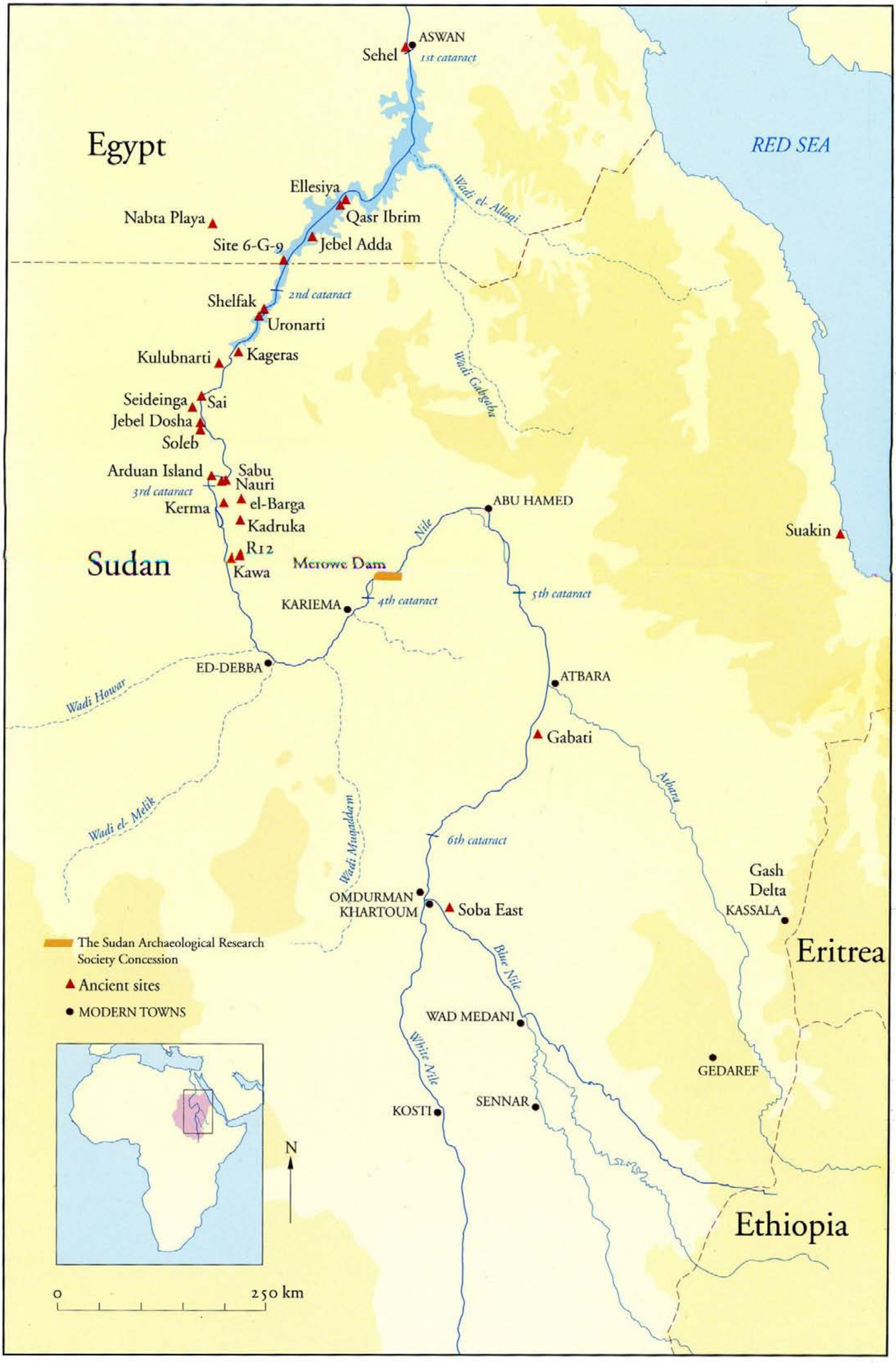
SUDAN & NUBIA

The Sudan Archaeological Research Society *Bulletin No. 8* *2004*



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1st cataract
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Nabta Playa
Qasr Ibrim
Site 6-G-9
Jebel Adda
2nd cataract
Shelfak
Uronarti
Kulubnarti
Kageras
Wadi Gabgaba
Seideinga
Sai
Jebel Dosha
Soleb
Arduan Island
Sabu
Nauri
3rd cataract
Kerma
el-Barga
Kadruka
R12
Kawa
Sudan
ABU HAMED
Nile
Merowe Dam
Suakin
KARIEMA
4th cataract
5th cataract
ED-DEBBA
ATBARA
Wadi Howar
Gabati
Atbara
Wadi el-Melik
Wadi Muqaddam
6th cataract
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Soba East
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Contents

Front Cover: Uronarti: view along 'Middle Street' towards the southern defences in March 2004 (photo Derek A. Welsby)

Gabati: Health in Transition

Margaret Judd

Introduction

A multiperiod cemetery, named after the nearby village of Gabati, was discovered in 1993 by Michael Mallinson and Laurence Smith, during a survey requested by the Sudan National Corporation for Antiquities and Museums, in response to the future construction of a tarmac highway between el-Geili and Atbara (Mallinson 1993). The following year, test excavations of nine graves revealed continuous use between the Meroitic and Medieval periods, based on grave furnishings and structures (Mallinson 1994). Later that year, a second project, directed by David Edwards, returned to the site to excavate as many graves as possible within one field season.

During this season, 63 Meroitic and 41 Post-Meroitic or later graves were excavated, resulting in a combined total of 113 excavated tombs between the two projects. Although a site report has been published by Edwards (1998) for the main excavation season and the final report of Mallinson and Smith is in press, the skeletal remains were not processed and systematically assessed.

The Meroitic graves were often multiple and the bulk of the human bones were bagged indiscriminately during excavation. Consequently, the bones must first be cleaned and sorted by anatomical element before individual skeletons can be rearticulated and their osteobiography determined. In contrast, the majority of the Post-Meroitic and Medieval burials were discrete, and the bones were fairly easily conjoined once cleaned. It was decided to begin with the assessment of the later burials because observations for the smaller complete cultural samples could be ascertained more quickly and thus expedite the communication of at least a portion of the final results for two of the three cultural samples. Chi-square tests were used to determine statistical significance and when cell units were less than five individuals the Yate's test was used.

