LOWER CARBONIFEROUS MIOSPORES FROM BONEPARTE GULF BASIN, AUSTRALIA

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ABSTRACT

The spore flora recovered from an argillaceous shale of Lower Carboniferous age from Boneparte Gulf basin, Australia, has been described. 10 genera and 14 species are recorded. The spore flora has typical Lower Carboniferous index spore genera like *Convolutispora, Velamisporites, Cristatisporites, Cincturasporites, Grandispora* and *Remysporites.*

AUSTRALIAN coal and other sedimentary deposits have been sporologically investigated by a number of workers. Spore floras from Upper Devonian, Upper Carboniferous — Permian and younger horizons of Australia have been studied in detail by Balme (1961), Balme & Hennelly (1955, 1956), Dulhunty (1945, 1946), Hennelly (1958), Cookson & Dettmann (1957, 1959) and other workers. The Lower Carboniferous sediments from Australia which have not been investigated sporologically so far are dealt with here.

The present study describes an assemblage of spores recovered from Milligans Bore, Boneparte Gulf Basin of Western Australia. The spore flora recovered, though poor in content, is significant.

MATERIAL AND METHODS

The material consisted of a lump of argillaceous shale presented by Mr. B. E. Balme to Dr. D. C. Bharadwaj, who very kindly placed it at my disposal for investigation.

The shale was boiled with Hydrochloric acid for 10 minutes, and after successive washing was again boiled with Nitric acid (commercial) for 10 minutes. It was then repeatedly washed and treated with Potassium hydroxide for 10-15 minutes. After the final washing the macerate was collected for microscopic study. Slides were directly prepared from the macerate with Glycerine Jelly. All the macerated material was used up for preparation of slides as it was very poor in spore content. The spores are usually dense and dark, not well preserved or mutilated. The average specimen count is less than 10 spores per slide.

SYSTEMATIC DESCRIPTION

Anteturma —*Sporites* H. Pot. 1893
Turma —*Triletes* (Reinsch) Pot. & Kr. 1954
Subturma —*Azonotriletes* Luber, 1935
Infraturma —*Laevigati* (B. & K.) Pot. 1956

***Punctatisporites* (Ibr.) Pot. & Kr. 1954**

Generotype — Punctatisporites punctatus Ibr. 1933.

Punctatisporites cf. *obesus* (Loose) Pot. & Kr. 1955
Pl. 1, Fig. 1

Description — Dark yellowish brown, circular, 120 μ. Y-mark distinct, ray arms reaching up to $\frac{3}{4}$ radius. Exine laevigate, ± 3 μ thick in optical section.

Comparison — P. obesus (Loose) Pot. & Kr., distinguishes in possessing smaller trilete mark. *P.* cf. *obesus* described by Horst (1955) is smaller in size. The other species of *Punctatisporites* described by Butterworth and Williams (1958), Hacquebard (1957) and others from the Lower Carboniferous sediments are all smaller in size and differ considerably from the specimen described here.

Punctatisporites sp.
Pl. 1, Fig. 2

Description — Yellowish brown, circular with many irregular folds, 86 μ. Y-mark obscured due to folds. Exine laevigate, ± 2 μ thick.

Comparison — P. cf. *obesus* described above is much bigger in size and possesses a distinct trilete mark.

Remarks — Since only one specimen has been recovered it is difficult to place it among any of the known species.

Punctatisporites debilis Hacq. 1957
Pl. 1, Fig. 3

Holotype — Hacquebard 1957, Pl. 1, Fig. 5.
Loc. Typ. — Horton group, Nova scotia, West gore.

For diagnosis and description — See Hacquebard 1957, p. 308.

Infraturma—*Apiculati* (B. & K.) Pot. 1956

***Convolutispora* H. S. & M. 1955**

Generotype — Convolutispora florida H.S. & M. 1955.

Convolutispora sp. A.

Pl. 1, Figs. 4-6

Description — Dark brown miospores, circular — subcircular, 100-110 μ. Y-mark hardly decipherable. Exine beset with up to 8 μ broad and equally high pila, which anastomose to form a obvermiculate pattern on the surface, pila distinctly seen on the extrema lineamenta.

