SUDAN & NUBIA

The Sudan Archaeological Research Society

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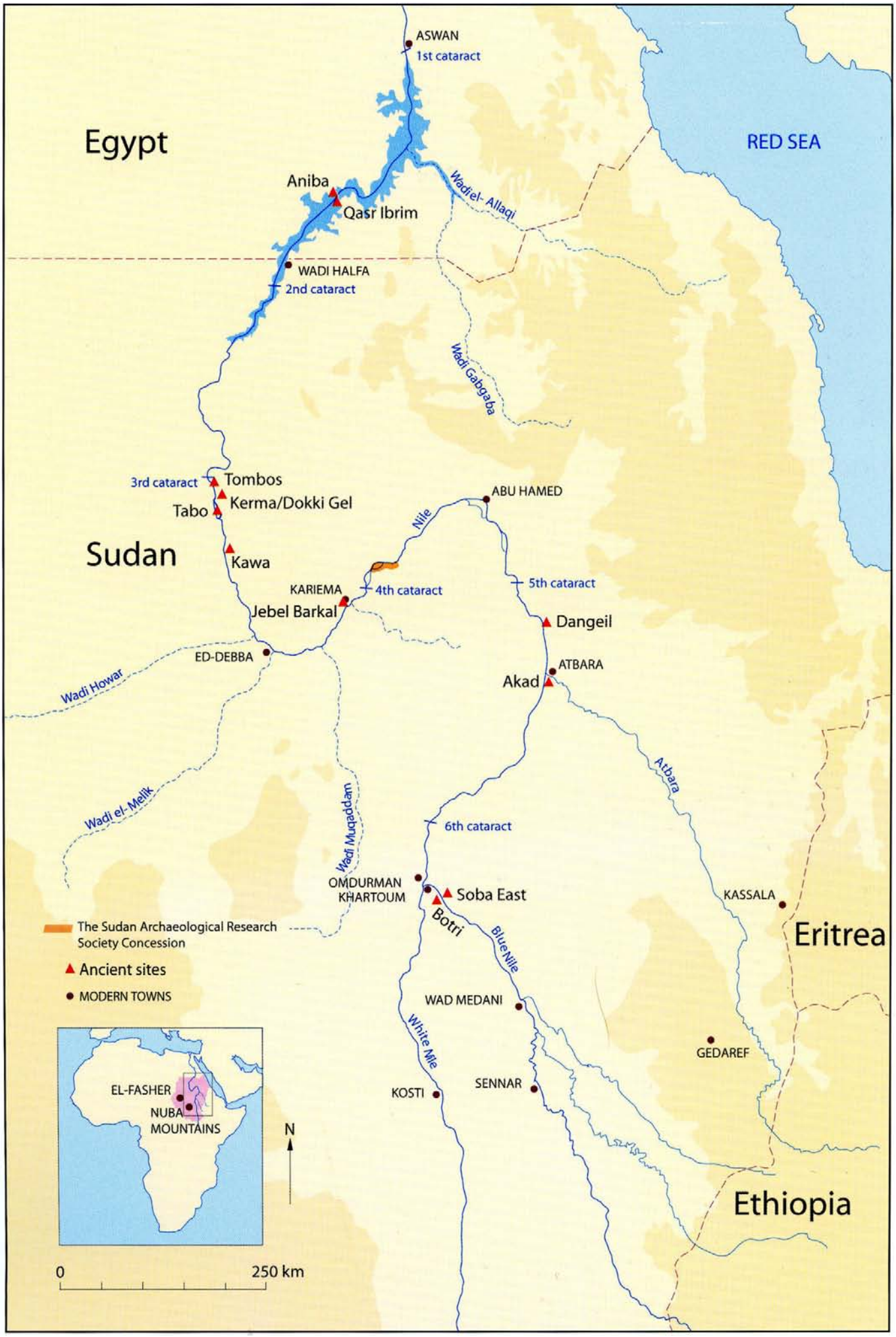
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6th cataract
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KHARTOUM
Soba East
KASSALA
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Eritrea
Blue Nile
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Front cover: Village on the Island of Dirbi in the SARS concession above the Fourth Nile Cataract (photo: D. A. Welsby).