Demographic distribution of the Post-Meroitic and Medieval samples

Adults formed the majority of both skeletal samples (Table 1). Nonadult categories were defined as foetal, infant (new born-3 years), child (3-12 years) and adolescent (12-20 years). Age was determined predominantly by the dental eruption sequence (Ubelaker 1978, fig. 62), but when dentition was absent long bone development tables were referred to (Scheuer and Black 2000). The adults were assigned to one of four age cohorts once biological sex was established. Because bone preservation was quite good (i.e., some bones were broken, but the majority were present) the more reliable age assessment methods, the pubic symphysis and sternal rib ends summarised by Buikstra and Ubelaker (1994, 21-23), were used. Similarly, biological sex was easily determined due to the complete preservation of the innominates and crania (Buikstra and Ubelaker 1994, 18-20). There were no adults for whom biological sex or age cohort was questionable. The graves of two infants could not be confidently dated to a specific cultural period. Two additional children were identified by a few fragments in the burials of their peers, which indicated the reuse or complete destruction of the previous grave; alternatively, portions of bodies disturbed and left on the surface during redigging of graves, may have been introduced to nearby grave fills. These individuals are not included in the analysis here, but will be catalogued in the final skeletal report.

Table 1. Age distribution.

	Post-Meroitic		Medieval	
Cohort	**n**	**%**	**n**	**%**
Foetus	3	8	2	11
Infant	6	16	1	6
Child	5	14	3	17
Adolescent	3	8	0	0
20-25	6	16	3	17
25-35	11	30	3	17
35-50	2	5	6	33
50+	1	3	0	0
Total (N)	***37***	***100***	***18***	***100***

The distribution of males and females was fairly equal, with the exception of a slightly greater number of Post-Meroitic females than males (Table 2). There was no significant difference between the numbers of people under 25 compared to those over 25 years of age between the sexes. However, there were substantially more young adults (< 35 years of age) among the Post-Meroitic people. There were very few adults over 50 years of age in either sample, which is likely attributable to the small sample size and is a phenomenon observed among many archaeological skeletal collections.

