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PRESERVATION AND VARIABILITY OF *TRIPARTITES INCISOTRILOBUS* (NAUMOVA) EMEND. AND *MUROSPORA AURITA* (WALTZ) PLAYFORD.

Abstract. — Two spore species are newly described on the basis of exceptionally rich and singularly preserved material from the Moscow Basin (Viséan); these are *Tripartites (Trilobozonotriletes) incisotrilobus* (Naumova), which is emended, and *Murospora aurita* (Waltz) Playford, the diagnosis of which is extended. The variability of these species and the dependence between the original spore structure and the state of preservation is shown.

INTRODUCTION

The material studied was obtained from one sample of brown coal from the Moscow Basin.

The crushed coal was oxydated with potassium hydroxide, no further chemical treatment being required.

The sample yielded a great number of well preserved megaspores and miospores, most of which were easily identified as Viséan species described by Dijkstra & Piérart (1957) and Luber & Waltz (1938) from the Moscow Basin. Both megaspores and miospores were much less flattened than those described from other Carboniferous basins, therefore the material was the most suitable for the purpose of spore morphology observations.

The present paper presents the results of observations on two spore species, namely *Tripartites (Trilobozonotriletes) incisotrilobus* (Naumova) emend. and *Murospora aurita* (Waltz) Playford. The variability of these species and the dependence between the original spore structure and the state of preservation is shown.

The number of Carboniferous spore genera and species greatly exceeds that of the same taxa of the well-studied macroflora. It is therefore believed that the spores include some elements of the flora not represented among the macrofossils. This is undoubtedly true in many cases but, on the other hand, not enough attention has hitherto been paid to the variability of spores and some states of preservation which very often cause multiplication of the number of newly created genera and species which are in fact only synonymes.

Bearing this in mind, the authors tried to show the relation between the original spore structure and the state of preservation of fossil spores. The studied material of spores was very rich and preserved in unique way. The species *Tripartites (Trilobozonotriletes) incisotrilobus* (Naumova) has been emended, the species *Densosporites subcrenatus* being included in the synonymy of the former; a series of intermediate forms linking these two species is shown in Pl. XXV, Figs 1-10. The great variability of spores belonging to *Murospora aurita* (Waltz) Playford is also presented (Pl. XXVI, Figs 1-11; Pl. XXVII, Figs 1-13), the description of this species has been extended, the most complete specimens and possible isolated spore bodies being included. The authors suppose that the outermost wall layer in spores of this species may represent the perisporium (*sensu* Erdtman, 1969). The description of *Murospora aurita* (Waltz) Playford is supplemented by the reconstruction (Plate XXVIII).

All the figured specimens are housed in Laboratory of Geology of Mineral Resources, Institute of Geological Sciences, Polish Academy of Sciences, in Kraków. The microscope readings are based on a Zeiss microscope NfPk, No 410559.

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DESCRIPTIONS

The discussed species have been assigned to the supra generic groups according to the system introduced by R. Potonié & Kremp (1954, 1955, 1956) and R. Potonié (1956, 1958, 1960, 1966, 1970), subsequently expanded by Richardson (1965). The other systems proposed for Palaeozoic spores are those by Neves & Owens (1966) and by Smith & Butterworth (1967). In both these systems different states of the intexine detachment were regarded to be a feature of taxonomic value; whether this was an original and permanent feature of a spore group or a secondary one resulting from fossilisation or chemical treatment was not considered. However, it is known by those who work on spores from sporangia, recent or fossil, that even in spores from a single sporangium the exine layers may be separated in various degrees or not separated at all. This has been shown very clearly, for instance, by Pettitt (1966) on several examples of occasional intexine detachment in some spores of Pteridophytes. According to this author, "within a single microsporangium of Isoetes spores can be found that could be classified when dispersed as either cavate or not so, if the current definition for this structural condition was applied to them."

The decision whether a spore cavity is incidental and therefore has no taxonomic value or is a permanent feature of a ripe spore depends on the author's judgement. It seems that spores which are truly camerate posses an air-bladder or pseudo-saccus, placed equatorially or equatoral-distally, present in all specimens of a particular species. But if exine layers are detached in various places and to a various degree or if thin intexine is detached and strongly folded inside relatively thick exoexine the cavity present is most certainly incidental.

According to this, the present authors consider the detachment of wall layers occurring in various degrees in spores of *Murospora aurita* (Waltz) Playford as secondary and therefore of no taxonomic value.

Anteturma **Proximegerminantes** R. Potonié, 1970
Turma **Triletes** — Zonales R. Potonié, 1970
Subturma **Auritotriletes** R. Potonié & Kremp, 1954
Infraturma **Auriculati** (Schopf) Potonié & Kremp, 1954

Genus *Tripartites* Schemel, 1950

Type species: *Tripartites vetustus* Schemel, 1950

Remarks. — The diagnosis of *Tripartites* accepted here is that given by Schemel (1950), subsequently expanded and modified by Jachowicz (1966).

