ON THE MORPHOLOGY AND BOTANICAL AFFINITIES OF *Lundbladispora* BALME 1963 IN THE PERMIAN OF THE PARANÁ BASIN, BRAZIL[1]

M. MARQUES-TOIGO[2]
A. T. PICARELLI[2]

ABSTRACT

Morphological variations observed in specimens so far identifield as *Lundbladispora braziliensis* (PANT & SRIVASTAVA) MARQUES-TOIGO & PONS 1974, have led to the identification of one more species for the genus: *Lundbladispora riobonitensis* sp. nov. Both species constitute frequent and characteristic forms in the southern Brazilian Gondwana coals. Possible affinities of these miospores with the Selaginellales are also discussed.

RESUMO

Variações morfológicas observadas em espécimens até então identificadas como *Lundbladispora braziliensis* (PANT & SRIVASTAVA) MARQUES-TOIGO & PONS 1974, levaram a identificação de mais uma espécie para o gênero: *Lundbladispora riobonitensis* sp. nov. As espécies constituem formas freqüentes e características nos carvões Gondwânicos Sul-brasileiros. Também são discutidas possíveis afinidades desses miosporos com Selaginellales.

INTRODUCTION

Lundbladispora Balme 1963 is widely distributed within the Permian sediments of the Paraná Basin, in southern Brazil. Among the microfloristic associations of coals of the Rio Bonito Formation, this genus accounts for 80-90% of the palynological content.

In 1965 PANT & SRIVASTAVA described a new species of *Densosporites*, *Densosporites braziliensis*, from several coal samples from Brazil. This species was mentioned again in 1967 by TIWARI & NAVALE for the same samples. In 1974, MARQUES-TOIGO & PONS carried out a study on the coal of the Irui Coalfield, Rio Grande do Sul State, in which a new combination was proposed for the species *Densosporites braziliensis*, since the features observed were considered to be more comparable to that genus.

Several analyses of specimens have been made due to the frequency with which they occur. Evident variations in the sculptural pattern of *Lundbladispora* permit the creation of the new species *Lundbladispora riobonitensis* and require the emendation of the diagnosis for *Lundbladispora braziliensis*.

Besides the taxonomic study, the authors have tried to define botanical affinities for this genus based on the literature and through comparison with modern species os *Selaginella*.

MATERIALS AND METHODS

This study was based on several analyses of Gondwana sediments from the Paraná Basin of the states of Rio Grande do Sul, Santa Catarina and Paraná, Brazil.

The slides were the same of as those used by MARQUES-TOIGO & PONS (1974); DIAS-FABRÍCIO (1981); PICARELLI & MARQUES-TOIGO (1983). The best preservation of the spores is mainly observed in the Irui, Gravataí-Morungava, Minas do Leão, Chico Lomã and Charqueadas Coalfields, all belonging to the Rio Bonito Formation in the State of Rio Grande do Sul (Fig. 1).

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[2] Instituto de Geociências, UFRGS, Rua Gen. Vitorino, 255
90000 – Porto Alegre, RS, Brasil.

