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Correspondence

The use of two pollen records from deep sea cores to frame adaptive evolutionary change for humans: a comment on "Neanderthal extinction and the millennial scale climate variability of OIS 3" by F. d'Errico and M.F. Sánchez Goñi ☆

d'Errico and Sánchez Goñi (2003) outline a palaeoenvironmental scenario for the late survival and extinction of Neanderthals in southern Spain during the OIS 3 (48–26 kyr BP). This can be described as follows: (i) during the H4 event (35.3–33.9 kyr), Modern Humans failed to colonize southern Iberia because of the arid environments that characterized this event in the region. In contrast, since at least 36.5 kyr BP, Modern Humans were able to expand over the Franco-Cantabrian region because this was more humid and would have provided adequate resources, in particular for large mammals feeding on extensive grasslands. (ii) After the H4 event, owing to the return of milder climatic conditions southern Spain saw the expansion of open Mediterranean forests, and this resulted in the progressive colonization of this region by Modern Humans and the definitive extinction of Neandertal populations at ca. 27 kyr BP.

These conclusions are reached from the correlation between archaeological data from western Europe and palaeoenvironmental sequences from two IMAGES pollen deep sea cores, the off-Lisbon MD95-2042 and the Alborán MD95-2043 (Sánchez Goñi et al., 2002). Pollen-stratigraphical changes in these two sequences have been 'spectrally tuned' be in phase with Dansgaard-Oeschger climatic stages, which seems sufficient for these records to be classified by the authors as "the best palaeoenvironmental data for the OIS 3" (p. 771) and reach the category of "luxury" (p. 777).

This letter arises from disagreement over the suitability of restricting the understanding of terrestrial environmental change in Southern Spain during the last full-glacial to two marine pollen records. I will focus on the contention that d'Errico and Sánchez Goñi (2003) make from analysis of the marine sequences that during the cold/dry phases of the OIS 3, low-biomass, desert steppes of *Artemisia*, Chenopodiaceae and *Ephedra* developed in southern Iberia. This evidence is in direct contrast to a number of studies from pollen assemblages from both lake, peatbogs and cave sediments which demonstrate (i) the stationary character of the south-eastern coastal Mediterranean forest and north African thermophilous scrub during the OIS 3 (Carrión et al., 1995, 2003), (ii) that, in continental areas of southern Spain, grasses, even pines, were more abundant than *Artemisia* during the study period (Pons and Reille, 1988, Carrión et al., 1998), (iii) that Moderns did not reach many areas of Mediterranean Spain following the expansion of forests, but rather phases of xerophytization (Carrión et al., 1999), and (iv) that several cold events of the OIS 3 coincide with expansions of Mediterranean forests (Carrión and van Geel, 1999). Palynological findings join to faunal remains to suggest the coincidence in many areas of several different biotopes associated to long-term human presence (Carrión et al., 2003; Finlayson and Giles Pacheco, 2000). Differences observed in vegetation sequences of the Iberian Peninsula for the OIS 3 are the logical consequence of physiographic heterogeneity and complex biological history of the region.

Much of the d'Errico and Sánchez Goñi's (2003) paper is spent justifying why all the terrestrial records from southern Spain are at odds with these marine records. I would recommend that the original papers on the sites of Arcy (Leroi-Gourham and Leroi-Gourham, 1964), Valiña (Fernádez Rodrígez et al., 1993), Romaní (Burjachs and Julià, 1994), Perneras (Carrión and Munuera, 1997), Banyoles (Pérez Obiol and Julià, 1994), and Padul (Pons and Reille, 1988) are studied. I am rather concerned about the way they reinterpret the environmental significance of cave pollen spectra (pp. 772, 773) using pollen rain studies…from lakes!

I do not wish to challenge the evidence put forward by d'Errico and Sánchez Goñi site by site. I wish to point out additional facts that should have taken into account when interpreting their own records. Given these facts, plus the conflict between the marine evidence with the terrestrial sequences, I suggest that the overall interpretations of d'Errico and Sánchez Goñi (2003) may be re-assessed, or at least indicate that their conclusions should be viewed with extreme caution.

(1) There is an uncertain and large pollen source area for the marine sediments. Sánchez Goñi et al. (2002, p. 96) maintain that the main pollen supply to the Alboran core is the vegetation colonising the southern part of Iberia. However, if the North African pollen contribution is negligible, how can be

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explained the abundance of *Cedrus* pollen (often above 30%) in MD95-2043? (Sánchez Goñi et al., 2002). In this context, Horowitz's (1992) experience with marine pollen assemblages from the margins of arid lands in Israel should have not been disregarded. Here he demonstrated that the oscillations of *Artemisia* and chenopod pollen can result, at least partially, from variations in wind regimes, marine currents, or the rate of relative contribution of terrigenous materials (e.g. runoff, alluvial fans). It is noteworthy that *Isoetes* and *Artemisia* maxima show opposing patterns, which is compatible with the alternation of terrigenous and airborne pollen periods. Such a process would explain better the rapid changes observed in the MD95-2042 and MD9595-2043 pollen sequences and would not require vegetation to shift after each ocean/ climate event (d'Errico and Sánchez Goñi, 2003).

