Were environmental or demographic factors the driving force behind Middle Stone Age innovations in southern Africa?

Sir — Past human responses to environmental changes have long interested archaeologists. During the last glacial cycle, southern Africa experienced marked climatic fluctuations, as recorded in ice-core records from West and East Antarctica.[1–7] Two phases of technological and behavioural innovation, known as the Still Bay (SB) and Howieson's Poort (HP) industries, also occurred during this interval of the Middle Stone Age (MSA). Recently, we reported improved estimates for the start and end dates, and durations, of these two industries, and argued that the SB and HP did not reflect a response to environmental factors alone.[8–11]

We drew this conclusion for two reasons. First, we noted that the HP occurred during a period of climatic warming between *c.* 65 and 60 thousand years ago (kyr), regardless of which Antarctic ice core is chosen for comparison, whereas the SB (*c.* 72 to 71 kyr) was not clearly associated with any such warming trend. Second, two subsequent MSA periods (the late and final MSA at Sibudu Cave[12]), and possibly also the immediately post-HP pulse at *c.* 56.5 kyr[(ref. 8)], occurred during warm intervals, yet none of these periods is notable for technological or behavioural innovations. Consequently, we could not identify any specific climatic conditions uniquely associated with both the SB and HP industries, which suggests that their emergence and demise were not driven by a common environmental cause.

Furthermore, we could find no spatial variation in the timing of the start or end of the SB and HP at sites spread across two million km^2 of southern Africa. This geographic area encompasses most major present-day climatic ranges and ecological zones, including coastal South Africa, mountainous Lesotho and arid Namibia. Given the lifestyle of hunter-gatherers, however, we recognise that the preferred sites for human habitation and access to resources would likely have changed over time in response to environmental influences—a view encapsulated in our statement (on p. 734 of ref. 8) that 'Environmental factors may have been responsible for episodic occupation and abandonment of rock shelters (*26*) [ref. 12 here], but they were not necessarily the driving force behind technological change.' Thus, it is only the link to technological and behavioural *innovations* that we directly challenged.

In recent scientific correspondence, Thackeray[13] also argues for enhanced archaeological visibility at certain times, in response to environmental factors. This conclusion is consistent with the view expressed in the first part of the quotation above from ref. 8, which he omits to report. We disagree with Thackeray, however, that temperature variations played an important role in SB and HP innovations—not only for the reasons given above, but also because his environmental reconstructions are based on correlations with the Vostok ice-core record,[1] which are less secure than they might appear. For example, he associates the SB with a warm period, but this is not necessarily true: the temperature trends inferred from various Antarctic ice cores—obtained more recently and some at higher temporal resolution than the Vostok core—are not entirely congruent over the relevant time period (see refs 3–6 and Fig. 4 in ref. 8). Thackeray also compares temperature reconstructions for Klasies River with those at Vostok, using the original chronology for this ice core[1] as the frame of reference. He argues that the HP began during a warm interval and extended into the subsequent period of cooler climate. However, the revised Vostok chronology[2] indicates that this climatic cooling did not occur until after *c.* 59 kyr, which is in close agreement with the other Antarctic records for the relevant time period.[3–6]

The 'gap' between the end of the SB (*c.* 71 kyr) and the start of the HP (*c.* 65 kyr) occurred during a comparatively cold period of the last glacial cycle (Oxygen Isotope Stage 4), but mean annual temperatures in Antarctica at this time were only ~3°C cooler than at the height of the bracketing warm intervals.[5,7] Given the ambiguities involved in interpreting the Antarctic temperature records[7] and in extrapolating them to southern Africa, we remain cautious about linking the technological and behavioural innovations of the SB and HP to environmental factors alone. Furthermore, as the timing of these industries cross-cuts diverse climatic and ecological zones, elucidating the putative role of climate change will require well-dated continental records from sites and biomes throughout southern Africa. As a trigger for these MSA innovations, we instead favour some mechanism related to the expansions and isolations of modern human populations within Africa at about this time,[8–11] as identified by genetic studies[14–17] and supported by demographic models of cultural evolution.[18,19]

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