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Investigation of equid paleodiet from Schöningen 13 II-4 through dental wear and isotopic analyses: Archaeological implications

Florent Rivals [a, b, c, *], Marie-Anne Julien [d, j, k, 1], Margot Kuitems [f], Thijs Van Kolfschoten [f], Jordi Serangeli [g], Dorothée G. Drucker [e], Hervé Bocherens [e, h], Nicholas J. Conard [g, i]

[a] Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain
[b] Institut Català de Paleoecologia Humana i Evolució Social (IPHES), C. Marcel·lí Domingo s/n, Campus Sescelades URV (Edifici W3), 43007 Tarragona, Spain
[c] Area de Prehistoria, Universitat Rovira i Virgili (URV), Avinguda de Catalunya 35, 43002 Tarragona, Spain
[d] Institute for Archaeological Sciences, University of Tübingen, Rümelinstr. 23, 72070 Tübingen, Germany
[e] Department of Geosciences, Biogeology, University of Tübingen, Hölderlinstr. 12, 72074, Tübingen, Germany
[f] Faculty of Archaeology, Leiden University, Reuvensplaats 3-4, 2311 BE Leiden, The Netherlands
[g] Department of Early Prehistory and Quaternary Ecology, University of Tübingen, Schloss Hohentübingen, 72070 Tübingen, Germany
[h] Senckenberg Centre for Human Evolution and Palaeoecology, Hölderlinstr. 12, 72074, Tübingen, Germany
[i] Senckenberg Centre for Human Evolution and Palaeoecology, University of Tübingen, Schloss Hohentübingen, 72070 Tübingen, Germany
[j] Centre for the Archaeology of Human Origins, Archaeology Department, University of Southampton, Avenue Campus, Southampton SO17 1BF, UK
[k] Unité Histoire Naturelle de l'Homme Préhistorique (UMR 7194), Sorbonne Universités, Muséum national d'Histoire naturelle, CNRS, 1 rue René Panhard, 75013 Paris, France

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ABSTRACT

The paleodietary traits of the equid population from Schöningen 13 II-4 were investigated through tooth mesowear and microwear analyses, as well as stable isotopic analyses. The mesowear pattern observed on the upper teeth indicates a low abrasion diet with a significant amount of browse in the diet of the horses. The tooth microwear analysis and the isotopic data confirm that the horses from Schöningen 13 II-4 were mixed feeders, like many populations from other Pleistocene localities in Northern and Eastern Europe. Microwear also provides information on seasonal changes in the diet of the horses and offers the possibility to test hypotheses about the presence of one or several horse populations. Our analysis determined that the assemblage of horse remains from Schöningen 13 II-4 resulted from multiple accumulation events, which took place at different periods of time.

Introduction

Schöningen is an open lignite mine located in northern Germany, 90 km east of Hannover. Systematic archeological research has been carried out on a large number of sites at this location since 1983. The Schöningen 13 II site was discovered in 1994 and became famous with the discovery of wooden spears (Thieme, 1997). The stratigraphical (Lang et al., 2012) and the biostratigraphical (Van Kolfschoten, 2012, 2014) records of Schöningen 13 II-4 indicate a correlation with Marine Isotope Stage (MIS) 9 and an age of about 300 ka BP (thousands of years before present) (Geyh and Krbetschek, 2012; Sierralta et al., 2012). The pollen assemblage associated with level II-4 is dominated by trees, shrubs, and forbs, with *Pinus* and *Betula* as dominant species (Urban, 2007; Urban et al., 2011). Among the archeological remains (including the wooden spears), the site has yielded a rich bone assemblage consisting mainly of large mammal remains. In Schöningen 13 II-4 the main large mammal species is the horse (*Equus mosbachensis*), which represents 85% of the large mammal remains in that level (Van Kolfschoten et al., 2015).

Pleistocene horses are usually depicted as obligate grazers, but recent studies using tooth wear and stable isotopes identified mixed feeding or even browsing traits in a number of populations in North America, Africa, and Europe, with some individuals feeding mainly under closed canopy forests (Bocherens et al., 1999; Kaiser and Franz-Odendaal, 2004; Rivals et al., 2009a; Mihlbachler et al., 2011). Horse populations from middle and late Pleistocene localities from Northern and Eastern Europe were found to be browsers or mixed feeders

* Corresponding author.
E-mail address: florent.rivals@icrea.cat (F. Rivals).
[1] Present address: Archaeology Department, University of Southampton, Avenue Campus, Southampton SO17 1BF, UK and UMR 7194 CNRS, Département de Préhistoire du Muséum national d'Histoire naturelle, 1 rue René Panhard, 75013, Paris, France.

