FOSSIL POLLEN GRAINS OF PROTEACEOUS TYPE FROM TERTIARY DEPOSITS IN AUSTRALIA

By Isabel C. Cookson*

[*Manuscript received March* 22, 1950]

Summary

Seventeen sporomorphs of possible proteaceous affinities have been described from Tertiary (?Oligocene – Miocene) deposits of south-eastern Australia. The majority of these appear to have been pollen grains of extinct species.

The sporotypes *Banksieaeidites* and *Beaupreaidites*, each represented by two sporomorphs, are morphologically identical with pollen grains of the tribe Banksieae and two species of *Beauprea* (*B. elegans* and *B. spathulaefolia*) respectively.

The resemblance between the sporomorph *Proteacidites annularis* and pollen of *Xylomelum occidentale*, a species now confined to Western Australia, is discussed. Attention is drawn to the likeness of the sporomorph *Proteacidites symphyonemoides* to pollen of *Symphyonema; Proteacidites truncatus* to pollen of *Isopogon* and *Proteacidites adenanthoides* to pollen of *Adenanthos barbigera.*

A morphologically distinct pollen type from brown coal at Moorlands in South Australia is described under the sporomorph *Triorites magnificus.*

I. Introduction

A variety of pollen grains which are morphologically conformable with those of living members of the family Proteaceae occur in a number of Australian Tertiary deposits (see Pike 1948). This, at first sight, may appear surprising since pollination in this family normally takes place through the agency of insects and birds (Bentham 1873; Müller 1883; Brough 1933; Carey 1941). A small amount of scattering by wind apparently does take place since Phillips (1941) in a paper dealing with atmospheric pollen caught in and about Sydney, New South Wales, reports that "a few pollen grains of Proteaceae have been caught from time to time" and notes that "the highest percentage was 1.2 from Parramatta." During the present investigation this question was attacked from a different angle (cf. Carroll 1943) with similar results. A pollen analysis of lichen thalli taken from an area rich in Proteaceae near Perth, Western Australia, was carried out. The material, kindly supplied by Dr. B. J. Grieve, was subjected to acetolysis and the spores which had collected on the surface of the thalli were concentrated and mounted in the usual manner. Examination of the concentrate revealed the presence of numerous fern spores, pollen grains of Myrtaceae, Compositae, some monosulcate types, and a low percentage of proteaceous pollen grains. These included a single grain of *Isopogon* sp., and a few grains of a species of *Adenanthos*.

* Botany School, University of Melbourne.

Such results, as far as they go, suggest that pollen grains of the Proteaceae are unlikely to be major constituents of spore-bearing deposits. They do not, however, preclude the possibility of their presence in smaller numbers. Furthermore, clusters of pollen grains can usually be found on the central stigmatic processes of fully opened and fading flowers, so that if such flowers or floral parts were to fall into developing sediments they would clearly provide an additional source of pollen grains for later fossilization.

The present paper deals with some of the more conspicuous proteaceoid types occurring in Australian Tertiary deposits. Little or no doubt exists as to the family or even generic relationships of some of these, but the affinity of others is less certain.

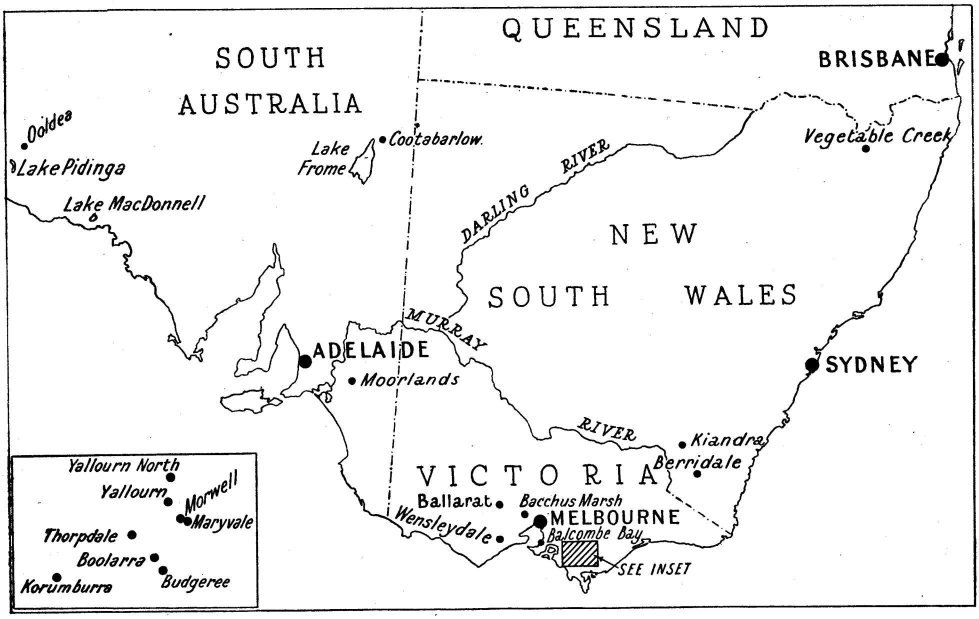


Fig. 1.—Map of south-eastern Australia showing location of deposits in which proteaceous-like pollen has been found. (Prepared by the Geological Survey of Victoria.)

