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PALEONTOLOGICAL CONTRIBUTIONS

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PALYNOMORPHS FROM SOUTH AMERICA

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CONTENTS

PART 1

NEW LATE CRETACEOUS PALYNOMORPHS FROM SOUTHERN SOUTH AMERICA

ABSTRACT

Three new palynomorph form genera and new species of *Azolla* and *Ariadnaesporites* are described from Upper Cretaceous rocks of southern Argentina and Chile. Morphologically, these taxa differ considerably from previously described Upper Cretaceous genera and species.

INTRODUCTION

This paper describes several new palynomorph genera and species from Upper Cretaceous sediments of extreme southern Argentina and the adjacent area of Chile (Fig. 1). These new taxa were encountered during a general study of Cretaceous palynomorphs from southern South America and represent only the most unique and morphologically unusual of the many undescribed forms in the assemblages. The palynomorphs selected for discussion in this paper are also of interest in that they are unlike those reported by several authors from Upper Cretaceous sediments of Australia, Africa, and the northern hemisphere.

Although several studies of the Cretaceous macroflora of southern Argentina have been reported (ARCHANGELSKY, 1963a-c, 1964; HERBST, 1962), Cretaceous palynologic investigations have been limited to studies of the Baqueró Formation (Early Cretaceous) of Santa Cruz province (ARCHANGELSKY & GAMERRO, 1965, 1966; GAMERRO, 1965a,b) and of Cretaceous and Tertiary microplankton from Tierra del Fuego (MENÉNDEZ, 1965). No information is available on Cretaceous palynomorphs from Chile.

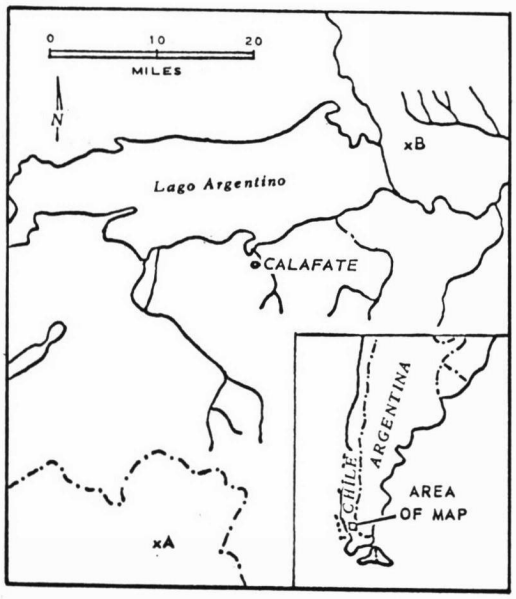


FIG. 1. Location of sample localities at Río de las Chinas (A) and at Lago Argentino (B).

Holotypes and paratypes of the new genera and species have been deposited in the United States National Museum, Washington, D. C. Each specimen has been ringed and may be located by using the coordinates given after the slide number in the plate descriptions. The coordinates are given in millimeters and are measured from the lower right-hand corner of the cover glass, upward in the *y* direction and to the left in the *x* direction.

Acknowledgment is made to Esso Exploration, Inc., and Esso Production Research Company for permission to publish this paper.

LOCALITIES

The new genera and species are based on specimens obtained from two samples of the Forteleza Formation collected near the headwaters of Río de las Chinas, Chile, and two samples from the basal part of the Mata Amarilla Formation collected near Lago Argentino, Argentina. A brief description is given below for both the localities and the sample lithologies.

Río de las Chinas Locality.—Near headwaters of Río de la Chinas, 19 miles north of Lago Sarmiento and approximately 4 miles south of the Argentina-Chile border, Magallanes Province, Chile.

Sample 1.—Coal bed 1.5 feet thick and approximately 200 feet below the top of the Forteleza Formation.

Sample 2.—Shaly coal bed a few feet above sample 1. In addition to the new taxa described in this paper, the samples from Río de las Chinas yielded the following palynomorphs:

Gleicheniidites sp.
Sphagnumsporites sp.
Podocarpidites sp.
Dacrydiumidites sp.
Podosporites microsaccatus (COUPER, 1953)
Microcachryidites antarcticus COOKSON, 1947
Phyllocladidites mawsonii COOKSON, 1947
Tricolpites spp.
Tricolporites spp.
Porocolpopollenites spp.
Triporopollenites spp.

Lago Argentino Locality.—Two miles southeast of Estancia Ascunción and 5.5 miles north of the eastern tip of Lago Argentino, Santa Cruz Province, Argentina.

Sample 1.—Olive-gray to dark-gray mudstone with abundant carbonaceous material.

Sample 2.—Sandstone containing carbonaceous material and large coal fragments.

In addition to the new taxa described in this paper, the samples from the Lago Argentino locality yielded the following palynomorphs:

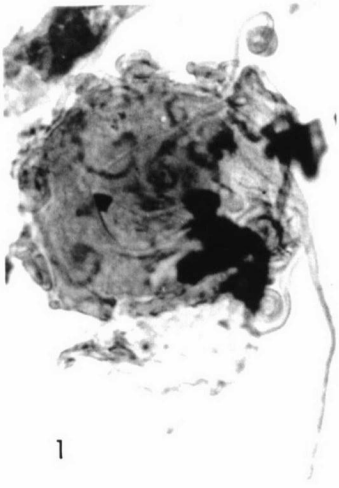
Cicatricosisporites spp.
Gleicheniidites sp.
Rouseisporites sp.
Podosporites microsaccatus (COUPER, 1953)
Microcachryidites antarcticus COOKSON, 1947
Cuparieidites sp.
Tricolpites spp.
Tricolporites spp.
Porocolpopollenites spp.
Triporopollenites spp.

SYSTEMATIC DESCRIPTIONS

Genus ARIADNAESPORITES Potonié, 1956, emend. Tschudy, 1966

ARIADNAESPORITES MICROMEDUSUS Stough, n. form. sp.

Trilete microspore completely enclosed by perium; surface smooth; rays of trilete extend to equator and margined by well-developed lips; spore wall approximately 1.5 μ thick; perium with poorly developed proximal acrolamella or trifolium and 9 to 14 distally attached elators; points of attachment of elators evenly spaced over distal surface; elators ribbon-like extensions of perium;



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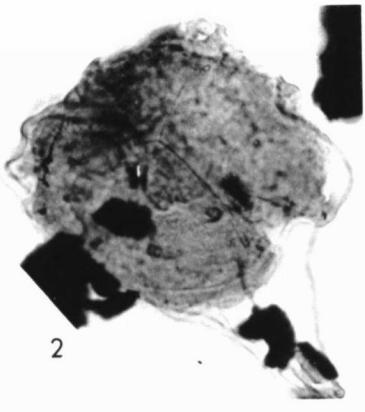

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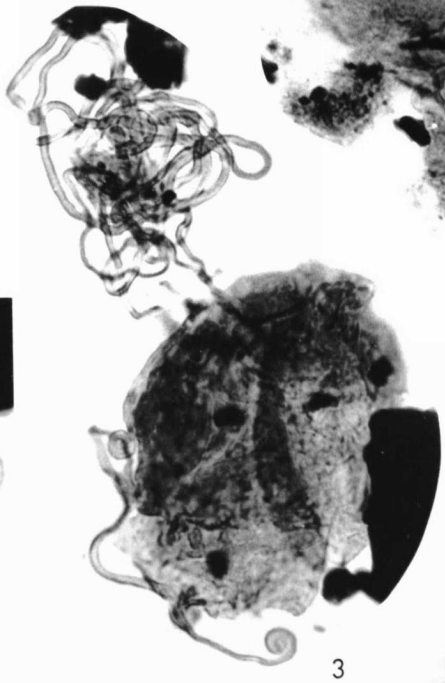

