore No.2 were inspected and one sample, from 680-700 feet was considered suitable for palynological study. The remainder were too oxidized to contain palynomorphs. The cuttings from 680-700 feet contained a few spores which, although carbonized, were well preserved. The forms recorded in the sample include:-

Leiotriletes sp. 168 (*)

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*All form-species listed or described here, whether or not they have been published, are allocated numbers (e.g. Ancyrospora sp. 180) which correspond to their catalogue number in the B.M.R. palynology type collection.

Geminospora lemurata Balme (sp.169) (relatively abundant)

Lophozonotriletes sp. 170 (rare)

Radiaspora sp. 178

Auroraspora cf. A. micromanifestus (Hacquebard) (sp.179) (rare)

Ancyrospora sp. 180

Ancyrospora sp. 181

Ancyrospora cf. A. simplex Guennel (sp. 182)

These spores are briefly described below and illustrated in Plate 1. ‡

‡ The specimens shown in this plate occur in two permanent slides (MFP 3128.1 and MFP 3128.2) of the B.M.R. palynology slide collection. Their position in the slides is given, in tenths of a millimetre, relative to a zero mark on the slide, according to the method outlined by Traverse (1958).

Genus Leiotriletes (Naumova 1953) Potonié and Kremp, 1954

Leiotriletes sp.. 168

Plate 1, Figure 1

Description (based on eight specimens) - Spore diameter 40-45μ, shape semiangular to circular in polar view. The relatively flat contact areas give the proximal face a slightly pyramidal shape, the distal face is slightly convex. The Y-mark, 1.5-2 μ wide, has labra and is surrounded by a darkened area which narrows gradually towards the equator and broadens sharply to about 3-4μ wide at the equator. Exine psilate, but under oil immersion fine concentric lines can be seen on the proximal surface.

Genus Geminospora Balme 1960

Geminospora lemurata Balme 1960 (sp.169)

Plate 1, Figures 2 and 3

Description (based on eleven specimens) - Spore diameter 39-66μ. Outline semiangular to circular in polar view, proximal face pyramidal, distal face slightly convex. The spore consists of a 3-5μ thick exoexine enclosing a smooth thin-walled (1μ thick) mesosporoid of circular outline in polar view. The Y-mark is of uniform thickness of about 1μ, it has weak labra and extends almost to the equator of the mesosporoid. In some specimens the exoexine is clearly made up of two layers of comparable thickness; a light inner layer and a darker outer one which on the distal surface is ornamented with irregularly shaped granules less than 1μ high and up to 1μ wide. Figure 3 shows a specimen in which the exoexine is partially separated from the mesosporoid and which has a darkening of the exoexine above the Y-mark. A similar darkening of the exoexine is shown in Figure 2 but in this specimen the darkening is confined to the immediate vicinity of the distal pole.

Genus Lophozontriletes (Naumova, 1953) Potonié 1958

Lophozonotriletes sp. 170

Plate 1, Figure 4

Description (based on two specimens)- Spore diameter 50-56μ, shape circular in polar view, distal face convex. The strong concavity of the proximal face of the specimen illustrated in Figure 4 may be a preservational effect. Dehiscence indistinct but bounded by well defined, slightly sinuous, raised lips (2μ high) which extend about two thirds of the way along the radius of the spore. The spore has a dense cingulum 4-7μ thick. Ornamentation of the proximal face consists of fine (less than 0.5 μ) granules which are concentrated on the cingulum and give it a dark appearance when the spore is examined with a low magnification objective. The distal face is ornamented with 4-6μ diameter, 1.5-3μ high granules which are between 3-6μ apart, have irregular bases and are frequently mammilate.

Genus Radiaspora Hoffmeister, Staplin and Malloy 1955

Radiaspora sp. 178

Plate 1, Figure 5

Description (based on four specimens)- In polar view the spore has a rounded triangular outline, the distal face is slightly convex and the proximal face pyramidal. The Y-mark is about 1μ wide at the proximal pole and tapers slightly towards its termination just short of the equator. On the distal surface the exine forms radial thickenings which originate at the equator, where they are 2-5μ apart and 1-2μ wide, and taper to a width of about 1μ halfway along the radius of the spore. From this point most of the ribs continue less strongly to the distal pole.