The Value and Future Potential of Human Skeletal Remains Excavated at the Fourth Cataract

Tina Jakob

The purpose of this contribution is not to present a completed study, but to outline the value and potential of the human remains excavated by the SARS/British Museum missions which comprised part of the Merowe Dam Salvage Project over the course of five field seasons. Here a brief summary of the number of individuals recovered, as well as avenues of analysis, are presented.

Due to time and funding constraints most skeletal analyses are conducted macroscopically. Other complementary techniques include radiography and CT scanning, the latter especially useful when analysing mummified remains. Lastly, microscopic analysis, such as histology, or stable isotope analysis and ancient DNA studies are possible, although they are of a destructive nature and, therefore, have to be used in cases where questions cannot be answered otherwise.

Table 1. Approximate number of individuals excavated by the SARS teams.

Period	No. of individuals
Neolithic	3
Kerma	12
Kerma Ancien	16
Kerma Moyen	5
Kerma Classique	168
Kushite	3
Meroitic	40
Post-Meroitic	52
Christian	852
Total	1,151

Table 1 details a breakdown of the number of individuals excavated by the SARS missions within its concession. Among the 1,151 individuals are also approximately 40 naturally mummified bodies. It is obvious that there are striking differences in the number of individuals available for study, ranging from only three individuals for the Neolithic and Kushite periods respectively to as many as 852 for the Christian period. While it is essential that all these 1,151 individuals are analysed, regardless of their archaeological period, only larger cemetery populations will allow for meaningful results fit for comparison with other cemeteries already excavated in Sudan, or those to be excavated in the future. The overall aim of skeletal analysis is to reconstruct the life of past people and one recurrent problem in doing so is preservation; it is obvious that the more fully preserved a skeleton is, the more information can be obtained.

Preservation

Unfortunately, due to grave robbing and other disturbances, some of the human remains are not as well-preserved as they could be. There are also problems with taphonomic processes, for example, while bones appear to be well preserved during excavation, they can be very firmly attached to the ground and it then becomes virtually impossible to lift them intact. Other problems arise from intentional or unintentional activities, disturbance by later grave cuts, or by grave robbing activities in search of valuable objects. However, the majority of individuals, especially from Christian contexts, are exceptionally well preserved and it can be expected that the maximum amount of information can be gained from analysing them.

Analysis

How long will it take to analyse all the skeletons and mummies excavated in the concession of the Sudan Archaeological Research Society? With a total of 1,151 individuals the initial analysis would take one osteologist 575.5 days, assuming two individuals can be cleaned, recorded and analysed in one day. This translates into 115 weeks, or a little more than two years if no breaks or holidays are taken. As it is not a realistic approach to complete this task singlehandedly, it will be necessary to involve several researchers and institutions. However, to facilitate data comparison between different samples, it is necessary to agree on a standard protocol, for example, based on recommendations compiled by Buikstra and Ubelaker (1994) and Brickely and McKinley (2004).

Demography

What information can be obtained from the skeletons and the mummified remains?

The demographic profile of a population is a prerequisite for any analysis of population health. It is generally easier to estimate age at death in non-adults. Bone maturation and dental development can be assessed and compared to modern populations. This will, of course, introduce a certain amount of error as the modern comparison might not be a valid one and differences in growth and maturation should be expected due to differences in diet and health. Estimating age at death for adults is less straightforward, due to the fact that people age at individual rates. Numerous techniques have been developed to solve this problem – although none of them is very accurate. Usually, 10-year age categories are as precise as possible, with methods such as tooth attrition or the degeneration of the pubic symphysis (Jackes 2000). A relatively new technique is tooth cement annulation, which is based on analysis of tooth cement which formed on an annual basis and recent studies have shown that it is more accurate than any of the con-

ventional methods. However, it requires the sectioning of at least one tooth per individual (Wittwer-Backofen *et al.* 2004).

