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SOME MEGASPORES FROM SOUTH AFRICA AND AUSTRALIA

by

S. J. Dijkstra

Geologisch Bureau, Akerstraat 88, Heerlen, Holland.

INTRODUCTION

Dr. Plumstead has sent a number of samples from South Africa to us for maceration of the spores from them and for an attempt to determine the horizons from the megaspores only. Other details were not given. In addition to these samples we had some from Australia, and it became very interesting to compare the spores from S. Africa with those from Australia or other Gondwana deposits in India or Brasil.

MATERIAL AND METHOD

The samples from S. Africa are:

G.B. No. 2 109; No. 1. Visible megaspores, President Steyn Gold Mine, Orange Free State, just above tillite;

G.B. No. 2 110; No. 2. Farm Good Hope, Transvaal;

G.B. No. 2 111; No. 3. Visible megaspores, New Schoongezicht Colliery, 14′ above No. 2 seam;

G.B. No. 2 112; No. 4. Salisbury Borehole, 366′, Orange Free State.

G.B. No. 2 113; No. 5. Specimen 8516, Waterberg, Transvaal;

G.B. No. 2 114; No. 6. Visible megaspores, Borehole P 2,555′, Coalbrook Colliery;

G.B. No. 2 115; No. 7. Visible megaspores, Virginia;

G.B. No. 2 116; No. 8. Visible megaspores, St. Helena No. 7 (*Leptophloem australis* zone);

G.B. No. 2 117; No. 9. Tiny Lycopod stems and Lycopod leaves, President Brand, Orange Free State;

G.B. No. 2 118; No. 10. Bubye Coal, Upper Portion, Southern Rhodesia;

G.B. No. 2 134; No. 11. Dundas Seam, above sandstone band, Hlobane, Natal;

G.B. No. 2 135; No. 12. Coking Seam, Hlobane, No. 2, Natal;

G.B. No. 2 136; No. 13. Gus Seam, Coronation area, Hlobane, No. 2, Natal;

G.B. No. 2 137; No. 14. No. 18 Section, Gus Seam, Hlobane, Natal;

G.B. No. 2 138; No. 15. Greenside Colliery, Transvaal.

The samples from Australia are:

G.B. No. 2 068; Greta Coal Measures, Lab. No. 10 729–3/16, Seam Greta, Coll. Pelton, Sub Section D;

G.B. No. 2 069; Upper Coal Measures, Tomago Stage, Lab. No. 9 350–3/16″, Seam Big Ben, Coll. Buchanan, Maitland, Sub Section H;

G.B. No. 2 070; Upper Coal Measures, Newcastle Stage, Lab. No. 7 873 3/16, Seam Young Wallsend, Coll. Stockton Borehole, Sub Section D;

G.B. No. 2 071; Upper Coal Measures, Tomago Stage, Lab. No. 7 399, Seam Liddell, Coll. State Coal Mine, Sub Section K;

G.B. No. 2 072; Greta Coal Measures, Lab. No. 1 993, Seam Homoville, Upper Coll. Hebburn 1, Sub Section B;

G.B. No. 2 073; Upper Coal Measures, Newcastle Stage, Lab. No. 8 587, 3/16, Seam Young Wallsend, Coll. Beston, Sub Section D.

A number of the samples from South Africa consisted of shaly material and in some of them the megaspores were already visible before any maceration treatment had been done. Other samples, No. 10–15, consisted of coal. The samples were macerated with the help of the Zetzche method. At first there appeared to be an important difference between these samples. The first nine numbers needed a maceration time of ¾ hour, and with the exception of No. 2, the residue was composed of a large or a rather large number of very big megaspores. The coaly samples, No. 10–15, needed a maceration time of at least 2 hours or more, and the residue was composed of woody vessels, sometimes with a single remnant of an undeterminable spore, with the exception of No. 14 and especially of No. 15 in which numerous megaspores were noticed. In comparison with the first mentioned specimens these were much smaller and of a quite different character. In consequence of the material it can be said that the coalification of the samples of the last group was too high, or nearly so, by which the spores were attacked by the acid at the same rate as the other components of the coal and were dissolved with them. Experiences of such coals have taught that after

The G.B. numbers are those of the Geol. Bureau at Heerlen, the numbers 1–15 are of Doctor Plumstead.

Mr. H. R. Brown, director Commonwealth Scientific and Industrial Research Organization, Coal Research Section, Australia, has kindly sent some coal samples to us.

maceration practically only woody vessels remain. Indeed a name such as 'Coking Seam' does not give encouragement to expect good results with a spore treatment.

The Australian samples consisted of coal; they needed a maceration time of 4–5 hours or even longer. They contained a good many megaspores, with the exception of No. 2 069 in which only some cuticles could be observed. These Australian megaspores are small or medium in size; the variation in species was small.

The spores were photographed under reflected light, after having been covered with ammonium chloride. By this ornamentations such as ridges, appendages, punctation, etc. were accentuated. A drawback of this method is that small dirt particles on the wall of the spore and even on the cover-glass of an ordinary foraminifera cardboard slide on which the spores were placed during the photographing become visible. Sometimes they are accentuated too much, by which a smooth wall appears to be finely punctuate (P1. I, fig. 6).

After termination of this manuscript, when description and photography of the spores had been finished, we received a paper of Bharadwaj and Tiwari, 1970, in which they described a method by which they were able to study the internal structure of spores. Some specimens were treated, after maceration, with 5% KOH for about 30 seconds, or longer (2–10 minutes), by which some species became transparent. In some cases a dilute (10%) HNO_3 treatment preceded the alkali treatment. By this the spores became more transparent, the inner body was distinct and bore cushions on its proximal face in some species. Moreover the size increased, sometimes even more than double the original size in the dry condition. We have used this method for three species which we expected to be suitable for this treatment. They are: *T. australis, robus* and *subnitens*. The result was very poor, after a treatment of half an hour they did not become transparent, and the increase in size was inconsiderable. Replacing them, after washing in water, in a strong (75%) HNO_3 the wall became transparent within some minutes. The three species studied did not show cushions on their proximal face.

RELATION BETWEEN THE DIMENSION OF THE SPORES AND THE AGE OF THE DEPOSITS IN WHICH THEY OCCUR.

Studies on megaspores have shewn that spores of the Carboniferous, and especially those of the Lower Carboniferous, are by far the largest (Dijkstra, 1956; Dijkstra and Piérart, 1957, and Dijkstra, 1971). Mesozoic megaspores are distinguishable from the Carboniferous ones, taken collectively, simply on the basis of their smaller size (Chaloner, 1959). He has plotted the mean size of megaspores of various assemblages in a table that shows a general trend of size decreasing from the Carboniferous to the Upper Cretaceous. He has suggested that most of the large Carboniferous megaspores are known to have been borne by arborescent lycopods, whereas two of the smallest Carboniferous megaspores were apparently borne by herbaceous lycopods. It is therefore a plausible hypothesis that the decline in megaspore size may be correlated with the decline in the arborescent lycopods.

Concerning the size of Devonian megaspores a short survey of some investigators of various basins is given. These basins are chosen involuntary. A more extensive survey on Lower Carboniferous and Devonian megaspores is given by Dijkstra, 1971. A repetition in this paper is superfluous.

