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Dietary seasonal variations in the Medieval Nubian population of Kulubnarti as indicated by the stable isotope composition of hair

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ABSTRACT

Objectives: The island of Kulubnarti is located in Sudanese Nubia and contains two cemeteries, named R and S, which are dated to AD 550–800. In order to provide more detailed dietary information for this population and examine seasonality of diet, we analyzed the carbon isotope composition of hair samples from both cemeteries.
Materials and methods: Forty seven separate hair samples from 8 adults, 29 adolescents, 7 infants and 3 individuals with unknown age were analyzed. Long hair samples were cut transversely and divided into 2 cm longitudinal segments, to examine temporal variations in the dietary carbon sources.
Results: The average carbon isotope value for the whole population was −17.95‰ (SD = 1.8). A significant difference between the two cemeteries was found with variances in the amount of C_4 dietary carbon sources consumed.
Discussion: The results of hair isotope compositions concur with previous soft tissue investigations of Kulubnarti population which suggested that the dietary regimen contains a mix of C_3 and C_4 plant-based sources. A seasonal variation in diet can be inferred from the sequential hair segments of Kulubnarti individuals. These suggest a dietary transition between dominant C_3 plant-based sources in winter to dominant C_4 ones in summer with a small contribution of the non-harvested, alternative, crop.

1. Introduction

Isotopic reconstructions of palaeodiet in ancient populations give insights into patterns of subsistence and resources available and determine variations in the diet among populations. Stable carbon and nitrogen analysis ($\delta^{13}C$, $\delta^{15}N$) have been widely used in the reconstruction of diet of ancient populations. Most plants consumed by humans use either the C_3 or the C_4 photosynthetic pathway which results in isotopically distinct ranges of $\delta^{13}C$. For example, C_3 plants have $\delta^{13}C$ values ranging from −23‰ to −31.5‰ (O'Leary, 1981, 1988; Kohn, 2010), whereas the range of $\delta^{13}C$ values for C_4 plants is between −11‰ and −14‰ (O'Leary, 1988; Codron et al., 2005). By measuring $\delta^{13}C$ in human tissue, the identification of consumed plant type can be deduced, provided that the fractionation between the $\delta^{13}C$ of the preserved tissue sample and that of the diet is known. It has been assumed that $\delta^{13}C$ values of human hair are enriched by ~3‰ relative to that of the diet and reflect the protein part of the diet (Nakamura et al., 1982; O'Connell and Hedges, 1999; Sealy, 2001; Sponheimer et al., 2003). Nitrogen isotopic analysis indicates the sources of protein in the diet, and differentiates between marine and terrestrial diets as well as helps in investigating the ancient weaning practices (Tykot, 2006). In contrast to carbon isotopes, which cannot be used in an investigation of the trophic level, nitrogen isotopic analysis could estimate the proportions of meat to vegetable material in dietary protein. Therefore, $\delta^{15}N$ values could infer the trophic level of the individual (Ambrose and DeNiro, 1986; Hobson, 2007). As is the case for carbon, there is a fractionation of about 3–5‰ between the tissue $\delta^{15}N$ value and that of the consumed diet (Schoeninger, 1985; Ambrose and DeNiro, 1986; Ambrose, 1991; Sealy, 2001; Minagawa and Wada, 1984; Hedges and Reynard, 2007).

1.1. The Kulubnarti cemeteries

The site where our samples came from is the island of Kulubnarti. This island is situated about 130 Km south of Wadi Halfa in modern-day Sudan (Fig. 1). Kulubnarti is located in the centre of an area known as Batn el-Hajar or “Belly of the rock” that extends between the second