The localities of most of the deposits which will be referred to have already been mentioned in a previous paper (Cookson 1946). To these six new localities (all of which are shown in the accompanying map) have now to be added, namely:

Yallourn North—Open cut in brown coal, immediately north of the Latrobe River at Yallourn, Victoria.

Wensleydale—About 10 miles north-west from Anglesea, Victoria.

Bacchus Marsh—Lucifer Mine, half a mile south-east of Bacchus Marsh railway station, Victoria.

Lake MacDonnell—Close to the sea on the west coast of Eyre Peninsula, about 8 miles south of Penong, the terminal station of the 3 ft. 6 in. gauge railway line and 63 miles distant from Thevenard, South Australia.

Pidinga—About 35 miles south-east of Ooldea, a siding on the east-west railway line 427 miles from Port Augusta, South Australia.

Cootabarlow—At Lake Cootabarlow, east of and near Lake Frome, South Australia.

The system of nomenclature followed is that proposed by Erdtman in 1947 for fossil pollen grains and spores and adopted by Cookson (1947) and Ross (1949). The terms used in the pollen morphological descriptions are after Erdtman (1948).

Measurements and photographs of the fossil pollen grains haven been taken from material which, with one exception, has been prepared by the use of the acetolysis method. A 12½ per cent. solution of sodium hypochlorite has been found useful for the preliminary examination of sediments and for the rapid checking of results. If necessary, it may be preceded by treatment with hydrofluoric acid.

II. Descriptions of Pollen Grains Studied

Beaupreaidites n. spt.

Plate 1, Figs. 2, 4, 6, 7

Although occurring in small numbers only, this sporotype has been observed in preparations from several widely separated Australian Tertiary deposits. It is characterized by its medium size, straight sides, colpoid apertures, tapering exine, and finely reticulate sexine. In all these features it shows a remarkable resemblance to the pollen of two species of the New Caledonian genus *Beauprea.* In fact, had the colpoid type of aperture not already been observed in the Proteaceae by its occurrence in *Beauprea,* the proteaceous affinity of this sporotype might not have been recognized. As the result of a comparison of the fossil and living pollen grains it now appears probable that species of *Beauprea* were components of the Tertiary flora of southern Australia.

Beaupreaidites elegansiformis n. spm.

Plate 1, Figs. 2-4

Grains.—Triangular with straight sides and rounded angles; equatorial diameter 36-52 μ, average 45 μ; apertures colpoid, sometimes with irregular slits which extend beyond the apertural regions.

Exine.—About 2.3 μ, tapering towards the apertures; sexine and nexine of about equal thickness.

Sexine.—Baculate, reticulate, mesh of reticulum small, becoming considerably reduced towards the apertural areas, the latter lighter in colour in both stained and unstained preparations as in pollen of the living species *Beauprea elegans* Brongn. et Gris (Plate 1, Fig. 1) and *Beauprea spathulaefolia* Brongn. et Gris; muri psilate.

Affinity.—Closely similar in all respects to pollen of *Beauprea elegans.*

Distribution.—Widely distributed in south-eastern Australia.

Brown coal: Yallourn open cut, 32 and 62 ft. from top of coal; Moorlands; Lake MacDonnell bore 213 ft. 6 in.-217 ft. (Preparation by K. Pike.)

Ligneous clay: Lucifer Mine, Bacchus Marsh; Hoddles Creek, Victoria.

Mudstone: Vegetable Creek.

BEAUPREAIDITES VERRUCOSUS n. spm.*

Plate 1, Figs. 6, 7

This sporomorph conforms to the description given above for *B. elegansiformis* but differs from it in the presence of small, irregularly disposed thickenings on the surface of the sexinous reticulum. Similar localized thickenings of the muri occur in the majority of pollen grains of *Beauprea spathulaefolia* (Plate 1, Fig. 5) so that the establishment of a second sporomorph, on this feature alone, appears to be justified.

Affinity.—Closest morphological agreement is with pollen of *Beauprea spathulaefolia.*

Distribution.—*Ligneous clay*: Lucifer Mine, Bacchus Marsh; Cootabarlow Bore.

BANKSIEAEIDITES n. spt.

Pollen grains of this sporotype are sub-isopolar, bilateral, biaperturate; the ectonexine is thickened around the apertures. They closely resemble pollen grains of living species of *Banksia* and *Dryandra* which comprise the tribe Banksieae, and there is little doubt that they belonged to Tertiary members of this tribe. Since, however, the pollens of *Banksia* and *Dryandra* are indistinguishable from one another, the fossil grains cannot be attributed to either genus.

BANKSIEAEIDITES MINIMUS n. spm.

