

https://dspace.org/

Preliminary study of the Karroo palynology in the Mid-Zambezi Basin, Rhodesia

Falcon, R M S

2015-01-20
http://hdl.handle.net/10539/16645

Downloaded from a DSpace repository. https://dspace.org/

cryptogams and Gangamopterids. The latter group are known to be associated with tillites in other regions (South Africa, Plumstead, 1967), and their presence obviously infers a cold to frigid climate. The abundance of lower orders and the knowledge of glaciation in the vicinity also implies a very wet environment.

2. During Black Shales and Coals and Upper Wankie Sandstone deposition - the prevailing macroflora consists of a mixture of vascular cryptogams, and increasing evidence of Proto-conifers and Glossopteride. Gangamopterids gradually decrease in abundance which is evidence of amelioration of the climate. The wet conditions obviously continue to prevail, supporting the abundant mixed flora which initially gave rise to the coal and carbonaceous horizons.

3. During Madumabisa times, the gradual dominance of pollens, and in particular Striatiti, infers the presence of the true Glossopteris flora. Triletes, Monocolpates and non-striate disaccites indicate that cryptogams, cycado-ginkgopsids and protoconifers are well

established in the macrofloral assemblage. The abundance of wind-disseminated gymnospermous pollen and the plant forms associated with them indicate the existence of large gymnospermous woodlands with possibly a smaller percentage of cryptogams living on the edge of the pools and swamps known to exist at that time. The seasonal production of miospores (suspected by Plumstead, 1967) and the deciduous fall of leaves indicates a seasonal change in climate. This view is supported by the growth rings of trees known to occur in correlated horizons. Fluctuation of warm to cold seasons are therefore indicated.

These interpretations must be regarded as tentative, as future basin analysis will give a more reliable set of facts on which to base climatic and ecological conditions. A single borehole core is subject to local ecological and edaphic factors and is thus not reliable for regional analyses.

6. SUMMARY AND CONCLUSIONS

1. The Matabola Flats borehole core, Mid-Zambezi Valley, Rhodesia was sampled for the maceration and extraction of miospores. The borehole core is 1 206 ft deep, and passes through Madumabisa Shales, Upper Wankie Sandstones, Black Shales and Coals, Lower Wankie Sandstones, Dwyka, Sijarira Sandstones (Basement).

2. A standardised maceration schedule was compiled from a series of experiments on Karroo rocks. 105 samples were processed, of which 45 per cent proved to be productive and in a suitable condition for analysis.

3. Microscopic analysis and a photographic catelogue (in contact print form) were completed. 55 genera and 100 species were described and classified along the lines of the three basic "schools" of systematics whose work has been published in Southern Africa.

4. From the microscopic analysis, quantitative and qualitative results were obtained. From this the microfloral trends of the major miospore taxa were drawn, and the stratigraphic ranges of the individual species compiled.

5. From this synthesized information, a tentative zonal scheme was drawn up for adaption and use in future correlation.

6. It was concluded from palynological evidence that the sequences in the Matabola Flats borehole core were typical of Lower to Middle Gondwana Assemblages.

7. Four miospore assemblages are distinct with three transition zones between them. These were correlated with the Florizones of South Africa (compiled by G.F. Hart, 1967) and coincide (very closely) in all but the Dwyka. This confirms Bond's South African equivalent age proposals for the Rhodesian stratigraphic units, based on other evidence. Other comparisons were drawn in Africa and abroad in Gondwanaland, implying that quantitatively and qualitatively similar microfloral assemblages are known from Madagascar, India, Australia and Antarctica during Lower Gondwana times.

8. Three major climatic phases are presumed to have evolved during the times of the Matabola Flats sedimentation, based on climatic and macrofloral evidence. That climatic changes occurred is confirmed by the microfloral assemblage changes. Climates may be interpreted to a certain degree by the inferred macroplant affinities - the earliest climate supported abundant vascular cryptogams (Triletes) with cold-loving gangamopterid elements (Monosaccites).

During Black Shales and Coals and Upper Wankie Sandstone, the apparent association of Protoconifers (non-striate disaccates), Cycado-ginkgopsids (Monocolpates) and vascular cryptogams (Triletes) with the consistent appearance of Glossopterid (Striatiti) members indicates a mixed flora existing in what must have been a wet but cool climate following the glacial epoch. The waning of the Gangamopterid (Monosaccites) elements also indicates an ameliorating climate.

During Madumabisa Mudstone times the dominance of pollens, indicating the presence of Protoconifers (non-striate disaccates), Glossopterid (Striatiti), Cycado-ginkgopsid (Monocolpate) elements, with minor vascular cryptogams (Triletes) in the macrofloral assemblage infers a drier, warmer climate. The fact that these pollens are associated with plants known to be deciduous seasonal distributors of pollen and leaves also infers a distinct seasonal change from warm to cold.

9. The conclusions drawn so far illustrate the potential of palynology in Rhodesia. Gaps exist where horizons are unproductive or too highly carbonaceous to yield satisfactory results. Further work throughout the entire stratigraphic sequence, and study of the microflora at species level can indeed serve to fill in the gaps of knowledge still existing in Southern Africa palynological research today.

7. ACKNOWLEDGEMENTS

The author would like to express her sincere thanks to a number of people for their invaluable help, advice and unstinted support.

On the academic side, much appreciation is extended to Professor G. Bond of the University of Rhodesia, Salisbury, who supplied the material and under whose guidance and encouragement this work was undertaken. To him and his (very willing and able) Technical Assistants, Messrs. Jack Locke, sincere thanks are extended for the tremendous assistance in initially evolving an extraction technique and processing all the macerated samples. At the University of the Witwatersrand, (Bernard Price Institute of Palaeontology) where this work continued after leaving Salisbury, equally sincere thanks are extended to Dr. E.P. Plumstead, who supervised this work and for her patient and helpful advice. To Dr. A.R.S. Cruikshank much appreciation is owed for his keen interest in this work, and for obtaining a senior bursary in order to assist financially in the latter months of writing. To Mr. J. Anderson, and Dr. H. Pienaar, thanks are due for the initial encouragement in this field of research and subsequent discussion, and likewise thanks are extended to Dr. B.E. Balme, Dr. M. Muir, Dr. B. Owens, Dr. J. Utting, Dr. W.S. Lacey and Dr. E. Kemp for helpful advice via correspondence in the initial stages of this study.

All this was especially appreciated when the work began in Salisbury, Rhodesia, due to limited literature and experience in this branch of research.

Due to the fact that most of this research was conducted at home, it is regarded as pertinent to mention my sincere thanks to all my family for their encouragement and patient understanding.

To my husband in particular, I owe a tremendous debt of gratitude for his strong backing. His help in processing and printing 1 450 photographs at home, and his ready suggestions and advice in all fields have been a great source of encouragement.

Finally, thanks are extended to Mr. J. Weatherall for plate reproductions, to Mrs. E. Stevenson for so ably typing the manuscript of this thesis, and to Mrs. M. Crews for assisting in drafting the charts and figures.

8. BIBLIOGRAPHY

AUTHOR	DATE	
ALPERN, B.	1964	"La Stratigraphie Palynologique du Stephanien et du Permien" 5e Cong. Int. de Strat. et Geol. Carbonifere compte rendu. 3, p. 1119-1129.
————	1970	"Les Divisions palynologiques du Westphalien superior et la limite Westphalien - Stephanien" Colloque sur la Stratig. du Carbonif., 55, (C.I.M.P.)
BAIN, G.W.	1970	"Position for the Magnetic Pole during the Permian Period" Second Gondwana Symposium, South Africa.
BALME, B.E.	1952	"The Principle Microspores of the Permian Coals of Collie, Western Australia" Geol. Surv., Bull., No. 105, part 1, p. 154-201.
————	1957	"Upper Palaeozoic Microflora in Sediments from the Lake Phillipson Bore, South Australia" Aust. J. Sci., 20, (2), p. 61.
————	1959	"Some Palynological Evidence Bearing on the Development of the Glossopteris Flora": In The Evolution of Living Organisms. p. 269-280.

AUTHOR	DATE	
BALME, B.E. (Contd.)	1960a	"Upper Devonian (Frasnian) spores from the Carnavon Basin, Western Australia". The Palaeobotanist 9, (1 and 2).
————	1960b	"Notes on some Carboniferous spore assemblages from Western Australia". C.R. IVe Congr. Strat. Carb. Heerlen, p. 25-31.
————	1963	"Plant microfossils from the Lower Triassic of Western Australia". Palaeontology, 6, (1), p. 12-40.
————	1964b	"The Palynological record of Australian Pre-Tertiary Floras" in Ancient Pacific Floras, University of Hawaii Press, p. 49-80.
————	1966	"Palynology of Permian and Triassic strata in the Salt Range and Trans-Indus Range, West Pakhistan" (M.S.).
BALME, B.E. AND BUTTERWORTH, M.A.	1952	"Stratigr. Significance of certain fossil spores in Central Group of British Coalfields". Trans. Instit. of Mining Eng., 3, (2).

AUTHOR	DATE	
BALME, B.E. AND HENNELLY, J.P.E.	1955	"Bisaccate sporomorphs from Australian Permian coals". - Aust. J. Bot. 3, (1), p. 89-98.
———	1956a	"Monolete, monocolpate and alete sporomorphs from Australian Permian sediments". - Aust. J. Bot. 4, (1), p. 54-67.
———	1956b	"Trilete sporomorphs from Australian Permian sediments". - Aust. J. Bot. 4, (3), p. 240-260.
BALME, B.E. AND PLAYFORD, G.	1967	"Late Permian plant microfossils from the Prince Charles Mountains, Antarctica". Rev. de Micropalaeont., 10, (3), p. 179-192.
BALME, B.E. AND SEGHOVES, K.	1966	"Peltacystia gen. nova: a microfossil of uncertain affinities from the Permian of Western Australia". J. of Roy. Soc. Western Australia, 49, (1), p. 26-31.
BALME, B.E. AND HASSELL, C.W.	1962	"Upper Permian spores from Canning Basin, Western Australia". Micropalaeontology 8, (1), p. 1-28.

AUTHOR	DATE	
BANDYOPADHYAY, N.N.	1967	"Sporological Studies and Mio-floristic Provinces of the Lower Gondwanas of India and Stratigraphical Evaluation". UNESCO Gondwana Symposium Mar. del Plata., Argentina, p. 5-6.
BHARADWAJ, D.C.	1955	"Spore Genera from the Upper Carboniferous Coals of the Saar and their value in Stratigraphic Studies". Palaeobotanist 4, p. 119-149.
———	1962	"The miospore genera in the coals of Raniganj Stage (Upper Permian), India" — Palaeobotanist 9, (1), p. 68-106.
———	1964	"Potonieisporites Bhard., Ihre Morphologie, Systematik, und Stratigraphie". Fortschr. Geol. Rheinld. U. Westf., 12, p. 545-554.
———	1966	"Distribution of spores and pollen grains dispersed in the Lower Gondwana Formations of India". Symp. of Flor. and Stratig. of Gondwanaland, p. 69-84.

AUTHOR	DATE	
BHARADWAJ, D.C. AND TIWARI, R.S.	1964	"On two monosaccate genera from Barakar Stage of India". Palaeobotanist 12, p. 139-146.
————	1970	"Palynological Sub-division of the Gondwana Sequence in India". Second Gondwana Symposium, South Africa.
BHARADWAJ, D.C. AND SAIJUHA, S.K.	1964	"Sporological Study of Seam VIII in the Raniganj Coalfield, Bihar (India) - Part 1. Description of spores dispersae". Palaeobotanist 12, (1-2), p. 181-215.
BOND, G.	1952	"The Karroo System in Southern Rhodesia". Sym. Gondwana XIXe Cong. Geol. Internat. Alger., p. 209-222.
————	1954	"The Lamellibranchia and Plants from the Lower Karroo Beds of Northern Rhodesia". Geol. Mag., 91, 3, p. 189-192.
————	1955	"The Madumabisa (Karroo) Shales in the Middle Zambezi Region". Trans. Geol. Soc. S. Afr., 58, p.-71-99.
————	1967	"A Review of Karroo Sedimentation and Lithology in Southern Rhodesia". I.U.G.S. Reviews for the first Symposium on Gondwana stratigraphy, Mar del Plata, Argentina.