Arctic: Chaloner, 1959.
Canada: McGregor, 1960, Melville Island.
U.S.A.: Pettitt, 1965, Maine and Perry.
Scotland: Richardson, 1965.
England: Mortimer and Chaloner, 1967.
Ireland: Chaloner, 1968.
Belgium: Piérart, 1964, Roncquières, Brabant.
U.S.S.R.: Nikitin, 1934, Voronesh.

In general it can be said that the Devonian megaspores described from these basins are small or medium in size, and smaller than the largest Lower Carboniferous megaspores.

THE PRESUMABLE AGE OF THE SAMPLES FROM SOUTH AFRICA

Not knowing the exact age of these samples studied from South Africa our provisional conclusion was that the samples 1–9 belong together. Their spores, although of new species, and consequently not comparable with those of Tchad, Egypt, Moscow or other basins, are of very old age, probably belonging to the Lower Carboniferous. This conclusion is influenced by the large diameter of some of them. The other samples, No. 10–15, and especially those of which megaspores could be isolated, are much younger, and their spores are better comparable with species from India, Australia and Brazil. Dr. Plumstead, on being so informed, answered that she would have expected Nos. 1, 4, 7, 8, 9 to be from similar zones, just as 3 and 6 could be also. She expected No. 2 to be different and probably a little younger; 5 and 10 she wanted to check. They are more likely to be typical Gondwana Lower Permian coals. No. 11–14 are Natal coking coals and in this country this usually means that they have been burnt and spores are destroyed; 15 should be the youngest and comparable with India.

THE INFLUENCE OF THE CRUSHING ON THE SHAPE OF THE SPORES

During the study and especially in the description of the spores the question sometimes arose about their original shape. Chaloner, 1953, has discussed the transformation of some spherical and saucer-shaped species after flattening. A thin-walled spherical species normally shows (except for the apical prominence) after flattening a circular outline with one or two tangential folds. If the wall is thicker, a circular disc is produced, without the formation of any folds. A more or less saucer-shaped spore will show two properties on crushing, which distinguish it from the spherical species. Firstly it has the tendency to settle flat in the matrix before fossilization and, in those cases where it does this, the apex of the spore will appear in the centre of the disc; in a spherical spore the apex might appear anywhere in the disc. Secondly a saucer-shaped spore will occasionally settle on edge, so producing a crumpled and more or less elliptical form when flattened.

Species of which the proximal-distal axis is considerably longer than the transverse axis, for instance the fertile form of *Cystosporites* species and many species belonging to *Lagenicula*, generally fall in a lateral direction in the coalforming swamps and are flattened in this way, by which their apical prominence is clearly distinguishable. If, however, they fall perpendicularly with their distal or proximal axis in the mud, then the prominence is less clearly visible, but lobes built by the triradiate ridges and the arcuate ridge are clearly visible (Pl. IV, fig. 47). Besides the shape of the spore the composition of the sediment may influence the fossil. If they fall in a coarse sandy deposit the grains can cause cavities in the wall of the spore (Pl. IV, fig. 46).

A more interesting deformation in the shape of fossils occurs when the sediment in which they are embedded is shifted by a lateral tectonic pressure. A sample of coal of Spain contained some hundreds of specimens of *Endosporites* (?) *radiatum* (*Triletes karczewski* Zerndt). As is known, this species is triangular, saucer-shaped and its triradiate ridges are of the same length. All the specimens of that Spanish sample were no longer equilateral; one of the ridges was shorter (Dijkstra, 1955, Pl. 41, fig. 28). Besides this species all others of that sample (*T. mamillarius, T. glabratus, T. praetextus*) were deformed in the same way. A very suggestive example of deformation by lateral pressure can be observed in the collection of the Geol. Bureau at Heerlen. It is a petrified stem of 28 cm in length; its diameter is 27 cm. The stem is divided by lateral pressure into four slices that are still connected; the displacement is 36 cm. If parts of such a brittle fossil can be shifted without breaking the tougher wall of a spore may easily be deformed. The triradiate ridges of specimens of the same species may vary in shape, and can be straight or undulate. Probably this is a question of deformation during the fossilization or even long before that process, caused by wrinkling of the ridges during drying of the coat.

DESCRIPTIONS

A. Spores of South Africa

Aphanozonati

Triletes compressus sp. nov.
Pl. I, figs. 1–3; holotype fig. 7.

Spore round-subtriangular in outline, flattened in proximal-distal direction. Diameter 1 320–2 030 μ (the mean of 9 measured specimens being 1 613 μ). Triradiate ridges generally straight, sometimes undulate, 7/8 of the diameter of the spore in length, 30 μ broad, 25 μ high. Arcuate ridges, if distinguishable, 15 μ broad. Where they meet the triradiate ridges the former are curved in the direction of the apex of the spore. Whole coat of the spore more or less reticulate. Reticules 10–25 μ in diameter, on the contact faces stretched in radial direction. Coat about 20 μ thick.

Discussion and comparison. In some respects, especially in shape, this species resembles *T. eregliensis* (Dijkstra, 1952, Westphalian D, Turkey). The coat of the latter is not reticulate, but provided with truncate, obconical papillae. *T. compressus* is more related to *T. patulus* (Dijkstra and Piérart, 1957, Lower Carboniferous of Moscow). The latter is smaller, its diameter varies from 760–990 μ, its coat is finely punctate.

Occurrence: Sample No. 2 111, New Schoongezicht Coll.: No. 2 112, Salisbury Borehole, Orange Free State; No. 2 114, Coalbrook Coll.; No. 2 116, St. Helena No. 7.

Triletes calvus sp. nov.
Pl. I, figs. 4–6; holotype fig. 6

Spore rounded in outline, flattened in proximal-distal direction. Diameter 710–930 μ (the mean of 4 measured specimens being 822 μ). Triradiate ridges straight, 7/8 of the radius of the spore in length, 15 μ broad, 20 μ high. The highest near the apex of the spore. Arcuate ridges not or hardly distinguishable. Whole coat of the spore a little rough to finely reticulate.

Discussion and comparison. This is a species with practically no characteristic ornamentation; its only characteristic property is its long narrow triradiate ridges. *T. patulus* (Dijkstra and Piérart, 1957) is of the same size, but its triradiate ridges are much shorter and wider. The 'tubercles' on the photographs are impurities on the coat of the spore and do not belong to it.

Occurrence: Sample No. 2 111, New Schoongezicht Coll.; No. 2 113, Waterberg, Transvaal.

Triletes inflexus sp. nov.
Pl. I, figs. 7–9; holotype fig. 8

Spore rounded-subtriangular in outline, flattened in proximal-distal direction. Diameter 470–730 μ (the mean being 619 μ, 8 specimens measured). Triradiate ridges straight, exceptionally undulate, nearly as long as the radius of the spore, 30 μ broad, 20–30 μ high, highest near the apex of the spore. Contact faces and arcuate ridges clearly distinguishable. Arcuate ridges 15 μ broad. The distal and the proximal part of the spore (the contact faces excepted) are thickened and swollen. Where the triradiate ridges meet the arcuate ridges the latter are sometimes curved a little in the direction of the apex of the spore. The wall of the spore is smooth.

Discussion and comparison. The triradiate ridges of this species are wider than those of *T. calvus*. Its contact faces are, with respect to the rest of the coat of the spore, pressed inwards. Probably here the coat is much thinner. The contact faces of *Triangulatisporites membranatus* Butterworth and Spinner, 1967, are relatively smaller, 3/4 of the proximal surface, and their triradiate ridges seem to be narrower.

Occurrence: Sample No. 2 111, New Schoongezicht Colliery; No. 2 112, Salisbury Borehole, Orange Free State; No. 2 117, President Brand.