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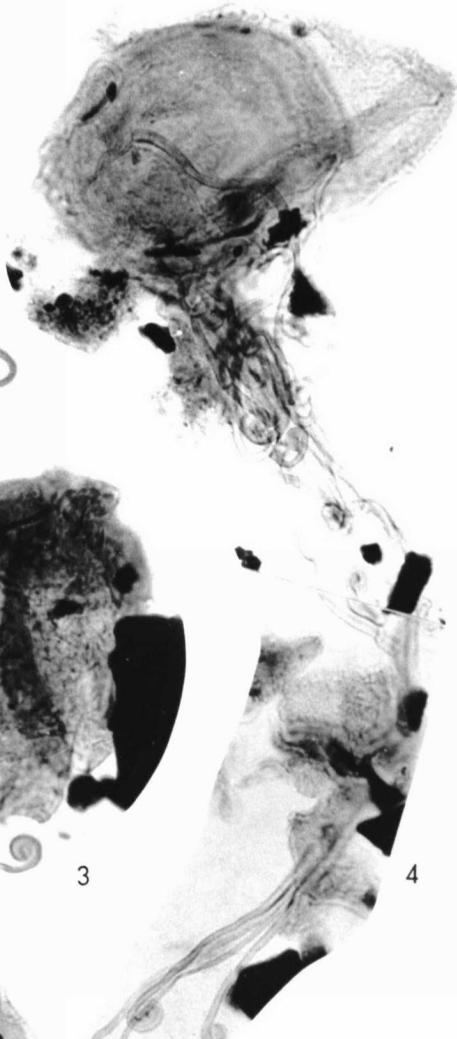

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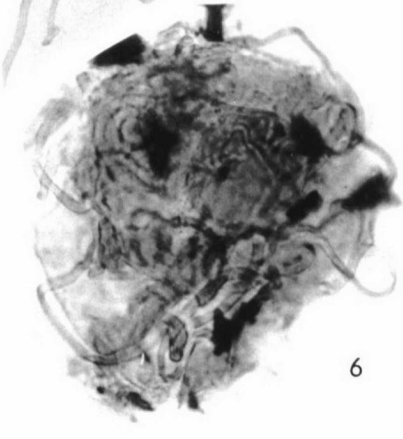

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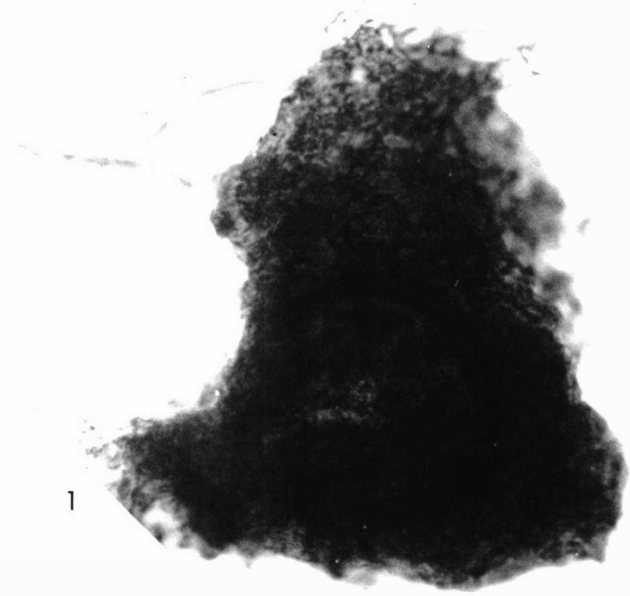
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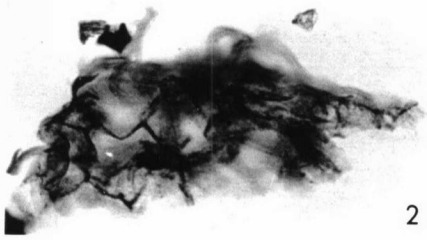
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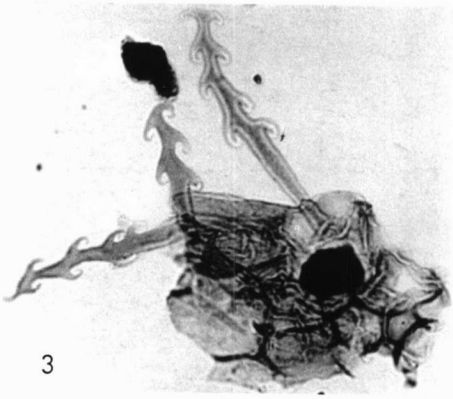
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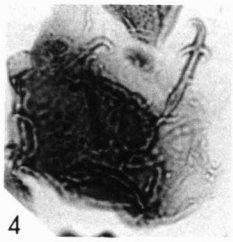
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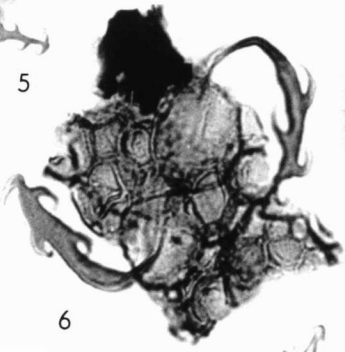
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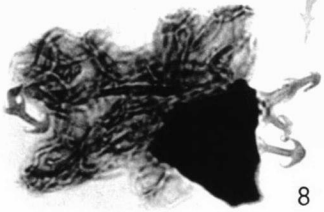
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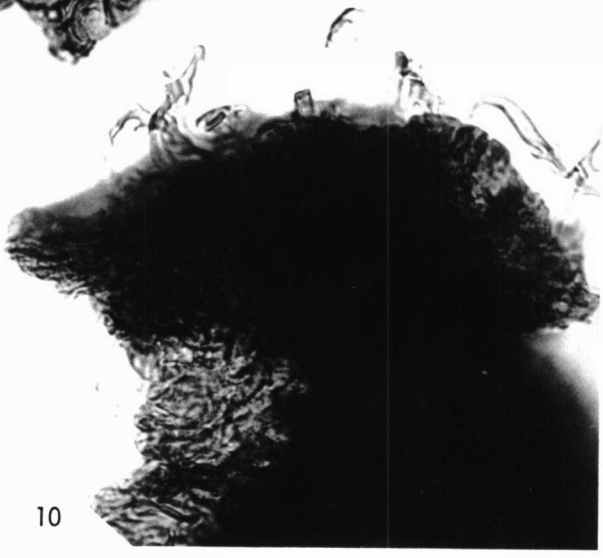
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surface of elators laevigate to finely granulose; distal termination of each elator commonly tightly coiled, pointed, and with slight expansion in width just proximal to tip; perium closely adhering to distal surface; diameter of spore body in polar view 42 to 54 μ and in equatorial view 60 to 65 μ; maximum length of elators 230 μ; average width of elators 3 μ. Measurements based on 12 specimens.