Table 2. Demographic distribution of adults.

	Post-Meroitic N=20				Medieval N=12			
	Male		*Female*		*Male*		*Female*	
Cohort	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
20-25	2	10	4	20	1	8	2	17
25-35	5	25	6	30	2	17	1	8
35-50	1	5	1	5	3	25	3	25
50+	0	0	1	5	0	0	0	0
Total	***8***	***40***	***12***	***60***	***6***	***50***	***6***	***50***

When the distribution of adults to nonadults for the two samples were compared, there was no significant difference between the samples (P = .37), although there were more childhood deaths during the earlier period. Again, this discrepancy is more likely a factor of sample size rather than an epidemiological event because a high percentage of childhood death is associated with the Medieval period, as observed at Kulubnarti (Van Germen *et al.* 1990), et-Tereif (Judd, field observations) and Soba East (Filer 1998).

Very few adolescents were recovered, which is not untypical. In modern developing communities, once an individual reaches 10 years of age, they have escaped or conquered many of the disease processes that claim infants or children during their growing years, which is often an outcome of their exposure to the same environmental or occupational risks as adults (McElroy and Townsend 1989, 135-137, 142-143). Numerous clinical studies, aimed to proactively improve conditions for children in developing countries, report that infantile diarrhoea claims the majority of children before they reach five years of age. Other contributors to infant mortality include intestinal parasites, tetanus, malaria, anaemia, trauma, and congenital birth defects (Woodruff *et al.* 1984)

Children in agricultural communities across cultures play a vital role in the production and processing of crops as various tasks are repetitive, require little strength and are unskilled, for example, they might plant with a digging stick, weed, carry loads, feed animals, do laundry and fetch water (Sullen and Mace 1997). The age of net production is the age when children work more than they consume and become a benefit to the household after being a burden in infancy; among intensive agriculturalists, this age can be as low as the age of six years. In contrast, the families of foragers, pastoralists and horticulturalists tend to be smaller because children are perceived as consumers of the family economic output during their entire growth period (Kramer and Boone 2002). It is, therefore, beneficial that agriculturalists have larger families, with seven children being the mean of the completed family in a developing rural village — paradoxically, many of these children will succumb to the childhood diseases associated with a swelling community size and agricultural hazards (McElroy and Townsend 1989, 142-143; Purschwitz and Field 1990; Wilk 1993). Among an archaeological skeletal sample the intensification of an agricultural subsistence strategy, often the outcome of technological 'improvement', should similarly result in an escalation in family and community size as well as a corresponding amplification in the frequency of nonadult deaths due to their susceptibility to the 'diseases of civilization' and occupational risk.

Foetal and infant deaths

The number of recovered foetal remains is unusual, as is the number of infants under one year old, when compared to earlier Nubian skeletal collections (e.g., Beckett and Lovell 1994; Coppa and Palmieri 1988; Filer 1992; Judd 2001; 2003; Simon 1992). This may be the result of the excavation strategy or differential burial practices, which further reiterates the need for large representative sample sizes from cemetery excavations. The remains of five foetuses were recovered, and four of them were interred with young females. The foetuses from Tombs 2 and 132 were laid away from the female's pelvic area. The foetus in Tomb 97 was situated immediately below the female's pelvis and was most likely buried with its mother, but shifted slightly due to post-mortem taphonomic processes. The context of the 19-week old foetus in relation to the female in Tomb 83 is unknown and the foetus in Tomb 91 was buried discretely in a grave cutting into a Meroitic tomb.

Miscarriage is an acute event, claiming the child or the child and mother. The evidence is not recoverable from the bioarchaeological record as the swiftness of the process, whatever the aetiology, does not manifest itself on the skeletal remains. Patches of coarse woven bone indicative of non-specific infection were observed on the remains of three of the females, and the presence of infection may have predisposed these women to an untimely death. The fourth female bore porous lesions on the interior eye orbits—cribra orbitalia—a characteristic skeletal indicator of anaemia.