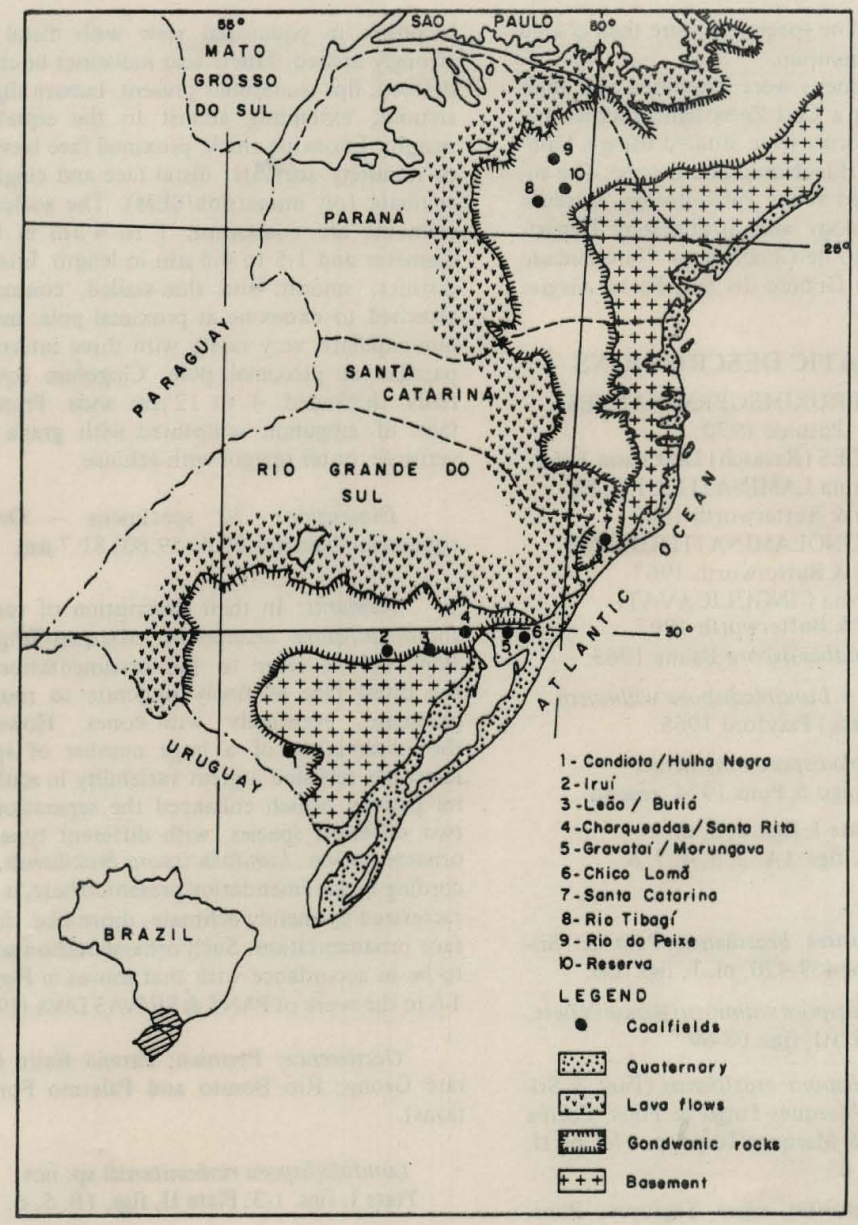

Fig. 1 – Location of the main occurrences of *Lundbladispora* in southern Brazil.

Fossil spore extraction techniques vary with the type of sediment being processed, but all consist of two basic steps: the removal of extraneous material and the concentration of miospores in the samples. The chemical treatments are the same as those most commonly used in microspore extraction: removal of carbonates by hidrochloric acid, removal of silicates by hydrochloric acid, removal of unsaturated organic soil colloids (humic acids) with a solution of potassium hidroxide (KOH). Cold Schulze solution (Potassium chlorate and concentrated Nitric Acid) was the oxidant used for the coal samples. Miospores were mounted in Canada balsam.

In the modern material, cellulose and hemicellulose were removed by acetolysis, using a mixture of acetic anhydride and concentrated sulfuric acid. The spores were mounted in unstained glycerine jelly.

Scanning electron microscope (SEM) investigation greatly increased the resolution of exine surface morphology of *Lundbladispora* species. The specimens were fixed to the stubs with double-faced adhesive tape, which proved to be the best suited for use with these fossil

palynomorphs. The specimens were then coated with carbon/aluminium.

The specimens were examined and photographed using a Carl Zeiss light microscope, while selected forms were studied using a Cambridge Scanning Electronic Microscope. The slides are deposited at the Paleontology Museum of the Paleontology and Stratigraphy Department of Instituto de Geociências, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.

SYSTEMATIC DESCRIPTIONS

Anteturma PROXIMEGERMINANTES
Potonié 1970
Turma TRILETES (Reinsch) Dettmann 1963
Suprasubturma LAMINATITRILETES
Smith & Butterworth 1967
Subturma ZONOLAMINATITRILETES
Smith & Butterworth 1967
Infraturma CINGULICAVATI
Smith & Butterworth 1967
Genus *Lundbladispora* Balme 1963

Type species – *Lundbladispora willmottii* (Balme) Playford 1965.

Lundbladispora braziliensis
Marques-Toigo & Pons 1974, emend.

Plate I, figs. 4, 5, 6;
Plate II, figs. 1A, 2, 3, 4, 7, 8.

