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## **Skeletal Biology of Neolithic Human Remains from Dakhleh Oasis, Egypt**

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### **Introduction**

Dakhleh Oasis is located in the Western Desert of Egypt, roughly 800 km south and west of Cairo and 250 km west of Luxor (Mills 1979). One of 5 major Oases in the region, it measures about 100 km in width by 25 km in length (Cook et al. 1988). Since 1977, the Dakhleh Oasis Project has been investigating the prehistory and history from the mid-Pleistocene to Roman times. One of us (JLT) was invited to join the project in 1996, to focus on the recovery and analysis of prehistoric human remains. Human remains are well known in the oasis from Pharaonic and Roman times (e.g. Molto 2000; Fairgrieve & Molto 2000) but, prior to these times, no skeletal evidence has been analyzed until recently.

During the initial phases of the Dakhleh Oasis Project, much of the Oasis was surveyed to discover the extent and nature of the archaeological material remains. At this time, several skeletons were noted eroding out of sediments beneath, and/or from, a deflated surface associated with the Sheikh Muftah cultural unit (McDonald, personal communication). Artifacts from this unit include pottery, ground stone, copper fragments, and chipped stone (McDonald et al. 2001). Faunal remains of domestic and wild fauna are associated with these artifacts. Radiocarbon dating was carried out on charcoal from hearths from several sites. Initial results indicated dates from ca. 7800 to  $4720 \pm 80$  B.P. for the Sheikh Muftah cultural unit (McDonald 1993), but these now have been revised to ca. 5200-4000 B.P. (McDonald et al. 2001). One skeleton was retrieved in the early 1980's and placed in storage until recently.

In 1996, three of these burials, now in a fragmented state of preservation, were relocated near the village of Sheikh Muftah. In subsequent field seasons, two more, almost complete individuals were found, not yet eroded from the soil.

These two skeletons were fairly intact, but in a fragile state, requiring the use of consolidants to ensure their preservation during excavation. Four of these five individuals were buried in a flexed position indicating a common mortuary practice. Fragments of a sixth individual, thought to be more of the one recovered in the early 1980's, was located near the village of Balat. However, examination of the remains revealed two individuals were present. Nearby, several toe bones were recovered and perhaps represent an additional burial not yet excavated. In total, the dental and skeletal remains of seven individuals from the mid-Holocene have been recovered and one burial remains to be excavated. Of these six individuals have been analyzed and provide interesting insights into the lifeways of Dakhleh's Neolithic peoples.

The mid-Holocene is a time of significant climate change in the Sahara. Environmental evidence suggests that from the early to mid-Holocene, ca. 9500 to 6100 BP, a humid phase took place in the eastern Sahara (McDonald 2001 1999; 1998; 1996; 1993) followed by a period of aridification. By 5000 B.P., as a direct consequence of this drying trend, the desert surrounding Dakhleh became increasingly arid and virtually uninhabitable. As a result, the oasis became a refuge for the local pastoralists, who had to rely more heavily on its resources. Archaeological evidence confirms that the majority of the Sheikh Muftah sites dating to this time period are located near the center of the oasis where some water remained available (McDonald et al. 2001). Faunal remains from these sites are highly fragmented and it is possible that bones were being broken open to obtain marrow. This suggests that food was scarce and people were attempting to maximize resources available to them (Churcher 1983; McDonald 1999). According to Fagan (1995: 284) desert populations "...responded to drier conditions by settling closer to permanent water, where they faced the same problem as the people of the Nile – seasonal food shortages and the constant threat of starvation". To determine whether these individuals suffered from any dietary stress requires an examination of all dental and skeletal evidence available. The recovery of six individuals from this time period, then, provides a unique window into the life and health of people whose livelihood was affected by an increasingly arid environment.

The purpose of this chapter is to report on the skeletal biology of the available Neolithic human remains from Dakhleh Oasis. While some details of this research have already been published elsewhere (Thompson 2002; Thompson & Madden 2003), the presentation of this work forms a summary of results to date. This contribution therefore represents a work in progress, but provides interesting insights into the biology and behaviour of people from this time period.

## Sample

The sample reported on here consists of six individuals varying in their degree of preservation and extent of fragmentation. Specimens are numbered according to site location. As seen in Table 1, one individual comes from site 100, located near the village of Balat, and is numbered 100-1. Three individuals are from site 365 and are numbered 365-1, 365-2, and 365-3. Two individuals from site 375 are numbered 371-1 and 375-2. Sites 365 and 375 are located near the village of Sheikh Muftah. Table 1 lists age, sex, and pathology for each specimen.