Anaemia

The primary function of the red blood cells is to circulate oxygen from the lungs to other body tissues. Abnormalities of the haemoglobin structure in the red blood cells or decreases in the blood supply, produce an anaemic condition, which in some cases may be fatal if the body or brain is completely deprived. While there are many types of anaemia, three types may be identified macroscopically from archaeological skeletal remains. Two anaemic conditions are genetic, thalassemia and sickle cell anaemia, while the third, iron deficient anaemia, is acquired (Aufderheide and Rodríguez-Martín 1998, 345-350).

1. Thalassemia

The haemoglobin is composed of three parts — the heme containing iron molecules and two protein structures (alpha and beta chains). It is the protein structures that are genetically deficient in thalassemia and as a result the blood cells formed have reduced haemoglobin content (Steinbock 1976, 220).

2. Sickle cell anaemia

Sickle cell anaemia occurs when an individual inherits the haemoglobin S gene, which results in the hardening of iron in the blood cells after the oxygen that they carry is released. This causes the cells to shrivel up into a crescent-shape that has the potential to clog the blood vessels and consequently limits the ability of the body to receive its nutrients and oxygen. People that were homozygous for the sickle-cell gene, that is, they received the mutant gene from each parent, were susceptible to an early death in ancient times. Individuals who inherited one normal and one sickling gene normally exhibit only very mild anaemia, but develop a resistance to malaria because their abnormal blood cells live only about two weeks rather than the normal 120 days, which compromises the parasitic cycle.

3. Iron deficiency anaemia

Iron, the third component of haemoglobin, binds with oxygen in the lungs and circulates this oxygen to other cells. A decrease in the availability of iron and subsequent anaemic condition may be due to inadequate iron in the diet, an inability to absorb iron, infectious disease, or excess blood loss.

Post-cranial bone changes due to anaemia

To compensate for the reduced haemoglobin, the blood-producing bone marrow increases red blood cell production and as a consequence the marrow space expands, while the outer cortical bone decreases in thickness and weakens the bone. This 'stretching' of bone produces lacy lesions where the content of trabecular bone is the greatest — the epiphyses (ends of long bones), skull vault, and tubular bones of the hands and feet. The long bones become distorted as the metaphyses expand in width and the diaphyses become narrower. A similar process also affects the small bones of the hands and feet, but the entire medullary cavity widens and the small bones become block-like and lose their contours. The spine, pelvis and femoral heads are predisposed to osteoporosis and fracture (Aufderheide and Rodríguez-Martín 1998; Steinbock 1976, 224). These changes to the long bones are only observed in the genetic anaemias and because these manifestations were absent from the Gabati material, iron deficiency anaemia was the likely disease process.

Skull lesions of anaemia

Modifications to the skull are characteristic of all three anaemic conditions, although thalassemia produces the most severe lesions. The disproportionate production of red blood cells also involves the flat bones of the skull vault (the frontal, parietals and occipital) and produces porous lesions identified as 'porotic hyperostosis'. The honeycomb structure of the trabecular bone becomes spike-like, resulting in a 'hair-on-end' or 'crew-cut' appearance when the bone is viewed in cross-section. The porous lesions are most characteristically observed on the roof orbits of the eyes, where the outer bone is extremely thin; these orbital lesions are identified as 'cribra orbitalia' and are usually bilateral. Initial lesions occur as a series of fine pores that may eventually enlarge, coalesce, and in very extreme cases, as in one individual from Gabati, project into the orbital area (Plate 1).

