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

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## CHAPTER 19

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## 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).

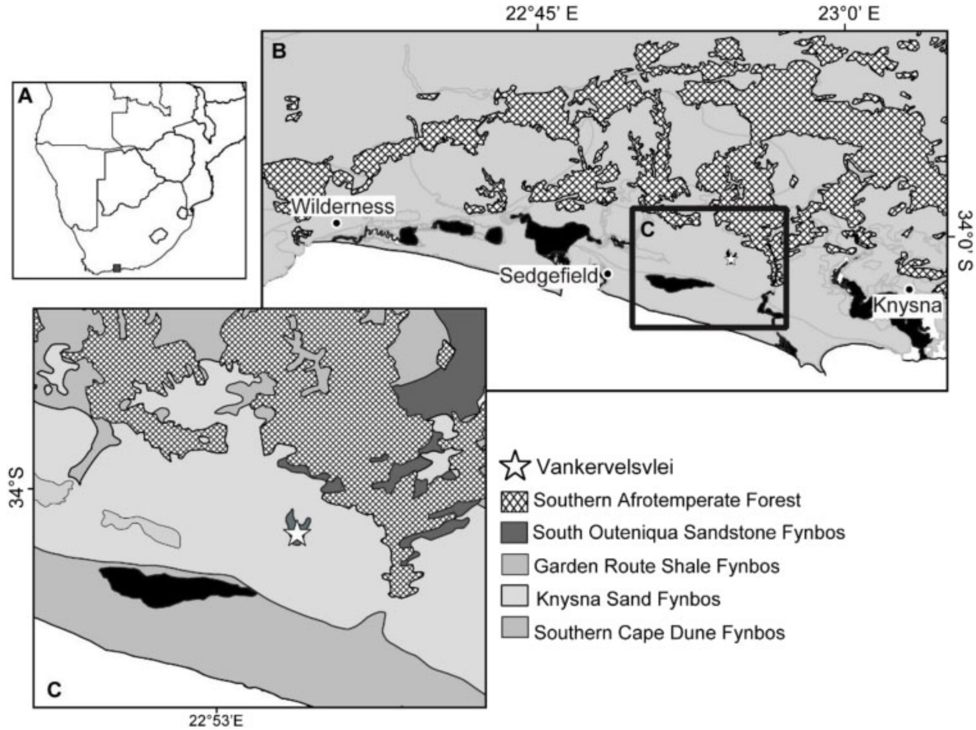


**Figure 1.** (A) Map of Africa showing the location of the southern Cape coast; (B) A section of the southern Cape coast between the towns of Wilderness and Knysna indicating the location of Vankervelsvlei and the current extent of Afrotemperate forest in the region; (C) The location of the sediment 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 VVV16-1-1-1/2

| 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; $5.0 \times 10^4$ sph/ml ± 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 μm and >100 μm. 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 |