Plate 1, Figs. 18, 19

Grain.—Plano-convex, length 24-35 μ, breadth 16-24 μ (occasionally as broad as long), width 19-21 μ; apertures 8-11 μ.

Exine.—Thin, 1.5 μ, apertural "collars" 2.5-3 μ deep.

Sexine.—Sculpture faint, probably a thick-walled reticulum.

Distribution.—*Brown coal*: Open cut, Yallourn North; open cut, Yallourn, at 62 and 92 ft. from top of coal.

* The southern distribution of *B. verrucosus* has recently been extended by its discovery in lignite from Ouse, Tasmania, the latitude of which is 42° 48′S.

Banksieaeidites elongatus n. spm.

Plate 1, Fig. 10

Grain.—Plano-convex; length 40-56 μ, breadth 20-27 μ; apertures 8-11 μ.

Exine.—About 2 μ thick, "collars" 5 μ deep.

Sexine.—Sculpture more clearly defined than in *B. minima,* probably a thick-walled reticulum.

Distribution.—*Brown coal*: Open cut, Yallourn North; Yallourn open cut at 62-92 ft. from top of coal.

Grains of *Banksieaeidites* have been observed in preparations of Moorlands coal and other deposits but their numbers are as yet too small for them to be reliably identified with either of the sporomorphs from Yallourn.

Proteacidites tuberculatus n. spm.

Plate 1, Figs. 12-14

Grain.—Large, triangular, with convex sides and concave apertures, the average equatorial diameter being 78 μ, the range from 60 to 96 μ.

Exine.—About 5.5 μ, tapering towards the apertures and showing clearly defined nexinous and sexinous layers; the ectonexine represents at least 80 per cent. of the total thickness of the exine and the endonexine is sharply defined.

Sexine.—Very thin, baculate, covered with approximately spherical tubercles, 3-4 μ high, which are arranged either irregularly or in a reticuloid pattern. Both the proximity and size of tubercles vary considerably in grains from different localities. The number of specimens observed, however, is, as yet, too small to permit a less generalized statement.

Affinity.—In spite of the distinctive form of *P. tuberculatus,* it cannot be matched with pollen of any living proteaceous species. It shows a superficial resemblance to pollen of *Beauprea balansae* Brongn. et Gris from New Caledonia (Plate 1, Fig. 11) but the smaller size, colpoid apertures, and reticulate sexine of the latter are important contrasting features. The sculpture of *P. tuberculatus* recalls, in slight measure, that of *Hakea pycnoneura* and *Hakea petiolaris* but the shapes of the grains and apertures do not agree with those of pollens of *Hakea.*

Distribution.—*Brown coal*: Yallourn open cut at 32 and 92 ft. below top of coal; Moorlands.

Ligneous clay: Lucifer Mine, Bacchus Marsh.

Proteacidites annularis n. spm.

Fig. 2 and Plate 1, Fig. 15

Grains.—Triangular with prominent apertural areas; sides straight to concave, apertures 5.8 μ; average equatorial diameter 32 μ with a range of 27 to 37 μ.

Exine.—2.76 μ thick, clearly differentiated into three layers. At the base of each apertural area an abrupt annular thinning of the ectonexine is followed by a pronounced thickening of the same layer which then gradually tapers towards the opening. This thickened area forms a "collar" around the aperture, the depth of which is about 5-6 μ; frequently the thinner portion beyond the "collar" is not preserved.

Sexine.—About half as thick as the nexine, sculpture in the form of a very fine reticulum.

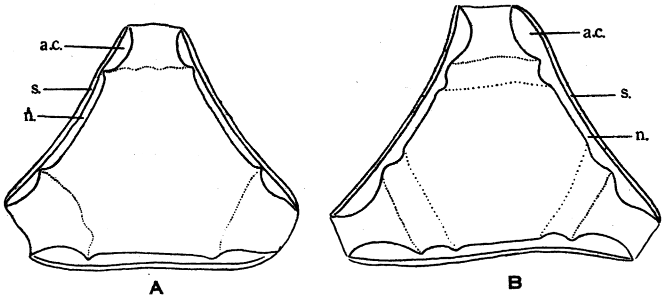


Fig. 2.—Camera lucida drawings of pollen grains of (*A*) *Proteacidites annularis* and (*B*) *Xylomelum occidentale*. *s.*, sexine; *n.*, nexine; *a.c.*, apertural "collar." x 835.

Affinity.—*P. annularis* probably recurs in the preparations more often than any other proteaceous pollen. It is readily identified by its apertural areas and "collars." Amongst recent species of Proteaceae similar features are most strongly marked in pollen of *Lambertia* Sm., *Xylomelum angustifolium* Kipp., *Xylomelum occidentale* R. Br., *Banksia* Linn., and *Dryandra* R. Br. The fossil grains being radiosymmetrical and triaperturate, comparison can be restricted to *Lambertia* and the two species of *Xylomelum* mentioned. Of the Lambertias, pollen of *Lambertia multiflorum* is most like the sporomorph *P. annularis*, but the "collars" of the latter are more strongly defined and the grains do not appear to be sub-isopolar.

