Acta Biologica Szeged. *20* (1—4), pp. 81—88 (1974)

ULTRASTRUCTURAL STUDIES ON MESOZOIC INAPERTURATE GYMNOSPERMATOPHYTA POLLEN GRAINS

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(Received January 18, 1973)

Abstract

Fine structural investigations were performed on Gymnospermatophyta pollen grains from the Nubian formation of the Oasis Farafra. The fine structure of *Inaperturopollenites limbatus* exine (lower level of Nubian formation; Jura era) corresponds in general to the wall of the palaeozoic Schopfipollenites species. The *Araucariacites* species from the upper level (Upper Cretaceous) however, are identical from ultrastructural point of view with the recent Gymnospermatophyta exines.

Introduction

The basis of the knowledge of the Mesozoic Gymnospermatophyta exine ultrastructure was established by PETTITT and CHALONER (1964) with their ultrastructural studies of the exines of *Classopollis*-type pollen grains. PETTITT (1966) reported very valuable data on the submicroscopic structures of Palaeozoic spores and primitive Gymnospermatophyta pollen grains. In studies on Jurassic and Upper Cretaceous Gymnospermatophyta exines, KEDVES and PÁRDUTZ (1973) obtained results suggesting the necessity to broaden the previous investigations. Thus, the exine ultrastructure of the Jurassic *Spheripollenites scabratus* COUPER 1958 agrees markedly with those of Angiospermatophyta ectexines, while the cf. *Araucariacites* v. *Granulatisporites* fsp. is of an angiospermid character. This justified the ultrastructural examination of other inaperturate pollen grains, and the present paper gives our recent results in this respect.

Materials and Methods

From the point of view of the aim of the examination, samples from the Nubian formation of the Farafra oasis, already studied with regard to their main light-microscopic types, were the most suitable. As reported previously (KEDVES, 1971), the lower level of the formation is Jurassic, and its upper level Upper Cretacean. The Jurassic samples contained great numbers not only of the *Classopollis* genus, but also of *Inaperturopollenites limbatus* BALME 1957, while in the Upper Cretacean samples pollen grains of the Araucariacites form-genus were comparatively frequent. The preparation of the examination material and the method used were described earlier (KEDVES and PÁRDUTZ, 1970).

Results

1. *Inaperturopollenites limbatus* BALME 1957 (Fig. 1, 2).

Note. — This differs substantially from the other, particularly Lower Tertiary inaperturate pollen grains; the exine attenuates strongly at its poles, and the wall is thicker along the "equator".

Examinations were made on five specimens, and the exine ultrastructure of the pollen grain could be regarded as completely elucidated. The exine is of a markedly gymnospermid character, and consists of ectexine and lamellar endexine, while the ectexine is not triply divided. In many cases the lamellar ultrastructure of the endexine is not pronounced; this is probably a result of secondary change following fossilization. In the equatorial part the ectexine is 2—3 times thicker than the endexine; it has a "sponge structure" and consists of anastomizing elements of variable form (Fig. 1,4; Fig. 2). The ultrastructural elements are arranged a little more densely in the vicinity of the surface than in the inner parts, at times giving the impression of a separate layer. The endexine has a markedly lamellar ultrastructure (Fig. 1,2,4). In the polar, attenuating part the thickness of the ectexine is by and large the same as that of the endexine. As regards its essence, the ultrastructure of the ectexine in this part agrees with that of the equatorial part, with the difference that its elements are arranged a little more densely (Fig. 1,3).

2. *Araucariacites* fsp.$_1$ (Fig. 3)

In this form-species too the exine is distinctly divided into two layers, ectexine and very finely lamellar endexine. The ectexine consists of elements of variable form: drop-shape, spherical or ellipsoid. As regards its size, two types can be established. The smaller ones, which are primarily spherical or ellipsoid in shape, are situated immediately above the endexine. Among these can be found the larger, drop-like or radially extended elements, which are frequently ramified at their terminals, with pointed or blunt-ended processes.

3. *Araucariacites* fsp.$_2$ (Fig. 4)

As regards its fundamental ultrastructural featŭres, this is the same as the previous form-species. A difference can be established in the ectexine: in this pollen grain the relatively large ultrastructural elements are approximately spherical or ellipsoid in form, without tapering processes. The smaller ectexine elements frequently anastomize.