Synonymy:

1965 – *Densosporites braziliensis* Pant & Srivastava, p. 469-470, pl. 1, figs. 1-6.

1975 – *Lundblasdispora willmottii* Balme; Ybert, p. 192, pl. III, figs. 68-69.

1975 – *Lundbladispora braziliensis* (Pant & Srivastava) Marques-Toigo & Pons; Corrêa da Silva & Marques-Toigo, p. 276, pl. II, figs. 13a, b.

1976 – *Krauselisporites niger* Segroves; Pons, p. 121-122, pl. II, figs. 17-18.

1978 – *Lundbladispora* cf. *L. simoni* Peppers; Burjack, p. 87, pl. III, fig. 6.

1979 – *Lundbladispora braziliensis* (Pant & Srivastava) Marques-Toigo & Pons 1974; Archangelsky & Gamerro p. 433, pl. IV, fig. 7.

1981 – *Lundbladispora braziliensis* (Pant & Srivastava) Marques-Toigo & Pons; Dias-Fabrício, pl. V, fig. 9.

1982 – *Lundbladispora* sp. Marques-Toigo *et alii*, p. 71, pl. I, figs. 23-25.

Emended diagnosis: Spores radial, trilete, cavate, cingulate. Amb convexly subtriangular; biconvex in equatorial view with distal face strongly arched. Trilete scar indistinct or clearly defined, lips sometimes present, laesura slightly sinuous, extending almost to the equatorial margin. Exoexine thick, proximal face laevigate or minutely scabrate, distal face and cingulum echinate (oil immersion/SEM). The sculptural elements are coalescent, 1 to 4 μm in basal diameter and 1.5 to 4.5 μm in length. Intexine distinct, smooth and thin-walled, commonly attached to exoexine at proximal pole; mostly non-papillate, very rarely with three interradial papillae at proximal pole. Cingulum equatorially thickened, 4 to 12 μm wide. Proximal face of cingulum sculptured with grana and verrucae, outer margin with echinae.

Dimensions: 50 specimens – Overall equatorial diameter 39.4 (59.80) 81.7 μm.

Remarks: In their description of species *Lundbladispora braziliensis*, Marques-Toigo & Pons (1974) refer to the ornamentation on the distal face as finely punctate to roughly granulate, eventually with cones. However, the observation of a large number of specimens has revealed a great variability in sculptural pattern, which enhanced the separation of two different species, with different types of ornamentation. *Lundbladispora braziliensis*, according to the emendation presented here, is characterized by mainly echinate, thorn-like, distal-face ornamentation. Such ornamentation seems to be in accordance with that shown in Figures 1-6 in the work of PANT & SRIVASTAVA (1965).

Occurrence: Permian; Paraná Basin (Itararé Group; Rio Bonito and Palermo Formations).

Lundbladispora riobonitensis sp. nov.
Plate I, figs. 1-3; Plate II, figs. 1B, 5, 6.

Holotype: Pl. I, fig. 1, Slide MP-P 316. (84.1 x 4.3)

Type locality: Iruí Coalfield, RS, Brazil, P7 Core, Rio Bonito Formation, Lower Permian.

Diagnosis: Spores radial, trilete, cavate cingulate. Amb convexly subtraingular, biconvex in equatorial view. Trilete scar indistinct or clearly defined, laesurae slightly sinuous accompanied by narrow labra, extending to the cingulum equatorial margin. Exoexine thick, proximal face laevigate or minutely scabrate, distal face finely textured with spongy

appearence (oil immersion/SEM). Cingulum bearing cones and few spinae confined to the outer margin. Intexine thin, indistinct, smooth, attached to exoexine at the proximal pole. Cingulum equatorialy thickened, 4-9 μm wide.

Dimensions: 50 specimens – Overall equatorial diameter 42.5 (59.8) 82.5 μm.

Description: Holotype 63.0 μm in equatorial diameter, amb subtriangular. Laesurae well defined, labra slightly sinuous, extending to the cingulum equatorial margin. Exoexine thick, proximal face punctate, distal face scabrate. Outer margin of the cingulum bearing small cone and spinae irregularly distributed. Intexine thin, well defined, 35.0 μm in diameter, attached to the proximal pole. Cingulum thickened, 4.2 – 5.2 μm wide.