Triletes densireticulatus sp. nov.
Pl. I, figs. 10–12; Pl. II, figs. 13, 14; holotype fig. 11.

Spore rounded in outline, generally flattened in proximal-distal direction. Diameter 800–1 180 μ (the mean being 987 μ, 17 specimens measured). Triradiate ridges straight or nearly so, 3/4–7/8 of the radius of the spore in length, 10–15 μ high, 15 μ broad. Arcuate ridges 15 μ broad. Contact faces clearly distinguishable. Where the triradiate ridges meet the arcuate ridges, the latter are curved in the direction of the apex of the spore. Whole wall of the spore, the contact faces included, finely reticulate, diameter of the reticules 5–12 μ.

Discussion and comparison. This species shows some resemblance to *T. compressus*, but the latter is larger, and especially the reticules of the coat are much rougher than the fine ornamentation in *T. compressus*.

Occurrence: Sample No. 2 115, Virginia; No. 2 109, President Steyn Gold Mine, Orange Free State; No. 2 117, President Brand, Orange Free State.

Triletes paucipinnatus sp. nov.
Pl. II, figs. 15–17; holotype fig. 16

Spore round in outline, flattened in proximal-distal direction, Diameter of the spore 730, 580, 570 μ. Triradiate ridges straight, 7/8 of the radius of the spore in length, about 15 μ broad and high. Contact faces scarcely distinguishable, arcuate ridges not visible. Coat of the spore, especially the distal part, rough. Moreover, the contact faces excepted, scarcely covered with appendages. Appendages up to 130 μ long, 5–10 μ broad, their tip spherical-clubshaped. Mutual distance of the appendage varies from 50–100 μ.

Discussion and comparison. As only one complete specimen and two broken ones could be noticed of which most appendages are broken off the shape of the tip of them may be discussable. As far as we know this species is not comparable with any other.

Occurrence: Sample No. 2 113, Waterberg, Transvaal.

(?) *Triletes suspectus* sp. nov.
Pl. II, figs. 18A, 18B; holotype

Spore (?) oval in outline, dimensions 3 400–4 000 μ. Wall on both sides irregularly reticulate. Size of the reticules varies from 50–120 μ.

Discussion. The nature of this object is questionable; probably it is a spore species, belonging to the Aphanozonati. However, triradiate and arcuate ridges, contact faces or other ornamentations could not be noticed. Only one specimen was found.

Occurrence: Sample No. 2 116, St. Helena No. 7.

Triletes transvalensis sp. nov.
Pl. II, figs. 19–22; Pl. III, figs. 23, 24; holotype fig. 20

Spore rounded-oval in outline, flattened in proximal-distal direction. Diameter of the spore 460–680 μ (the mean being 579 μ, 25 specimens measured). Triradiate arcuate ridges and contact faces not or hardly distinguishable. Whole coat of the spore densely covered with appendages. Appendages staff-shaped, up to 30–50 μ long, blunt-ended, sometimes wedge-shaped or hardly furcate. Mutual distance about 10 μ or less. Here and there fused by a thin, transparent substance. Coat of the spore about 10 μ thick.

Discussion and comparison. The appendages resemble in some respect those of *T. furcatus* Dijkstra, 1955 (= *Gulatriletes vulgatus* Bharadwaj and Tiwari), but the latter are longer and clearly furcate, the diameter of that species larger, the mean being 837 μ. An essential difference, however is that *T. furcatus* has a clearly distinguishable neck-like projection. The processes of *T. surangei* Prem Singg, 1953 (=*Singhisporites surrangei* Bh. and Tiw.), are much longer, as much as 131 μ and their density is not so crowded, and the diameter of that species varies from 643–819 μ. The coat of some *T. transvalensis* specimens is plicate, and shows some ridges that may be the triradiate ridges. This species was abundant in sample No. 2 138 by which the derivation of its name is justified.

Occurrence: Sample No. 2 138, Greenside Colliery, Transvaal.

Triletes subnitens sp. nov.
Pl. III, figs. 25–27; holotype fig. 25

Spore rounded in outline, generally flattened in proximal-distal direction. Diameter 590–820 μ (the mean being 704 μ, 16 specimens measured). Triradiate ridges 5/8 of the radius of the spore, 15 μ broad; arcuate ridges about 10 μ broad. Coat of the whole spore smooth to a little punctate and very thin.

Discussion and comparison. The coat of this species is very thin, sometimes so plicate that the ornamention is not always distinguishable; it is very brittle. The coat of *T. trivedi* Dijkstra, 1955 (= *Talchirella notabilis* Bhard. and Tiw.) is papillate.

The resemblance with *T. nitens* Dijkstra, 1955 (= *Talchirella nitens* Bhard. and Tiw.) is rather great. The diameter of *T. nitens* varies from 450–930 μ (the mean being 695 μ). Its triradiate ridges and generally its arcuate ridges are clearly distinguishable, but that may be caused by a better preservation. The triradiate ridges of *T. nitens* are relatively longer than those of *T. subnitens.* This specis did not show cushions on the proximal face after a treatment with alkali, whereas *Talchirella* species exhibit such objects, according to Bharadwaj and Tiwari.

Occurrence: Sample No. 2 138, Greenside Colliery, Transvaal; No. 2 137, No. 14, No. 8 Section, Gus Seam, Hlobane, Natal.

Triletes irregularis sp. nov.
P1. III, figs. 28–33; holotype fig. 28

Spore rounded-elliptical or irregular in shape, generally flattened in proximal-distal direction. Diameter 420–580 μ (the mean being 518 μ, 20 specimens measured). Triradiate ridges straight or undulate, 3/4–7/8 of the radius of the spore, 15 μ broad or more. Arcuate ridges not clearly distinguishable. Its coat is smooth and plicate.

Discussion and comparison. T. tchadiensis Dijkstra, 1971, is smaller, 300–460 μ (the mean being 366 μ), even the variety *major* is smaller than *T. irregularis. T. tchadiense* makes a solid impression, its triradiate ridges especially are substantial. It was very abundant and was observed in practically all studied samples of boring Tchad by which a perfect idea of this species could be obtained. These species are not identical. *T. irregularis* is very irregular in shape, it gives an impression of immaturity or abortion. As it was found in the same sample as *T. subnitens*, it may belong to it.

Occurrence: Sample No. 2 138, Greenside Colliery, Transvaal.

Zonales

Triletes capreolatus sp. nov.
P1. III, figs. 34–38;
holotype fig. 34, cotype fig. 37

Complete spore subtriangular in outline, flattened in proximal-distal direction. Body of the spore rounded 1 610–2 800 μ (the mean being 2 440 μ, 25 specimens measured). Triradiate ridges generally undulate, about 3/4 of the radius of the body of the spore in length, 30–80 μ broad, 25–100 μ high, highest at the apex of the spore. Arcuate ridges 40–60 μ broad. Zone up to 300 μ wide, widest at the contact places of the triradiate ridges with the arcuate ridges. Contact area clearly distinguishable. Coat of the body of the spore rough, finely punctate, 30 μ thick.

Discussion and comparison. Practically all specimens have lost their zone and perispore. Fig. 37 shows a specimen with some remains of the zone; the specimen on fig. 34 is surrounded by its perispore that encloses the whole body of the spore: zone, contact area and triradiate ridges. It is a thick fibrous mass with little structure, it builds a 90 μ wide crest on the triradiate ridges and a shapeless compressed mass in the apex of the spore. The zone is massive; radiating appendages fused by a rim at the periphery of the zone could not be observed. By this this species is not comparable with species such as *T. brasserti, T. rotatus, T. mucronatus,* etc. which are provided with such a zone.