Discussion

Comparison of these more recent results with the earlier findings leads to the following conclusions. The submicroscopic structure of the walls of the Palaeozoic Gymnospermatophyta micro-residues examined from several aspects by PETTITT (1966) is heterogeneous. Main types:

1. Completely homogeneous wall-structure; *Didymosporites scotti* CHALONER.

2. The outer layer is fibrillar, and the inner layer homogeneous; *Cystosporites giganteus* (ZERNDT) SCHOPF 1938.

3. The wall consists of uniformly three-dimensional sporopollenin elements which form a spongy structure; *Trigonocarpus* sp.

4. The outer layer is a spongy layer, and the inner layer has granular ultrastructure; *Florinites* sp.

5. The outer layer is spongy, and the inner lamellar; *Schopfipollenites* sp. This ultrastructure agrees with that of *Inaperturopollenites limbatus* BALME 1957. As regards ultrastructure, therefore, this Jurassic "inaperturate" pollen grain represents a very primitive type. From this point of view, of particular interest is the earlier studied *Spheripollenites scabratus* COUPER 1958, the exine of which consists only of ectexine, and this is of triple "angiospermid" division (tectum, columellae, foot layer). The ultrastructure of pollen grains of the *Classopollis* type (PETTITT and CHALONER 1964) is even more complex than that of the Angiospermatophyta. Thus, in the Jurassic the angiospermid too occurs in addition of the primitive exine ultrastructure in the inaperturate pollen grains. The Upper *Cretacean* cf. *Araucariacites* v. *Granulatisporites* fsp. (KEDVES and PÁRDUTZ, 1973) similarly has an ultrastructure reminiscent of the Angiospermatophyta. The significance of the exine ultrastructure of *Araucariacites* fsp.$_{1\ 2}$, also originating from this age, lies in the fact that this is the first successful demonstration of an ultrastructure of Gymnospermatophyta type similar to recent taxons in fossil inaperturate pollen grains. The data referring to the recent taxons can be found in the papers of GULLVAG (1966) and PETTITT (1966).

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Fig. 1. *Inaperturopollenites limbatus* BALME 1957

1. — Light-microscopic picture of ultrastructually studied specimen in embedded material. M: x1000
2. — Ultrastructure of the endexine. M: x25 000.
3. — Ultrastructure of the exine on the polar, attenuating wall-part. M: x25 000.
4. — Ultrastructure of the exine on the equatorial thicker wall-part. M: x25 000.
   Ectex. = ectexine, Endex. = endexine.

Fig. 2. *Inaperturopollenites limbatus* BALME 1957

1. — Partial tangential section of the ectexine. M: x25 000.
   Ectex. = ectexine, Endex. = endexine.

Fig. 3. *Araucariacites* fsp.$_1$

1. — Light-microscopic picture of ultrastructurally studied specimen in embedded material.
2. — Tangential section of the ectexine. M: x25 000.

3,4. — Cross-section of the exine. M: x25 000.
   Ectex. = ectexine, Endex. = endexine.

Fig. 4. *Araucariacites* fsp.$_2$

1. — Light-microscopic picture of ultrastructurally studied specimen in embedded material. M: x1000.
2. — Cross-sectional picture of the exine. M: x50 000.
3. — Tangential section of the ectexine, from the part above the endexine. M: x25 000.
4. — Tangential section of the ectexine, from the level of the larger ultrastructural elements. M: x25 000.
5. — Cross-sectional picture of the exine. M: x50 000.
   Ectex. = ectexine, Endex. = endexine.

