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AN ASSESSMENT OF THE HEALTH STATUS BY NON-SPECIFIC STRESS INDICATORS IN EARLY FARMING POPULATIONS FROM CENTRAL AND SOUTHERN AFRICA

NONHLANHLA DLAMINI

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DEDICATION

This thesis is dedicated to my beloved late mother, Duduzile Sylvia Dlamini, who had a wish to see me in 'one of those red gowns'. I hope to honour your wish one day, hopefully in the near future. Thank you for supporting my choice of path, and for your love.

Abstract

The adoption of an agricultural lifestyle had profound implications for nutritional ecology, health and behaviour of human populations.

The goal of this project was to generate information about the health status and disease patterns of early farming populations from central and southern Africa. Skeletal material was obtained from various 'Iron Age' sites in South Africa, Ingombe Ilede from Zambia, and Sanga and Katoto from the Democratic Republic of Congo. Palaeopathological analyses was done through the examination of non-specific stress indicators that included cribra orbitalia/porotic hyperostosis, Harris lines, linear enamel hypoplasias, sub-periosteal bone lesions and dental diseases.

The evidence from palaeopathology indicated that the environments played a major role in causing differences observed at micro-scale level. It is suggested that the health problems of these agricultural peoples are a result of their sedentary lifestyle and aggregation, which promoted maintenance and spread of infectious diseases; as well as high carbohydrate diets and dependence on a few main foodstuffs that affected their iron levels. The individuals from the forest region were less healthy than those in the dry or wet savanna zones.

Also, the impact of the stress experienced by these societies was not sufficient to cause stunted growth and thus did not affect their terminal heights.

The complex relationship between the environment, socio-cultural factors and biology has shown that subsistence economy only influences a fraction of human behaviour, health and well being.

The results of this study argue that generalisations about prehistoric farming peoples cannot be made, until further research work is done.

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Chapter 1: INTRODUCTION

Sub-Saharan Africa, an area that is populated today by thousands of different cultural groups who speak many languages of the Bantu linguistic phylum, has been the interest of many investigators from various disciplines. Linguists, archaeologists, historians, geneticists, physical anthropologists, ethnographers and many others are all intrigued by the high levels of biological and cultural diversity of sub-Saharan African populations. And yet, some degree of homogeneity in biological and cultural affinities among the people is found. So, who are these people?

One of the most significant expansions in Africa (and perhaps world wide) is the spread of the Bantu-speakers' into sub-Saharan Africa. Frequently the expansion of Bantu speakers is associated with much of the biological and cultural diversity and homogeneity of peoples in sub-Saharan Africa (Mitchell, 2002; Ribot, 2004). So, what is this expansion of Bantu speakers; where did it start; how did it start, and what led to its occurrence? These are some of the questions that come to mind when I think about a dispersal of people.

There are many explanations and hypotheses about this historic event. However, a brief description could be phrased as: a great complex population movement of both linguistic and cultural groups of people associated with the emergence of several food production strategies, from around three thousand years ago (Mitchell, 2002). The basis for linking the spread of farming with the expansion of Bantu speakers comes from the "...perceived homogeneity of the material culture of the earliest agricultural groups and that this was introduced rapidly and without local precursors..." (Mitchell, 2002: 259).

This period of expansion of the Bantu-speaking people and the spread of farming has been traditionally referred to as the 'Iron Age'. For the purpose of this study, the term 'Iron Age' will be used with caution and alternative terms such as early farming communities or early agro-pastoralists will be employed to refer to the people. Views that have been expressed about the traditional terminology, 'Iron Age', argue that the term is an "explicit borrowing from European prehistory (Summers, 1950)...and seems increasingly less useful because of the emphasis placed on iron working at the expense of other technologies…and its perceived insensitivity to the descendants of the communities themselves (Parkington & Hall, 1987b; Maggs, 1992a)" (Mitchell, 2002: 259).

In this chapter, I explore the evidence from linguistics, archaeology, genetics, physical anthropology and ethnography of the expansion of Bantu speakers into sub-Saharan Africa. In conjunction with this, the 'Iron Age' of central and southern Africa is reviewed in order to provide background for the cultural differentiation and continuity of this region. Since the expansion of the Bantu speakers seems to have been a southerly one from the north, at least in the early centuries, I start by discussing evidence of the 'Iron Age' from central Africa and move down into southern Africa.

The 'Iron Age' in central and southern Africa

Archaeological sites exhibiting a variety of different subsistence strategies, technological advances, as well as increasing sedentism and changes in material culture mark the appearance of the 'Iron Age' in central and southern Africa. It appears, however, that the many aspects of the 'Iron Age' cultural 'package' were not all introduced or established together at the same time, but that some came before and some later than others. This has been seen as indicating separate processes of cultural change (Phillipson, 2005).

In central Africa, the earliest village settlements occupied around the first millennium BC come from a series of sites in Cameroon, Gabon and Congo. Although these sites are categorised as belonging to the 'Iron Age' based on the presence of ceramics, some form of agriculture and increasing sedentism, evidence of iron working in these regions does not appear until around 500 BC (Phillipson, 2005). In contrast, perhaps in part due to the direction of the dispersal, the beginnings of farming and metallurgy took place at approximately the same time in most of southern Africa (D. Miller, 2002; Phillipson, 2005).

Metallurgy, a techno-cultural process often associated with African farming communities and hence its emphasis in the 'Iron Age', had an impact so great that extended far beyond its technological achievements. The significance of its technological benefits, as well as its cultural and social implications had a life-changing impact on prehistoric communities that adopted it. Technologically, it meant easier and more efficiency in land clearance for agricultural purposes. Division of sex roles were pronounced, as only men were allowed to work metal; while women could use the end-product (i.e. iron hoes for cultivation) (Phillipson, 2005). Iron artefacts during the 'Iron Age' include mainly utilitarian objects such as hoes, tools and weapons; whereas softer metals such as copper and later gold, were used for ornamental and personal adornment purposes. Artefacts from the softer metals include bangles, earrings, pendants, figurines and even currency.

Evidence for increased sedentism is another distinctive feature of the 'Iron Age' sites, ranging from semi-permanent villages to settlements with extended periods of habitation. Degree of sedentism is often associated with the type of subsistence that is practised by the inhabitants. In general, intensive herders need to move more frequently than farmers so as to provide graze for their animals (Fagan, 1965; de Maret, 1985b; Phillipson, 1995). Material culture in the form of housing structures of ranging diversity, settlement enclosures, storage bins, iron-smelting furnaces, etc. provide evidence about the degree of sedentism at 'Iron Age' sites in central and southern Africa. To the advantage of physical anthropology research, burials from the 'Iron Age' also become much more abundant than in earlier Stone Age sites, partly as a result of increased sedentism.

Farming or agriculture has been over-emphasised in the African 'Iron Age'; whereas various types of subsistence strategies related to differences in environments, existed during the 'Iron Age'. Subsistence economy during the 'Iron Age' can be divided into three elements: farming, herding and foraging. A combination of all these three strategies is common with varying degrees of each one practised, at a site. Categories based on subsistence economy that are often used for 'Iron Age' prehistoric communities are farmers, herders or a mixture depending on the predominant focus of the economic activity (Fagan *et al.*, 1969; de Maret, 1975; Denbow, 1983). Archaeological remains such as charred sorghum, millet grains, imprints of cereal on ceramics, grinding implements as well as iron hoes, provide evidence for agricultural activities in central and southern Africa (Inskeep, 1978; Vogel, 1987; de Maret, 1985b; Denbow, 1990).

Faunal remains of domesticated cattle, sheep and goat, chicken, as well as remains of livestock enclosures and animal waste have been found in many 'Iron Age' sites, lending support to a herding-oriented economy. In addition, many sites have yielded evidence of wild faunal exploitation, including riverine and marine resources. While floral remains do not preserve well on the ground, there is little doubt that both domestic and wild plants were exploited (de Maret, 1982; 1985a; Fagan *et al.*, 1969; Inskeep, 1978; Mitchell, 2002; Phillipson, 1995; 2005).