Comparison — C. tessellata, C. mellita and *C. ampla* described by Hoffmeister, Staplin and Malloy (*l.c.*) differ in possessing smaller pila for their ornamentation. *C. florida* H.S. & M., though possessing similarly large pila, is smaller in size. *C. cerebra* Butt. & Wills. (1958), possesses smaller, closely packed pila for its ornamentation. *C. varicosa* Butt. & Wills., has platy low set broad pila for its ornamentation. *C. cristata* Bharad. & Venk. (1961), is distinguishable from *C.* sp. in having smaller pila. *C. stigmoidea* Bharad. & Venk. (*l.c.*), has widely spaced, broad pila and is much smaller in size. *C. geniculata* Bharad. & Venk. (*l.c.*), has low set broad, distinct pila for its sculpture which do not anastomose.

Remarks — Since only few specimens have been found in the Australian sediments, I defer putting them into a new species. The ornamentation in *C.* sp. is distinct, the pila being prominent on the extrema lineamenta, and anastomosing on the exine to form vermiculate or obvermiculate ridges to give a convoluted look to the spores.

Cf. *Convolutispora* sp.

Pl. 1, Fig. 7

Description — Roundly triangular, blackish brown, 106 μ. Y-mark distinct, ray-arms almost going up to the equator, apex and vertex low, labra ± 8 μ broad on either side of the suture. Exine ornamented with 5-6 μ broad, irregularly arranged pila which cohere to form a rugose surface, giving an appearance of vermiculate ridges and furrows. Extrema lineamenta uneven and shows distinct pilate processes which constitute the ornamentation.

Comparison — Convolutispora H.S. & M., distinctly differs from the present specimen in having a ± circular shape and not possessing such an elaborately developed trilete apparatus as in cf. *Convolutispora* sp.

Remarks — Only one specimen has been recovered, which does not allow any further comparison. The spore has been placed near *Convolutispora*, due to its sculptural pattern constituting of short headed pila which anastomose on the surface to give a convoluted look to the spore.

***Apiculatisporis* (Ibr.) Pot. & Kr. 1956**

Generotype — Apiculatisporis aculeatus Ibr. 1933.

Apiculatisporis sp. A.

Pl. 1, Figs. 8 & 9

Description — Circular, 60 μ. Y-mark distinct, Y-rays going up to ½ radius, arms end blunt. Exine ornamented with up to 2 μ wide, equally long coni.

Comparison — Apiculatisporis maculosus described by Butterworth & Williams (*l. c.*) is much bigger in size and has larger coni for its ornamentation. *A.* cf. *maculosus* described by Bharadwaj & Venkatachala (*l.c.*) from Spitzbergen too is bigger in size and distinguishes in possessing grana interspersed between the coni. The other species of *Apiculatisporis* recorded by Potonié & Kremp (*l.c.*) and described by other workers are not comparable.

Apiculatisporis sp. B.

Pl. 1, Fig. 10

Description — Circular with many folds, 100 μ, Y-mark not decipherable. Exine ornamented with less than 2 μ wide coni.

Comparison—A. maculosus and other species described by Butterworth & Williams (*l.c.*) are distinctly different in possessing bigger sculptural elements. *Apiculatisporis* listed by Potonié & Kremp (1955) and described by later authors do not compare with this species.

Infraturma — *Murornati* Pot. & Kr. 1954

***Microreticulatisporites* (Knox) Bhard. 1955**

Generotype — Microreticulatisporites lacunosus (Ibr.) Knox, 1950.

Microreticulatisporites sp.

Pl. 1, Figs. 11 & 12

Description — Circular, generally folded, 70-84 μ. Y-mark present but often ob-

scured, blunt, going up to less than $\frac{1}{2}$ radius. Exine ornamented with low set, irregular muri enclosing $\pm$ 1 μ broad lumina, muri clearly recognized on the surface and along the open rays of the trilete mark.

