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CHAPTER 8

THE EFFECTS OF SOCIOECONOMIC CHANGE IN PREHISTORIC AFRICA: SUDANESE NUBIA AS A CASE STUDY

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INTRODUCTION

This chapter examines the effects of the transition to agriculture and the subsequent intensification of agricultural production on the biology of ancient populations from Lower Nubia. The analysis was derived from the human remains, and from an understanding of the geographical setting and the cultural adaptation of populations living in the area during the last 12,000 years. Specifically, we have examined the pattern of population growth, changes in morphology, alterations in growth and development, the impact of mortality and morbidity on life expectancy, and the impact of disease stress.

The selection of Lower Nubian remains is based on the excellent archaeological and skeletal remains recovered from the area. The Nubian material represents one of the most intensively studied archaeological populations in the world with 36 major

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excavations completed in the last 75 years and more than 1000 sites excavated (Adams 1977). These sites span a period from the hunting-gathering stage to agricultural intensification in the area.

Although Nubia provides an excellent opportunity for examining the impact of agricultural development on the biology of earlier populations, there are a number of problems that complicate attempts to measure the magnitude of that impact. The most important problem is that we do not have large samples of material from the critical periods during which the transformation to agriculture occurred. The best evidence comes from the phases in Nubian prehistory during which there is an intensification of agricultural production.

Lower Nubia is the portion of the Nile River Valley extending from the First Cataract at Aswan to the Second Cataract at Wadi Halfa (Figure 8.1). The region represented a main line of communication connecting sub Saharan Africa and the Meditteranean (Trigger 1965). The study will focus on the skeletal materials excavated near Wadi Halfa, and also on materials (from the Kulubnarti site) in an adjacent portion of Upper Nubia known as the Batn el Hajar.

CULTURE HISTORY

Populations used in this study include materials from the Mesolithic (ca. 12,000 B.C.), Neolithic (5000-3600 B.C.), A-Group (3400-2400 B.C.), C-Group (2400-100 B.C.), Meroitic (350 B.C.-A.D. 350), X-Group or Ballana (A.D. 350-550), and Christian (A.D. 550-1350) periods (Table 8.1). The skeletal material in this study was excavated during the course of the first University of Colorado Nubian Expedition, 1963-1964 season (of which Armelagos was a member), and the Colorado-Kentucky Expedition (in which Van Gerven was Principal Investigator).

The seven periods of Nubian prehistory can be placed into three broader phases of cultural development that are relevant to the interpretation of the impact of agriculture on biology. The first phase represents a period of transition from gathering and hunting to agriculture and includes the mesolithic and Neolithic periods. In Lower Nubia, the Neolithic development never resulted in the intensive exploitation of plants and animals that occurred in other areas. The next phase represents a nonintensive agricultural period in which the A-Group and C-Group utilized an annual cycle of produce. During the third phase, intensive utilization of the Nile Valley became possible because of the use of the waterwheel. The Meroitic, X-Group, and Christian periods display varying degrees of intensive agriculture. Summarized briefly in the next section are the cultural changes that have occurred during the major time periods.