Discussion.—Ariadnaesporites micromedusus is distinguished from other micro- and macrospore representatives of the genus by the presence of tightly coiled terminations of the elators. This characteristic, which was observed in all specimens of the new species, has not been reported for either the type species, *A. ariadnae* (Miner) Potonié (1956), or *A. cristatus* Tschudy (1966). Further, the presence of at least nine elators serves to distinguish *A. micromedusus* from forms described as *Capulisporites longiprocessum* Hills & Jensen (1966), *Caudaspora spinosa* Elsik (1967) and *Caudaspora verrucata* Elsik (1967) and characterized by the presence of one to three distal elators.

Occurrence.—Known only at the Río de las Chinas locality.

Types.—Holotype, Pl. 1, fig. 5; paratypes, Pl. 1, fig. 1-4, 6.

Illustrations.—Figure 2,*1*; Plate 1, figures 1-6. ——Fig. 2,*1*. Schematic cross section.——Pl. 1, fig. 1. Paratype, slide S1085AW-1, *x*, 9.0 mm., *y*, 13.8 mm., U.S. Natl. Mus. no. 41672.——Pl. 1, fig. 2. Paratype, slide S1085AW-3C, *x*, 32.7 mm., *y*, 12.2 mm., U.S. Natl. Mus. no. 41673.——Pl. 1, fig. 3. Paratype, slide S1085AW-4C, *x*, 7.2 mm., *y*, 13.9 mm., U.S. Natl. Mus. no. 41674.——Pl. 1, fig. 4. Paratype, slide S1085AX-1, *x*, 16.8 mm., *y*, 19.0 mm., U.S. Natl. Mus. no. 41675.——Pl. 1, fig. 5. Holotype, slide S1085AX-2, *x*, 9.4 mm., *y*, 13.7 mm., U.S. Natl. Mus. no. 41671; *a*, equatorial view showing elators on surface of perium, *b*, median focus showing trilete mark.——Pl. 1, fig. 6. Paratype, slide S1085AX-1, *x*, 22.7 mm., *y*, 9.0 mm., U.S. Natl. Mus. no. 41676. [All figures ×750.]

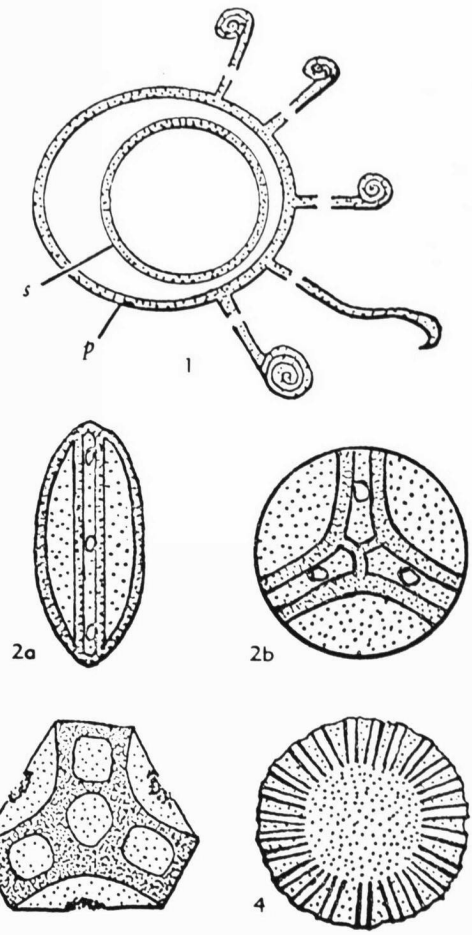

Fig. 2. Schematic diagrams of palynomorphs, not to scale. ——*1*. Cross-sectional view of *Ariadnaesporites micromedusus* Stough, n. form sp., showing trilete spore *(s)* and elator-bearing perium *(p)*.——*2a,b*. *Tricesticillus* Stough, n. form gen., showing equatorial *(2a)* and polar *(2b)* views.——*3*. Polar view of *Confossia* Stough, n. form. gen. ——*4*. *Patera* Stough, n. form gen.

Genus AZOLLA Lamarck, 1783

AZOLLA POLYANCYRA Stough, n. sp.

Cellular, granular massula of irregular shape covered with glaucidia, which are flattened, flexible, solid, and irregularly situated on massula; tips of glaucidia usually anchor-shaped but may be sharply pointed or recurved; 2 to 11 auxiliary hooks or barbs arise from opposite sides of flattened glaucidia; points of attachment of auxiliary hooks commonly alternate, rarely opposite; base of glaucidium may be expanded proximal to auxiliary hooks; microspore trilete, thick-walled, apparently smooth and 45 μ in diameter; observed diameter of masula 120-170 μ; glaucidia 27 to 43 μ in length and 1.5 to 4.5 μ in width. Based on 27 specimens.

Discussion.—Azolla polyancyra, the third species of *Azolla* to be recorded from the Creta-

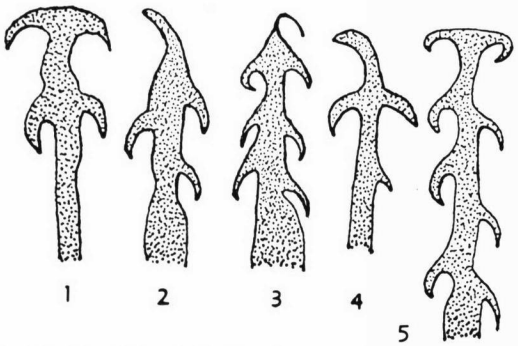

FIG. 3. Glaucidia of *Azolla polyancyra* showing variation in tips and arrangement of auxiliary hooks.

ceous and the first to be reported from South America, is distinguished from other species of *Azolla* by the presence of auxiliary hooks on each glaucidium and by comparatively large size of the microspore. *A. geneseana* HILLS & WEINER (1965) from the Upper Cretaceous of Canada, has glaucidia with tips possessing 2 to 4 projections, some of which appear to arise from the stalk just proximal to the anchor-shaped terminations. This condition, however, appears more as a modification of the tip and is distinct from the more or less regular arrangement of auxiliary hooks characteristic of *A. polyancyra*.

Glaucidia of *Azolla polyancrya* vary both in shape of the termination and arrangement of the auxiliary hooks on the glaucidia (Fig. 3). Anchor-shaped terminations (Fig. 3,*1-5*) are more common than either spear-shaped (Fig. 3,*3*) or recurved (Fig. 3,*4*) terminations. The auxiliary hooks are arranged commonly in an alternate pattern on sides of the glaucidium (Fig. 3,*2-3,5*); a few specimens, however, have oppositely arranged terminations (Fig. 3,*1,4*). Commonly some variation in the types of termination or arrangement of auxiliary hooks is observed on the glaucidia of individual specimens.

Occurrence.—Occurs commonly, especially as fragments of the massula, at the Lago Argentino locality and rarely at the Río de las Chinas locality; no evidence of megafossil *Azolla* remains was noted in samples from either locality.

Types.—Holotype, Pl. 2, fig. 1; paratypes, Pl. 2, figs. 2-9.