Comments - This form is similar to Radiaspora sp. A Balme 1960 except that its radial ribs are located on the distal surface. In this respect the Mereenie Water Bore specimens conform to the original generic diagnosis. Because the specimens were compressed, Balme (1960) was uncertain of the exact position of of the radial ribs of his Radiaspora sp. A from the Gneudna Formation of the Carnarvon Basin, Western Australia, but concluded that they were proximal. He suggested that Radiaspora sp. A should accordingly be placed in Emphanisporites McGregor 1960.

Genus Auroraspora Hoffmeister, Staplin and Malloy 1955

Auroraspora cf. A. micromanifestus (Hacquebard 1957) (sp. 179)

Plate 1, Figure 6

Description (based on two specimens) - Overall diameter 52μ, diameter of spore body 28-30μ, body outline subtriangular with strongly convex sides. Central body is dark, dense and is completely enclosed within a delicate, transparent bladder which has an irregular subtriangular outline in polar view. The body wall is 2-3μ thick and the bladder, at the equator, 5-7μ. The bladder, which is without a limbus, has broad-based, irregularly-shaped

projections up to 15μ long some of which have bifurcating tips. The Y-mark is thin (about 1μ) and extends to the equator of the spore body. On the bladder a slightly sinuous dark ridge runs parallel to the Y-mark and extends to the proximo-distal margin of the bladder.

Comments - The genus Auroraspora Hoffmeister, Staplin and Malloy 1955 includes spores with a dark subtriangular to subcircular central body completely enclosed in a delicate transparent bladder. Auroraspora is readily distinguishable from Endosporites which has a limbus and a central body which approximates the bladder in thickness. Cosmosporites is similar to Auroraspora but is ornamented with small cones or spines.

The Mereenie Water Bore specimen shown in Figure 6 conforms to the diagnosis of Auroraspora. It is structurally very similar to A. macromanifestus (Hacquebard) which includes Type A of Lang (1925) but is much smaller, having a diameter of only 52μ, compared with the 102-254μ of A. macromanifestus. It is therefore referred to as Auroraspora cf. A. micromanifestus (Hacquebard).

Genus Ancyrospora Richardson 1960

Ancyrospora sp. 180

Plate 1, Figure 7

Description (based on one specimen) - The specimen shown in Figure 7 is lighter in colour, less compressed and has many more bifurcating spines than others ascribed here to the genus Ancyrospora. It is rounded triangular in outline and has an overall diameter of 77μ. The diameter of the mesosporoid is 50μ. The Y-mark is clearly defined, straight and thin and tapers slightly towards the equator. It has low lips but the intexine of the mesosporoid is not folded back from the Y-mark as it is in Ancyrospora cf. A. simplex Guennel. On the psilate proximal face of the exoexine a Y-shaped ridge mirrors the Y-mark of the mesosporoid. The intexine is 1.5μ thick and the exoexine 3-5 μ thick. The exoexine on the distal surface is finely pitted and bears a number of 7-15μ long spines, approximately 7-15μ apart with bases 7-15u wide which taper to 2-3μ wide at about half or two thirds of the length of the spine and thence continue parallel-sided to terminate in anchor-shaped processes. The heads of the anchors are about 5-6u wide. Some spines taper sharply at the base and therefore have a longer parallel-sided section.

This species is distinguished from Ancyrospora sp. 181 and sp. 182 by the large size of its mesosporoid relative to overall diameter, by the relative abundance of its spines, most of which bifurcate and have broad bases and only a relatively short parallel sided section and by the fact that the intexine of the mesosporoid is not folded back from the Y-mark.