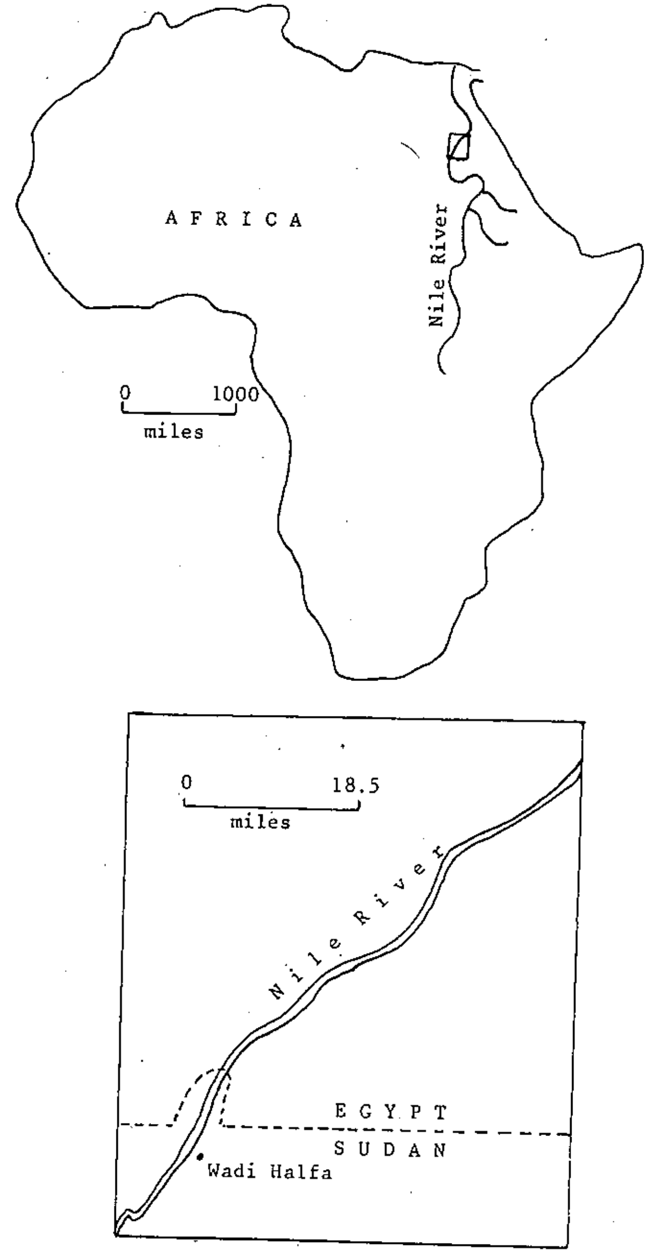

FIGURE 8.1. Map of Africa with enlarged section showing location of Wadi Halfa (reproduced from Martin 1983).

TABLE 8.1 Chronology and Sample Size of Remains Used in This Study[a]

Phase	Time	Scandanavian	Colorado	Kentucky-Colorado
Mesolithic	*11,950-6400 B.C.*		*39*	
A-Group	*3400-2400 B.C.*	*105*		
C-Group	*2400-1200 B.C.*	*653*	*21*	
Meroitic	*350 B.C.-A.D. 350*	*135*	*129*	
X-Group	*A.D. 350-550*	*156*	*218*	
Christian	*A.D. 550-13*	*57*	*403*	*188*

[a]The Scandanavian sample is used by Vagn Nielson (1970), the Colorado sample is from the Wadi Halfa area, and the Kentucky-Colorado sample is from the Batn el Hajar region of Kulubnarti.

Transitional Phase

Mesolithic (11,950-6400 B.C.)

The archaeological evidence indicates that the Mesolithic populations in Lower Nubia relied on the exploitation of large game, fish, and seed collecting (Greene and Armelagos 1972). Saxe (1966) cites evidence of large game hunting; the occurrence of bones of large bovine species in sites suggest semisedentary occupations. Fishing and shellfish gathering were substantiated by numerous fish vertebrae and shellfish remains found with the burials and throughout the sites. Many small and large grinding stones suggested the importance of gathering and utilization of wild grass seeds.

Neolithic (6000-3600 B.C.)

The development of agriculture appears late in Lower Nubia and is not pronounced in the archaeological record. The late occurrence of domesticated plants and animals may reflect geographic factors that impeded the spread from northern Africa into the southern portion, or may indicate that seed-collecting and fishing were extremely successful. In the Wadi Halfa Neolithic sites there is an indication of heavy reliance on fishing and hunting; some cultigens are found, however, implying at least incipient agriculture.

Nonintensive Agricultural Phase

A-Group (3400-2400 B.C.)

A-Group represents a transition from the Neolithic period in terms of both technology and subsistence. Economic behavior was specialized for Nile ecology and involved a mixed strategy. The archaeological record shows that domesticated grains, hunted animals, fish, and gathered seed constituted the dietary base. The farming strategy was not an intensive one; single annual crops were harvested and the success was dependent on the annual overflow of the Nile during the flood season (August-November) (Trigger 1965). The major crop, which was used as both a food source and fodder, was millet. Millet was less efficient in terms of productivity and nutritional content than other potential crops (such as barley and wheat), but could more predictably be harvested prior to the flood season.

The continuity of the A-Group population from Neolithic populations is substantiated in consistent settlement patterning, pottery styles, and burial practices (Adams 1977). Therefore, an indigenous development of transitional economy grew from existing conditions and local populations.

C-Group (2400-100 B.C.)

Similar to the A-Group in adaptive strategies, C-Group populations exhibited a mixed economy with reliance on domesticated grains (primary millet), fish, and hunted animals. There was an increase in trade items from the North (Egypt). The relative prosperity of the region was high.

The C-Group populations are directly descended from the A-Group, although they occur following a brief abandonment of Lower Nubia brought on by political and economic factors (Trigger 1965). Political pressure from the Old Kingdom had pushed indigenous Nubians from Lower to Upper Nubia during the A-Group to C-Group transition. The biological homogeneity of the two groups emphasizes the role of exogenous political and economic factors in the brief abandonment after the A-Group time period (ca. 2400 B.C.) (Adams 1977).

Following the C-Group period there was another exodus of Nubians southward. A slow but continual decrease in population size resulted from continued political pressure from Egypt (Trigger 1965). For 1000 years following the C-Group period, the region of Lower Nubia remained unoccupied because a decrease in the Nile water level created an effective barrier to exploitation of the area.