As regards the two species of *Xylomelum*, so close is the resemblance between the fossil grains and pollen of *X. occidentale* (Fig. 2 and Plate 1, Fig. 16) that a relationship between the two parent plants seems probable.

Distribution.—The most widely distributed and most numerous type.

Brown coal: Yallourn open cut, 32, 62, and 92 ft. from top of coal; Hoddles Creek, Victoria; Lucifer Mine, Bacchus Marsh; Moorlands; Cootabarlow Bore at 537-538 ft.

Ligneous clay: Lal Lal, near Ballarat; Wensleydale (G.S.V. 50083).

Mudstones: Balcombe Bay; Vegetable Creek.

Proteacidites symphyonemoides n. spm.

Plate 2, Fig. 17

Grain.—Triangular with straight or slightly convex sides narrowing somewhat towards the apertures; equatorial diameter averaging 32 μ and ranging from 24 to 37 μ; apertures about 3 μ.

Exine.—Thin, approximately 1.5 μ; not tapering towards the apertures.

Sexine.—Thicker than the nexine, baculate, reticulate; the muri have wavy outlines and the meshes are of irregular sizes and shapes.

Affinity.—This type approaches most nearly the pollen of the recent genus *Symphyonema* R. Br. The size of the grains and degree of coarseness of the sexinous reticulum appear to be intermediate between those of *S. paludosum* R. Br. and *S. montanum* R. Br.

Distribution.—*Ligneous clay*: Yallourn open cut, fruit zone collected by Dr. Austin Edwards.

Ligneous shale: Kiandra, C.S. 89.

Mudstone: Balcombe Bay.

Proteacidites truncatus n. spm.

Plate 2, Fig. 19

Grain.—Triangular with straight sides and transversely extended apertures; average equatorial diameter 46 μ.

Exine.—About 3 μ, tapering towards the apertures.

Sexine.—Baculate, reticulate, almost as thick as the nexine; mesh moderately large, becoming reduced towards the apertures.

Affinity.—*P. truncatus* is a rare type with characters which resemble those of *Isopogon* R. Br. The most striking feature of agreement, apart from the sexinous reticulum, is the equatorial extension of the apertures which give a truncate appearance to the angles of the grains. Of the recent species examined, the one with which the closest comparisons are possible is *I. anemonifolius* Knight (Plate 2, Fig. 18), an eastern Australian representative.

Distribution.—*Brown coal*: Yallourn open cut, at 32 and 62 ft. from top of coal.

Proteacidites adenanthoides n. spm.

Plate 2, Fig. 21

Grain.—Triangular, slightly sub-isopolar, sides more or less concave according to the position in which the grain is viewed; average equatorial diameter 43 μ, range 32-48 μ; diameter of the apertures about 3 μ.

Exine.—2.8 μ thick, nexine not thinning towards the apertures.

Sexine.—About half as thick as the nexine, widest between the apertures, reticulate. Reticulum baculate, practically identical in both hemispheres, mesh small, becoming finer towards the apertures, muri rather thick.

Affinity.—This sporomorph closely resembles pollen of the living genus *Adenanthos,* particularly that of *Adenanthos barbigera* (Plate 2, Fig. 20), both in form and type of sexinous reticulum. When closely compared with the latter, however, *B. adenanthoides* is seen to be less sub-isopolar with the width of the mesh the same over both poles and to have a thicker exine.

Distribution.—*Ligneous clays*: Wensleydale (G.S.V. No. 50083); Cootabarlow bore 493-515 ft., 515-537 ft.

Mudstone: Vegetable Creek

PROTEACIDITES CRASSUS n. spm.

Plate 2, Fig. 22

Grain.—Three or sometimes two-aperturate, sub-isopolar, plano-convex, average equatorial diameter 58 μ, polar axis about 27 μ, sides concave.

Exine.—2.3 μ, nexine not thinning towards the apertures.

Sexine.—Reticulate, slightly more than half as thick as nexine, widest between the apertures. Mesh of reticulum moderately large, finer in the convex hemisphere and towards the apertures, muri thick, baculae clearly defined.

Affinity.—The most conspicuous difference, apart from size, between this and the preceding sporomorph is the coarser reticulation and the stronger sub-isopolarity reflected in the greater width of mesh in the concave hemisphere. In this respect *P. crassa* is more *"adenanthoid"* than *P. adenanthoides.* It is regarded as pollen of an extinct proteaceous plant.

Distribution.—*Brown coal*: Moorlands.

Ligneous clay: Cootabarlow bore, 493-515 ft., 515-537 ft.

PROTEACIDITES GRANDIS n. spm.

Plate 2, Fig. 23

Grain.—Slightly sub-isopolar, more or less triangular in polar view, usually with deeply concave sides; large, the average equatorial diameter being 69 μ and the polar axis approximately 27 μ.

