QUATERNARY RESEARCH 42, 354–355 (1994)

LETTER TO THE EDITOR

Comment on Temperature Indices from a Late Quaternary Terrestrial Sequence at Wonderkrater, South Africa

An apparently complete Holocene sequence is available from a terrestrial core at Wonderkrater, situated in the northern Transvaal of South Africa (Scott, 1982). Multivariate analyses of pollen spectra from such cores have yielded temperature indices (Scott and Thackeray, 1987). The indices are summary statistics based on the first factor (F1, cf., principal component) generated from factor analyses of relative abundances of pollen grain abundances (Scott and Thackeray, 1987); similar temperature indices have also been calculated from micromammal abundance data obtained from Later Quaternary sequences in South Africa (Thackeray, 1987). The inference that the first factor is related to temperature has been based primarily on a dichotomy between taxa with high and low loadings on F1: taxa with F1 loadings at or near one extreme are today represented in warm subtropical environments, whereas those with F1 loadings at the opposite extreme occur today in cooler areas. Palaeoenvironmental indices have been calculated for each assemblage by summing the products of F1 loadings and percentage occurrences of the corresponding taxa. These indices have been standarized arbitarily between 0 (cold) and 100 (warm) and are referred to as SSF1 (summary statistics based on F1). Relatively high SSF1 indices are associated with high frequencies of taxa that are at present distributed primarily in warm subtropical environments. By contrast, low SSF1 values are associated with high frequencies of taxa that are known to prefer cooler or colder areas.

Relative changes in SSF1 temperature indices based on multivariate analysis of pollen spectra from Wonderkrater Core 3 (Scott and Thackeray, 1987) have recently been compared against oxygen isotope ratios from carbonates in a Tibetan core (Thackeray, 1993). Common trends are displayed, but the dating for Wonderkrater, as given by Scott (1990), is still in question.

Temperature indices for Wonderkrater Core 3 are listed for the first time in Table 1, together with associated depths, laboratory reference numbers, and radiocarbon dates. Despite uncertainties regarding the chronology of deposits at Wonderkrater (Scott, 1982; Scott and Thackeray, 1987; Scott, 1990), there is no doubt that a strong linear relationship exists between radiocarbon ages and depth in Core 3 (Fig. 1). Ages have been estimated, using

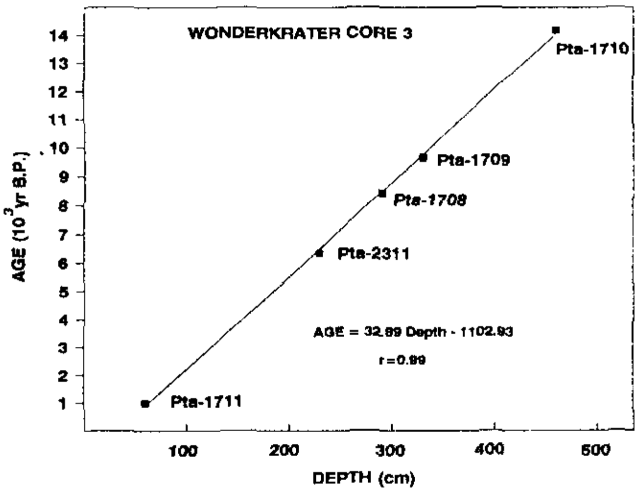

FIG. 1. Relationship between radiocarbon age and depth for five samples from Wonderkrater; data from Scott (1982).

the regression equation in Figure 1, for all of the Holocene samples from Core 3 for which temperature indices have been calculated. The Holocene temperature indices are plotted relative to these age estimates in Figure 2.

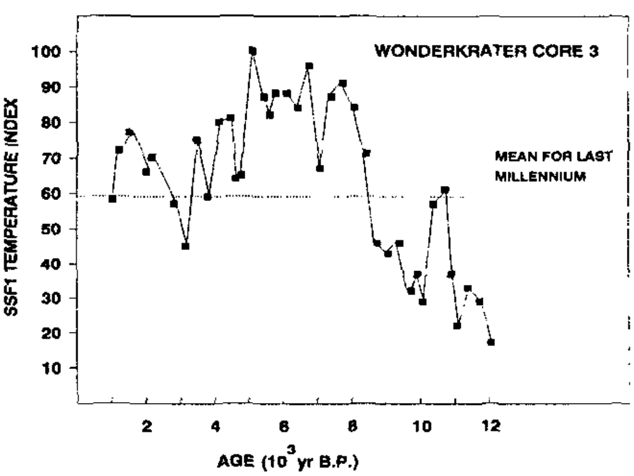

FIG. 2. Temperature index (SSF1) for Holocene deposits from Core 3, Wonderkrater, South Africa, based on multivariate analysis of pollen spectra (Scott and Thackeray, 1987); the chronology for temperature indices is based here on an age–depth relationship determined by linear regression using data listed in Table 1.