TABLE 1 SUMMARIZED CHARACTERISTICS OF ANCYROSPORA SPP. 180, 181, AND 182

	Ancyrospora sp. 180	Ancyrospora sp. 181		Ancyrospora cf. A. simplex Guennel (sp. 182)		
Location	MFP 3128.1/153.0141	MFP3128.1/111.0072	MFP 3128. 2/142.0149	MFP 3128.1/102. 0137	MFP 3128. 1/090.0121	MFP 3128.1/084 .0144
Plate 1 Figure	7	8	not figured	9	10	11
Body shape	Sub-circular	sub-circular	sub-circular	sub-circular	sub-circular	sub-circular
Overall diameter	77µ	135µ	112µ	85µ	89µ	63µ
Body Diameter	50µ	55µ	55µ	39µ	40µ	35µ
Y-mark	distinct	indistinct	indistinct	distinct	distinct	distinct
Proximal face	flat	pyramidal	slightly pyramidal	flat	flat	slightly pyramidal
Distal face	convex	slightly convex	slightly convex	flat	slightly convex	convex
Intexine thickness	1.5µ	1.5-3µ	1.5-3µ	1.5-3µ	1.5-3µ	1.5-2µ
Exoexine thickness	3.5µ	4-7µ	4-5µ	5-6µ	5-6µ	3-5µ
Flange	none	10-15µ	7-10µ	none	none	none
Pseudoflange	less than 5µ	none	none	5-10µ	7-10µ	?5-7µ
Spine length	7-15µ	15-35µ	10-25µ	5-15µ	7-20µ	5-7µ
Spine shape						
all		anchor shaped tips				
most	broad based with anchor-shaped tips		anchor-shaped tips.	spines with tips (?) broken off.	blunt and, with broad bases	blunt, with broad bases with bifurcating tips
some	narrow based with parallel sides and anchor-shaped tips		spines with tips (?) broken off	with anchor-shaped tips	narrow with anchor-shaped tips	
Other features	slight exoexine ridge		intexine slightly folded back from Y-mark	exoexine ridge intexine very slightly folded back from Y-mark	exoexine ridge intexine folded back from Y-mark	exoexine ridge intexine folded back from Y-mark.

Ancyrospora sp. 181

Plate 1, Figure 8

Description (based on three specimens) - This form is distinctive in that it is large (overall diameter, including spines, up to 135μ), has only the long bifurcating type of spine and a relatively small body (50-55μ) with a circular to semiangular shape in polar view. The Y-mark is indistinct but its position is clearly defined by the pyramidal shape formed by the contact areas; the distal face is slightly convex. The exine has two layers, the intexine which is 1.5-3μ thick and the exoexine which is 4-7μ thick. The exoexine extends equatorially as a flange 7-15μ wide and on the distal surface, where it is finely pitted, forms spines 10-35μ long. The spines have broad bases (7-10μ wide), taper sharply to a parallel sides 3-4μ wide midsection and terminate in an anchor-shaped process 5-8μ wide. Some specimens have open ended conical processes which apparently are the bases of bifurcating spines from which the ends have been broken. These open ended spines indicate that the bifurcating types are at least partly hollow, although the relatively high refractive index of most of the anchor shaped terminations indicates that this part of the spine is solid.