AUTHOR	DATE	
BOND, G. (Contd.)	1970	"The Dwyka Series in Rhodesia". Proc. Geol. Assoc. (London) 81, 3, p. 463-472. (Read Memorial Volume.)
BOND, G. AND STOCKMAYER, U.R.C.	1967	"Possible Ice Margin Fluctuations in the Dwyka Series in Rhodesia". Palaeogeography, Palaeoclimatology, Palaeoecology 3, (1967).
BOSE, M.N. AND KAR, R.K.	1966	"Palaeozoic spores dispersal from the Congo. I-Kindu-Kalima and Walikale Regions". Mus. Roy. Afr. Cent. Série in 8° Sciences Geologiques, 53, p. 1-238.
———	1967	"Palaeozoic spores dispersal from Congo. III - On some new miospore genera. Ann. Mus. Roy. Afr. Cent. Série in 8° Sciences Geologiques, 54, p. 87-104.
BOSE, M.N. AND MAHESHWARI, H.K.	1966	"Palaeozoic spores dispersal from Congo. II - The Epulu River (Ituri)." Ann. Mus. Roy. Afr. Centr. Série in 8° Sciences Geologiques, 53, p. 241-250.

AUTHOR	DATE	
BOSE, M.N. AND MAHESHWARI, H.K. (Contd.)	1968	"Palaeozoic spores dispersal from Congo. VII Coal Measures near Lake Tanganyika, South of Albertville". Ann. Mus. Roy. Afr. Centr. Série in 8° Sciences Geologiques, 60, p. 1-116.
CAHEN, M.	1954	Géologie du Congo Belge - Liege - Chap. XI, p. 277-300. H. Vaillant-Carmarre, Liege.
CHAPPELL, J. AND HUMPHREYS, M.	1970	"Glacial Sedimentation in the Lower Karroo, Mid-Zambezi Valley, Rhodesia". Second Gondwana Symposium, South Africa.
CLARKE, R.F.A.	1965	"British Permian saccate and monosulcate miospores". Palaeontology 8, (2), p. 322-354.
CREER, K.M.	1970	"Review and Interpretation of Palaeomagnetic Data from the Gondwana Continents". Second Gondwana Symposium, South Africa.
CROWELL, J.C. AND FRAKES, L.A.	1970	"Ancient Gondwana Glaciations". Second Gondwana Symposium, South Africa.

AUTHOR	DATE	
DRYSDALE, A. AND KITCHING, J.	1963	"Re-examination of the Karroo Succession and fossil localities of part of the Upper Luangwa Valley, Zambezi". Geol. Survey, Zambia, (Northern Rhodesia).
DRYSDALE, A. AND WELLER, J.N.	1966	"Karroo Sedimentation in Northern Rhodesia". Geol. Survey, Northern Rhodesia, (Zambia), LXIX, p. 39-69.
ERDTMANN, G.	1943	An introduction to Pollen Analysis: Waltham, Mass., Chronica Botanica Co., p. 239.
_____	1947	"Suggestions for the Classification of fossil and recent pollen grains and spores". Svensk. bot. Tidskr. 41, p. 104-114.
EVANS, P.R.	1967	"Upper Carboniferous and Permian palynological stages and their distribution in Eastern Australia". Bur. of Min. Res. (Australia), Report No. 1967/99.
FAEGRI, K. AND IVERSEN, J.	1950	Textbook of Modern pollen Analysis. Copenhagen, Munksgaard, p. 168.
FALCON, R.	1969	"Preliminary report on techniques investigated for use on Lower Karroo Rocks". Unpublished report, University of Rhodesia, Salisbury.

AUTHOR	DATE	
FELIX, C.J.	1963	"Mechanical Sample Disaggregation in Palynology". Micropalaeontology, 9.
FRAKES, L.A.	1970	"Glaciations and Associated circulation effects resulting from late Palaeozoic Drift of Gondwana". Second Gondwana Symposium, South Africa.
FRAKES, L.A. AND CROWELL, J.C.	1969	"Late Palaeozoic Glaciation I, South America". Geological Society of America Bulletin.
_____	1970	"Late Palaeozoic Glaciation II, Africa exclusive of the Karroo Basin". Geological Society of America Bulletin.
GHOSH, A.K. AND SASTRI, M.V.A.	1967	"A Review of the Lower Gondwanas of India". Geological Survey of India. First Symposium on Gondwana Stratigraphy, Mar del Plata, Argentina.
GHOSH, A.K. AND SEN, J.	1958	"A Study of the Microfossils and the Correlation of some productive Coal Seams of the Raniganj Coalfield, Bengal, India". Trans. Min. Geol. Inst., India, 43, (2), p. 67-98.

AUTHOR	DATE	
GOUBIN, N.	1965	"Description et repartition de principaux pollenites permiens, triasiques et jurassiques des Sondages du Bassin de Morondava (Madagascar)". Rev. de l'Inst. Francais du petrole et Annales des combustibles liquides XX (10), p. 1415-1461.
GOUGH, D.I.	1970	"Did an Ice Cap Break Gondwanaland?" Journal of Geophysical Research, 75, (23).
GRAY, J.	1965	"Palynological Techniques" in Handbook of Palaeontological Techniques. W.H. Freeman and Co., New York.
HART, G.F.	1960	"Microfloral Investigations of the Lower Coal-Measures (K2); Ketewaka - Mchuchuma Coalfield, Tanganyika". Bull. Geol. Surv. Tanganyika, 30, p. 1-18.
———	1962	"Palynology - The Key to Stratigraphy". South African Journal of Science, 58, No. 12, p. 365-374.
———	1963a	"A probable pre-Glossopteris microfloral assemblage from Lower Karroo sediments". South African Journal of Science 59, (5), p. 135-146.

AUTHOR	DATE	
HART, G.F. (Contd.)	1963b	"Microflora from the Mchuchuma-Ketewaka Coalfields, Tanganyika". Geol. Surv., Tanganyika, Bull. 36.
———	1964a	"A Review of the Classification and distribution of the Permian miospore; Disaccate Striatiti". C.R. Vº Congr. Strat. Carb., Paris, p. 1171-99.
———	1964b	"A Review of the Classification and distribution of the Permian miospore taxons; Disaccate Disaccitrilete". Submitted to the Geologischen Jahrbuch, Hanover.
———	1965a	"Chosgotriletes from the Lower Permian of South Africa". Annals Geol. Surv., South Africa, 3, (1964), p. 149-157.
———	1965b	"The microfloral succession of the coal-bearing Karroo rocks from the Mchuchuma River Valley, Ketewaka-Mchuchuma Coalfield, Tanzania". Bull. Geol. Surv., Tanganyika, 36, p. 1-27.
———	1965c	The Systematics and Distribution of Permian Miospores. Text-books: University of Witwatersrand Press, Johannesburg.

AUTHOR	DATE	
HAUGHTON, S.H. (Contd.)	1970	"A Review of the Gondwana (Karroo) System in Southern Africa". Second Gondwana Symposium, South Africa.
HELBY, R.J.	1966	"Sporologische Untersuchungen an der Karbon/Perm-Grenze im Pfälzen Bergland". Fortschr. Geol. Rheinld. U. Westf. 13, 1, S. 645-704.
———	1968	"The Carboniferous-Permian Boundary in Eastern Australia. An interpretation on the basis of Palynological Information." Spec. Publs. Geol. Soc., Australia, 2, p. 69-72, 1969.
HELBY, R.J. AND PLAYFORD, G.	1968	"Spores from a Carboniferous section in the Hunter Valley, New South Wales." Jour. Geol. Soc., Australia, 15, (1), p. 103-119.
	1970	"Preliminary Palynological Study of Kutting Sediments in Central Eastern New South Wales." Rec. of Geol. Surv., New South Wales, 11, (1), p. 5-14.
HENNELLY, J.F.F.	1958	"Spores and pollens from a Permian-Triassic transition. New South Wales, Australia." Linn. Soc., New South Wales, Proc., 83, (3), p. 363-369.

AUTHOR	DATE	
HOEG, O.A. AND BOSE, M.M.	1960	The Glossopteris flora of the Belgian Congo." Ann. Mus. Roy. du Congo Belge, Tervuren (Belg.) Ser. in 8, Sci. geol., 32, p. 1-106.
JANSONIUS, J.	1962	Palynology of Permian and Triassic sediments, Peace River Area, Western Canada." Palaeontographica, 110 (B), p. 35-98.
JERSEY, N.J. de	1962	Triassic spores and pollen grains from the Ipswich Coalfield, Queensland." Geol. Survey, Publ., No. 307, p. 1-18.
KAR, R.K.	1966	Palynology of the Barren Measures Sequence from Jharia Coalfield, Bihar, India." Summary and Discussion." Symp. of Flor. and Strat., of Gondwanaland, p. 121-127.
———	1967	Palaeozoic spores dispersal from Congo, VI - On the organisation of Monosaccate pollen grains." Ann. Mus. Roy. Afr. Centr. Série in 8° Sciences Geologiques, 54, p. 117-123.

AUTHOR	DATE	
KAR, R.K. AND BOSE, M.N.	1967	"Palaeozoic spores dispersed from Congo, III - Assise des schistes noirs de la Lukuga." Ann. Mus. Roy. Afr. Centr. Série in 8° Sciences Geologiques, 54, p. 1-87.
KITCHING, J.W.	1970	"A Short Review of the Beaufort Zoning in South Africa." Second Gondwana Symposium, South Africa.
LACEY, W.S.	1959	"Occurrence of presumed Glossopteridean Fructifications in Rhodesia and Nyasaland." Nature 184, p. 1592-1593.
———	1961	"Studies in the Karroo Floras of Rhodesia and Nyasaland Part 1. A geological account of the plant bearing deposits." Proc. and Trans. Rhodesia Sci. Assoc. 49, Pt. 1, p. 26-53.
LACEY, W.S. AND HUARD-MOINE, D.	1966	"Karroo Floras of Rhodesia and Nyasaland, Part 2. The Glossopteris Flora in the Wankie District of Southern Rhodesia." Symposium on Floristics and Stratigraphy of Gondwanaland, p. 13-25, Birbal Sahrni Inst. of Palaeobot., Lucknow, India.

AUTHOR	DATE	
LACEY, W.S. AND HUARD-MOINE, D.	1969	"Karroo Floras of Rhodesia and Malawi, Part 3. Glossopteris flora in Tangadzi River, Southern Malawi. New Records of Plants in the Lower Karroo of Southern Rhodesia and Malawi." Ibid.
LEE, H.W	1964	"A modified method of Coal Maceration." Micropalaeontology 10, (4).
LELE, K.M.	1964	"Studies in the Talchir Flora of India: 2. Resolution of the Spore Genus Nuskoleporites, Potonie and Klaus." Palaeo-botanist, 12 (2), p. 147-168.
———	1966	"Studies in the Talchir Flora of India - 4. Quest for the early traces and subsequent development of the Glossopteris flora in the Talchir stage." Symp. on Flor. and Strat. of Gondwanaland. Birbal Sahrii Institute, Lucknow.
LELE, K.M. AND MAITHY, P.K.	1964	"An unusual Monosaccate spore from the Karharbari Stage, Giridih Coalfield, India." The Palaeobotanist, 12, (3), p. 307-312.

AUTHOR	DATE	
LESCHIK, G.	1959	"Sporen aus den "Karru-Sandsteinen" von Norronaub (Südwest-Afrika)." Senckenberg leth. 40, (2), p. 51-95.
MAHESHWARI, H.K.	1966	"Note on a miospore assemblage from Gropat River Valley, M.P." "Curr. Sc.", April, 36, (7).
———	1966	"Studies in the Glossopteris Flora of India 29. Miospore assemblage from the Lower Gondwana Exposures along Banshoi River in Rajmahal Hills, Bihar." Palaeobotanist 15, (3), p. 258-280.
MAITHY, P.K.	1966	"Studies in Glossopteris Flora of India - 33; Fossil plants and Miospores from the Coal-bearing beds of Umaria Coal-fields." Palaeobotanist, 15, (1-3), p. 52-60.
MONTNLAY, A.C.M.	1954	"Geology of the Ketewaka-Mchuchuma Coalfield, Njombe District." Tang. Geol. Surv. Bull. 21.