Based on the archaeological remains, environmental characteristics and geography, 'Iron Age' populations have been categorised into two distinctive groups according to economic reliance: 1) groups with a subsistence emphasis on farming or agriculture and material culture similarities with Western African Bantu speakers, and 2) groups with a subsistence emphasis on herding with material culture similarities of Eastern African Bantu-speaking groups (Huffman, 1989b). Within eastern and southern Africa, evidence from the 'Early Iron Age' (*circa* 500 BC to 1000 AD) indicates that the early iron-using peoples in this area shared a great degree of similarity in their material culture and that these groups are thought of as coming from similar culture complexes to the north (Huffman, 1989a; Denbow, 1990; Mitchell, 2002; Phillipson, 1995; 2005). Later into the second millennium AD ('Late Iron Age'), there seems to be increasing cultural change and a great diversity in material culture and economies within the region. This change could have been the result of influences from outside the region or local establishments or both (Maggs, 1984; Huffman, 1989a).

In the hope of understanding the 'Iron Age' culture in central and southern Africa, archaeologists have utilised information from archaeological remains, while trying to reconcile their findings with evidence from linguistics, physical anthropology, genetics and ethnography. The following sections provide the general evidence for 'Iron Age' migrations and cultural differentiation.

Linguistic Evidence for 'Iron Age' Migrations in central and southern Africa

The meaning of the term '-ntu' – "person", is common to the many Bantu languages that are spoken over a large area of sub-Saharan Africa. Today, about 450 related languages spoken in sub-Saharan Africa form the large group of Bantu languages.

The Bantu languages belong to the largest linguistic phylum (Niger-Kordofanian, including Niger-Congo), as well as the largest linguistic subset in Africa (Williamson & Blench, 2000). The Niger-Congo sub-phylum is spoken from western to southern Africa throughout most of two thirds of sub-Saharan Africa, and it has ramified into several branches. The eastern group (Benue-Congo) includes the Bantoid languages from which the Bantu originated (Williamson & Blench, 2000).

In the attempt to trace population movements in the past, linguists have looked at the history of languages and the amount of change, similarity and borrowing in a language. Different techniques, of varying reliability, that have been used to interpret relationships between various or related languages include lexicostatistics, glottochronology and recently, maximum-parsimony (Guthrie, 1962; Ehret, 1982a; Vansina, 1995; Holden, 2002). Lexicostatistics is a method by which the affinities of languages, based on core vocabulary, are reconstructed. Linguistic splits can also be relatively dated through linguistic evolution, in lexicostatistics (Swadesh, 1971). Glottochronology compares two languages by composing a core vocabulary list from potentially related languages. The higher the percentage of similarity, the more recent the split between the two languages (Nurse, 1982; Ehret, 1982a; 1982b).

Similar to phylogenetic methods developed in evolutionary biology, linguistic divergence that occurs after speech communities divide can also be mapped hierarchically on a tree. "Maximum-parsimony is an optimality criterion that operates directly on discrete data (such as a list of cognate words) minimising the number of character changes on the tree, or tree length" (Holden, 2002: 793).

Using these techniques, linguists have been trying to trace the geographic origin and distribution of related Bantu languages. To date, there are several linguistic models that have been proposed for the routes of the Bantu-languages dispersal. The common broad lines are as follows: after a first differentiation and dispersal from a primary Bantu centre, there were several secondary centres of expansion from which western and eastern streams directed towards the south followed by fissions within each main sub-division.

Because the Eastern Bantu languages are less diverse than the Western-Central group, Heine (1980) proposed that a later eastern wave, originating from a secondary western

Congo centre must have emerged (Heine, 1980; Ehret, 1997; Holden, 2002). Models of the exact route of the Bantu-speakers dispersal are never definitive, especially when the shape of linguistic trees changes according to the number of languages included. Nevertheless, most linguists like archaeologists agree that this expansion did not necessarily follow a regular pattern. This is corroborated by Vansina (1995) who proposes an alternative way to view the Bantu-language expansion, "...the present geographic distribution of Bantu languages is the outcome of **many** complex historical dynamics involving successive dispersals of individual languages over a time span of millennia and involving reversals as well as successes" (Vansina, 1995: 195).

Regardless of the arguments between linguistic scholars about the spread of the Bantu languages, there is a general agreement that the process of language differentiation was from an ancestral proto-Bantu language localised in the region of North-Western Cameroon, and that the spread was in an eastward direction towards the region of the Great Lakes within the last 3 000 to 4 000 years (Guthrie, 1962; Heine, 1973; Ehret, 1982b; Phillipson, 1993).

With all the hypotheses or theories put forward by linguists, one must cautiously be reminded that language cannot be equated to a specific population, nor can it be equated to material culture (Vansina, 1995). Furthermore, as the rate at which languages change is not always constant, absolute dating is <u>not</u> possible (Coupez, 1989).

<u>Genetic Evidence in 'Iron Age' Reconstructions</u>

Recent molecular genetic research, based on the highly mutative mitochondrial DNA (mtDNA) and the non-recombining portion of the Y-chromosome (NRY), have exploited these loci to assess the origins of contemporary population diversity on a world-wide scale (Underhill *et al.*, 2001; Pereira *et al.*, 2001). The mtDNA and the Y-chromosome have been chosen by geneticists looking at human diversity and origins particularly because of their sensitivity to the influences of genetic drift, especially founder effect.

Global large scale population movements dated during geological time periods relevant to the history of anatomically modern humans, including the Holocene, have been mapped out geographically by Underhill *et al.*, (2001: 48, Figures 3a to 3h). From these hypothesised chronological distributions of Y-chromosome mutations and groups, it is evident that large-scale population movements took place in sub-Saharan Africa from around the region of the Grassfields in the north-west towards the south, during the Holocene.

Genetic analyses of diversity to provide information about population migrations have been particularly difficult in Africa because of "...the characteristic demographic phenomena of recurrent migration, population expansion and contraction including bottlenecks, population sub-structure generated by limits on gene flow and more recent admixture effects over a long time depth" (Pereira *et al.*, 2001: 439). However, Pereira and co-workers were able to sequence haplogroups L3b, L3e1a and subsets of L1a and L2a of the mtDNA of contemporary Mozambican populations and reached well-founded conclusions. The haplogroups proved to represent traces left by the expansion of Bantu speakers from the north, as well as a southern influence from the indigenous KhoiSan-speaking populations. An approximate age range of 6 700 +/- 2 100 years BP from the northern affinity (haplogroup subset L2a) is more or less compatible with linguistic and archaeological data on the expansion of Bantu speakers (Pereira *et al.*, 2001).

Using both classical markers and DNA polymorphisms, other studies of human genetic variation have shown that the majority of variation exists among individuals within local populations (Carvalli-Sforza *et al.*, 1994; Spedini *et al.*, 1999; Pereira *et al.*, 2001). In his review of "The History and Geography of Human Genes", Carvalli-Sforza and colleagues were able to demonstrate that Bantu-speaking populations have high intra-population variation and low inter-population variation. This finding was based on the founder effect phenomenon that assumes loss of genetic diversity in relation to large-scale dispersal of populations. The overall homogeneity within sub-Saharan Africa lends support to the hypothesis that Bantu-speaking people could be an outcome of a relatively recent expansion of a small group of people (Vansina, 1995).

Several other molecular studies done in sub-Saharan Africa that use new genetic markers, with the aim of unravelling the dynamics of the expansion of Bantu speakers, include those by Soodyall *et al.* (1996), Jenkins (1982), and Chen *et al.* (1995).

Overall, genetic evidence for a founder effect phenomenon causing homogenisation within Bantu-speakers, as well as differences in some polymorphisms that are likely to be the result of environmental and cultural factors, are all consistent and agree with the archaeological and linguistic data available so far (Nurse *et al.*, 1985; Tobias, 1974; Carvalli-Sforza *et al.*, 1994).