Derivation of name: From the Rio Bonito Formation, Paraná Basin, Lower Permian, southern Brazil.

Comparison: Lundbladispora riobonitensis sp. nov. is distinguished from *L. braziliensis* Marques-Toigo & Pons (1974) emend. based on sculptural elements. The latter species shows an echinate distal face, while *L. riobonitensis* has a predominantly finely textured (spongy) exoexine. *Lycospora spongiosa* Marques-Toigo (1974) is closely comparable to the present species in the similarity of the sculptural elements on the exoexine. *Lundbladispora playfordii* Balme (1963), described by Ybert 1975 (Pl. III, figs. 65-67) and Burjack (1978; Pl. III, figs. 4-5), *Densosporites* sp. (in Marques-Toigo *et alii*, 1975, Pl. III, figs. 10-11) all recorded from the Rio Bonito Formation, Paraná Basin, southern Brazil, and the specimens assigned to *L. braziliensis* by Archangelsky & Gamerro (1979, Pl. IV) to the Chacoparanaense Basin, Argentina, is clearly comparable to the description of *Lundbladispora riobonitensis* sp. nov.

Affinities: According to Balme (1963), dispersed microspores belonging to *Lundbladispora* are probably related to herbaceous lycopsids of the Selaginellales. Comparison of modern Brazilian cavate spores of some Selaginellales and dispersed fossil spores of *Lundbladispora* exhibits a remarkable similarity in morphographic characteristics. *Selaginella mildei* HIER (Pl. I, figs. 7-8) is closely comparable to *Lundbladispora riobonitensis* sp. nov. in the sculptural elements on the distal and proximal face as well as the cavate nature of the exine.

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Explanations of the Plates

Plate I

Figs. 1, 2, 3 – *Lundbladispora riobonitensis* sp. nov.: Fig. 1 – Holotype, proximal focus, Iruí Coalfield, Slide MP-P 316 (84.1 x 4.3); Fig. 2 – Distal focus, Charqueadas Coalfield, Slide MP - P 3065 (101 x 12.7); Fig. 3 – Lateral view, Iruí Coalfield, Slide MP-P 317 (90.1 x 6.8).

Figs. 4, 5, 6 – *Lundbladispora braziliensis* Marques-Toigo & Pons 1974 emend.: Fig. 4 – Proximal focus, Prep. MP-P 3065 (106.2 x 2.6); Fig. 5 – Equatorial focus, Charqueadas Coalfield, Slide MP-P 3065 (106.2 x 2.6); Fig. 6 – Distal focus, Slide MP-P 3065 (102.5 x 2.6).