Tripartites (*Trilobozonotriletes*) *incisotrilobus* (Naumova) emend.
Pl. XXV, Figs 1-10)

1938. *Zonotriletes incisotrilobus* (Naum.) Waltz; A. A. Luber & I. E. Waltz, p. 19, Pl. 4, Fig. 42; Pl. A, Fig. 10.
1938. *Zonotriletes subcrenatus* Waltz; *Ibidem*, p. 19, Pl. 4, Fig. 43.
1956*a*. *Trilobozonotriletes inciso-trilobus* Naum.; A. M. Ishchenko, Pl. 7, Figs. 64-65.
1956*b*. *Trilobozonotriletes inciso-trilobus* Naum.; A. M. Ishchenko, p. 94, Pl. 18, Fig. 220.
1956. *Tripartites* (*Zonotriletes*) *incisotrilobus* (Naum.) Pot. & Kr.; R. Potonié & G. Kremp., p. 92.
1958. *Trilobozonotriletes inciso-trilobus* Naum.; A. M. Ishchenko; p. 92, Pl. 12, Fig. 153.
1958. *Hymenozonotriletes subcrenatus* (Waltz) Ishch.; *Ibidem*, p. 77, Pl. 9, Fig. 112.
1960. *Tripartites inciso-trilobus* (Waltz) Pot. & Kr.; F. L. Staplin, p. 26, Pl. 5, Fig. 17.

1960. *Tripartites golatensis* Staplin; *Ibidem*, p. 27, Pl. 5, Figs 15, 16.
1961. *Tripartites incisotrilobus* (Naum.) Pot. & Kr.; N. F. Hughes & G. Playford, p. 33, Pl. 2, Fig. 15.
1962. *Tripartites incisotrilobus* (Naum) Pot. & Kr.; G. Playford, p. 604, Pl. 85, Figs 15—17.
1963. *Densosporites subcrenatus* (Waltz) Pot. & Kr.; G. Playford, p. 623, Pl. 88, Figs 8, 9.
1963. *Trilobozonotriletes inciso-trilobus* Naum.; G. I. Kedo, p. 92, Pl. 11, Figs 259-262.
1966. *Trilobozonotriletes inciso-trilobus* Naum.; G. I. Kedo, p. 97, Pl. 9, Figs 168-171.
1966. *Trilobozonotriletes solidus* Kedo sp. n.; *Ibidem*, p. 100, Pl. 9, Fig. 176.
1966. *Trilobozonotriletes abnormis* Kedo sp. n.; *Ibidem*, pp. 100-101, Pl. 9, Figs 177-179.
1966. *Euryzonotriletes subcrenatus* (Waltz) Kedo & Jushko; *Ibidem*, p. 71, Pl. 4, Fig. 88.
1966. *Tripartites (Trilobozonotriletes) incisotrilobus* (Naum.) Pot. & Kr.; A. Jachowicz, Pl. 2, Figs 38-41, Pl. 7, Figs 1-9.
1967. *Tripartites (Trilobozonotriletes) incisotrilobus* (Naum.) Pot. & Kr.; A. Jachowicz p. 33, Pl. 18, Figs 2-4.
1967. *Tripartites apertus* (Ishch.) Jachowicz; *Ibidem*, p. 33, Pl. 18, Fig. 5.
1967. *Tripartites incisotrilobus* (Naum.) Pot. & Kr.; M. S. Barss, p. 34, Pl. 9, Fig. 4.
1967. *Euryzonotriletes subcrenatus* (Naum.) Byvsheva; T. V. Byvsheva, p. 29, Pl. 9, Figs 10-11.
1967. *Trilobozonotriletes inciso-trilobus* Naum.; *Ibidem*, Pl. 12., Figs 1-4 (5?).

Emended diagnosis. — Spores radial, trilete; amb subtriangular with rounded apices, margin crenulate. Laesure distinct, straight, simple, reachching spore body margin or almost so. Spore body well defined, triangular, with straight, convex or concave sides and rounded apices; punctate or laevigate. Cingulum one-third to half spore radius in width (in uncorroded specimens), consisting of two concentric, not clearly delimited zones. Inner zone one-third cingulum wide interradially, wider at the apices; exine of this zone thick and homogeneous, exine of the outer zone thinner (lighter) and originally of uneven thickness, which makes it appear folded and wrinkled.

Dimensions (40 measured specimens):

Equatorial diameter	36.3—70.4 mμ
Diameter of central area	23.1—39.4 mμ
Height of auriculae or width of cingulum	9.9 (11.0) — 20.9 (25.3) mμ

Description. — Amb of spores variable, from subtriangular with rounded apices and convex or almost straight sides (in uncorroded specimens) to concavely subtriangular (in corroded specimens). A continuous row of intermediate forms linking these two types may be observed. Cingulum one-third to half spore radius, consisting of two indistinctly delimited, concentric zones; inner zone thick and homogeneous, outer one thinner and wrinkled. Outer zone particularly nonresistant to destructive factors; it becomes destroyed mainly within interradial regions and to lesser degree, at the apices.

