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A Biological Assessment of Continuity and Change in the Neolithic Populations of Upper Nubia

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The aim of this paper is to provide a preliminary assessment of the question of biological continuity within Neolithic populations of Upper Nubia. Geographically, Nubia generally refers to the portion of the Nile Valley between the 1st and the 6th cataract (**figure 1**), and is traditionally assimilated to a corridor connecting Egypt and sub-Saharan Africa. Culturally, current research prompts us to broaden and relax this definition to arrive at a much larger area that is more permeable to external cultural influences and population movements. In the context of this article the focus is on a smaller region, the Kadruka¹ concession, located between the 3rd and 4th cataract of the Nile and on five sites from this area. Each of the sites selected for study is situated along an ancient branch of the Wadi el Khowi (**figure 2**). While J. Reinold previously excavated four of the five sites between the 1980s and the early 2000s, the fifth site, KDK 23, is part of a new project underway since 2014. From a funerary archaeological, as well as biological standpoint, what is so interesting is the density of sites in this area and how closely located each of the sites are to one another, as well as to others in the region. This density represents a truly unique opportunity in terms of research potential because to have as much data, and from such a restrained area and relative time period allows for interesting and important comparisons in terms of populations and practice.

While the Kadruka sites all date from the Middle Neolithic, they are not all in use at the same time and their use does not span the same portions of this larger period (**figure 3**). For example, on the basis of ceramic typologies, J. Reinold identified two phases of use for KDK 21, while the KDK 2 is thought to have a total of five phases of use, each spanning different intervals (**Reinold, 2001, p. 6-7**). Analysis of the ceramic typologies for each of the five sites by the Franco-Sudanese mission is ongoing for the Kadruka concession. The reality of disparate chronological attributions and the incomplete nature of the inquiry into these chronologies must be taken into consideration when comparing each ensemble.

In terms of the theoretical framework for this paper, one of the goals of this study was to exploit data from the vast work of J. Reinold with a renewed methodology and a different set of goals. The work included here is structured by an analytic method that functions of multiple levels and that seeks to provide an improved and in depth

¹ When referring to individual sites we will use the abbreviation KDK for Kadruka.

understanding of the ways in which each of these funerary ensembles functioned, from the individual, to their burial, to the ensemble of burials represented by a cemetery, then groupings of such sites from a regional perspective as well as a diachronic perspective. At each level the goal was to read the funerary record and to discern practices and timelines, thus identifying biological realities and variants. What we wish to examine is how a reading of the biological and the archaeological data allows for a more complete understanding of how these sites functioned. What this analysis revealed was a relative diversity beneath an overarching homogeneity.

While each site is taken equally into consideration within this theoretical framework, the sites are not equal in terms of the degree to which we can consider that the excavated or studied material is representative of the whole (**figure 4**). Specifically, the cases of KDK 2 and KDK 23 are important in terms of the relative reliability of the results. In the case of KDK 2, by far the largest of the five burial mounds, J. Reinold only summarily excavated the site. Furthermore, material from only 43 of the total 116 burials was retrieved for study. Moreover, it was also unfortunately the case that only a very schematic, partial mass plan for the site and no useable individual burial plans were retrieved. Therefore, in the analysis of the burial trends KDK 2 will not figure in the results. As for KDK 23, the kôm is still being excavated and what we have observed is that there was a very high number of juvenile individuals in the upper strata of the mound and excavation continued, not only have fewer juvenile individuals been found, but the material culture has shifted over time. So, the results for KDK 23 in terms of funerary trends should be replaced within the framework of an ongoing excavation, but the biological results do appear to have stabilized at this time. The present study takes into account a total of 386 adults, and 257 juveniles, for a total combined of 643 individuals. From an archaeological standpoint it was possible to study 656 burials. It was possible to calculate an age for 241 juveniles and 142 adults. Sex estimation was only possible for 78 of these adults, but 220 provided post-cranial measurements that allow for a subsequent secondary sex analysis, which added 29 individuals, thus augmenting the number of sexed individuals to a total of 107.