AUTHOR	DATE	
MENENDEZ, C.A.	1967	"Palynological record of Pre-Tertiary Floras from Argentina." UNESCO First Gondwana Symposium Mar del Plata, Argentina, Reviews, p. 13.
NAVALE, G.K.B.	1965	"Petrographic and sporological studies of some coals from Talchir Coalfields, Orissa, India." Palaeobotanist, 14, (1-3), p. 61-69.
NAVALE, G.K.B. AND TIWARI, R.S.	1966	"A preliminary sporological analysis of some Coalfields from Talchir Coalfield, India." Palaeobotanist, 15, (1-2), p. 47-51.
NEVES, R.	1958	"Upper Carboniferous Plant Spore Assemblages from the Gastrioceras Subcrenum horizon, North Staffs." Geol. Mag. Vol. XCV., No. 1.
NEVES, R. AND DALE, A.	1963	"A modified filtration system for palynolog. preparations." Nature 198, (4882).
PANT, D.D.	1955	"On two new disaccate spores from the Rachhus Marsh Tillite, Victoria (Australia)." Ann. Mag. Nat. Hist., (12), 8, p. 757-764.
_____	1958	"The structure of some leaves and fructifications of the Glossopteris flora of Tanganyika." Bull. Mus. (Nat. Hist.) Geol. 3, (4)

AUTHOR	DATE	
PANT, D.D. (Contd.)	1958	"Structure of some roots and spores from the Lower Gondwana (Permo-Carboniferous) of East Africa." Vijnana Parishad Anusandhan Patrika, Allahabad, India, 1, (4), p. 231-244.
PANT, D.D. AND MEHRA, B.	1963	"On the occurrence of Glossopterid spores in the Bacchus Marsh Tillite, Victoria, Australia." Grana Palynologica 4, (1), p. 1-120.
PIERART, P.	1959	"Contribution a l'étude des spores et pollens de la flore à Gloseopteris contenue dans les charbon de la Luena (Katanga)." Acad. R. Sci. Colon., Mem. 8, (4), p. 1-80.
_____	1966	"Remarques sur quelques genres et especes de spores dispersae du Gondwana inférieur (sub-turma Monosaccites)." Symp. on Flor. and Strat. of Gondwanaland, Birbal Sahni Institute, Lucknow.
PLAYFORD, G. AND DETTMAN, M.E.	1965	"Rhaeto-Liassic plant microfossils from the Leigh Creek Coal Measures, South Australia" - Senckenberg. leth. 46, p. 127-81.

AUTHOR	DATE	
PLAYFORD, G. AND HELBY, R.	1968	"Spores from a Carboniferous Section in the Hunter Valley, New South Wales." Journ. Geol. Soc., Australia, 15, (1).
POTONIE, R. AND LELE, K.M.	1961	"Studies in the Talchir flora of India - I. Sporae dispersae from the Talchir beds of South Rewa Gondwana Basin." Palaeobotanist, 8, (1-2), p. 22-37.
POTONIE, R. AND KREMP, G.	1955	"Die sporae dispersae des Rhurkabons ihr Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte. Teil I." Palaeotographica, 98, (B), p. 1-136.
———	1956a	"Die sporae dispersae des Rhurkabons ihr Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte. Teil II." Ibid, 99, (B), p. 85-191.
———	1956b	"Die sporae dispersae des Rhurkabons ihr Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte. Teil III." Ibid, (C), p. 65-121.

AUTHOR	DATE	
POTONIE, R.	1956c	"Synopsis der Gattungen der sporae dispersae. Teil I: Sporites." Beih. Geol. Jb., 23, (1-103).
PLUMSTEAD, E.P.	1957	Coal in Southern Africa, Witwatersrand University Press, Johannesburg, p. 1-25.
———	1962	"Fossil Floras of Antarctica." Trans-Antarctic Expedition 1955-1958. Scientific Report No. 9, 2, p. 154, London.
———	1966 a	"The Story of South Africa's Coal." Optima 16, 4, p. 186-202. Published by Anglo-American Corporation, De Beers and Charter Consolidated Groups, Johannesburg.
———	1966 b	"Recent Palaeobotanical Advances and Problems in Africa." Symposium on Floristics and Stratigraphy of Gondwanaland, p. 1-12. Birbal Sahni Inst. of Palaeoboty, Lucknow, India.
———	1967 a	"A Review of contributions to the knowledge of Gondwana Megaplant Fossils and Floras of Africa published since 1950." I.U.G.S. Reviews Gondwana Symposium, Mar del Plata, Argentina.

AUTHOR	DATE	
PRINSTEAD, E.P. (Contd.)	1967 b	"A General Review of the Devonian Fossil Plants found in the Cape System of South Africa." Palaeontologia Africana, X, 1-83, Pl. I - XIV.
————	1969	"Reflections on the earliest plant life and its great contribution to the life of today." J. Sen. Memorial volume.
————	1970	"Recent Progress and the Future of Palaeobotanical correlation in Gondwanaland." Second Gondwana Symposium, South Africa.
QUENNELL, A.M. AND AITKEN, W.G.	1956	"Summary of the Geology of Tanganyika, Part 1," Memoir No. 1., Tanganyika, 1956.
RAISTRICK, A.	1933	"The Microspores of Coal and their use in Correlation." Inst. of Min. Eng., Vol. LXXXV, (4), p. 225.
————	1934	"The Correlation of Coal Seams by Microspore Content, Part 1. Seams of Northumberland." Inst. of Min. Eng., Vol. LXXXVII, Part 3.

AUTHOR	DATE	
RAKOTOARIVELO, H.J.	1960	"Etude palynologique de quelques echantillons de houille du Bassin de la Sakoa (Madagascar), Tananarive" Serv. geol. Madagascar, p. 1-51.
———	1970	"Palynostratigraphie comparée du basin houillère de la Sakoa - Sakamena (Madagascar)." Second Gondwana Symposium, South Africa, 1970.
REINET, M.H.P.	1954	"Plant microfossils from the Coal seams near Dannhauser, Natal." Trans. Proc. Geol. Soc., South Africa, 57, p. 27-36.
SCHOPF, J.M. WILSON, L.R. AND BENTALL, R.	1944	"An annotated synopsis of Palaeozoic fossil spores and the definition of generic groups." Rep. Invest. Ill. St. Geol. Surv., 91, p. 1-73.
SEGROVES, K.R.	1967	"Anitinized microfossils of probable non-vascular origin from the Permian of Western Australia." Micropalaeontology 13, p. 289-305.
———	1970	"Saccate plant microfossils from the Permian of Western Australia." Grana Palynol. 9, p. 174-227.

AUTHOR	DATE	
SEGROVES, K.L. (Contd.)	1970	"Permian spores and pollen grains from the Perth Basin, Western Australia". Grana Palynol. 10, No. 1
————	1970	"The sequence of Palynological Assemblages in the Permian of the Perth Basin, Western Australia." Second Gondwana Symposium, South Africa.
SEN, J.	1948	"A Study of the microfossils and the Correlation of some productive coal seams of the Raniganj Coalfield, Bengal, India". Trans. Min. Geol. Inst., India, 43, (2), p. 67-95.
————	1953	"Principles and problems of microfloral correlations of Indian Coal Seams - special reference to Karharbari Coalfield". Bull. Nat. Inst. Sci., India, No. 2, p. 129-40.
SMITH, A.H.V. AND BUTTERWORTH, M.A.	1967	"Miospor- / in the Coal Seams of the Carboniferous of Great Britain". Spec. papers in Palaeontol. No. 1, (June, 1967), (The Palaeontological Association, London).

AUTHOR	DATE	
STRATTEN, T.D.	1966	"Some New Conclusions drawn from a basinal analysis of the Dwyka Series in the Karroo Basin". Palaeontolog. Afr., XI.
_____	1967	"A preliminary report on a directional study of the Dwyka tillites in the Karroo Basin of South Africa". First Gondwana Symposium, (I.U.G.S.), Mar del Plata, Argentina.
_____	1970	"Sub-Karroo Geology of the Karroo Basin in South Africa". Ibid.
_____	1970	"Tectonic framework of sedimentation during the Dwyka Period in South Africa". Second Gondwana Symposium, South Africa.
TAVENER-SMITH, R.	1962	"Karroo Sedimentation in a part of the Mid-Zambezi Valley". Trans. and Proc. of Geol. Soc., Vol. LXV, (1).
TIWARI, R.S.	1965	"Miospore assemblage in some coals of Barakar Stage (Lower Gondwana) of India". Palaeobotanist, 13, (2), p. 168-214.

AUTHOR	DATE	
TAMBOON, J.A.	1962	"On some disaccate pollen grains [illegible] Middle Jurassic age." Grana Palynologica, 3, (2), p. 13-44.
TSCHUDY, R.H. AND SCOTT, R.A.	1969	"Aspects of Palynology" (ed. R.H. Tschudy and R.A. Scott), J. Wiley and Sons, New York.
VENKATACHALA, B.S., GOUBIN, N. AND KAR, R.K.	1967	"Morphological study of Guttulapollenites, Goubin." Pollen et Spores, 9, (2), p. 357-362.
VIRKKI, C.	1939	"On the occurrence of similar spores in a Lower Gondwana tillite from Australia and Lower Gondwana Shales from India." Indian Acad. Sc. Proc., 9, p. 7-12.
———	1946	"Spores from the Lower Gondwana of India and Australia." Proc. Nat. Acad. Sci., India, 15, (4-5), Section B, p. 93-176.
WATSON, R.L.	1960	"The Geology and Coal Resources of the Country around Wankie, Southern Rhodesia." Southern Rhodesia Geol. Surv. Bull. No. 48.
———	1962	"The Geology of the North-western portion of the Wankie Coalfield, Southern Rhodesia." Geol. Surv. Short Report No. 39.

AUTHOR	DATE	
WATSON, R.L. (Contd.)	1962	"The Geology of the Kamativi and Lubimbi Areas, Southern Anoamba. Geol. Surv. Bull. No. 57.

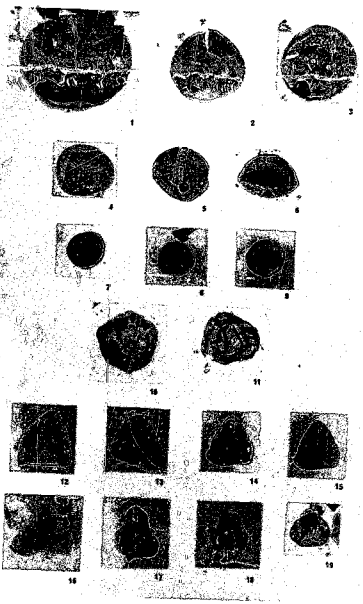
EXPLANATION TO PLATE 1 - TRILETES (LAEVIGATI)

N.B. Magnification x 500 except where stated

N.B. The reference number includes film number, negative number and sample level

Fig.	Name	Reference No. of Specimen	Notes
1-3	Punctatisporites gretensis	1-24/736/541	Semi proximal view showing general outline;
	"	2- 5/[illegible]/1006	Proximal view showing trilete suture;
		3-14/620/[illegible]	Proximal view note thick exine;
4-6	Punctatisporites gretensis forma minor	4-15/453/940	Proximal view showing general outline;
		5-43/1255/940	Proximal view showing infra-punctate sculpture in thick exine;
	"	6- 3/115/1058	Proximal view specimen folded; note trilete aperture;
7-9	Retusotriletes diversiformis	7-39/1142/853	Proximal view showing general structure;
		8-33/974/414	Proximal view showing small dark contact area around trilete suture;
	"	9-26/773/408	Proximal view showing dark contact area around trilete suture;
10-11	Calamospora plicata	10-42/1225/940	Semi-proximal view showing polygonal folding and trilete suture;
	"	11- 8/215/990	Semi-proximal view showing polygonal folding and trilete suture;
12-15	Deltoidospora directa	12-41/1216/420	Proximal view, showing general structure, laevigate exine and raised labra along trilete suture;
	"	13-27/828/408	Proximal view, showing general structure, laevigate exine and raised labra along trilete suture;
	"	14-27/806/408	Proximal view, showing general structure, laevigate exine and raised labra along trilete suture;
	"	15-27/807/408	Proximal view, showing general structure, laevigate exine and raised labra along trilete suture;
16-19	D. lukugaensis	16-22/669/537	Proximal view showing general structure, concave outline, wide labra framing trilete suture;
	"	17-21/701/537	Proximal view showing general structure, concave outline, wide labra framing trilete suture;
	"	18-29/875/408	Proximal view showing general structure, concave outline, wide labra framing trilete suture;
	"	19-37/1079/426	Sub-lateral view.