Occurrence: Sample No. 2 113, Waterberg, Transvaal; No. 2 114, Coalbrook Colliery; No. 2 115, Virginia; No. 2 116, St. Helena No. 7, President Brand, Orange Free State.

Triletes lepidus sp. nov.
P1. IV, figs. 39–41; holotype fig. 39

Spore generally rounded in outline and generally flattened in proximal-distal direction. Diameter of the whole spore, the zone included, 790–1 140 μ (the mean being 960 μ, 8 specimens measured). Triradiate ridges straight, about 300 μ long, 20 μ broad. Arcuate ridges 20 μ broad, not always distinguishable; contact faces clearly visible. Distal area and proximal area, the contact faces excepted, covered with a thick entangled mass of appendages, building at the equator a zone up to 400 μ wide. The individual shape of the appendages is difficult to distinguish, but with some isolated parts of the zone these appendages, running in radial direction, appear to be about 10 μ wide and allied with each other by a transparent substance. The coat of the contact area is rough-striate.

Discussion and comparison. This species is not comparable with species such as *T. brasserti, rotatus, mucronatus*, etc. of which the equatorial zone is composed of a number of radial running appendages that are fused at their periphery, building a rim. By this these species look like a wheel with spokes surrounded by a ring. In some respects it shows some resemblance to *T. furcatus* Dijkstra, 1955 (= *Gulatriletes furcatus* Bharad. and Tiw.), but that species is distinguishable by its neck-like projection. This species most resembles *Triangulatisporites rootsii* Chaloner, 1959, but the dimension of the latter is much smaller (diameter, including the flange, 485–524 μ; the mean being 507 μ and the width of the flange varies from 70–107 μ).

Occurrence: Sample No. 2 138, Greenside Colliery, Transvaal.

Triletes pusillus sp. nov.
P1. IV, figs. 42A, 42B; holotype

Spore rounded-subtriangular, flattened in proximal-distal direction. Diameter 370–510 μ (the mean being 426 μ, 10 specimens measured). Triradiate ridges straight, 3/4 of the radius of the spore in length, ca. 20 μ broad, the widest in the direction of the periphery. Contact faces clearly distinguishable, arcuate ridges not obvious. Coat of the spore verrucose, contact faces finely punctuate.

Discussion and comparison. We have treated this species with alkali, but the spore did not become more transparent, an inner body could not be observed, cushions on the proximal face could not be observed, and the increase in size was unimportant. By this a comparison with species belonging to *Srivastavaesporites*, described by Bharadwaj and Tiwari, is difficult. *S. karanpuraensis* looks to be very similar, but its triradiate ridges are tapering towards the ends, which is not the case with *T. pusillus; S. endosporitiferus* has a well-defined inner body and is larger; *S. dijkstrae* is characterized by the absence of well defined contact area; *S. indicus* has an inner body and its triradiate ridges are slightly narrowed towards their ends; *S. utkalensis* has an inner body and is larger and its verrucae are much higher; finally *S. tenuis* and *labiosus* (= *T. tenuis* and *T. labiosus* Dijkstra, 1935) are much larger than *T. pusillus*.

Occurrence: Sample No. 2 138, Greenside Colliery, Transvaal.

Lageniculae

Triletes turnaui sp. nov.
P1. IV, figs. 43–48; P1. V, fig. 49? ;
holotype fig. 48

Spore rounded or elliptical in outline, flattened in proximal-distal, lateral, but generally in oblique direction. Diameter 1 080–1 860 μ (the mean being 1 528 μ, 25 specimens measured). Triradiate ridges generally straight, sometimes undulate, 3/4–7/8 of the radius of the spore in length, 30–40 μ broad, highest at the apex of the spore building a pyramidal elevation, about 200 μ in height. Arcuate ridges sometimes clearly distinguishable and about 30 μ wide. Coat of the spore smooth to a little rough, about 15 μ thick.

Discussion and comparison. The pyramidal elevation is not always distinguishable, being best visible in specimens flattened in lateral direction. The surface of the wall of the spore depends moreover on the substratum in which the specimen is embedded. Fig. 46 shows a specimen that was deposited in sandy grains. We do not know a lageniculate species with a smooth wall of these dimensions. Some of the Moscow species (Dijkstra and Piérart, 1957) are very large too, but their wall is covered by a number of appendages.

Derivation of name: after Dr. Elzbieta Turnau of Krakow, who has given me many valuable suggestions during her study stay at Heerlen.

Occurrence: Sample No. 2 109, President Steyn Gold Mine, Orange Free State; No. 2 111, New Schoongezicht Colliery; No. 2 114, Borehole P. 2.555', Coalbrook Colliery; No. 2 116, St. Helena No. 7; No. 2 117, President Brand, Orange Free State.

Triletes brachytrachelos sp. nov.
P1. V, figs. 50–55; holotype fig. 50

Spore oval or rounded in outline, flattened in proximal-distal or in lateral direction. Diameter 870–1 940 μ (the mean being 1 429 μ, 30 specimens measured). Triradiate ridges 7/8 of the radius in length, 30 μ broad and up to 200 μ in height, the highest at the apex of the spore, building a neck-line elevation. Arcuate ridges 40 μ wide; where they meet the triradiate ridges triangular lobes are distinguishable, 100 μ in radial, 150 μ in transverse direction. The coat of the spore, the contact faces more or less excepted, rough-reticulate, densely covered with conical appendages, ca. 10 μ in length.

Discussion and comparison. The neck-line elevation is not always visible, its length is up to 700 μ. Some specimens still in a tetrad are covered with a red translucent substance. Probably they are not fully developed specimens. *T. catenulatus* Winslow, 1962, is much smaller (425–740 μ), the shape is different, and the appendages longer. *Biharisporites ocksensis* Chaloner, 1959, has no triangular lobes, its surface is finely granular, or covered with 10 μ high cones. *T. angulatus* Zerndt, 1937, has much larger triangular lobes, its cones vary from 6–24 and its wall is moreover covered with irregularly shaped tubercles. *T. brasiliensis* Dijkstra, 1955, is more comparable, but that species is smaller, its diameter varies from 650–1 610 μ (1 013 μ for the mean), it shows some semi-spherical objects on its wall. *T. punctatus* Trivedi, 1953, is smaller, its diameter is 806 μ long, excluding the neck-like elevation 194 μ in length. Its coat is punctate, the punctae being 12,8 μ in breadth and 11,2 μ in length.

Occurrence: Sample No. 2 114, Coalbrook Colliery; No. 2 115, Virginia; No. 2 116, St. Helena No. 7; No. 2 117, President Brand, Orange Free State.

B. Spores of Australia

Aphanozonati

Triletes australis sp. nov.
P1. V, figs. 56–59; P1. VI, figs. 60–62;
holotype fig. 59

Spore rounded in outline, flattened in proximal-distal direction. Diameter 870–1 190 μ (the mean being 1 049 μ, 25 specimens measured). Triradiate ridges generally undulate, sometimes straight, about 1/2 of the radius of the spore in length, 30–40 μ in breadth and up to 30 μ in height. Arcuate ridges not distinguishable. Whole wall of the spore, the contact faces excepted, densely covered with appendages up to 110 μ in length, staff-shaped and furcate at the tip, the bases generally mutually joined by a thin transparent substance. Contact faces covered with very short appendages to punctuate. The coat of the spore is about 10 μ thick.