## Assessment of the dentition

A detailed description of the dentition is in preparation. However, germane to the issue of health and behaviour is a discussion of dental pathology including enamel hypoplasia and hypocalcification, dental caries, periodontal disease, and dental abscesses.

Enamel hypoplasia is a pathology that affects teeth during development and is thought to indicate stress events like poor nutrition, infection, parasitism, and weaning (Duray 1996; Buikstra & Ubelaker 1994; Goodman & Rose 1991; Hillson 1979; Malville 1997; Moggi-Cecchi et al. 1994; Wright 1997 but see also Saunders and Keenleyside 1999) or result of hereditary anomalies and localized trauma (Duray 1996; Goodman & Rose 1990). Enamel opacities such as hypocalcification are more likely an indicator of systematic stress from disease or inadequate nutrition (Buikstra & Ubelaker 1994). Since both pathological conditions occur during dental development, they present a unique opportunity to assess health and potential health stressors.

During normal growth, enamel formation can be disrupted by nutritional or disease stressors and the disruption appears as a horizontal groove or shallow depression around the crown of the tooth or as pits in the enamel (Malville 1997; Goodman et al. 1992). While some variation in dental development is known to occur between populations (e.g. Friedlaender & Bailit 1969; Mayhall et al. 1978; Jaswal 1983; Owsley & Jantz 1983; Tompkins 1996), the general chronology of tooth formation is known (Liversidge 2003) and so the age at which the stress event occurred can be estimated. While some teeth are more susceptible to hypoplasia than others, the documentation of events on all teeth potentially provides a more complete record of childhood stress events (Wright 1997).

As seen in Table 1, several of the Dakhleh people present both hypoplasia and hypocalcification. While some defects likely occurred during weaning, others occur during later stages of the development of the dentition, at about age 10, suggesting that systematic stress from disease and/or poor nutrition occurred throughout the growth period.

Dental caries represent a way of assessing dietary regimes of past populations. Research has shown a clear increase in the incidence of caries from prehistoric to historic times in Egypt and neighbouring regions (Hillson 1996; Armelagos 1969; Green 1972). In particular, there is a correlation between increased caries rates and a shift from a hunting and gathering economy to one based more on agriculture (Pfeiffer & Fairgrieve 1994; Beckett & Lovell 1994). Hunter-gatherers tend to have a low caries rate when their diet contains meat and low carbohydrate plant food (Hillson 1996). With the increase of starch in the diet, linked to the introduction of cereal agriculture, root caries are more common, especially in adults, although root caries are also linked to periodontitis (Hillson 1996). With the introduction of highly cariogenic sugars the incidence of occlusal (pit and fissure) and/or interproximal caries rates increases, and more agricultural children present caries than in previous time periods (Hillson 1996).

The archaeological remains indicate that, in Sheikh Muftah times, in the mid-late Holocene, people were primarily pastoralists (McDonald 1993). Bowen & Pearson (1993) found that pastoralists, with a diet rich in protein and milk products, had lower caries rates because dairy products coated the tooth and afforded some protection against caries production. However, as seen in Table 1, four individuals suffered from root caries. While no teeth affected by caries were recovered for 365-1 (a surface scatter of bone fragments, teeth, and fragments of gnathic remains), this individual suffered from an abscess and periodontal disease. Only some of the dentition was recovered from 100-1 and many teeth are covered in a layer of calculus preventing analysis (but see comment below). Despite the small sample size, this finding raises interesting questions about the dietary components of these people.

Periodontal disease involves bone loss around the teeth as the result of infection and inflammation of the periodontal ligament and surrounding tissues. Several factors are related to the incidence of periodontal disease, including age, sex, environment, diet, dental hygiene, as well as genetics (Hillson 1996). Individual 365-1 presents abscesses in the maxilla and mandible. Bone loss may therefore be due to periapical periodontitis (contributing to dental root caries) and/or acute abscessing in this instance. Individual 365-2 presents typical vertical bone loss on the buccal side of several mandibular teeth. Of interest, is the apparent link between levels of carbohydrate intake (associated with agriculture), and levels of alveolar bone loss as well as accumulation of calculus on teeth (Hillson 1996).