Comparison — Among the *Microreticulatisporites* described from the Lower Carboniferous sediments, *M. fundatus* H.S. & M., is much smaller in size and is characterized by peaked muri, forming large meshes. *M. concavus* Butt. & Wills., is distinctly triangular in shape and smaller in size. *M. lunatus* is also smaller in size and differentiates in possessing peaked muri for its ornamentation. *M. microreticulatus* Knox, and *M. punctatus* Knox, though possessing, low set muri are much smaller in size and thus are hardly comparable. *M. cribellarius* (Horst) Pot. & Kr., is distinctly triangular with low set, irregular muri. *M. erinacianus* (Horst) Pot. & Kr., is closely comparable to *M.* sp. described here, but it differs in possessing irregularly set fine muri for its ornamentation. *M.* cf. *erinacianus* described by Butterworth and Williams (*l.c.*) is distinctly triangular in shape and hence cannot be compared with the species described here. Among the species recorded by Potonié & Kremp, all the species distinguish in having peaked muri. Since only few specimens are recorded, nothing more can be said about the taxonomic position of this species.

Remarks — Bhardwaj (1955) has emended the genus *Microreticulatisporites* (Knox) Pot. & Kr., and restricted to triangular spores possessing a distinct trilete mark and an extrareticulate ornamentation. The spores described, are circular with a trilete mark and clearly recognizable extrareticulate ornamentation. As there is no other genus to accommodate such spores, they have been placed for the present under Cf. *Microreticulatisporites*.

Infraturma — *Perinotriliti* Erdt. 1947

***Velamisporites* Bharad. & Venk. 1961**

Generotype — *Velamisporites rugosus* Bharad. & Venk. 1961.

Velamisporites rugosus Bharad. & Venk. 1961

Pl. 2, Figs. 14-16

Holotype — Bharadwaj & Venkatachala, 1961, pl. 2, Fig. 25.

Loc. Typ. — Pyramidenberg, Spitzbergen.

Remarks — The spores illustrated here also show clearly the characteristic perisporial covering as in the holotype and the diplotype. In the specimens figured in Pl. 2, Figs. 14 & 15, the perisporium completely envelopes the spore exine, rendering the ornamentation of the spore exine and the trilete mark inconspicuous while in the specimen figured in Pl. 2, Fig. 16 the trilete mark going only up to $\frac{1}{3}$ radius can be clearly seen and the spore exine is thick in this case. The granulose perisporium envelopes the spore.

Turma —*Zonales* Pot. & Kr. 1954
Subturma —*Zonotriletes* Waltz, 1935
Infraturma—*Cingulati* Pot. & Kr. 1954

***Cristatisporites* (Pot. & Kr.) Bharad. & Venk. 1961**

Generotype — *Cristatisporites indignabundus* (Loose) Pot. & Kr. 1955.

Cristatisporites cf. *regalis* Bharad. & Venk. 1961

Pl. 2, Fig. 17

Description — Roundly triangular in polar view with bluntly conical angles, 98×128 μ. Central body roundly triangular; 46×70 μ; lighter in colour than the dark, thick equatorial cingulum. Cingulum $\pm$ 20 μ wide following the contour of the spore body, dense nearer the body and lighter towards the equator. Y-mark $\pm$ distinct, rays going up to the equatorial margin; dark, thickened ridges clearly seen on the angles of the cingulum. Exine irregularly covered over by less than 2 μ wide grana.

Comparison — *Cristatisporites regalis* is different, in possessing a thick cingulum, and a smaller spore body. Since only one specimen has been recovered, any further comparison is difficult.

***Cincturasporites* (Hacq. & Barss 1957) Bharad. & Venk. 1961.**

Generotype — *Cincturasporites altilis* Hacq. & Barss 1957.

Cincturasporites sp.

Pl. 2, Figs. 19 & 20

Description — Spores circular — roundly triangular, 90-120 μ. Y-mark hardly perceptible. Central body distinct, covered equatorially by 20-30 μ wide cingulum,

which is not uniformly thickened all over.

Comparison — The spores assigned to *Cincturasporites* by Hacquebard & Barss (*l.c.*) and Bharadwaj & Venkatachala (*l.c.*) do not compare with the present species, in their having a prominent trilete mark.