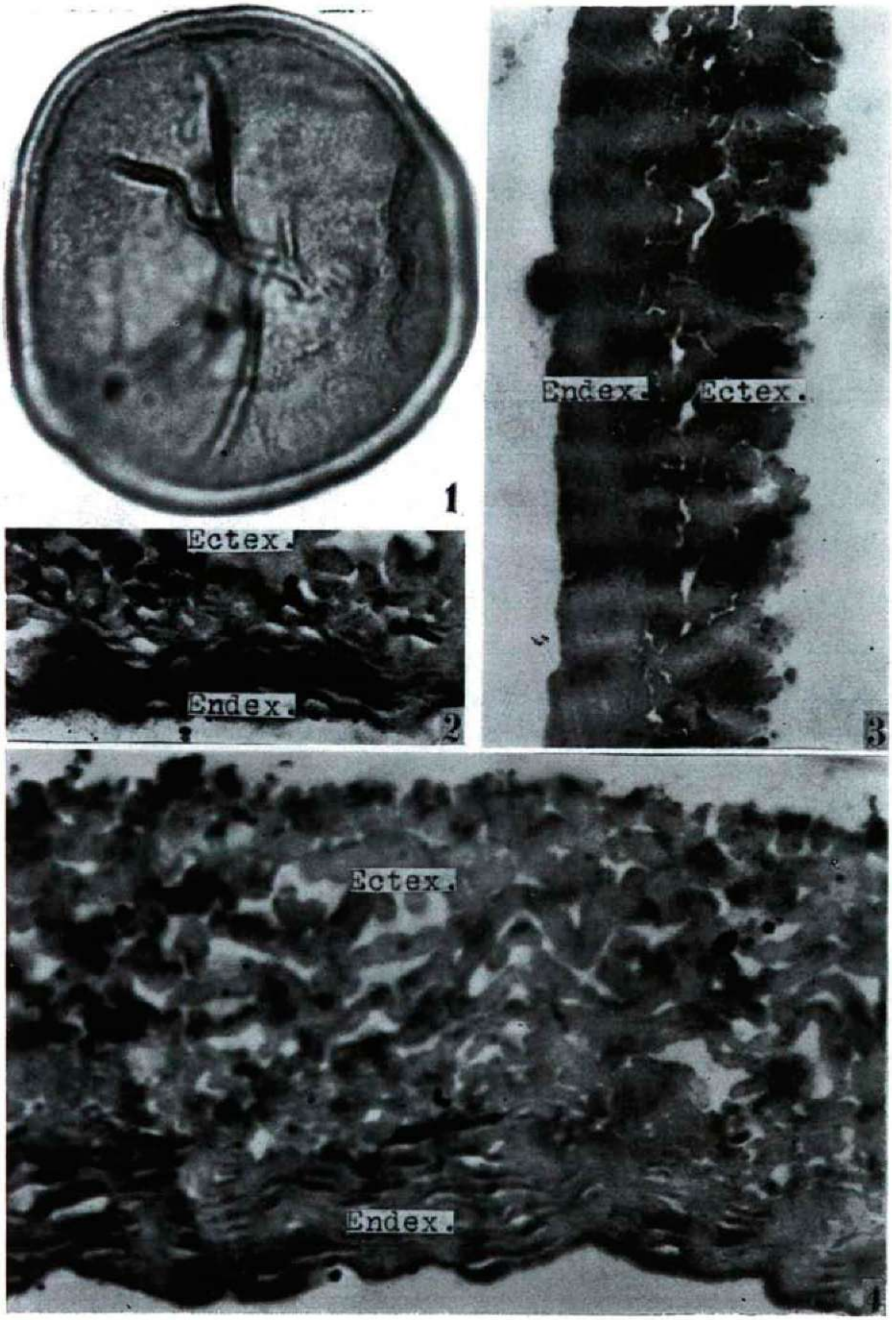

Fig. 1