PLATE 1 - TRILETES (LAEVIGATI)

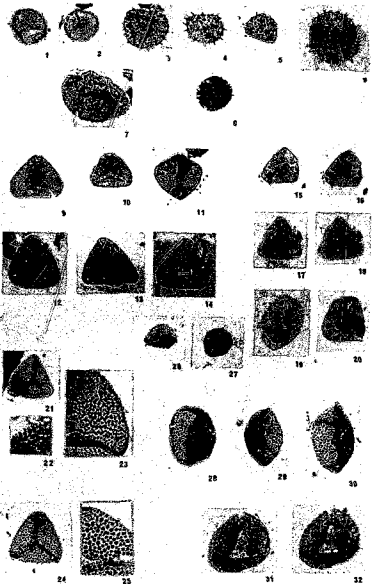


EXPLANATION TO PLATE 2.- TRILETES (APICULATE)

Magnifications x 500 except where stated

Fig.	Name	Reference No. of Specimen	Notes
1-2	Auriculatisporis levis	1- 5/67/1006	Polar view, showing laevigate proximal suture and distal and equatorial conj;
	"	2-30/921/406	Polar view, showing laevigate proximal suture and distal conj;
3-5	Auriculatisporis filiformis	3-29/879/537	Small-type distal view, showing rounded [illegible]
	"	4-43/1269/940	Distal view; irregularly placed conj;
	"	5-43/1268/940	Distal view; irregularly placed conj;
6	Auriculatisporis cornuta	6-24/715/537	Semi-proximal view; showing irregular spini;
7	Baculatisporites sp.cf. B. biarcuatus	7-41/1203/333	Lateral view, folded, showing pili and bacilli;
8	Baculatisporites comaumensis	8- 1/26/1130	Proximal view showing 5-8 angled lumen between distinct wall;
9-16	Granulatisporites trotula	9- 3/95/1064	Distal view showing regularly granulate exine;
	"	10- 2/49/1064	Proximal view showing reduced sculpture;
	"	11-42/1237/940	Equatorial view showing reduction of sculptural element proximally;
	"	12-40/1159/760	Proximal view, showing laevigate proximal exine, granulate distal exine;
	"	13-35/1044/414	Proximal view showing laevigate proximal exine, granulate distal exine;
	"	14-26/778/408	Proximal view, labrate trilete suture;
	"	15-42/1225/940	Proximal focus, laevigate proximal exine;
	"	16-42/1234/940	Distal focus, granulate distal exine;
17-20	Microbaculispora microsegnis	17-28/853/408	Proximal view partially laevigate proximal exine, micro-baculicate distal exine;
	"	18-28/854/408	Distal view; micro-baculate exine;
	"	19-31/1068/420	Equatorial view;
	"	20-36/1133/853	Distal view;
21-23	Verrucosisporites sp.cf.	21-29/792/408	Distal view, showing flat topped, polygonal, regular verrucae;
	V. praedictus/stus	22-26/793/408	(H.M. x 1000) Detail of 21 showing flat topped verrucae;
		23-26/794/408	(H.M. x 1000) Detail showing polygonal elements faintly joined;
24-25	Verrucosisporites naumovi	24-43/1220/940	Distal view, showing well spaced verrucae;
	"	25-28/795/408	(H.M. x 1000) Detail of 24 showing irregular elements;
26-27	Verrucosisporites sp.cf. V. naumovi	26-13/378/950	Equatorial view, showing verrucate distal surface, and granulate proximal surface;
		27- 4/427/975	Proximal view; showing trilete suture;
28-30	Verrucosisporites sp. A.	28-43/1259/940	Semi-polar view showing irregular flattened verrucae;
	"	29-43/1234/940	" " " "
	"	30- 8/241/900	" " " "
31-32	Verrucosisporites sp. B.	31-39/1127/885	Proximal view with open trilete suture in focus;
		32-39/1126/885	Proximal view with coarse verrucate sculpture in focus;

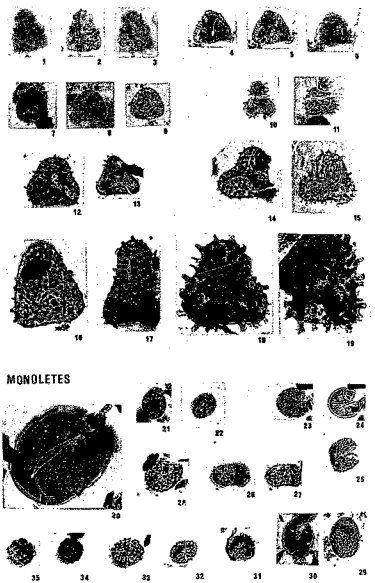
PLATE 2 - TRILETES (APICULATI)



EXPLANATION TO PLATE 3 – TRILETES (APICULATI) CONTD.

Fig.	Name	Reference No. of Specimen	Notes
1-6	Reinschospora sp.	1-35/1032/414	Sub-polar view, showing proximal focus, ribbon like labra and row of inter-radial spines;
	"	2-35/1033/414	Sub-laevigate proximal exine;
	"	3-35/1031/414	Sub-spinate distal surface;
	"	4-36/[illegible]/414	Sub-polar view, proximal focus showing raised labra;
	"	5-36/1064/414	Sub-[illegible]gate proximal exine; N.B. inter-radial spines within a thin flange;
	"	6-36/1063/414	Sub-spinate distal exine;
7-9	Apiculatisporis minutus	7-36/1111/426	Proximal view; showing conate sculpture minute;
	"	8-44/1330/95	Proximal view;
	"	9-44/1329/95	Proximal view;
10-11	Acanthotriletes tereteangulatus forma minor	10-10/300/537	Proximal view; spinate sculpture;
		11- 9/262/537	Proximal view;
12-13	Neoraistrickia sp.	12- 5/209/1064	Distal view; pillate sculpture;
		13-10/268/940	Proximal view; proximal exine sculpture reduced;
14-15	Acanthotriletes tereteangulatus	14-20/606/537	Proximal view; spinate sculpture
		15-19/563/537	Proximal view;
16-17	Lophotriletes sp.	16-24/739/541	Proximal view; conate sculpture
	"	17-22/668/537	Proximal view;
18-19	Neoraistrickia ramosa	18-23/669/537	Distal polar view; spinate bacillate sculpture;
	"	19-23/682/537	Distal sub-polar view;
	MONOLETES		
20	Laevigatosporites colliensis	20-22/678/537	Proximal view;
21-22	L. sp. 1	21-31/951/420	Proximal view, showing characteristic double fold;
	"	22-37/1075/426	Proximal view;
23-25	Punctatosporites granulatus	23-27/830/408	Terminal view, showing granulate sculpture;
		24-27/829/408	Terminal view, showing extent of monolete suture;
	"	25-37/1071/420	Semi-terminal view;
26-27	Spinosporites sp.	26-37/1077/420	Distal view; spinate sculpture;
	"	27-37/1072/420	Distal view; showing reduced sculpture and monolete suture;
28	Thymospora thiesseni	28-28/848/408	Semi-terminal view, showing verrucate sculpture;
29-35	Thymospora pseudothiesseni	29-44/1335/95	Lateral view, showing reticulate sculpture and pseudo cingulate structure;
	"	30-38/1100/426	Terminal view; open monolete suture;
	"	31-37/1080/420	Lateral view;
	"	32-31/945/420	Lateral view;
	"	33-30/905/420	Lateral view;
	"	34-29/867/420	Lateral view;
	"	35-37/1076/420	Lateral view;

PLATE 3 - (APICULATI)

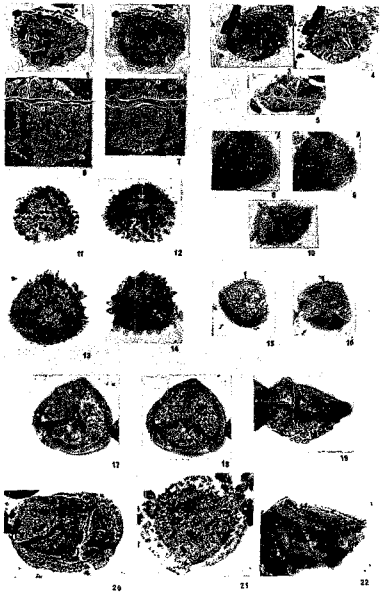


MONOLETES

EXPLANATION TO PLATE 4 - ZONALES

Fig.	Name	Reference No. of Specimen	Notes
1-7	Cirratriradites africanensis	1-26/784/408	Proximal view, showing general structure;
		2-26/783/408	Proximal view, showing suture length and thin labra;
	"	3-26/795/408	Sub-equatorial view, showing distal conate sculpture;
	"	4-26/795/408	" " " " "
	"	[illegible]	Equatorial view; [illegible] equatorially;
	"	6-41/1201/333	Proximal view; dentate zone;
	"	7-40/1204/333	" " " "
8-10	Gondisporites sp.cf. G. vrystaatensis	8-30/922/408	Proximal view; showing [illegible] sculpture at cava spinate;
	"	9-30/923/408	" " " "
	"	10-30/919/406	Sub-equatorial view;
11-12	Zinjispora bullata	11- 8/238/990	Proximal view, showing bulbous elements;
	"	12- 8/228/990	Distal view, showing bulbous elements;
13-14	Zinjispora zonalis	13-42/1248/940	Proximal view, showing separated pointed elements;
	"	14-39/1139/853	Sub-proximal view, showing separated pointed elements;
15-16	Zinjispora eccensis	15-34/1005/414	Distal view showing numerous apiculate elements;
	"	16-34/1006/414	Proximal view, showing reduction in size of sculpture elements;
17-19	Densosporites sp.	17-19/570/537	Proximal view, showing thickened labra and cingulum;
	"	18-19/568/537	Proximal view, showing proximal coarse granulate exine;
	"	19-19/579/537	Equatorial view, showing distal verrucate sculpture;
20-22	Gondisporites novus sp. nova	20-25/745/541	Proximal view, showing suturies extending to margin and fine granulate exine;
	"	21-25/741/541	Distal view, showing conate sculpture;
	"	22-25/752/541	Equatorial view, showing equatorial zone on cava;

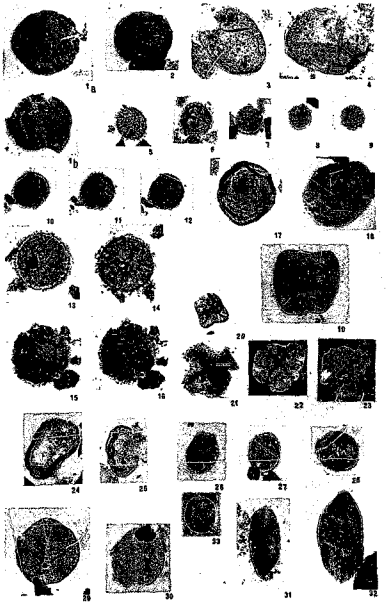
PLATE 4 – ZONALES



EXPLANATION TO PLATE 5 - ALETES: ANATES: PLICATES

Figs.	Name	Reference No. of Specimen	Notes
1-2	Pilosporites calculus	1a-23/690/537	In-aperturate spore with a fractured exine;
	"	1b-21/923/537	" " " " "
	"	2-22/870/537	In-aperturate spore, showing shagreen exine;
3-4	Granulate spore sp.cp.	3- 1/17/1130	In-aperturate spore with fractured exine, short irregulate folding and fine granulate sculpture;
	"	4- 7/193/1006	" " " " "
5-12	Verrucosisporites colliensis	5-35/1047/414	In-aperturate spore, with long colpi axinal elements;
	"	6-33/986/414	Note inverted folding;
	Variety 1	7-33/971/414	Note fractured exine;
	"	8-33/975/414	Note possible suture;
	"	9-34/1037/414	Note inverted folding;
	"	10-34/1028/414	Proximal focus of "Hairy" exine;
	"	11-34/1027/414	Equatorial view of "Hairy" exine;
	"	12-34/1028/414	Note directional flex of "Hairy" elements;
13-16	Verrucosisporites colliensis	13-25/755/541	In-aperturate spore; proximal focus of "Hairy" exine;
	"	14-25/756/541	Equatorial focus showing "Hairy" elements;
	Variety 2	15-25/761/541	Proximal focus;
	"	16-25/760/541	Equatorial focus, note apparent double wall of exine;
17-18	Circulisporites waonus Kp. nov.	17-23/694/537	In-aperturate spore, showing concentric rings in exine;
	"	18-18/582/537	" " " " "
19	Tetrasporites sp.	19-39/1125/885	In-aperturate spore, tetrartae, note quadri-lateral outline with punctate exine;
20-23	Quadrisporites sp.cf. Q. horridus	20- 6/181/1006	Seal-folded tetrad showing granulate exine;
	"	21-14/416/975	Poorly preserved specimen showing granulate exine;
	"	22-43/1269/940	Note sub-laevigate exine (eroded);
	"	23-16/491/975	Note width of crassealla;
24-25	Marsupiopollenites sp.	24-41/1202/333	Monocolpate spore; seat-proximal view showing thickened rim;
	"	25-44/1327/95	Note indistinct suture;
26-27	Marsupiopollenites triradiatus	26-30/918/438	Monocolpate spore with trilete suture;
	triradiatus forma	27-41/1212/333	" " " " "
28	triradiatus	28-35/1043/414	" " " " "
29-30	Cycadopites nevesi	29-43/1271/940	Distal focus showing rounded outline and concave suture;
	"	30-44/1328/95	Distal focus, note granulate exine;
31-32	Cycadopites cymbatus	31- 2/52/1064	Distal view, showing elongate oval with narrow parallel sided sulcus;
	"	32-42/1242/940	" " " " "
33	Marsupiopollenites triradiatus forma striatus	33-38/1139/853	Distal view, showing faint striations and trilete aperture;

