Atlas of the tropical West African pollen flora

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Abstract

The accurate and consistent identification of fossil pollen is essential to allow robust inferences to be drawn with regard to past climate and vegetation change. Identifications are best achieved through the direct inspection of reference material. Most substantial reference collections are held at prestigious university’s in Europe or the United States of America which can restrict access for researchers trying to advance palynology in less developed countries. Digital imaging and fast spreading access to the internet means that it is now possible to produce and disseminate high quality images from pollen reference collections. In this paper we contribute to this growing body of work by presenting images of 364 pollen/spore taxa from West Tropical Africa both as printed plates with a key, and within an associated online searchable database.

Highlights

- 129 plates of 364 pollen/spore taxa
- Coverage of most pollen taxa identified in tropical West African fossil pollen records
- Comprehensive key to pollen identification

Keywords (x6): Africa, identification, key, images, pollen, tropical
1. Introduction

The accurate identification of fossil pollen and spores underpins our ability to reconstruct past vegetation and subsequently infer variation in the Earth’s system. Palaeo-palynology can provide, among other things, evidence for past changes in climate (e.g. Davis and Shaw, 2001; Overpeck et al., 1990), biome (e.g. Jolly et al., 1998; Tarasov et al., 1998; Williams et al., 2004) and biodiversity (e.g. Brown, 1999; Odgaard, 1999; Rull, 1987) across the geological record. At one extreme the incredible resilience of pollen/spore chemistry (sporopollenin) allows palynology to provide evidence for the evolution of plants on timescales of millions of years (e.g. Crane et al., 1995; Wikström et al., 2001). Whilst at the other, the influence of human activity upon plants allows the actions of people within the landscape to be traced in the recent past (10-100’s years ago) (e.g. Brugam, 1978; Piperno and Flannery, 2001). The integrity of the information supplied by palynologists to all these areas is reliant on consistent typing or, where possible, identification of the specimens found in the fossil record.

Since its inception morphological identification of pollen grains has been standard practice through comparison with modern material (von Post, 1916, reprinted 1967). Subsequently numerous atlases for pollen and spore identification have been produced from across the globe, including: Beug, 2004; Colinaux et al., 1999; Faegri and Iversen, 1989; Moore et al., 1991; Reille, 1999; Roubik and Moreno, 1991. The proliferation of pollen/spore atlases has facilitated the expansion of the field of palynology and helped with international standardization of identifications. In addition, as computing power has developed, there has been an increase in the number, and sophistication, of online searchable pollen databases (e.g. Bush and Weng, 2007; Lezine, 2005; QPG, 2008). However, geographical coverage and access to images for pollen identification remains patchy.
The most substantial atlases for African pollen and spore identification are: (i) in print (Reille, 1998, 1999), and (ii) online the African pollen database (Lezine, 2005). Both contain thousands of images of species within hundreds of families, and therefore provide good general coverage of taxa likely to be found in the fossil record. In addition, pollen/spore atlases for specific regions have also been produced, e.g. East Africa (Riollet and Bonnefille, 1976), as well as for individual countries: (i) Chad (Maley, 1970), (ii) Ethiopia (Bonnefille, 1971a, b), (iii) Ivory Coast (Ybert, 1979), (iv) Nigeria (Sowunmi, 1973), (v) South Africa (Scott, 1982; van Zinderen Bakker, 1953, 1956; van Zinderen Bakker and Coetzee, 1959), and (vi) Sudan (El Ghazali, 1993). In this paper we contribute to this body of knowledge by presenting c. 3000 images and identification keys for >450 pollen and spore taxa commonly found in tropical West Africa.

2. Materials and methods

2.1 Selection of pollen and spore taxa

Taxa were selected for inclusion within this tropical West African pollen atlas based upon two criteria: (i) they had been previously identified within fossil records obtained from terrestrial and marine settings within the region (Dupont et al., 2000; Elenga et al., 1994; Frédoux, 1994; Leroy and Dupont, 1994; Lezine and Vergnaud-Grazzini, 1993; Maley and Livingstone, 1983; Talbot et al., 1984), and/or (ii) they had been identified as significant in the regional flora (Hall and Swaine, 1981).

2.2 Organisation and presentation of images

Images are presented on 129 plates showing both polar and equatorial views of the grain where it was possible to obtain images. Plates are organised by pollen morphology to allow
ease of reference when examining fossil pollen material; following (Beug, 2004). In addition, to facilitate interrogation of the images based on botanical classification the family, genera and species of the images are listed in Table 1 with reference to plate number. The paper is accompanied by a searchable online database which integrates the images presented here with the c. 6000 images of >1000 taxa from the Neotropical Pollen database (Bush and Weng, 2007). To access a Freeware version of the complete revised Tropical Pollen Database download and unpack the TopicalPollenDB2013.zip file from the supplementary online section of this paper. Please note due to the high number of pictures the file is large (2.77GB) and an Apple Macintosh computer running Mac OS X 10.6 or higher is required to run the software. We hope that the combination of our images with those of Bush and Weng (2007) within a freeware format online will promote further expansion by other research groups which will lead to the eventual development of a comprehensive pan-tropical searchable online pollen and spore identification tool.

2.3 Provenance of specimens and image capture

Images and descriptions of all pollen and spores were obtained from the reference collection of c. 30,000 specimens housed within the Department of Biology at Duke University which has been collected and curated by DAL. Reference material was sourced from herbaria and laboratories around the globe; full details for individual specimens can be found on the accompanying online database.

Images were obtained using QCapture software (v. 3.1.1) with a QImaging Micropublisher 3.3 RTV camera mounted on a Nikon Eclipse 50i microscope. All images were taken through a Nikon Plan Fluor 40x/0.75 DIC M/N2 objective.

3. Terminology
Terminology follows Punt et al. (2007).

4. Nomenclature

Taxonomic nomenclature follows conventions of Beug (2004).

5. Polyads

Plates I-III

Key

1. Comprising eight grains
   - Comprising twelve grains
   - Comprising more than twelve grains

2. Surface psilate (Plate I: 1-3)
   - Surface scabrate (Plate I: 4-6)  
     \textit{Calpocalyx brevibracteatus} \textit{Xylia evansii}

3. Polyad diameter less than 40µm
   - Polyad diameter greater than 40µm (Plate II: 1-3)  
     \textit{Acacia clavigera}

4. Surface scabrate (Plate I: 7-9)
   - Surface psilate (Plate I: 10-12)  
     \textit{Acacia seyal} \textit{Acacia eggelingii}

5. Polyad arrangement non-uniform
   - Polyad arrangement uniform (Plate III: 4-6)  
     \textit{Parkia velutina}

6. Polyad diameter less than 110µm (Plate II: 4-6)
   - Polyad diameter greater than 110µm (Plate III: 1-3)  
     \textit{Parkia inundabilis} \textit{Parkia bussei}

6. Tetrads

Plate IV

Key

1. Visible collumnae
   - Invisible collumnae (Plate IV: 1-4)  
     \textit{Erica arborea}

2. Surface verrucate (Plate IV: 5-7)
   - Surface scabrate (Plate IV: 8-9)  
     \textit{Mimosa strigillosa} \textit{Uvariopsis congensis}

7. Vesiculate
Plate V

*Podocarpus milanjianus* (Plate V: 1-6)
8. Inaperturate, including Polypodiaceae

Plates VI-XVI

Key

1. Surface reticulate
   - Surface echinate
   - Surface psilate
   - Surface reticulate
   - Surface foveolate (Plate VII: 4-7)
   - Surface verrucate
   - Surface gemmate (Plate VII: 1-3)
   - Surface perforate (Plate VI: 5-7)
   - Surface scabrate

2. Equatorial grain shape circular
   - Equatorial grain shape suboblate (Plate IX: 9-11)
   - Equatorial grain shape subprolate (Plate VIII: 10-13)
   - Equatorial grain shape rectangular (tall) (Plate IX: 1-8)

3. Equatorial grain diameter ~9-11µm (Plate X: 1-4)
   - Equatorial grain diameter ~12-18µm (Plate XI: 8-10)
   - Equatorial grain diameter ~27-33µm (Plate XI: 11-14)
   - Equatorial grain diameter ~40-55µm
   - Equatorial grain diameter ~63-77µm
   - Equatorial grain diameter ~70-90µm (Plate XII: 7-10)
   - Equatorial grain diameter ~90-110 (Plate XIII 1-2)

4. Wall thickness ~2µm (Plate XII: 1-3)
   - Wall thickness ~4µm (Plate XII: 4-6)

5. Wall thickness ~2µm (Plate XIII 5-7)
   - Wall thickness ~6µm (Plate XIII: 3-4)

6. Equatorial grain shape circular
   - Equatorial grain shape suboblate (Plate VII: 8-11)
   - Equatorial grain shape oblate (Plate VI: 1-4)
   - Equatorial grain shape subprolate (Plate VIII: 14-17)

