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STUDIES ON THE MORPHOLOGY OF POLLEN GRAINS OF THE LEGUMINOSAE - THE MIMOSOIDEAE

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Summary

The morphology of pollen grains of 23 species of the Mimosoideae in Ghana as seen under the light microscope is described. Six of the species had solitary grains (monads) while the remaining 17 species had compound grains (polyads) with 4, 8, 16, 20, 24, 28 or 32 grains, depending on the species. Features such as differences in pollen grain size, arrangement of individual grains in the polyads, apertural conditions, wall thickness and wall sculpturing varied sufficiently for most of the species to be recognized by their pollen morphology.

Introduction

No research on pollen has been reported in Ghana despite the importance of pollen characters in plant taxonomic and phylogenetic studies. There are some records of relevant studies in other West African countries. For example, before 1973, there existed only short descriptions of pollen grains of Nigerian species scattered over several journals (Thanikaimoni, 1972). A major work was published almost 20 years ago by Sowunmi (1973) on pollen grains of 150 woody plants of Nigeria belonging to 47 families. Studies in other countries in the West African sub-region will complement the work in progress on the Nigerian flora.

Experimental

Plant species

Pollen samples were taken from 23 plant species, consisting of both fresh and herbarium specimens. The fresh specimens consisted of *Acacia angustissima* (Mill.) Kuntze, *A. nilotica* var. *adansonii* (Guill. & Ferr.) Kuntze, *A. nilotica* var. tomentosa (Benth.) A.F. Hill, *Albizia lebbeck* (Linn.) Benth., *Calliandra surinamensis* Benth., *Dichrostachys cinerea* (Linn.) Wight & Arn., *Enterolobium cyclocarpum* (Jacq.) Griseb., *Leucaena leucocephala* (Lam) de Wit, *Mimosa pudica* Linn., *Pithecellobium dulce* (Roxb.) Benth., *Samanea saman* (Jacq.) Merrill, *Schrankia leptocarpa* DC. and *Tetrapleura tetraptera* (Schum. & Thonn.) Taub. Voucher specimens of the fresh materials have been placed in the Ghana Herbarium, Department of Botany, University of Ghana, Legon.

Pollen grains of *Acacia karroo* Hayne, *A. polyacantha* Willd. subsp. *polyacantha* (Hochst *ex* A. Rich.) Brenan , *Albizia zygia* (DC.) J.F. Macbr., *Aubrevillea kerstingii* (Harms) Pellegr., *Calliandra portericensis* (Jacq.) Benth., *Calpocalyx brevibracteatus* Harms, *Neptunia oleracea* Lour., *Prosopis africana* (Guill. & Perr.) Taub. and *Xylia evansii* Hutch. were obtained from herbarium specimens of the Ghana Herbarium.

Treatment of pollen grains

Studies were based on both acetolysed and non-acetolysed materials. Acetolysis was according to Erdtman (1952). The acetolysed material was chlorinated (Erdtman, 1952), mounted in glycerine jelly and the slides sealed with nail varnish. Fresh grains (non-acetolysed) were mounted in aceto-carmine glycerol jelly (Mark, 1954). Pollen measurements were made under × 40 and × 100 objective lenses using a calibrated graticule. Measurements of pollen grains and polyad size, pore size and wall thickness were based on 40 grains selected randomly

from five slides from each species. Pollen terminology is after Erdtman (1969).

Results and discussion

The pollen grains of the 23 species showed a wide range of forms: monads (single grains) and polyads (compound grains) of 4, 8, 12, 16, 20, 24, 25 and 32 grains. While the individual grains of the polyads in some species were easily separable, those of other species adhered so firmly that they were not separated by acetolysis. In the case of the latter, accurate measurements could only be made on the entire polyads.

Acacia angustissina *(Mill.) Kuntze (Fig. 1c). Fresh material, University Research Station, Legon, Accra*

Pollen shed in octads, circular to ovoid in shape; mean widest diameter 25.92 ± 2.05 μm (range 22.4 - 28.8 μm). Grains in a regular arrangement of 4 and 4 in two planes. One directly above the other. Grains failed to separate and, therefore, measurements could not be taken on individual grains.

Exine thin, about 2.0 μm; sexine and nexine of equal thickness; sexine psilate. Furrows and pores were not discernible in this material.

Acacia karroo *Hayne. Herbarium material. Ghana Herbarium, Legon, Accra. O. Volr. 648*

Compound grains (polyads), circular to ovoid in shape, mean widest diameter 45.06 ± 2.43 μm (range 41.6 - 48.0 μm); composed of 16 grains in a regular arrangement: 8 grains in the centre, forming a sort of cubical block of 4 and 4 in two synchronized planes; surrounded by eight peripheral grains lying along the dividing plane of the two tiers of central group.