(2) The authors fail to address the fact that the most abundant and characteristic species of the coastal vegetation of southeastern Spain are zoophilous angiosperms whose pollen is absent or strongly underrepresented in the sediment of deltas, lagoons, watercourses and marine sediments (Carrión, 2002). It is unlikely that these species are recent arrivals to the region, or disappeared from it during the Quaternary, as they point to an Ibero-North African disjunction linked to late-Miocene reopening of the Strait of Gibraltar. To suggest that they were not present therefore is to ignore the most basic understanding of the limitations of palaeoecology in marine sediments.

(3) d'Errico and Sánchez Goñi (2003) compare the steppes dominated by Poaceae such as *Stipa tenacissima* and *Lygeum spartum* with those by *Artemisia barrelieri* and Chenopodiaceae in terms of carbon storage, concluding that the first group would be more able to sustain populations of large hervibores in the north of Iberia during the cold events of the OIS 3. This is not realistic, because both *Stipa tenacissima* and *Lygeum spartum* are very fibrous and unpalatable (even for goats and camels!), while *Artemisia barrelieri*, as a number of chenopods (*Atriplex*, *Beta*, *Chenopodium*) show a generally better digestibility (Ben Salem et al., 1998).

(4) The palynocentrist approach adopted by d'Errico and Sánchez Goñi (2003) when framing a theory of adaptive evolutionary change for humans is at odds with palaeontological findings. In order to demonstrate that southern Iberian landscapes were unable to feed large mammals during the cold phases of OIS 3, it would be necessary to seek for evidence of fauna extinctions during H4 and H3 events. Ironically, a number of "large mammals" were living in southern Iberia during the whole OIS 3, with no evidence for species gaps in the palaeontological database (e.g. Vega-Toscano, 1988; Martínez Valle, 1996; Finlayson and Giles Pacheco, 2000; Pérez Ripoll and Martínez Valle, 2001). Faunas that could provide food resources for humans are available during even colder periods of the OIS 2. Both lines of evidence appear to have been ignored in this paper.

(5) Inherent in the d'Errico and Sánchez Goñi (2003) model is the implication that there was rapid and large-range contraction/expansion of distribution area of a number of species. Here the paradox is that the occurrence of biodiversity hotspots in southern Spain (e.g. Strait of Gibraltar region and Aljibe Mountains, Alcaraz-Cazorla-Segura ranges, Sierra Nevada, Mounts of Málaga) is not compatible with a history of pronounced habitat fragmentation (Ojeda et al., 2000). This includes not only reproductive sensitivity to populational size, but also plant–animal interactions, including availability of pollinators and vectors of seed/fruit dispersal (Harrison and Bruna, 1999; Tellería and Santos, 2001).

I will not venture into palaeoanthropological issues, but wonder whether the manifest association between Neanderthal disappearance and incompetence does reflect a modern evolutionary focus, or conversely, a hyper-reductive conception of an intrinsically complex process.

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A stationary Mediterranean forest in southeastern Iberia during OIS 3? A reply to the comments by J.S. Carrión ☆

Carrión challenges our interpretation of the pollen record from marine sequences located off South Iberia by arguing that our palaeoenviromental reconstruction is in contradiction with that proposed, mostly by him, on the basis of pollen data "from lakes, peat bogs and cave deposits" from southern Spain, indicating that the Mediterranean forest persisted almost unchanged in the coastal areas during OIS 3 and was apparently not affected by the D-O millennial scale climatic variability. He suggests that in order to sort out these contradictions we should consider alternative interpretations for our marine pollen spectra, and in particular the possibility that these spectra do not reflect the vegetation colonising the nearby continent during OIS 3. We are going to show that the four statements he presents in the introduction of his comment as firmly established palaeoecological facts must be seen as no more than working hypotheses unsupported by the evidence he cites and contradicted by a growing body of multiproxy palaeoenvironmental data. In the second part of this reply we will show that his criticism of our work applies in fact to his own conclusions.

Mediterranean forest and the cold events of OIS 3

Carrión misleadingly inflates the range of sites that would have produced palynological evidence contradicting our hypotheses. No lake sequences and only two peat bogs, Padul and Navarrés, the latter only marginally covering OIS 3, are available for study in South Iberia. This is surprising considering that this author has repeatedly used (Carrión et al., 1999, 2003, p. 1071, 124) the lack of such sequences to justify his interest in cave deposits in spite of the well known serious drawbacks of these deposits for palaeoecological reconstruction.

The studies cited by Carrión (Carrión et al., 1995, 2003) to shore up the stationary character of the Mediterranean forest and Ibero-Maghrebian

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