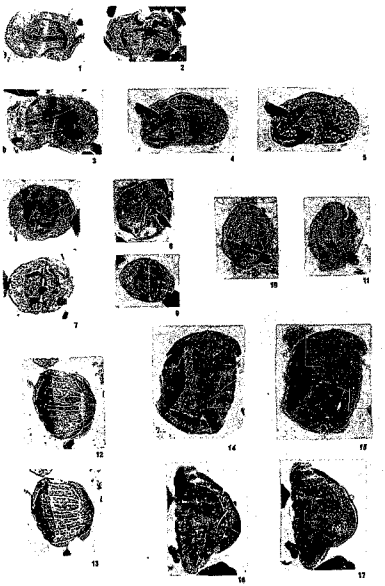
PLATE 5 - ALETES; JUGATES; PLICATES



EXPLANATION TO PLATE 6 – DISACCITES – STRIATITI

Fig.	Name	Reference No. of Specimen	Notes
1-2	Protohaploxypinus globus	1-28/843/408	Disaccate striate pollen, showing central proximal longitudinal sulcus, framed by thickened lips;
	"	2-31/938/408	" " " "
3-5	Protohaploxypinus limpidus	3-35/1048/408	Proximal view, showing narrow transverse distal sulcus;
	"	4-26/824/408	Equatorial view, showing slight sacci distal inclination;
		5-26/825/408	Equatorial view, showing coarse reticulation of sacci;
6-11	Protohaploxypinus diagonalis	6-29/868/408	Proximal view. Indistinct t-a elongated central body;
	"	7-29/887/408	Proximal narrow distal sulcus;
	"	8-26/781/408	Proximal indistinct oblique striae;
	"	9-26/813/408	Proximal narrow distal sulcus;
	"	10-44/1334/95	Proximal indistinct oblique striae;
	"	11-44/1333/95	Proximal fine infra-reticulation;
12-17	Protohaploxypinus sp. B.	12-44/1308/95	Semi-proximal view, showing terminal attachment of sacci;
	"	13-44/1307/95	Semi-proximal view, showing striation patterns;
	"	14-24/730/537	Distal view, showing lateral attachments of small sacci;
	"	15-24/731/537	Proximal view, showing granulate sculpture on rib exines;
	"	16-22/664/537	Terminal view, outline of small terminal sacci;
	"	17-22/665/537	Terminal view, showing fine infra-reticulation of sacci;

PLATE 6 - *DISACCITES - STRIATITI*



EXPLANATION TO PLATE 7 – STRIATITI

Fig.	Name	Reference No. of Specimen	Notes
1-7	Protohaploxypinus sp.cf. P. coraiensis	1-21/638/639/640/537	Polar view, distal focus showing distal fractured sulcus;
	"	2-21/636/537	Distal focus, showing clear in ra-reticulation of sacci (x 250);
	"	3-21/637/537	Proximal focus showing curved ribs and indistinct central body (x 250);
	"	4-21/644/537	Terminal view, showing thickened ribs;
	"	5-21/643/537	Terminal view, showing lateral sacci attachment;
	"	6-22/658/537	Semi-polar view, distal focus;
	"	7-22/655/657/537	Proximal focus, showing sub-parallel striations;

PLATE 7 – STRIATITI















EXPLANATION TO PLATE 8 - STRIATITI

Fig.	Name	Reference No. of Specimen	Notes
1-4	Protohaploxypinus sp. A.	1- B/219/990	Polar view, proximal focus showing central longitudinal sulcus;
	"	2- B/153/1006	Sub-equatorial view, showing proximal longitudinal sulcus;
	"	3- B/152/1006	Sub-equatorial view, showing coarse infra-reticulation of sacci;
	"	4-17/503/975	Equatorial view, showing slight distal inclination;
5-8	Protohaploxypinus amplus	5- A/126/1058	Semi-proximal view, showing indistinct striae with parallel fold on proximal cap;
	"	6-17/506/975	Distal view, showing striae on distinct central body;
	"	7-17/505/975	Distal view, shows peripheral folds along distal sacci roots;
	"	8-17/501/975	Polar view, showing striae and distal peripheral sacci folds;

PLATE 8 - STRIATITI

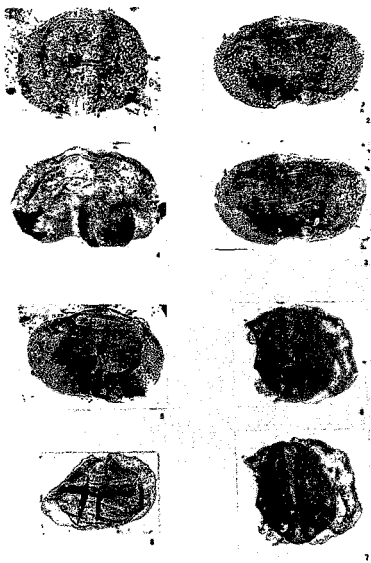
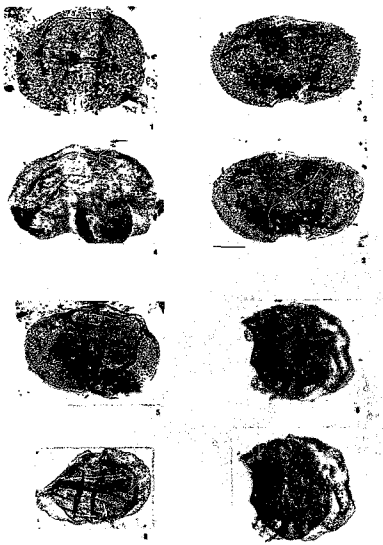


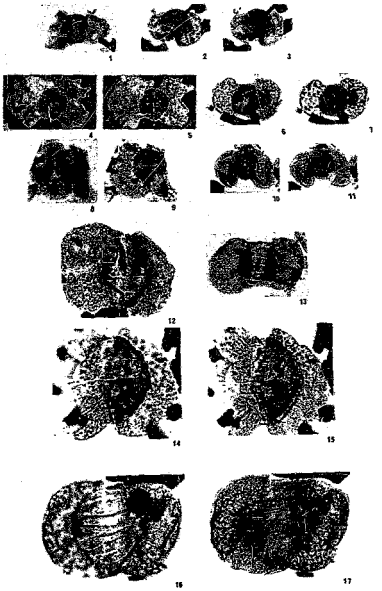
PLATE 8 - *STRIATITI*



EXPLANATION TO PLATE 9 - STRIATITI

Figs.	Name	Reference No. of Specimen	Notes
1-3	Striatopodocarpites cancellatus	1-30/915/408	Proximal view, showing sub-parallel striae;
	"	2-30/901/408	Distal view, showing distinct central body;
	"	3-30/902/408	Distal view, showing sacci overlapping distal sulcus;
4-11	Striatopodocarpites sp.cf. S. fusus	4-41/1205/333	Polar view, proximal focus, showing striae and large flimsy sacci;
	"	5-41/1206/333	Polar view, distal focus, showing narrow sulcus;
	"	6-26/832/408	Polar view, distal focus showing narrow distal sulcus;
	"	7-26, a51/408	Polar view, proximal focus, showing indistinct striae;
	"	8-38/1118/426	" " " "
	"	9-38/1117/426	Polar view, distal focus, showing narrow distal sulcus;
	"	10-28/841/408	Semi-polar view, distal focus, showing narrow distal sulcus;
	"	11-28/842/408	Semi-polar view, showing indistinct striae;
12-15	Striatopodocarpites ramus	12-24/712/537	Distal view, showing sub-parallel striae, marginal crest to proximal caps; distal sulcus narrow due to compression;
	"	13-36/1074/414	Proximal view, showing sub-parallel ribs and wide distal sulcus;
	"	14-25/768/541	Proximal view, showing sub-parallel striae and marginal crest;
	"	15-25/769/541	Distal focus, showing indistinctly width of distal sulcus;
16-17	Striatopodocarpites communis	16-21/647/537	Polar view, proximal focus, showing sub-parallel to oblique striae;
	"	17-21/646/537	Polar view, distal focus, showing indistinct sulcus and coarse infrareticulation of sacci;

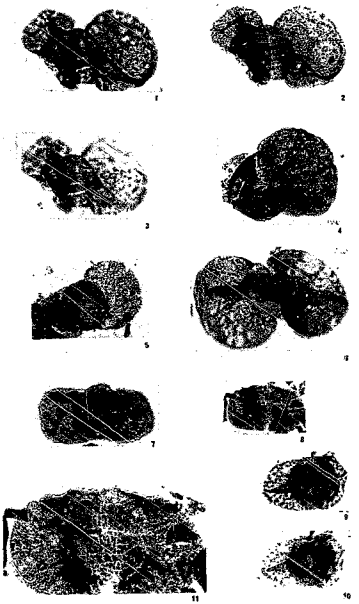
PLATE 9 - STRIATITI



EXPLANATION TO PLATE 10 - STRIATITI

Fig.	Name	Reference No. of Specimen	Notes
1-6	Striatopodocarpites octostriatus	1-21/634/537	Semi-polar view, proximal focus, showing thickened marginal crest to proximal cap;
	"	2-21/633/537	Semi-polar view, showing sacci structures;
	"	3-20/604/537	Semi-polar view, proximal focus showing thickened longitudinal striae with short irregular transverse striae;
	"	4-23/692/537	Semi-distal view, showing narrow distal sulcus and thickened marginal crest to proximal cap;
	"	5-38/1119/426	Proximal view, partially compressed pollen grain, showing semi-parallel striae;
	"	6-23/699/537	Semi-polar view, showing general structure;
7-11	Striatopodocarpites sp. A.	7-22/667/537	Proximal view, showing irregular longitudinal and transverse striae, sacci compressed;
	"	8-23/705/537	Proximal view, showing general structure (x 200);
	"	9-29/896/408	Proximal view, showing darkened central body with irregular longitudinal and short transverse striae;
	"	10-27/897/408	Proximal view, showing compression of sacci;
	"	11-23/704/705/537	Proximal view, showing irregular longitudinal and short transverse striae; and darkened radial folds of sacci;