7. Equatorial grain shape circular

8. Inaperturate, including Polypodiaceae

Plates VI-XVI

Key

1. Surface reticulate
   - Surface echinate
   - Surface psilate
   - Surface reticulate
   - Surface foveolate (Plate VII: 4-7)
   - Surface verrucate
   - Surface gemmate (Plate VII: 1-3)
   - Surface perforate (Plate VI: 5-7)
   - Surface scabrate

2. Equatorial grain shape circular
   - Equatorial grain shape suboblate (Plate IX: 9-11)
   - Equatorial grain shape subprolate (Plate VIII: 10-13)
   - Equatorial grain shape rectangular (tall) (Plate IX: 1-8)

3. Equatorial grain diameter ~9-11µm (Plate X: 1-4)
   - Equatorial grain diameter ~12-18µm (Plate XI: 8-10)
   - Equatorial grain diameter ~27-33µm (Plate XI: 11-14)
   - Equatorial grain diameter ~40-55µm
   - Equatorial grain diameter ~63-77µm
   - Equatorial grain diameter ~70-90µm (Plate XII: 7-10)
   - Equatorial grain diameter ~90-110 (Plate XIII 1-2)

4. Wall thickness ~2µm (Plate XII: 1-3)
   - Wall thickness ~4µm (Plate XII: 4-6)

5. Wall thickness ~2µm (Plate XIII 5-7)
   - Wall thickness ~6µm (Plate XIII: 3-4)

6. Equatorial grain shape circular
   - Equatorial grain shape suboblate (Plate VII: 8-11)
   - Equatorial grain shape oblate (Plate VI: 1-4)
   - Equatorial grain shape subprolate (Plate VIII: 14-17)

7. Equatorial grain shape circular

8. Inaperturate, including Polypodiaceae

Plates VI-XVI

Key

1. Surface reticulate
   - Surface echinate
   - Surface psilate
   - Surface reticulate
   - Surface foveolate (Plate VII: 4-7)
   - Surface verrucate
   - Surface gemmate (Plate VII: 1-3)
   - Surface perforate (Plate VI: 5-7)
   - Surface scabrate

2. Equatorial grain shape circular
   - Equatorial grain shape suboblate (Plate IX: 9-11)
   - Equatorial grain shape subprolate (Plate VIII: 10-13)
   - Equatorial grain shape rectangular (tall) (Plate IX: 1-8)

3. Equatorial grain diameter ~9-11µm (Plate X: 1-4)
   - Equatorial grain diameter ~12-18µm (Plate XI: 8-10)
   - Equatorial grain diameter ~27-33µm (Plate XI: 11-14)
   - Equatorial grain diameter ~40-55µm
   - Equatorial grain diameter ~63-77µm
   - Equatorial grain diameter ~70-90µm (Plate XII: 7-10)
   - Equatorial grain diameter ~90-110 (Plate XIII 1-2)

4. Wall thickness ~2µm (Plate XII: 1-3)
   - Wall thickness ~4µm (Plate XII: 4-6)

5. Wall thickness ~2µm (Plate XIII 5-7)
   - Wall thickness ~6µm (Plate XIII: 3-4)

6. Equatorial grain shape circular
   - Equatorial grain shape suboblate (Plate VII: 8-11)
   - Equatorial grain shape oblate (Plate VI: 1-4)
   - Equatorial grain shape subprolate (Plate VIII: 14-17)
7. Equatorial grain diameter ~17-23µm
- Equatorial grain diameter ~36-44µm (Plate XIV: 1-3)
- Equatorial grain diameter ~63-77µm (Plate XIII: 8-10)
- Equatorial grain diameter ~81-99µm (Plate XIV: 4-7)

8. Wall thickness ~0.5µm (Plate XIV: 8-11)
- Wall thickness ~1.5µm (Plate XV: 1-4)

9. Equatorial grain shape circular
- Equatorial grain shape suboblate
- Equatorial grain shape subprolate

10. Polar grain shape circular (Plate XI: 1-4)
- Polar grain shape quinquangular
- Polar grain shape triangular (convex) (Plate X: 13-16)

11. Wall thickness ~1µm (Plate VII: 16-19)
- Wall thickness ~2µm (Plate VII: 12-15)

12. Equatorial grain diameter ~35-45µm (Plate XI: 5-7)
- Equatorial grain diameter ~50-70µm (Plate VIII: 1-6)

13. Equatorial grain diameter ~50-60µm (Plate X: 11-12)

14. Wall thickness ~1µm (Plate X: 8-10)
- Wall thickness ~2µm (Plate X: 5-7)

15. Equatorial grain shape circular (Plate XVI: 4-10)
- Equatorial grain shape suboblate (Plate VIII: 7-9)

16. Equatorial grain diameter ~150-200µm (Plate XV: 5-6)
- Equatorial grain diameter unknown (Plate XVI: 1-3)

9. Monoporate

Plate XVII
Key

1. Surface scabrate (Plate XVII: 1-2)  
   - Surface reticulate  
   Guaduella oblonga

2. Pore size ~1.5µm (Plate XVII: 6-8)  
   - Pore size ~2µm  
   Typha angustifolia

3. Wall thickness ~1µm (Plate XVII: 3-5)  
   - Wall thickness ~1.5µm (Plate XVII: 9-11)  
   Typha australis
   Typha capensis

10. Monocolpate

Plates XVIII-XXI

Key

1. Surface psilate
   - Surface gemmate (Plate XIX: 6-8)  
   Borassus aethiopum
   - Surface perforate (Plate XXI: 4-6)  
   Acidanthera brevicollis
   - Surface foveolate
   - Surface scabrate
   - Surface echinate
   - Surface reticulate

2. Equatorial grain shape rectangular (tall) (Plate XVIII: 1-2)
   - Equatorial grain shape rhombic (tall) (Plate XVIII: 6-8)
   - Equatorial grain shape circular
   Raphia ruffia

3. Polar grain shape triangular (convex) (Plate XX: 4-6)
   - Polar grain shape circular (Plate XX: 1-3)
   Nymphaea lotus
   Nymphaea caerulea

4. Equatorial grain shape rectangular (tall) (Plate XIX: 9-10)
   - Equatorial grain shape rhombic (tall) (Plate XIX: 11-13)
   Hyphaene natalensis
   Hyphaene ventricosa

5. Equatorial grain shape subprolate
   - Equatorial grain shape rectangular (tall) (Plate XVIII: 3-6, Plate XVIII: 17-18, Plate XVIII: 19-21)
   Raphia farinifera
   Calamus erectus
   Calamus gracilis

6. Polar grain shape triangular (convex) (Plate XVIII: 9-11)
   - Polar grain shape circular
   Elaeis guineensis

7.
7. Collumnae invisible (Plate XX: 7-9)  
- Collumnae visible (Plate XX: 10-11)  
Chlorophytum floribundum  
Asparagus falcatus

8. Wall thinner on pole (Plate XXI: 7-9)  
- Wall of even thickness  
Aneilema johnstonii

9. Equatorial grain size ~50-60µm (Plate XXI: 10-12)  
- Equatorial grain size ~75-85µm (Plate XXI: 13-15)  
- Equatorial grain size ~85-95µm (Plate XXI: 16-18)  
Commelina africana  
Crinum powellii  
Crinum pauciflorum

10. Colpus length full  
- Colpus length 2/3 (Plate XXI: 1-3)  
- Colpus length 1/2 (Plate XX: 12-13)  
- Colpus length 1/3  
Dracaena reflexa  
Dracaena camerooniana

11. Collumnae invisible (Plate XVIII: 12-14)  
- Collumnae visible (Plate XIX: 4-5)  
Ancistrophyllum secundiflorum  
Borassus machadonis

12. Equatorial grain size ~35-45µm (Plate XIX: 1-3)  
- Equatorial grain size ~45-55µm (Plate XVIII: 15-16)  
Eremospatha sp.  
Ancistrophyllum laurentii

11. Syncolporate

Plate XXII

Key

1. Equatorial grain size ~15-20µm (Plate XXII: 7-10)  
- Equatorial grain size ~20-25µm (Plate XXII: 1-3)  
- Equatorial grain size ~30-37µm (Plate XXII: 4-6)  
Syzygium guineense  
Eugenia michoacanensis  
Myrcia sp.

12. Diporate

Plates XXIII-XXV

1. Equatorial grain shape rectangular (tall) (Plate XXIII: 1-4)  
- Equatorial grain shape sub-prolate (Plate XXIII: 5-9)  
Musanga smithii  
Musanga leo-errerae
- Equatorial grain shape sub-oblate 2.  
- Equatorial grain shape circular 4.

