**Cultivation of choice: new insights into farming practices at Neolithic lakeshore sites**

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**Technical appendix**

*1. Selection of carbonised crop remains for isotope analysis—Hornstaad-Hörnle IA*

Between five and ten carbonised cereal grains of naked wheat (*Triticum durum/turgidum* type), barley (*Hordeum vulgare* ssp. *nudum*) and/or einkorn (*T. monococcum*) from each sampling location with sufficient material were selected for isotopic analysis (*n* = 179; see Figure 3 and Table S1). All cereal grains come from the burnt layer, dated to 3910 cal BC. The charred crop remains were well preserved: epidermal surfaces were largely intact and morphology was overall virtually undistorted, enabling identification of species or type (cf. Figure 7).

<TABLE S1>

*2. Selection of carbonised crop remains for isotope analysis—Sipplingen*

Between five and ten carbonised cereal grains of naked wheat (*Triticum durum/turgidum* type), barley (*Hordeum vulgare* ssp. *nudum*) and glume wheats (*T. monococcum* and *T. dicoccum*), and 5 carbonised pea seeds (*Pisum sativum*) were selected for isotopic analysis (*n* = 45; Table S2). The charred crop remains were well preserved (see Figure 7) and came from eight different phases, dating to between 3919 and 2855 cal BC.

<TABLE S2>

*3. Preparation of carbonised crop remains for isotope analysis*

Cereal grains and pulses were examined at ×7–45 magnification for visible surface contaminants, such as adhering sediment or plant roots; these were removed by gentle scraping. Twenty samples from Hornstaad (10 grains in each) and 10 samples from Sipplingen (10 grains in each) were crushed. Half of each sample was then subjected to acid-base-acid (ABA) pretreatment, a procedure commonly applied to charcoal and charred plant remains prior to radiocarbon and stable isotope analysis (Bronk Ramsey 2008; Ascough *et al*. 2011) and considered appropriate for use on archaeobotanical remains (Fraser *et al*. 2013; Vaiglova *et al*. 2014). This three-step procedure consists of: 1) treatment with 10ml of 0.5M hydrochloric acid at 70°C for 30–60 minutes, or until any effervescing ceases, then rinsing in distilled water three times; 2) treatment with 10ml of 0.1M sodium hydroxide at 70°C for 60 minutes, followed by rinsing in distilled water until the solution is clear and the pH neutral, using a minimum of three rinses; 3) treatment with 10ml of 0.5M hydrochloric acid at 70°C for 30–60 minutes, followed by three rinses in distilled water and final freeze drying. Dried samples were weighed into tin capsules for stable isotope analysis.

A paired t test showed a significant difference in the δ15N values of non-treated and ABA-pretreated aliquots from Hornstaad (t(19) = -2.58, p = 0.02), but the mean of the differences in δ15N was -0.2‰ (95%CI [-0.3, -0.03‰]), and the largest difference in δ15N was 0.64‰. Given the reasonably large measurement errors associated with archaeological plant δ15N values (standard deviation up to 0.8‰ when normalised against standards), it was decided not to ABA-pretreat the remaining samples from Hornstaad. A paired t test showed no significant difference in the δ15N values (t(9) = -1.11, p = 0.30) of non-treated and ABA-pretreated aliquots from Sipplingen. It was also decided, therefore, not to ABA-pretreat the remaining samples from Sipplingen.

*4. Preparation of faunal bones for isotope analysis*

Between 0.5 and 1g of bone was cleaned of any visible dirt or carbonate crusts using an aluminium oxide air abrasive. Collagen was isolated using a modified ‘gelatinisation method’ based on the methods of Longin (1971). Bone collagen samples of approximately 1mg were weighed into tin capsules for stable isotope analysis.

*5. Stable isotope analysis*

The δ15N values of bone collagen and charred crop remains were determined on a Sercon EA-GSL mass spectrometer. An internal alanine standard was used to calculate raw isotope ratios. For bone collagen, two-point normalisation was carried out using four replicates each of caffeine and seal bone collagen. The δ13C and δ15N values of charred crop remains were determined separately due to the low concentration of nitrogen in the samples. For δ13C, two-point normalisation to the VPDB scale was obtained using four replicates each of IAEA-C6 and IAEA-C7, while for δ15N, the standards were USGS40 and IAEA-N2. Reported measurement uncertainties are the calculated combined uncertainty of the raw measurement and reference standards, after Kragten (1994). The average measurement uncertainty for δ13C was ±0.35‰, and for δ15N, it was ±0.66‰. These calculations were performed using the statistical programming language R. (3.0.2). An offset of -0.31‰ was applied to the determined cereal grain δ15N values to account for the effect of charring (Nitsch *et al.* 2015).

*6. Spatial analysis of crop δ15N values*

The Getis-Ord Gi\* statistic (Getis & Ord 1992) was used to test for clustering of the cereal grain δ15N values. Clustering was only considered within a 1.5m fixed distance; this is half the average house width.

*7. Estimating a δ15N baseline for unmanaged plants from herbivore bone collagen δ15N values*

An indication of the δ15N value of unmanaged (i.e. unmanured) plants at each site was estimated by subtracting 4‰, which is the average trophic enrichment between herbivore bone collagen and diet (e.g. Steele & Daniel 1978) from the mean herbivore bone collagen δ15N value. At Hornstaad-Hörnle IA, the mean δ15N value of wild and domestic herbivores was the same (Table S1), and it was therefore assumed that domestic herbivores had an insignificant proportion of managed crops in their diet. In addition, the relatively low δ13C values of wild aurochs and some cattle indicate a ‘canopy effect’, presumably from feeding in dense woodland (Heaton 1999), but, despite this, their δ15N values do not differ from those cattle feeding in more open habitats. This demonstrates that the δ15N values of unmanaged (unmanured) plants were relatively homogenous around Hornstaad-Hörnle IA.

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