PLATE 10 - STRIATITI



EXPLANATION TO PLATE 33 – STRIATITI

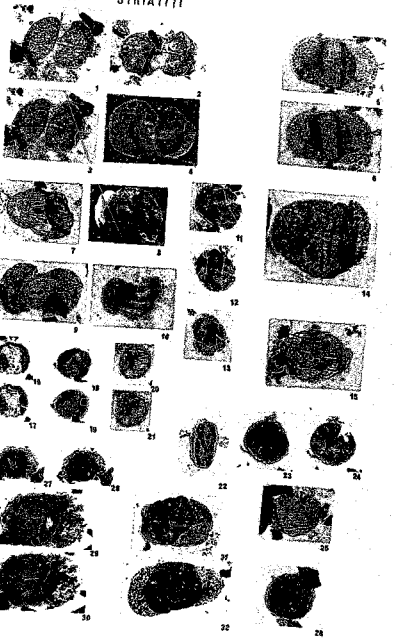
Fig.	Name	Reference No. of Specimen	Notes
1-4	Lueckisporites virkkiae	1-44/1309/95	Proximal view, showing central longitudinal sulcus and coarse infra-reticulation of sacci;
	"	2-44/1336/95	Proximal view, showing general structure;
	"	3-44/1310/95	Proximal view, showing central longitudinal sulcus with subsidiary lateral striae;
	"	4-44/1314/95	Proximal view, showing striae patterns
5-6	Hamiapollenites sp. A.	5-33/980/414	Proximal view, showing oblique to sub-parallel longitudinal striae with long transverse striae;
	"	6-33/979/414	Proximal view, showing broad distal sulcus with peripheral folds at the base of distal sacci roots;
7-8	Striatopinites multistriatus	7-44/1321/95	Semi-polar view, showing small terminally attached sacci and I-a elongate central body;
	"	8-38/999/414	Compressed specimen, semi-polar view, showing small terminally attached sacci;
9-10	Taeniaesporites sp.cf. I. novialensis	9-26/797/408	Proximal view, showing four broad ribs separated by relatively indistinct wide striae;
	"	10-38/1106/426	Eroded specimen, showing broad ribs;
11-13	Guttulapollenites hannonicus	11-44/1316/95	Semi-distal view, proximal vent open;
	"	12-44/1318/95	" " " " " "
	"	13-44/1311/95	Semi-distal view;
14	Hamiapollenites karroensis	14-20/602/537	Proximal view, showing longitudinal striae with long transverse distal striae framing a central transverse sulcus;
15	Vittatina africana	15-33/965/414	Proximal view, showing thickened striations;
16-21	Vittatina minima	16-36/1071/414	Polar view, proximal focus, showing longitudinal striae;
	"	17-36/1070/414	Polar view, distal focus, showing terminal thickened structures;
	"	18-35/1036/414	Polar view, proximal focus, showing longitudinal striae;
	"	19-35/1035/414	Polar vise, distal focus, showing rudimentary sacci (infra-punctate);
	"	20-44/1312/95	Semi-polar view, showing rudimentary terminal sacci;
	"	21-44/1313/95	Semi-polar view, showing longitudinal striae;

Continued/...

EXPLANATION TO PLATE II - STRATITI
(Continued)

Fig.	Name	Reference No. of Specimen	Notes
22-26	Vittatina africana	22-14/1324/414	Compressed specimen, showing continuous striae;
	"	23-31/948/414	Semi-proximal view, showing transverse and longitudinal striae
	"	24-31/946/414	Semi-proximal view, showing continuation of striae;
	"	25-27/835/408	Proximal view, showing general structure;
	"	26-33/977/414	" " "
27-28	Accosporites sp.	27-29/882/408	Proximal view, showing rudimentary irregular trilete suture;
	"	28-29/883/408	Proximal view, showing sacci attachment;
29-30	Lisitsiporites sp.	29-38/1095/426	Proximal view, showing zonolete suture;
	"	30-38/1094/426	Proximal view, showing general structure;
31-32	Illinites unicus	31- 8/246/380	Semi-polar view, with proximal trilete suture and distal peripheral folds along sacci roots;
	"	32- 7/213/1066	Proximal view, showing indistinct proximal trilete suture and distal peripheral folds along sacci roots;

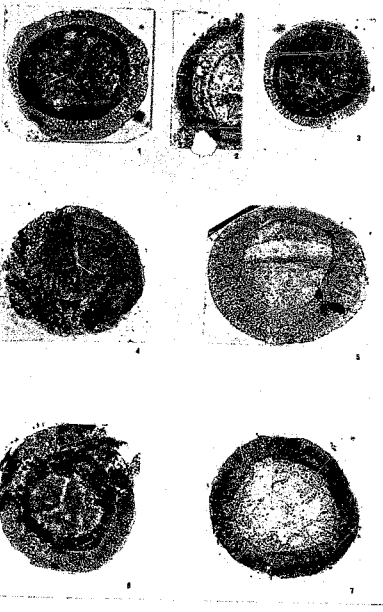
PLATE 11 - STRIATITI



EXPLANATION TO PLATE 12 - MONOSACCITI

Fig.	Name	Reference No. of Specimen	Notes
1-7.	Plicatipollenites Indicus	1-27/808/985	Proximal view, showing trilete suture, equatorial peripheral folds below proximal saccus detachment line and narrow sacci offlap;
	"	2- 2/53/1004	An empty saccus, showing narrow sacci width;
	"	3-18/553/890	Distal view, showing narrow sacci width and equatorial peripheral folds;
	"	4-42/1226/940	Proximal view, showing trilete suture and sub-equatorial peripheral folds below saccus. Detachment line with overlap equal to offlap;
	"	5- 2/90/1006	Empty saccus, showing broad proximal width of saccus;
	"	6- 7/183/1006	Proximal view, showing uneven trilete suture and equatorial to sub-equatorial peripheral folds; offlap less than overlap;
	"	7- 2/38/39/1116	Empty saccus, showing relatively broad proximal saccus width;

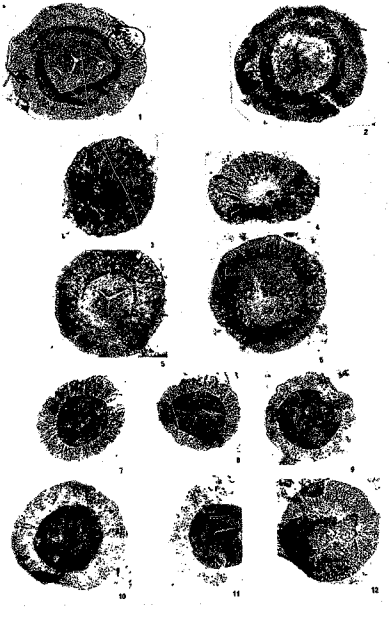
PLATE 12 - MONOSACCITI



EXPLANATION TO PLATE 13 - MONOSACCITI

Fig.	Name	Reference No. of Specimen	Description
1-2	Plicatipollenites indicus	1-15/458/885	Proximal view, showing general structure;
	"	2- 7/191/192/1006	" " " " "
	"	3-14/407/408/975	Proximal view, showing preservational folds with saccus oiflap - equal to overlap;
	Virkkipollenites sahtae	4- 2/47/1084	Empty saccus, showing pleating effect;
		5- 2/37/1118	Proximal view, showing trilete suture;
		6- 1/21/1130	Distal view of empty saccus, showing pleating effect;
7-(9)	Virkkipollenites densus	7- 5/64/100	Proximal view, showing dense central body, trilete suture and sub-equatorial peripheral folds below saccus detachment line;
	"	8- 7/186/1006	Distal view, showing general structure, and frilling of saccus;
	"	9-18/547/985	Proximal view, showing infra-punctate sculpture on central body exine;
(10-12)	Elilasaccites elilaensis	10-43/1264/1265/940	Distal view, showing general structure, saccus outline entire;
	"	11- 8/220/990	Proximal view, showing uneven trilete suture;
	"	12- 2/51/1064	Empty saccus, showing radially elongate infra-reticulation of saccus exine, margin entire; specimen partially hidden;

PLATE 13 - MONOSACCITI



EXPLANATION TO PLATE 14 - MONOSACCITI

Fig.	Name	Reference No. of Specimen	Notes
1-2	Potonieisporites novicus	1-30/1132/885	Proximal view, showing short equatate sutura bilateral saccate condition, and infra-punctate sculpture on central body exine;
	"	2-15/420/940	Proximal view, showing equatorial peripheral folds below saccus detachment line;
3	Potonieisporites rhoanus	3-14/435/975	Proximal view, showing bilateral monosaccate condition parallel transverse distal peripheral folds, circular proximal peripheral folds and elongated longitudinal proximal suture;
4	Potonieisporites hennellyi	4- 6/177/1006	Proximal view, showing bilateral monosaccate condition, trilete suture and transversely oval outline of proximal saccus detachment line;
5-6	Florinites eremus	5-24/728/537	Proximal view, showing large folded saccus, small dense central body with indistinct saccus detachment;
	"	6-37/1067/420	Semi-proximal view, showing almost obscured central body and large flimsy saccus;
7-9	Densoisporites indicus	7-25/745/541	Proximal view of folded specimen illustrating coarse sacci infra-sculpture; lisbon along sacci margin and dense central body;
	"	8-34/1010A/414	Polar view, proximal focus, showing granulate sculpture on central body, indistinct proximal equatorial detachment of saccus and faint trilete suture extending onto saccus exine;
	"	9-34/1010B/414	Polar view, distal focus, showing complete distal detachment of saccus from central body;
10	Vesticlasporites sp.	10- 1/24/1130	Detail of empty saccus showing disjunctate condition with joining lateral bladders: N.B. Differential infra-sculpture;
11	Cahenisaccites sp.	11-24/728/729/537	Detail of empty saccus, showing bilateral monosaccate condition; similar infra-sculpture and structure;

PLATE 14 - MONOSACCITI



















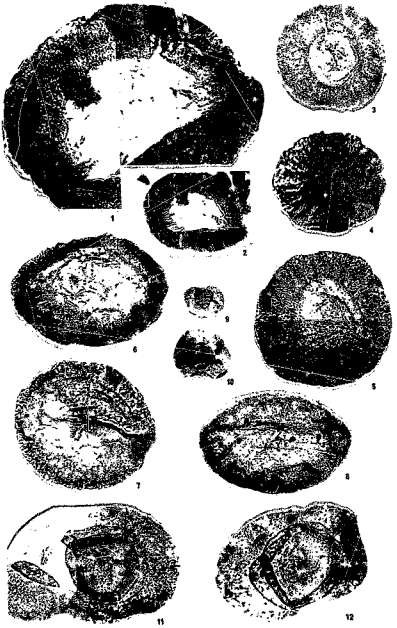


EXPLANATION TO PLATE 14a - MONOSACCITI

N.B. Magnification x 500 except where stated

Fig.	Name	Reference No. of Specimen	Notes
1-2	Parasaccites sp.	1-22/660/662/537	Semi-proximal view, showing light central body, dark coarsely structured saccus;
	"	2-22/663/537	Showing general structure (x 200);
3	Virkkipollenites mehtae	3-20/601/1006	Proximal view, showing central body outline, distinct saccus roots and slight frill in saccus;
4-5	V. radialis	4- 2/59/1064	Proximal view, showing dense triangular central body;
	"	5- 1/7/6/1130	Proximal view, showing rupture in central exine (empty saccus);
6-8	V. obscurus	6-14/415/416/975	Proximal view, showing triletе suture;
	"	7-43/1267/68/940	Proximal view, showing triletе suture, saccus infra-structure and indistinct (partial) outline of central body;
	"	8- 1/2/940	Proximal view, slightly compressed;
9-10	Striomonosaccites sp.	9-34/1025/414	Proximal view of small specimen, showing striate central body;
	"	10-28/859/408	Proximal view, showing compressed specimen; central body striate;
11-12	Potonieisporites granulatus	11-22/660/940	Proximal view, showing peripheral folds monolete suture. Specimen torn;
	"	12-15/456/975	Proximal view, showing outline of central body, peripheral folds associated with saccus roots, monolete suture and bilateral organisation;

PLATE 14 a - MONOSACCITI



EXPLANATION TO PLATE 15 - DISACCIATRILETI

Fig.	Name	Reference No. of Specimen	Notes
1-2	Platysaccus radialis (LESCHIK) HART, NOR. COMB.	1-27/863/408	Distal view, showing t-a oval central body, concave distal sacci roots;
		2-31/956/414	Proximal view, showing diploxylonoid outline and longitudinally elongated sacci;
3	Platysaccus sp.cf. P. (Leschiki) HART	3-37/1074/426	Distal view, showing distinct central body, large flimsy sacci and indistinct distal roots;
4	Alisporites sp.cf. pilosus	4-34/1015/414	Proximal view, showing slight diploxilinity, distinct central body and broad distal zone;
5	Alisporites gracilis	5-42/1223/940	Polar view, showing broad distal zone and coarse radially elongated lumen in sacci infra-reticulation;
6-7	Alisporites tenuicorpus	6-16/345/940	Semi-polar view, showing haploxylonoid outline and coarse rounded lumen in sacci infra-[illegible]lation;
	"	7-17/510/940	Polar view, sho[illegible] broad distal zone; specimen slightly folded;
8-9	Sulcatisporites ovatus	8-44/1325/95	Semi-distal view, showing narrow sulcus; haploxylonoid rounded outline;
	"	9-26/841/408	Distal view, showing narrow sulcus and central body;
10-11	Sulcatisporites splendens	10-31/931/408	Proximal view, showing central body and haploxylonoid longitudinally oval outline;
	"	11-23/871/408	Distal view, showing narrow distal sulcus
12-13, 15	Vesicaspora sp. A.	12-25/744/541	Polar view, showing (l-a) oval central body (outline touched-up) and distinct lateral bladders;
—	"	13-25/762/541	Semi-terminal view, showing terminal attachment of sacci and relatively indistinct sacci roots;
	"	15-34/1019/414	Proximal view, showing (l-a) oval central body, and longitudinal tear in sacci and central body exine;
14	Vesicaspora sp. B.	14-37/1087/426	Proximal views, showing dense central bodies and slight diploxylonoid outline;
16-18	Sulcatisporites potonieii	16-24/717/718/537	Distal view, showing indistinct central body, coarse sacci infra-reticulation and distal sulcus;
	"	17-26/776/408	Semi-distal view, showing central body, sacci separating distally and coarse sacci infra-reticulation;
	"	18-29/873/408	Distal view, rounded outline and narrow distal sulcus;