Biological anthropological data and craniometry

The basic principle of natural selection states that phenotype or the physical form of a species reflects both its genetic make-up and the environmental circumstances during its growth (Huxley, 1942; Ridley, 1996). Human beings are not excluded from this basic law of nature. From what seems like a simple phenomenon dawns the complexity of using biological morphology in understanding the present sub-Saharan African population diversity and inferring past evolutionary processes of this region. Because of the paucity of ancient skeletal samples in Africa, especially in Western and Central Africa, historical skeletal populations have been alternatively employed by researchers in Biological Anthropology. But the use of historical populations complicates the process of unravelling past population movements that have been hypothesised for sub-Saharan Africa.

Firstly, there are millions of Bantu-speaking peoples with different economies, living in different environments and undergoing different adaptations, today (Hall & Morris, 1983). Furthermore, modern variation that exists among sub-Saharan Africans has been influenced by additional population movements and growth from all parts of the world and locally, especially during the last five hundred years. For example, there is now little doubt that agricultural groups admixed, to some level, with indigenous hunter-gatherers and pastoralists within the different regions of sub-Saharan Africa (Cavalli-Sforza *et al.*, 1994). In turn, this then obscures the founder effect phenomenon of homogenisation in Bantu-speakers.

Secondly, environmental factors that have most probably played an important role in shaping modern sub-Saharan African populations are not clearly observable. Although various studies have tried to correlate a series of morphological features to climatic parameters, their findings are not completely insightful (Hiernaux, 1963; 1974). Despite all this complexity and difficulty of the biological model, biological anthropologists have used craniometry as a tool to address the consequences of the expansion of Bantu speakers from a biological perspective (Rightmire, 1976; Hiernaux, 1976; Froment, 1992a; 1992b; 1993; 1995 in Ribot, 2002).

According to the craniometric analyses of Froment (1992a; 1992b; 1993; 1995; 1998 in Ribot, 2004), the broad southward cline of sub-Saharan Bantu-speaking groups showing low biological distances between each other and marked differences with KhoiSan could reflect two major micro-evolutionary processes: firstly, a progressive homogenisation due to population admixture through adoption of agriculture; and secondly, a retention of early differentiation through isolation and retention of hunter-gathering. These phenomena related to the changes in subsistence patterns probably occurred during the expansion of Bantu speakers and indirectly shaped the present biological diversity in sub-Saharan Africa. Therefore, Froment's work provided indirect supporting evidence for the expansion of Bantu speakers, as the author noticed no marked differences within the Bantu-speaking populations (Ribot, 2004).

Other studies on craniometric diversity in sub-Saharan population groups include de Villiers' work on "The Skull of the South African Negro: a biometrical approach and morphological study" (1968); Morris (1984) who analysed proto-historic populations from the Northern Cape of South Africa, and Steyn's work (1994) on "An assessment of the health status and physical characteristics of the prehistoric population from Mapungubwe". Although these studies looked at populations from the same geographical area (South Africa), their results are relevant in supporting theories of population movement and admixture.

Using the largest sample of metrical data available so far, Ribot's work on craniometric variation in modern Africans is invaluable to the study of skull morphology as the outcome of a complex process of diversification – the expansion of

Bantu speakers (2002). After analysing 957 skulls with the aid of multivariate analysis (fourteen cranial variables and five for the mandible), Ribot was able to demonstrate that patterns of variation left traces of a homogenisation process due to a common origin resulting from the Bantu-speakers dispersal (Ribot, 2002; 2004). She, however, cautions the interpretation of the craniometric results in relation to the effects of only one historical event as other sources of diversity (geographical barriers, recent population admixtures, nature and size of sample) were more than likely interactive.

Archaeological Evidence for 'Iron Age' Migrations

There is no doubt that large migrations of people took place into central and southern Africa, but that these migrations were the major impetus for any cultural change seen in the archaeological record is too simplistic (Vansina, 1995). Moving away from the simplistic, conservative views and interpretations of 'Iron Age' migrations, archaeologists in southern Africa have come a long way into the stage where 'Iron Age' culture change is currently interpreted. A much more holistic approach showing evidence for a variety of forces interplaying has now been adopted to interpret the prehistoric past of sub-Saharan Africa (Clist, 1991; de Maret, 1982; 1985a, Phillipson, 1995).

Currently, the archaeology of this region has demonstrated that mechanisms such as diffusion of ideas, independent development, regional continuity, as well as migration of peoples were all involved in shaping the prehistoric culture of this region. Furthermore, research now indicates that the relationships between the indigenous hunter-gatherers and the incoming agro-pastoralists were much more complex than previously thought (Vansina, 1995).

In archaeological research, material culture has been the fundamental tool for tracing population movements in southern and central Africa. Ceramics, which are often found in abundance, have played a major role in interpretations of culture change in this region. In conjunction with linguistic data, archaeologists have analysed continuities in ceramic and other material cultural remains, and have postulated models for 'Iron Age' population movements, which they refer to as "streams" (Figure 1.01).

The concept of sedentism has also been closely associated with the expansion of Bantu speakers (Clist, 1991). Therefore, any signs of sedentism since the last 5 000 years, such as semi-permanent living structures, pottery, food production, food-storage facilities, etc., have been investigated by archaeologists. Radiocarbon dates of the archaeological evidence suggest that the dispersal started in West-Central Africa, in the region of Congo/Gabon around 4 000 and 1 000 BC (Mitchell, 2002; Phillipson, 2005). Others, however, have postulated that two centres of origin exist for the dispersal of Proto-Bantu speakers; one in west-central Africa and another in north-east Africa in the region of Kenya and Tanzania. Whatever the case may have been, it is generally accepted that the move (migrations and/or diffusion of ideas) was southwards (Huffman, 1989a; Denbow, 1990; Phillipson, 1995, 2005).
The earliest evidence of occupation by food-producing people in the north-east comes from the western side of Lake Victoria at around 500 BC.

In Figure 1.01, the postulated migration patterns for 'Iron Age' populations and/or ideas are shown for the west and east centres of origin. Based on ceramic typology, the 'Eastern Stream, has been referred to as the Chifumbaze Complex, which first appears in the site of Urewe north of Lake Victoria in Kenya (Mitchell, 2002; Phillipson, 2005). Frequently associated with iron-smelting debris, Urewe ceramics have been discovered in East Africa's Interlacustrine area from around 2 500 BP (Mitchell, 2002). Spreading southwards all the way to Kwa-Zulu Natal/South Africa by the 3rd century AD, sites with Chifumbaze-related ceramic assemblages have been found in eastern, south-central and southern Africa. A broad distinction exists between different sets of assemblages within the Chifumbaze Complex, and two divisions have been identified. The Urewe Tradition, which covers most of eastern, south-central and parts of southern Africa have two further branches: the Kwale branch and the Nkope branch. The Kalundu Tradition, which includes assemblages from Angola through western Zambia, Botswana and Zimbabwe into South Africa, forms the second division of the Chifumbaze Complex (Eastern Stream in Figure 1.01) (Huffman, 1989b; Mitchell, 2002; Phillipson, 2005).

While the Proto-Eastern Bantu speakers moved along the Great Lakes and southwards, the ancestral Western Bantu speakers moved south along the Atlantic coast. Archaeological sites in Gabon and Congo-Brazaville dating 3 000 to 2 300 BP (earlier than in the east) have presented with pottery of a prototype for Western Stream ceramics. From Congo-Kinshasa down to southern Zambia, north-western Botswana and northern Namibia, later facies of the Western Stream ceramics known as the Naviundu Tradition have been found (Huffman, 1989a; Denbow, 1990; Mitchell, 2002). The earliest evidence for iron working in the inland of Gabon appears around 500 BC; while in the Congo, evidence for iron smelting occur by the second and third centuries BC (Clist, 1987; Denbow, 1990).