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whereas the populations from the Mediterranean area were grazers (Rivals et al., 2009a; Rivals, 2012; Ecker et al., 2013).

In the present paper, we use tooth microwear (microscopic scars produced by the interaction of food items on the occlusal surface of the teeth) and mesowear analyses (cusp relief and shape), as well as stable isotopic analyses, to study the dietary traits of the horse assemblage from Schöningen 13 II-4.

Besides classical uses in dietary interpretations of ungulates, the application of tooth wear analyses on archeological assemblages offers the possibility of identifying single or multiple depositional events. Part of the horse assemblage from Schöningen 13 II-4 is known to be the result of hominid hunting activities (Thieme, 1997, 2005; Voormolen, 2008; Conard et al., 2015). Some authors have even suggested that the assemblage is the result of a single mass-kill event (Musil, 2007; Thieme, 2007).

On the basis of the data gathered on the dietary traits of the horse assemblage from Schöningen 13 II-4, we test two hypotheses: (1) the horse population(s) had a mixed feeding dietary strategy; and (2) the assemblage is the result of a single accumulation event.

Material and methods

The horse molars analyzed in this study are from the site of Schöningen 13 II-4. Tooth mesowear was examined directly on the fossil specimens and high resolution molds for tooth microwear, as well as samples for isotopic analysis were taken in May 2012 at the Faculty of Archaeology at Leiden University. Before analysis, the material was carefully examined to refit the teeth from the same individuals looking at crown height and contact facets between teeth. Only one tooth from each association was sampled.

Mesowear analysis

Mesowear analysis, first introduced by Fortelius and Solounias (2000), is a method of categorizing the gross dental wear of ungulate molars by evaluating the relief and sharpness of cusp apices in ways that are correlated with the relative amounts of attritive and abrasive dental wear. Mesowear is scored macroscopically from the buccal side of upper molars (Fig. 1), preferably the paracone of M2 (Fortelius and Solounias, 2000). A diet with low levels of abrasion (high attrition) maintains sharpened apices on the buccal cusps as the tooth wears. In contrast, high levels of abrasion, associated with a diet of siliceous grass and/or a high rate of soil or dust particle ingestion results in more rounded and blunted buccal cusp apices. Unworn (and marginally worn) teeth, extremely worn teeth, and those with broken or damaged cusp apices are omitted from mesowear analyses. Cusp sharpness is sensitive to ontogenetic age among young individuals (who have not yet developed substantial wear facets) and among dentally senescent individuals. However, for intermediate age groups, which typically include the majority of individuals in a fossil collection, mesowear was found to