2. Pore shape elliptic (tall) (Plate XXIII: 10-15)  
- Pore shape circular  
  \textit{Chlorophora excelsa} 3.

3. Pore morphology thickened pore (Plate XXIII: 16-17)  
- Pore morphology plain (Plate XXIII: 18-19)  
  \textit{Antiaris toxicaria}  
  \textit{Ficus ingens}  

4. Pore shape irregular (Plate XXIV: 1-5)  
- Pore shape circular with annulus 4.  
- Pore shape circular 5.  
  \textit{Iodes ovalis} 6. 

5. Surface psilate (Plate XXIV: 6-9)  
- Surface scabrate (Plate XXIV: 10-12)  
  \textit{Baissea multiflora}  
  \textit{Motandra guineensis}  

6. Pore morphology thickened pore (Plate XXIV: 13-19)  
- Pore morphology plain 7.  
  \textit{Trema orientalis}  
  \textit{Trema guinensis}  
  \textit{Morinda citrifolia}  

7. Equatorial grain diameter \(\sim 18-22\mu m\) (Plate XXIV: 20-22)  
- Equatorial grain diameter \(\sim 63-77\mu m\) (Plate XXV: 1-2)  

\textbf{13. Dicorporate}  
Plate XXVI  

Key  
1. Pore size \(\sim 10\mu m\) (Plate XXVI: 1-6)  
- Pore size \(\sim 4\mu m\) (Plate XXVI: 7-11)  
  \textit{Justicia cordata}  
  \textit{Justicia flava}  

\textbf{14. Triporate}  
Plates XXVII-XXXIV  

Key  
1. Surface granulate (Plate XXVII: 1-7)  
- Surface echinate 2.  
- Surface psilate 3.  
- Surface reticulate 8.  
- Surface scabrate 17.  
  \textit{Allophylus africanus}  

2. Polar grain diameter \(\sim 18-21\mu m\) (Plate XXVII: 18-21)  
  \textit{Iodes ovalis}
8-11)  
- Polar grain diameter ~35-45µm (Plate XXVII: 12-14)  
- Polar grain diameter ~50-70µm (Plate XXVIII: 1-3)  

Piliostigma reticulatum  
Bombax brevicuspe

3. Polar grain shape circular  
- Polar grain shape triangular (convex)  

4. Polar grain diameter ~12-16µm (Plate XXVIII: 4-6)  
- Polar grain diameter ~20-30µm (Plate XXVIII: 10-12)  

Sesuvium sessile  
Baissea multiflora

5. Pore size ~1-3µm  
- Pore size ~4-5µm (Plate XXVIII: 19-21)  

6. Polar grain diameter ~8-12µm (Plate XXVIII: 7-9)  
- Polar grain diameter ~18-22µm (Plate XXVIII: 16-18)  

Sabicea floribunda  
Coula edulis  
Heisteria parvifolia

8. Pore morphology thickened pore  
- Pore morphology slightly extruded  
- Pore morphology extruded  
- Pore morphology plain  
- Pore morphology thinning sexine  

9. Polar grain diameter ~25-35µm (Plate XXVIII: 22-24)  
- Polar grain diameter ~40-50µm (Plate XXIX: 1-6)  

Bombax buonopozense  
Plectronia vulgaris

10. Polar grain diameter ~14-16µm (Plate XXIX: 10-15)  
- Polar grain diameter ~45-55µm (Plate XXIX: 16-18)  
- Polar grain diameter ~60-80µm (Plate XXIX: 7-9)  

Lasianthus africanus  
Kirkia acuminata  
Ceiba pentandra

11. Polar grain diameter ~36-44µm (Plate XXX: 1-7)  
- Polar grain diameter ~54-66µm (Plate XXX: 8-10)  

Vigna fischeri  
Cardiospermum grandiflorum

12. Polar grain shape circular
- Polar grain shape triangular (convex) 14.

13. Pore size ~3µm (Plate XXX: 11-14)  
- Pore size ~5µm (Plate XXX: 15-18)  
- Pore size ~6µm (Plate XXX: 19-21)

14. Pore size ~6µm (Plate XXXI: 1-6)  
- Pore size ~8µm (Plate XXXI: 13-15)  
- Pore size ~25µm (Plate XXXI: 16-17)

15. Polar grain diameter ~10-15µm (Plate XXXI: 7-12)  
- Polar grain diameter ~36-45µm (Plate XXXII: 1-3)  
- Polar grain diameter ~45-55µm 16.

16. Pore shape circular (Plate XXXII: 4-6)  
- Pore shape elliptic (tall) (Plate XXXII: 7-13)

17. Polar grain shape circular  
- Polar grain shape triangular (convex)

18. Pore shape rectangular (broad) (Plate XXXII: 14-19)  
- Pore shape circular  
- Pore shape circular (with annulus)

19. Polar grain diameter ~18-22µm (Plate XXXIII: 1-4)  
- Polar grain diameter ~27-33µm (Plate XXXIII: 5-7)

20. Pore morphology sunken pore (Plate XXXIII: 8-13)  
- Pore morphology slightly extruded (Plate XXXIII: 14-17)

21. Polar grain diameter ~10-15µm (Plate XXXIV: 1-3)  
- Polar grain diameter ~18-24µm 22.  
- Polar grain diameter ~40-60µm (Plate XXXIV: 4-7)

22. Wall thickness ~0.25µm (Plate XXXIV: 8-9)  
- Wall thickness ~1.5µm (Plate XXXIV: 10-14)

15. Tricolporate

Plates XXXV-XXXIX
Key

1. Surface psilate (Plate XXXV: 1-5)
   - Surface clavate/psilate (Plate XXXVI: 6-11)
   - Surface scabrate (Plate XXXV: 6-10)
   - Surface striate (Plate XXXIX: 6-11)
   - Surface reticulate

   2. Equatorial grain shape rectangular (tall) (Plate XXXVII: 1-6)
   - Equatorial grain shape rhombic (tall) (Plate XXXVII: 7-12)
   - Equatorial grain shape circular (Plate XXXVIII: 19-20)
   - Equatorial grain shape rhombic (broad) (Plate XXXVIII: 7-12)
   - Equatorial grain shape suboblate (Plate XXXVIII: 1-6)
   - Equatorial grain shape prolate
   - Equatorial grain shape subprolate

   3. Colp length 1 (Plate XXXVI: 1-5)
   - Colp length 2 (Plate XXXVI: 24-26)

   4. Polar grain shape triangular (convex)
   - Polar grain shape circular
   - Polar grain shape tri-lobate

   5. Equatorial grain diameter ~15-25µm (Plate XXXVII: 13-18)
   - Equatorial grain diameter ~40-50µm (Plate XXXIX: 1-5)

   6. Wall thickness <2 µm (Plate XXXV: 17-21)
   - Wall thickness >2 µm

   7. Equatorial grain diameter ~27-37µm (Plate XXXVI: 18-23)
   - Equatorial grain diameter ~40-50µm (Plate XXXV: 22-27)

   8. Wall thickness ~2µm (Plate XXXVI: 12-17)
   - Wall thickness ~3µm (Plate XXXV: 11-16)
   - Wall thickness ~10µm (Plate XXXVIII: 13-18)

16. Tricolporate

Plates XL-CXIV
Key

1. Equatorial grain shape circular
   - Equatorial grain shape oblate (Plate XL: 1-6) 2.
   - Equatorial grain shape perprolate (Plate XL: 7-11) Gerrardina foliosa
   - Equatorial grain shape prolate
   - Equatorial grain shape rectangular (tall) Thecacoris gymnogyne
   - Equatorial grain shape rhombic (broad) 3.
   - Equatorial grain shape rhombic (tall)
   - Equatorial grain shape sub-oblate 4.
   - Equatorial grain shape sub-prolate 5.
   - Equatorial grain shape undetermined 6.

2. Surface psilate
   - Surface reticulate 7.
   - Surface scabrate 8.
   - Surface striate (Plate XL: 12-17) Vepris uguenensis 9.

3. Surface psilate
   - Surface reticulate
   - Surface striate 10.

4. Surface psilate
   - Surface reticulate
   - Surface scabrate 11.

5. Surface psilate (Plate XLI: 1-10) Alchornea floribunda
   - Surface clavate/pilate (Plate XLI: 11-16) Ilex mitis
   - Surface reticulate 12.
   - Surface scabrate 13.