Remarks. — *Zonotriletes subcrenatus* (Naumova) Waltz (Luber & Waltz, 1938) has been included here to the synonymy of *Tripartites incisotrilobus.* The very rich material from the Moscow Basin enabled the authors to trace all intermediate forms from the convexly-subtriangular ones, with a complete cingulum corresponding with *Densosporites subcrenatus,* through forms with small wanes of the cingulum and some others with larger interradial wanes to the forms in which only the apical parts of the cingulum remained, these having a typical appearance of *Tripartites incisotrilobus* (see Pl. XXV, Figs 1-10). The similarity between *Densosporites subcrenatus* and *Tripartites incisotrilobus* was observed earlier by Waltz (Luber & Waltz, 1938) and Kedo (1966). Playford (1962) considered this similarity as incidental.

Tripartites incisotrilobus (Naumova) emend. combines the features of two different genera — *Densosporites* and *Tripartites,* and consequently the generic assignment becomes an arbitrary matter.

The species *Trilobozonotriletes solidus* Kedo (1966) and *Trilobozonotriletes abnormis* Kedo (1966) fall within the limits of variability of *Tripartites incisotrilobus* (Naum.) emend.

Comparison. — *Densosporites variomarginatus* Playford (1963, p. 629, Pl. 89, Figs 9, 11-13) is much larger and possesses a cingulum with radiating or striated appearance and with punctations arranged parallel to the central area outline. It corrodes in the same way as *Tripartites incisotrilobus.*

Occurrence. — USSR: Moscow Basin, Kizel, Selisharovo, Borovicki, Voronezsh regions, Pripyat depression, Dneper-Donetz Basin — Lower Carboniferous; Volga-Ural region, Western Donetz — Viséan. Poland: Upper Silesia — lowermost Namurian A; Lower Silesia — Namurian A; Holy Cross Mountains, — Lower Carboniferous; Lublin Basin — Viséan, Canada, Alberta — Mississippian. Vestspitsbergen — Lower Carboniferous.

Subturma **Zonotriletes** Waltz, 1935

Infraturma **Cingulati** (R. Potonié & Klaus) Dettman, 1963

Genus *Murospora* Sommers, 1952

Type species: *Murospora kosankei* Sommers, 1952

Murospora aurita (Waltz) Palyford, 1962

(Pl. XXVI, Figs 1-11; Pl. XXVII, Figs 1-13; Text-Fig. 1)

1938. *Zonotriletes auritus* Waltz; A. A. Luber & I. E. Waltz, p. 17, Pl. 2, Fig. 23.
1957. *Cincturasporites auritus* (Waltz) Hačqu. & Barss; P. A. Hacquebard & M. S. Barss, p. 24, Pl. 3, Fig. 6.
1957. *Cincturasporites irregularis* Hacq. & Barss; *Ibidem,* p. 25, Pl. 3, Fig. 9.

1957. *Cincturasporites sulcatus* (Waltz) Hacq. & Barss; *Ibidem*, p. 24, Pl. 3, Fig. 6.
1957. Spore Type B; *Ibidem*, p. 45, Pl. 6, Fig. 10.
1958. *Trilobozonotriletes trivalvis* (Waltz) Ishch.; A. M. Ishchenko, Pl. 12, Fig. 150 (non 149, 151).
1960. *Murospora varia* Staplin; F. L. Staplin, p. 30, Pl. 6, Figs 16-18.
1960. *Murospora* sp. cf. *Murospora varia* Staplin; *Ibidem*, p. 35, Pl. 6, Fig. 19.
1961. *Cincturasporites auritus* (Waltz) Hacqu. & Barss; N. F. Hughes & G. Playford, p. 35, Pl. 3, Fig. 19.
1962. *Cincturasporites auritus* (Waltz) Hacqu. & Barss; N. F. Hughes, M. E. Dettmann & G. Playford, p. 251, Pl. 37, Figs 6-8.
1962. *Murospora aurita* (Waltz) Playford; G. Playford, p. 609, Pl. 87, Figs 1-6; Text-figs. 6a-q, 7.
1962. *Stenozonotriletes stenozonalis* (Waltz) Ishch.; *Ibidem*, p. 606, Pl. 86, Figs 2-3.
1966. *Euryzonotriletes trivialis* Kedo & Jushko; G. I. Kedo, p. 64-65, Pl. 3, Figs 67-68.
1966. *Euryzonotriletes macroduplicatus* Naum.; *Ibidem*, p. 69, Pl. 4, Figs 81-82, 83?
1967. *Euryzonotriletes auritus* (Waltz) Byvsh.; T. V. Byvsheva, p. 25, Pl. 7f, Figs 1-10.
1967. *Murospora aurita* (Waltz) Playford; M. S. Barss, Pl. 9, Fig. 11.
1967. *Murospora aurita* (Waltz) Playford; C. J. Felix & P. P. Burbridge, Pl. 66, Fig. 8.
1969. *Murospora aurita* (Waltz) Playford; F. A. Hibbert & W. S. Lacey, p. 431, Pl. 81, Fig. 10.
1969. *Murospora* cf. *aurita* (Waltz) Playford; E. Lanzoni & L. Magloire, Pl. 4, Figs 11, 12.
1970. *Murospora aurita* (Waltz) Playford; H. Kaiser, p. 103, Pl. 21, Figs 6-8.
1972. *Murospora aurita* (Waltz) Playford; A. Jachowicz, Pl. 22, Fig. 5.