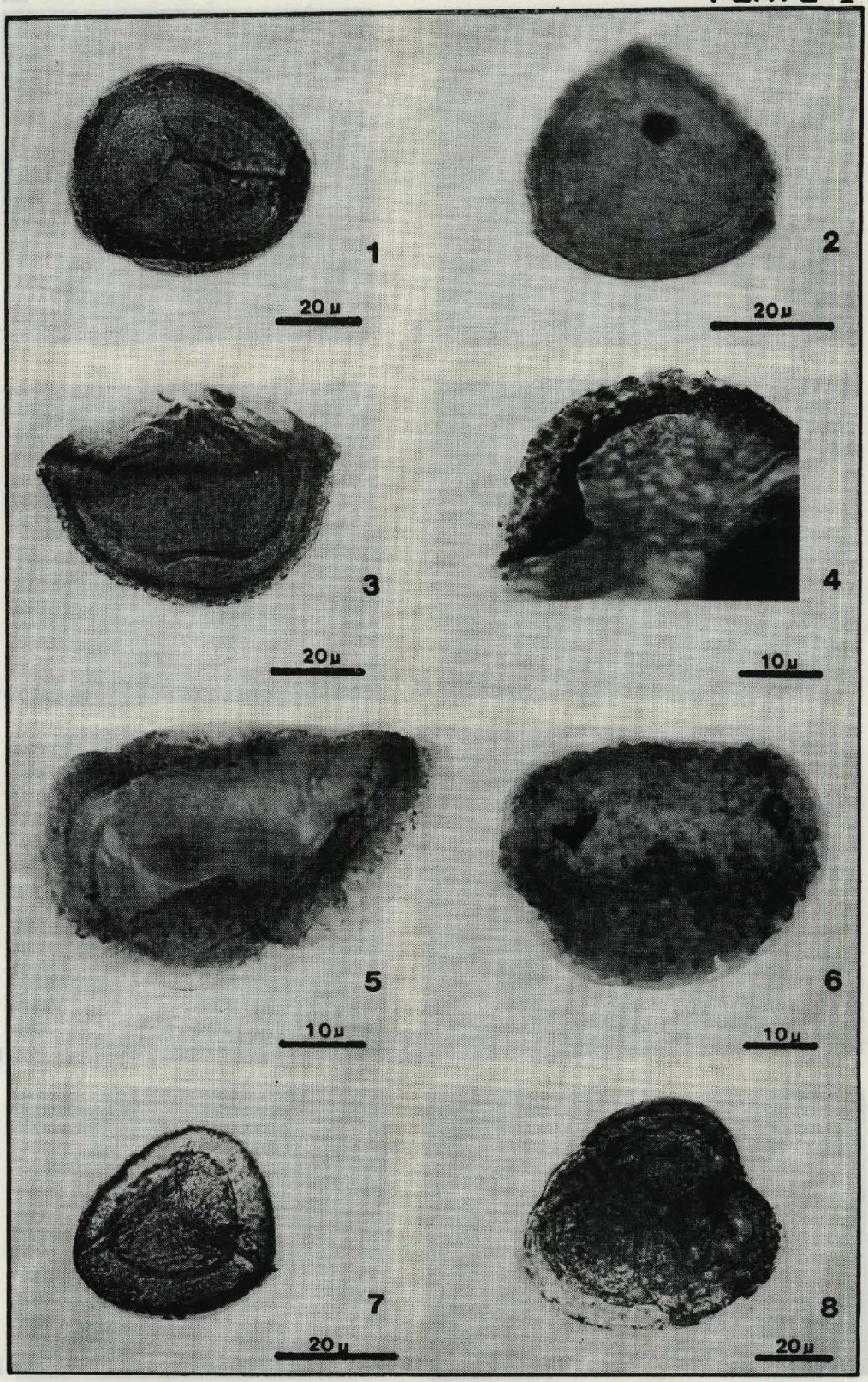
Figs. 7, 8 – *Selaginella mildei* Hier: Fig. 7 – Proximal focus, Slide 3201; Fig. 8 – Tetrad, Slide MP–P 3201.

Plate II

Figs. 1A, 2, 3, 4, 7, 8 – *Lundbladispora braziliensis* Marques-Toigo & Pons 1974 emend.: Fig. 1A – SEM, distal aspect, Minas do Leão Coalfield, Prep. 1951; Fig. 2 – SEM, detail showing sculptural elements, same locality as fig. 1, Prep. 1951; Fig. 3 – SEM, tetrad aspect, same locality, Prep. 1954; Fig. 4 – SEM, detail showing sculptural elements, Iruí Coalfield, Prep. 258; Fig. 7 – SEM, proximal aspect showing trilete scar, Iruí Coalfield, Prep. 258; Fig. 8 – SEM, detail showing sculptural elements, Iruí Coalfield, Prep. 257.

Figs. 1B, 5, 6 – *Lundbladispora riobonitensis* sp. nov.: Fig. 1B – SEM, Minas do Leão Coalfield, Prep. 1951; Fig. 5 – SEM, tetrad aspect, Minas do Leão Coalfield, Prep. 1951; Fig. 6 – SEM, detail showing sculptural elements.

PLATE I



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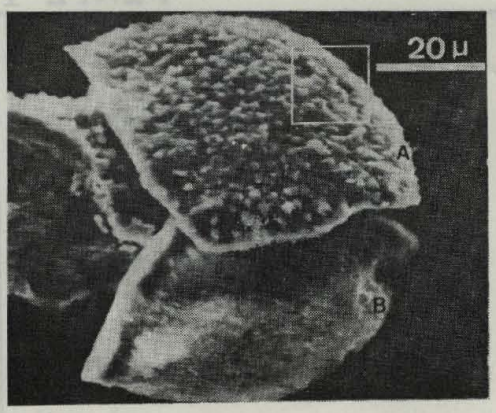