0033-5894/94 $6.00

TABLE 1

Temperature Indices (SSF1) for Core 3, Wonderkrater, South Africa, Based on Multivariate Analysis of Pollen Spectra (Scott and Thackeray, 1987)

Pollen sample no.	Depth (cm)	SSF1 temperature index	Radiocarbon age (yr B.P.) and laboratory no.
5533	10	70	
5535	20	70	
5536	25	64	
5537	30	57	
5539	40	40	
5541	50	56	
5543	60	79	1000 ± 50 Pta-1711
5544	65	58	
5545	70	72	
5547	80	77	
5550	95	66	
5551	100	70	
5556	120	57	
5558	130	45	
5560	140	75	
5562	150	59	
5565	160	80	
5567	170	81	
5568	175	64	
5569	180	65	
5571	190	100	
5573	200	87	
5575	205	82	
5576	210	88	
5578	220	88	
5580	230	84	6330 ± 75 Pta-2311
5552	240	96	
5586	250	67	
5588	260	87	
5590	270	91	
5592	280	84	
5594	290	71	8390 ± 85 Pta-1708
5599	300	46	
5601	310	43	
5603	320	46	
5605	330	32	9640 ± 80 Pta-1709
5606	335	37	
5609	340	29	
5611	350	57	
5613	359	61	
5615	365	37	
5616	370	22	
5618	380	33	
5622	390	29	
5624	400	17	
5626	410	18	
5628	420	1	
5632	430	22	
5634	440	16	
5635	445	23	
5638	460	20	14180 ± 110 Pta-1710
5640	470	18	
5644	480	30	
5645	485	27	

Note. Core 3 pollen samples listed by laboratory numbers and depth in core; radiocarbon ages listed for five samples from Core 3 (Scott 1982).

Figure 2 shows trends that have previously been associated with global changes in temperature during the Holocene (Thackeray, 1990, 1993). Notably, the Younger Dryas appears to be represented by pollen from Wonderkrater samples 5605, 5606, and 5609, at depths of 330, 335, and 340 cm, respectively, from deposits that are here dated ca. 10,000 yr B.P. (uncalibrated, close to 11,000 cal yr B.P.). These results appear to correspond to relative changes in $\delta^{18}O$ in marine shells from Elands Bay Cave on the southwest African coast, also associated with the Younger Dryas (Cohen *et al.*, 1992).

REFERENCES

Avery, D. M. (1982). Micromammals as palaeoenvironmental indicators and an interpretation of the Late Quaternary in the southern Cape Province, South Africa. *Annals of the South African Museum* **85**, 183–374.

Cohen, A. L., Parkington, J. E., Brundrit, G. B., and van der Merwe, N. J. (1992). A Holocene marine climate record in mollusc shells from the Southeast African coast. *Quaternary Research* **38**, 379–385.

Craig, H. (1965). The measurement of oxygen isotope temperatures. *In* "Stable Isotopes in Oceanographic Studies and Paleotemperatures" (E. Tongiorgi, Ed.), pp. 1–24. CNR, Pisa.

Deacon, J. J. (1979). Excavations at Boomplaas Cave—A sequence through the Upper Pleistocene and Holocene in South Africa. *World Archaeology* **10**, 241–257.

Heaton, T. H. E., Talma, A. S., and Vogel, J. C. (1986). Dissolved gas palaeotemperatures and O-18 variations derived from groundwater near Uitenhage, South Africa. *Quaternary Research* **25**, 79–88.

Jouzel, J., Lorius, C., Petit, J. R., Genthon, C., Barkov, N. I., Kotlyakov, V. M., and Petrov, V. M. (1987). Vostok ice core: A continuous isotope temperature record over the last climatic cycle (160,000 years). *Nature* **329**, 403–408.

Scott, L. (1982). A late Quaternary pollen record from the Transvaal bushveld. *Quaternary Research* **17**, 399–370.

Scott, L. (1990). Environmental changes reflected by pollen in some Holocene sediments from Transvaal, South Africa and Marion Island, Southern Ocean. *South African Journal of Science* **86**, 464–466.

Scott, L., and Thackeray, J. F. (1987). Multivariate analysis of Late Pleistocene and Holocene pollen spectra from Wonderkrater, Transvaal, South Africa. *South African Journal of Science* **83**, 93–98.

Talma, A. S., and Vogel, J. C. (1992). Late Quaternary paleotemperatures dervied from a speleothem from Cango Cave, Cape Province, South Africa. *Quaternary Research* **37**, 203–213.

Thackeray, J. F. (1990). Temperature indices from Later Quaternary sequences in South Africa: Comparisons with the Vostok Core. *South African Geographical Journal* **72**, 47–49.

Thackeray, J. F. (1993). Palaeoenvironmental indices for Late Quaternary sequences in South Africa and Tibet: A comparison. *South African Journal of Science* **89**, 170–171.

Thackeray, J. F. (1987). Late Quaternary environmental changes inferred from small mammalian fauna, southern Africa. *Climatic Change* **10**, 285–305.

Vogel, J. C. (1983). Isotopic evidence for the past climates and vegetation of southern Africa. *Bothalia* **14**, 391–394.

Francis Thackeray

Department of Palaeontology and Palaeoenvironmental Studies
Transvaal Museum, P.O. Box 413, Pretoria 0001