



HAL
open science

A c. 650 year pollen and microcharcoal record from Vankervelsvlei, South Africa

Nadia Du Plessis, Brian M Chase, Lynne J Quick, Paul Strobel, Torsten
Haberzettl, Michael E Meadows

► **To cite this version:**

Nadia Du Plessis, Brian M Chase, Lynne J Quick, Paul Strobel, Torsten Haberzettl, et al.. A c. 650 year pollen and microcharcoal record from Vankervelsvlei, South Africa. *Palaeoecology of Africa*, 2021, pp.301 - 308. 10.1201/9781003162766-19 . hal-03426388

HAL Id: hal-03426388

<https://hal.umontpellier.fr/hal-03426388>

Submitted on 12 Nov 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

CHAPTER 19

A c. 650 year pollen and microcharcoal record from Vankervelsvlei, South Africa

Nadia du Plessis

Department of Environmental and Geographical Science, University of Cape Town, Rondebosch, South Africa

Brian M. Chase¹

Institut des Sciences de l'Evolution-Montpellier (ISEM), University of Montpellier, Centre National de la Recherche Scientifique (CNRS), EPHE, IRD, Montpellier, France

Lynne J. Quick

African Centre for Coastal Palaeoscience, Nelson Mandela University, Port Elizabeth, South Africa

Paul Strobel

Physical Geography, Institute of Geography, Friedrich Schiller University Jena, Germany

Torsten Haberzettl

Physical Geography, Institute of Geography and Geology, University of Greifswald, Germany

Michael E. Meadows²

Department of Environmental and Geographical Science, University of Cape Town, Rondebosch, South Africa

¹Other affiliation: *Department of Environmental and Geographical Science, University of Cape Town, Rondebosch, South Africa*

²Other affiliation: *School of Geographic Sciences, East China Normal University, Shanghai, China; and College of Geography and Environmental Sciences, Zhejiang Normal University, China*

19.1 SITE DETAILS

The Vankervelsvlei wetland is situated along the southern Cape coast of South Africa, about *c.* 5 km inland at an elevation of 152 m asl, surrounded by a lithified aeolian dune of Middle to Late Pleistocene age (Illenberger 1996) (Figure 1A, B). The site falls within the year round rainfall zone, with moisture being delivered from both temperate and tropical climate systems.

Vankervelsvlei is an enclosed and endorheic wetland that is today covered with a floating vegetation mat primarily comprising several species of Cyperaceae, as well as some Bryophytes and Pteridophytes (Irving and Meadows 1997; Quick *et al.* 2016). The surrounding dune(s) are covered by pine plantations (*Pinus*) with scrub forest elements (e.g. *Cassine*, *Euclea*, *Kiggelaria*) occupying the area between the plantations and the wetland. Along the wetland edges, vegetation predominantly consists of fynbos pioneer communities (*Erica*, Restionaceae, *Leucadendron* (Proteaceae), *Passerina*) (Quick *et al.* 2016). Northward of Vankervelsvlei, Southern Afrotemperate forest is present in patches, largely represented by *Ocotea bullata*, *Olea capensis*, *Afrocarpus falcatus* and *Podocarpus latifolius* (in the pollen record we cannot differentiate between these species, as such these are all labelled *Podocarpus* for the purpose of this paper) (Midgley *et al.* 2004) (Figure 1C).