The frequency of cribra orbitalia was greatest among the Medieval people, although the demographic distribution pattern was dissimilar (Table 3). Only children presented

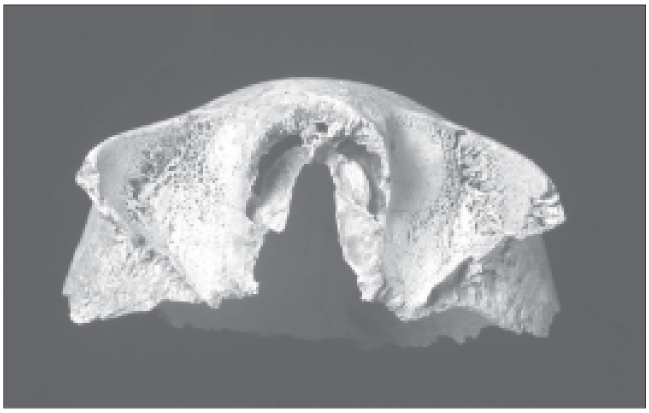

Plate 1. Advanced stage of cribra orbitalia showing spicules of bone projecting into the eye socket.

these lesions among the Post-Meroitic people, while adults bore the majority of orbital lesions among the Medieval people. The difference in frequency was statistically significant between the two adult groups (P = .02), while the difference between the groups of children was not significant (P = .73). When cribra orbitalia was present in other contemporary Medieval skeletal samples, the frequency amongst children was always greater than among adults (Table 4).

Females are at risk of anaemia when of child-bearing age as blood is lost due to menstruation or iron stores are depleted by the foetus or milk supply. Children require excess iron for growth and their bodies continue to require more iron until they reach adulthood. Any depletion of iron will lead to anaemia and accelerated red blood cell production. Once adulthood is reached, additional iron is not need to grow, but only to maintain the body, and as a result when the environment and diet are comparable for children and adults, we would expect to see a greater frequency of anaemia among children (Aufderheide and Rodríguez-Martín 1998, 346).

Table 3. Distribution of cribra orbitalia at Gabati.

Cohort	Post-Meroitic			Medieval		
	n	*N*	*%*	*n*	*N*	*%*
Males	0	8	0	2	6	33.0
Females	0	12	0	2	6	33.0
Foetal-3 years	2	9	22.5	0	3	0
3-20 years	2	8	25.0	1	3	33.0
Total	***4***	***37***	***10.8***	***5***	***18***	***27.8***

The aetiology of anaemia among ancient people remains controversial and earlier researchers considered low dietary iron due to a greater reliance on crops such as maize or sorghum to be the most probable cause. More recent studies report that anaemia continues to persist in protein-laden societies and parasitic gut infections are the more likely source

[1] See Soren (2003) for an account of malaria among infants and children in 5th century AD Teverina, Italy.

Table 4. Frequency of cribra orbitalia among adults and children at other Sudanese Medieval sites.

Site	Reference	% Adults	% Children
el-Geili	(Coppa and Palmieri, 1988)	35	86
Kulubnarti	(Carlson *et al.*, 1974)	6	88
Soba East	(Filer, 1998)	16	22
et-Terief	Judd, personal observation	48	82

of reduced red blood cell counts (Kent 1986; Reinhard 1992; 1996).

Anaemia and malaria

Malaria, is one of the silent epidemics that goes unnoticed among archaeological populations,[1] but remains endemic in Sudan today (e.g., Ali *et al.* 2002; Raman *et al.* 1995). Malaria is spread by the female Anopheles mosquito who ingests the malaria parasites while feeding on an infected victim, carries them until they are fertilised and reproduce, then injects them from her salivary glands into her next victim. The parasites enter the blood stream, attack the red blood cells, and systematically destroy them, which produces cellular waste. This destruction of the red blood cells and their recyclable iron predisposes the individual to an anaemic condition (Aufderheide and Rodríguez-Martín 1998, 228-231). The most severe form of malaria produced by the *Plasmodium falciparum* parasite is a more fatal and rapid process that reaps a high mortality rate primarily among foetuses, increases maternal deaths and premature births. For example, Maitra *et al.* (1993) observed 31% foetal losses and 60% premature births. Skeletal manifestation of this strain of malaria would not be evident in the bones due to the acute nature of the disease process, but would be evident in the mortality pattern. Females are particularly susceptible during the first pregnancy and also during the first trimester (Maitra *et al.* 1993; Singh *et al.* 1999). Mosquitoes are attracted to still, stagnant waters and therefore, the more efficient agricultural irrigation technology introduced during the Nubian Post-Meroitic period (e.g., the saqia water-wheel), while improving crop yield, may have contributed to the deterioration of health among the Nile Valley people.