Illustrations.—Figure 3; Plate 2, figures 1-10. ——Fig. 3,*1,5*. Glaucidia showing variation in tips and arrangement of auxiliary hooks.——Pl. 2, fig. 1. Holotype, slide S1017S-2, *x*, 15.9 mm., *y*, 15.4 mm., U.S. Natl. Mus. no. 41677; complete massula, ×750.——Pl. 2, fig. 2. Paratype, slide S-1017R-2, *x*, 2.0 mm., *y*, 11.8 mm., U.S. Natl. Mus. no. 41678; fragment of massula, ×750.——Pl. 2, fig. 3. Paratype slide S1017R-3, *x*, 25.1 mm., *y*, 16.7 mm., U.S. Natl. Mus no. 41679; fragment of massula, ×750.——Pl. 2, fig. 4. Paratype, slide S1017R-3, *x*, 37.7 mm., *y*, 4.9 mm., U.S. Natl. Mus. no. 41680; fragment of massula, ×750.——Pl. 2, fig. 5. Paratype, slide S1017R-4S, *x*, 16.9 mm., y, 18.2 mm., U.S. Natl. Mus. no. 41681; fragment of massula, ×650.——Pl. 2, fig. 6. Paratype, slide S1017S-2, *x*, 24.6 mm., *y*, 6.6 mm., U.S. Natl. Mus. no. 41682; fragment of massula, ×750. ——Pl. 2, fig. 7. Paratype, slide S1017R-1, *x*, 6.0 mm., *y*, 3.4 mm., U.S. Natl. Mus. no. 41683; fragment of massula, ×750.——Pl. 2, fig. 8. Paratype, slide S1017R-3, *x*, 33.1 mm., *y*, 0.1 mm., U.S. Natl. Mus. no. 41684; fragment of massula, ×750. ——Pl. 2, fig. 9. Paratype, slide S1017R-2, *x*, 9.2 mm., *y*, 19.6 mm., U.S. Natl. Mus. no. 41685; fragment of massula, ×750.——Pl. 2, fig. 10. Paratype, slide S1017S-2, *x*, 39.0 mm., *y*, 13.7 mm., U.S. Natl. Mus. no. 41686; portion of massula, ×750.

Genus TRICESTICILLUS Stough, n. form gen.

Palynomorph prolate; wall structurally two-layered, consisting of thin, continuous inner layer upon which are situated three elliptical bands which are centered on equator and joined to one another at each pole by small triradiate structure; porate apertures occur in areas between adjacent ellipses.

The genus is based on numerous specimens of which two are assigned to *Tricesticillus* sp. and the others to the type species, *T. americanus*.

Type species.—*Tricesticillus americanus* STOUGH, n. form. sp.

Illustrations.—Figure 2,*2*.——Fig. *2a,b*. Schematic diagrams of equatorial and polar views.

TRICESTICILLUS AMERICANUS Stough, n. form sp.

Palynomorph prolate; wall 2-layered and composed of a thin granulose to verrucose inner layer bearing 3 large thickened elliptical bands; these elliptical structures centered on equator with long axes parallel to long axis of grain; all 3 elliptical structures interconnected at each pole by small

triradiate structure; porate apertures discernible in well-preserved specimens in narrow areas between adjacent elliptical bands; pores arranged in 3 groups with 3 pores in each group; within each group one pore is located on equator and one each in a subpolar position in each hemisphere; polar diameter, 27 to 32 μ; width of bands forming ellipses, 3 to 4 μ; wall thickness, less than 1 μ. Based on more than 50 specimens.

Discussion.—Specimens of *Tricesticillus americanus* can be distinguished from those of *Tricesticillus* sp. by their larger size and by having a greater area enclosed within the elliptical structures. No porate apertures were observed on about 50 percent of the specimens studied. Failure to observe the apertures on other specimens was due to unfavorable preservation or orientation.

Occurrence.—Found commonly in both samples from the Lago Argentino locality.

Types.—Holotype, Pl. 3, fig. 1; paratypes, Pl. 3, figs. 2-8.

Illustrations.—Plate 3, figures 1-8.——Pl. 3, fig. 1. Holotype, slide S1017R-3, *x*, 13.1 mm., *y*, 9.8 mm., U.S. Natl. Mus. no. 41687; *a*, high focus, *b*, median focus, ×750.——Pl .3, fig. 2. Paratype, slide S1017R-3, *x*, 15.1 mm., *y*, 16.2 mm., U.S. Natl. Mus. no. 41688; *a*, high focus, *b*, median focus, ×750.——Pl. 3, fig. 3. Paratype, slide S1017R-2, *x*, 2.3 mm., *y*, 6.8 mm., U.S. Natl. Mus. no. 41689; *a*, polar attachment of elliptical bands, *b*, same structure on opposite pole, ×1000.——Pl. 3, fig. 4. Paratype, slide S1017R-2, *x*, 1.9 mm., *y*, 13.1 mm., U.S. Natl. Mus. no. 41690, ×750.——Pl. 3, fig. 5. Paratype, slide S1017R-2, *x*, 13.0 mm., *y*, 16.5 mm., U.S. Natl. Mus. no. 41691; ×750.——Pl. 3, fig. 6. Paratype, slide S1017R-2, *x*, 2.5 mm., *y*, 14.7 mm., U.S. Natl. Mus. no. 41692, ×750.——Pl. 3, fig. 7. Paratype, slide S1017R-2, *x*, 13.4 mm., *y*, 14.8 mm., U.S. Natl. Mus. no. 41693, ×750.——Pl. 3, fig. 8. Paratype, slide S1017R-3, *x*, 18.9 mm., *y*, 18.1 mm., U.S. Natl. Mus. no. 41694; polar view, ×750.

TRICESTICILLUS sp.

Two specimens, identified simply as *Tricesticillus* sp., differ from the type species by being smaller (18 μ in polar diameter) and by having relatively thicker elliptical bands that enclose smaller areas of the palynomorph surface.

Illustrations.—Plate 3, figures 9-10.——Pl. 3, fig. 9. Slide S1017R-3, *x*, 33.2 mm., *y*, 9.3 mm., U.S. Natl. Mus. no. 41695, ×750.——Pl. 3, fig. 10. Slide S1017R-3, *x*, 16.2 mm., *y*, 7.1 mm., U.S. Natl. Mus. no. 41696, ×750.

Genus CONFOSSIA Stough, n. form. gen.

Palynomorphs with 3 equatorial porate apertures and ornamented with 3 broad, perforate, interaperturate bands which are joined together at both poles; 2-layered wall composed of thin inner layer and thickened discontinuous outer layer which forms interaperturate bands.

Discussion.—*Confossia* and *Tricesticillus*, although seemingly unlike typical modern angiospermic pollen in their morphology, both are characterized by a two-layered wall and porate apertures. These characteristics suggest that the two-form genera are the pollen either of angiosperms or of plants closely related to angiosperms. The morphology of *Confossia* and *Tricesticillus* (Fig. 2,*3-4*) is basically similar. Both form genera can be thought of as having three elliptical bands which are centered on the equator and whose long axes are parallel to the polar axis of the grain. The location of the porate apertures in relation to the elliptical bands, however, is different. The pores of *Tricesticillus* lie between the elliptical bands and those of *Confossia* are within the elliptical bands.

The genus *Confossia* is based on numerous specimens of which 9 are assigned to *C. rara*, 1 to *C.* sp., and the others to the type species, *C. vulgaris*.

Type species.—*Confossia vulgaris* Stough, n. form sp.

Illustration.—Fig. 2,*3*. Schematic diagram of polar view.

CONFOSSIA VULGARIS Stough, n. form sp.

Outline in polar view roundly triangular to triangular with truncated apices; palynomorph with 3 poorly developed equatorial porate apertures and 3 smooth, broad, perforate, interaperturate bands joined at both poles; bands with very large and rounded to rectangular perforations; one perforation centered on each pole and one perforation on each band situated in each hemisphere; inner-wall layer thin and granulose; total wall thickness, 1 μ or less; diameter in polar view, 25 μ; width of interaperturate band, 8 to 9 μ; width of perforations 5 to 6 μ. Based on numerous specimens.