Remarks — All the specimens recovered by me from the shale are badly preserved and thus do not allow a clear comparison, with the already known species of *Cincturasporites*. However, it is important to note the presence of this genus from the Australian sediments.

Cf. *Cincturasporites* sp.

Pl. 2, Fig. 18

Description — Roundly triangular with rounded angles and convex sides, 74 μ. Y-mark easily noticeable, ray arms almost going up to the equatorial contour. Equatorial cingulum ± 6-10 μ broad.

Comparison — The spores cannot be well compared with *Cincturasporites* described by Hacquebard and Barss (1957) and Bharadwaj & Venkatachala (1961). The presence of an equatorial expanse and a distinct trilete mark, has lead me to place the spores recovered here, nearer *Cincturasporites* than with any other genus. I have recovered only few ill-preserved specimens and hence it is not possible at present to place it definitely in any genus.

***Cirratriradites* Wilson & Coe 1940**

?*Cirratriradites* sp.

Pl. 2, Fig. 21

Description — Roundly triangular with rounded angles, ± 100 μ. Y-mark distinct, arms only going up to the equatorial limit of the spore body. Spore body roundly triangular, laevigate. Zona ± 20 μ, infragranulose, almost following the contour of the spore body.

Comparison — *C. solaris* Hacq. & Barss, differs in possessing a larger zonal appendage. *C. exilis* Bharad. & Venk., is hardly comparable, it differs in its overall size, and the ratio between spore body and zona. All the other species listed by Potonié & Kremp (1956) differ from *C.* sp. in possessing an ornamented spore body and distinct distal foveole.

Turma —*Pollenites* Pot. 1931
Subturma —*Saccites* Erdt. 1947
Infraturma —*Monosaccites* (Chitaley) Pot. & Kr. 1954

***Remysporites* Butt. & Wills. 1958**

Generotype — Remysporites magnificus (Horst) Butt. & Wills. 1958.

Remysporites sp.

Pl. 1, Fig. 13

Description — Circular, dark brown, ± 140 μ. Y-mark open. Central body circular, dark, ± microreticulate as can be seen in the open trilete area, otherwise indistinct due to the thick and dark nature of the spore. Bladder covering the body uniformly allround, the structure of the bladder not recognizable.

Comparison — *R. magnificus* as illustrated by Butterworth and Williams (*l.c.*) and Bharadwaj and Venkatachala (*l.c.*) though coming in the same size range is different in possessing a bladder which is much larger in size as compared to *R.* sp.

***Grandispora* H. S. & M. 1955**

Generotype — Grandispora spinosa H.S. & M. 1955.

Grandispora spinosa H.S. & M. 1955.

Pl. 2, Fig. 22

Holotype — Hoffmeister, Staplin and Malloy, 1955; Pl. 39, Fig. 10.

Loc. Typ.— Hardinsburg formation, U.S.A.

MIOFLORAL COMPOSITION AND COMPARISON

The spore florule is very poor in forms and consists of 10 genera and 14 species. The following genera are recorded, and the number of specimens of each genus recovered in the entire macerate has been noted.

Genus	No. of Specimens recovered
Punctatisporites	5
Apiculatisporis	3
Convolutispora	10
Microreticulatisporites	6

Genus	No. of Specimens recovered
Velamisporites	12
Cristatisporites	1
?Cirratriradites	1
Cincturasporites	4
Cf. *Cincturasporites*	6
Grandispora	2
Remysporites	1
Indeterminable	6

The representation of genera and species is very scarce as compared to the other Lower Carboniferous deposits studied. The presence of some of the typical Lower Carboniferous spore genera of the northern hemisphere (Bharadwaj & Venkatachala, 1961), viz., *Convolutispora*, *Velamisporites*, *Cincturasporites*, *Grandispora* and *Remysporites* is significant. Among the other genera present, *Cristatisporites*, is also known to occur in the Lower and Upper Carboniferous of northern hemisphere.

Thus it is apparent that the Lower Carboniferous miofloras as far south as Australia are characterized by a significant type of assemblage, broadly similar to that of northern hemisphere, which can be recognized in contrast to the mioflora of younger and older horizons.