TABLE 8.2 Estimates of Population Growth Based on Settlement Patterns of Excavated Archaeological Sites in Lower Nubia[a]

Phase	*Population Estimate*
Nonintensive	
A-Group	*13,000*
C-Group	*17,500*
Intensive	
Meroitic	*60,000*
X-Group	*44,000*
Christian	*50,000*

[a]*Trigger 1965:160.*

Intensive Agricultural Phase

Meroitic (350 B.C.-A.D. 350)

The reoccupation of Lower Nubia occurred simultaneously with the development of the waterwheel (*saqia*) in Upper Nubia (Adams 1970). The waterwheel increased the productive potential of the region, permitting support of a larger population than before (Table 8.2). Farmers could now grow several crops a year, and the level areas farther back from the Nile (as well as the high banks) could be watered and used (Trigger 1965). However, crops grown on these lands required a much greater investment acre-by-acre than did single annual crops grown on the alluvial flood plains. The new system therefore required increased inputs of both time and energy.

The Meroitic culture flourished at this time and Lower Nubia was important for trade and communication between the Mediterranean and sub Saharan Africa. However, most of the settlements were small and relatively poor. The inhabitants of Lower Nubia were being ruled from Upper Nubia and may have been supporting the area with agricultural products (Adams 1977). Even with the waterwheel, agricultural potential was relatively low, and trade accounted for much of the growth (Trigger 1965).

The archaeological record shows a farming strategy that now involved three growing seasons. Crops harvested included millet, wheat, barley, beans, tobacco, lentils, peas, and watermelon (Trigger 1965). Dates, mangoes, and citrus trees could also be kept watered during dry seasons to produce more fruit. Cattle, sheep, and goats probably were herded and animal husbandry may have been only slightly less important than agriculture (Adams 1977). Cattle were used to run the waterwheel, and were not eaten. Trigger (1965) suggests that milk and butter may have been important sources of food for trade.

The Meroitic people had a strong incentive for development of the full agricultural potential of their region. Immediately to the north lay the wealthy Roman province of Dodekashoenos, a terminus for the caravan trade with sub Saharan Africa. The Lower Nubians, subjects of the Upper Nubian Kingdom of Meroë, traded their surplus agricultural produce to this "industrialized" Roman province (Adams 1970). In return they received a bountiful range of the trade goods of Mediterranean civilization. Toward the later stage of the Meroitic period, the Lower Nubians had achieved a more sophisticated level of cultural development than the area had ever seen before. Settlement patterns indicate that the population size increased and clustered into dense pockets around the irrigated fields (Trigger 1965).

By A.D. 350, the decline of the Kingdom of Kush and the Kingdom of Meroë brought an end to prosperity in Lower Nubia. The Roman Empire was beset with governmental instability, famine, plagues, and wars (Adams 1977).

X-Group (Ballana Culture) (A.D. 350-550)

During the X-Group period, the large population centers fissioned into smaller villages concomitant with a decentralization of power and an increase in local village autonomy (Trigger 1965). Several researchers have emphasized qualitative differences in artifacts between Meroitic and X-Group populations and have suggested a cultural decline due to an invasion of new population into Lower Nubia (e.g., Batrawi 1946; Morant 1925). However, an analysis of artifacts suggests that there are no striking differences (Adams 1977). Burial patterns, pottery types, iron spears, arrowheads, and tools were common to both periods (Trigger 1965). While the quality of X-Group pottery may not have been equal in fabric or decoration to that previously produced in Meroitic times, it was very similar and all differences could be traced to a Mediterranean origin (Adams 1970). It would appear, therefore, that indigenous Nubian influences remained strong into the X-Group period. Similarities in technological and ideological realms suggest continuity (Trigger 1965; Vagn Nielson 1970). Genetic and biological continuity has also been documented using discrete dental traits (Greene 1966) and cranial traits (Berry and Berry 1973; Berry et al. 1967).

X-Group subsistence activities were similar to the Meroitic strategy of intensive agriculture with moderate animal husbandry (Vagn Nielson 1970). Due to local autonomy of Nubian villages, trade networks and trade items were not very pronounced. This lack of luxury and exotic artifacts in the archaeological record has been interpreted as a "decline" in the cultural achievements previously reported for the Meroitic (Adams 1977). Whether the shift in percentage of trade items is due to a decline in artistic ambitions or to a decline in necessity of reciprocal trading of agricultural goods for "hard" goods is debatable. While there is no evidence supporting a change in the underlying subsistence pattern, X-Group people were more independent, and were not obliged to trade agricultural products. It is not clear from the archaeological record to what degree the X-Group may have been practicing intensive agriculture, but there appears to have been a reduced demand for food from neighboring cities.

Christian (A.D. 550-1300)

The Christian period shows much cultural growth and religious reunification. Initially controlled by Egypt, the church rose to become the focus of Nubian independence. Urbanization and stratification are evident in the housing styles, architecture, and settlement patterns (Adams 1977). Populations began to cluster in large centers and monastic communities toward the end of the time period, but there was not an increase in population size on a large scale (Table 8.2).

Subsistence strategies were a continuation of the previous two time periods. Agricultural practices did seem to intensify, however. In environmentally poor regions, artificial terraces were built as high as the waterwheel could reach (Trigger 1965). Trade networks were once again very strong. Trigger (1965:145) states that Nubians were trading several hundred slaves to Egypt each year in return for wheat, barley, lentils, cloth, and horses. In addition, dates, figs, grapes, and other fruits were imported from Egypt. Intensification of agricultural activities, with no evidence for large increases in the population size, suggests a greater demand for goods in the cities.