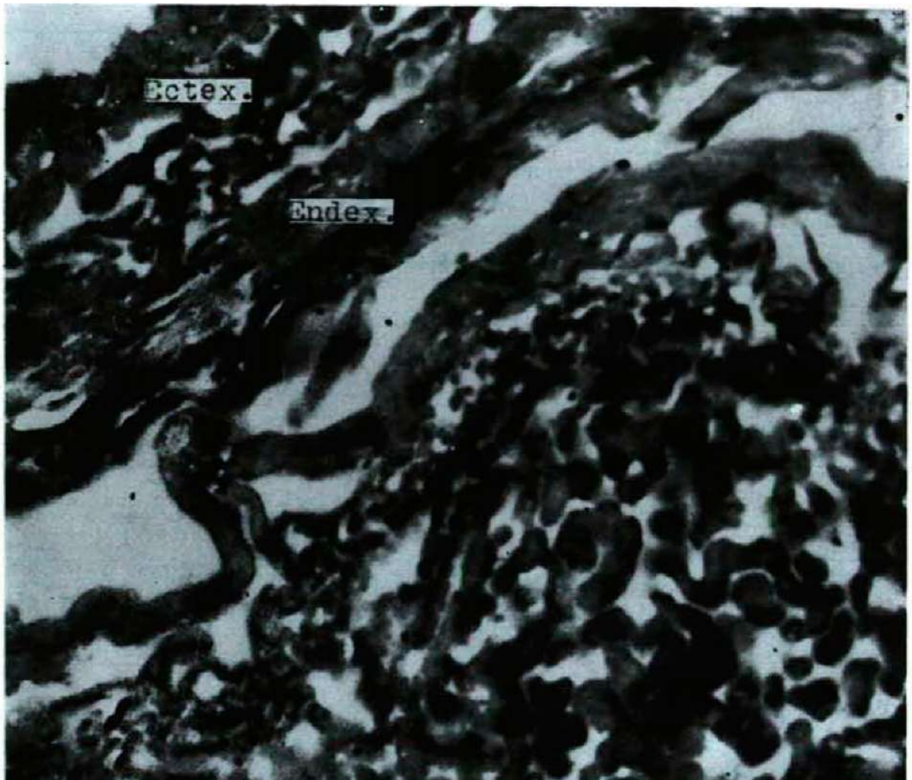

Fig. 2

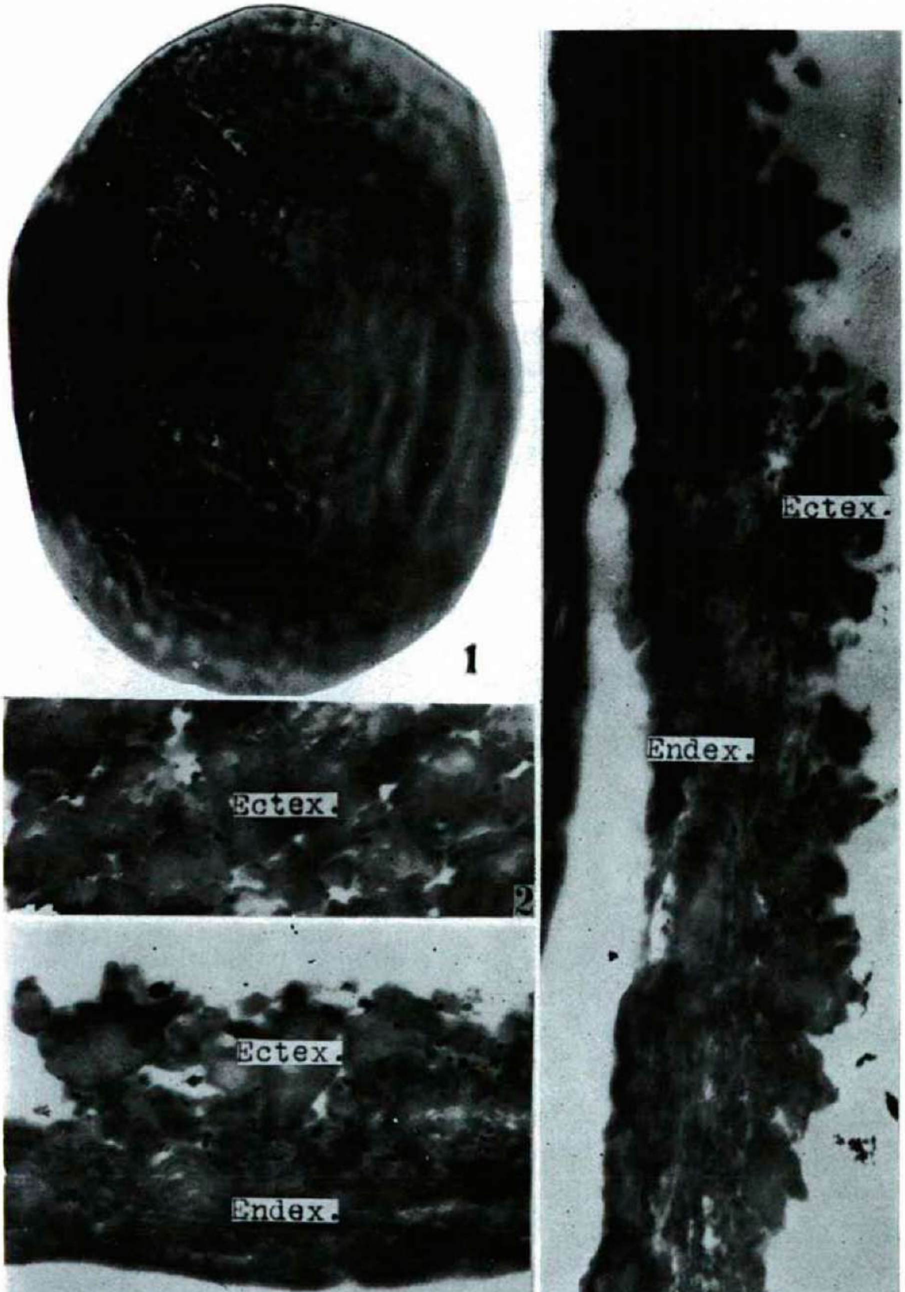