Discussion.—Confossia vulgaris is distinguished from *C. rara* and *C.* sp. described below by the lack of small perforations on the interaperturate band which is characteristic of the latter forms.

In general, morphologic variation within the species is minor. A few specimens, however, have a rounded outline (Pl. 3, fig. 13, 16) rather than the triangular outline of most specimens. Another specimen (Pl. 3, fig. 13) has smaller perforations and a wider interaperturate band than observed in other specimens.

Occurrence.—Occurs abundantly in both samples from the Lago Argentino locality.

Types.—Holotype, Pl. 3, fig. 11; paratypes, Pl. 3, fig. 12-17.

Illustrations.—Plate 3, figures 11-17.——Pl. 3, fig. 11. Holotype, slide S1017R-2, *x,* 27.6 mm., *y,* 13.7 mm., U.S. Natl. Mus. no. 41697.——Pl. 3, fig. 12. Paratype, slide S1017R-1, *x,* 13.2 mm., *y,* 10.4 mm., U.S. Natl. Mus. no. 41698.——Pl. 3, fig. 13. Paratype slide S1017R-3, *x,* 11.8 mm., *y,* 5.8 mm., U.S. Natl. Mus. no. 41699.——Pl. 3, fig. 14. Paratype, slide S1017R-1, *x,* 28.3 mm., *y,* 12.5 mm., U.S. Natl. Mus. no. 41700.——Pl. 3, fig. 15. Paratype, slide S1017R-1, *x,* 29.8 mm., *y,* 7.5 mm., U.S. Natl. Mus. no. 41701.——Pl. 3, fig. 16. Paratype, slide S1017R-3, *x,* 6.6 mm., *y,* 13.4 mm., U.S. Natl. Mus. no. 41702.——Pl. 3, fig. 17. Paratype, slide S1017R-1, *x,* 14.2 mm., *y,* 4.3 mm., U.S. Natl. Mus. no. 41703. [All figures are ×750.]

CONFOSSIA RARA Stough, n. form sp.

Rounded outline in polar view; 3 poorly developed porate apertures situated on equator and 3 smooth, broad, perforate interaperturate bands joined together at poles; perforations of bands differ in size, number and distribution; smaller perforations commonly arranged in pairs between larger perforations; surface between bands and within perforations thin and granulose; diameter in polar view 24 to 28 μ; average width of interaperturate band 9 μ; diameter of larger perforations 5 to 7 μ; diameter of smaller perforations 1 to 3 μ. Based on 9 specimens.

Discussion.—Confossia rara is distinguished from *C. vulgaris* by the perforations of different size. The number, size, and arrangement of perforations on the interaperturate bands of *C. rara* differ considerably. The polar areas, in general, seem to have numerous small perforations, whereas the larger perforations are equatorial, or nearly so.

Occurrence.—Occurs sparsely in both samples from the Lago Argentino locality.

Types.—Holotype, Pl. 3, fig. 18; paratypes, Pl. 3, fig. 19-20.

Illustrations.—Plate 3, figures 18-20.——Pl. 3, fig. 18. Holotype, slide S1017R-4S, *x,* 15.7 mm., *y,* 8.6 mm., U.S. Natl. Mus. no. 41704; *a,* high focus, *b,* median focus.——Pl. 3,fig. 19. Paratype, slide S1017R-3, *x,* 10.6 mm., *y,* 10.7 mm., U.S. Natl. Mus. no. 41705.——Pl. 3, fig. 20. Paratype, slide S1017R-2S, *x,* 5.7 mm., *y,* 5.7 mm., U.S. Natl. Mus. no. 41706. [All figures are ×750.]

CONFOSSIA sp.

Confossia sp. resembles *C. rara* more closely than the type species because of the several small perforations on the interaperturate band. It apparently has, however, several unique morphological characteristics which distinguish it from the two previously described species. These characteristics are 1) narrow rings that encircle the larger and smaller perforations, 2) narrow ridges that join several of the perforations, and 3) narrow lines that outline the edges of the inaperturate bands. A valid assessment of these features is precluded at this time because only one specimen is known.

Illustration.—Plate 3, figure 21. Slide S1017R-2, *x,* 6.2 mm., *y,* 13.3 mm., U.S. Natl. Mus. no. 41707; *a,* high focus, *b,* low focus, ×750.

Genus PATERA Stough, n. form. gen.

Flattened, radially symmetrical; outline circular to elliptical; radiating bands or folds extending outward to the equator from structureless polar areas.

Discussion.—The genus is based on 17 specimens of which 11 have been assigned to the type species *Patera crassa* and 6 to *P. tenuis* (Fig. 2,*4*).

Type species.—Patera crassa Stough, n. form sp.

Illustration.—Figure 2,*4*. Schematic diagram.

PATERA CRASSA Stough, n. form sp.

Flattened, radially symmetrical; circular to somewhat elliptical in outline; polar area structureless and from it radiate 21 to 23 flattened, marginally thickened, granulose ridges; ridges extend to equator on both sides of palynomorph;

surface with scattered granules; wall thickness less than 1 μ; diameter averages about 33 μ; length of radiating ridges 8 to 12 μ; width of radiating ridges 2.5 to 4 μ. Based on 11 specimens.

Occurrence.—Sparsely at the Lago Argentino locality.

Types.—Holotype, Pl. 3, fig. 23; paratypes, Pl. 3, fig. 22, 24.

Illustrations.—Plate 3, figures 22-24.——Pl. 3, fig. 22. Paratype, slide S1017R-2, *x*, 31.7 mm., *y*, 3.8 mm., U.S. Natl. Mus. no. 41709.——Pl. 3, fig. 23. Holotype, slide S1017R-3, *x*, 7.0 mm., *y*, 20.8 mm., U.S. Natl. Mus. no. 41708.——Pl. 3, fig. 24. Paratype, slide S1017R-2, *x*, 24.8 mm., *y*, 9.3 mm., U.S. Natl. Mus. no. 41710. [All figures are ×750.]

PATERA TENUIS Stough, n. form sp.

Flattened, radially symmetrical; elliptical in outline; polar area structureless and from this radiate 19 to 21 folds or poorly developed flattened ridges; wall thickness less than 1 μ; diameter averages 27 μ; length of radiating folds or ridges 7 to 10 μ; width of folds or ridges 2 μ. Based on 6 specimens.

Discussion.—Patera tenuis is distinguished from the type species *P. crassa* by its thinner wall and less well-developed radiating ridges.

Occurrence.—Sparsely at the Lago Argentino locality.

Types.—Holotype, Pl. 3, fig. 27; paratypes, Pl. 3, fig. 25-26, 28.

Illustrations.—Plate 3, figures 25-28.——Pl. 3, fig. 25. Paratype, slide S1017R-1, *x*, 32.1 mm., *y*, 4.2 mm., U.S. Natl. Mus. no. 41712.——Pl. 3, fig. 26. Paratype, slide S1017R-1, *x*, 18.5 mm., *y*, 15.8 mm., U.S. Natl. Mus. no. 41713.——Pl. 3, fig. 27. Holotype, slide S1017R-3, *x*, 39.2 mm., *y*, 11.7 mm., U.S. Natl. Mus. no. 41711.——Pl. 3, fig. 28. Paratype, slide S1017R-5S, *x*, 2.5 mm., *y*, 11.0 mm., U.S. Natl. Mus. no. 41714. [All figures are ×750.]