Discussion and comparison. T. furcatus Dijkstra, 1955 (*Gulatriletes furcatus* Bharadwaj and Tiwari) has a neck-like projection, its appendages are shorter and its contact faces smooth to sparsely covered with small objects. *T. trivedi* Djikstra, 1955 (*Talchirella notabilis* Bhar. et Tiw.) is smaller (380–780 μ, 630 μ for the mean). Moreover both former species show on the proximal side, after treating with alkali, irregularly arranged pits or cushions along their triradiate mark. These objects could, after alkali treatment, not be observed in *T. australis*. *T. catenulatus* Winslow, 1962, is also much smaller, has an apical projection and its spines are shorter. *Singhisporites radialis* Bharadwaj and Tiwari, 1970, is smaller, 375–508 μ.

Occurrence: Sample No. 2 068, Greta Coal Measures, Colliery Pelton (in great numbers); No. 2 072, Upper Coal Measures, Newcastle Stage, Colliery Stockton; No. 2 073, Greta Coal Measures, Tomago Stage, Colliery State Coal Mine.

Triletes robur sp. nov.
P1. VI, figs. 63–70; holotype fig. 63

Spore rounded in outline, flattened in proximal-distal direction. Diameter 740–1 240 μ (the mean being 991 μ, 50 specimens measured). Triradiate ridges straight, 3/4 of the radius of the spore in length, 12–15 μ broad, the same in height. Arcuate ridges hardly distinguishable. Coat of the spore, especially the distal part, rough, densely covered with blunt-ended, fleshy papillae, 5–7 μ (up to 15 μ) in length.

Discussion and comparison. The triradiate ridges end at the point of contact with the arcuate ridges. After a treatment with alkali, pits or cushions on the proximal side of the spore could not be observed. We have compared it with *Srivastavaesporites* species Bharadwaj and Tiwari, 1970. However, most of the species described by them are considerably smaller than *T. robur*. It is in dry conditions even larger than some of them in wet condition. *T. labiosus* Dijkstra, 1955, is somewhat larger than *T. robur*, its surface is smooth to finely punctate. Although Pant and Srivastava, having received some specimens of this species from us, could not observe pits or cushions after an alkali treatment, Bharadwaj and Tiwari, 1970, have placed *T. labiosus* in *Srivatavaesporites*.

Occurrence: Sample No. 2 068, Greta Coal Measures, Seam Greta, Colliery Pelton; No. 2 070, Upper Coal Measures, Newcastle Stage, Seam Young Wallsend; No. 2 071, Upper Coal Measures, Tomago Stage, Seam Liddell, Colliery State Coal Mine; No. 2 073, Upper Coal Measures, ? Newcastle Stage, Seam Young Wallsend, Colliery Boston.

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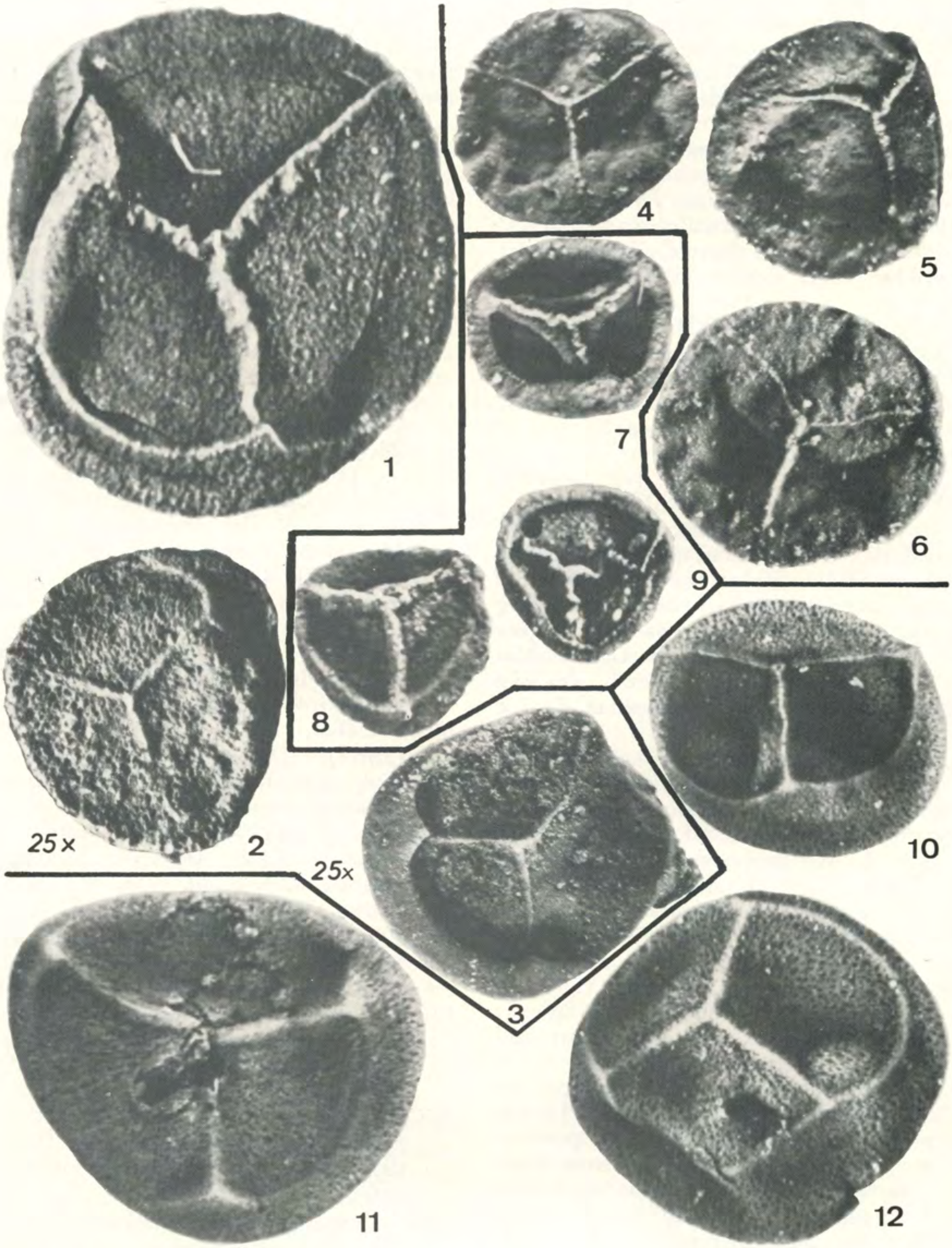

Plate I

Fig. 1 *Triletes compressus* sp. nov., sample No. 2 111–No. 3, S. Africa.
Fig. 2 *Triletes compressus* sp. nov., sample No. 2 116–No. 8, S. Africa.
Fig. 3 *Triletes compressus* sp. nov., sample No. 2 114–No. 6, S. Africa.
Figs. 4–6 *Triletes calvus* sp. nov., sample No. 2 111–No. 3, S. Africa.
Fig. 7 *Triletes inflexus* sp. nov., sample No. 2 111–No. 3, S. Africa.
Figs. 8, 9 *Triletes inflexus* sp. nov., sample No. 2 117–No. 8, S. Africa.
Figs. 10–12 *Triletes densireticulatus* sp. nov., sample No. 2117–No. 9, S. Africa.