6. Surface psilate
   - Surface striate
   - Surface reticulate
   - Surface scabrate (Plate LXXVIII: 4-7) Daniella oliveri

7. Surface psilate
   - Surface striate (Plate XLII: 1-7) Crudia bracteata
   - Surface reticulate 14.
   - Surface scabrate (Plate XLII: 8-14) Parinari curatellifolia

8. Surface echinate
   - Surface psilate
   - Surface reticulate
   - Surface scabrate
   - Surface striate 15.

9. Pore shape circular (Plate XLIII: 1-6) Diospyros mespiliformis
   - Pore shape elliptic (broad) (Plate XLIII: 7-9) Lotus chazaliei
- Pore shape lalongate (Plate XLIII: 10-16) Canarium schweinfurthii
- Pore shape lolongate (Plate XLIV: 1-14) Heliotropium sp. x2

10. Pore shape circular Balanites glaber
- Pore shape elliptic (tall) (Plate XLV: 1-6)

11. Pore shape circular Centroplacus glaucinus
- Pore shape elliptic (broad) (Plate XLV: 7-12)

12. Pore shape circular (Plate XLV: 13-18) Indigofera leptoclada
- Pore shape circular with annulus 15.
- Pore shape concave 16.
- Pore shape lalongate (Plate XLVI: 1-8) Millettia psilopetala
- Pore shape rectangular (broad) 18.
- Pore shape lolongate 21.
- Pore shape rhombic (tall) (Plate XLVI: 9-16) Argomuellera macrophylla
- Pore shape squared 23.
- Pore shape elliptic (tall) (Plate XLVII: 1-6) Balanites aegyptiacus
- Pore shape irregular (Plate XLVII: 7-12) Martretia quadricornis
- Pore shape undetermined (Plate XLVIII: 1-3) Cliffortia nitidula

13. Pore shape circular 26.
- Pore shape rectangular (broad) (Plate XLVIII: 4-9) Parinari holstii
- Pore shape lalongate (Plate XLVIII: 10-15) Macaranga schweinfurt
- Pore shape lolongate (Plate XLVIII: 16-22) Prunus africana

14. Pore morphology with an operculum (Plate XLIX: 1-8) Alchornea cordifolia
- Pore morphology sunken pore (Plate XLIX: 9-12) Medusandra richardsiana

15. Pore morphology thickened pore (Plate XLIX: 14-18) Commiphora campestris
- Pore morphology sunken pore (Plate L: 1-7) Commiphora scheffleri

16. Pore morphology thickened pore (Plate L: 8-16) Erythrococca bongensis
- Pore morphology sunken pore 17.
- Pore morphology slightly extruded (Plate LI: 1-5) Amanoa strobilacea
- Pore morphology extruded (Plate LI: 6-12) Discoglypremna caloneura

17. Pore position mid-wall (Plate LII: 1-8) Entada abyssinica
- Pore position corner (Plate LII: 9-15) Baphia massaiensis

18. Pore morphology thickened pore 19.
- Pore morphology sunken pore 20.

19. Colpus length full (Plate LIII: 1-6) Mallotus wrayi
- Colpus length >2/3 (Plate LIII: 7-12)  
  *Fagara macrophylla*

20. Polar grain shape circular (Plate LIII: 13-18)  
- Polar grain shape triangular (convex) (Plate LIV: 1-8)  
  *Olea hochstetteri*  
  *Ixora aneimenodesma*

21. Wall thickness even  
- Wall thinner on pole (Plate LIV: 9-16)  
  *Anthostema aubryanum*

22. Polar grain shape tri-lobate (Plate LV: 1-7)  
- Polar grain shape circular (Plate LV: 8-15)  
  *Agelaea heterophylla*  
  *Adenia nicobarica*

23. Visible collumnae  
- Invisible collumnae (Plate LVI: 1-3)  
  *Salacia kraussii*

24. Polar grain shape tri-lobate (Plate LVI: 4-8)  
- Polar grain shape triangular (convex)  
  *Maytenus senegalensis*

25. Equatorial grain diameter ~17-25µm (Plate LVI: 9-14)  
- Equatorial grain diameter ~25-35µm (Plate LVII: 1-8)  
  *Hippocratea affinis*  
  *Hippocratea africana*

26. Pore morphology extruded (Plate LVII: 9-14)  
- Pore morphology slightly extruded (Plate LVIII: 1-8)  
  *Grandidiera boivinii*  
  *Cynometra alexandri*

27. Pore shape lalongate (Plate LVIII: 9-13)  
- Pore shape rhombic (broad) (Plate LVIII: 14-20)  
  *Calantica jalbertii*  
  *Blighia wildemaniana*

28. Colpus length full  
- Colpus length >2/3  
  29.  
  30.  
  31.  
  32.  
  33.  
  34.  
  35.

29. Pore shape circular  
- Pore shape concave  
- Pore shape elliptic (tall)  
- Pore shape lalongate  
- Pore shape rhombic (broad) (Plate LIX: 1-6)  
- Pore shape squared (Plate LIX: 7-13)  
- Pore shape undetermined  
  *Corchorus fascicularis*  
  *Strephonema pseudocola*  
  *Ritchiea capparoides*

30. Equatorial grain diameter ~18-22µm (Plate LX: 1-6)  
- Equatorial grain diameter ~45-55µm (Plate LX: 7-9)  
  *Crossopteryx febrifuga*  
  *Cissus petiolata*

31. Pore morphology sunken pore (Plate LXI: 1-6)  
- Pore morphology thinning sexine (Plate LX: 7-9)  
  *Ritchiea capparoides*  
  *Spondianthus preussii*
32. Pore morphology plain (Plate LXI: 7-13)  
- Pore morphology slightly extruded (Plate LXII: 1-7)  
  *Blighia unijugata*  
  *Cissus quadrangularis*

33. Pore morphology plain (Plate LXII: 8-13)  
- Pore morphology sunken pore (Plate LXIII: 1-5)  
  *Grewia bicolor*  
  *Vepris humbertii*

34. Pore morphology plain (Plate LXIII: 6-11)  
- Pore morphology slightly extruded (Plate LXIV: 1-6)  
  *Rubus scheffleri*  
  *Drypetes gerrardii*

35. Pore shape circular (Plate LXIV: 7-11)  
- Pore shape concave  
- Pore shape elliptic (broad) (Plate LXIV: 12-17)  
- Pore shape irregular (Plate LXV: 1-6)  
- Pore shape rectangular (broad) (Plate LXV: 7-15)  
- Pore shape rhombic (tall) (Plate LXV: 16-21)  
  *Flacourtia indica*  
  *Avicennia nitida*  
  *Dasylepis assinensis*  
  *Hannoa* sp. (x2)  
  *Ormocarpum kirkii*

36. Pore morphology thickened (Plate LXVI: 1-7)  
- Pore morphology extruded (Plate LXVI: 8-14)  
  *Maesobotrya hirtella*  
  *Cassipourea flanaganii*

37. Pore shape elliptic (tall) (Plate LXVI: 15-20, LXVII: 1-4)  
- Pore shape lolongate  
  *Lannea* sp. (x2)  
  38.

38. Pore morphology thinning sexine (Plate LXVII: 5-9)  
- Pore morphology plain (Plate LXVIII: 1-5)  
  *Isoberlinia angolensis*  
  *Isoberlinia doka*

39. Pore morphology thinning sexine (Plate LXVIII: 6-12)  
- Pore morphology sunken pore (Plate LXIX: 1-7)  
  *Scytopetalum tieghemii*  
  *Euphorbia hypericifolia*  
  *Pterocarpus abyssinicus*  
  *Pterocarpus lucens*  
  41.

40. Pore shape elliptic (tall) (Plate LXIX: 8-13)  
- Pore shape lolongate (Plate LXIX: 14-19)  
- Pore shape rectangular (broad)  
  *Dodonaea viscosa*  
  *Tabernaemontana ventricosa*  
  *Sterculia tragacantha*  
  *Prosopis africana*  
  *Hagenia abyssinica*  
  *Monotes kerstingii*
43. Visible colurnnae (Plate LXXIII: 1-6)
  - Invisible colurnnae (Plate LXXIII: 7-12)
    *Copaifera gorskiana*
    *Pygeum africanum*

44. Pore shape concave (Plate LXXIII: 13-18)
  - Pore shape lolongate
    *Acridocarpus macrocalyx*

45. Wall thickness even (Plate LXXIV: 1-7)
  - Wall thicker on pole (Plate LXXIV: 8-14)
    *Guibourtia arnoldiana*
    *Griffonia simplicifolia*

46. Pore morphology thinning sexine (Plate LXXV: 1-6)
  - Pore morphology sunken pore
  - Pore morphology plain
    *Lannea humilis*

47. Colpus length full (Plate LXXV: 7-12)
  - Colpus length >2/3 (Plate LXXVI: 1-6)
    *Sclerocarya birrea*
    *Spondias mombin*

48. Pore shape elliptic (tall) (Plate LXXVII: 1-6)
  - Pore shape rhombic (broad) (Plate LXXVII: 7-12)
    *Berlinia bifoliolata*
    *Teclea villosa*