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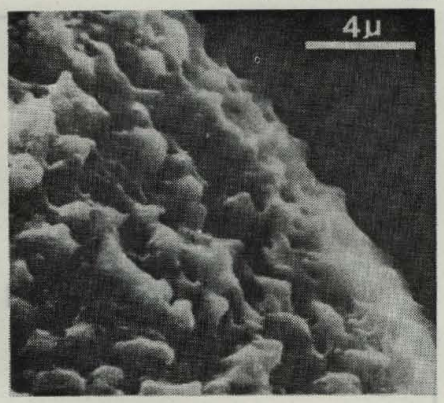

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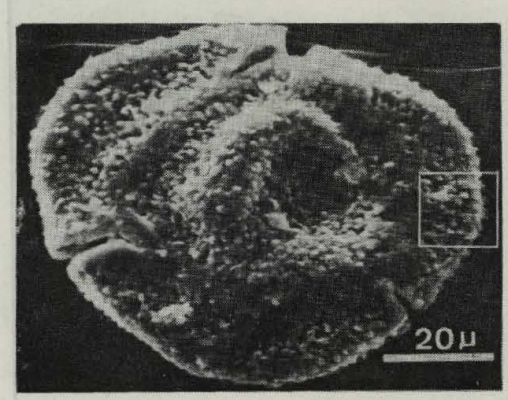

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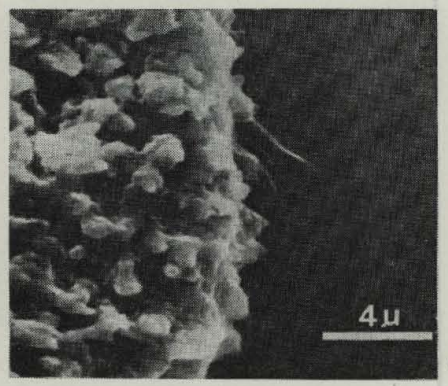

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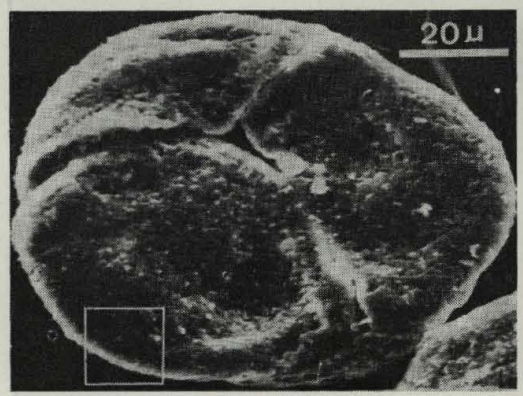

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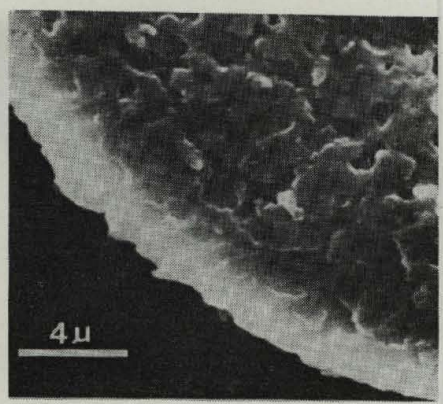

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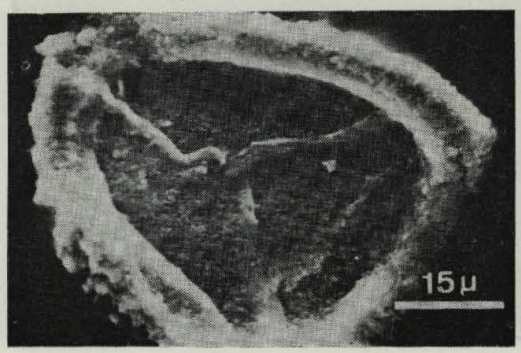

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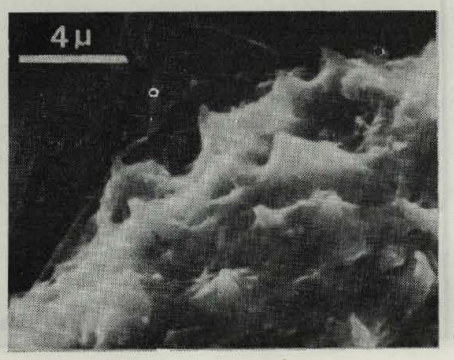

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