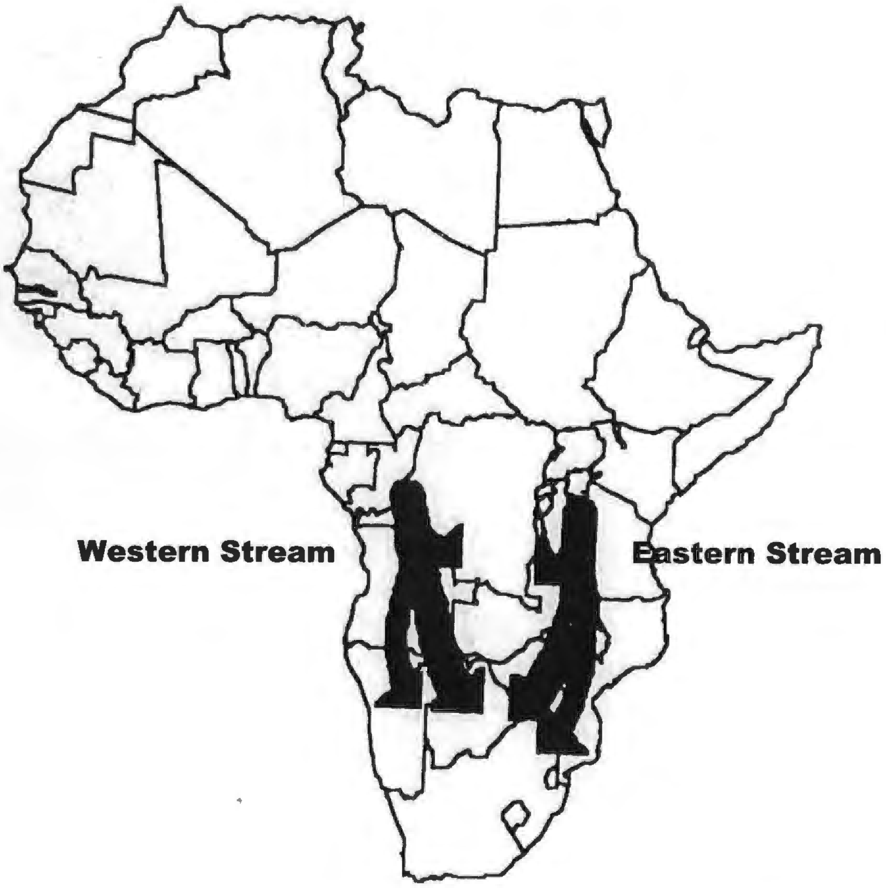


Figure 1.01 Postulated Migration Patterns for 'Iron Age' Populations (adapted from Murphy, 1996)

Another important aspect of the Bantu expansion is the emergence, spread and diversification of various kinds of food production, i.e. horticulture, agriculture and herding. Archaeologically, food production is represented by the presence of floral and faunal remains of domesticated types. Indirect evidence for food production comes from material culture, i.e. artefacts used for the procurement and processing of food. The geographical distribution of vegetal crops and domesticated fauna, which is a reflection of differences in the environments, can be traced archaeologically in Western, Central and Eastern Africa (Cornevin, 1993). Evidence of a type of horticulture as indicated by artefacts such as polished stone tools, grinding stones and palm oil nuts, comes from the forests of West-Central Africa around the first millennium BC. The sites of Obobogo/Cameroon and Okala/Gabon have yielded traces of village compounds with refuse pits, pottery, grinding equipment, animal husbandry and evidence of horticulture at around 1 500 BC (de Maret, 1982; 1985a; Clist, 1987).

It is now clear that no single hypothesis can be used to explain the subsequent evidence of related yet so diverse 'Iron Age' traditions throughout this region. Based on cultural continuity and culture change, the distinctions between the 'Early Iron Age' (500 BC to 1 000AD) and the 'Late Iron Age' (after 1 000AD) have been postulated for the 'Iron Age' period in South Africa. The distinctions, however, have not been accepted by all scholars, since the basis of it is empirical and thus should be treated as arbitrary divisions (Huffman, 1984).

Ethnographic and Ethnohistoric Comparisons with the 'Iron Age'

With its shortcomings and limitations, the use of ethnography has been valuable in interpretation of prehistoric farming culture dynamics and worldview in central and southern Africa (Robertshaw, 1990; Hall, 1986; Huffman, 1982; 1986). As already indicated by linguistics, one of the major distinctions employed in distinguishing Bantu-speaking groups south of the Sahara is that between Eastern and Western Bantu speakers (Vansina, 1995; Nurse & Philippson, 2003, Mitchell, 2002). Differences in economy and ideology between Eastern and Western Bantu-language speaking groups have been intensively explored by ethnographers in sub-Saharan Africa (Huffman, 1990, Phillipson, 1995).

Phillipson (1995) talks about the significant variation between different areas that have been observed by researchers and that "...clear correlations may be seen with the general lifestyle, economy and socio-political system of the inhabitants. People in south-eastern Africa whose lives centre around their herds of cattle, often live in villages where houses, usually round, are arranged around a central byre. In parts of southern *Zaire* (DRC today), on the other hand, the predominantly agricultural people live in rectangular houses set in straight lines beside a street" (Phillipson, 1995: 198). Huffman's (1989b) synopsis has provided the basis for comparison between Eastern and Western Bantu-speaking groups. Below is a list of differences in economy, marriage patterns and ideology found between Eastern and Western Bantu speakers, south of the Sahara.

Western Bantu	**Eastern Bantu**
- matrilineal descent	patrilineal descent
- arranged marriages by service	arranged marriages by payment
- few if any own cattle	cattle form major part of economy
- currency: metal, copper crosses	currency: cattle
- agriculturalists	pastoralists

Figure 1.02 shows the distribution of various rules of descent (and cattle and/or milk-based economies) within the African continent (Murdock, 1959).

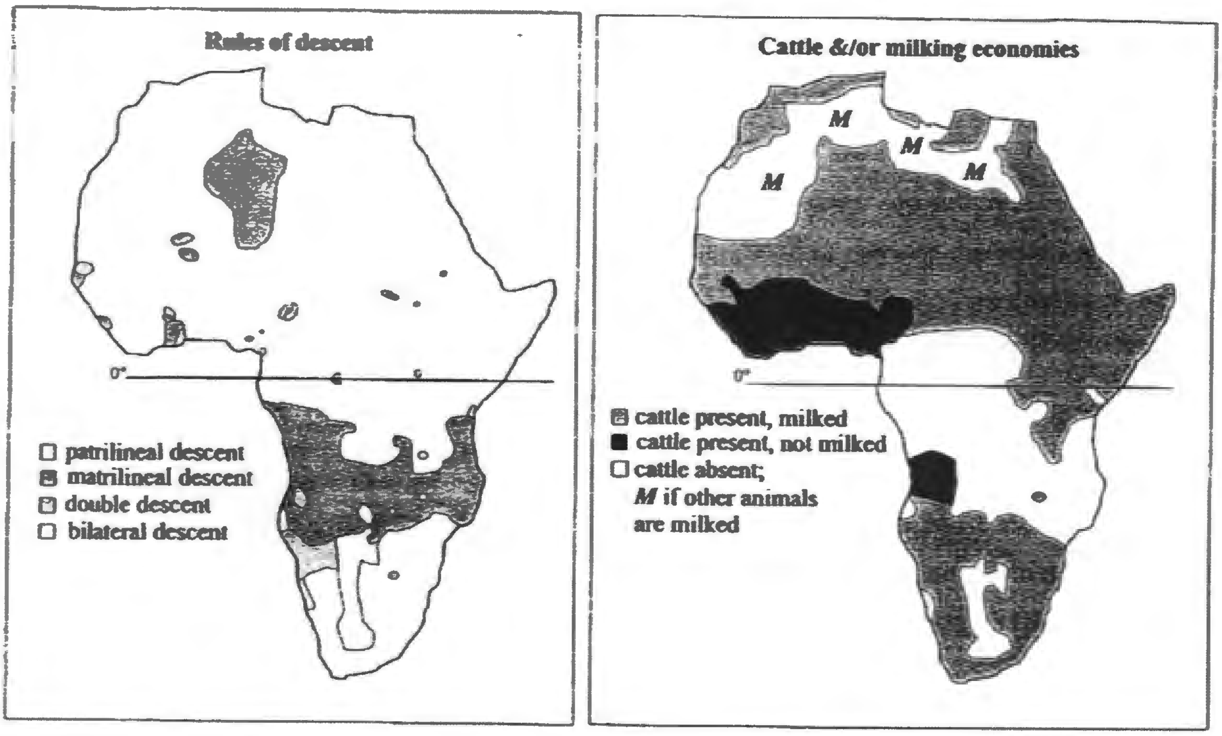


Figure 1.02 Comparison of the distribution of the various lines of descent and cattle and/or milk-based economies within Africa (after Murdock, 1959)

The connection between spatial organisation and other forms of material culture that reflect the social structure, ritual and political dynamics mentioned above, can be seen in the different settlement patterns of the two Bantu-speaking groups.