PALYNOMORPH A

One specimen of this unusual form was recovered from sample 2 at the Lago Argentino locality. The arrangement of the 4 porate apertures is somewhat suggestive of some species of *Aquilapollenites* Rouse (1957) in that 3 apertures lie in a plane with the fourth aperture at right angles to this plane. The lips of 3 pores are granulose and the fourth pore has a flange or collar which may have been present around the other pores also. The specimen measures 20 by 28 μ.

Illustration.—Plate 3, figure 29. Slide S1017R-4S, *x*, 12.7 mm., *y*, 3.7 mm., U.S. Natl. Mus. no. 41715; ×750.

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PART 2

A NEW SPECIES OF GOTHANIPOLLIS KRUTZSCH FROM CHILE

ABSTRACT

A new species of *Gothanipollis* KRUTZSCH from the Late Tertiary of Chile is described, thus recording the presence of the genus in South America.

INTRODUCTION

Specimens of a new form species of *Gothanipollis* KRUTZSCH (1959) were recovered from the Empresa Nacional del Petroleo Puerto Montt No. 1 well drilled near the city of Puerto Montt in the Central Valley of Chile. Individuals were obtained from Late Tertiary rocks comprising a mixed lagoonal and continental sequence (SASS & NEFF, 1965). This section, characterized by conglomerate and continental sand with carbonaceous intercalations and associated plant remains, is overlain immediately by coarse-grained to boulder deposits which may represent a Quaternary moraine or interglacial deposit.

The identification of *Gothanipollis* is of particular interest because the genus has not been recognized previously in the Tertiary of South America. *Gothanipollis* has been reported previously from Europe (KRUTZSCH, 1959) and the southeastern United States (ENGELHARDT, 1964).

The holotype and paratypes are deposited in the U.S. National Museum, Washington, D.C. The coordinates following the slide number on the plate descriptions are in millimeters and are measured to the left in the *x* direction from the lower right-hand corner of the cover glass and toward the top of the slide in the *y* direction; each specimen has been ringed.

Acknowledgment is made to the Empresa Nacional del Petroleo, Esso Exploration, Inc., and Esso Production Research Company for permission to publish this paper.

SYSTEMATIC DESCRIPTION

Genus GOTHANIPOLLIS Krutzsch, 1959

Type Species.—Gothanipollis gothani KRUTZSCH, 1959.

GOTHANIPOLLIS CHILENSIS Stough, n. sp.

Triaperturate, syncolporate pollen. Outline in polar view concavely triangular with strongly blunted apices; apices thickened, raised, and prominently curved outward in equatorial plane; wall thickness to 1 to 1.5 μ; apertures striate; well-developed interapical swellings of ectosexine (*Luftkissen* of KRUTZSCH) extend along equator between apices; swellings in polar view are 4 to 8 μ wide, extend to 2 to 3 μ beyond margin of endosexine, and appear as an interapical flange; distinct darkening around polar junction of colpi; ornamentation of apices and poles psilate; interapical swelling appears roughened to granulose; diameter, in polar view, 18 to 23 μ; 20 specimens available.

Discussion.—Specimens of *Gothanipollis cockfieldensis* ENGELHARDT (1964) from the Eocene of southeastern United States resemble closely *G. chilensis*. The new species differs from *G. cockfieldensis* in having consistently well-developed interapical swellings of the ectosexine and more strongly truncated apices.

Morphologically, *Gothanipollis chilensis* is similar to a pollen grain illustrated by ERDTMAN (1965, fig. 1a) and identified as pollen of *Phrygilanthus destructor,* a modern South American

representative of the Loranthaceae. Further evidence to suggest a relationship between fossil *Gothanipollis* and some living members of the Loranthaceae is the similarity of pollen of the modern African species *Loranthus eylesii* WEIMARCK to *G. gothani* KRUTZSCH (1959). Also similarity of the fossil form to pollen identified as *Taxillus kaempfi* by IKUSE (1956) was noted by ENGELHARDT (1964).

Occurrence.—Recovered from cores at depths of 1,538 and 2,107 meters in the Puerto Montt No. 1.

Types.—Holotype, Pl. 4, fig. 1; paratypes, Pl. 4, fig. 2-4.

Illustrations.—Plate 4, figures 1-4.——Pl. 4, fig. 1. Holotype, slide S963 (1), *x*, 37.9 mm., *y*, 13.7 mm., U.S. Natl. Mus. no. 41716.——Pl. 4, fig. 2. Paratype, slide S963F (1), *x*, 34.1 mm., *y*, 10.4 mm., U.S. Natl. Mus. no. 41717.——Pl. 4, fig. 3. Paratype, slide S963 (2), *x*, 35.2 mm., *y*, 2.1 mm., U.S. Natl. Mus. no. 41718.——Pl. 4, fig. 4. Paratype, slide S963 (1), *x*, 14.3 mm., *y*, 15.2 mm., U.S. Natl. Mus. no. 41719. [All figures are ×800. Figures 1a,b, 2a,b, and 3a were photographed with transmitted light; others with phase-contrast illumination.]

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PART 3

HYPOCRITITRILETES, A NEW TRILETE SPORE GENUS FROM ARGENTINA

ABSTRACT

Hypocrititriletes, a new genus of trilete spore from the Cretaceous of southern Argentina, somewhat resembles the Paleozoic genus *Knoxisporites* POTONIÉ & KREMP (1954). It is characterized by curvaturae perfectae and a distal triradiate band.

INTRODUCTION

Specimens of a morphologically unusual trilete spore were recovered from an unnamed Middle Cretaceous light-gray shale containing carbonaceous stringers and plant remains. The sample was collected by geologists from Esso Argentina, Inc. along Río Guanaco at Estancia La Herradura between Lago Viedma and Lago Argentino, Santa Cruz province, in the Magallanes basin of southern Argentina (Fig. 4).

The holotype and paratypes of the type species have been deposited with the U.S. National Museum, Washington, D.C. Three unnamed specimens are in the permanent collection of Esso Production Research Company, Houston, Texas. Each specimen has been ringed and may be found by using the coordinates given with the plate explanation. The coordinates are in millimeters and are measured from the lower right-hand corner of the cover glass to the left in the *x* direction and toward the top of the slide in the *y* direction.

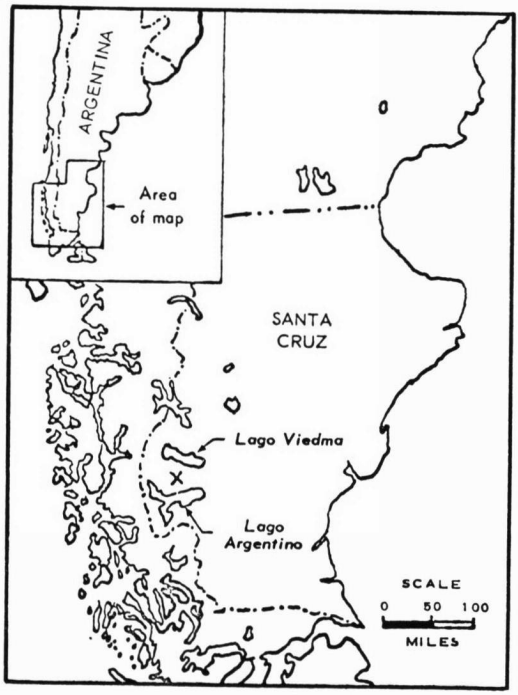


FIG. 4. Extreme southern Argentina showing the sampled locality (X) between Lago Viedma and Lago Argentino.