Sex estimation

It is generally not possible to assess sex in non-adult individuals, although attempts have been made to use specific measurements of the skull and innominate bones (Saunders 2000). Although DNA analysis could be helpful, not every individual would have enough DNA preserved, considering the hot climatic conditions to which the bones have been exposed. In addition, large scale destructive sampling would also be undesirable.

In contrast, sex estimation is fairly accurate for adult individuals. Usually morphological features of the skull and pelvis are used (Buikstra and Ubelaker 1994). However, it was noticed during excavation that some individuals showed male features of the skulls while their pelves were clearly female. This obviously has implications for less well preserved individuals where the pelvic area might not be preserved and sex assessment based on the skull would be wrong.

Plate 1. Subadult individual from the Christian cemetery at site 4-M-142.

It can be expected that the percentage of adult male and female individuals will be approximately equal. If there are any obvious biases towards either sex, this needs explaining. Model life tables assume a high infant mortality and an initial assessment of a small Christian cemetery (site 4-M-142) did confirm this. Slightly more than 50% of all individuals were non-adults (below the age of 18 years), with the majority of them under the age of 4 years (Plate 1). Young children, together with the elderly, are the most vulnerable in any society, and it can be expected that detailed analysis of these individuals will reveal information about their general health.

Growth rates and adult stature

Disruption in subadult health can be assessed by comparing dental age with skeletal age, obtained from long bone measurements. Among the comparable collection from Kulubnarti, for example, it is apparent that a number of individuals show differences between these two age indicators, with skeletal maturation often lacking behind (Van Gerven and Greene 1999, table 24). As growth is more susceptible to stress factors, this might be an indicator of ill health or nutritional stress.

Adult stature might also reveal problems during a person's growth period, although a shorter than average stature indicates that despite the person having experienced some health problems, he or she actually survived into adulthood. Stature is also genetically determined, and, therefore, less accurate as a health indicator than growth rates in non-adults.

Non-metric traits

Dental and skeletal non-metric traits are traditionally used to determine whether individuals were related to each other (Saunders 1989). However, inheritance patterns of many of these traits are not yet well understood. Dental non-metric traits are considered more reliable, but a recent study using a post-medieval population from London, where family groups were known, revealed that people who were not related had a higher likelihood of sharing dental traits (Kuba 2007).

Some skeletal traits have been associated with specific activities, such as squatting facets on the lower end of the leg with habitual squatting posture. They do, however, also occur in unborn babies and have been linked to hyperflexion of the foot *in utero* (Barnett 1954).

Dental enamel hypolasia

A commonly observed non-specific stress indicator is dental enamel hypoplasia (DEH), lines or pits especially found on anterior teeth. Their occurrence is linked to childhood malnutrition and disease, being formed after tooth crown development has been interrupted and the child subsequently recovers. Age of occurrence can be calculated and then adds a demographic aspect to the study of DEH. At Kulubnarti, for example, most lines were formed at the ages of 4-5 years (Van Gerven and Greene 1999, fig. 15).

Dental disease and dietary reconstruction

Dental disease is also commonly seen in skeletal populations and an increase in diseases such as caries, calculus and den-

tal abscesses is associated with advancing age. High caries rates are linked to a diet high in carbohydrates, and all dental diseases indicate less than perfect dental hygiene. However, dental disease is mutifactorial in origin and is, therefore, not solely linked to diet or hygiene (Lukacs 1989). Diet could also be investigated with the help of stable isotope analysis, although the feasibility of destroying tooth and bone samples has to be carefully evaluated. Alternatively, recent research on modern populations has demonstrated that fingernails can be useful for dietary reconstruction (Nardoto *et al.* 2006). Since fingernails are sometimes preserved in the Fourth Cataract individuals, they might be used instead of teeth and bones.