Dimensions (150 measured specimens):

Overall equatorial diameter	37.4—115 mμ
Diameter of central area	27.5— 55.0 mμ
Width of lips	2.8— 6.0 mμ

Descriptions. — Spores radial, trilete; amb subcircular, subtriangular to irregular; margin smooth or lobate. Laesurae distinct, straight, length equals radius of spore body, lips 2.8—6 mμ wide with slightly undulating margin. Spore body thick-walled (approximately 5 mμ), convexly subtriangular with pointed apices. Cingulum smooth and thick, one-third to half spore radius in width, variably thickened (uniform or lobate). Lobes from two to six in number, arcuate or kidney-shaped. Exoexine and intexine separated in various degrees along equator. Detachment takes place especially within thickened parts of cingulum; in spores with lobate cingulum separation takes place within lobes which become bulging (Pl. XXVI Fig. 9; Pl. XXVII, Figs 1-7, 9). In many specimens also a third, outermost wall layer is preserved; originally it encloses the whole spore but is most often preserved only at lobes or apices.

Remarks. — The specimens figured in Pl. XXVII, Figs. 11-13 may represent the isolated spore bodies of these spores. It seems possible that spore bodies of this type might have been described as some species belonging to *Stenozonotriletes*.

The outermost wall layer in spores of *Murospora aurita* is absent in some specimens; it seems that this layer easily becomes destroyed but it may also be not fully developed in some specimens (unripe ones). Thus it is likely that this layer represents the perisporium. A similar structure can be observed in spores of some recent ferns; for example *Cibotium princeps* (see Pl. XXV, Figs. 11-13) posses the perisporium which is loosely connected with the exoexine. Among the acetolised spores perisporium — less exines and also isolated spore bodies (intexine) are often to be seen.

In the studied material spores of *Murospora aurita* structure but possessing a monoletum or a scar intermediate between triletum and monoletum were also observed; similar forms were described by Playford (1962) from Spitsbergen.

Occurrence. — USSR: Moscow, Kizel, Selizharovo, Borovicki and Voronezh regions — Lower Carboniferous; Pripyat depression, Volgaural region — Viséan. Poland: Holy Cross Mountains — Tournaisian to Viséan: Lublin Basin — Viséan. Spitsbergen — Viséan (possibly to Namurian A); Bear Island — Viséan. England: North Wales — Tournaisian to Viséan. Canada: Alberta — Upper Mississippian. USA. South Oklahoma — Springer Formation. Algerien: Sahara — Upper Viséan.

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SPOSÓB ZACHOWANIA I ZMIENNOŚĆ SPOR *TRIPARTITES INCISOTRILOBUS* (NAUMOVA) EMEND. I *MUROSPORA AURITA* (WALTZ) PLAYFORD.

Streszczenie

W pracy niniejszej przedstawiono wyniki badań dotyczące dwóch gatunków spor: *Tripartites* (*Trilobozonotriletes*) *incisotrilobus* (Naumova) emend. i *Murospora aurita* (Waltz) Playford z dolnego karbonu Basenu Moskiewskiego. Autorzy dysponowali bardzo bogatym materiałem spor, o wyjątkowo dobrym stanie zachowania, co pozwoliło na prześledzenie ogromnej zmienności wyżej wymienionych gatunków oraz wykazanie wpływu pierwotnej budowy spor na sposób ich zachowania w stanie kopalnym.

Emendowano gatunek *T. incisotrilobus* (Naum.), włączając do synonimiki spory zaliczane dotąd do gatunku *Densosporites subcrenatus* (Waltz) Pot. & Kr., zilustrowano pełny szereg form przejściowych łączących oba te gatunki.

Pokazano zmienność gatunku *Murospora aurita* (Waltz) Playford, poszerzono opis tego gatunku o formy pełniej zachowane i ewentualne izolowane ciałka spor. Podano przypuszczenie, że najbardziej zewnętrzną błoną spor jest „perisporium". Opis uzupełnia rekonstrukcja spor *M. aurita*.

Opisana kolekcja znajduje się w Zakładzie Nauk Geologicznych P.A.N. w Krakowie.

ЯДВИГА КАРЧЕВСКА, ЭЛЬЖБЕТА ТУРНАУ

СПОСОБ ЗАХОРОНЕНИЯ И ИЗМЕНЧИВОСТЬ СПОР *TRIPARTITES INCISOTRILOBUS* (NAUMOVA) EMEND. И *MUROSPORA AURITA* (WALTZ) PLAYFORD

Резюме

В настоящей работе представлены результаты изучения двух видов спор: *Tripartites (Trilobozonotriletes) incisotrilobus* (Naumova) emend. и *Murospora aurita* (Waltz) Playford из нижнего карбона Подмосковного бассейна. Авторы располагали очень богатым споровым материалом исключительно хорошей сохранности, что дало возможность проследить сильную изменчивость указанных видов и доказать влияние первичного строения спор на способ их захоронения в ископаемом виде.