SYSTEMATIC DESCRIPTIONS

Anteturma SPORITES H. Potonié, 1893

Turma TRILETES Reinsch, 1881, emend. Potonié & Kremp, 1954

Genus HYPOCRITITRILETES Stough, n. gen.

Spores trilene; proximal surface with curvaturae perfectae composed of ridges; distal surface ornamented with large triradiate band formed by pairs of parallel linear elements centered on distal pole; trilete and distal triradiate band so situated in relationship to one another that in polar view rays of trilete bisect angles formed by arms of distal triradiate band.

Discussion.—The genus is distinguished from other trilete spore genera by both the curvaturae perfectae and the distal triradiate band. The relative position of the trilete and the triradiate band is suggestive of some species of the Paleozoic genus *Knoxisporites* POTONIÉ & KREMP (1954). The genus is derived from 17 specimens, of which 14 have been assigned to the type species *Hypocrititriletes insolitus*. The remaining specimens represent two unnamed species.

Type Species.—*Hypocrititriletes insolitus* Stough, n. sp.

HYPOCRITITRILETES INSOLITUS Stough, n. sp.

Spores trilete; outline irregularly circular to somewhat elliptical; proximal surface having curvaturae perfectae with curvaturae composed of ridges of irregular width and locally serrated or knobbed; trilete rays extend three-fourths distance to equator; lips generally closed, narrow, translucent, and raised, and extend as much as 3 μ above surface of spore at proximal pole; distal surface ornamented with prominent triradiate band centered on pole; band composed of paired parallel, raised, continuous ridges essentially uniform in width; some ridges ornamented with small knobs; positive elements between arms of triradiate band angular, irregular in outline, and randomly situated; some specimens have 3 ridges paralleling equator and interconnecting terminations of distal triradiate band; other specimens seem thickened equatorially. Wall thickness, 1 to 2 μ; diameter, in polar view, 50 to 62 μ (average 55 μ).

Discussion.—*Hypocrititriletes insolitus* is distinguished from the forms noted here by the unmodified curvaturae perfactae. Specimens of *H. insolitus* differ morphologically in development of the distal subequatorial ridge or equatorial thickening. One specimen (Pl. 1, fig. 1) has only a narrow ridge interconnecting terminations of the distal triradiate band, whereas another (Pl. 1, fig. 2) has an additional equatorial thickening which merges with the distal triradiate band. The later also appears to have a two-layered wall with the outer layer detached from the inner layer around the equator.

Type.—Holotype, Pl. 4, fig. 5; paratypes, Pl. 4, fig. 6-7.

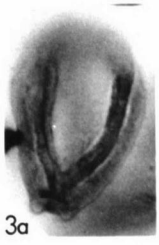
Illustrations.—Figure 5,*1*; Plate 4, figures 5-7. ——Fig. 5,*1a,b*. Diagrammatic representation of proximal and distal polar views.——Pl. 4, fig. 5. Holotype, slide S1017AD(1), *x*, 17.4 mm., *y*, 4.4 mm., U.S. Natl. Mus. no. 41720; *a*, proximal surface, *b*, distal surface.——Pl. 4, fig. 6. Paratype, slide S1017AD(1), *x*, 5.8 mm., *y*, 13.0 mm., U.S. Natl. Mus. no. 41721; *a*, proximal surface, *b*, distal


1a


1b


2a


2b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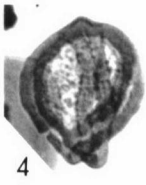
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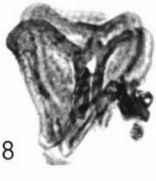
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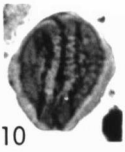
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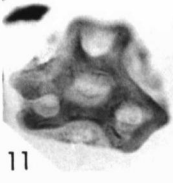
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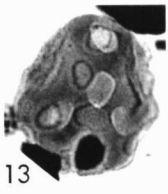
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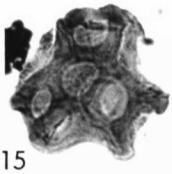
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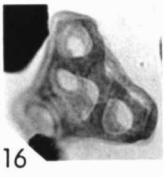
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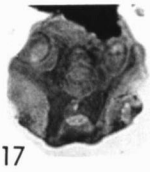
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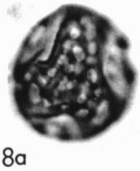
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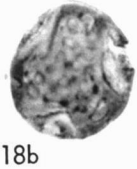
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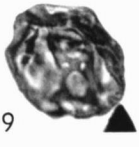
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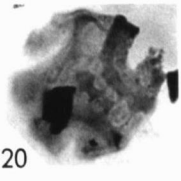
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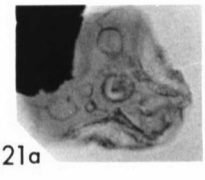
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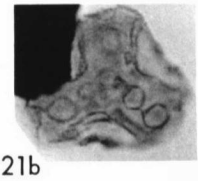
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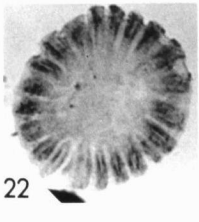
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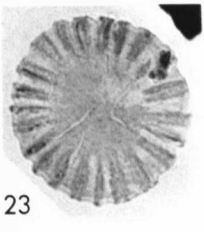
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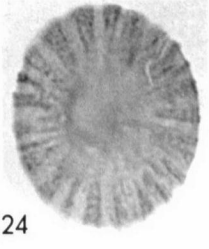
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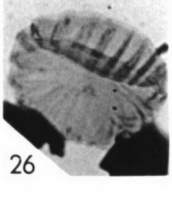
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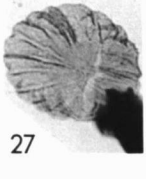
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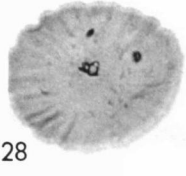
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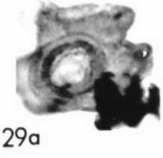
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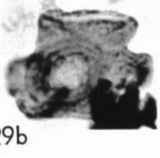
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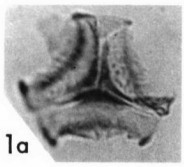
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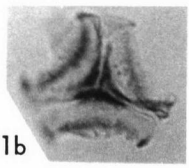
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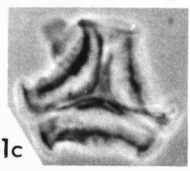
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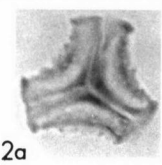
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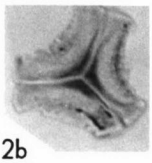
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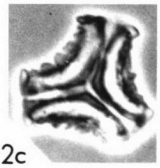
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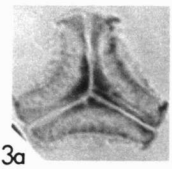
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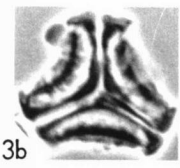
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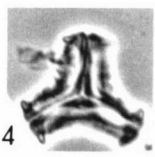
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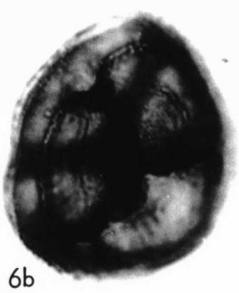
5a