49. Pore shape circular
  - Pore shape elliptic (broad)
  - Pore shape rhombic (broad)
  - Pore shape zonorate (Plate LXXVIII: 1-3)
    *Corchorus trilocularis*

50. Pore morphology thinning sexine (Plate LXXIX: 1-6)
  - Pore morphology sunken pore (Plate LXXX: 1-6)
    *Aubrevillea platycarpa*
    *Caloncoba angolensis*

51. Pore morphology thinning sexine (Plate LXXX: 7-12)
  - Pore morphology sunken pore (Plate LXXXI: 1-7)
    *Avicennia officinalis*
    *Calcsasia dinklagei*

52. Pore morphology plain (Plate LXXXII: 8-12)
  - Pore morphology sunken pore (Plate LXXXII: 1-7)
    *Hildegardia barteri*
    *Zizyphus mauritiana*

53. Pore morphology plain (Plate XXII: 7-10)
  - Pore morphology thinning sexine (Plate LXXXII: 8-13)
  - Pore morphology extruded (Plate LXXXII: 14-17)
    *Syzygium guineense*
    *Dialium guianense*
    *Irvingia smithii*

54. Pore shape circular
  - Pore shape elliptic (broad)
  - Pore shape elliptic (tall) (Plate LXXXII: 18-23)
    *Mitragyna inermis*
- Pore shape irregular
  - Pore shape lalongate (Plate LXXXIII: 1-7)  
  - Pore shape squared (Plate LXXXIII: 8-13)  
  - Pore shape rectangular (broad) (Plate LXXXIV: 1-3)

55. Pore morphology extruded (Plate LXXIX: 7-10)
  - Pore morphology thinning sexine
  - Pore morphology sunken pore

56. Polar grain shape triangular (convex) (Plate LXXXIV: 4-10)
  - Polar grain shape triangular (straight) (Plate LXXXIV: 11-18)

57. Wall thickness even (Plate LXXXV: 1-8)
  - Wall thinner on pole (Plate LXXXV: 9-14)

58. Pore morphology sunken pore (Plate LXXXVI: 1-20)
  - Pore morphology thinning sexine (Plate LXXXVII: 1-6)
  - Pore morphology extruded (Plate LXXXVII: 7-14)

59. Visible collumnae (Plate LXXXVIII: 1-6)
  - Invisible collumnae (Plate LXXXVIII: 7-13)

60. Pore shape concave (Plate LXXXIX: 1-7)
  - Pore shape rectangular (broad) (Plate XC: 1-5)
  - Pore shape elliptic (tall)

61. Wall thickness even (Plate XCI: 1-7)
  - Wall thinner on pole (Plate XCI: 8-13)

62. Pore shape circular
  - Pore shape circular with annulus (Plate XCI: 14-19)
  - Pore shape concave
  - Pore shape elliptic (broad)
  - Pore shape rectangular (broad) (Plate XCII: 1-5)
  - Pore shape rectangular (tall) (Plate XCII: 6-13)
  - Pore shape rhombic (broad) (Plate XCII: 14-19)

63. Pore morphology sunken pore (Plate XCIII: 1-7)
  - Pore morphology thinning sexine (Plate XCIII: 8-13)
64. Colpus length 2/3 (Plate XCIII: 14-16)
  - Colpus length 1/2 (Plate XCIV: 1-3)
  
  65. Pore shape circular
  - Pore shape concave
  - Pore shape elliptic (broad)
  - Pore shape elliptic (tall)
  - Pore shape irregular
  - Pore shape lalongate
  - Pore shape lolongate
  - Pore shape rectangular (broad) (Plate XCIV: 4-10)
  - Pore shape rectangular (tall) (Plate XCV: 1-6)
  - Pore shape rhombic (broad) (Plate XCVI: 1-7)
  - Pore shape undetermined (Plate XCVI: 8-15)
  
  66. Pore morphology sunken pore
  - Pore morphology thinning sexine (Plate XCVII: 1-6)
  
  67. Pore position mid-wall (Plate XCVII: 7-13)
  - Pore position corner
  
  68. Equatorial grain diameter ~27-33µm (Plate XCVII: 14-17)
  - Equatorial grain diameter ~50-60µm (Plate XCVIII: 1-7)
  
  69. Pore morphology sunken pore (Plate XCVIII: 8-14)
  - Pore morphology thinning sexine (Plate XCIX: 1-7)
  - Pore morphology slightly extruded (Plate XCIX: 8-13)
  
  70. Pore morphology sunken pore
  - Pore morphology extruded (Plate C: 1-8)
  - Pore morphology slightly extruded (Plate C: 9-15)
  
  71. Equatorial grain diameter ~25-30µm (Plate C: 16-23)
  - Equatorial grain diameter ~30-40µm (Plate CI: 1-6)
  
  72. Pore morphology thickened (Plate CI: 7-12)
  - Pore morphology extruded (Plate CII: 1-8)
  - Pore morphology slightly extruded (Plate CII: 9-14)
  - Pore morphology plain
73. Pore position mid-wall (Plate CIII: 1-7)  
- Pore position corner  

**Anthostema senegalense**

74. Extine type tectate (Plate CIII: 8-14)  
- Extine type semitectate (Plate CIV: 1-7)

**Ormocarpum sennooides**  
**Salacia pyriformis**

75. Pore morphology sunken pore  
- Pore morphology thickened (Plate CIV: 8-13)

76. Polar grain shape circular (Plate CV: 1-6)  
- Polar grain shape triangular (convex) (Plate CV: 7-14)

**Lotus arabicus**  
**Uapaca heudelotii**

77. Pore position corner (Plate CV: 15-20)  
- Pore position mid-wall

**Vepris gossweileri**

78. Pore size ~8µm (Plate CVI: 1-6)  
- Pore size ~2µm (Plate CVI: 7-12)

**Zanthoxylum procerum**  
**Odyendea gabunensis**

79. Pore morphology sunken pore (Plate CVI: 13-20)  
- Pore morphology thinning sexine (Plate CVII: 1-8)  
- Pore morphology plain (Plate CVII: 9-15)

**Convolvulus trabutianus**  
**Millettia tanaensis**  
**Oncoba dentata**

80. Pore shape concave (Plate CVII: 16-23)  
- Pore shape elliptic (broad)  
- Pore shape irregular (Plate CVIII: 1-7)  
- Pore shape lalongate  
- Pore shape lolongate  
- Pore shape rectangular (broad) (Plate CVIII: 8-12)

**Detarium le-testui**  
**Kiggelaria africana**  
**Sarcophrynium brachystachyum**

81. Pore morphology extruded  
- Pore morphology thinning sexine (Plate CVIII: 13-20)

**Cassia longiracemosa**

82. Wall thickness ~3µm (Plate CIX: 1-7)  
- Wall thickness ~1µm (Plate CIX: 8-14)

**Tephrosia nana**  
**Tephrosia elata**

83. Pore morphology plain (Plate CIX: 15-19)  
- Pore morphology sunken pore (Plate CX: 1-8)

**Dissomeria crenata**  
**Homalium buchholzii**

84. Colpi width ~15µm (Plate CX: 9-14)  
- Colpi width ~35µm (Plate CX: 15-20)

**Cassia burttii**  
**Copaifera carrissoana**

85. Pore shape circular  
- Pore shape lalongate (Plate CXI: 1-7)  
- Pore shape lolongate (Plate CXII: 1-6)

**Vepris eugeniifolia**  
**Hymenostegia afzelii**
86. Equatorial grain diameter ~27-33µm (Plate CXI: 8-15)
- Equatorial grain diameter ~35-50µm (Plate CXI: 16-20)

87. Pore morphology plain
- Pore morphology sunken pore (Plate CXII: 7-9)
- Pore morphology thickened

88. Polar grain shape triangular (convex) (Plate CXII: 10-12)
- Polar grain shape tri-lobate (Plate CXIII: 1-3)

89. Visible collumnae (Plate CXIII: 6-7)
- Invisible collumnae (Plate CXIII: 4-5)

90. Pore morphology sunken pore (Plate CXIII: 8-15)
- Pore morphology thinning sexine (Plate CXIV: 1-6)

17. Stephanoporate

Plate CXV

Key

Funtumia latifolia (Plate CXV: 1-3)

18. Stephanocolpate

Plates CXVI-CXX

Key

1. Full length of grain
   - 2/3 the full length of grain
   - 1/2 the full length of grain
   - < 1/3 the full length of grain (Plate CXVI: 1-7)
   - Colpi length undetermined (Plate CXVI: 8-9, Plate CXVI: 10-11)

2. Equatorial grain shape subprolate (Plate CXVII: 1-4)
   - Equatorial grain shape rectangular (broad)
3. Equatorial grain shape circular (Plate CXIX: 1-5)  
- Equatorial grain shape suboblate (Plate CXIX: 6-9)