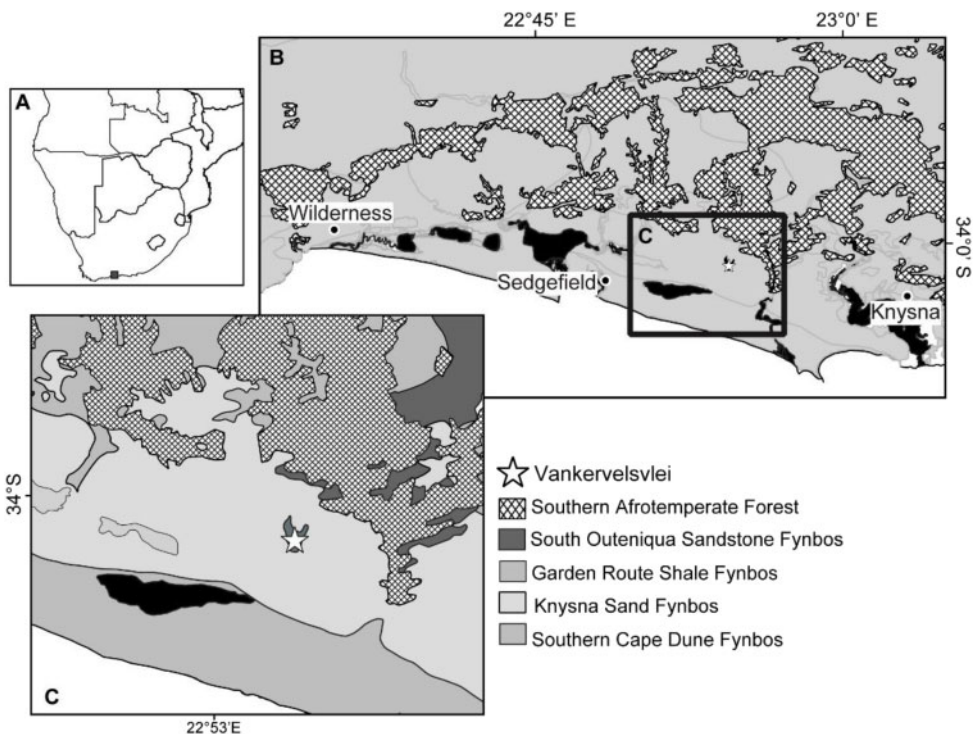


Figure 1. (A) Map of Africa showing the location of the southern Cape coast; (B) A section of the southern Cape coast between the towns of Wilderness and Knysna indicating the location of Vankervelsvlei and the current extent of Afrotemperate forest in the region; (C) The location of the sediment core VVV16 and the contemporary distribution of the dominant vegetation types (Mucina and Rutherford 2006).

Table 1. Sediment description for core sections VVV16-4 and VVV16-1-1/2

Core section (VVV)	Depth from surface (cm)	Sediment colour	Other observations
16-4	0–41	brownish	mainly roots, macro plant remains
	41–55	brownish	more sediment than above
16-1-1-1	80–90	dark brown to black	vertical plant roots wetter than above
	90–137	darker than above	vertical plant roots drier than above
	137–147	dark brown to redish	finer roots than above
16-1-1-2	148–183	dark brown to black	fine roots high water content
	183–205	dark brown to redish	fine roots

19.2 SEDIMENT DESCRIPTION AND METHODS

The sediment cores VVV16-4 (55 cm), VVV16-1-1-1 (67 cm) and VVV16-1-1-2 (57 cm) (34°0'46.8"S, 22°54'14.4"E) were both recovered using a UWITEC piston corer. Combined, the core sections are used here to create a 205 cm long record. Due to the nature of this waterbody, VVV16-4 was a push core from the surface while VVV16-1 started at 80 cm depth below the surface, resulting in the c. 25 cm gap between the two sections.