PLATE 15 - DISACCIATRILETI

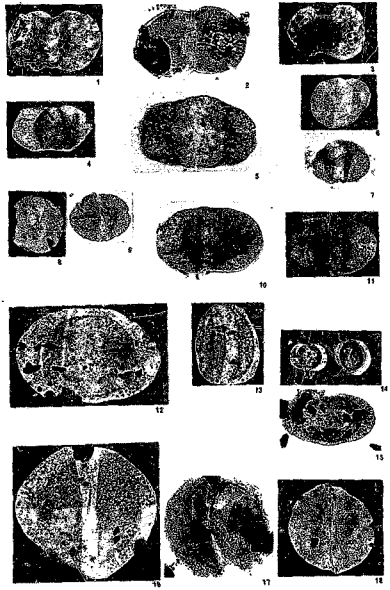


Fig 2 DISTRIBUTION OF MAJOR MIOSPORE TAXA

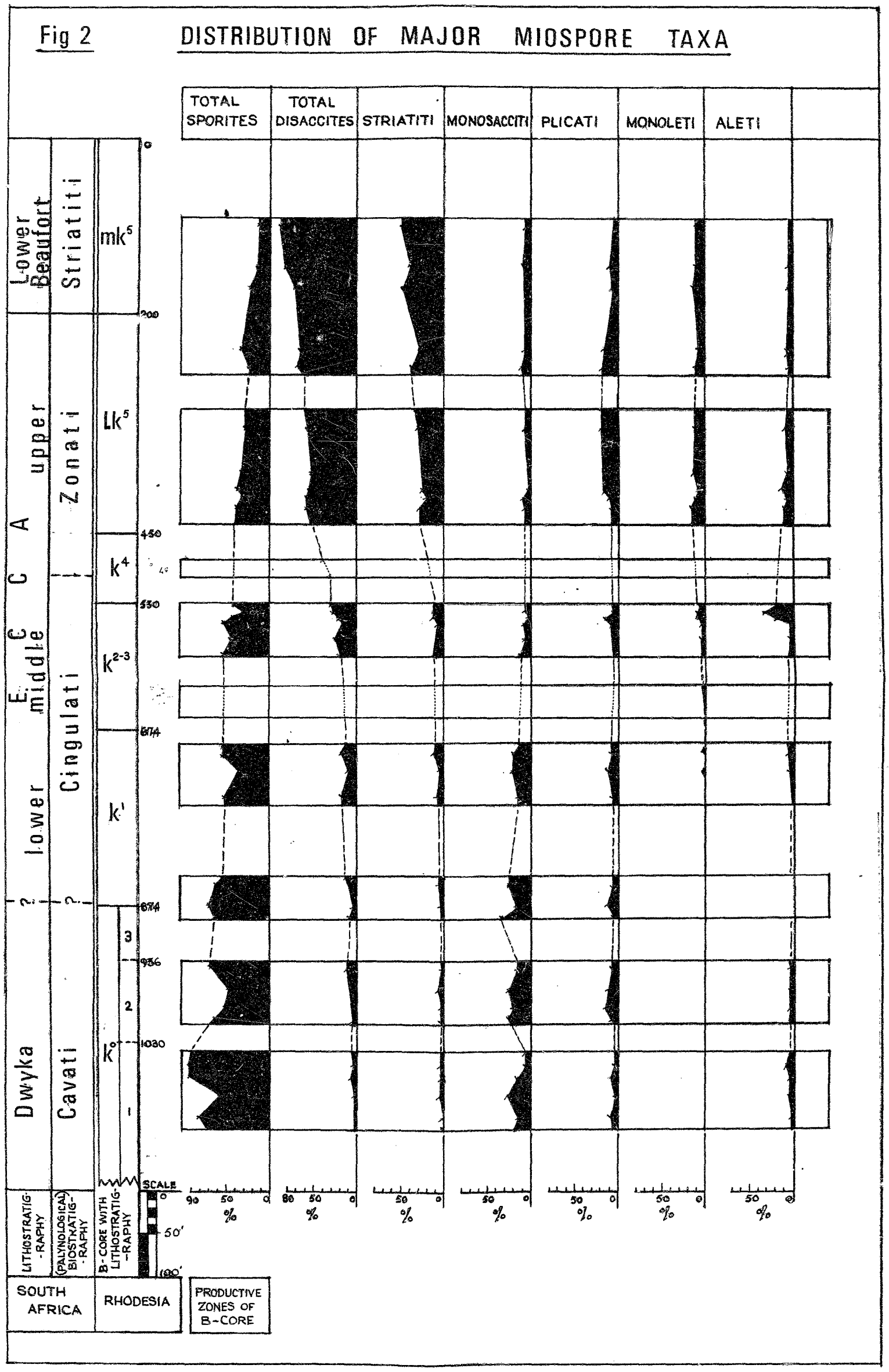


Fig. 1 MATABOLA FLATS BOREHOLE CORE — SHOWING SAMPLING & LITHOLOGY

INTERNATIONAL TIME SCALE	LITHOLOGICAL SUCCESSION OF CORE	SAMPLE LEVELS [PRODUCTIVE ZONES]	PALYNOLOGICAL CONTENT ABUNDANCE P F G	PALYNOLOGICAL CONTENT PRESERVATION P F G	LOCAL STRATIGRAPHIC SUCCESSION	SOUTH AFRICAN EQUIVALENT
PERMIAN upper / middle / lower — PERMO — CARBONIFEROUS ?		70, 95, 110, 148, 165, 205, 233, 240, 260, 266, 272, 278, 284, 290, 296, 302, 308, 314, 320, 326, 333, 339, 345, 351, 357, 363, 372, 378, 384, 390, 396, 402, 408, 414, 420, 426, 432, 439, 444, 450, 456, 480, 531, 537, 544, 550, 556, 562, 568, 574, 580, 586, 592, 598, 604, 610, 616, 622, 628, 634, 640, 646, 652, 658, 664, 690, 695, 705, 726, 760, 823, 840, 853, 880, 885, 890, 923, 928, 940, 975, 990, 1006, 1012, 1028, 1034, 1040, 1046, 1052, 1058, 1064, 1100 (6 SAMPLES), 1101, 1114, 1118, 1124, 1130, 1136, 1142, 1163, 1170	? NIL; P POOR; F FAIR; G GOOD	? NIL; P POOR; F FAIR; G GOOD	M/K⁵	LOWER BEAUFORT SERIES
					K⁵ MADUMA BISA SHALES — L/K⁵	
					K⁴ UPPER WANKIE SANDSTONE	ECCA SERIES
					K²⁻³ BLACK SHALES AND COALS	
					K¹ LOWER WANKIE SANDSTONE	
					LIMNOGLACIAL TILLITE — CYCLE 3	DWYKA SERIES
					LIMNOGLACIAL — GLACIAL OUTWASH GRAVELS — CYCLE 2	
					DWYKA K°	
					LIMNOGLACIAL — CYCLE 1 — OUTWASH GRAVELS — TILLITE	
					SIJARIRA SANDSTONES	