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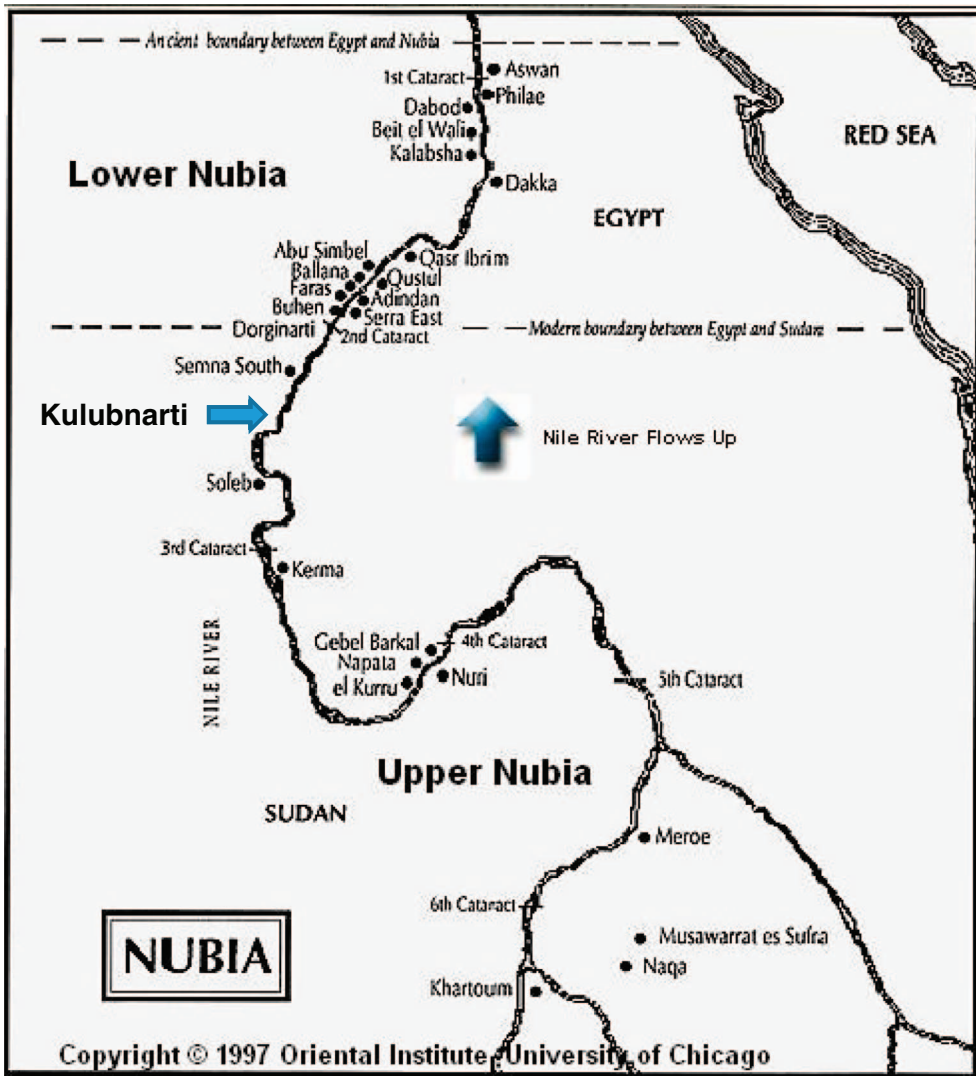

Fig. 1. Map of ancient Nubia showing location of Kulubnarti.

and Dal cataracts of the Nile River. The Nile in this region is filled with rocks and rapids separating a succession of tiny islands (Van Gerven et al., 1995). Nubia is one of the most hot and arid regions in the world and the Batn el-Hajar area is one of the most rugged and inhospitable parts of Nubia. These climatic conditions have helped to preserve desiccated natural mummies containing bones as well as soft tissues, including hair, in the Kulubnarti cemeteries (White and Schwarcz, 1994). Depending on the Nile and its annual inundation, the Kulubnarti population lived as sedentary agriculturalists producing a range of crops. Their diet consisted mainly of cereal grains, accompanied by small amounts of animal protein (Trigger, 1976; Adams et al., 1999; Turner et al., 2007; Basha et al., 2016). The site of Kulubnarti comprises two cemeteries, R & S (Fig. 2), both dating to the Christian period (AD 550–800) as indicated by analysis of burial styles, associated textiles and grave goods (Adams et al., 1999). The S cemetery was situated within an old and long-dry *wadi* near west side of the island. The R cemetery was located on west bank of the Nile just opposite to southern end of the island. Both cemeteries were burial places for people who had lived on the island of Kulubnarti (for more details see Adams et al., 1999). A slightly better health condition of R cemetery individuals has been reported from earlier palaeopathological studies compared with S cemetery individuals (Van Gerven et al., 1981; Hummert, 1983; Hummert and Van Gerven, 1983; Sandford et al., 1983; Van Gerven et al., 1990; Mittler and Van Gerven, 1994; Sandford and Kissling, 1994; Albert and Greene, 1999). It has been urged to investigate dietary profile of the two cemeteries and to examine possible dietary differences that might contribute to health status variation noticed between them.

As the Kulubnarti population practiced farming that depended on the Nile and its annual fluctuation, some seasonal variation in subsistence and diet might be expected. The alluvial plains of Batn el Hajar supported the seluka system of agriculture which produced crops depending on annual inundation of the Nile (Adams, 1977; Hibbs et al., 2011). Both kinds of plants, C_3 and C_4, were used as crop plants in ancient Nubia; C_3 crops (e.g. wheat, barley) prefer the cooler conditions of the winter season which extended from November to March. C_4 crops (e.g. millet and sorghum) were planted in the summer season but in less quantity. The flood season (damora) extended from August to November, and during this time only the fields that used saqiya irrigation (a method apparently not used by our Kulubnarti population) were able to produce crops (Adams, 1977). In addition, the Christian period witnessed the rise of the Nile to one of its highest documented levels which might have affected the farming of the summer C_4 plants at Kulubnarti (Adams, 1967; Trigger, 1965; Hibbs et al., 2011). Unfortunately, there were no available dietary materials collected from the site to be isotopically analyzed. However, local isotopic values for Nubian and Nile valley plants have been reported in White and Schwarcz (1994) and used as reference plants. These plants have been thought to be important in ancient Nubian diets as some of them were recovered through an archaeobotanical survey that done by Rowley-