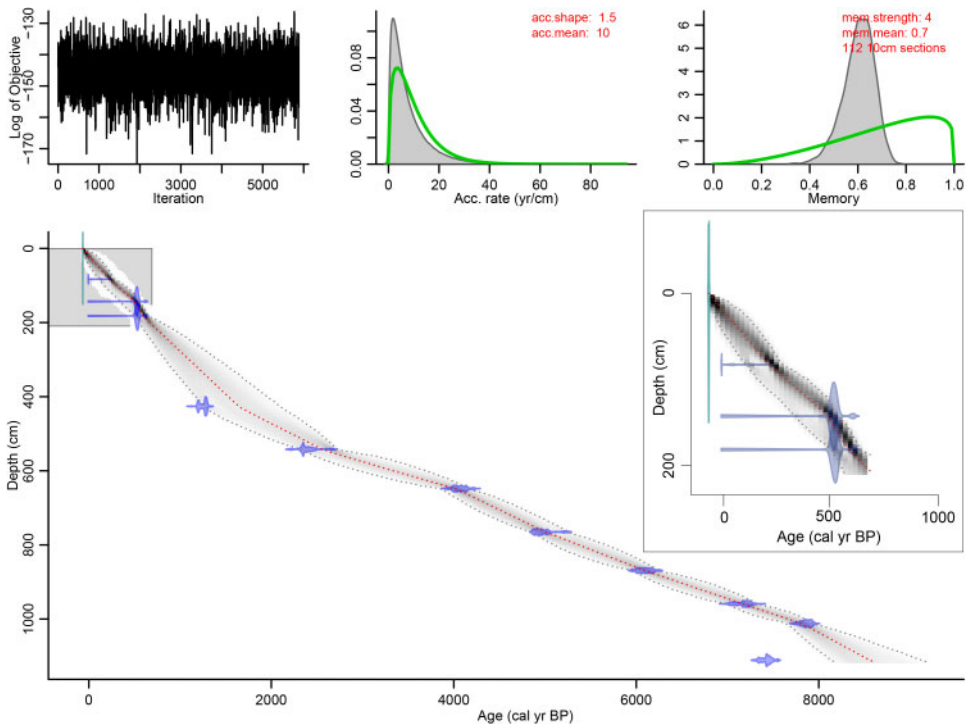
A total of 24 samples, with a minimum weight of 2 g, were processed using standard palynological methods as per Faegri and Iversen (1989) and Moore *et al.* (1991) with adaptations for dense media separation (Nakagawa *et al.* 1998). LacCore's polystaene microsphere pollen spike (0.5 ml per sample; 5.0×10^4 sph/ml \pm 7%) was added to each sample to determine pollen concentrations. Pollen grains were examined and counted using a Zeiss Axiostar Plus microscope. Identification of pollen were based on comparison with reference material from the Environmental and Geographical Science department at the University of Cape Town, and published images (Van Zinderen Bakker 1953, Van Zinderen Bakker and Coetzee 1959, Welman and Kuhn 1970 and Scott 1982). Charcoal particles were counted together with pollen grains using the particle count method (Tinner and Hu 2003), and were classified according to size: 10–100 μ m and > 100 μ m. Counts of 300 terrestrial pollen grains, or three slides, were performed for each sample. Three samples were excluded due to insufficient pollen concentrations; depths 50, 54 and 182 cm.

19.3 DATING

The age-depth model for this section of the VVV16 composite record is based on three AMS 14 C ages from organic macro-particles in VVV16-1-1-1 and VVV16-1-1-2 (Table 2) and compliments an age-depth model previously published by Strobel *et al.* (2019) (Figure 2). The samples were dated at the Poznan Radiocarbon Laboratory (Poland). The resultant ages were calibrated using the SHCal13 curve (Hogg *et al.* 2013). The age-depth model was developed with the R software package Bacon (v2.3) (Blaauw and Christen 2011).

Table 2. Radiocarbon and calibration details for VVV16. The designation Poz indicates that the samples were dated at the Poznan Radiocarbon Laboratory. All samples were calibrated using the SHCal12 curve (Hogg *et al.* 2013).

Lab ID (Poz-)	Depth (cm)	Core section (VVV-)	¹⁴ C age (BP)	1σ error	2σ cal age range (cal BP)	Median cal age (cal BP)	c. AD
92269	83	16-1-1-1	10	30	21–240	57	1893
92270	143	16-1-1-1	545	30	504–551	527	1423
102442	182	16-1-1-2	60	30	505–555	530	1420

**Figure 2.** The age-depth model for composite core VVV16. The grey box indicates the part of the sequence presented in this paper (enlarged in the inset); the lower part of the record was previously published by Strobel *et al.* (2019) (10–4 m composite depth). The 2σ probability distribution of calibrated ¹⁴C ages is presented in blue and the 95% confidence intervals are represented by the grey dotted line. The dotted red line represents the best model according to the weighted mean age at each depth.