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EXPLANATION OF PLATES

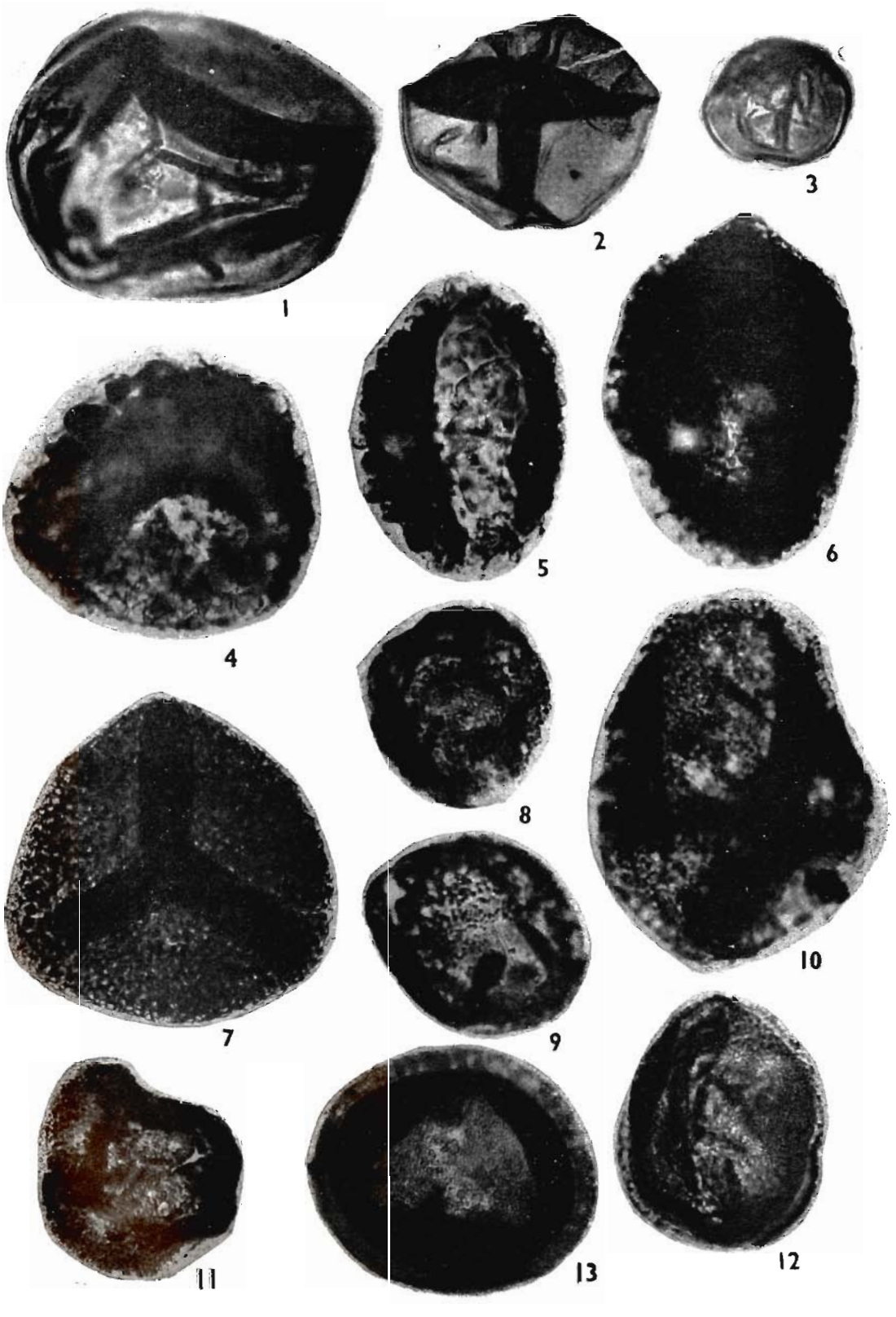
(*All magnifications* × 500, *except otherwise stated. Slides are preserved at Birbal Sahni Institute of Palaeobotany, Lucknow, India*)

