Palynological evidence for vegetation patterns in the Transvaal (South Africa) during the late Pleistocene and Holocene

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ABSTRACT

Palynological evidence relating to the nature of Late Quaternary vegetation types and plant migrations in the Transvaal is briefly summarized. It is suggested that, after an early temperate, relatively moist phase and a subsequent relatively dry phase lasting until about 25 000 yr B.P., a vegetation-type with ericaceous elements developed. It resembled belts presently occurring above the treeline and was possibly widespread over the plains of the Transvaal during the last glacial maximum period. In the central parts of the province, warm semi-arid savanna subsequently expanded during the early Holocene and was followed by a more broad-leaved type of woodland in the late Holocene. This change probably resulted from slightly wetter and, at times, also slightly warmer and cooler conditions.

RESUME

PREUVE PALYNOLOGIQUE DE L'EXISTENCE DE TYPES DE VÉGÉTATION AU TRANSVAAL (AFRIQUE DU SUD) PENDANT LA DERNIÈRE PÉRIODE DU PLEISTOCÈNE ET L'HOLOCÈNE

La preuve palynologique relative à la nature des migrations de plantes et des types de végétation à la fin du Quaternaire, au Transvaal est brièvement résumée. Il est suggéré qu'après une phase d'abord tempérée et relativement humide et ensuite une phase relativement sèche perdurant jusqu'à environ 25 000 ans B.P., un type de végétation avec des éléments éricacés se développait. Il ressemblait aux étages qui se rencontrent actuellement au dessus de la ligne des arbres et était sans doute étendu sur les plaines du Transvaal durant l'apogée de la dernière période glaciaire. Dans les parties centrales de la province, des savannes chaudes semi-arides s'étendirent ensuite durant le début de l'Holocène et furent suivies par un type de forêt claire à feuilles plus larges. Ce changement résulta probablement de conditions légèrement plus humides et, à certains moments, aussi de conditions légèrement plus chaudes et plus froides.

INTRODUCTION

The purpose of this paper is to reconstruct the vegetation pattern of the Transvaal during the Late Quaternary by means of results obtained from pollen analyses of spring and other deposits and to assess the possible implications concerning migration and evolution. Marked climatic changes are reported to have occurred all over the world during the Pleistocene period and it is believed that, as elsewhere, these events had a major influence on the composition of the vegetation in Southern Africa. Up to now we have very little evidence of the nature of the Late Pleistocene vegetation types in the interior of the subcontinent. The important pollen diagram from Florisbad in the Orange Free State (Van Zinderen Bakker, 1957) which shows a change from a more karroid to grassland vegetation during the Late Pleistocene, is at present difficult to interpret in view of new age determinations (Rightmire, 1978) which show that the deposits are much older than previously believed. The pollen diagram from Aliwal North, Cape Province (Coetzee, 1967) only represents the terminal Pleistocene and early Holocene vegetation which developed after the amelioration of the full 'glacial' climate. Except for the oldest zone, the reconstructed vegetation does not differ widely from the present type which is transitional between karoo shrubland and grassland.

The framework for the present reconstruction was derived from pollen cores from organic and peat deposits of which the Wonderkrater thermal spring site, situated in the bushveld savanna of the low central plateau in the Transvaal (Fig. 1), is the most important. Details concerning the vegetation at Wonderkrater and large-scale pollen diagrams are presented by Scott (1982a). In the present paper, only idealized pollen diagrams (Figs 3 & 4) and a brief summary, compiled from data of four pollen profiles, are presented in order to demonstrate more clearly, changes in the environment. Supporting data from other sites in the region such as Rietvlei, Moreletta River, Scot, and Tate Vondo (Fig. 1), are

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Fig. 1.—Locality map. Shaded area above 1 500 m. * = Florisbad. + = Aliwal North.
Pollen was extracted from the organic and peat deposits by means of standard palynological techniques mainly employing digestion in 10% KOH and mineral separation with ZnCl₂-solution (S.G. ±2). Eighteen relevant ¹⁴C age determinations of various deposits were carried out by Dr J. C. Vogel of the CSIR, Pretoria.

THE POLLEN EVIDENCE AND INTERPRETATIONS

Micrographs of the most important indicator taxa are presented in Fig. 2. The pollen diagrams (Figs 3 & 4) from Wonderkraker show the regional pollen (A) which is made up of important AP (arboreal pollen) and NAP (non-arboreal) in the so-called pollen sum (Faegri & Iversen, 1964) and the total pollen composition (B) which consists largely of local elements. The regional palaeoenvironmental reconstructions are described by Scott (1982b).