Individual grains triangular or polygonal in shape; mean widest diameter 19.02 ± 1.34 μm (range 16.0 - 220.8 μm); 3-colporate; syncolpate; furrows deep. Exine 3.0 - 3.5 μm on distal side; proximal side thinner; sexine and nexine of equal thickness; sexine psilate.

Acacia nilotica *var.* adansonii, *(Guill. & Perr.). Kuntze. Fresh material. Zoti, Accra*

Compound grains, circular to ovoid in shape; mean widest diameter 50.88 ± 3.18 μm (range 48.0 57.6 μm); composed of 16 grains in a regular arrangement as described for *A. karroo.* Grains failed to separate and, therefore, measurements for individual grains could not be taken. Grains, however, appeared 3-colporate (syncolpate); furrows deep. Exine about 2.0 μm thick, sexine and nexine of equal thickness; sexine psilate.

Acacia nilotica var. *tomentosa* (Benth.) A.F. Hill (Fig. 1a). Fresh material. Legon, Accra.

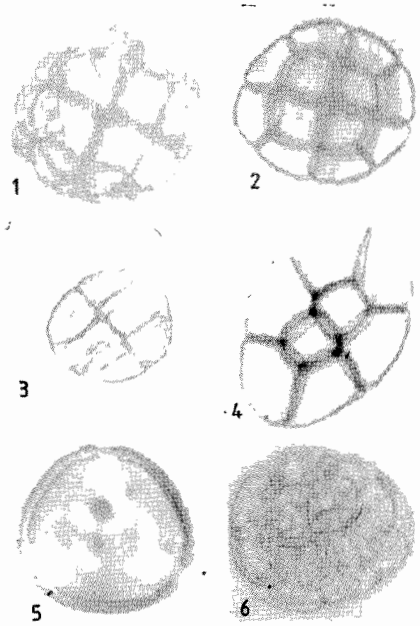

Fig. 1. Photomicrographs showing the nature of pollen in some species of the Mimosoideae: a. *Acacia nilotica* var. *tomentosa* (×1250); b. *Albizia lebbeck* (×700); c. *Acacia angustissima* ×1200); d. *Calliandra surinamensis* (×500); e. *Leucaena leucocephala* (×1150); f. *Tetrapleura tetraptera* (×1150).

Compound grains, circular in shape; mean diameter 53.6 ± 2.8 μm (range 51.2 - 57.8 μm); composed of 16 grains in a regular arrangement as described for *A. karroo*. Individual grains squarish to rectangular in shape; mean widest diameter 20.20 ± 3.30 μm (range 16.0 - 25.6 μm); 3-colporate; syncolpate; furrows deep and conspicuous. Exine thick, about 4.0 μm; sexine thicker than nexine granular.

Acacia polyacantha *Willd. subsp.* campylacantha *(Hochst. ex A. Rich.) Brenan. Herbarium material. Ghana Herbarium, Legon, Accra. J. K. Morton A2060*

Compound grains, circular in shape; mean diameter 44.45 ± 1.92 μm (range 41.6 - 48.0 μm); composed of 16 grains in a regular arrangement as described for *A. karroo*. Individual grains circular, squarish or rectangular in shape; mean widest diameter 18.56 ± 2.02 μm (range 16.0 - 22.4 μm). Exine about 2.0 μm thick; sexine and nexine of equal thickness, sexine psilate. No apertures were observed in this material.

Albizia lebbeck *(Linn.) Benth. (Fig. 1b). Fresh material. Legon, Accra*

Compound grains, circular to ovoid in shape, mean widest diameter 85.12 ± 2.66 μm (range 83.2 - 89.6 μm); composed of 16 grains in regular arrangement as described for *A. karroo*. Individual grains ovoid to squarish in shape; mean widest diameter 27.36 ± 2.84 μm (range 22.4 - 32.0 μm).

Exine generally thin; that of exposed parts slightly thicker (about 1.5 - 2.0 μm); sexine slightly thicker than nexine; sexine finely granular. Furrows and pores were not discernible in this species.

Albizia zygia *(DC.) J.F. Macbr. Herbarium material. Ghana Herbarium, Legon, Accra. Morton & Gledhill GC52228*

Compound grains, circular to ovoid in shape; mean widest diameter 75.05 ± 6.13 μm (range 70.4 - 86.4 μm), composed of 16 grains in a regular arrangement as described for *A. karroo*. Individual grains circular, squarish or rectangular in shape; mean widest diameter 24.0 ± 2.16 μm (range 19.2 - 26.6 μm); 4- to 6-porate; pores circular, covered by granular membranes.