The enlargement of all the photographs is 50X, except in some specimens the enlargement is indicated on the plates. The photographs were made by L. R. Funcken.

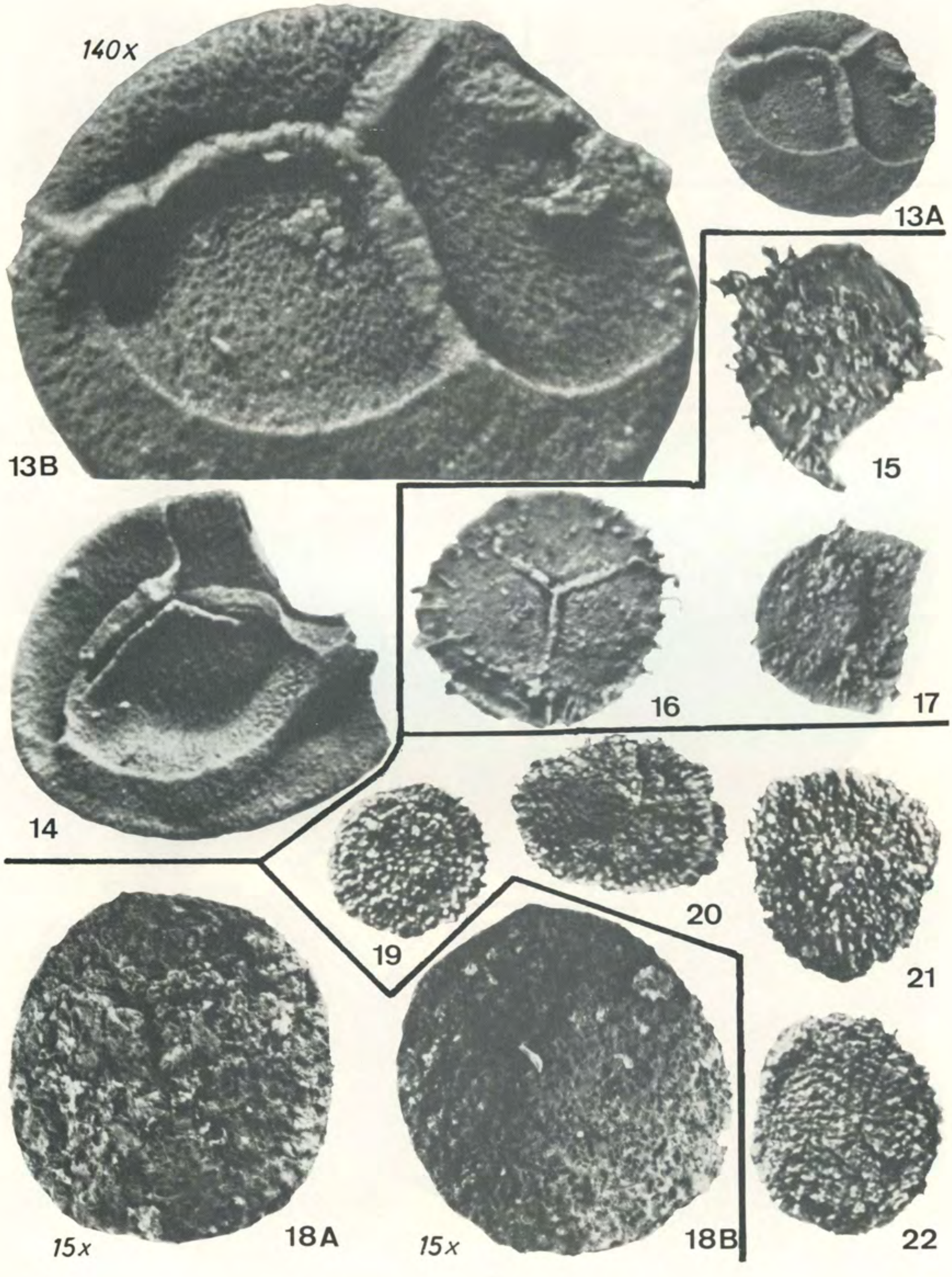

Plate II

Figs. 13A, 13B *Triletes densireticulatus* sp. nov., sample No. 2 109–No. 1, S. Africa.
Fig. 14 *Triletes densireticulatus* sp. nov., sample No. 2 117–No. 9, S. Africa.
Figs. 15–17 *Triletes paucipinnatus* sp. nov., sample No. 2 113–No. 5, S. Africa.
Figs. 18A, 18B (?)*Triletes suspectus* sp. nov., sample No. 2 116–No. 8, S. Africa.
Figs. 19–22 *Triletes transvalensis* sp. nov., sample No. 2 138–No. 15, S. Africa.