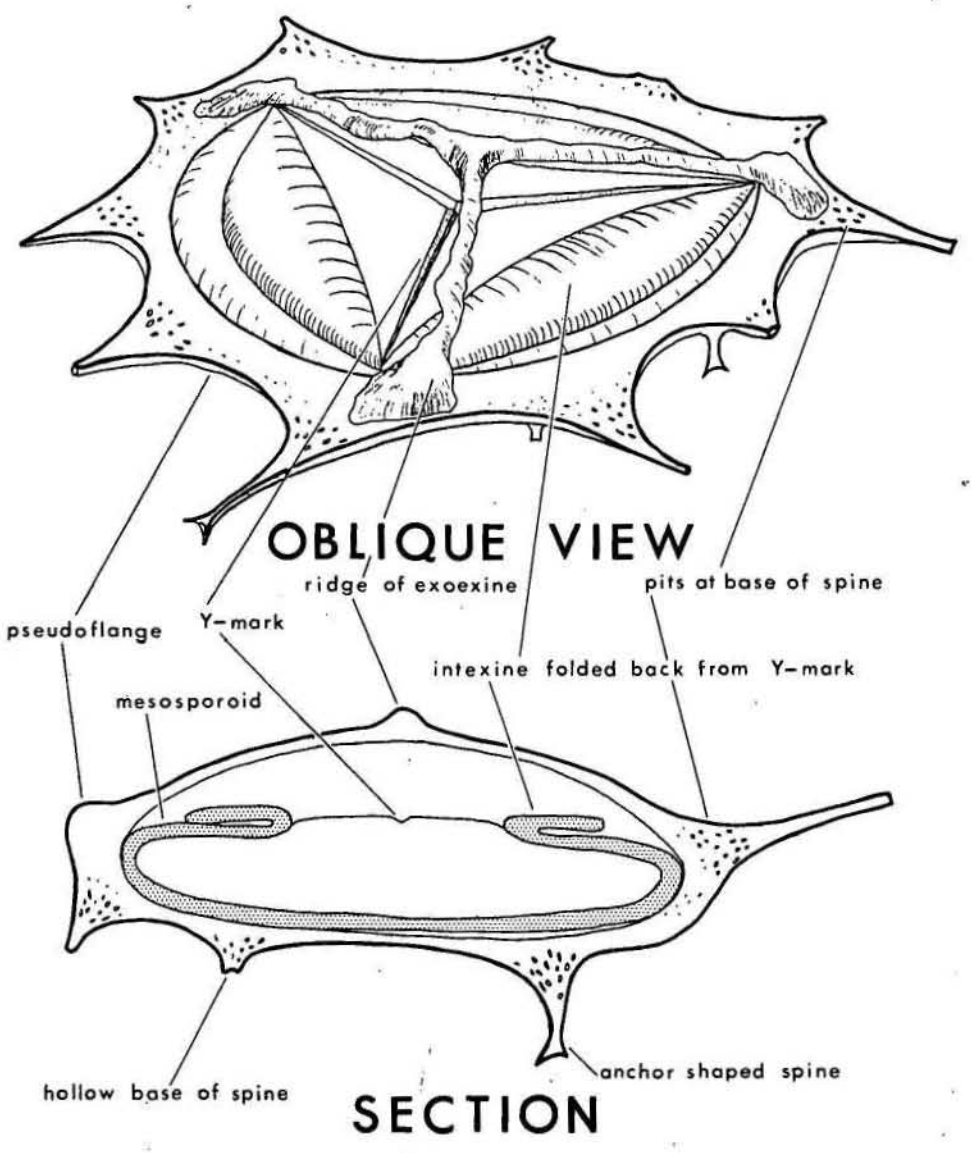
Ancyrospora sp. 181 differs from Ancyrospora sp. 180 and sp. 182 in its large overall size (greater than 100μ), its indistinct Y-mark, its possession of an equatorial flange rather than a pseudoflange and by the fact that it has long spines most of which terminate in anchor-shaped processes.

Ancyrospora cf. A. simplex Guennel 1963 (sp. 182)

Plate 1, Figures 9,10 and 11; Text figure 1

Description (based on twenty-two specimens) - Outline of exoexine, excluding spines, circular to rounded triangular, body outline circular. Overall diameter including spines 63-90μ, body diameter 35-42μ. The spore consists of a psilate mesosporoid enclosed in a pitted exoexine which equatorially and distally develops broad-based spines. Many specimens have the intexine of the mesosporoid folded back from the Y-mark to produce a light coloured, triangular shaped area. Figures 9,10 and 11 illustrate various degrees of development of this condition. Above the straight Y-mark (1-1.5μ wide) the exoexine forms a sinuous Y-shaped ridge which runs parallel to the Y-mark and terminates in three darkened, thickened areas at the angles. No equatorial extension of the exoexine is present but a pseudoflange (5-10μ wide) is formed by the union at the equator of the broad bases of the spines. The spores shown in Figures other 9, 10 and 11 have only a few bifurcating spines but most of their spines seem to have open ends which indicate that their terminations, perhaps bifurcating, have been broken off. Text figure 1 shows a hypothetical reconstruction of Ancyrospora cf. A. simplex Guennel.