Exine of exposed walls about 2.0 μm thick, that of inner walls thinner; sexine slightly thicker than nexine; sexine reticulate.

Aubrevillea kerstingii *(Harms) Pellegr. Herbarium material. Ghana Herbarium, Legon, Accra. A.A. Enti FH 1271.*

Solitary grains (monads), isopolar, radially symmetrical; prolate (P Polar axis) 40.64 ± 2.6 μm; E (Equitorial axis) 30.08 ± 1.65 μm); amb circular to triangular; 3-colporate; sometimes syncolpate. Colpi narrow with well defined margins; ora elongated longitudinally. Exine about 2.0 μm; sexine appears to be thicker than nexine; sexine granular.

The observations made in this study agree generally with those of Sowunmi (1973).

Calliandra portoricensis *(Jacq.) Benth. Herbarium material. Ghana Herbarium, Legon, Accra. Hossain and Agyakwa GC35516*

Compound grains, circular in shape, mean diameter 107.36 ± 5.44 μm (range 99.2 - 115.3 μm); composed of 16 grains in a regular arrangement as described for *A. karroo*. Individual grains circular, squarish or rectangular in shape; mean widest diameter 37.92 ± 2.99 μm (range 35.2 - 44.8 μm).

Exine about 3.2 μm thick on distal side, proximal side thinner; sexine and nexine of equal thickness; sexine psilate. Apertures were not discernible in this material.

Calliandra surinamensis *Benth. (Fig. 1d). Fresh material. Legon, Accra*

Pollen shed in club-shaped octads, mean widest diameter 166.4 ± 6.56 μm (range 156.0 - 176.0 μm),

grains in a regular arrangement: 2 grains in the centre, surrounded by 6 peripheral grains. Octads provided with a stalk with a basal disc which probably attaches to insect pollinators. Grains failed to separate and, therefore, measurements could not be taken on individual grains.

Exine thin, about 1.5 - 2.0 μm thick, interrupted by circular pores; sexine and nexine of equal thickness; sexine granular.

The stalk with basal disc of *C. surinamensis* is probably similar to that of *Inga anomala* described by Mohl (1835). Woodhouse (1935) suggested that the octad with stalk and disc is the highest development attained among the compound grains of dicotyledons.

Calpocalyx brevibracteatus *Harms. Herbarium material. Ghana Herbarium, Legon, Accra. Itarold E. Box 3306*

Pollen grains united in octads; circular or ovoid in shape; mean widest diameter 38.40 ± 2.61 μm (range 35.2 - 41.6 μm); pollen grains arrangement irregular; sometimes 5 and 3 or 4 and 4 in two synchronized planes. Individual grains ovoid to squarish in shape; mean widest diameter 17.37 ± 1.71 μm (range 16.0 - 19.2 μm); 3- to 4-porate. Exine thin, about 1.5 - 2.0 μm thick; sexine and nexine of equal thickness; sexine finely reticulate.

Dichrostachys cinerea *(Linn.) Wight & Arn. Fresh material. Legon, Accra*

Only solitary grains were observed, agreeing with the reports of Erdtman (1952) and Sowunmi (1973). Grains isopolar to sub-isopolar; radially symmetrical; amb circular to triangular, equatorial view variously shaped; varying sizes ranging from 28.8 to 38.4 μm; mean widest diameter 32.48 ± 3.1 μm. Exine thick, about 3.0 - 3.5 μm, with undulating or warty surface, 3-porate or 3-colporate; pore membranes granular, projecting beyond the surface of the grain.

Van Zinderren Bakker & Coetzee (1959) found polyads of 16 grains in *D. cinerea*, while Guinet (1969) found compound grains of varying numbers of 8, 12, 16 or more. Further studies on *D. cinerea* from different geographical areas may explain the different observations, which have so far been made on the species.

Entada abyssinica *Steud.* ex *A. Rich. Herbarium material. Ghana Herbarium, Legon, Accra. Hall & Enti GC42685*

Solitary grains isopolar, radially symmetrical; subprolate (P35.71 ± 2.72 μm; E29.12 ± 2.80 μm) or oblate spheroidal (P32.84 ± 2.26 μm; E36.43 ± 2.28 μm); amb circular to ovoid; 3-colporate; sometimes syncolpate. Colpi broad, tapering to acute ends; ora transversely elongated. Exine about 3.5 μm; sexine thicker than nexine; sexine granular.