Exine.—3.7 μ thick, gradually thinning towards the apertures.

Sexine.—Baculate, about as thick as the nexine, reticulate; the reticulum similar in both hemispheres with wide lumina and narrow muri, becoming minute towards the apertures.

Affinity.—The affinities of this sporomorph are obscure. It is unlike pollen of living proteaceous species. As regards the fossil sporomorphs a general likeness to *P. crassa* may be mentioned but in size, the degree of sub-isopolarity, and coarseness of the sexinous reticulum, the two are distinct.

Distribution.—*Ligneous clay*: Wensleydale (G.S.V. 50083).

PROTEACIDITES RETICULATUS n. spm.

Plate 1, Fig. 24

Grain.—Triangular, sub-isopolar, plano-convex, sides usually deeply concave; size medium, average 27 x 41 μ oblate.

Exine.—Thin, 2.3 μ, tapering towards the apertures.

Sexine.—In the form of a delicate, wide-meshed reticulum which becomes very fine near the apertures; the lumina are wider and the muri thicker in the concave hemisphere; the muri are composed of pilate elements which sometimes appear to form a minute mural reticulum.

Affinity.—The affinity of this sporomorph is obscure.

Distribution.—*Brown coal*: Moorlands.

PROTEACIDITES INCURVATUS n. spm.

Plate 2, Figs. 25, 26

Grain.—Large, triangular, with more or less deeply concave sides; range in equatorial diameter from 44 to 80 μ; apertures from 14 to 20 μ, slightly concave.

Exine.—Thick, 3.5-5 μ, tapering and curving in towards the apertures.

Sexine.—About as wide as the nexine, baculate, somewhat reticuloid at high focus, pilate groups becoming smaller towards the apertures.

Affinity.—Although the general morphology of this sporomorph points distinctly towards the Proteaceae, it is not definitely comparable with pollens of any living species. The clearly marked tapering and incurving of the exine towards the apertures distinguishes *P. incurvatus* from the simpler pollen grains of *Hakea* and *Grevillea.* The examples from Wensleydale and Pidinga (Plate 2, Fig. 26) are somewhat smaller and the pilate groups of the sexine coarser than in the grains from Moorlands.

Distribution.—*Brown coal*: Moorlands, South Australia; Pidinga, South Australia, bore at 35 ft. 6 in. to 41 ft. 6 in.

Ligneous clay: Wensleydale (G.S.V. No. 50083).

PROTEACIDITES RECTOMARGINIS n. spm.

Plate 2, Fig. 27

Grain.—Large, triangular, sides straight; equatorial diameter 64 μ, range 50-80 μ; apertures slightly concave, about 14 μ.

Exine.—3.5 μ, of even width throughout.

Sexine.—About the same width as the nexine; baculate, pilate groups approximately the same size throughout. Sometimes the smooth nexinous surface is exposed by the partial or complete destruction of the sexine.

Affinity.—In general morphology this sporomorph resembles pollen grains of *Petrophila media* and *Petrophila ericifolia.* In both these species the grains are large, triangular, with straight sides, and slightly concave apertures. There appears to be a divergence, however, when the sexinous patterns are compared. The question of the affinity of *P. rectomarginis* must therefore remain open.

Distribution.—Ligneous clay: Lucifer Mine, Bacchus Marsh, Victoria.

Proteacidites callosus n. spm.

Plate 3, Fig. 28

Grain.—Triangular with straight sides; average equatorial diameter 41 μ, range 35-48 μ.

Exine.—2.5 μ thick, ectonexine thickened at the apertures.

Sexine.—Slightly thicker than the nexine, baculate, reticulate, mesh fine, irregular, muri thick.

Distribution.—Brown coal: Moorlands.

Proteacidites parvus n. spm.

Plate 3, Fig. 29

Grain.—Triangular, sides straight; equatorial diameter about 35 μ; apertures slightly concave.

Exine.—1.8 μ, of even thickness throughout.

Sexine.—Slightly thicker than nexine; finely baculate.

Distribution.—Mudstone: Vegetable Creek.

Proteacidites obscurus n. spm.

Plate 3, Figs. 30, 31

Grain.—Triangular, sides straight to concave; average equatorial diameter 38 μ, range 35-43 μ.

Exine.—4 μ thick, ectonexine prominent, slightly thickened towards the apertures where it appears lancet-shaped in optical section (Plate 3, Fig. 30).

Sexine.—Delicate, thinner than nexine; widely baculate and somewhat reticuloid except near the apertures where it is thicker and more homogeneous. Frequently the sexine covering the general body of the grain is only partially (Plate 3, Fig. 31) or not at all preserved.

Affinity.—Obscure. It may represent the pollen of an extinct proteaceous plant but is unlike that of any of the living species.

Distribution.—Brown coal: Moorlands; Yallourn, 32 ft. from top of coal.
Mudstone: Balcombe Bay.

Triorites magnificus n. spm.