Изменен вид *T. incisotrilobus* (Naumova) путем включения в синонимику спор, которые до сих пор относились к виду *Densosporites subcrenatus* (Waltz) Pot. & Kr. Показан полный ряд промежуточных форм, объединяющих оба вида.

Продемонстрирована изменчивость вида *Murospora aurita* (Waltz) Playford, расширено описание этого вида на основании лучше сохраненных форм и изолированных тел спор. Высказывается предположение, что наружной оболочкой спор является периспорий. Описание дополнено реконструкцией спор *M. aurita.*

Описанная коллекция находится в Отделении геологических наук ПАН в Кракове.

EXPLANATIONS OF PLATES

Pls XXV-XXVII: all figures ×500, from unretouched negatives

Plate XXV

Figs 1-10. *Tripartites incisotrilobus* (Naumova) emend.
Fig. 1. Slightly corroded specimen; slide MAT/45, 6.40 8.102
Fig. 2. Slightly corroded specimen; slide MAT/47, 0.41 4.104
Fig. 3. Specimen with two sides corroded; slide MAT/42 0.42 7.102
Fig. 4. Speciman with two sides corroded; slide MAT/48, 7.37 3.117

Fig. 5. Specimen with corroded sides; slide MAT/44.
Fig. 6. Specimen with strongly corroded sides; slide MAT/44, 7.51 0.102
Fig. 7. Specimen with corroded sides; slide MAT/44
Fig. 8. Specimen with strongly corroded sides; slide MAT/46, 5.44 8.104
Fig. 9. Specimen with strongly corroded sides; slide MAT/48, 6.39 2.115
Fig. 10. Specimen with strongly corroded sides; slide MAT/SG23
Figs 11-13. *Cibotium princeps*
Fig. 11. Spore with perisporium.
Fig. 12. Spore without perisporium
Fig. 13. Intexine.

Plate XXVI

Figs 1-11. *Murospora aurita* (Waltz) Playford,
Figs 1, 2. Specimen with complete perine, proximal and distal focus; slide MAT/42; 4.43 3.98.
Fig. 3. Specimen without perine; oblique compression; slide MAT/48, 8.50 1.102.
Figs 4, 5. Specimen without complete perine, proximal and distal focus; slide MAT/44, 5.35 5.99.
Fig. 6. Specimen without perine, exoexine partly detached at equator; slide MAT/44, 6.52 8.118.
Fig. 7. Specimen with perine; slide MAT/48, 8.50 5.105.
Fig. 8. Specimen with perine preserved at lobes, exoexine partly detached at equator; slide MAT/48, 1.35 5.96.
Fig. 9. Specimen with perine preserved at lobes, exoexine partly detached at equator; slide MAT/47, 5.33 2.107.
Fig. 10. Specimen without perine, oblique compression; slide MAT/46, 0.33 3.100.
Fig. 11. Specimen without perine, equatorial compression; slide MAT/45, 7.42 8.111