BANTU SETTLEMENT PATTERNS (after Huffman, 1989b)

Western Bantu	**Eastern Bantu**
- rectangular houses	circular houses
- houses in rows or rectangles	houses in circle around cattle kraal
- extended burials in cemeteries outside settlement	flexed burials, sometimes division of sexes; males in kraal area, females around settlement area
- elaborate grave goods: iron gongs, ceremonial axes, copper crosses, beads, bark cloth	ox hides, pottery, beads
- sedentary	some degree of mobility

Utilising the ethnographic data presented above, archaeologists have compared the material culture remains and settlement patterns from ‘Iron Age’ sites in central and southern Africa, to illuminate the prehistoric past of early farming communities (Evers, 1984; Huffman, 1989a; 1989b; de Maret, 1985b; Denbow, 1990).

On the archaeological ground, some sites in central and southern Africa exhibit some aspects of economy, material culture and settlement patterns of historic and/or present-day Eastern Bantu-speakers; while other sites share a greater affinity with the characteristics of contemporary Western Bantu-speaking peoples (Kuper, 1982; Denbow, 1984; Huffman, 1989a; 1989b). Regional variability as well as independent development is also observable in some archaeological sites in this region, especially those belonging to the later centuries of the ‘Iron Age’. Juxtaposition of the Eastern and Western Bantu patterns of culture has also been identified on ‘Iron Age’ sites in southern Africa.

The patterns outlined above have been used to support arguments of cultural continuity that is presumably associated with population movements.

Isotope studies in reconstructing 'Iron Age' diets/subsistence

The popular phrase "You are what you eat" has been questioned, debated and tested by many parties in all fields: from biological anthropologists/archaeologists to physicians to dieticians and even ordinary people interested in their culinary habits or cultures. Food or nutrition is one of the most essential requisites for any individual's survival, growth and development. Influenced by a number of factors such as the environment or ecology and culture dynamics, diet also has profound effects on the general health status and/or disease processes that any individual at any given time in space is subjected to.

Because of this intimate relationship between diet and health, it was important to determine the dietary components of the early farming populations under study, in order to compile a more comprehensive picture of the health status of these peoples. To complicate the picture a little, archaeological remains from early 'Iron Age' sites indicate evidence for a variety of subsistence strategies including farming, herding and/or foraging, but the actual contributions of any one of these economies is still unclear. For example, some of the distinctions often made based on evidence from archaeology and ethnography are those between Western and Eastern African groups (de Maret, 1982; 1985a; Fagan *et al.*, 1969; Inskeep, 1978; Mitchell, 2002; Phillipson, 1995; 2005). Groups migrating from West Africa were thought to rely on wild fauna, including marine and riverine resources, as well as gathered and cultivated tubers and legumes. Eastern groups, on the other hand, relied on domesticated livestock (sheep, goat and cattle), and cereal crops and to some degree, wild resources were exploited (Stahl, 1984; Phillipson, 1995).

So, how do we go about reconstructing actual dietary components of past peoples? The use of stable isotope analysis in archaeological human skeletal remains has greatly enhanced our ability to characterise past human diets on a more direct individual level, relative to the general, group-oriented evidence provided by archaeological material remains (Ambrose, 1993; Larsen, 1997; 2002).

In this dissertation, the data from stable isotope studies were used to fully understand the effects of dietary behaviour and nutritional ecology on the health of early farming populations from central and southern Africa. For more detailed reviews on stable isotope ratios or signatures, see Craig (1957); Hoefs (1987); van der Merwe and Vogel (1989); Hatch *et al.* (1967) and others. Stable isotope research in east, central and southern Africa has taken a tall stand in providing information about prehistoric subsistence of peoples in this region. Studies such as those by Ambrose (1986); Sealy (1986); Sealy and van der Merwe (1988); Lee-Thorp and co-workers (1993) and many others, have contributed a vast amount of information on diets of many different prehistoric populations in sub-Saharan Africa. Ambrose (1986) showed that there was a very close match between the archaeologically and ethnographically interpreted diets and the diets indicated from the stable isotope analysis.

Attempting to prove or disprove the prehistoric diet of populations from the south-western Cape, Sealy and van der Merwe carried out a study whose results indicated two periods of subsistence during the Holocene. During 3000 – 2000 BP, $\delta^{13}C$ values indicated a marine based diet, and after 2000 BP isotopic evidence indicated a mixed diet of terrestrial and marine resources (Sealy and van der Merwe, 1988).

Some of the relatively recent work done on archaeological human skeletal remains from 'Iron Age' contexts in southern Africa, includes reviews like Lee-Thorp and colleagues' "Isotopic evidence for diets of prehistoric farmers in South Africa" (1993) and Murphy's "(The) Skeletal elements of the Iron Age in central and southern Africa: a bioarchaeological approach to the reconstruction of prehistoric subsistence" (1996). In general, the results of these studies were similar or perhaps comparable. In South Africa, for example, there was a wide variety of $\delta^{13}C$ and $\delta^{15}N$ values that reflected adaptations to local environments by 'Iron Age' farmers (Lee-Thorp *et al.*, 1993).

Material from Botswana and Zambia shows slightly different patterns for the early farming and herding peoples in these regions (Murphy, 1996). To summarise the evidence from stable isotope analyses from these regions, Murphy concludes that "...The stable isotope values from all the sites indicated a heavy reliance on C_4 sources. The most likely candidates for these sources being domesticated cereals such as sorghum and millet. Protein sources for the various sites were either dominated by C_3 sources (domestic or wild plants, browsing animals) or were a combination of C_3 and C_4 sources. While no sites had evidence of specialised pastoral adaptations, some sites (Kgaswe and Taukome, in Botswana) had a heavier reliance on animal products than others (Isamu Pati, Simbusenga, Ingombe Ilede, in Zambia)" (Murphy, 1996: ix).

Research Focus

Given the information presented above from archaeological and stable isotope analyses, two major distinctions of subsistence economy are discernable. Groups with a heavy reliance on agriculture who are mainly distributed along the African tropics and West Africa, and groups referred to as pastoralists or herders with an emphasis on domesticated animals. The latter are mainly found in savanna environments of east and southern Africa. However, population groups with a combination of agriculture and herding contributing to the diet are also commonly found. Such groups of people are often referred to as agro-pastoralists or as having a mixed economy.

The above-mentioned distinctions of agriculturalists, pastoralists and/or agro-pastoralists have also been analysed for variations in health and disease prevalence. Research results on living populations in southern and central Africa has shown a tendency for lower dental caries frequencies and lower parasite burdens on pastoral people, but with an increased risk of exposure to zoonotic diseases (Morris, 1984; 1992b; Peckmann, 2002). On the contrary, agriculturalists tend to have higher parasite loads and infectious diseases, and a rise in caries rates mainly as a result of their subsistence strategy, as well as their lifestyle (Steyn, 1994; Murphy, 1996; Mosothwane, 2003).

Studies of living populations show that under circumstances of increased population size and overcrowding, conditions that are conducive to the maintenance and spread of infectious diseases are established (Larsen, 1997; Lewis, 2002).
In terms of nutrition, the adoption of an agricultural way of life meant a narrowing of diet, often involving reduced availability of animal protein in combination with an increased reliance on a limited number of domesticated plants, which when served as a primary part of diet offer a poor nutritional base. The result is a tendency for high levels of iron-deficiency anaemia and slower growth rates in children (Larsen, 1997; 1998; Cohen & Armelagos, 1984; Stuart-Macadam & Kent, 1992).