Plate 3, Figs. 32-35

This pollen grain in its triangular, triaperturate form superficially resembles pollen of the Proteaceae, but when its general morphology and sclerine stratification are examined unusual features become evident. For the present it seems advisable to regard it as having belonged to an extinct plant of uncertain affinities and to refer it to the sporotype *Triorites*. It is described here partly because of its interest from a pollen morphological point of view and partly for its possible usefulness as a zone fossil.

Grain.—Large, 55 x 71 μ, oblate, the equatorial diameter ranging from 53 to 88 μ; triangular, with straight to slightly concave sides.

Exine.—Thick, 9-10.5 μ, composed of four clearly defined layers. Of these the two inner are nexinous (ecto and endonexine) with an approximate width of 2.5 μ and the two outer are sculptinous (sexine and ?perine). The inner layer of the sculptine is broad, about 4.5 μ, and has a pitted or somewhat spongy consistency. The outer layer of the sculptine, which is about 2.5 μ thick, is highly refractive and does not take the stain (basic fuchsin) like the rest of the exine. It is baculate and in surface view appears reticuloid (Plate 3, Fig. 33). In some specimens it is partially or completely destroyed, thus exposing the "spongy" layer (Plate 3, Fig. 35).

Another unusual feature of this sporomorph is the position of the true apertures. These appear to be situated at the bases of cavities formed by forward annular extensions of the exine. Moreover, the sculptinous layers turn in to line these extra-apertural cavities, thereby completely enveloping the distal extensions of the ectonexine.

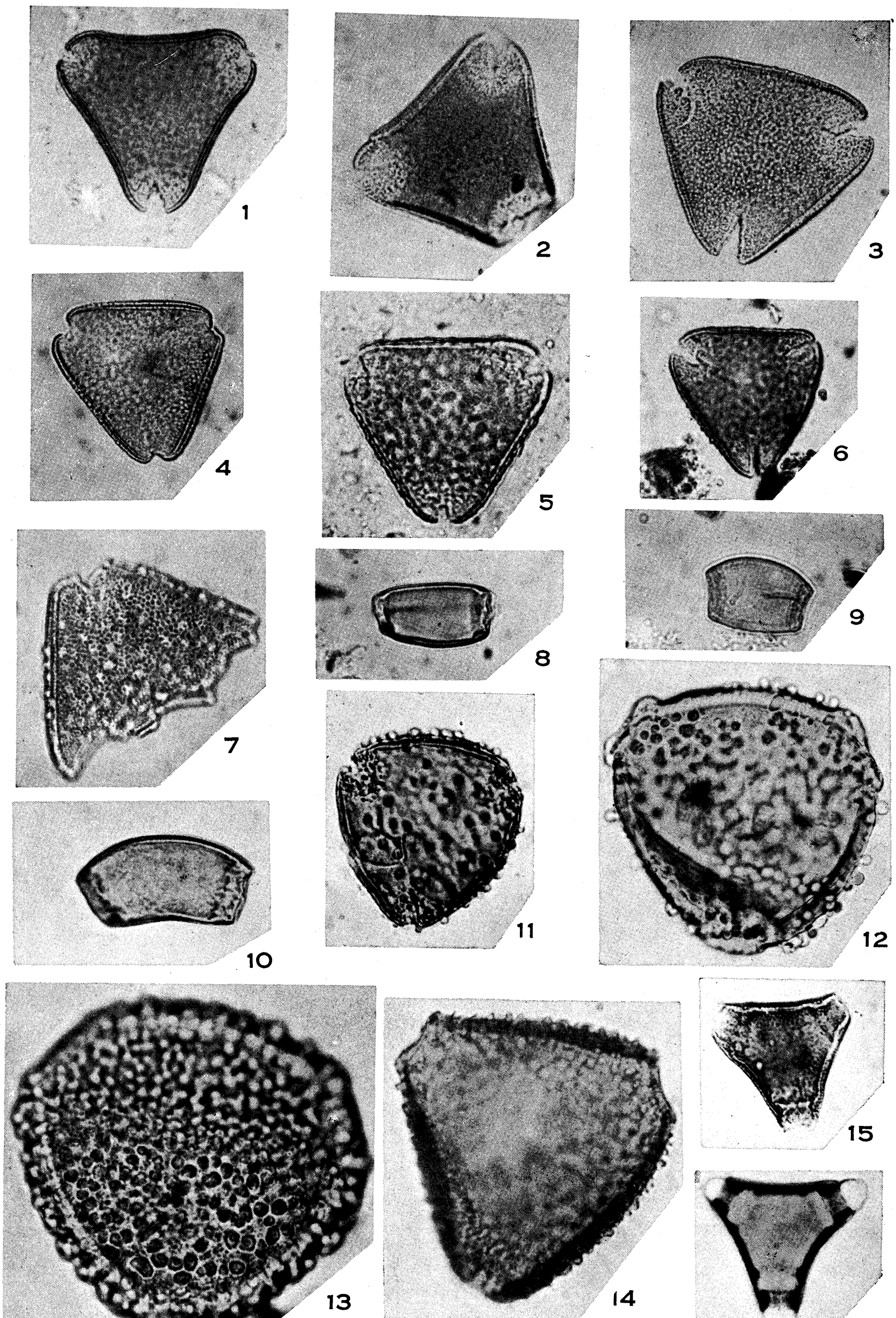
Distribution.—Brown coal: Moorlands.