Selected palaeopathological cases

A number of burials presented some interesting pathological lesions:

Tomb 59 (Post-Meroitic)

Two young males 23-35 years of age and covered with matting were interred facing each other on a north-south axis; a small wooden pot and spatula were the only artefacts associated with the burial (Edwards 1998, 82, 85, 134). Each male bore an unusual shoulder injury. Individual 754B who was interred on the east side of the grave and placed slightly under Individual 754A, suffered a fractured left clavicle where it articulates to form the shoulder joint with the scapula and humerus (Plate 2). The angle of this fracture was 60° indicating that the force of the injury was indirect and likely due to a fall on the hand or shoulder, which produced an overlap when the two broken bone ends slid against each other. The clavicle healed in this position, but the scapula was also involved. Because the clavicle was shortened by overlapping, the tip that normally articulates with the scapular spine, shifted away from this position towards the vertebral column. Subsequently, a new joint was formed by the movement of these two articulating bones, which implies that the shoulder joint continued to function normally with no additional complications (e.g., osteoarthritis) and the individual resumed his normal activities. The second male bore an implement inflicted injury on the posterior humerus, which also truncated the anterior edge of the articulating scapula (Plate 3). The resulting gauge was rounded rather than a V-shaped lesion that is associated with a weapon such as an axe, sword or knife, and therefore, this lesion might be attributed to a surgical procedure. The lesion was perfectly healed and again, no complications were observed.

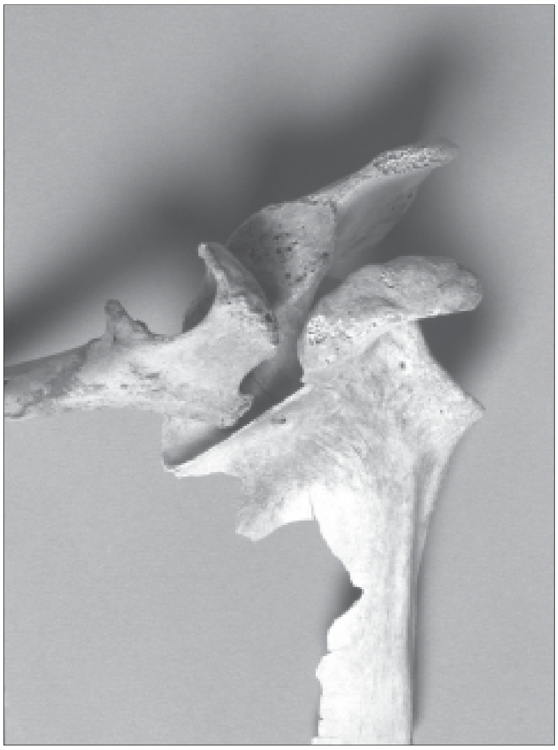

Plate 2. Posterior view of the right humerus and scapula showing a well-healed lesion produced by an instrument.

Plate 3. Fractured and dislocated left clavicle and false joint created on acromial process of the scapula.

Tomb 90 (Medieval)

The 40-45 year old male interred in Tomb 90 bore a suite of lesions that suggest an active life irrespective of less than optimal health. Bilateral cribra orbitalia, whatever the aetiology, reveals that an anaemic condition was present, and the individual likely experienced bouts of fatigue and weakness (Aufderheide and Rodríguez-Martín 1998, 346). Irrespective of this, or perhaps during his peak years, the individual performed heavy labour, as represented by the osteoarthritic lesions on both shoulder joints and the spinal column, as well as herniated intervertebral discs. Three fingers on the left hand were broken and the part of the right forearm (the olecranon of the ulna) that articulates with the humerus and permits the elbow to flex was absent, either congenitally or as a result of non-union of a healed fracture; the presence of osteoarthritis on all of the surrounding articular surfaces suggests that this individual was not prevented from performing daily tasks. A small depression fracture above the left eye orbit discloses that this man was not a stranger to conflict.