These reviews on the differences in subsistence strategies and their related health 'patterns' are mainly based around ecological influence. So, does this mean that any differences in health and disease patterns found among sub-Saharan African populations living in different ecological zones are a result of their subsistence or economic influence? Or are other factors, such as cultural dynamics, also involved? How can we then determine which factors are involved in influencing the general health status of early farming societies?

Variations in health and diet based on the different subsistence strategies of living hunter-gatherers, agricultural, and pastoral populations provide the basis for the exploration of similar differences in the prehistoric skeletal material from southern Africa. Palaeopathology can look at a combination of environmental and socio-cultural influences associated with subsistence strategies. Therefore, this study uses palaeopathological approaches to explore the relationship between health, diet and/or behaviour and (the role of) the environment. The **central objectives** of this study are:

1. To attempt to generate information about the health and disease patterns of early farming populations in central and southern Africa,
2. To examine the health and disease patterns between populations in different environments or ecological zones (in relation to subsistence strategy),
3. To assess the health and disease patterns between males and females within and between different ecological zones (in relation to differential access to food and other resources that could be a result of socio-cultural influences),
4. To explore differences and similarities in health and disease patterns through time (i.e. 'Early' versus 'Late' Iron age), and
5. To evaluate the impact of stress, if present, on the skeletal growth of these people.

This project examines non-specific physiological stress markers in order to provide some insights into the health and disease patterns of early farming communities in central and southern Africa. The non-specific stress indicators that are observed on the skeletal remains include cribra orbitalia and/or porotic hyperostosis, Harris lines or growth arrest lines, linear enamel hypoplasia and sub-periosteal bone lesions. Dental condition and pathology is also examined, as they relate to diet and general oral hygiene. These include occlusal attrition, antemortem tooth loss, dental caries, periodontitis, and dental abscesses. Definitions of stress, as well as osteological techniques used to identify stress, are given in Chapter 2 of this dissertation.

In this study, I make use of skeletal populations from various sites in the Democratic Republic of Congo (Sanga and Katoto); Zambia (Ingombe Ilede) and various 'Iron Age' sites around South Africa (e.g. K2 and Mapungubwe), to 'predict' the health and disease patterns of sub-Saharan Africans during the 'Iron Age'. This is done in order to contribute to the knowledge of pre-colonial peoples of central and southern Africa, so that we may understand the present in terms of the past.

Dissertation Format

This dissertation consists of seven chapters that are presented as a series of steps, each providing specific material that will ultimately meet the aims of this study. In Chapter 1, I have provided the background information on the 'Iron Age' of central and southern Africa through the exploration of linguistic, genetic, biological, archaeological as well as ethnographic evidence of the expansion of Bantu speakers. Data from stable isotope studies were employed for the reconstruction of 'Iron Age' diets. The objectives of the current research study were also brought forward.
Chapter 2 defines what is meant by stress and the use of osteological techniques in the reconstruction of health and disease patterns of past peoples.
In Chapter 3, a review of the geography, climate, flora and fauna of the research area during the Holocene and today, is explored in order to provide background on the landscape of the early farming societies under study. Then each archaeological site from the research area is described so as to highlight differences of microclimates that could exist at each site. Chapter 4 deals with the general methodology applicable to the skeletal remains, such as the selection criteria, and the estimation of sex and age of the individuals; after which a description and identification of each stress marker as well as how it was recorded is provided.

The results of the pathological conditions, with some statistical test results, are analysed and their frequencies and patterns are presented in Chapter 5. In Chapter 6, after posing some questions, answers are discussed in terms of the issues generated by the data. The results or findings of this study are then compared with data from other studies in the research area and relevant neighbouring areas. Chapter 7 synthesises the overall information gathered from the palaeopathological evidence about the health status of early farming populations from central and southern Africa.

Chapter 2: LITERATURE REVIEW ON STRESS

According to the Oxford Reference Dictionary (1986), stress is defined as a demand in physical and mental strength. Other definitions of stress suggest that it is a response to a stressor of physical, chemical or emotional nature, in which the existence and well-being of an organism is challenged or threatened (Yehuda & Mostofsky, 2006). But what is the relevance and effect of stress in our lives and on our health? Stress usually has a negative impact on health. When prolonged or recurring, stress may lead to diseases by disrupting metabolic homeostasis as well as compromising the body's immune system (Chiras, 2002). For example, people under a lot of stress are twice as likely to suffer from colds and flu as those who are not. The duration of stress or the stressor and our ability to cope with it, must therefore be taken into consideration when pondering the effects of stress. Elevated stress has functional consequences as it may impede on our work capacity through physical or cognitive impairment. Basically, stress causes a lot of suffering and reduces the quality of life of an individual and the community in which he belongs (Russell, 1988).

It is now apparent that there is a connection between stress and health, whether the stress is of a physical, environmental, social or psychological nature (Chiras, 2002). To accept the idea of stress as an important aspect of health is to embrace a holistic concept of health issues. Stress-health connections are fascinating because the idea of a linkage between mental and emotional factors and physical health touches on questions about how the mind and body relate. Recognition of the role of psychological and behavioural factors in the genesis and management of disease has greatly contributed to the understanding of disease in clinical settings (Russell, 1988). But because it is not possible to measure stress levels and/or stressors in archaeological populations, reliance on the consequences of stress, such as disease outcome, provides the palaeopathologist an opportunity to learn about stress experienced in the past (Ortner & Aufderheide, 1991).

In so far as stress is concerned, therefore, it is clear that its definition and interpretation is primarily guided by the choice of question under investigation. In palaeopathology, stress can thus be defined as any physiological disturbance that results in physical change in the anatomy; the causes of which can rarely be known (Larsen, 1997; Cohen & Armelagos, 1984; Goodman, *et al.*, 1984). Because of this

narrow scope in our definition and ability to assess stress in past populations, the duration of stress is of great importance. Diseases often result from long-term or chronic stress, which may elicit an anatomical change.
It is this manifestation of stress on human tissues that remain the main focus of palaeopathological research. Indicators of chronic stress in osteology; include sub-periosteal bone lesions, porotic hyperostosis, slow growth rates, retarded growth and so on. Acute stressors can also elicit anatomical manifestations, but these are few and rare. For acute stressors to affect the anatomy, they have to be so severe as to compromise normal routines in order to mobilise all energies and resources to survive or cope with the stress (Angel, 1981). This is done on the expense of other vital processes like growth and development. Growth arrest lines, also known as Harris lines, and linear enamel hypoplasias are examples of acute stressors indicative of an arrest of growth during developmental years.

Moreover, because palaeopathology relies on skeletal remains as a tool in the understanding of disease and health, reconstruction of circumstances that created the biological response become vital. The environment is an emphasised aspect of most of these circumstances as it plays such an important influential role on health. Also, we recognise that individuals and societies in different or similar environmental settings are differentially affected by stress. To discover the mechanisms by which these differences occur stress has been understood to be a product of three key factors that include 1) environmental constraints; 2) cultural systems; and 3) host resistance (Cohen & Armelagos, 1984; Larsen, 1997). Other conditioning factors include genetic predispositions, age, sex, past experiences, dietary factors and climate, all of which render individuals differentially susceptible to stress (Yehuda & Mostofsky, 2006).

The model proposed by Cohen and Armelagos (1984) “emphasises the environment in providing both the resources necessary for survival and the stressors that may affect the health of the population” (Larsen, 1997: 6). For example, low-lying valley habitats can provide the best water sources, fertile land, vegetation and other resources that enhance the standard of living; at the same time these habitats may provide prime environments for the survival and spread of disease vectors like anophelines (malaria) that affect the health of people living in them. Cultural systems may also serve as protective buffers or even magnify existing stresses or produce new ones. Cranial

deformations practiced by certain native groups in North and South America (for example, the Tiwanaku cultural group) may lead to necrosis, synostosis of anatomical tissues, and even cause death (Aufderheide & Rodriguez-Martin, 1998). In these instances, stress is created by these communities purely on the basis of appearance.
In terms of culture changes in subsistence systems, the intensification of agriculture allowed for a greater population density while causing lower quality diets and amplifying interpersonal strife as access to quality nutrients was getting limited (Cohen & Armelagos, 1984).