19.4 INTERPRETATION

Fifty-nine different taxa were identified from this section of the VVV record, spanning the period c. AD 1300 to present. Due to the core composition, the assemblage was divided into two zones – the first comprising cores VVV16-1-1-1 and 16-1-1-2 and the second being VVV16-4. Pollen concentrations in VVV16-1-1-1/2 vary from 2.34×10^3 to 1.15×10^4 grains·g⁻¹, and in VVV16-4 they range between 2.56×10^3 and 6.20×10^4 grains·g⁻¹.

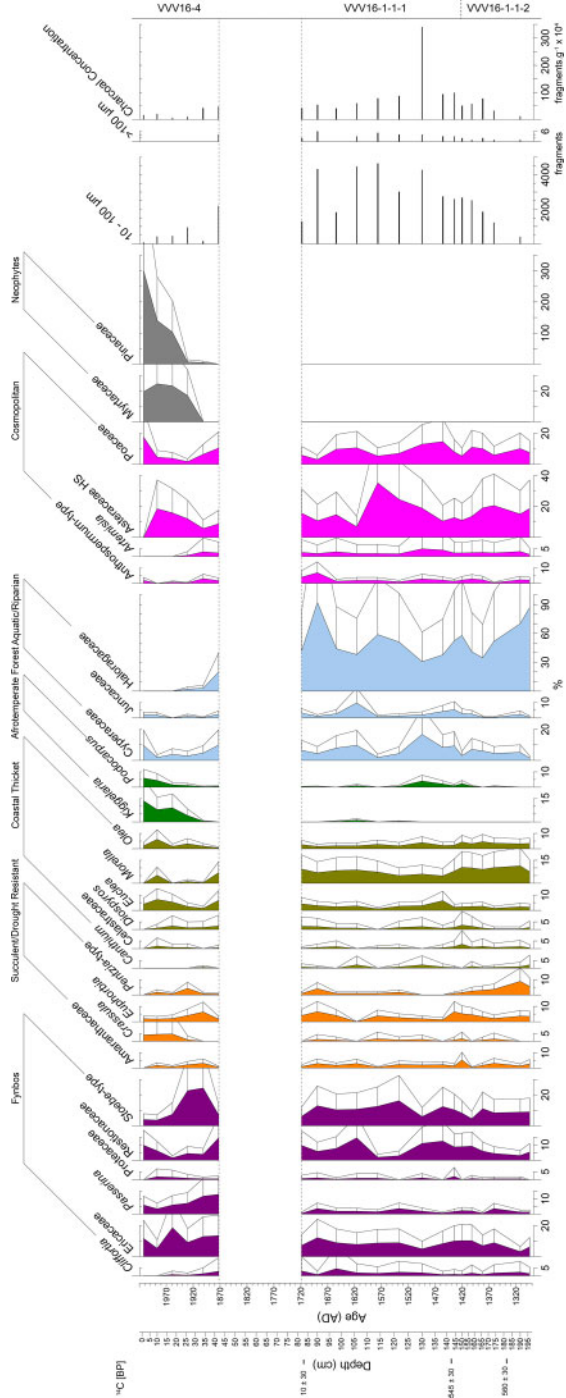


Figure 3. Relative pollen percentage diagram for VVV16-4 and VVV16-1-1/2 organized according to ecological affinity, with charcoal concentrations and charcoal fragment counts. Pollen taxa occurring at less than 5% are not shown. Exaggeration curves 2× for the taxa presented here. Charcoal and pollen concentrations were calculated in the same manner using microsphere counts.