Summary

The archaeological reconstruction of the culture history shows the impact of environmental variables and political and religious change. There are periods of environmental instability (decline in the level of the Nile) in which Nubia was not habitable, such as the 1000-year hiatus following the C-Group occupation. In other periods during which environmental factors were constant, political and religious factors were primary features of cultural change. The transitions from Meroitic to X-Group to Christian phases were due to such sociopolitical factors.

The major shift in the food base in Nubia occurred during the Mesolithic-Neolithic transition (3600 B.C.). During this time, the subsistence activities changed from a reliance on hunted and gathered food to a food base that included a single annual crop of millet during the following nonintensive phase (A- and C-Group phase, 3400-100 B.C.). While cultigens appear to be part of the diet, the ecological uncertainty of the Nile precluded total reliance on them. With the adoption of the waterwheel, agricultural potential increased and the cultigens became very important in the diet as well as in trade. The Meroitic (350 B.C.-A.D. 350) shows an intensive use of the land to produce three annual cycles of harvesting, which promoted a dependence on a broad variety of cultigens. The Christian group (A.D. 550-1350) shows a similar pattern of intensive agriculture. The time period between the Meroitic and the Christian phase, the X-Group (A.D. 350-550), does show a decrease in intensive farming, reflecting sociopolitical changes.

During the Meroitic and Christian periods, large power centers outside the local villages linked the area into pronounced trade networks. This influenced the flow of goods and access to goods. Because of reciprocal trade ties, the Meroitic and Christian groups showed an intensified pattern of production that was not related to an internal increase in population size (refer to Table 8.2). This pattern suggests a flow of the cultigens to the neighboring cities. The X-Group resembles the earlier A- and C-Groups, with little political interaction, loosely structured autonomous villages, and little or no trade with neighboring cities. The X-Group villages were more evenly spaced along the Nile.

Ecologically, the area was marginal with respect to agriculture. The amount of arable land was limited and even slight declines in available land could have had significant effects on the agricultural potential. While the waterwheel allowed some independence from random fluctuations in the water table and allowed for irrigation when necessary, agricultural potential remained limited. The exploitation of farming villages during periods of outside political control, therefore, could have a dramatic impact on the food available for the local peasantry.

POPULATION GROWTH

There are at present no published reports estimating the populations size during the Mesolithic-Neolithic transitional phase. Trigger (1965:160) estimates that the population size for the A-Group was 13,000 and that it rose to 17,500 in the C-Group period in Lower Nubia. During the Meroitic, the population rose to 60,000, but there was a 26% decrease in the X-Group period (to 44,000). There was a slight increase during the Christian phase to 50,000 (Table 8.2). These estimates are based on the size and relative numbers of settlement components in the archaeological samples, and not on absolute numbers.

During the period of nonintensive agriculture (A- and C-Group), population size averaged 15,000. Reliance on annual flooding for produce severely limited population growth. Moreover, the decline in the Nile water level made the area inhospitable for 1000 years. Then, with the rise in the Nile and the use of the waterwheel, the intensification of agriculture became a major factor in population growth. In addition, the unification of Nubia under Meroitic political influence also stimulated intensification of agricultural

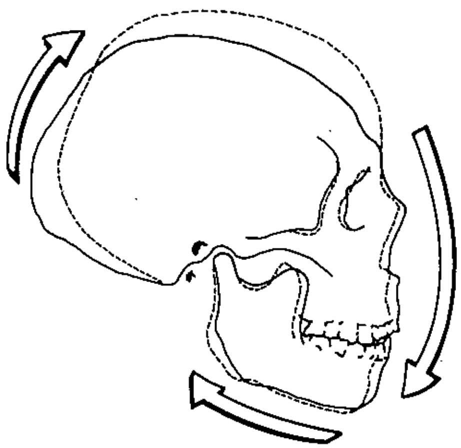

FIGURE 8.2. Changes in cranial morphology from the Mesolithic (——) to the MXCH (Meroitic, X-Group, and Christian, combined) (----). These changes involved a reduction in the size of the masticatory muscles, a reduction in the size of the lower face, a reduction in cranial length, and an increase in cranial height.

production and population growth. Following the breakup of the Meroitic empire, there was a loss of one-quarter of the population. This decline during the X-Group period likely represents a lack of demand for intensified agricultural activity, and a decrease in the amount of overall activity in Lower Nubia related to trade and communication between the Mediterranean and sub Saharan Africa. The slight growth during the following period reflects the impact of religious re-unification.