4. Surface baculate (Plate CXX: 1-6)  
- Surface reticulate (Plate CXX: 7-14)

19. Stephanocolporate

Plates CXXI-CXXII

Key

1. Polar grain shape elliptic (Plate CXXI: 1-7)  
- Polar grain shape circular (Plate CXXII: 1-7)

20. Heterocolporate

Plate CXXIII

Key

1. Pore shape elliptic (tall) (Plate CXXIII: 1-6)  
- Pore shape elliptic (broad) (Plate CXXIII: 7-12)  
- Pore shape rectangular (broad) (Plate CXXIII: 13-17)  
- Pore shape concave  
- Pore shape squared (Plate CXXIII: 18-23)

2. Pore morphology extruded (Plate CXXIII: 24-29)  
- Pore morphology sunken pore (Plate CXXIII: 30-35)

21. Periporate

Plates CXXIV-CXXIX

Key

1. Pore shape irregular  
- Pore shape circular  
- Pore shape circular with annulus  
- Pore shape elliptic broad (Plate CXXIV: 1-4)
2. Surface pattern reticulate
   - Surface pattern scabrate (Plate CXXIV: 5-8)
   - Surface pattern verrucate (Plate CXXV: 1-3)
   - Surface pattern psilate (Plate CXXV: 4-6)

3. Pore section plain (Plate CXXIV: 9-14)
   - Pore section thinning sexine (Plate CXXIV: 15-18)

4. Surface pattern reticulate
   - Surface pattern echinate

5. Equatorial grain diameter ~27-33 µm (Plate CXXIV: 19-22)
   - Equatorial grain diameter ~36-44 µm (Plate CXXVI: 1-3)
   - Equatorial grain diameter ~90-110 µm (Plate CXXVI: 4-7)

6. Equatorial grain diameter ~20-30 µm (Plate CXXVII: 1-4)
   - Equatorial grain diameter ~60-80 µm (Plate CXXVII: 5-8)
   - Equatorial grain diameter ~80-120 µm

7. Wall thickness ~5 µm (Plate CXXVIII: 5-6)
   - Wall thickness ~12 µm (Plate CXXIX: 1-2)

8. Equatorial grain diameter ~35-45 µm (Plate CXXVIII: 1-4)
   - Equatorial grain diameter ~45-55 µm (Plate CXXIX: 3-6)

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Table caption

**Table 1:** List of pollen species shown on plates ordered alphabetically by family, genus and species.
Plate captions

5. Polyads

Plate I: 1-3 *Calpocalyx brevibracteatus*, 4-6 *Xyilia evansii*, 7-9 *Acacia seyal*, 10-12 *Acacia eggelingii*.

Plate II: 1-3 *Acacia clavigera*, 4-6 *Parkia inundabilis*.

Plate III: 1-3 *Parkia bussei*, 4-6 *Parkia velutina*.

6. Tetrads

Plate IV: 1-4 *Erica arborea*, 5-7 *Mimosa strigillosa*, 8-9 *Uvariopsis congensis*.

7. Vesiculate

Plate V: 1-6 *Podocarpus milanjianus*.

8. Inaperturate, including Polypodiaceae

Plate VI: 1-4 *Illigera rhodantha*, 5-7 *Acidanthera brevicollis*.

Plate VII: 1-3 *Borassus aethiopum*, 4-7 *Trichomanes mandiocanum*, 8-11 *Pycnanthus dinklagei*, 12-15 *Alternanthera nodiflora*, 16-19 *Alternanthera repens*.

Plate VIII: 1-6 *Piptostigma mayumbense*, 7-9 *Dichrostachys unijuga*, 10-13 *Scaphopetalum thonneri*, 14-17 *Pandanus livingstonianus*.

Plate IX: 1-4 *Xyris welwitschii*, 5-8 *Xyris aristata*, 9-11 *Xyris montana*.

Plate X: 1-4 *Peperomia* sp., 5-7 *Nephrolepis exaltata*, 8-10 *Nephrolepis biserrata*, 11-12 *Lonchitis currori*, 13-16 *Nymphaea lotus*.

Plate XI: 1-4 *Nymphaea caerulea*, 5-7 *Uvaria kirkii*, 8-10 *Tiliacora funifera*, 11-14 *Scaphopetalum letestui*.

Plate XII: 1-3 *Psychotria goetzei*, 4-6 *Croton gratissimus*, 7-10 *Croton macrostachyus*.

Plate XIII: 1-2 *Dicranolepis usambarica*, 3-4 *Tribulus terrestris*, 5-7 *Morinda citrifolia*, 8-10 *Barteria acuminata*.

Plate XIV: 1-3 *Iodes kamerunensis*, 4-7 *Illigera appendiculata*, 8-11 *Lemna gibba*.

Plate XV: 1-4 *Pandanus kirkii*, 5-6 *Tylophora sylvatica*.
Plate XVI: 1-3 Artabotrys likimensis, 4-6 Dichrostachys cinerea, 7-10 Dichrostachys glomerata.

9. Monoporate

Plate XVII: 1-2 Guaduella oblonga, 3-5 Typha australis, 6-8 Typha angustifolia, 9-11 Typha capensis.

10. Monocolpate

Plate XVIII: 1-2 Raphia rufia, 3-6 Raphia farinifera, 6-8 Phoenix reclinata, 9-11 Elaeis guineensis, 12-14 Ancistrophyllum secundiflorum, 15-16 Ancistrophyllum laurentii, 17-18 Calamus erectus, 19-21 Calamus gracilis.

Plate XIX: 1-3 Eremospatha sp., 4-6 Borassus machadonis, 7-8 Borassus aethiopum, 10-11 Hyphaene natalensis, 12-13 Hyphaene ventricosa.

Plate XX: 1-3 Nymphaea caerulea, 4-6 Nymphaea lotus, 7-9 Chlorophytum floribundum, 10-11 Asparagus falcatus, 12-13 Dracaena camerooniana.

Plate XXI: 1-3 Dracaena reflexa, 4-6 Acidanthera brevicollis, 7-9 Aneilema johnstonii, 10-12 Commelina africana, 13-15 Crinum powellii, 16-18 Crinum pauciflorum.

11. Syncolporate

Plate XXII: 1-3 Eugenia michoacanensis, 4-6 Myrica sp., 7-10 Syzygium guineense.

12. Diporate

Plate XXIII: 1-4 Musanga smithii, 5-9 Musanga leo-errerae, 10-15 Chlorophora excelsa, 16-17 Antiaris toxicaria, 18-19 Ficus ingens.

Plate XXIV: 1-5 Iodes ovalis, 6-9 Baissea multiflora, 10-12 Motandra guineensis, 13-19 Trema orientalis, 20-22 Trema guinensis.

Plate XXV: 1-2 Morinda citrifolia.

13. Dicolporate

Plate XXVI: 1-6 Justicia cordata, 7-11 Justicia flava.

14. Triporate

Plate XXVII: 1-7 Allophylus africanus, 8-11 Iodes ovalis, 12-14 Piliostigma reticulatum.
Plate XXVIII: 1-3 Bombax brevicaule, 4-6 Sesuvium sessile, 7-9 Coula edulis, 10-12 Baissea multiflora, 13-15 Sabicea floribunda, 16-18 Heisteria parviflora, 19-21 Protea susannae, 22-24 Bombax buonopozense.

Plate XXIX: 1-6 Plectronia vulgaris, 7-9 Ceiba pentandra, 10-15 Lasianthus africanus, 16-18 Kirkia acuminata.

Plate XXX: 1-7 Vigna fischeri, 8-10 Cardiospermum grandiflorum, 11-14 Triplochiton scleroxylon, 15-18 Nesogordonia fertilis, 19-21 Entada umbonata.

Plate XXXI: 1-6 Nesogordonia parvifolia, 7-12 Dichapetalum mossambicense, 13-15 Vigna luteola, 16-17 Psychotria fractinervia.

Plate XXXII: 1-3 Paullinia pinnata, 4-6 Entada pursaetha, 7-13 Protea trichanthera, 14-19 Leptaulus daphnoides.

Plate XXXIII: 1-4 Celtis zenkeri, 5-7 Celtis mildbraedii, 8-13 Anthocleista grandiflora, 14-17 Hymenocardia acida.

Plate XXXIV: 1-3 Dichapetalum stuhlmannii, 4-7 Turraeanthus africana, 8-9 Striga forbesii, 10-14 Celtis integrifolia.

15. Tricolpate

Plate XXXV: 1-5 Gunnera chilensis, 6-10 Napoleona imperialis, 11-16 Farsetia stenoptera, 17-21 Premna maxima, 22-27 Premna resinosa.

Plate XXXVI: 1-5 Leucas calostachys, 6-11 Vitex amboniensis, 12-17 Vitex doniana, 18-23 Tetracera alnifolia, 24-26 Aneulophus africanus.