19.4.1 VVV16-1-1-1/2 (AD 1300–1720; 196–82 cm; 15 samples): Coastal thicket – Afrotemperate Forest

Coastal thicket is prominent from the start of the record remaining elevated until *c.* AD 1420. This group is mainly represented by *Morella* – likely the dune, scrub and heath species *M. quercifolia* and *M. cordifolia*. Afrotemperate forest pollen percentages are low, increasing after AD 1400 to near maximum values (5.2%) at *c.* AD 1420. Haloragaceae is similarly elevated here. Fynbos pollen percentages increase towards *c.* AD 1460, Restionaceae displays a similar trend. Ericaceae generally follows this pattern with *Stoebe*-type also present. The thermophilous taxon *Pentzia*-type, is present at maximum percentages near the start of the sequence at *c.* AD 1310, followed by a decline in both this taxon and the drought/resistant group, to near minimum values at *c.* AD 1460. *Euphorbia* is present in relatively substantial proportions throughout the record (with peaks at *c.* AD 1430, 1580 and 1690). The sustained presence of *Euphorbia* could be related to enhanced dune movement in the region as opposed to a climatic response. These trends might indicate generally warmer and drier conditions around *c.* AD 1300 with moisture availability increasing towards *c.* AD 1420, and a decline in temperature moving into the Little Ice Age (LIA) – a cooling period identified in the Northern Hemisphere at this time (*c.* AD 1300 – 1850) (Jones *et al.* 2001; Matthews and Briffa 2005).

After *c.* AD 1420, coastal thicket percentages are lower until *c.* AD 1580. Afrotemperate forest taxa are more prominent in the assemblage during this period which could reflect a stage of vegetation succession and/or climatic conditions more conducive to enhanced forest spread. Both Cyperaceae and *Podocarpus* are present at maximum percentages at *c.* AD 1500 which could suggest a preceding period of enhanced moisture availability and/or reduced rainfall seasonality. Maximum charcoal concentrations at *c.* AD 1460 are followed by a notable increase in drier asteraceous fynbos (Asteraceae HS; high-spined) until *c.* AD 1580. This could indicate a progressively drier environment or alternatively a local vegetation response to a large fire event, as inferred from the peak in charcoal concentrations. *Stoebe*-type values increase after *c.* AD 1500, remaining elevated towards the top of this section of the record, *c.* AD 1690, probably reflecting a colder LIA environment.

Throughout this part of the record Cyperaceae and Restionaceae display similar trends, while Haloragaceae (likely *Myriophyllum spicatum*), the most prominent taxon in the record, displays an opposite pattern. These trends are possibly related to changing water levels in Vankervelsvlei.

19.4.2 VVV16-4 (AD 1870–2010/Present; 42–1 cm; 6 samples): *Pinus* and Myrtaceae

Pinus and Myrtaceae (most likely *Eucalyptus*) are first seen in this section, reflecting the influences of the forestry industry that became established in the late AD 1700's and still remains active in the region today.

Kiggelaria, largely absent from the pollen assemblage, becomes more prevalent in this section. As *Kiggelaria* percentages increase, other scrub forest elements, i.e. *Euclea* and *Morella*, decline. This vegetation succession was probably triggered by the establishment of the pine plantations in the area. A significant decline in Haloragaceae is further noted in this section of the record.

ACKNOWLEDGEMENTS

This study was funded by the German Federal Ministry of Education and Research (BMBF). The investigations were conducted as part of a pilot study for the collaborative project 'Regional

Archives for Integrated Investigations' (RAiN), embedded in the international research programme SPACES (Science Partnership for the Assessment of Complex Earth System Processes). We also thank the anonymous reviewer and William Gosling for their helpful comments.

DATA AVAILABILITY

The pollen and microcharcoal data presented here is available at:
<http://apps.neotomadb.org/Explorer/?datasetid=48875>