Infectious disease (specific and non-specific infections)

Dental diseases, such as abscesses, can penetrate the maxillary sinuses and might be responsible for causing chronic inflammatory responses, or maxillary sinusitis. This disease is also associated with exposure to air pollution, for example, caused by smoke from open fires. Slightly higher rates of maxillary sinusitis have been found in women at Kulubnarti. However, as cooking probably took place outside, indoor air pollution was unlikely to be a contributing factor and other explanations must be found (Roberts 2007).

Other so-called stress indicators are non-specific infections seen as new bone formation. These can occur on any bone of the human skeleton, but as the name indicates the pathogen causing this infection is not known, and the newly-formed bone might not even be caused by infection, but could also be the response to trauma, for example, to the lower legs (Roberts and Manchester 2005).

Specific infectious diseases such as tuberculosis (TB) have been reported from Egypt and Sudan (Roberts and Buikstra 2003). The occurrence of TB has been associated with animal domestication and it has been assumed that humans contracted the disease from living in close proximity with their animals, or through contaminated animal products such as milk and meat. However, recent ancient DNA studies of skeletons and mummies from Abydos have demonstrated the absence of the bovine form of TB (Zink *et al.* 2004).

In addition, it also needs to be considered that other diseases such as fungal or mycotic infections might cause similar bone changes as TB, so diagnosis will not always be accurate. Furthermore, not everybody suffering from TB will display changes to their bones and we can expect to see only a small proportion of the actual prevalence of the disease (Ortner 2003).

Metabolic disease

Sieve-like perforations of the orbital roof known as cribra orbitalia can be found in individuals with iron deficiency anaemia. These lesions are usually more prevalent in children and occur in their active form. Lesions can also be seen in adults, but are generally remodelled or healed and indicate iron deficiency anaemia in childhood (Roberts and Manchester 2005). A preliminary study of the human remains from the Fourth Cataract excavations has already shown that cribra orbitalia commonly occurred in non-adult individuals. A similar picture was found at Kulubnarti, where a large proportion of individuals under the age of 15 years showed evidence of cribra orbitalia (Van Gerven and Greene 1999).

Cribra orbitalia might indicate lack of iron in a child's diet, especially in cereal dependent populations, but it can also be caused by blood loss due to pathogen infestation. The analysis of soil samples taken from the intestinal area of skeletons during excavation might reveal the parasite load of these individuals and could determine whether parasite infestation was a contributing factor for these lesions to be found in skeletons from the Fourth Cataract. Additionally, cribra orbitalia can demonstrate the body's iron withholding mechanism where iron is deliberately withdrawn to starve an invading pathogen, indicating the presence of infectious diseases.

Joint disease

One of the most commonly seen diseases in skeletal populations is linked to joint degeneration, especially osteoarthritis. The occurrence of osteoarthritis increases with increasing age, but the pattering of osteoarthritis has also been linked to specific activities, such as grinding cereals (Molleson 1989). However, repetitive use is only one cause of osteoarthritis and a number of other factors, such as age and trauma, should also be considered.

Trauma

Very few people escape skeletal trauma during their life and fractures and dislocations have been reported in Sudanese individuals as early as the beginning of the 20th century (Wood-Jones 1910). The analysis of fractures and their comparison with modern clinical studies can tell us about the causes and injury mechanisms. For example, spondylolysis, or separation of the neural arch, is linked to bend-

Plate 2 Healed fracture of distal ulna in an adult individual from the Kerma Classique *cemetery at site 4-L-88(A).*

ing stresses but needs a predisposing congenital weakness in this area to occur. Fractures of the clavicle are seen in people who fall off horses, but they can also occur from simple falls (Roberts and Manchester 2005). However, some fractures are less easy to evaluate. The fracture of the distal ulna (Plate 2) is also known as a 'Parry fracture'. It may be caused by warding off a blow to the face. However, 'Parry fractures' can also occur by a fall on the outstretched hand, a scenario likely to happen in the rugged terrain of the Fourth Cataract. In this case the fracture healed well, probably because the unbroken radius acted as a splint. In contrast, the healing of the femur fracture shown on Plate 3 is much less satisfactory. This type of fracture would have been caused by an immense amount of force, maybe due to a fall from some considerable height, since this bone is the largest and strongest in the human skeleton. It is remarkable that this fracture healed at all, considering the amount of soft tissue damage which must have occurred. Nevertheless the right leg of this person was severely shortened and probably impacted on this individual's daily activities.