Plate XXXVII: 1-6 Scytopetalum tieghemii, 7-12 Dichostemma sp., 13-18 Cissampelos mucronata.

Plate XXXVIII: 1-6 Brachystegia spiciformis, 7-12 Brachystegia leonensis, 13-18 Azelia bracteata, 19-20 Paramacrolobium coeruleum.

Plate XXXIX: 1-5 Petersia africana, 6-11 Berlinia grandiflora.

16. Tricolporate

Plate XL: 1-6 Gerrardina foliosa, 7-11 Thecacoris gymnogyne, 12-17 Vepris uguenensis.

Plate XLI: 1-10 Alchornea floribunda, 11-16 Ilex mitis.

Plate XLII: 1-7 Crudia bracteata, 8-14 Parinari curateifolia.
Plate XLIII: 1-6 Diospyros mespiliformis, 7-9 Lotus chazaliei, 10-16 Canarium schweinfurthii.

Plate XLIV: 1-6 Heliotropium bacciferum, 7-14 Heliotropium subulatum.

Plate XLV: 1-6 Balanites glaber, 7-12 Centroplacus glaucinus, 13-18 Indigofera leptoclada.

Plate XLVI: 1-8 Millettia psilopetala, 9-16 Argomuellera macrophylla.

Plate XLVII: 1-6 Balanites aegyptiacus, 7-12 Martretia quadricornis.

Plate XLVIII: 1-3 Cliftonia nitidula, 4-9 Parinari holstii, 10-15 Macaranga schweinfurt, 16-22 Prunus africana.

Plate XLIX: 1-8 Alchornea cordifolia, 9-12 Medusandra richardsoniana, 14-18 Commiphora campestris.

Plate L: 1-7 Commiphora scheffleri, 8-16 Erythrococca bongensis.

Plate LI: 1-5 Amanoa strobilacea, 6-12 Discoglypremna caloneura.

Plate LII: 1-8 Entada abyssinica, 9-15 Baphia massaiensis.

Plate LIII: 1-6 Mallotus wrayi, 7-12 Fagara macrophylla, 13-18 Olea hochstetteri.

Plate LIV: 1-8 Ixora aneimenodes, 9-16 Anthostema aubryanum.

Plate LV: 1-6 Agelaea heterophylla, 7-14 Adenia nicobarica.

Plate LVI: 1-3 Salacia kraussii, 4-8 Maytenus senegalensis, 9-14 Hippocratea affinis.

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Plate LVIII: 1-8 Cynometra alexandri, 9-13 Calantica jalbertii, 14-20 Blighia wildemaniana.

Plate LIX: 1-6 Corchorus fascicularis, 7-13 Strephonema pseudocola.

Plate LX: 1-6 Crossopteryx febrifuga, 7-9 Cissus petiolata, 10-17 Spondianthus preussii.

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Plate LXII: 1-7 Cissus quadrangularis, 8-13 Grewia bicolor.

Plate LXIII: 1-5 Vepris humbertii, 6-11 Rubus scheffleri.

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Plate LXV: 1-6 Dasylepis assinensis, 7-9 Hannoa klaineana, 10-15 Hannoa undulata, 16-21 Ormocarpum kirkii.
Plate LXVI: 1-7 *Maesobotrya hirtella*, 8-14 *Cassipourea flanaganii*, 15-20 *Lannea stuhlmannii*.

Plate LXVII: 1-4 *Lannea triphylia*, 5-9 *Isoberlinia angolensis*.

Plate LXVIII: 1-5 *Isoberlinia doka*, 6-12 *Scytopetalum tieghemii*.

Plate LXIX: 1-7 *Euphorbia hypericifolia*, 8-13 *Pterocarpus abyssinicus*, 14-19 *Pterocarpus lucens*.

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Plate LXXI: 1-6 *Sterculia tragacantha*, 7-12 *Prosopis africana*.

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Plate LXXVI: 1-6 *Spondias mombin*.

Plate LXXVII: 1-6 *Berlinia bifoliolata*, 7-12 *Teclea villosa*.

Plate LXXVIII: 1-3 *Corchorus trilocularis*, 4-7 *Daniella oliveri*.

Plate LXXIX: 1-6 *Aubrevillea platycarpa*, 7-10 *Cardiospermum corindum*.

Plate LXXX: 1-6 *Caloncoba angolensis*, 7-12 *Avicennia officinalis*.

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Plate LXXXIII: 1-7 *Tetrorchidium didymostemon*, 8-13 *Gaertnera paniculata*.

Plate LXXXIV: 1-3 *Uapaca bojeri*, 4-10 *Pericopsis angolensis*, 11-18 *Rhynchosia memnonia*.

Plate LXXXV: 1-8 *Piptadenia africana*, 9-14 *Brachystegia spiciformis*.

Plate LXXXVI: 1-8 *Lecaniodiscus cupanioides*, 9-15 *Chyranthus obliquinervis*, 16-20 *Chyranthus sacleuxii*.

Plate LXXXVII: 1-6 *Sesbania goetzei*, 7-14 *Ixora brachypoda*.
Plate LXXXVIII: 1-6 *Rhynchosia* sp., 7-13 *Prosopis alpataco*.

Plate LXXXIX: 1-7 *Centaurea perrottetii*.

Plate XC: 1-5 *Centaurea dimorpha*.

Plate XCI: 1-7 *Artemisia judaica*, 8-13 *Artemisia* sp., 14-19 *Tabernaemontana retusa*.

Plate XCII: 1-5 *Lophira alata*, 6-13 *Trichodesma africanum*, 14-19 *Diospyros austroafricana*.

Plate XCIII: 1-7 *Diospyros abyssinica*, 8-13 *Afrolicania elaeosperma*, 14-16 *Casearia engleri*.

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Plate XCVI: 1-7 *Rhizophora mangle*, 8-15 *Euphorbia cussonioides*.

Plate XCVII: 1-6 *Rhektophyllum congense*, 7-13 *Securinega virosa*, 14-17 *Detarium senegalense*.

Plate XCVIII: 1-7 *Cola nitida*, 8-14 *Rhizophora mucronata*.

Plate XCIX: 1-7 *Ritchiea fragariodora*, 8-13 *Millettia oblate*.

Plate C: 1-8 *Cassine parvifolia*, 9-15 *Nauclea esculenta*, 16-23 *Maesobotrya barteri*.

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Plate CII: 1-8 *Bridelia micrantha*, 9-14 *Euphorbia grandicornis*.

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Plate CIV: 1-7 *Salacia pyriformis*, 8-13 *Grewia glandulosa*.

Plate CV: 1-6 *Lotus arabicus*, 7-14 *Uapaca heudelotii*, 15-20 *Vepris gossweileri*.

Plate CVI: 1-6 *Zanthoxylum procerum*, 7-12 *Odyendea gabunensis*, 13-20 *Convolvulus trabutianus*.

Plate CVII: 1-8 *Millettia tanaensis*, 9-15 *Oncoba dentata*, 16-23 *Detarium le-testui*.

Plate CVIII: 1-7 *Kiggelaria africana*, 8-12 *Sarcophrynium brachystachyum*, 13-20 *Cassia longiracemosa*.

Plate CIX: 1-7 *Tephrosia nana*, 8-14 *Tephrosia elata*, 15-19 *Dissomeria crenata*. 

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Plate CX: 1-8 Homalium buchholzii, 9-14 Cassia burttii, 15-20 Copaifera carrissoana.

Plate CXI: 1-7 Vepris eugeniiifolia, 8-15 Cynometra pedicellata, 16-20 Aphloia theiformis.

Plate CXII: 1-6 Hymenostegia afzelii, 7-9 Placodiscus amaniensis, 10-12 Nauclea diderrichii.

Plate CXIII: 1-3 Microdesmis sp., 4-5 Rinorea welwitschii, 6-7 Rinorea oblongifolia, 8-15 Pericopsis laxiflora.

Plate CXIV: 1-6 Baphia obovata.

17. Stephanoporate

Plate CXV: 1-3 Funtumia latifolia.

18. Stephanocolpate

Plate CXVI: 1-7 Borreria densiflora, 8-9 Borreria ruelliae, 10-11 Sesamum indicum.

Plate CXVII: 1-4 Afzelia quanzensis.

Plate CXVIII: 1-6 Diodia scandens.

Plate CXIX: 1-5 Mitracarpus hirtus, 6-9 Sesamum angustifolium.

Plate CXX: 1-6 Diodia aulacosperma, 7-14 Mitracarpus verticillatus.

19. Stephanocolporate

Plate CXXI: 1-7 Atroxima afzeliana.

Plate CXXII: 1-7 Securidaca longopedunculata.