III. Acknowledgments

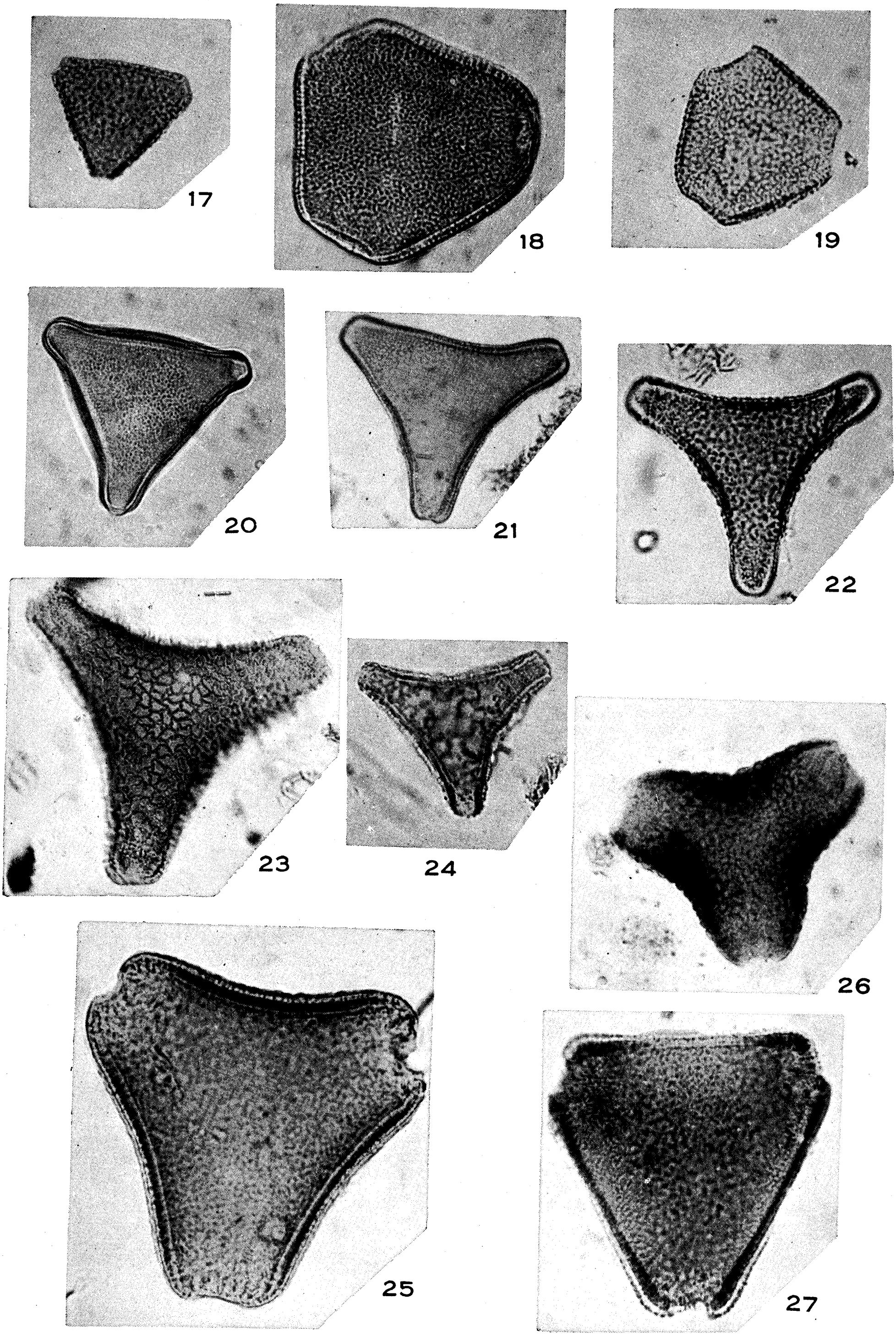
The present study was mainly carried out at the Palynological Laboratory at Stockholm and the author wishes to express thanks to Dr. Erdtman for his kind hospitality and help during its progress. The photographs, which are the work of Mr. K. E. Samuelsson of the Palaeobotanical Department, Swedish Museum of Natural History, were made available through the courtesy of Professor T. G. Halle and it is a pleasure to thank him for the facilities afforded. This work was made possible by considerable financial assistance from the Commonwealth Scientific and Industrial Research Organization.