Enterolobium cyclocarpum *(Jacq.) Griseb. Fresh material. Legon, Accra*

Compound grains, circular in shape; mean diameter 93.2 ± 5.53 μm (range 83.2 - 99.2 μm), composed of 28 grains in a regular arrangement; 16 grains in the centre arranged 8 and 8 in synchronized two planes, surrounded by 12 peripheral grains. Individual grains ovoid to squarish in shape; mean widest diameter 24.16 ± 1.63 μm (range 22.4 - 25.6 μm); 3- to 4-porate; pore areas covered by granular membranes.

Exine thin, about 1.5 - 2.0 μm; sexine and nexine of equal thickness; sexine psilate. Compound grains break up easily and most grains become distorted after acetolysis.

Erdtman (1952) reported that *E. cyclocarpum* had polyads; individual grains 21.0 μm with circular apertures about 4.0 μm, provided with granulate membranes.

Leucaena leucocephala *(Lam) de Wit (Fig. 1f). Fresh material. Legon, Accra*

Solitary grains, isopolar, radially symmetrical; pro-

late spheroidal (P57.07 ± 4.28 μm; E49.87 ± 5.01 μm); amb circular to triangular; 3- to 4-colporate, sometimes 3- or 4-porate. Colpi broad, tapering towards the poles; boundaries not sharply defined; colpi membranes finely granular.

Exine about 3.5 μm thick, sexine thicker than nexine except at the pores where nexine is distinctly thicker (crassinexinous); sexine coarsely granular. Ora circular in shape. The observations recorded here generally agree with the short description provided by Erdtman (1952) for the species.

Mimosa pudica *Linn. Fresh material. Legon, Accra*

Pollen shed in tetrahedral tetrads; tetrad very small in size; widest diameter about 9.6 μm (range 9.2 - 9.7 μm) with firmly attached grains. Exine thin, sexine psilate. No furrows or pores were discernible.

Neptunia oleracea *Lour. Herbarium material. Ghana Herbarium, Legon, Accra. Akpabla 1977*

Solitary grains, isopolar, radially symmetrical; prolate spheroidal (P56.67 ± 2.6 μm; E58.34 ± 4.16 μm); amb circular to triangular, 3-colporate; sometimes syncolpate. Colpi broad, tapering to acute ends. Exine about 3.5 μm; sexine thicker than nexine; sexine granular.

Erdtman (1952) described the pollen of *Neptunia floridana* as being 3-colporate; longest diameter 47.0 μm; sexine and nexine of equal thickness.

Pithecellobium dulce *(Roxb.) Benth. Fresh material. Legon, Accra*

Compound grains, circular in outline, mean diameter 88.90 ± 4.03 μm (range 83.2 - 92.8 μm); composed of 16 grains in a regular arrangement as described for *A. karroo*. Grains separate easily after acetolysis and most of them become distorted.

Individual grains ovoid, circular or squarish in shape; a few triangular or wedge-shaped forms; mean widest diameter 30.72 ± 3.18 μm (range 22.4 - 35.2 μm); 3- to 6-porate; pore membranes granular. Exine thin, about 2.0 μm, exposed parts slightly thicker; sexine finely granular.

Prosopis africana *(Guill. & Perr.) Taub. Herbarium material. Ghana Herbarium, Legon. Accra. Goodall GC15304*

Solitary grains, isopolar, radially symmetrical; prolate (P34.24 ± 1.54 μm; E27.20 ± 3.10 μm); amb circular to triangular; 3-colporate, sometimes syncolpate. Colpi narrow with distinct margins; somewhat constricted at the equator; ora faintly demarcated and elongated longitudinally. Exine about 3.5 μm; sexine slightly thicker than nexine sexine finely granular.

Observations made in this study agree largely with those of Woodhouse (1935) and Erdtman (1952) for *P. glandulosa* except that the 2-colporate grains observed by Erdtman were not seen in this material.

Samanea saman *(Jacq.) Merrill. Fresh material. Legon, Accra*

Compound grains; circular to ovoid in shape; mean widest diameter 119.04 ± 3.30 μm (range 115.2 - 121.6 μm); composed of 24, 28 or 32 grains in regular or irregular arrangement. Individual grains ovoid, squarish or polygonal in shape; mean widest diameter 25.92 ± 2.05 μm (range 22.4 - 28.8 μm); 3- to 5-porate, pore membrane granular. Exine thin, about 2.0 μm; exposed parts and corners of angular grains slightly thicker; sexine and nexine of equal thickness; sexine granular.