REFERENCES

- Blaauw, M. and Christen, J.A., 2011, Flexible paleoclimate age-depth models using an autoregressive gamma process. *Bayesian Analysis*, **6**(3), pp.457–474, 10.1214/ba/1339616472.
- Fægri, K. and Iversen, J., 1989. *Textbook of Pollen Analysis*, (Chichester: John Wiley & Sons Ltd).
- Hogg, A.G., Hua, Q., Blackwell, P.G., Niu, M., Buck, C.E., Guilderson, T.P., Heaton, T.J., Palmer, J.G., Reimer, P.J., Reimer, R.W., Turney, C.S.M. and Zimmerman, S.R.H., 2013, SHCal13 Southern Hemisphere Calibration, 0–50 000 Years Cal BP. *Radiocarbon*, **55**(4), pp.1889–1903, 10.2458/azu_js_rc.55.16783.
- Illenberger, W.K., 1996, The Geomorphological Evolution of the Wilderness Dune Cordons, South Africa. *Quaternary International*, **33**, pp.11–20, 10.1016/1040-6182(95)00099-2.
- Irving, S.J.E. and Meadows, M.E., 1997, Radiocarbon Chronology and Organic Matter Accumulation at Vankervelsvlei, near Knysa, South Africa. *South African Geographical Journal*, **79**(2), pp.101–105, 10.1080/03736245.1997.9713630.
- Jones, P.D., Osborn, T.J. and Briffa, K.R., 2001. The evolution of climate over the last millennium. *Science*, 292(5517), pp.662–667, 10.1126/science.1059126.
- Matthews, J.A. and Briffa, K.R., 2005, The 'Little Ice Age': Re-Evaluation of an Evolving Concept. *Geografiska Annaler. Series A, Physical Geography*, **87**(1), pp.17–36, 10.1111/j.0435-3676.2005.00242.x.
- Midgley, J.J., Cowling, R.M., Seydack, A.H.W. and van Wyk, G.F., 2004, Forest. In *Vegetation of Southern Africa*, edited by Cowling, R.M., Richardson, D.M., and Pierce, S.M., (Cambridge: Cambridge University Press), pp. 278–296.
- Moore, P.D., Webb, J.A. and Collinson, M.E., 1991, *Pollen Analysis* 2nd edition (Oxford: Blackwell Scientific Publications).
- Mucina, L. and Rutherford, M.C., 2006, *The Vegetation of South Africa, Lesotho and Swaziland*, (Pretoria: South African National Biodiversity Institute, Sterlitzia).
- Nakagawa, T., Brugiapaglia, E., Digerfeldt, G., Reille, M., De Beaulieu, J.-L. and Yasuda, Y., 1998, Dense media separation as a more efficient pollen extraction method for use with organic sediment/deposit samples: Comparison with the conventional method. *Boreas*, **27**, pp.15–24, 10.1111/j.1502-3885.1998.tb00864.x.
- Quick, L.J., Meadows, M.E., Bateman, M.D., Kirsten, K.L., Mäusbacher, R., Haberzettl, T. and Chase, B.M., 2016, Vegetation and climate dynamics during the last glacial period in the fynbos-afrotropical forest ecotone, southern Cape, South Africa. *Quaternary International*, **404**, pp.136–149, 10.1016/j.quaint.2015.08.027.
- Scott, L., 1982, Late Quaternary fossil pollen grains from the Transvaal, South Africa. *Review of Palaeobotany and Palynology*, **36**(3–4), pp.241–278, 10.1016/0034-6667(82)90022-7.
- Strobel, P., Kasper, T., Frenzel, P., Schitteck, K., Quick, L.J., Meadows, M.E., Mäusbacher, R. and Haberzettl, T., 2019, Late Quaternary palaeoenvironmental change in the year-round rainfall

- zone of South Africa derived from peat sediments from Vankervelsvlei. *Quaternary Science Reviews*, **218**, pp. 200–214, 10.1016/j.quascirev.2019.06.014.
- Tinner, W. and Hu, F.S., 2003, Size parameters, size-class distribution and area-number relationship of microscopic charcoal: relevance for fire reconstruction. *The Holocene*, **13**(4), pp.499–505, 10.1191/0959683603hl615rp.
- Welman, W.G. and Kuhn, L., 1970, *South African Pollen Grains and Spores*, Volume VI, (Amsterdam-Cape Town: AA Balkema).
- Van Zinderen Bakker, E.M., 1953, *South African Pollen Grains and Spores*, Volume I, (Cape Town: AA Balkema).
- Van Zinderen Bakker, E.M. and Coetzee, J.A., 1959, *South African Pollen Grains and Spores*, Volume III, (Cape Town: AA Balkema).