Given the time lapse between excavation and study and the degraded state in which much of the material was retrieved from the 4 previously excavated sites, the representativity is generally satisfactory and we can consider that this study was particularly fruitful in terms of identifying variability of practice and identity. Characterizing the population consisted most notably of age estimations for the juvenile segments of the populations and sex estimations for the adult portions. In terms of population types, the Kadruka ensemble demonstrates two very distinct variations. The most significant difference between these two types is the contrast between normative representations of the lowest age groups within certain cemeteries compared to their near total absence in the other ensembles (**figure 5**). While the KDK 2 population cannot be said to be representative of the whole of the kôm, as so little of its total surface was excavated, we have chosen to include it for the very precise reason that it speaks to the presence of these lower age groups, linking it perhaps to funerary trends closer to KDK 21 and 23, as opposed to KDK 1 and 18. These profiles may change for KDK 23, and in the case of KDK 2 are not necessarily representative of the population included in the cemetery as a whole, however, the data from KDK 1, KDK 18 and KDK 21 may be considered as such. The remarkable similarity between KDK 1 and KDK 18 and the marked difference between those two and KDK 21 and KDK 23 is intriguing. The mortality profiles calculated for these populations, based on this data utilize a methodology that calculates estimated percentages of mortality for pre-vaccine

populations, allowing us to compare the mortality profiles of each cemetery with what would be expected of such a population and assert its normality or not (**Ledermann, 1969**). Each ensemble is compared with a “natural” mortality profile and in this case based on a life expectancy at birth of 30 years of age. What is interesting is that in the cases of KDK 1 and 18, while the profiles are coherent with the expectations for this mortality profile starting at the age group of 5 to 9 years of age, the lowest age groups do not fall within the bounds (**figure 6**). This doesn't mean that those children weren't dying, but rather that they were either excluded from the cemetery (potentially receiving another specific treatment) or that those remains were somehow lost. As we can see this is not the case for Kadruka 23 or 21, where what is demonstrated is coherent with an egalitarian access to the cemeteries. Further analyses are needed to identify the exact cut off age for inclusion in each cemetery. Our analyses based on burial placement and general conservation exclude the possibility that erosion or destruction led to this lack of evidence for KDK 1 and KDK 18. Furthermore, our comparisons and research into regional data suggest a diversity of treatment for the youngest segments of the population in prehistory in Nubia.

The estimates for differences between inclusion rates of the two sexes demonstrate no significant differences in the case of each site (**figure 7**).² However, analysis of population distances through discrete trait analysis suggests that certain populations may be pooled and may thus improve our results for secondary sex analysis. Thus, we may hope to pronounce more effectively on any relevant and significant differences in treatment between male and female individuals within the cemeteries.

Indeed, in terms of similarity or diversity from a biological perspective, this source of information also affords us insight into relative proximity of populations. Using discrete traits and mean measure of divergence calculations (**Santos, 2018**) we were able to compare the five Kadruka populations and assess relative degrees of resemblance or divergence. What was revealed was that the ensemble is not homogenous. Indeed certain groups are more closely correlated than others. It remains to be determined to what degree, if any, these groupings correlate with differences and similarities observed in funerary or cultural practices.

The biological data doesn't only allow us to discuss identity, but also provides information concerning lifeways and practice. While poor bone conservation also complicates any definite comparison of pathology and relative health, what can be ascertained is that in each of the Kadruka populations there is evidence for cribra orbitalia (**figure 8**), which can be linked to anemia, healed fractures or breaks of long bones (**figure 9**), as well as periapical lesions, in one case with such severity that special foodstuffs would have to have been prepared in order to ensure survival (**figure 10**), and a few instances of DISH (diffuse idiopathic skeletal hyperostosis) (**figure 11**), which can be linked to lifestyle and may cause debilitation of the individual (**Waldron, 2009, p. 115-167**). Thus, despite poor bone conservation, the biological data affords substantial insight into episodes of stress, illness and also in some cases of care and healing. While infections and malnutrition and trauma are attested to, so are restored or rehabilitated individuals, or individuals surviving at least some time in fragilized states of existence. A certain number of marks or traces left on teeth and bone also allow us to estimate the relative health of populations, as well as give us insight into certain

² Chi-squared tests were performed for each site and in all cases the results demonstrate no significant difference in terms of the number of male and female burials.

cultural practices. Linear dental enamel hypoplasia (**figure 12**), calculus (**figure 13**) and caries (**figure 14**) all elucidate not only health, but life experience, with enamel hypoplasia being linked to periods of stress, illness or malnutrition, and caries and calculus being linked to oral hygiene, diet and therefore by extension, food ways (Waldron, 2009, p. 236-239, 240-241; Goodman et Rose, 1991, 1999; Langsjoen, 1998, p. 402 ; Hillson, 2005, p. 290-303).