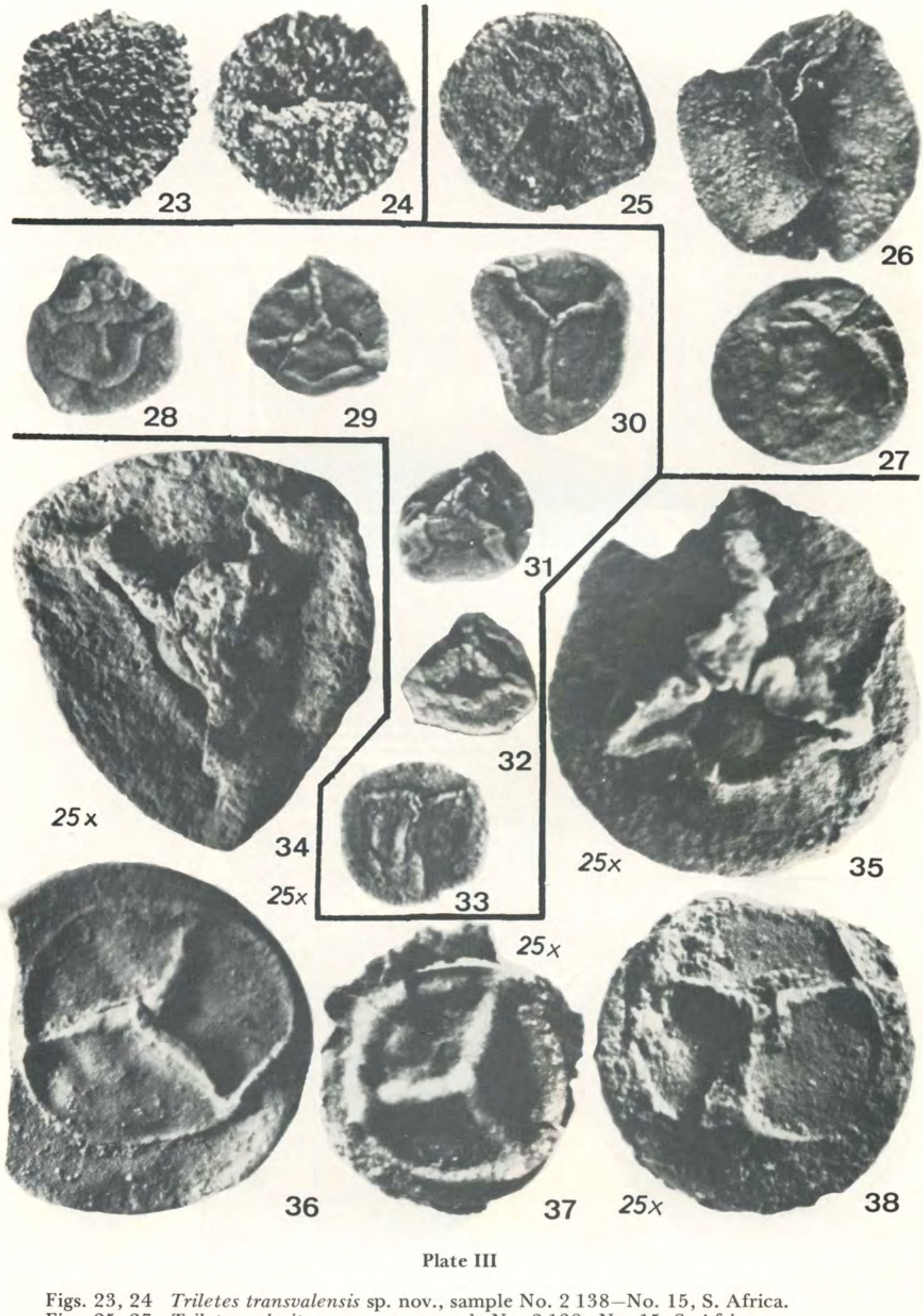

Plate III

Figs. 23, 24 *Triletes transvalensis* sp. nov., sample No. 2 138–No. 15, S. Africa.
Figs. 25, 27 *Triletes subnitens* sp. nov., sample No. 2 138–No. 15, S. Africa.
Fig. 26 *Triletes subnitens* sp. nov., sample No. 2 137–No. 14, S. Africa.
Figs. 28–33 *Triletes irregularis* sp. nov., sample No. 2 138–No. 15, S. Africa.
Figs. 34, 35 *Triletes capreolatus* sp. nov., sample No. 2 116–No. 8, S. Africa.
Figs. 36, 38 *Triletes capreolatus* sp. nov., sample No. 2 114–No. 7, S. Africa.
Fig. 37 *Triletes capreolatus* sp. nov., sample No. 2 115–No. 6, S. Africa.
Fig. 34 Specimen surrounded by its perispore.
Fig. 37 Specimen with remains of its zone.

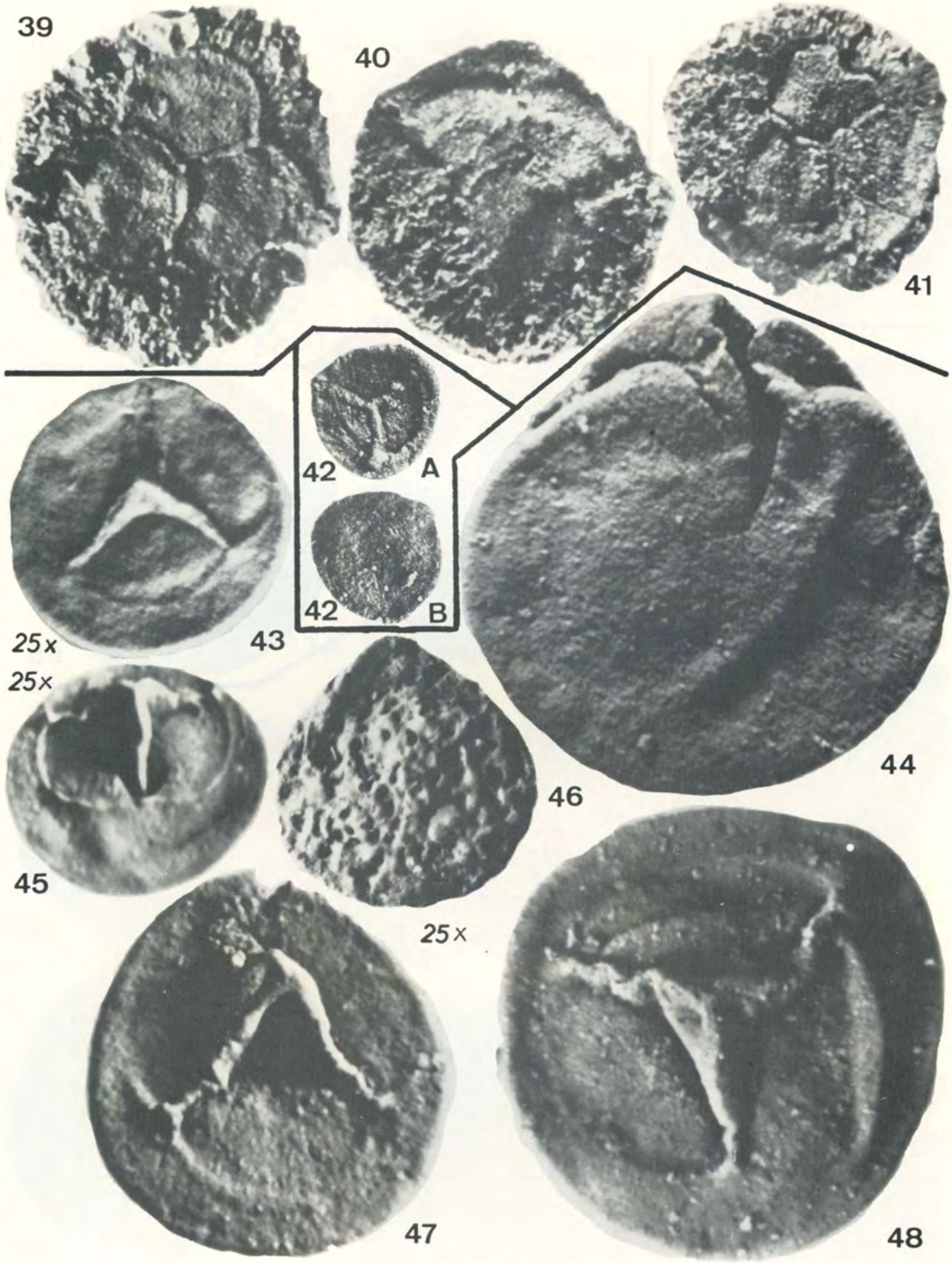

Plate IV

Figs. 39–41 *Triletes lepidus* sp. nov., sample No. 2 138–No. 15, S. Africa.
Figs. 42A, 42B *Triletes pusillus* sp. nov., sample No. 2 138–No. 15, S. Africa.
Figs. 43–45, 47, 48 *Triletes turnaui* sp. nov., sample No. 2 109–No. 1, S. Africa.
Fig. 46 *Triletes turnaui* sp. nov., sample No. 2 116–No. 8, S. Africa. Specimen deposited in sandy grains.