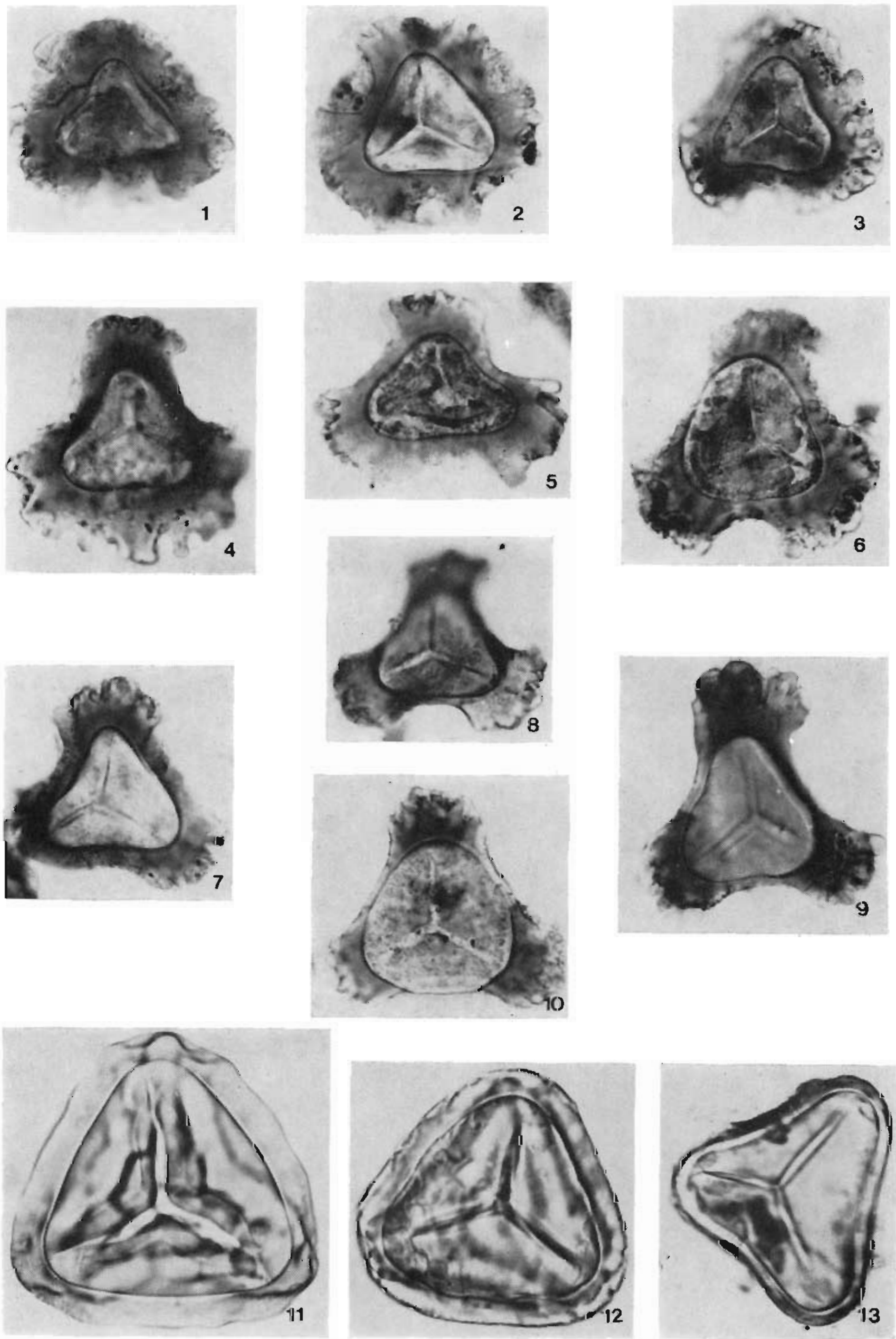
Plate XXVII

Figs 1-13. *Murospora aurita* (Waltz) Playford.
Figs 1, 2. Specimen with perine preserved at apices, proximal and distal focus; slide MAT/48, 9.42 0.105.
Fig. 3. Specimen with perine preserved at apices; slide MAT/45, 2.40 1.106.
Fig. 4. Specimen without perine; exoexine detached at apices; slide MAT/48, 1.31 1.92.
Fig. 5. Specimen with perine preserved at apices; slide MAT/45, 5.46 0.104.
Fig. 6. Specimen with partly preserved perine; slide MAT/44, 1.34 6.105.
Fig. 7. Specimen with perine preserved at apices; slide MAT/44, 1.34 6.105. MAT/8, 0.45 1.101.
Fig. 8. Uncomplete specimen — spore body with proximal surface attached; slide MAT/48, 0.45 1.101.
Fig. 9. Specimen with perine preserved at lobes; slide MAT/45, 2.40 7.106.
Fig. 10. Uncomplete specimen — spore body with proximal surface attached; slide MAT/47, 0.41 0.104.
Fig. 11. Spore body; slide MAT/46, 3.36 1.110.
Fig. 12. Spore body; slide MAT/48, 4.45 1.91.
Fig. 13. Spore body; slide MAT/45, 7.47 4.99.