5b


6a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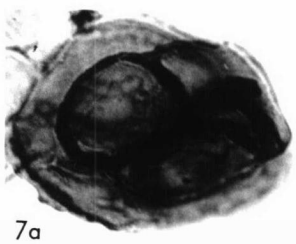
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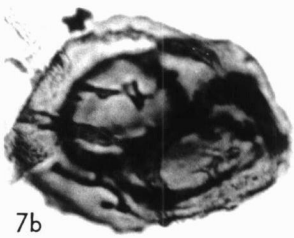
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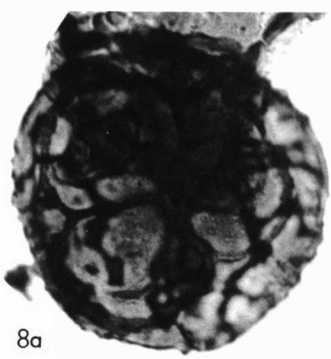
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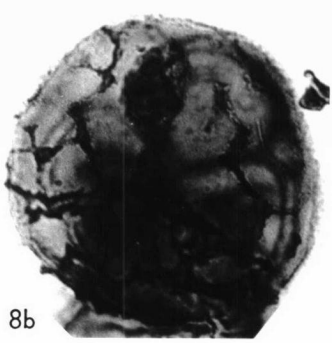
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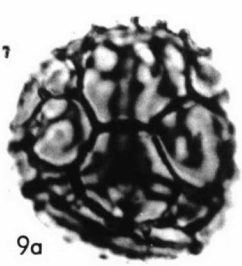
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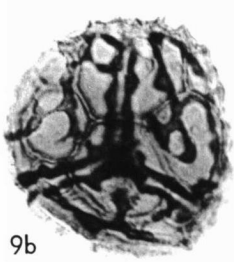
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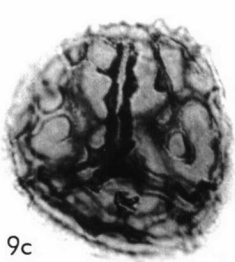
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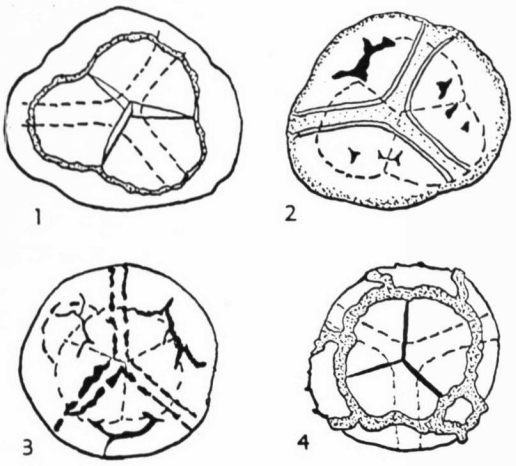

FIG. 5. Diagrammatic representation of *Hypocrititriletes* STOUGH, n. gen. The dotted lines indicate locations of morphologic features on the opposite side.——*1a,b. H. insolitus* STOUGH, n. gen., n. sp., with proximal polar view *(1a)* showing raised trilete and irregularly ridged curvaturae and distal polar view *(1b)* showing triradiate band formed by parallel ridges.——*2. H.* sp. 1 showing distal ornamentation.——*3. H.* sp. 2 showing additional loops in curvaturae opposite rays of the trilete.

surface.——Pl. 4, fig. 7. Paratype, slide S1017AD (3), *x*, 33.9 mm., *y*, 5.1 mm., U.S. Natl. Mus. no. 41722; *a*, proximal surface, *b*, distal surface. [All plate figures are ×600.]

HYPOCRITITRILETES sp. 1

The two examples of *Hypocrititriletes* sp. 1 differ from *H. insolitus* in 1) having a more complex curvaturae, 2) having a less developed triradiate band, and 3) being larger. A specimen (Pl. 4, fig. 8) has a single secondary loop developed proximally opposite one ray of trilete. Distally, triradiate band poorly developed and composed of separated irregular elements arranged somewhat lineraly. Average diameter of the two specimens in polar view, 71 μ.

Illustrations.—Figure 5,*2*; Plate 4, figure 8. ——Fig. 5,*2*. Diagrammatic representation of distal ornamentation, not to scale.——Pl. 4, fig. 8. Slide S1017AD(2), *x*, 33.0 mm., *y*, 10.4 mm., U.S. Natl. Mus. no. 41723; *a*, proximal surface, *b*, distal surface; ×600.

HYPOCRITITRILETES sp. 2

This form represented by a single specimen, differs from the type species in having additional loops in curvaturae opposite ends of trilete rays. It is smaller (55 μ) than *Hypocrititriletes* sp. 1 and distal triradiate band formed of continuous ridges.

Illustrations.—Figure 5,*3*; Plate 4, figure 9. ——Fig. 5,*3*. Diagrammatic representation showing additional loops in curvaturae opposite rays of the trilete.——Pl. 4, fig. 9. Slide S1017AD(2), *x*, 10.0 mm., *y*, 1.3 mm., U.S. Natl. Mus. no. 41724; *a*, proximal surface, *b*, median focus through equatorial plane, *c*, distal surface; ×600.

REFERENCE

POTONIÉ, ROBERT, & KREMP, G. O. W., 1954, *Die Gattungen der palaeozoischen Sporae dispersae und ihre Stratigraphie:* Geol. Jahrb., v. 69, p. 111-94, 5 fig., 17 pl.

PART 4

PALYNOMORPHS FROM THE ZIPAQUIRA SALT, COLOMBIA

ABSTRACT

A sparse assemblage of palynomorphs indicative of a Portlandian-Albian age was recovered from a shale collected within the Zipaquirá salt of Colombia.

DISCUSSION

A sparse assemblage of spores and pollen was recovered from a bedded shale collected by R. C. SHUMAKER, Humble Oil & Refining Company, from within the Zipaquirá salt which crops out near Bogotá, Colombia. The Zipaquirá salt is thought to be diapiric, arising from Triassic-Jurassic roots and penetrating mid-Cretaceous (Turonian through Campanian) rocks near the surface (CAMPBELL & BÜRGL, 1965).

The assemblage consists of *Classopollis* sp. (isolated and united grains), *Cycadopites* sp., *Ephedrapites* sp., *Cicatricosisporites* spp., *Contignisporites* sp., *Gleicheniidites* sp., and *Applanopsis* sp. cf. *A. trilobatus* (BALME) emend. GOUBIN et al. (1965). Observation of the diagnostic characteristics of these palynomorphs was greatly facilitated by repeated bleaching of the acid-insoluble residue during processing.

The occurrence of *Cicatricosisporites* indicates that the assemblage is no older than Late Jurassic (Portlandian); the occurrence of *Contignisporites* and *Applanopsis*, which occur commonly in the Jurassic and Early Cretaceous and generally are lacking in sections younger than Early Cretaceous (Albian), suggests that the assemblage is no younger than Albian. The age of the shale within the salt, therefore, is interpreted to be within the Portlandian to Albian interval.

If the shale collected within the Zipaquirá salt is actually in place as is assumed, the polynological findings suggest strongly that the salt is considerably younger than interpreted previously.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to the Esso Production Research Company and to International Petroleum (Colombia) Ltd. for permission to publish this short note.

REFERENCE

CAMPBELL, C. J., & BÜRGL, H. F., 1965, *Section through the Eastern Cordillera of Colombia, South America:* Geol. Soc. America, Bull., v. 76, p. 567-590, 6 fig., 1 pl.