Post-Meroitic graves with weapons (Tombs 1 and 72B)

Of the graves excavated only two contained weapons. The graves were those of two males less than 35 years of age, which hints that the individuals were involved in military service or perhaps a specific occupational activity, such as hunting. One partial iron blade and one arrowhead fragment was found in Tomb 1 (Edwards 1998, 113, 121), while six iron arrowheads were recovered from Tomb 72B (Plate

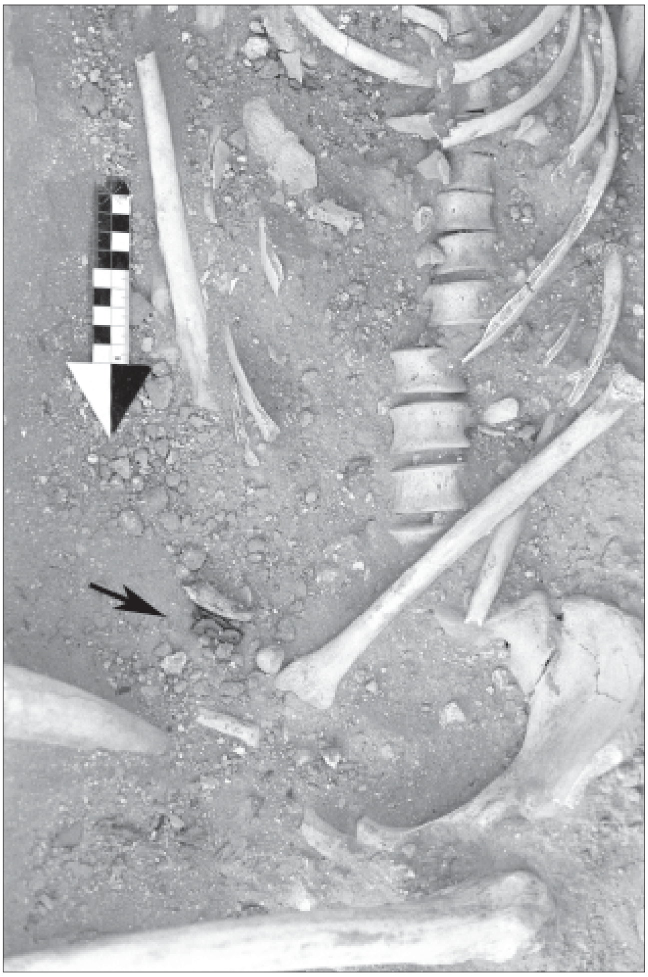

Plate 4. Burial a Post-Meroitic male Tomb 72B with cluster of six iron arrowheads on the right side of the individual's pelvic area.

4) (Edwards 1998, 113, 121). Both males displayed robust muscle insertions, particularly on the bones of the upper body and coincidentally, each male also endured a fractured radial head.

Summary

While the detailed quantitative analysis is currently in process, general observations of the health patterns of the Post-Meroitic and Medieval individuals from Gabati revealed universal palaeopathological features as well as alterations to the health spectrum previously observed among earlier Nubian cultures:

1. Dental calculus and osteoarthritis were present to some degree in approximately 50% of the adult population and increased with age.
2. Minor traumatic lesions, such as an injury received from stubbing one's toe or muscle pulls, were born by a majority of the males and about 40% of females. Gross long bone fracture or skull injuries associated with lethal and non-lethal violence or accident were rare.
3. There were no specific infectious diseases (e.g., leprosy, tuberculosis) that appear in other civilisations during

this era, although lesions associated with non-specific infection were present.

4. Child mortality escalates in contrast to earlier Nubian cultures, a characteristic observed among other Medieval skeletal collections.

5. The high frequency of young female, infant and foetal deaths and lesions associated with anaemia, in a period when we assume that irrigation agriculture intensified, suggests that malaria may have been a factor responsible for some of the deaths observed at Gabati.

Acknowledgements

A very special thanks are extended to the volunteers who continue to help with the processing of the Gabati skeletal collection and to Claire Messenger and Richard Parkinson of the Department of Ancient Egypt and Sudan (The British Museum) who administer and recruit volunteers for this task.

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