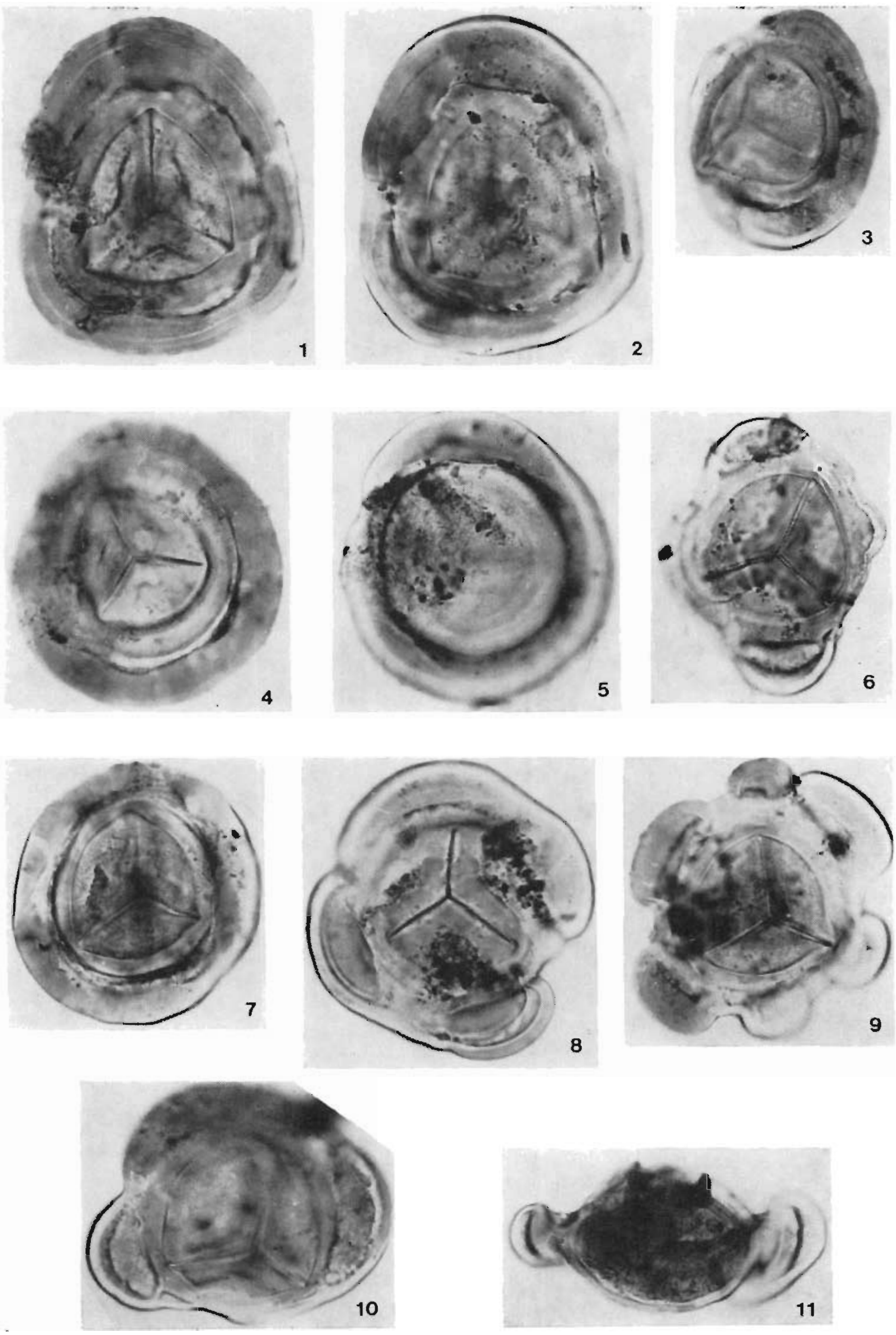
Plate XXVIII

Structural features of *Murospora aurita* (Waltz) Playford in surface and sectional views, $\times$ 750.

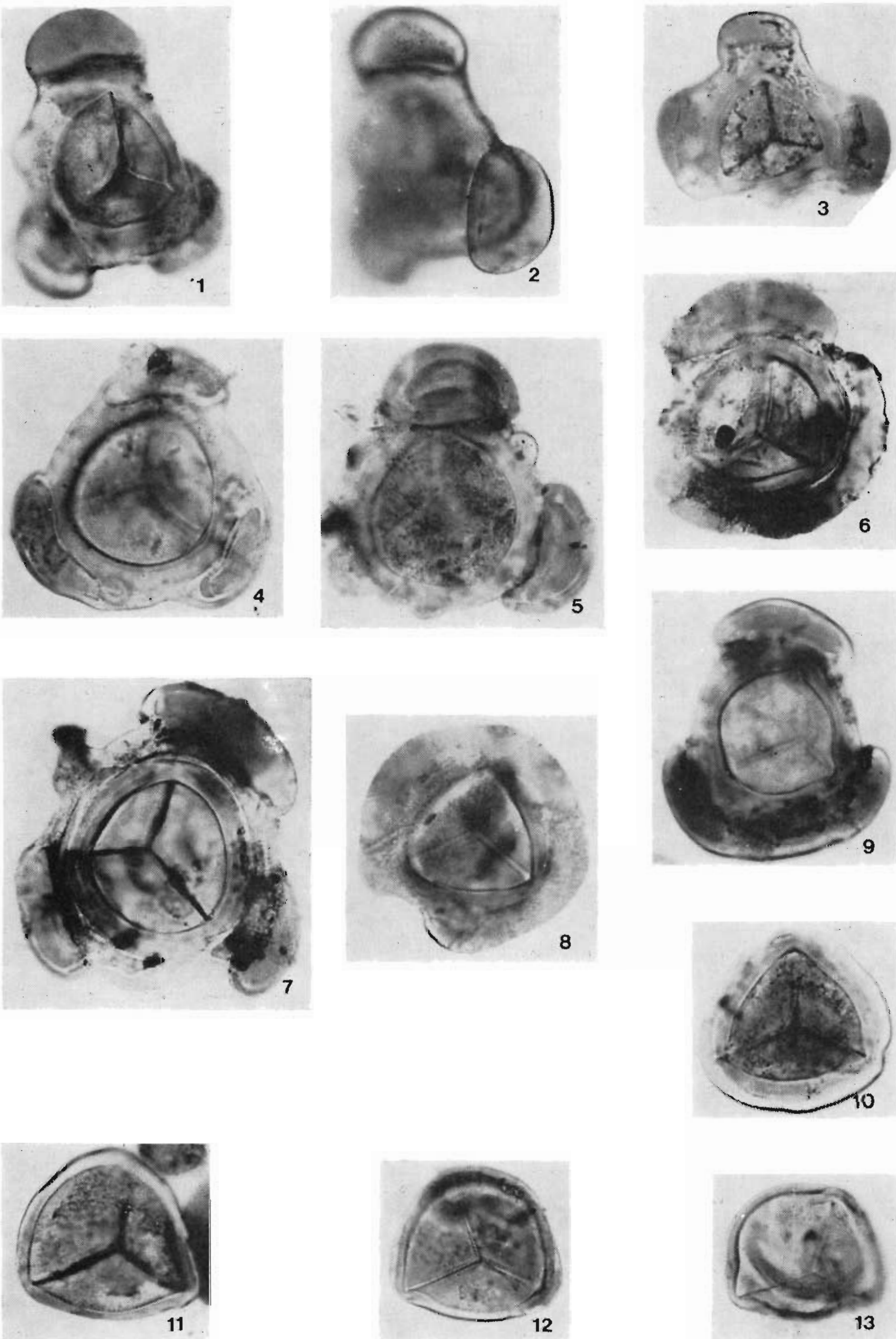
p = perine e = exoexine i = intexine
Fig. A, A_1. specimen with complete perine, exoexine detached at equator.
Fig. B, B_1. specimen with perine preserved at apices, exoexine partly detached.
Fig. C, C_1. specimen without perine, exoexine partly detached.