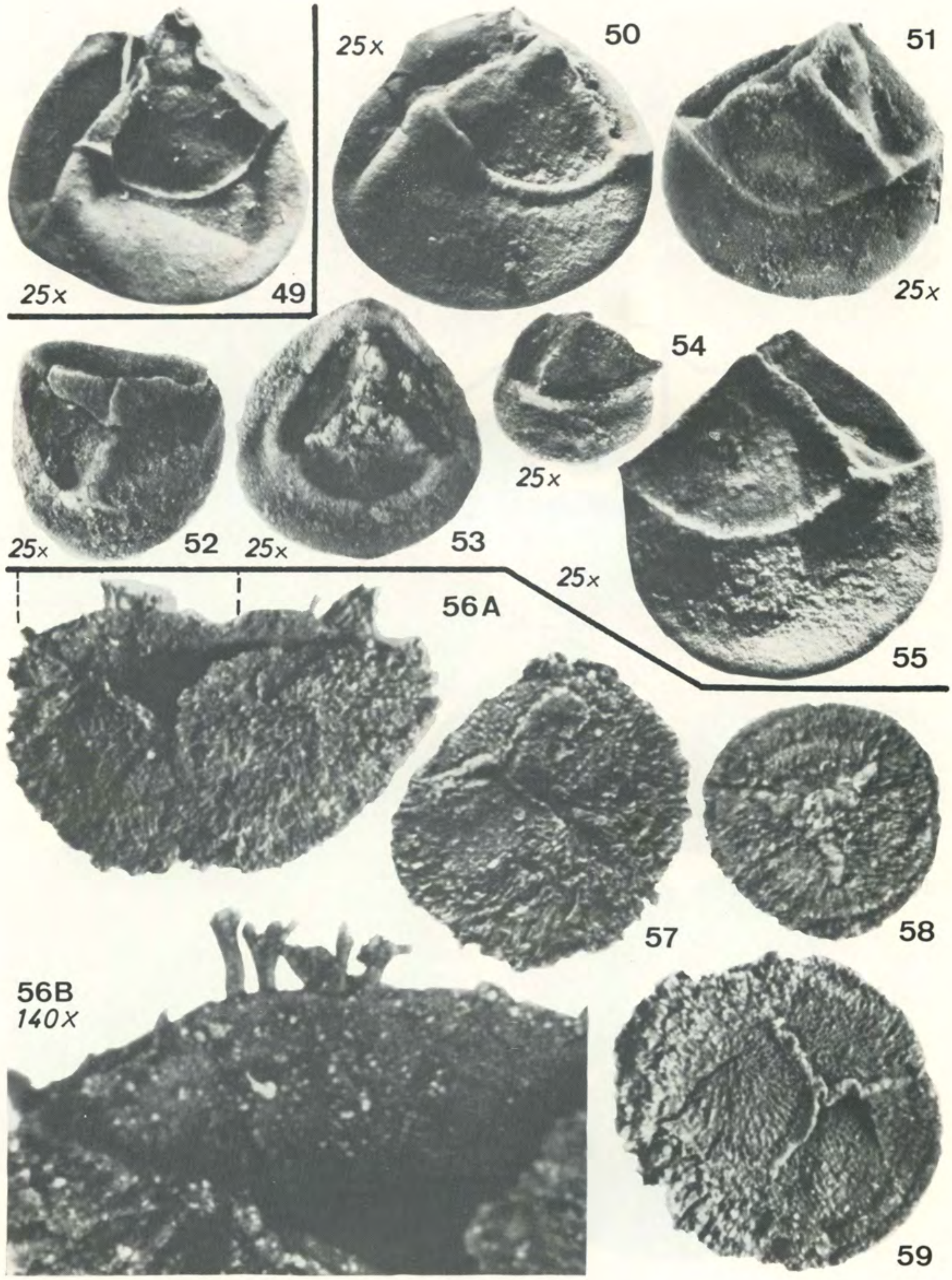

Plate V

Fig. 49 *Triletes* cf. *turnaui*, sample No. 2 111–No. 3, S. Africa.
Figs. 50–55 *Triletes brachytrachelos* sp. nov., sample No. 2 114–No. 6, S. Africa.
Figs. 56–59 *Triletes australis* sp. nov., sample No. 2 073, Australia.

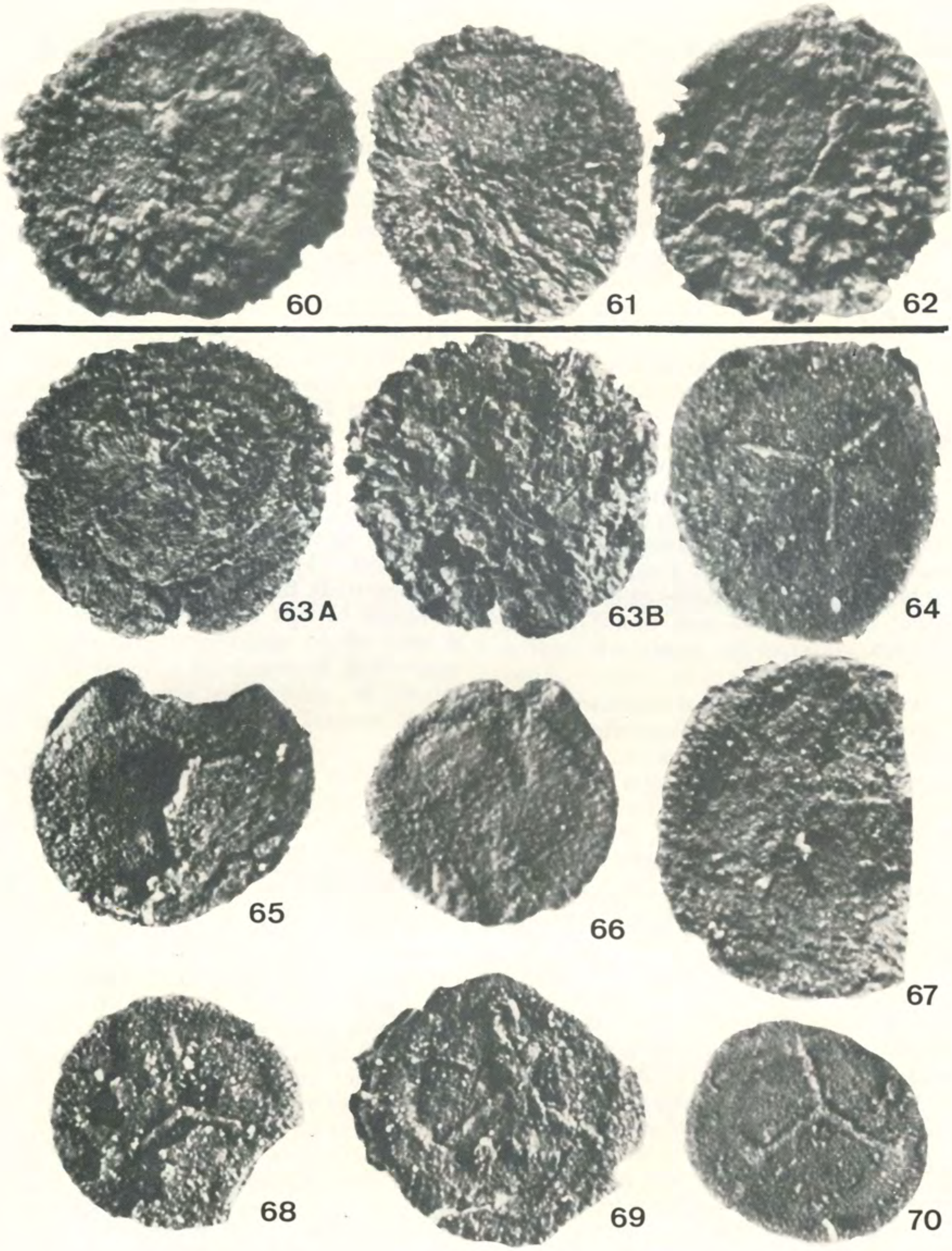

Plate VI

Figs. 60–62 *Triletes australis* sp. nov., sample No. 2 073, Australia.
Figs. 63, 65, 69 *Triletes robur* sp. nov., sample No. 2 070, Australia.
Figs. 64, 66–68, 70 *Triletes robur* sp. nov., sample No. 2 068, Australia.