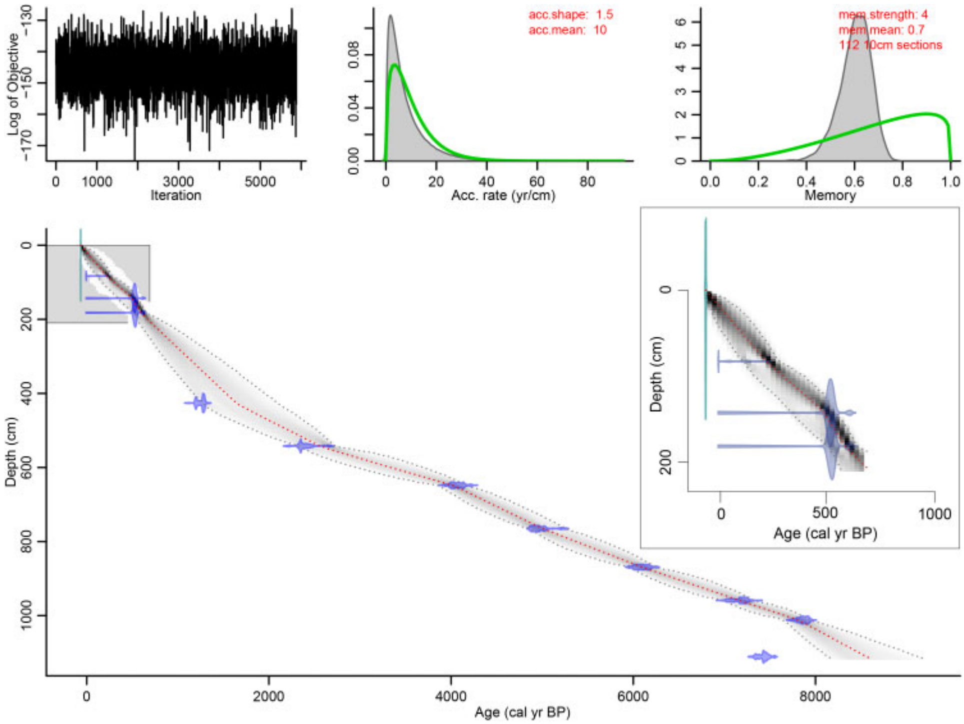


**Figure 2.** The age-depth model for composite core VVV16. The grey box indicates the part of the sequence presented in this paper (enlarged in the inset); the lower part of the record was previously published by Strobel *et al*. (2019) (10–4 m composite depth). The 2σ probability distribution of calibrated $^{14}$C 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 $2.34 \times 10^3$ to $1.15 \times 10^4$ grains·g$^{-1}$, and in VVV16-4 they range between $2.56 \times 10^3$ and $6.20 \times 10^4$ grains·g$^{-1}$.

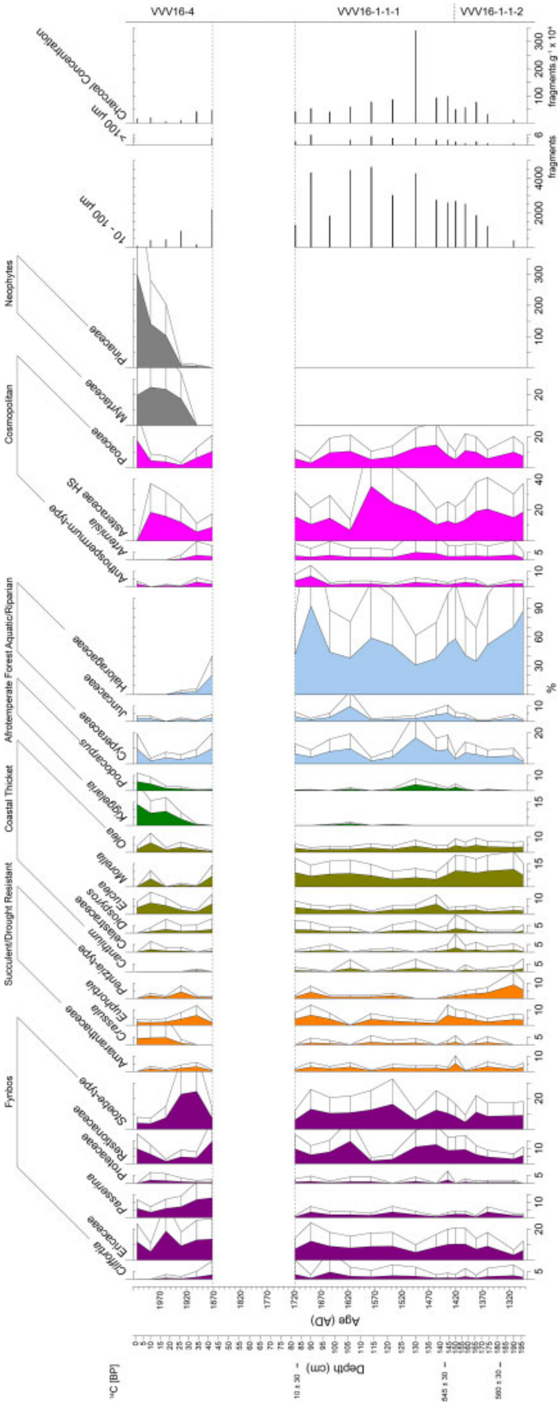

**Figure 3.** Relative pollen percentage diagram for VVV16-4 and VVV16-1-1-1/2 organized according to ecological affinity, with charcoal concentrations and charcoal fragment counts. Pollen taxa occurring at less than 5% are not shown. Exaggeration curves 2× for the taxa presented here. Charcoal and pollen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

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## DATA AVALIABILITY

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

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