The role played by the individual's ability to resist or cope with stress is significant when both environmental constraints and cultural systems are insufficient to buffer stress. Host resistance is influenced by age and sex of an individual, as well as his genetic predisposition (Cohen & Armelagos, 1984). For example, one of the clearest interactions between the environment, disease and host resistance relates anophelines, malaria and abnormal haemoglobins. In certain areas infested by endemic malaria, individuals with the sickle-cell gene, have a protective benefit of not getting affected by this disease (Angel, 1981; Jenkins, 1977; Stuart-Macadam & Kent, 1992).
Age-related differences for host resistance are usually highlighted by the fact that children are more vulnerable to stress (such as malnutrition and infectious disease) than other age groups because of their low immunity (Mensforth, *et al.*, 1978).

Ideally, if environmental constraints and host resistance were to remain unchanged; cultural differences may therefore be related to variation in stress levels (Cohen & Armelagos, 1984). A good example of this scenario would be the spread and maintenance of HIV and AIDS in modern-day populations. In the South African context, for instance, assuming that the environmental constraints and host resistance are constant, the one thing that seems to be perpetuating this pandemic in the different population groups is their different cultures. In this situation, some groups would be buffered by their cultural inclinations and others would be more at risk of getting stress and disease (http://portal.unesco.org/culture; http://www.health24.com).
Inevitably, it is this difference and variation in cultures that drives research in palaeopathology because our primary goal is human health.
It is important to mention that stress cannot be directly measured in skeletal remains. So, how can we assess health that is related to stress experienced by a society, if we

cannot measure stress? However, since stress does leave a series of indicators in bone and teeth, to a limited degree it is possible to assess stress and health of skeletal populations.

Anatomical indicators of stress may be specific or non-specific. Specific stress indicators are those that can be associated with a known pathogenesis and aetiology of the disease. Diseases such as tuberculosis, some treponemal syndromes and leprosy, to mention a few, tend to leave specific lesions on the skeleton that can be linked to the pathogenesis of the disease, i.e. the parts of the body that are involved. Other systemic physiological disruptions such as chronic malnutrition or infectious disease usually leave non-specific lesions on the skeleton. Thus, non-specific stress markers are difficult to diagnose as the stimulant of the physiological disruption is assumed (Buikstra & Cook, 1980; Larsen, 1997, 2002).

Our goal as stress-health researchers is to be able to 'read' and interpret these indicators of stress; to be able to make meaning of them. So, we ask questions like: does evidence of disease in archaeological bone tissue indicate that the individual or population had poor health during life or perhaps indicating inadequacy to adapt to their environments? Is it possible that the very presence of stress is an indication of the individual's attempt to survive or adapt to their environment? These and many more questions are of critical importance in the interpretation of palaeopathological data and the subsequent inferences drawn for the individual or population under consideration (Aufderheide & Rodriguez-Martin, 1998; Ortner & Aufderheide, 1991; Wood *et al.*, 1992).

To maximise our ability to reconstruct health and disease patterns in skeletal populations, we often employ multiple indicators of stress. The use of multiple indicators of stress allows us to examine several levels of information concerning prehistoric health. Macroscopic observations, which remain the core of palaeopathological analyses, provide us with indicators of gross disease manifestations that can be seen with the naked eye. Advances in radiological, chemical and microscopic techniques allow us the opportunity to confirm macroscopic indicators of disease and even detect disease processes that normally could not be observed with the naked eye (Cohen & Armelagos, 1984; Ortner & Aufderheide, 1991).

In recognising the limitations in the use of osteological remains and techniques, palaeopathologists reconcile their findings with evidence from other disciplines. Where possible, cultural, botanical, ecological, genetic, medical, written and ethnographic evidence is used in conjunction with palaeopathological data. The powerful integration of health indicators and information from other disciplines provides a more complete picture of past human health and behaviour.

Of utmost importance is the interpretation of our data. What does the output indicate; what does it mean? (Wood *et al.*, 1992). As already mentioned, disease that produces in human tissues an anatomical pathological change large enough to be detected macroscopically, are principal to the investigation of disease in antiquity. When dealing with interpretation of palaeopathological data, knowledge and understanding of the nature, transmission and epidemiology of disease become increasingly important. This is also the area in which time and space dimensions of disease play a very vital role (Aufderheide & Rodriguez-Martin, 1998; Ortner & Aufderheide, 1991). Thus, joining forces with medical and anthropological knowledge, brings not only complimentary skills together, but also equip the researcher with a tool for interpreting anatomical lesions as well as identifying their cause. Medical knowledge of disease also enables us to appreciate the variation in severity, morphology and frequency that characterise palaeopathological lesions (Aufderheide & Rodriguez-Martin, 1998).

The intriguing complex relationship between iron metabolism, anaemia and disease offers a good example of how medical and anthropological knowledge compliment each other. In the palaeopathological record, the lesions known as cribra orbitalia and porotic hyperostosis have been commonly found in skeletal populations world-wide. Their presence and meaning have puzzled many scholars in this field and other disciplines. Towards the mid 20th century, these lesions have been found to be associated with iron-deficiency anaemia (Angel, 1981; Henschen, 1961; Stuart-Macadam & Kent, 1992; and many others).

Iron-deficiency anaemia, however, could be a result of many maladies, ranging from insufficient iron supply and absorption to chronic infectious disease. It is only since the late twentieth century, however, that physicians and biological anthropologists have explained the prevalence of anaemia in different populations in terms of iron metabolism, disease prevalence and the body's defence system (See Wardsworth, 1992; Arthur & Isbister, 1987; Stuart-Macadam & Kent, 1992; Kent *et al.*, 1990; Cook, 1990). It was this knowledge and understanding that led to a more comprehensive understanding of the variation and prevalence of this lesion in different populations. We now know that presence of anaemia in past populations, as indicated by the skeletal lesions known as cribra orbitalia and porotic hyperostosis could mean any of the following:

1) Either that the dietary iron supply and absorption was inadequate; or that
2) The chronic state of infectious disease present in the environment was involved in lowering iron levels; or that
3) Genetic anaemias were an important issue in the lives of the individuals under consideration.

It is also not unlikely that all of the above scenarios were active at the same time in causing a low iron status in individuals affected (Stuart-Macadam & Kent, 1992).

Still in the context of anaemia, the variation in severity of the lesions has been explained in the light of the progressive state of the condition causing the anaemia (Stuart-Macadam & Kent, 1992). Without the collaborative work of these authors and physicians, none of this information could have been gleaned from the skeleton alone. It is emphasised once again that all these observations and interpretations are best understood in the wider socio-cultural and environmental contexts of the individual or society.

Furthermore, evidence to support or disprove the proposed cause of one stress marker can be obtained from the correlation of that particular stress indicator with other indicators of stress. For example, supporting evidence for the proposed prevalence of infectious disease leading to high incidences of porotic hyperostosis may come from sub-periosteal bone lesions and even low growth rates (Larsen, 1997).

With all this said, shortcomings are a reality in the interpretation of palaeopathological data because the 'answer' is never straightforward. There is almost always an alternative explanation or inference; especially since we can never truly know how things really were in the past. The complex nature of things and human behaviour must never be underestimated. Thus, to exercise caution when interpreting data is the first step in setting standards for our research. The search and compilation of a list of alternative explanations is of equal importance, because the majority of our work has an empirical basis. We cannot overstate the importance of valid and reliable comparisons within and between studies (Wood *et al.*, 1992).

The association of Harris lines and linear enamel hypoplasias and disruption of growth is clear; but their presence versus their absence in an individual is not. For example, does their absence indicate an individual or population free from hardship of this nature? Is it indicative of differences in host resistance at such an early age? What about sex-related issues: young boys versus young girls?