The older the individuals, the more likely significant pre-mortem tooth loss, caries and abscesses are in the record. Among other things, this makes eating more difficult, and therein we may find evidence for the preparation of particular foods, for affected individuals, as we mentioned above (in the case of figure 10). Tooth loss was not only influenced by poor health and hygiene, but also by cultural practice, likely with the working of fibers or leather, as documented most famously among Alaskan populations (**Turner et al., 1991**). What is referred to as LSAMAT (or lingual surface attrition of the maxillary anterior teeth), is a well known by product of this type of activity (**Turner and Machado, 1983**) and is characterized by an unequal pattern of wear between upper and lower teeth, as well as significantly oblique wear of the lingual surfaces of upper teeth (**figure 15**). Other evidence of the use of teeth as tools, include grooving across the lingual and occlusal surfaces (**figure 16**) (**Lefèvre, 1973; Fléchier and Verdène, 1974; Lukacs and Pastor, 1988; Bonfiglio et al., 2004**), as well as significant fracturing of both anterior and posterior teeth (**figure 17**) (**Molnar, 1971; Budinoff, 1951; Turner and Machado, 1983**). The analysis of these practices from a diachronic perspective is part of an ongoing project.

We can also extend our comparisons to the R12 site excavated by Donatella Usai and Sandro Salvatori (**Salvatori and Usai, 2008, p. 100-104 ; Judd, 2008, p. 98-100**), so as to provide an even more complete picture of the relative diversity or homogeneity of experience between populations of the Sudanese Neolithic. While KDK 18 demonstrates similar rates of caries as the R12 cemetery, KDK 1, 21 and 23 all present much higher rates. Calculus deposits are relatively stable across the KDK populations, but markedly higher than at the R12 cemetery. Finally the rates of dental enamel hypoplasia, demonstrate a decrease, from KDK 18 to 23 to 21 to 1 (**figure 18**). The data therefore seems to suggest that these populations were perhaps not influenced by the same stressors or pathologies, and did not exploit exactly the same food ways. There may also be implications for the status of individuals buried in each cemetery (**Goodman and Rose, 1991**). Higher percentages of caries and calculus have been correlated to an increasingly agricultural diet (**Humphrey et al., 2014 ; Lanfranco and Eggers, 2010**). The comparison of the total number of adult individuals observed and their rates of LSAMAT presence are illustrative of the relative variability of this practice within populations, with percentages as low as 54 for KDK 18 and as high as 84% for KDK 1 (**figure 19**).

The archaeological record also affords us significant insight into culture and practice. For the Kadruka ensemble several categories of data were taken into account: orientation and positioning of the deceased (as opposed to burial orientation as the burial cuts were rarely visible) and grave good inclusion.

Firstly, the orientation of the deceased within the burials appears to point to a variety of codified orientations. The data is simplified here, and is based on an axis drawn between the head and hips. What is immediately apparent, is that KDK 1 and 18 present very similar patterns of burial orientation with a majority of orientations with the head to the North and a near absence of burials with the head to the West. In the case of KDK 21 a majority of individuals are buried with their heads to the South, while

at KDK 23 there is a remarkable diversity of orientations. In both cases individuals are found with heads to the West, as compared to KDK 1 and KDK 18, however there is a near absence of individuals with their heads to the East in the case of KDK 21 (**figure 20**).

The positioning of deceased within their burials appears to demonstrate two major trends. While KDK 1 and 21 show an overwhelming majority deposited generally on their left side, with some variation of the position of the torso (85% and 75% respectively), KDK 18 and 23 demonstrate a slightly more equilibrated relationship between left and right side placement (62% and 56% general left side placement respectively). While in general the data points to no significant differences based on age groups, at KDK 18 there are slightly more juveniles positioned on the right than there are adults, and at KDK 23 the majority of individuals in a ventral position are juveniles (**figure 20**). Comparisons based on age, sex and regional patterns will appear in a forthcoming article and demonstrate variability of practice.

The data gathered relative to the inclusion of different types of grave goods also underscores variability of practice and significant differences between the sites (figure 21). While ceramics are heavily present at KDK 21 and KDK 23 (63% and 61% respectively), these figures decrease at KDK 1 and KDK 18 (50% and 43% respectively). The opposite is true however of bucrania where we see very low percentages for KDK 21 and KDK 23 (7% and 4% respectively) and middle ranges for KDK 18 (28%) and finally extremely high numbers for KDK 1 with over half of the observed burials including bucrania, and oftentimes multiple deposits. Other data is not as clear-cut, as in the case of lithic materials, where the sites of KDK 18, KDK 21 and KDK 23 demonstrate similar rates of inclusion (between 35 and 39%), while KDK 1 presents a slightly higher number (50%). Further analyses based on concentration of deposits and correlation to age and sex are ongoing and will appear in a forthcoming article.

In conclusion, the Kadruka sites differ significantly in some ways from one another, as well as from other regional examples such as the R12 site, while in other instances they appear analogous. It remains to be seen whether or not this data can be used to illustrate cultural and biological assemblages in evolution. What are certainly illustrated are assemblages presenting variations within codified practices, as well as differences in health and access to cemeteries.