PLATE 1

1. *Punctatisporites* sp. A. Photo 228/3; Slide 161/14.
2. *Punctatisporites* sp. B. Photo 227/3; Slide 161/1.
3. *Punctatisporites debilis* Hacq. Photo 227/34; Slide 161/13.
4. *Convolutispora* sp. A. Photo 227/16; Slide 161/11.
5. *Convolutispora* sp. A. Photo 228/13, Slide 161/21.
6. *Convolutispora* sp. A. Photo 228/10, Slide 161/14.
7. Cf. *Convolutispora* sp. Photo 228/14; Slide 161/14.
8. *Apiculatisporis* sp. A. Photo 227/28, Slide 161/13.
9. *Apiculatisporis* sp. A. Photo 234A/6, Slide 161/12.
10. *Apiculatisporis* sp. B. Photo 227/10, Slide 161/11.
11. *Microreticulatisporites* sp. Photo 228/17; Slide 161/22.
12. *Microreticulatisporites* sp. Photo 227/9; Slide 161/14.
13. *Remysporites* sp. × 250. Photo 234A/2; slide 161/20.

PLATE 2

14. *Velamisporites rugosus* Bharad. & Venk. Photo 194; Slide 161/10.
15. *Velamisporites rugosus* Bharad. & Venk. Photo 197; Slide 161/14.
16. *Velamisporites rugosus* Bharad. & Venk., without the perisporial cover. Photo 193, Slide 161/9.
17. *Cristatisporites* sp. Photo 227/4; Slide 161/2.
18. Cf. *Cincturasporites* sp. Photo 227/13; Slide 161/11
19. *Cincturasporites* sp. Photo 227/15; Slide 161/11.
20. *Cincturasporites* sp. Photo 227/16; Slide 161/12.
21. *? Cirratriradites* sp. Photo 227/8; Slide 161/8.
22. *Grandispora* sp. Photo 227/7; Slide 161/11.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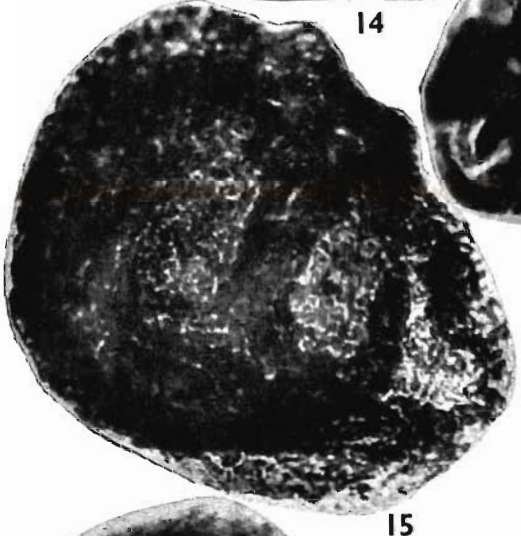

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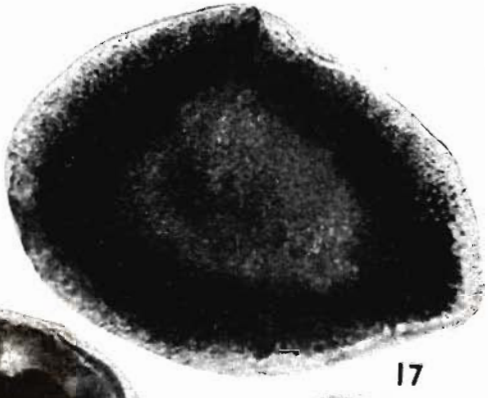

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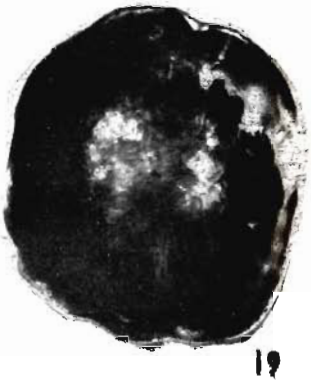

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