Plate 3 Poorly healed fracture of right femur belonging to the individual buried in the later Kushite or post-Meroitic grave at site 4-L-41(B).

Fracture type and amount of healing can best be assessed by radiography to enable the assessment of probable injury mechanisms. Most fractures are likely to be caused by accidental falls, although examples of interpersonal violence have been reported in Sudanese skeletal populations (Judd 2004; 2006). At least two examples of blunt force trauma to the head have been recognized in skeletal remains from the SARS excavations, both dating to the Christian period, and a closer analysis will probably reveal more evidence for violence.

Miscellaneous diseases

One final example is a case of hyperostosis frontalis interna, or thickening of the internal side of the frontal bone (Plate 4). So far, only one other example of this disease has been published from Sudanese skeletal populations (Armelagos and Chrisman 1988). This might indicate that the disease, which predominantly affects elderly women, was indeed rare in the past, although it is commonly observed in modern populations (Hershkovitz *et al.* 1999). On the other hand, it could also hint towards a gap in osteological research.

Neoplastic disease is another which is much more prevalent today than in the past. However, a lack of radiographic examination might have also contributed to the apparently low number of cases and a recent study of individuals from Tombos has revealed two cases of benign tumours (Buzon 2005).

A number of diseases prevalent in modern Sudan, such as malaria, schistosomiasis and leishmaniasis, could potentially be found in ancient human remains by detecting the causative pathogen through its DNA. Ancient DNA (aDNA) analysis has been successfully performed in a number of cases (Sallares and Gomzi 2001; Willcox 2002).

Conclusions

This aim of this brief overview was to demonstrate the importance of any future studies of human remains from the Fourth Cataract excavations. These remains are an irreplaceable source of information about the health and disease of the past inhabitants of the Fourth Cataract, especially when their archaeological context is taken into consideration during analysis. The skeletons and mummified remains together with their material culture are all there is left of the people who inhabited the Fourth Cataract region of Sudan.

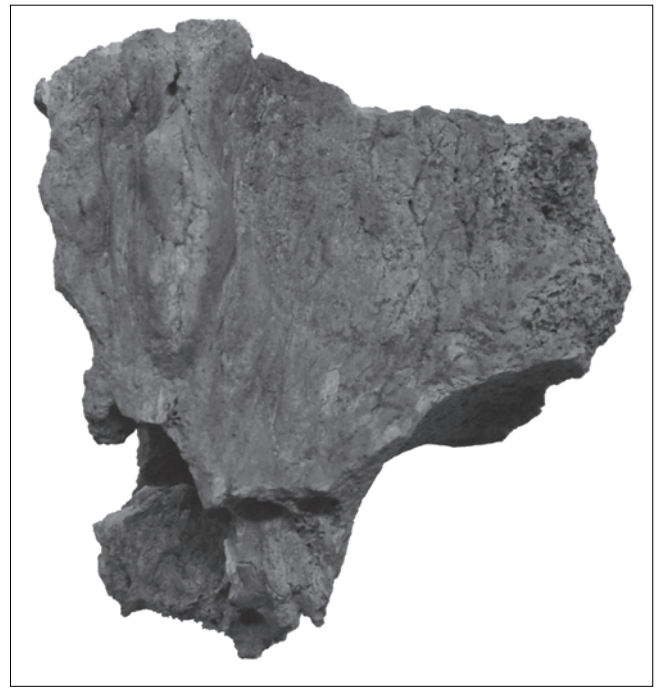

Plate 4. Hyperostosis frontalis interna in an adult individual from Kerma Ancien *cemetery at site 4-K-203.*

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