Ancyrospora sp. 182 is distinguished from Ancyrospora 180 and 181 by the triangular shaped area which is formed by the folding back of the intexine of the mesosporoid from the Y-mark



TEXT FIGURE 1 Interpretation of the structure of *Ancyrospora* cf. *A.simplex* Guennel (sp.182)

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and by the strong sinuous ridge of exoexine which on the proximal side runs parallel to the Y-mark of the mesosporoid. This species has only rare anchor shaped spines but has many other spines which although blunt, appear as though their possibly anchor-shaped ends have been broken off.

Comments - Lang (1925) recorded as Type G spores with anchor-shaped spines in the Old Red Sandstone at Cromarty, Scotland. Numerous authors have subsequently described spores with similar processes in Devonian deposits from widely separated geographic localities.

The spores from the Mereenie Water Bore include forms with anchor-shaped processes which are assigned to the genus Ancyrospora Richardson 1960 because they are radial and trilete, and have a flange or pseudoflange and a circular, subcircular or subtriangular equatorial outline. Ancyrospora spp. 180 and 181 are not assigned to published species because of their relatively small size. Ancyrospora sp. 180 closely resembles Lang's Type G (Figure 13) and Ancyrospora sp. 181 is similar to both the "new genus" and "Grandispora (?)" of Hoffmeister et al (1955, Plate 1, figures 6 and 10 respectively).

Guennel (1963) believed that the spore which he nominated Ancyrospora simplex was "unquestionably related" to the genotype Ancyrospora grandspinosa even though it is only half the size of the latter and lacks the bifurcating spines which Richardson set down as a diagnostic feature of the genus. The Mereenie Water Bore specimens illustrated in Figures 9,10 and 11 are of comparable size to Ancyrospora simplex Guennel and indistinguishable from that species except that they have bifurcating spines, although rare, and confined to the distal surface, and therefore conform to Richardson's diagnosis of the genus Ancyrospora.

AGE OF THE SAMPLE

Few well preserved spore assemblages have been described from Australian Devonian sediments and not many of these are from strata which can be reliably dated by marine faunas.

Sediments containing Devonian microfloras have been encountered in several wells in the Great Artesian Basin. Two of these wells, Phillips-Sunray Etonvale No.1 and S.P.L. No.1 (Birkhead) are considered here, although in neither well can the sediments containing the microfloras be reliably dated by associated marine faunas. De Jersey (1962) ascribed Etonvale No.1 Cores 12 (6955 feet) - 15 (7548 feet) and Birkhead Core 5 (5136-5141 feet) to the Middle Devonian because they contained several diagnostic forms including Radiaspora sp. De Jersey has not yet described or figured his listed types and it is therefore not possible at present to compare them in detail, although the assemblages he recorded appear to be essentially similar to the Pertnjara microflora. Adequate direct comparison of the material from Etonvale and Birkhead with that from the Mereenie Water Bore is not possible because insufficient material has been examined by the author. However, inspection of Etonvale No.1 Core 16 (8055 feet) and the cuttings from 5035 feet from S.P.L. No.1 (Birkhead) showed that these samples contained a few highly carbonized spores which are very similar to Ancyrospora sp. 181.

Balme (1960) described spore assemblages from the Frasnian Gneudna Formation of the Carnarvon Basin and from the Famennian of the Fitzroy Basin (Balme, 1960). The assemblages from the Gneudna Formation are characterized by Geminospora lemurata, cf. Ancyrospora spp. and radially ribbed spores which Balme referred to Radiaspora. The Fitzroy Basin assemblages are completely different. Balme recorded only one species, Retusotriletes cf. R. pyjchovii in both the Gneudna and the Fitzroy Basin assemblages but noted that many of the species which occur in the Fitzroy Basin Famennian range into the Lower Carboniferous.

The Mereenie Water Bore assemblage is compared with that from the Gneudna Formation since it contains abundant Geminospora lemurata and Ancyrospora spp. It also contains spores with radial ribs which belong to Radiaspora but which differ from Balme's "Radiaspora" in that their ribs are distally situated.