### **Assessment of the skeleton**

Porotic hyperostosis was observed on the crania of individuals 365-1 and 375-2. Porotic hyperostosis is an anemic condition indicating physical stress

(Fairgrieve & Molto 2000). In both cases the condition was assessed as minimal: several small perforations of the frontals and parietals were noted. Due to the fact that these individuals were adults, with only minimal indications of porotic hyperostosis, this likely represents a state of healing (Aufderheide & Rodriguez-Martin 1998). However, it has been shown that individuals who suffered from porotic hyperostosis also experienced a reduced life expectancy. At this point the sample is not large enough to establish a normal life expectancy to contextualize the occurrence of this disease. Currently, researchers are debating the cause of this anemic condition, but believe it could be due to inadequate diet, malaria (thalassemia), parasites, or other infectious agents (Angel 1967; Stuart-Macadam 1992; Fairgrieve & Molto 2000).

An area of periostitis, or sclerotic bone, was seen on a fragment of femur shaft of individual 375-2. Sclerotic bone appears during the healing process, resulting from trauma, infection, or disease (Aufderheide & Rodriguez-Martin 1998) and is laid down on the outer cortex of the bone giving it a porous, raised and/or striated appearance (Ortner & Putschar 1985). Periostitis sometimes correlates with other health indicators like porotic hyperostosis (Ortner 2003; Aufderheide & Rodriguez-Martin 1998).

Individual 365-2 presented with calcaneal (or heel) spurs on both feet. These spurs are known as peripheral enthesopathies, which are osteophytic lesions, located at tendon attachment areas (Larsen 1997). They form as the result of strenuous activities like long distance walking and running (Cox & Mays 2000; Larson 1997).

Degenerative joint disease, or arthritis, was present in only one individual, 365-2. This was the only individual in the sample who had reached at least 40 years of age, therefore it seems likely that this form of degenerative joint disease is age related. Arthritis occurs for a variety of reasons including infection, trauma, heredity, and physical activity (Larsen 1997). There are several types of arthritis that generally cause different kinds of bony change and have different patterns of skeletal distribution. For example, rheumatoid arthritis (Waldron et al. 1994) was ruled out in this case based on the absence of erosive lesions and incongruent skeletal distribution patterns. In addition, although osteophytes were present on the vertebrae, there was no evidence of fusion of the vertebral joints, thus ruling out psoriatic arthritis, Reiter's syndrome, ankylosing spondylitis, and diffuse idiopathic skeletal hyperostosis (Arriaza 1993; Rothschild et al. 1999). This narrows the diagnosis to osteophytosis or osteoarthritis. It is generally understood that both conditions are related to mechanical stress (Bridges 1994; 1991; Jurmain 1990; Maat et al. 1995). Osteophytosis affects the bodies of the vertebrae causing lipping around the margins, while osteoarthritis of the vertebrae affects the articular facets of joints, causing eburnation, porosity, and

osteophytes (Bridges, 1994). An individual may suffer from osteophytosis alone or a combination of osteophytosis and osteoarthritis (Maat et al. 1995). The lumbar vertebrae are usually affected more often by arthritic changes than the thoracic or cervical vertebrae (Bridges 1994; Jurmain 1990). It is interesting that 365-2 suffered from osteophytes in all types of vertebrae. This may point to an active lifestyle but is not necessarily associated with a particular form of subsistence (Bridges 1991).

In addition to the vertebrae, 365-2 also showed arthritic changes in the form of lipping at the glenoid fossa of the scapula, the distal humerus, the proximal radius and ulna, and the clavicle. Jurmain's (1990) work relates advancing age of an individual to osteophytic changes in the shoulder more than changes that occur in other joints, which may be due to other causes. According to Maat et al. (1995), peripheral osteophytosis is usually more frequent in those suffering from osteoarthritis. Arthritis tends to occur more frequently in females, but, until more skeletal specimens are recovered, we are unable to determine whether sex differences occur in this population (Bridges 1991; Larsen 1997). An interesting fact is that 365-2 also suffered from a cervical vertebral fracture which may relate to his arthritic condition.

The compression fracture of the cervical vertebrae in 365-2 is not severe. The vertebrae itself has taken on a wedge-like shape due to the collapse of the anterior internal structures of the vertebral body (Arbitol & Kostuik 1998). This level of compression fracture is considered stable and would not likely have resulted in the death of the individual or the need for excessive care by the community. (Rah & Errico 1998). Compression fractures can be categorized as injuries resulting from accidents, loss of bone mass associated with arthritis, or mechanical stresses (Larsen 1997). According to Larsen, accidental injuries occur most frequently in the long bones and ribs. The breakage patterns do not seem to apply to accidental injury in this individual. Due to the weight and rugose nature of the bones of individual 365-2, loss of bone mass, or osteoporosis due to an arthritic condition, appears unlikely. However, the bones have not yet undergone radiographic examination, which may help to test this hypothesis. Therefore, based on our current assessment, this cervical vertebrae fracture is more likely due to the micro-trauma (small tears or breaks in the tissue) experienced during repetitive mechanical stress associated with daily tasks. Lovell (1994) states that the cervical spine can be adversely affected in individuals who carry objects on their heads in the course of their daily activities. It may be that this individual transported heavy items on his head on a regular basis.