The earliest pollen zone (W1 in Fig. 3) which formed earlier than 30 000 yr B.P. consists of pollen assemblages differing widely from those produced by the present woodland type which falls within the area of Acocks's (1953) Sourish Mixed Bushveld (veld type 19). In total, the AP (arboreal pollen) is higher than in the present spectra. AP-taxa which are of importance are Podocarpus (~34%), Oleaceae (~14%) and Combretaceae (~15%), whereas the modern pollen sum has lower AP-values consisting mainly of Combretaceae (~6%), Euclea (~6%), Tarchonanthae (~5%) and relatively high numbers of NAP, especially Compositae (~50%). Zone W1 is therefore thought to represent a relatively more mesic woodland on the plains and the high numbers of Podocarpus suggest that the montane forests in the nearby Waterberg were more extensive. The presence of Kiggelaria pollen (~23%) supports the idea of wetter conditions. In general, the occurrence of small numbers of macchia elements suggests slightly cooler conditions than at present. The next zone (W2) shows a gradual decline in the numbers of AP, especially in Podocarpus pollen (~10%), whereas Tarchonanthae (~18%) and Capparaceae (~14%) increase. This zone appears to indicate a change to a drier more open type of savanna. Zone W3 represents a short interval when Podocarpus (56%) dominated the pollen sum. The significance of this event is not clear. Zone W4 shows another important change in the diagram. Here the arboreal pollen content is even lower than in W2, consisting of Podocarpus (~10%) and Myrica (~26%). The NAP, which is important, consists of elements such as various Compositae, especially Stoebe-type (~26%), and also smaller but persistent numbers of macchia elements such as Ericaceae, Passerina and Cliffortia. The reconstructed vegetation compares best with present types occurring above the treeline in the Drakensberg at altitudes of more than 1 000 m higher than Wonderkraker (1 100 m altitude). Therefore an average cooling of around 5–6°C is suggested. This cold phase corresponds with the last glacial maximum period recorded roughly between 28 000 and 14 000 yr B.P. elsewhere in the world.

The suggested lowering of vegetation zones by about 1 000 m would imply that cool open grassland or shrubland must have occupied most of the plateau above ±1 000 m. Preliminary findings from Pretoria and Venda also provide tentative support for a lowering in the vegetation belts such as is suggested by Zone W4 and may help to show that open vegetation was widespread. In those from Pretoria, open grassland or shrubland pollen with Stoebe-type and small numbers of indicators like Ericaceae and Passerina are recorded in current palynological studies of stream deposits in the Moreletta River (Fig. 1). Although no age for these layers is available, they are likely to be of Late Pleistocene or early Holocene age as they belong to the lower section of a ±50 cm layer of gray clay underlying a 20 cm peat layer with terminal age of ±5 220 yr B.P. (Verhoeft, 1972). Spectra suggesting fairly open vegetation are also recorded from peats of ±2 m depth at Tate Vondo in Venda. Grass pollen is dominant and other NAP includes Ericaceae and Passerina. The AP consists mainly of Podocarpus and of some Combretaceae and Myrica. The results of current ¹⁴C dating will help to determine the age of these spectra. Although it is not certain at this stage whether a vegetation type from above the treeline is represented, these results together with the data from the Moreletta River could eventually support those from Wonderkraker and help to demonstrate that the lowering of the treeline in the Late Pleistocene was quite widespread. Open vegetation could have extended as far north as Zambia in the present miombo woodland. If 1 400 m altitude where there is tentative evidence for a more open vegetation in the form of a 22 000 yr old pollen sequence (Livingstone, 1971). This 5 m profile is dominated by grass pollen and below 0,5 m depth has fair numbers of Podocarpus, Olea and Myrica as the main AP component and shrubs such as Ericaceae and Cliffortia as NAP. Livingstone is, however, understandably cautious about his interpretation of this profile and did not provide a definite vegetational reconstruction.

At the end of the Pleistocene, climatic amelioration took place while Zone W5 at Wonderkraker was deposited (Fig. 4). The NAP, especially Chenopodiaceae (~48%), is still very prominent, but there is a marked reduction in the percentages of macchia types while semi-arid woody elements reappear. The spectra of Zone W5 seem to represent an open dry savanna. During the next zone (W6), the Capparaceae (~21%) and Tarchonanthae (~25%) expand, while Podocarpus and Proteaceae pollen grains virtually disappear from the sequence. Very similar modern pollen spectra are recorded from the present warm Kalahari Thornveld (Acocks, 1953, veld type 16) of which the nearest small patch occurs...
Fig. 2.—Some important fossil palynomorph types from Quaternary deposits in the Transvaal: a, Podocarpus; b, Myrica; c, Proteaceae; d, Oleaceae; e, Burkea; f, Euclca; g, Combretaceae; h, Spirostachys; i, Tarchonantheae; j, Capparaceae; k, Liliaceae; l, Compositae; m, Stoebe-type; n, Ericaceae; o, Passerina; p, Clifforia; q Chenopodiaceae; r, Cyperaceae; s, Typha; t, Fern-sphere; u, Gramineae.
448  PALYNOCOLOGICAL EVIDENCE FOR VEGETATION PATTERNS IN THE TRANSVAAL (SOUTH AFRICA) DURING THE LATE PLEISTOCENE AND HOLOCENE