Spores like Geminospora lemurata, which have a thick exoexine enclosing a mesosporoid, have been described from the U.S.S.R. by Naumova (1953) who reported them to be most abundant in the Givetian and Lower Frasnian and rare in the Famennian. Balme cited the abundance of Geminospora lemurata in the Gneudna Formation as confirmatory evidence of the Frasnian age given to the formation by Glenister (1956) on the basis of its spiriferid brachiopods. The relative abundance of Geminospora lemurata in the sample from the Pertnjara Formation may similarly indicate an early Upper Devonian age.

Radiaspora has been reported in Carboniferous (Mississippian) sediments (Hoffmeister et al., 1955). According to Naumova the genus is relatively common in Russian Middle and early Upper Devonian sediments. Many subsequent assessments of the stratigraphic value of Radiaspora seem to have been based on Naumova's observations. Balme (1960) and de Jersey (1962) used the abundance of Radiaspora as evidence of a Middle Devonian age but its stratigraphic significance within the Australian Devonian is still uncertain in view of its apparent life range in Europe and North America and because relative abundance is not a good criterium on which to base such initial long distance correlations. In view of this uncertainty and the fact that Radiaspora is rare in the Mereenie Water Bore sample its presence cannot define the position of the sample within the Devonian succession.

The abundance of Ancyrospora spp. is the most distinctive feature of the Mereenie Water Bore samples. Spores of a wide variety of morphological types having spines with anchor shaped terminations have been reported from Australia, Canada, France, Germany, Scotland, Spitzbergen, U.S.A. and the U.S.S.R. They appear to be confined to the Devonian and have not been reported in well-dated sediments older than the early Middle Devonian. Naumova reported that these spores first appear in the Givetian of the U.S.S.R., reach their acme in the Frasnian and decline in abundance in the Famennian. This agrees with Richardson's (1962) observations on the stratigraphic distribution of several genera with bifurcating processes. Richardson reported that the acme of Ancyrospora was in the late Middle to early Upper Devonian. The apparent absence of Ancyrospora and other forms with bifurcating, anchor shaped processes in the Upper Devonian of the Fitzroy Basin suggests that the life range of these fossils may be similarly constricted in Australia. If this is so, the abundance of Ancyrospora spp. in the Mereenie Water Bore sample supports the conclusion, based on the abundance of Geminospora lemurata, that the sample is of late Middle or early Upper Devonian age.

Additional evidence for the Middle or Upper Devonian age of the basal part of the Pertnjara Formation comes from a vertebrate fossil.

Miss J. Gilbert-Tomlinson (personal communication) has supplied the following data:

"Plates of the dermal armour of the placoderm Bothriolepis have been identified in collections from a sandstone lens in the basal siltstone of the Pertnjara Formation.

"The fossils were first collected by R.M. Hopkins of Magellan Petroleum Corporation in 1963. They occur on the northern side of Dare Plain, north flank of Mereenie Anticline Lat. 24°S., Long. 131°36'E).

"Most of the records of Bothriolepis are from the Upper Devonian, and hence this age is preferred for the present fossils. A Middle Devonian age, is, however, not impossible".