MORPHOLOGICAL CHANGES RELATED TO THE DEVELOPMENT AND INTENSIFICATION OF AGRICULTURE

Cranial-Facial Changes

Nubian Mesolithic populations are characterized by robust crania, typically with large brow ridges, large flattened faces, and bun-shaped occiputs (Greene and Armelagos 1972). Changes in later Nubian populations involve a progressive decrease in the robusticity of the entire craniofacial complex, a rotation of the mid-face and lower face to a position more inferior to the cranial vault, and a relative increase in cranial height with a decrease in length (Carlson and Van Gerven 1977; Van Gerven et al. 1979) (Figure 8.2).

Earlier interpretations of the change in craniofacial morphology relied on racial admixture hypotheses which explains all changes in cranial morphology in terms of replacement of one population by another (Batrawi 1946). More recent biocultural models have proposed that a dietary change involving a reduction in attrition rate and an increase in cariogenic foods could have precipitated selection for smaller and morphologically less complex teeth. This then could have led to a reduction in facial architecture with a compensatory change in the cranial vault and base to meet the stresses acting on them (Carlson and Van Gerven 1977; Greene and Armelagos 1972).

The most dramatic change in facial morphology occurs from the Mesolithic phase to the nonintensive agricultural phase of A- and C-Group. Unfortunately, Neolithic material is not available to document the period of most rapid change. The morphological changes described continue from the nonintensive phase to the intensive phase. Given the archaeological reconstruction of dietary changes, the impact of a shift from foods obtained by gathering and hunting to a staple consisting of millet may have provided the impetus for natural selection and the changes in craniofacial morphology.

Stature

Stature has been assessed for all the major groups except for the Neolithic. Based on the maximum length of the femur, the greatest difference between mean values (for both males and females) is found between the A-Group and the X-Group. This difference is significant at the 5% level (Vagn Nielson 1970). Although the reduction in stature is similar for both males and females, only the males show a statistically significant decline. For males, the greatest average length of femur occurs for the A-Group, with 47.6 cm, and it decreases to 45.5 and 45.0 cm in the C-Group and Meroitic, respectively. However, the X-Group males show a significant decrease to 44.5 cm, and femoral length increases to 45.0 cm in the Christians. Females show less variation in femur length, with the A-Group having a mean of 42.5 and the C-Group a mean of 42.1 cm. The Meroitic, X-Group, and Christian females all show femur lengths of approximately 41 cm (Table 8.3).

INTENSIFICATION OF AGRICULTURE AND CHANGES IN THE PATTERN OF DISEASE

The lack of extensive skeletal material from the Mesolithic-Neolithic phase makes it difficult to directly assess the impact of the transition from gathering and hunting to agriculture. In our sample, there is even difficulty in analyzing material from

TABLE 8.3 Maximum Femoral Lengths for the Combined Excavated Sites from Lower Nubia[a]

	Males		Females		
Phase	Maximum femoral length (cm)	N	Maximum femoral length (cm)	N	Dimorphism (%)
Mesolithic	46.05	4	43.76	6	105.23
A-Group	47.6	3	42.5	7	111.92
C-Group	45.5	55	42.1	47	107.94
Meroitic	45.0	28	41.9	35	107.61
X-Group	44.5	36	41.8	27	106.55
Christian	45.0	10	41.4	12	108.55

[a]*Data as summarized by Vagn Nielson (1970:86).*

the nonintensive agricultural period. What we have been able to demonstrate is that during the period of intensive agriculture (Mroitic, X-Group, and Christian), there is a pattern of nutritional deficiency that is related to the intensification of agriculture. We do not know whether this pattern existed in periods of less intense agricultural activity, but the few indications that we do have suggest that the earlier dietary base was sufficient.

Long Bone Growth and Development

The pattern of long bone growth and development in the juvenile portion of the prehistoric Nubian remains (representing the Meroitic, X-Group, and Christian phases) was studied in order to identify periods of probable stress (Armelagos et al. 1971). Unfortunately, no such data from the earlier Nubian groups are available for comparison.) This analysis provides a measure of the amount of developmental stress experienced by the subadult portions of the agricultural phase. While no intergroup comparisons are available, the data for the combined intensive agricultural phases suggest that the subadults were experiencing developmental stress.

A comparison of the Nubian data with the data for a sample of present-day American boys highlights the effects of this stress. Among Americans, growth is accelerated for the first several years of life, and decelerates rapidly thereafter. The second period of acceleration begins in mid-childhood and reaches a peak during the adolescent growth spurt. By contrast, Nubian growth apparently declined steadily from the first through the seventh years of life,

reaching a point of little or no increase between the ages of five and seven. The two periods of "catch-up" growth are visible as episodes of sharply accelerated increase in bone length.

Although the patterns of Nubian long bone lengths do not appear grossly abnormal, both the rapid deceleration of growth in early childhood and the cessation of growth around age six suggest the presence of stress at these periods. Since the process of growth requires high inputs of energy and protein, any factor that interferes with these requirements can affect growth. Growth retardation could be a result of either decreased nutrient intake or increased nutrient requirements, as in the case of trauma or infection.