SOME INDICATOR POLLEN TYPES (AP UNDERLINED)

<table>
<thead>
<tr>
<th>W4</th>
<th>Zone</th>
<th>DEPTH (CM)</th>
<th>POLLEN SUM (%)</th>
<th>TOTAL COMPOSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>M YRICA STOEBE-TYPE ERICACEAE CLIFFORTIA PASSERINA</td>
<td>W3</td>
<td>400</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>W2</td>
<td>500</td>
<td></td>
<td></td>
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<tr>
<td>PODOCARPUS</td>
<td>W1</td>
<td>600</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>700</td>
<td></td>
<td></td>
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<tr>
<td>TARCONANTHEAE</td>
<td></td>
<td>800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPPARACEAE</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>COMPOSITAE</td>
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<tr>
<td>PODOCARPUS</td>
<td></td>
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<tr>
<td>COMBRETACEAE</td>
<td></td>
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<tr>
<td>OLEACEAE</td>
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<tr>
<td>PODOCARPUS</td>
<td></td>
<td></td>
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<tr>
<td>OTHER SWAMP ELEMENTS</td>
<td>CYPERACEAE</td>
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<td></td>
</tr>
<tr>
<td>NON-ARBOREAL POLLEN</td>
<td>GRAMINEAE</td>
<td></td>
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<tr>
<td>AQUATICS</td>
<td>POLLEN SUM COMPONENT</td>
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</tbody>
</table>

FIG. 3.—Pollen diagram of Late Pleistocene peat deposits from Wonderkrater (adapted from Scott, 1982a).

FIG. 4.—Pollen diagram of Late Pleistocene and Holocene peat deposits from Wonderkrater (adapted from Scott, 1982a).
about 100 km SSW of Wonderkrater around Pienaarsrivier Station. It is therefore possible that a similar kind of bushveld occupied a wider area and reached as far north as the foot of the Waterberg. In the next zone (W7), Combretaceae (=S18%) become prominent, whereas the Capparaceae and Tarcho-
nantheae decline somewhat. Oleaceae and Prote-
taceae also return in small numbers and support the conclusion of a swing to slightly wetter conditions. In the next zone (W8), the AP shows a decline while NAP, especially Compositae (=89%), becomes prominent. These spectra show a resemblance to modern surface pollen samples from upland wood-
land types and therefore possibly represent a more open, slightly cooler vegetation. The same kind of change also occurs around this time in a pollen sequence from the north of the Soutpansberg at 'Scot' (Scott, 1982). In the next zone (W9), bushveld pollen increases again and Combretaceae (=16%) and Proteaceae (=12%) become prominent. Comparison of these spectra with a surface spectrum from just north of Warmbad representing Sour Bushveld (Acocks, 1953, veld type 20) and dominated by Faurea saligna, shows strong similarities and suggests that it again became warmer, while slightly more humid conditions than at present still persisted. It is possible that this zone is coeval with an event recorded in the southern Transvaal highveld when a temporary expansion of the woodland occurred over the northern parts of the plateau at Rietvlei (Scott & Vogel, in preparation). However, this expansion might also have occurred earlier, coinciding, perhaps, with the deposition of the slightly mesic Zone W7 or W6b at Wonder-
krater. Current 14C-dating of the Rietvlei profile will throw more light on this occurrence. The nearby Moreletta River pollen sequence (in preparation), however, suggests that a marked increase in the slighter mesic Zone W7 or W6b at Wonder-
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In conclusion, the Late Quaternary record in the Transvaal seems to show a constantly migrating vegetational system but, as far as evolution of new taxa is concerned, no sign of it can be detected palynologically over this relatively short time interval. The method can, by its nature, not show evolutionary changes in plants, but only the appearance or disappearance of pollen taxa in the fossil record. Evolution of new pollen taxa only becomes noticeable over a longer time sequence ranging into the Tertiary. The modern macchia in the Cape Province evolved during the Tertiary together with the considerable and more lasting cooling of the climate in the Miocene (Coetzee, 1978). Before this cooling, the vegetation in the Transvaal region must also have been more tropical, but at this stage any fossil evidence of its nature is lacking.

ACKNOWLEDGEMENTS

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