## Discussion/Conclusion

Although age estimates are approximate, based on the amount of wear on the occlusal surface of the dentition, it can be estimated that the average life expectancy for these people was between 20-30 years of age (Thompson 2002). The pathological evidence indicates that the population, represented by these individuals, was possibly subject to long periods of health stress during childhood and throughout their lifetime. What caused the health stress is unknown, but diet, malarial infection, or parasitic infestations are likely candidates.

One individual, 365-2, gives us special insight into the lifeways of these people. This 40 year old male lived long enough to develop age-related arthritis in several locations throughout his body. In addition, evidence of arthritis linked to repetitive activities and the presence of a mechanically induced enthesopathic lesion on his calcaneus suggests a highly active lifestyle. This individual was the only one with an associated burial item. The copper pin associated with this male could be a status symbol, but „the lack of noticeable burial monuments or of elaborate grave goods... reinforces the picture of small, egalitarian groups“ (McDonald et al. 2001). In addition, the presence of the artefact with this active individual reinforces the hypothesis (McDonald et al. 2001) that there was some contact between the Nile Valley occupants and peoples of the outlying oases. Males from the Nile Valley Predynastic cemetery of Hierakonpolis, roughly coeval with the Sheik Muftah Unit, carried copper pins in leather pouches at their waists (Friedman 1998). Furthermore, ceramics from the Nile Valley have been found at Sheikh Muftah localities, including Locality 100 where one burial was found. Thus there are several lines of evidence that connect Dakhleh Oasis to other areas within Egypt at this time. Future research will concentrate on a comparison between biological affinities of the Dakhleh Oasis sample as compared to one from the Nile Valley to investigate the possibility of movement between these two regions.

No archaeological materials were found within the burial context that would suggest their economic/dietary strategy, but we assume these people are the makers and users of the Sheik Muftah cultural remains. The domestic fauna associated with these material remains indicate pastoralism, while the presence of wild fauna points to limited hunting indicating a mixed economy. What is interesting is that the occurrence of root caries in the dentition of several individuals, including the 40 year old male, in addition to the overall heavy dental wear, suggests an increased dependence on starch-rich plant foods. According to McDonald et al. (2001), changes seen archaeologically over the course of the Holocene may reflect increasing sedentism or an increased reliance on cultivars during the Sheikh Muftah period. This hypothesis may be substantiated, in the

future, by the analysis of dental calculus (Dobney & Brothwell 1986; Fox et al. 1996) and/or chemical analysis of bone.

The climatic information shows the Sheik Muftah period to be a decreasingly hospitable time, with an increase in aridity in the surrounding region (McDonald et al. 2001). Shallow, open water or swamp may have been present, at least west of the Balat cultivation (McDonald, 1982 field notes) providing evidence to support the fact that the water in the region may have been drying up, and may have contributed to the restriction of these people to the more central part of the oasis. The stress evidenced in the dental and skeletal pathologies of this sample may reflect worsening conditions imposed by the changing environment. These burials therefore provide us with new information about the Neolithic peoples of Dakhleh Oasis and expand our knowledge of the desert populations during the mid-Holocene of Egypt.

Table 1: Incidence of Dental and Skeletal Pathology in the Dakhleh Sample

Site/ individual #	Age	Sex	Hypoplasia	Hypocalcification	Carries	Abcesses	Periodontal disease	Porotic Hyperostosis	Periostitis	Peripheral enthesopathies	DJD*	Fracture
100-1	Adult	M	X?	—	—	—	—	—	—	—	—	—
365-1	17-25	M	X	X	—	X	X?	X	—	—	—	—
365-2	40-45	M	—	—	X	—	X	—	—	X	X	X
365-3	20-25	F	X	X	X	—	—	—	—	—	—	—
375-1	25-35	M	X	X	X	—	—	—	X	—	—	—
375-2	30-35	?	X	X	X	X	—	X	—	—	—	—

\* DJD=Degenerative Joint Disease



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