middle / upper — KAROO SYSTEM — lower

EXPLANATION OF BOREHOLE LOG

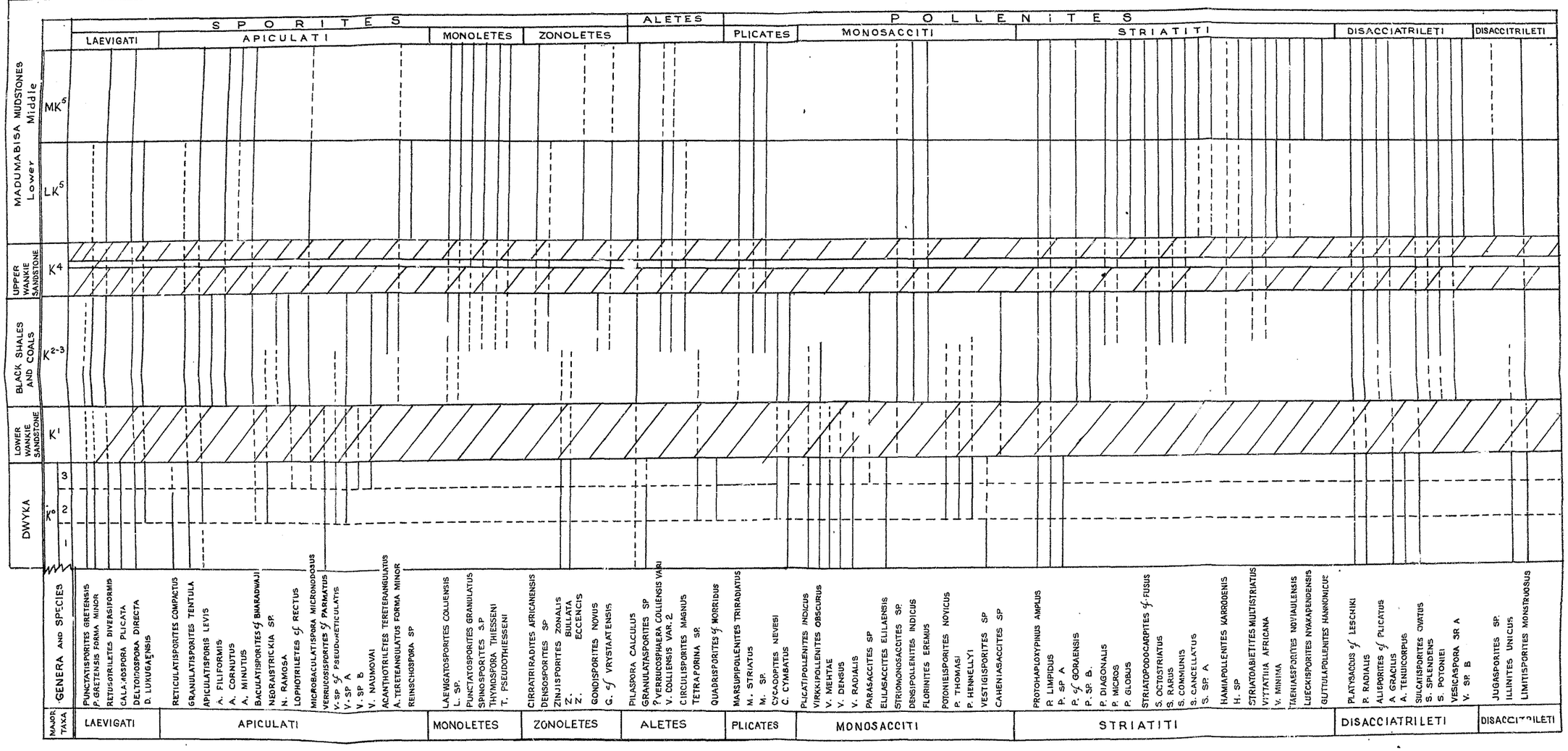
SCALE : 0 50 100 150

LIMESTONE; CONGLOMERATE; NON VARVED (MEDIUM GREY MUDSTONES); CARBONACEOUS SHALES

FINE SANDSTONE; TILLITE; VARVED (MEDIUM GREY MUDSTONES); COAL SEAMS

COARSE SANDSTONES AND GRITS; PALE SILTY SHALES AND MUDSTONES; NON VARVED - DARK (CARBONACEOUS) SHALES

Fig 3 DISTRIBUTION OF GENERA AND SPECIES IN THE MATABOLA BOREHOLE CORE



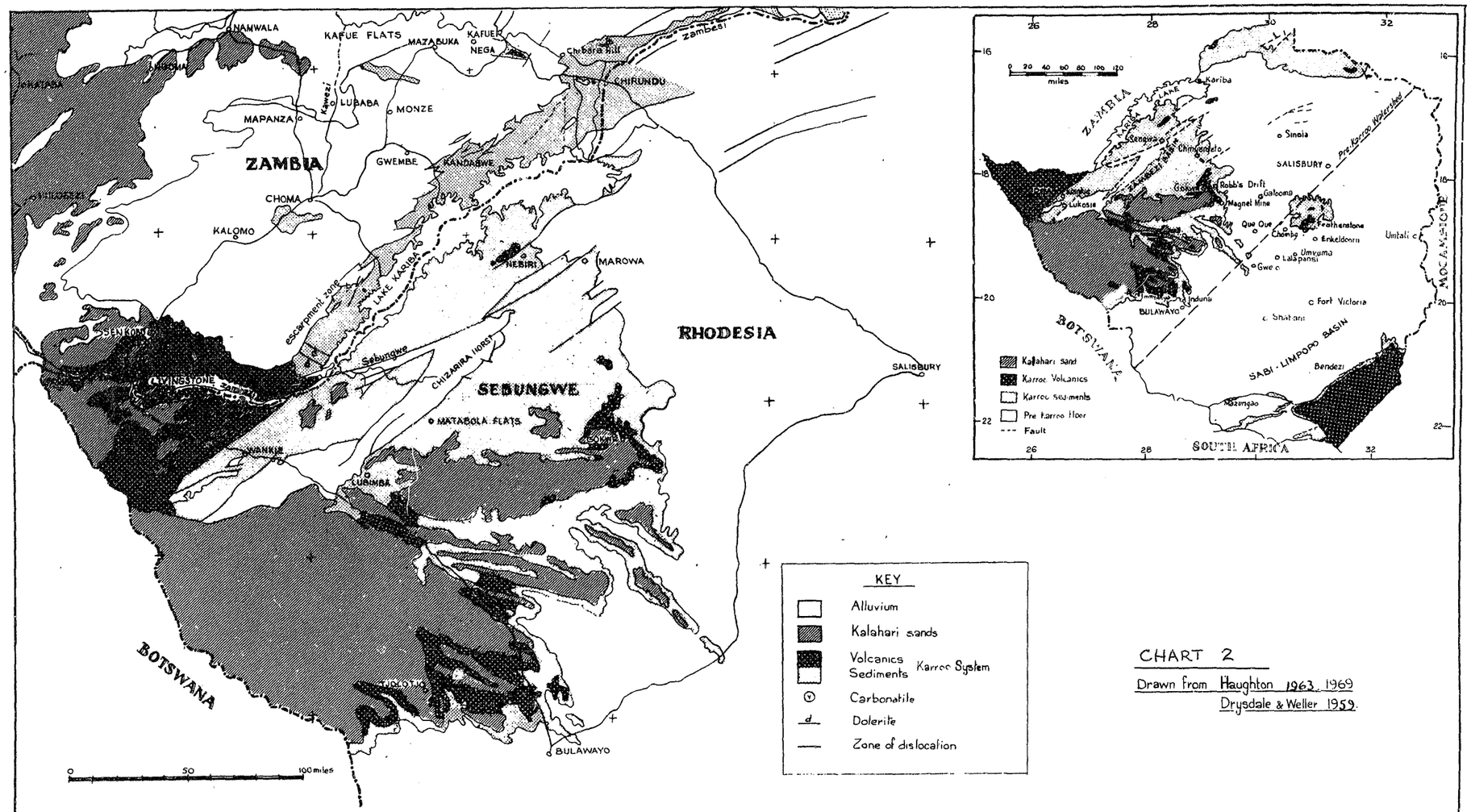
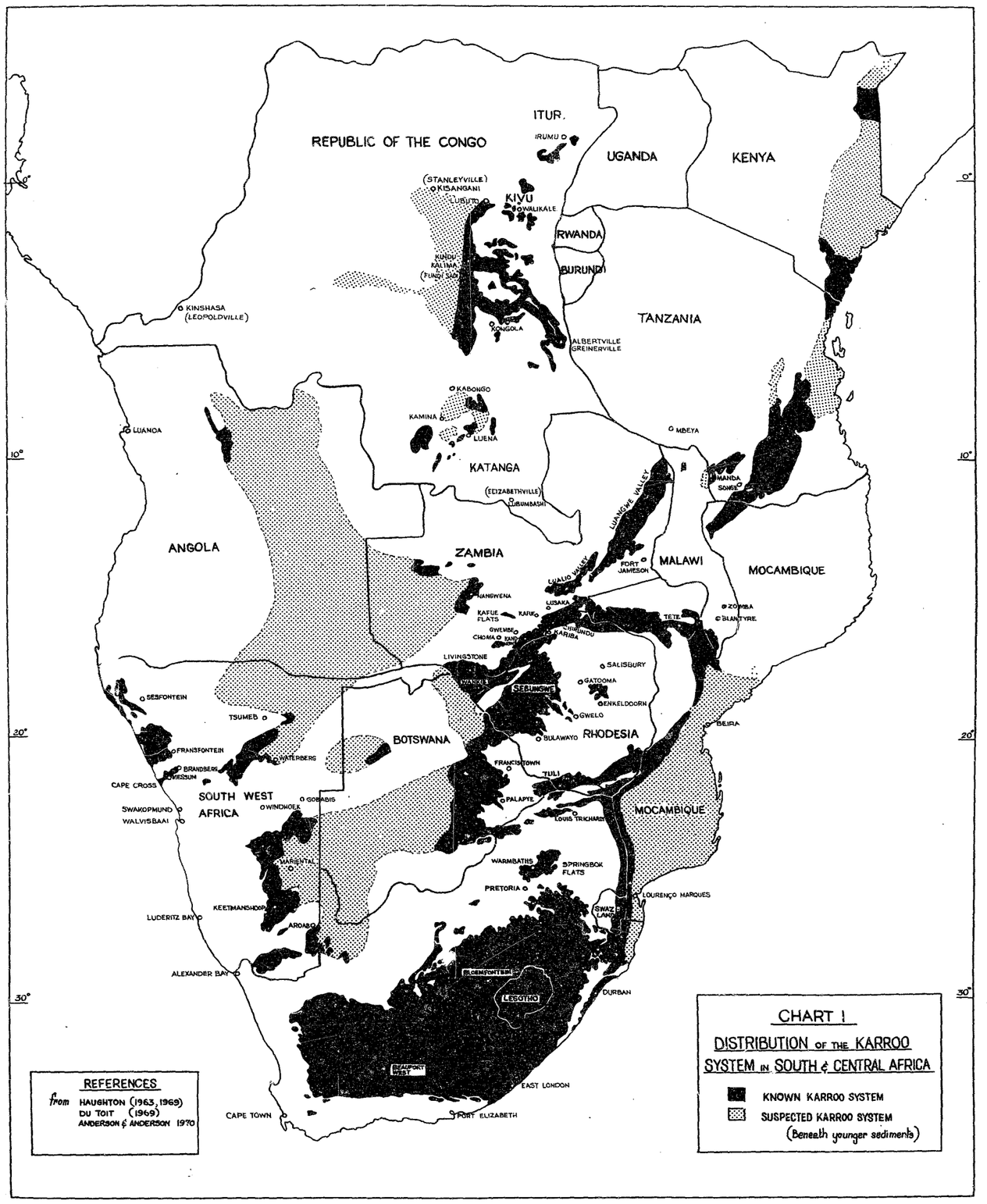


CHART 2

Drawn from Haughton 1963, 1969
Drysdale & Weller 1959.



REFERENCES

from HAUGHTON (1963, 1969)
DU TOIT (1969)
ANDERSON & ANDERSON 1970

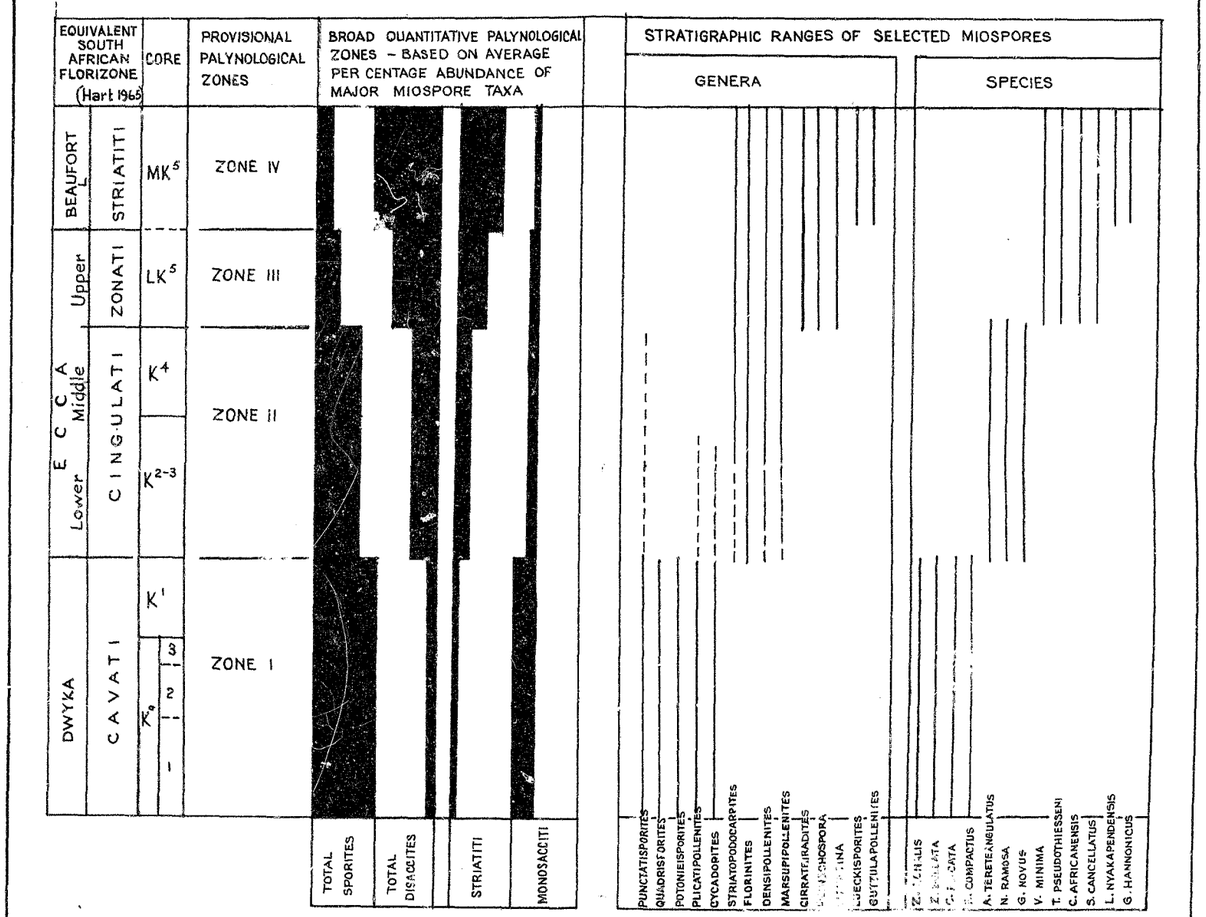
CHART 1

DISTRIBUTION OF THE KARROO SYSTEM IN SOUTH & CENTRAL AFRICA

KNOWN KARROO SYSTEM

SUSPECTED KARROO SYSTEM
(Beneath younger sediments)

Fig 4 **PALYNOLOGICAL ZONES IN THE MATABOLA FLATS BOREHOLE CORE**





Author Falcon R M S (Rosemary Margaret Sarah)
Name of thesis Preliminary Study Of The Karroo Palynology In The Mid-zambezi Basin, Rhodesia. 1972

PUBLISHER:
University of the Witwatersrand, Johannesburg
©2013

LEGAL NOTICES:

Copyright Notice: All materials on the University of the Witwatersrand, Johannesburg Library website are protected by South African copyright law and may not be distributed, transmitted, displayed, or otherwise published in any format, without the prior written permission of the copyright owner.

Disclaimer and Terms of Use: Provided that you maintain all copyright and other notices contained therein, you may download material (one machine readable copy and one print copy per page) for your personal and/or educational non-commercial use only.

The University of the Witwatersrand, Johannesburg, is not responsible for any errors or omissions and excludes any and all liability for any errors in or omissions from the information on the Library website.