IV. References

Bentham, G. (1873).—*J. Linn. Soc.* (*Bot.*) **13**: 58.
Brough, P. (1933).—*Proc. Linn. Soc. N.S.W.* **58**: 33.
Carey, G. (1941).—"Botany by Observation." (Angus and Robertson: Sydney).
Carroll, G. (1943).—*Amer. J. Bot.* **30**: 361.
Cookson, I. C. (1946).—*Proc. Linn. Soc. N.S.W.* **71**: 49.
Cookson, I. C. (1947).—*Brit., Aust., N.Z. Antarctic Res. Exped. Rep.* Ser. A. **2**: 127.
Erdtman, G. (1947).—*Svensk Bot. Tidskr.* **41**: 104.
Erdtman, G. (1948).—Geol. Fören Förhandl. Stockholm, **70**: 265.
Müller, H. (1883).—"The Fertilization of Flowers." (Macmillan and Co.: London.)
Phillips, M. E. (1941).—*Med. J. Aust.* **2**: 189.
Pike, K. (1948).—*Min. Rev., Adelaide* No. 88, p. 271.
Ross, Nils-Erik (1949).—*Bull. Geol. Instn. Univ. Upsala* **34**: **125**.



COOKSON.— FOSSIL POLLEN GRAINS OF PROTEACEOUS TYPE FROM TERTIARY DEPOSITS IN AUSTRALIA



Cookson.—Fossil Pollen Grains of Proteaceous Type from Tertiary Deposits in Australia

Explanation of Plates 1-3

All the figures are from untouched negatives; the pollen grains are magnified 500 diameters.

Plate 1

Fig. 1.—Pollen grain of *Beauprea elegans,* New Caledonia.
Fig. 2.—*Beaupreaidites elegansiformis* n. spm., Bacchus Marsh, Victoria.
Fig. 3.—*Beaupreaidites elegansiformis* n. spm., Yallourn, Victoria, 32 ft. below top of coal.
Fig. 4.—*Beaupreaidites elegansiformis* n. spm., Moorlands, South Australia.
Fig. 5.—Pollen grain of *Beauprea spathulaefolia,* New Caledonia.
Fig. 6.—*Beaupreaidites verrucosus* n. spm., Wensleydale, Victoria.
Fig. 7.—*Beaupreaidites verrucosus* n. spm. Fragment of a large grain to show roughened surface of sexinous reticulum.
Figs. 8 and 9.—*Banksieaeidites minimus* n. spm., Yallourn North, Victoria.
Fig. 10.—*Banksieaeidites elongatus* n. spm., Yallourn North, Victoria.
Fig. 11.—Pollen grain of *Beauprea balansae,* New Caledonia.
Fig. 12.—*Proteacidites tuberculatus* n. spm. Grain in optical section showing (on the left-hand side) thick ectonexine, thin sexine and ?perinous tubercles. Yallourn, Victoria.
Fig. 13.—*Proteacidites tuberculatus* n. spm. A large example focused to show tubercles and baculae of sexine. Yallourn, Victoria.
Fig. 14.—*Proteacidites tuberculatus* n. spm., Lucifer Mine, Bacchus Marsh.
Fig. 15.—*Proteacidites annularis* n. spm., Moorlands, South Australia.
Fig. 16.—Pollen grain of *Xylomelum occidentale,* Western Australia.

Plate 2

Fig. 17.—*Proteacidites symphyonemoides* n. spm., Yallourn, Victoria.
Fig. 18.—Pollen grain of *Isopogon anemonifolius,* New South Wales.
Fig. 19.—*Proteacidites truncatus* n. spm., Yallourn, Victoria.
Fig. 20.—Pollen grain of *Adenanthos barbigera,* Western Australia.
Fig. 21.—*Proteacidites adenanthoides* n. spm., Wensleydale, Victoria.
Fig. 22.—*Proteacidites crassus* n. spm., Moorlands, South Australia.
Fig. 23.—*Proteacidites grandis* n. spm., Wensleydale, Victoria.
Fig. 24.—*Proteacidites reticulatus* n. spm., Moorlands, South Australia.
Fig. 25.—*Proteacidites incurvatus* n. spm., Moorlands, South Australia.
Fig. 26.—*Proteacidites incurvatus* n. spm., Pidinga, South Australia.
Fig. 27.—*Proteacidites rectomarginis* n. spm., Bacchus Marsh, Victoria.

Plate 3

Fig. 28.—*Proteacidites callosus* n. spm., Moorlands, South Australia.
Fig. 29.—*Proteacidites parvus* n. spm., Vegetable Creek, New South Wales.
Fig. 30.—*Proteacidites obscurus* n. spm., Moorlands, South Australia.
Fig. 31.—*Proteacidites obscurus* n. spm. A grain with sexine preserved only around the apertures. Moorlands, South Australia.
Figs. 32-34—*Triorites magnificus* n. spm. A grain focused at three different levels. Moorlands, South Australia.
Fig. 35.—*Triorites magnificus* n. spm. A grain from which the outer layer of sculptine has almost entirely disappeared. The complete thickness of the exine can be seen on the left-hand side near the upper aperture.