Porotic Hyperostosis

Vagn Nielson (1970) has analyzed all adult skeletons with crania present for the presence of cribra orbitalia and porotic hyperostosis. Unfortunately, there are no published accounts for the Mesolithic-Neolithic rates of porotic hyperostosis, but there are reports for the A-Group through the Christian phases. Cribra orbitalia significantly decreases in adult males in the C-Group relative to those in the A-group. Frequencies of cribra orbitalia then increase slightly in the Meroitic, X-Group, and Christian groups. The females show a very different pattern of involvement. The highest frequency of cribra orbitalia for females is in the X-group and the lowest frequency is in the Christian group. The A-Group, C-Group, and Meroitic show relatively higher frequencies for females than for males (Table 8.4).

The Christian site of Kulubnarti has even higher frequencies of porotic hyperostosis. The two Christian cemeteries have frequencies of 94.4 and 82.0, with most cases showing slight or moderate pitting. Plotting the probability of individuals dying with and without porotic hyperostosis shows that those with the affliction had a much higher probability of dying in all age groups (Van Gerven et al. 1981).

Dental Caries and Enamel Microdefects

Armelagos (1969) analyzed the frequency of carious lesions for the Nubian series from Wadi Halfa. The percentage of carious lesions on the dentition was recorded by total number of teeth observed. The frequency was very low (1.0%) in the Mesolithic sample and increased to 18.0% in the Christian phase.

Rudney (1981) analyzed enamel microdefects for the Meroitic and X-Group populations from Wadi Halfa. Pathological band scores were derived from the frequency of bands per tooth and enamel hypoplasias were added to the score when they appear independent of a microdefect. For both the mesiobuccal and distolingual cusps, the pathological band scores are greater for subadults and

TABLE 8.4 Frequency of Cribra Orbitalia in Males and Females during the A-Group through the Christian Phases in Nubia[a]

	Males		Females	
Phase	Frequency (%)	N	Frequency (%)	N
A-Group	14.3	21	18.2	22
C-Group	2.9	140	11.2	18
Meroitic	5.2	77	14.6	89
X-Group	9.8	92	26.6	79
Christian	11.1	27	2.8	36

[a]*Data reported in Vagn Nielson (1970).*

adults in the Meroitic, and less in the X-Group subadults and adults. Two-way analysis of variance showed that the difference between the mean scores was significant ($p \le .001$). There are no other data to make even gross comparisons to other phases. This two-phase study is important, however, because it points to different patterns of stress between two groups that are agriculturalists. Because the X-Group shows less developmental stress it suggests that this period characterized by local autonomy and dispersed settlement patterns may have been less stressful.

Premature Osteoporosis

Huss-Ashmore (1978) analyzed microradiographs of femoral cross sections of 75 Wadi Halfa Nubian juveniles aged from birth to 14 years. Cortical thickness was measured and compared with the total midshaft diameter (Figure 8.3). Cortical thickness not only fails to increase with age, but shows evidence of an actual decrease after the age of 10. The mean percentage of cortical area was also plotted for the combined sample; it increased during the first two years and then declined sharply (Armelagos et al. 1982). A comparison with a modern well-nourished population illustrated important differences. Whereas the modern population (Garn 1970) showed a steady increase in percentage of cortical area from birth, the Nubian sample showed a decrease after the age of two. This information suggests that long bone growth was maintained at the expense of cortical bone growth. Since this study included only the subadults from the intensified agricultural periods (Meroitic, X-Group, and Christian), no comparison can be made with the transitional or non-intensive phases.

Evidence also exists that young adult females in the intensive agricultural phases were experiencing nutritional problems. There was a definite and continual loss of cortical bone (as measured by

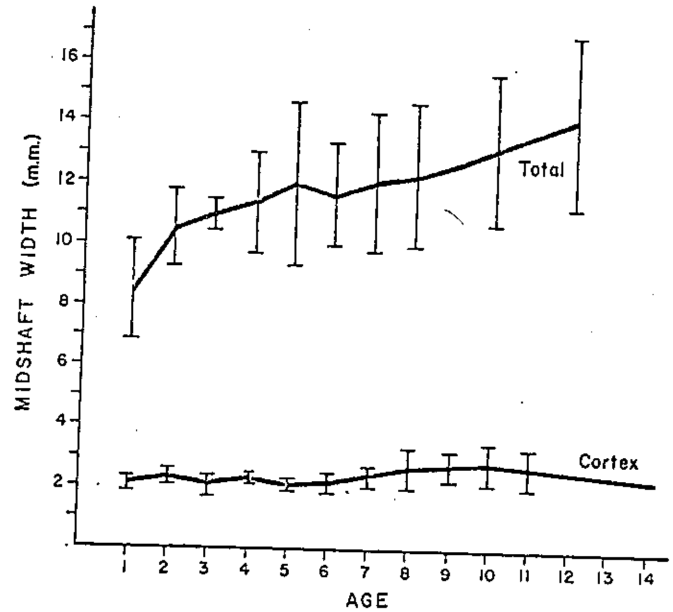

FIGURE 8.3. Femoral cortical thickness and midshaft width (means and standard deviations) plotted for subadult age. While total midshaft width increases with age, the actual thickness of the cortex does not, indicating the maintenance of growth at the expense of thickness. This is in response to protein-calorie malnutrition.

the percentage of cortical bone) in females following the twentieth year and continuing throughout life (Martin and Armelagos 1979). The early age of onset and the distinctive pattern of bone loss suggest that the female segment of the population was apparently characterized by premature bone loss not normally related to the aging process.