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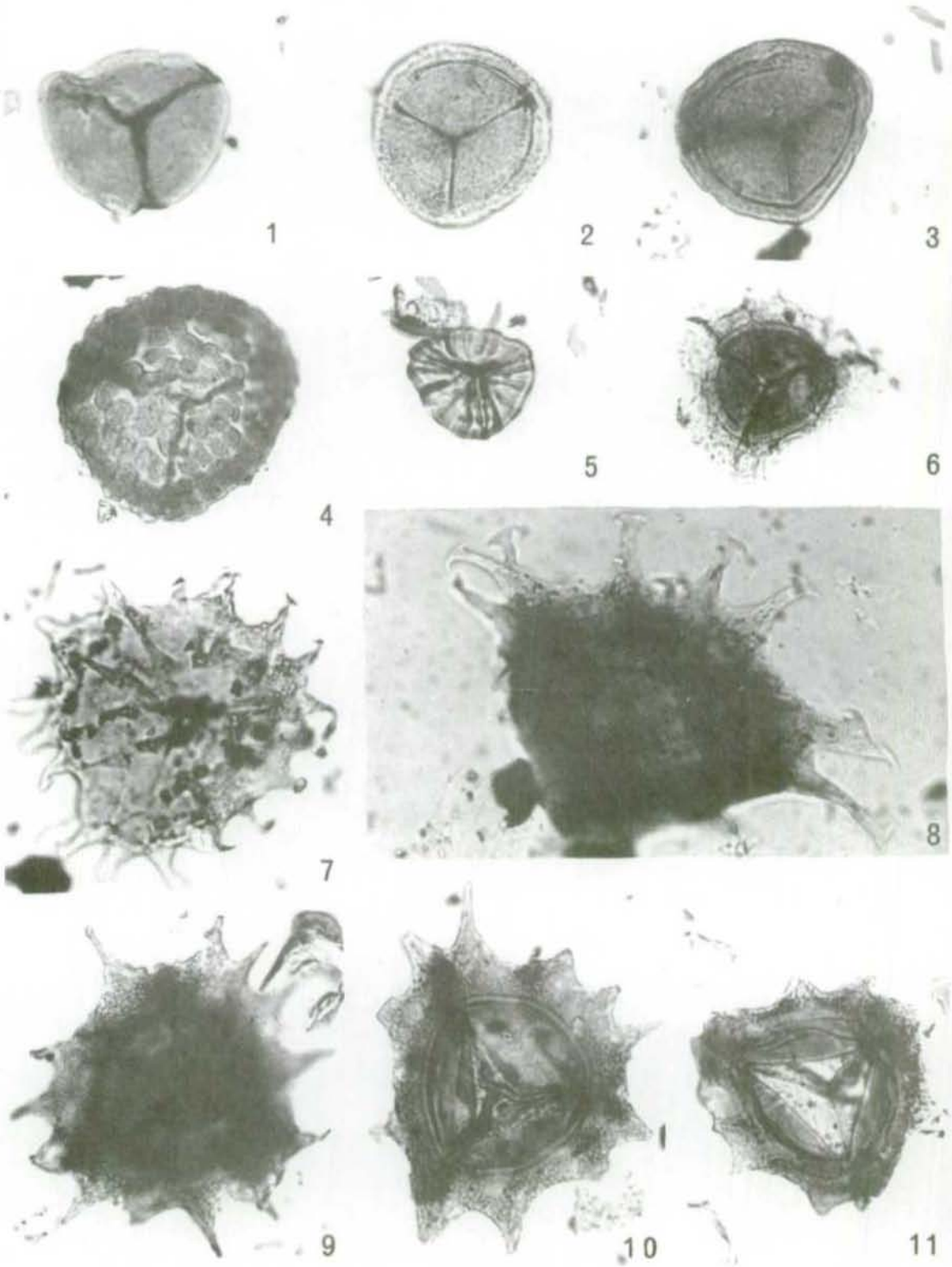
PLATE I



All magnifications X 750

Leiotriletes sp.168
Fig.1, MFP 3128.1/158.161

Geminospora lemurata Balme (sp.169)
Fig.2, MFP 3128.2/140.150
Fig.3, MFP 3128.1/124.086

Lophozonotriletes sp.170
Fig.4, MFP 3128.1/112.131

Radiaspora sp.178
Fig.5, MFP 3128.1/112.119

Auroraspora cf. A.micromanifestus (Hacquebard) (sp.179)
Fig.6, MFP 3128.2/099.154

Ancyrospora sp.180
Fig.7, MFP 3128.1/153.141

Ancyrospora sp.181
Fig.8, MFP 3128.1/111.072

Ancyrospora cf. A.simplex Guennel (sp.182)
Fig.9, MFP 3128.1/102.137
Fig.10, MFP 3128.1/090.121
Fig.11, MFP 3128.1/084.144