Schrankia leptocarpa *DC. Fresh material. Achimota, Accra*

Pollen grains shed in tetragonal tetrads; mean widest diameter 34.40 ± 2.04 μm (range 32.9 - 38.4 μm). Tetrads could not be separated and, therefore, measurements on individual grains could not be taken. Exine thin, about 2.0 μm; sexine appears thicker than nexine; sexine granular. Apertures were not discernible.

Tetrapleura tetraptera *(Schum. & Thonn.) Taub. (Fig. 1f). Fresh material. Legon, Accra*

Compound grains, ovoid or circular in shape; mean widest diameter 46.66 ± 2.97 μm (range 41.6 - 51.2 μm); composed of 16, 20 or 24 grains; arranged irregularly and asymmetrically. Individual grains circular, ovoid or squarish in shape; mean widest diameter 18.24 ± 1.55 μm (range 16.0 - 19.2 μm); 3- or 4- porate; pores circular. Exine thin, about 2.0 μm; sexine and nexine of equal thickness; sexine psilate.

Observations made in this study agree essentially with those of Sowunmi (1973).

Xylia evansil *Hutch. Herbarium material. Ghana Herbarium, Legon, Accra. J.B. Hall GC46991*

Compound grains; circular to ovoid in shape; mean widest diameter 51.84 ± 2.52 μm (range 48.0 - 54.4 μm); composed of 12 grains arranged irregularly and asymmetrically. Individual grains circular, ovoid or squarish in shape; mean widest diameter 19.20 ± 2.61 μm (range 16.0 - 22.4 μm). Exine thin; about 2.0 μm; sexine and nexine of equal thickness; sexine finely granular. No apertures were discernible in this material.

Conclusion

The species investigated here illustrate the pollen morphological variation in the Mimosoideae. The greatest variation occurs in pollen unit types which ranged from monads to polyads of 32 grains.

Interspecific variation in the number and arrangement of individual grains in the polyads was observed in *Calliandra* and *Acacia*. In *Calliandra*, spherical polyads of 16 grains were observed in *C. portoricensis* whereas in C. *surinamensis*, the grains were arranged in club-shaped octads. Similarly, spherical polyads of 16 grains were observed in *Acacia karroo*; *A. nilotica* var. *adansoni*, *A. nilotica var. tomentosa and A. polyacantha* subsp.*campylacantha*. The pollen *A. angustissima*, on the other hand, occur in spherical octads. The findings underscore the taxonomic importance of pollen morphological variation.

The pollen morphological survey of the Mimosoideae by Sorea (1969) in which 202 species representing 50 genera were studied is a major contribution to the systematic and evolutionary arrangement in the subfamily. The pollen grains were classified into five groups on the basis of established palynological trends and these in turn into 25 pollen types. He regarded the five pollen groups as five different evolutionary branches. He concluded that the evolutionary trend in pollen grains has been from colpate types through colporate to porate types; from relatively thin and simple exine to thicker exines with distinctly differentiated layers and sculpturing; from small-sized grains to larger ones; and from monads through tetrads to polyads with increasing number of grains.

By this classification, all the five groups were represented by species studied in this work. The genera *Aubrevillea, Entada, Leucaena, Neptunia* and *Prosopis* fall in Group 1, characterized by solitary, corporate grains with granular exine. Group 2 is made up of some species of only one genus - *Calliandra* - which produces club-shaped octads. The group is represented by *C. surinamensis*. Group 3 is made up of both monads and polyads; the monads of this group are supposed to be more advanced than those of Group 1. They have thicker and more elaborately sculptured exine and are porate. The member studied was *Dichrostacys cinerea*. Grains of Groups 4 and 5 are polyads. Members of Group 4 generally have small-sized polyads as exemplified by the genera *Calpocalyx, Mimosa, Schrankia* and *Xylia*. Group 5, characterized by larger polyads, was represented by the genera *Acacia, Albizia, Calliandra* (16-celled), *Pithecellobium* and *Samanea*.

A certain degree of intraspecific variation in pollen morphology was noted in some cases. This in-

volved polyad types, shapes and sizes e.g. *Samanea saman* and *Tetrapleura tetraptera*, as well as shape and apertural condition of individual grains as in *Dichrostachys cinerea*. Such intraspecific variation was also noted by Sowunmi (1973). This observation supports the remark by Guinet (1962) based on his study of the pollen of tropical plants in Asia that such variability seems widespread in the tropics. It is, therefore, important that in pollen studies, attention is paid to probable intraspecific variation so that variants of one species are not inadvertently assigned to two or more different species.

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