A microscopic study was undertaken to investigate the underlying processes that influenced the occurrence of premature osteoporosis (Martin 1983). Two separate processes at the histological level appear to be the determinants of the total amount of bone present. First, young females exhibit bones that are extremely porous due to the increase in resorption activity, and second, the bone that is present is not well mineralized, suggesting a slower rate of formation than normal.

Taken together, the trends in premature osteoporosis for subadults and young adult females suggest that the intensive agricultural phase produced nutritional inadequacies. While there is no comparison with the nonintensive and transitional phases, the presence of poorly mineralized bone and active resorption suggests that intensive agricultural strategies may produce subgroups at risk. These subgroups, because of increased nutrient demands, do not have access to necessary resources. In terms of skeletal growth, development, and mineralization, the nutritional problems could be general protein-calorie malnutrition, imbalances in the calcium/phosphorus ratio, or malabsorption of nutrients because of infections or trauma. These results are important, even without direct comparison to earlier groups, because the problems in mineralization and the resultant premature osteoporosis provide indisputable evidence of nutritional problems that can result from reliance on a single staple crop (in this case, millet).

Infectious Disease

The frequency of infectious lesions is extremely low in the Nubian Wadi Halfa populations. Unfortunately, there are no available data on the frequency of infectious lesions in the transitional or nonintensive agricultural phases. Among the Meroitic samples, only 6.6% of the individuals show evidence of infectious lesions. In the X-Group, 12.0% show evidence of infections, and the combined Christian sample shows 15.0% (Armelagos 1968). These comparatively low rates may be explained by evidence that prehistoric Nubians were ingesting tetracycline, a broad-spectrum antibiotic (Basset et al. 1981). Storage of grain in mud bins may have provided the environmental conditions for the growth of *Streptomyces*, a mold-like bacterium that produces tetracyclines. The amount of tetracycline ingested has not been determined, but a preliminary analysis of femoral cortical bone suggests at least "therapeutic" levels.

Fluorescent microscopy on the skeletal remains from Kulubnarti also show evidence of tetracycline ingestion, but at a lower rate (3.6%) (Hummert and Van Gerven 1982). The differences between the Wadi Halfa group (which shows extreme amounts of fluorescence) and the Kulubnarti sample may be the result of environmental and economic differences. Kulubnarti was an extremely isolated region with small-scale flood plain agriculture on family-owned plots. These plots probably provided direct familial use and little in the way of long-term storage, which would minimize grain spoilage.

Because even low-level ingestion of naturally occurring antibiotics can have an impact on infectious disease rates, it should be investigated via fluorescent microscopy on all prehistoric skeletal samples that come from cultures that may have stored grain.

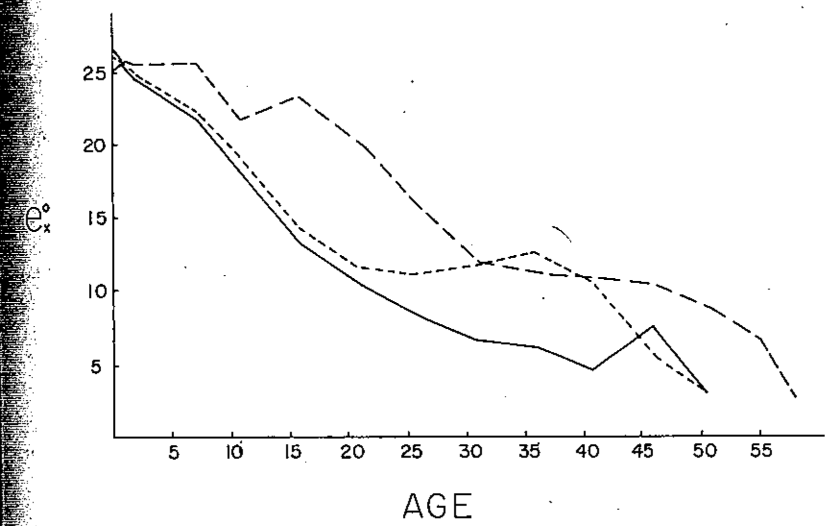

FIGURE 8.4. Life expectancy for each age group based on the mean age at death for the Meroitic (——), X-Group (----), and Christian (— —) phases.