Fig. 3

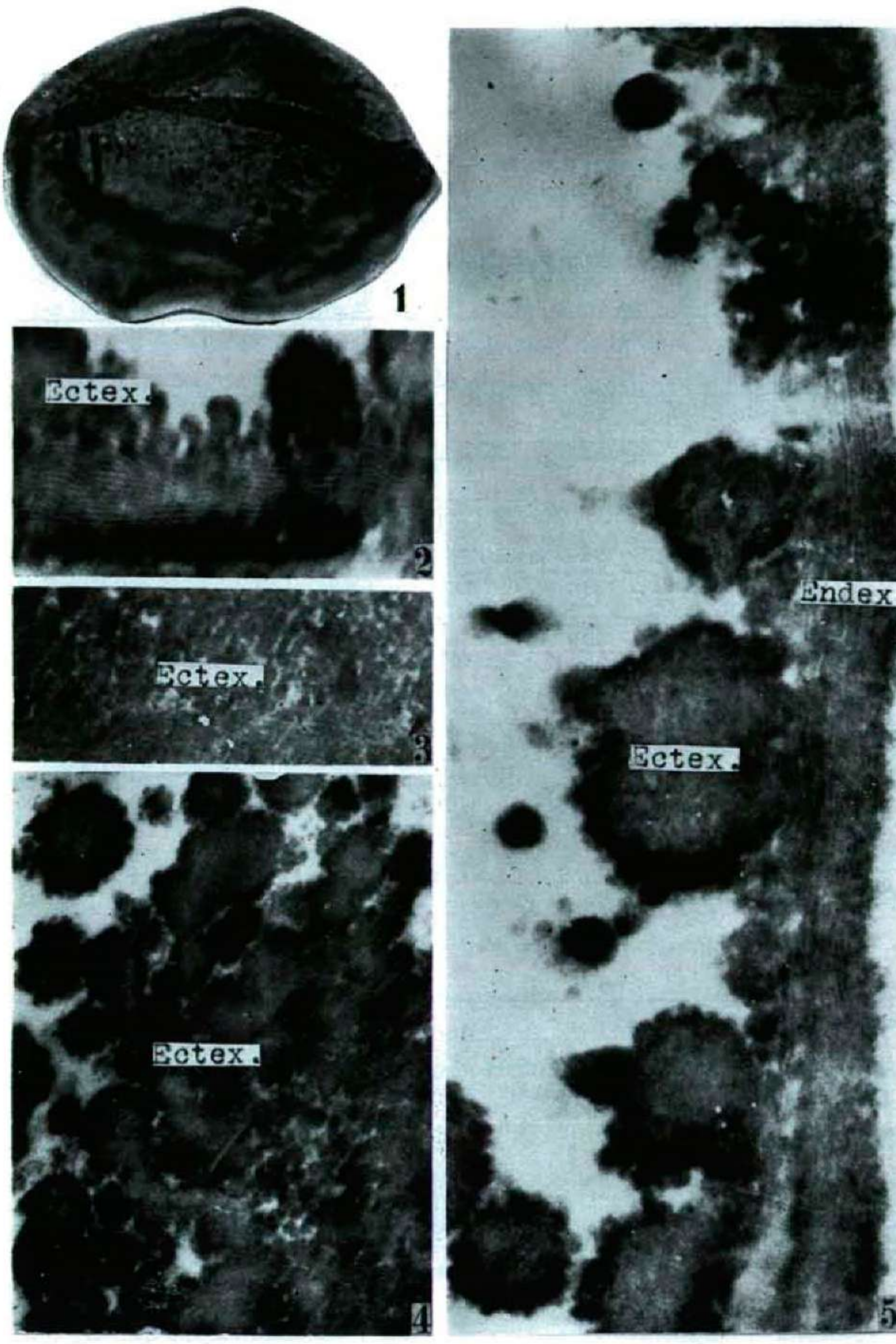

Fig. 4