20. Heterocolporate

Plate CXXIII: 1-6 Combretum aculeatum, 7-12 Terminalia brownii, 13-17 Combretum gueinzii, 18-23 Terminalia aemula, 24-29 Guiera senegalensis, 30-35 Pteleopsis diptera.

21. Periporate

Plate CXXIV: 1-4 Plantago lanceolata, 5-8 Celosia stuhlmanniana, 9-11 Celosia patentiloba, 12-14 Celosia trigyna, 15-18 Drymaria cordata, 19-22 Plantago major.

Plate CXXV: 1-3 Calystegia sepium, 4-5 Costus spectabilis.
Plate CXXVI: 1-3 *Plantago palmata*, 4-7 *Dicranolepis oligantha*.

Plate CXXVII: 1-4 *Bosqueia manongarivensis*, 5-8 *Ipomoea donaldsonii*.

Plate CXXVIII: 1-4 *Lychnis* sp., 5-6 *Hewittia sublobata*.

Plate CXXIX: 1-2 *Ipomoea ochracea*, 3-6 *Cerastium indicum*. 
Table 1: List of pollen species shown on plates ordered alphabetically by family, genus and species.

| Family          | Species                  | Plate |
|-----------------|--------------------------|-------|
| Acanthaceae     | Avicennia nitida         | LXIV  |
| Acanthaceae     | Avicennia officinalis     | LXXX  |
| Acanthaceae     | Justicia cordata         | XXVI  |
| Acanthaceae     | Justicia flava           | XXVI  |
| Achariaceae     | Caloncoba angolensis      | LXX   |
| Achariaceae     | Dasylepis assinensis     | LXV   |
| Achariaceae     | Grandidiera boivinii     | LVII  |
| Achariaceae     | Kiggelaria africana      | CVIII |
| Aizoaceae       | Sesuvium sessile         | XXVIII|
| Amaranthaceae   | Alternanthera nodiflora  | VII   |
| Amaranthaceae   | Alternanthera repens     | VII   |
| Amaranthaceae   | Celosia patenitloba      | CXXIV |
| Amaranthaceae   | Celosia stuhlmanniana    | CXXIV |
| Amaranthaceae   | Celosia trigyna          | CXXIV |
| Amaryllidaceae  | Crinum pauciflorum       | XXI   |
| Amaryllidaceae  | Crinum powellii          | XXI   |
| Anacardiaceae   | Lannea humilis           | LXXV  |
| Anacardiaceae   | Lannea stuhlmannii       | LXVI  |
| Anacardiaceae   | Lannea triphylla         | LXXV  |
| Anacardiaceae   | Sclerocarya birea        | LXXV  |
| Anacardiaceae   | Spondias mombin          | LXXVI |
| Annonaceae      | Artabotrys likimensis    | XVI   |
| Annonaceae      | Piptostigma mayumbense   | VIII  |
| Annonaceae      | Uvaria kirkii            | XI    |
| Annonaceae      | Uvariopsis congensis     | IV    |
| Aphloiacae      | Aphloia theiformis       | CXI   |
| Apocynaceae     | Baissea multiflora       | XXIV  |
| Apocynaceae     | Baissea multiflora       | XXVIII|
| Apocynaceae     | Funtumia latifolia       | CXV   |
| Apocynaceae     | Motandra guineensis      | XXIV  |
| Apocynaceae     | Tabernaemontana retusa   | XCI   |
| Apocynaceae     | Tabernaemontana ventricosa| LXX  |
| Apocynaceae     | Tylophora sylvatica      | XV    |
| Aquifoliaceae   | Ilex milis               | XLI   |
| Araceae         | Culcasia dinklagei       | LXXXI |
| Araceae         | Lemna gibba              | XIV   |
| Araceae         | Rhektophyllum congense   | XCVII |
| Arecaeeae       | Ancistrophyllum laurentii| XVIII |
| Arecaeeae       | Ancistrophyllum secundiflorum| XVIII|
| Arecaaeae       | Borassus aethiopum       | VII   |
| Arecaaeae       | Borassus aethiopum       | XIX   |
| Arecaaeae       | Borassus machadonis      | XIX   |
| Arecaaeae       | Calamus erectus          | XVIII |
| Arecaeeae       | Calamus gracilis         | XVIII |
| Arecaaeae       | Elaeis guineensis        | XVIII |
| Arecaaeae       | Eremospatha sp.          | XIX   |
| Arecaeeae       | Hyphaene natalensis      | XIX   |
| Arecaaeae       | Hyphaene ventricosa      | XIX   |
| Family         | Species                          | Volume |
|---------------|----------------------------------|--------|
| Arecaceae      | Phoenix reclinata                | XVIII  |
| Arecaceae      | Raphia farinifera                | XVIII  |
| Arecaceae      | Raphia ruß                              | XVIII  |
| Asparagaceae   | Asparagus falcatus                | XX     |
| Asparagaceae   | Chlorophyllum floribundum         | XX     |
| Asparagaceae   | Dracaena camerooniana             | XX     |
| Asparagaceae   | Dracaena reflexa                  | XXI    |
| Asteraceae     | Artemisia judaica                 | XCI    |
| Asteraceae     | Artemisia sp.                     | XCI    |
| Asteraceae     | Centaurea dimorpha                | LXXXIX |
| Boraginaceae   | Heliotropium bacciferum           | XLIV   |
| Boraginaceae   | Heliotropium subulatum            | XLIV   |
| Boraginaceae   | Trichodesma africanum             | XCI    |
| Boraginaceae   | Trichomonas mandiocanum           | VII    |
| Brassicaceae   | Farsetia stenopectera             | XXXV   |
| Burseraceae    | Canarium schweinfurthii           | XLIII  |
| Burseraceae    | Commiphora campestris             | XLIX   |
| Burseraceae    | Commiphora scheffleri             | L      |
| Cannabaceae    | Celtis integrifolia               | XXXIV  |
| Cannabaceae    | Celtis mildbraedii                | XXXIII |
| Cannabaceae    | Celtis zenkeri                    | XXXIII |
| Cannabaceae    | Trema guinensis                   | XXIV   |
| Cannabaceae    | Trema orientalis                  | XXIV   |
| Capparaceae    | Ritchiea capparoides              | LXI    |
| Capparaceae    | Ritchiea fragariodora             | XCIX   |
| Cardioteridaceae| Leptaulus daphnoides             | XXXII  |
| Caryophyllaceae| Cercastium indicum               | CXXIX  |
| Caryophyllaceae| Drymario cordata                  | CXXIV  |
| Caryophyllaceae| Lychnis sp.                      | CXXVIII|
| Celastraceae   | Cassine parvifolia                | C      |
| Celastraceae   | Elaeodendron buchanani            | XCV    |
| Celastraceae   | Hippocratea affinis               | LV     |
| Celastraceae   | Hippocratea africana              | LVII   |
| Celastraceae   | Maytenus senegalensis             | LV     |
| Celastraceae   | Salacia kraussii                  | LV     |
| Celastraceae   | Salacia pyriformis                | CIV    |
| Centropoleaceae| Centropoleus glaucinus            | XLV    |
| Chrysobalanaceae| Afrolicania elaeosperma       | XCVIII |
| Chrysobalanaceae| Parinari curatelifolia            | XLII   |
| Chrysobalanaceae| Parinari holstii                  | XLVIII |
| Combretaceae   | Combretum aculeatum               | CXXIII |
| Combretaceae   | Combretum guinezi                 | CXXIII |
| Combretaceae   | Guiera senegalensis               | CXXIII |
| Combretaceae   | Pteleopsis diptera                | CXXIII |
| Combretaceae   | Strephonema pseudocola            | LIX    |
| Combretaceae   | Terminalia aemula                 | CXXIII |
| Combretaceae   | Terminalia brownii                | CXXIII |
| Commelinaceae  | Anellema johnstonii               | XXI    |
| Commelinaceae  | Commelina africana                | XXI    |
| Connaraceae    | Agelaea heterophylla              | LV     |
| Convolvulaceae | Calystegia sepium                 | CXXV   |
| Convolvulaceae | Convolvulus trubutanus            | CVI    |
| Convolvulaceae | Hewittia sublobata                | CXXVIII|
Convolvulaceae  Ipomoea donaldsonii  CXXVII
Convolvulaceae  Ipomoea ochracea  CXXIX
Costaceae  Costus spectabilis  CXXV
Davalliaceae  Nephrolepis biserrata  X
Davalliaceae  Nephrolepis exaltata  X
Dichapetalaceae  Dichapetalum mossambicense  XXXI
Dichapetalaceae  Dichapetalum stuhlmannii  XXXIV
Dilleniaceae  Tetracera alnifolia  XXXVII
Dipterocarpaceae  Monotes kerstingii  LXXII
Ebenaceae  Diospyros abyssinica  XCVII
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