MORTALITY

The analysis of mortality profiles of the samples from the Meroitic, X-Group, and Christian cemeteries show that age-specific life expectancies of the Meroitic and X-Group populations were very similar, whereas life expectancy in the Christian sample was greater (Figure 8.4). The X-Group population experienced some improvements in life expectancy in early childhood, but the Christians show a greater life expectancy at every age. In general, mortality is high among infants, levels off slightly among young adults, and increases sharply among older adults (Armelagos 1969). Figure 8.4 presents the life expectancy at various ages for the three intensive agriculture phases. While mean ages at death for the Meroitic and X-Group are similar (24.48 and 25.17 years, respectively), after the age of 20 the X-Group show a distinct trend toward greater life expectancy.

Mortality data suggest that in the Wadi Halfa area, the breakup of the Kingdom of Meroë did not result in a decline in life expectancy. The re-unification of Nubia under Christianity, however, did result in considerable improvement in life expectancy.

SUMMARY

The shift from gathering and hunting in Nubia is difficult to identify in the archaeological record. While we can distinguish the transition from Mesolithic to Neolithic, the changes in adaptation are not as marked as one would expect. The Neolithic populations continued to supplement their diet with gathered seeds and hunted game. Even during the nonintensive phase (A- and C-Group), gathering and hunting continued to supplement agricultural products. The intensification only occurred during the Meroitic, X-Group and Christian periods when the waterwheel was used for irrigation.

The following observations have been made:

1. Significant population growth occurred with the transition to agriculture. The intensification of agriculture led to further increases. The intensification can be attributed to changes in the environment (the level of the Nile), technological factors (use of the waterwheel), and political influence such as the unification of the area into a wider political sphere. Specifically, there was a fourfold population increase during the earlier phase of intensification (Meroitic phase). The decline of Meroitic control of the area is reflected in a 21% decline in population size and is represented by the X-Group. With the re-unification under Christianity there was a 12% increase in population size.

2. The shift to agriculture and subsequent intensification had a significant impact on craniofacial morphology. There was reduction in robusticity of the face, an increase in cranial height, and a decrease in cranial length. The trend in facial reduction continued from the Mesolithic to the Christian period with the exception of a slight increase in prognathism during the X-Group period.

3. There is a reduction in the size and complexity of the teeth from the transitional phase (Mesolithic) to the intensive agricultural phase (Meroitic). Information is not available from the nonintensive phase (A- and C-Group).

4. The frequency of dental caries increases from 1% in the transitional Mesolithic phase to 18% in the intensive agriculture phase. The attrition of dental enamel may have been a factor in the low frequency of caries in the Mesolithic population. Lower intake of carbohydrates and sugar is obviously another factor. During the intensive agriculture phase, the trend was to increase periodontal disease, with a peak in the Christian period.

5. There is evidence of iron deficiency anemia in populations from both nonintensive and intensive phases of Nubian agricultural development.

6. During the intensive phase of agricultural development, there are a number of indicators that suggest serious nutritional deficiencies in the subadults. Combined with incidences of porotic hyperostosis, there is evidence also of premature osteoporosis and

retardation. These findings suggest that long bone growth is being maintained at the expense of cortical thickness.

7. During the intensive phase of agricultural development there are indications that there were nutritional problems in the adult portions of the populations. Although both males and females show evidence of iron deficiency anemia and premature osteoporosis, there is a higher frequency of these pathologies among young females. In the 20-29-year age range there is evidence that bone is being resorbed and formation of new bone is being disturbed. The loss of nutrients and minerals during repeated pregnancies and long lactation periods may be the cause of the problem. Problems with mineralization may also be due to protein deficiency.

8. The low frequency of infectious disease during the intensive agriculture phase was probably related to the ingestion of tetracyclines that contaminated the grain.

9. Variations in mortality during the intensive phase of agriculture may be related to changes in political structure. The lower life expectancy in the Meroitic population may reflect their marginal location to the center of the Kingdom of Meroë. The improvement during the X-Group period indicates that localized control may have some advantages, especially with respect to access to resources. Further improvement occurs during the Christian period (under reunification with the Wadi Halfa area as the political power center).

In sum, the bulk of the skeletal remains from Lower Nubia have been used to show a differential pattern of biological response related to agricultural *intensification*, and not to agricultural origins. While the agricultural food base changes little during the latter phases, the political and economic activities that determined the level of intensity of the agricultural strategy do change. Health indicators reflect the degree to which human groups have access to the actual cultigens that they grow. If cultigens are used as trade items to support the cities, the health of the group will decline as cultigens are traded for "hard goods." This is precisely what is seen in the Meroitic and Christian phases.

The data from Lower Nubia suggest that the larger core areas such as the Kingdom of Meroë and Egypt were supported in part by imported goods and slaves from the outer local peasantries. Lower Nubia near Wadi Halfa provided a corridor connecting Egypt with sub-Saharan Africa. Lower Nubia, as a case study of the impact of socioeconomic change, shows that while dependence on a single staple crop may be deleterious to health, the level of political and economic interactions is just as significant for health. The health data on the X-Group and the data from Kulubnarti suggest that agricultural groups fare better in terms of health when left to their own devices. Local autonomy and lessened trade interactions assure that the cultigens being grown will circulate throughout the villages, and that health and longevity will improve.

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