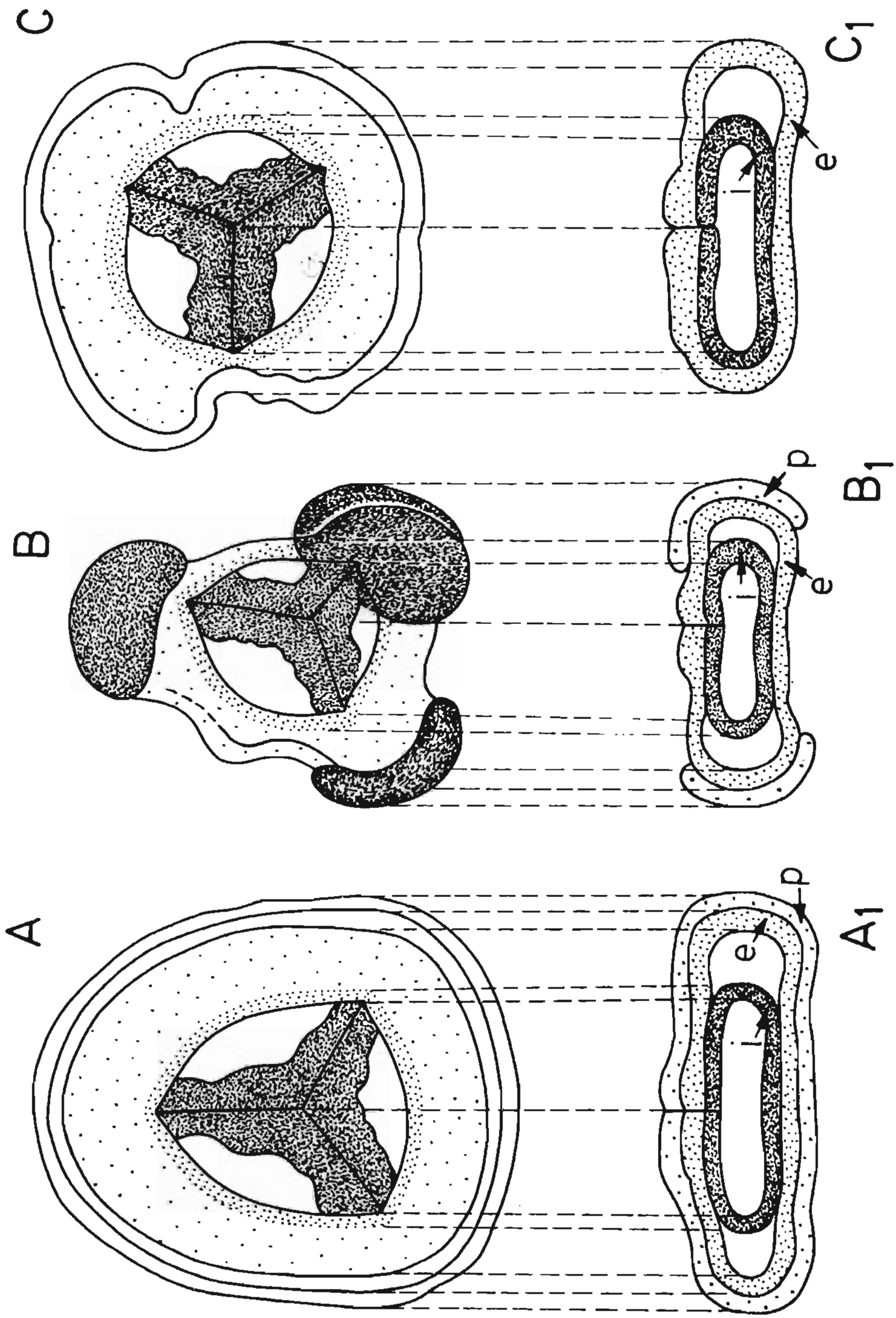
Phot. E. Turnau



Phot. E. Turnau



Phot. E. Turnau


A
A1
B
B1
C
C1
e
p
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