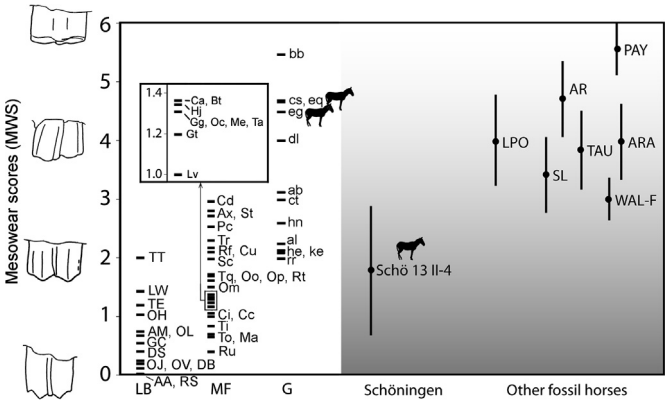

Figure 2. Horse mesowear from Schöningen 13 II-4 compared with extant ungulates (LB = leaf browsers; MF = mixed feeders; G = grazers) and other middle and late Pleistocene horse samples from Western Europe (AR = Abric Romaní; ARA = Caune de l'Arago; LPO = Le Portel-Ouest; PAY = Payre; SL = Salzgitter-Lebenstedt; TAU = Taubach; WAL-F = Wallertheim level F). Extant plains zebra *E. quagga* (eq) and Grevy's zebra *E. grevyi* (eg) are plotted among the extant grazers. Abbreviations of the other extant ungulates (Fortelius and Solounias, 2000): **Browsers**: AA = *Alces alces*, AM = *Antilocapra americana*, DB = *Diceros bicornis*, DS = *Dicerorhinus sumatrensis*, GC = *Giraffa camelopardalis*, LW = *Litocranius walleri*, OH = *Odocoileus hemionus*, OJ = *Okapia johnstoni*, OL = *Capreolus capreolus*, OV = *Odocoileus virginianus*, RS = *Rhinoceros sondaicus*, TE = *Tragelaphus euryceros*, TT = *Tragelaphus strepsiceros*; **Grazers**: ab = *Alcelaphus buselaphus*, al = *Sigmoceros lichtensteinii*, bb = *Bison bison*, cs = *Ceratotherium simum*, ct = *Connochaetes taurinus*, dl = *Damaliscus lunatus*, eg = *E. grevyi*, eq = *E. quagga*, he = *Hippotragus equinus*, hn = *Hippotragus niger*, ke = *Kobus ellipsiprymnus*, rr = *Redunca redunca*; **Mixed feeders**: Ax = *Axis axis*, Bt = *Budorcas taxicolor*, Ca = *Capricornis sumatraensis*, Cc = *Cervus elaphus canadensis*, Cd = *Rucervus duvaucelii*, Ci = *Capra ibex*, Cu = *Cervus unicolor*, Gg = *Gazella granti*, Gt = *Gazella thomsoni*, Hj = *Hemitragus jemlahicus*, Lv = *Lama vicugna*, Ma = *Antidorcas marsupialis*; Me = *Aepyceros melampus*; Oc = *Ovis canadensis*, Om = *Ovibos moschatus*, Oo = *Ourebia ourebi*, Op = *Ovis ammon poli*, Pc = *Procavia capensis*, Rf = *Redunca fulvorufula*, Rt = *Rangifer tarandus*, Ru = *Rhinoceros unicornis*, Sc = *Syncerus caffer*, St = *Saiga tatarica*, Ta = *Tragelaphus angasi*, Ti = *Tragelaphus imberbis*, To = *Taurotragus oryx*, Tq = *Tetracerus quadricornis*, Tr = *Boselaphus tragocamelus*.

be less sensitive to age and more strongly related to diet (Rivals et al., 2007) and therefore suitable for dietary reconstruction.

In this study, the standardized method (mesowear 'ruler') introduced by Mihlbachler et al. (2011) is employed (Fig. 2). The method is based on seven modern horse cusps (numbered from 0 to 6), ranging in shape from high and sharp (stage 0) to completely blunt with no relief (stage 6). Using the mesowear ruler as a reference, cusps equal to or sharper and higher in relief than reference cusp 0 were assigned a 0. Cusps that were morphologically intermediate between reference cusp 0 and reference cusp 1, or equal to reference cusp 1 were assigned a 1, and so forth. The average value of the mesowear data from a single sample of fossil dentitions corresponds to the 'mesowear score' (Mihlbachler et al., 2011).

Microwear analysis

Microwear features of dental enamel were examined using a stereomicroscope on high-resolution epoxy casts of teeth following

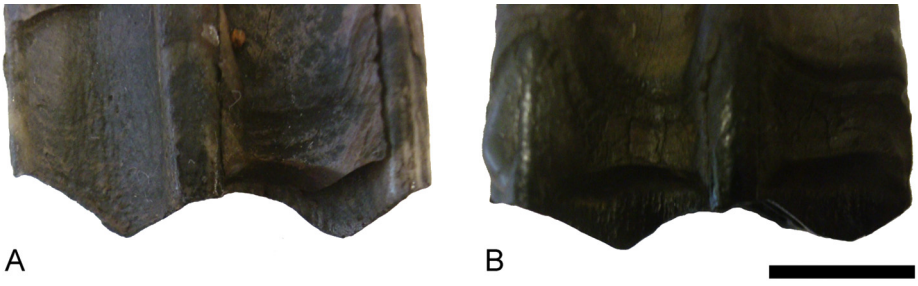

Figure 1. Horse upper teeth from Schöningen 13 II-4, buccal view. Right M2 Schö 695/51-3 (A) and left P4 Schö 719/13-8 (B). Scale bar = 1 cm.