As Buikstra and Cook (1980) write: "Our best strategy lies in a) developing appropriate disease models based in recent disease experience; b) careful observation of abnormal processes in bone; and c) detailed comparison of data with predictions from our model" (Angel, 1981: 512).

A recent study done at the Institute of Anatomy, Berlin (Germany), which investigated the possibilities of computed tomography for visualising cribra orbitalia could indeed provide a model for interpreting and confirming this lesion in skeletal populations (Exner *et al.*, 2004).

Currently, our goal is to strengthen these collaborations with clinical research in the hope of strengthening the variation and interpretation of health in past populations.

Chapter 3: MATERIALS

a) Research area: Geography, Climate, Flora and Fauna

In order to explore the biological effects of behaviour and economy on health, it is necessary to review the geography, climate, flora and fauna of the landscape of early farmers.

The skeletal material utilised in this research comes from three countries within the regions of central and southern Africa: the southeastern Democratic Republic of Congo (DRC) (often categorised as central Africa), Zambia and South Africa (southern Africa) (Figure 3.01). Within the research area there is only one rainy season, usually between the months of September and April (White, 1983). Because climate is an interaction of a variety of features, such as temperature, rainfall, solar radiation and altitude, biogeographers and ecologists commonly describe climates using classification systems (Schulze & McGee, 1978). One of the most commonly used systems is Koppen's classification of world climates based on the relationship between precipitation and evapotranspiration. Using Koppen's system, there are three climate zones for the tropical region of Africa: arid, savanna and rainforest. The current research area falls within the savanna climate zone (Delany & Happold, 1979). Savanna climates range from moist (900-1600mm annual rainfall) in the latitudes closer to the equator, to dry (300-900 annual rainfall) in the southern African latitudes.

White (1983) and Werger (1978) have subdivided Africa into regions based on floristic communities. All of the archaeological sites studied in this dissertation belong to the same phytochorological subdivision – the Zambezian domain. Zambezian vegetation ranges from miombo (dry deciduous woodland) or savanna woodland in the wetter regions to savanna grassland in the drier areas.

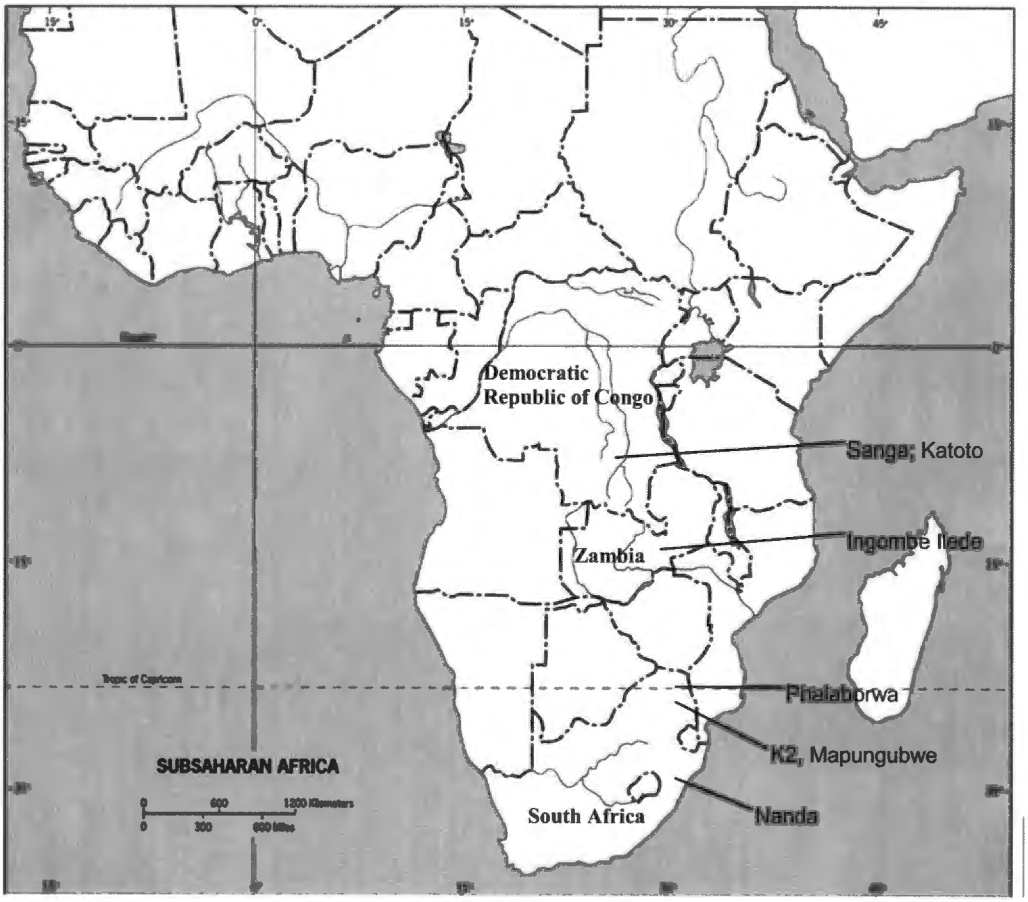


Figure 3.01 Map distribution of major sites in research area

There are a wide variety of edible plants, both wild and domesticated, available in the Zambezian region. Researchers on the prehistory of domesticates in sub-Saharan Africa have often associated "crop complexes" with particular geographic regions (Stahl, 1984). For example, cereal crops such as sorghum and millet are often associated with East Africa, and forest crops like sweet potatoes, palm nuts and bananas are components of West African agriculture (Stahl, 1984). These crops are related to environment, and in south-central Africa areas with higher rainfall (DRC, Zambia) have more cultivated forest crops and those with less rainfall (South Africa) more cereal crops. Commonly grown domesticates in south-central Africa can be seen in Table 3.02 and edible wild plants are listed in Table 3.01.

As with both climate and vegetation, the fauna of the research area also falls into one region – the Aethiopian zoogeographical region (Delany & Happold, 1979; Werger, 1978). Delany & Happold (1979) looked at the distribution of mammals in the savanna regions of Africa and found twice as many species in the wetter savanna region (800-1000mm annual rainfall) than in the drier savanna (350-400mm annual rainfall). This is in part due to the loss of vertical habitats more common in moister areas, so there are fewer primate species in dry savanna, for example. Loss of dense tree cover, however, leads to more grass cover and shrubs, which in turn accommodate diverse populations of hoofed mammals (Delany & Happold, 1979). A list of mammals common to the research area can be found in Table 3.03.

A variety of domesticates are common to south-central Africa, including cattle, goats, sheep and dogs (Table 3.04). Cattle herding requires an environment with the appropriate temperature, rainfall and vegetation. As Smith points out in his discussion of pastoralism in Africa:

> "In Africa the main pastoral production areas are related to rainfall, vegetation cover and various diseases, as well as the distribution of tsetse flies, which are vectors of trypanosomiasis, fatal to cattle and small stock. This means that the upper limits of rainfall in these areas would be between 500 and 700mm, since this is the minimum precipitation needed to support tsetse, and the lower limits around 100mm depending on the local conditions" (1992: 128).

Tsetse flies live in shaded, moist and warm regions throughout Africa and are hinderance to any serious cattle keeping in areas of infestation (Smith, 1992; White, 1984). Tsetse infestation is commonly associated, for example with savanna woodland in the wetter regions and can be found throughout most of DRC and in parts of Zambia (Smith, 1992). While tsetse can be detrimental to livestock, it does not affect wild animals. This is because the local fauna have built up a resistance to the parasite through evolution (Smith, 1992). So, hunting is still possible in tsetse-infested regions.

Rainfall is an important factor for both agriculture and pastoralism. Pastoral activities usually occur in regions with yearly rainfall between 100-700mm (Smith, 1992), while agriculture occurs in areas with rainfall between 200-800mm (Mace, 1992). Mace (1992) believes that the combination of pastoralism agriculture helps to maximise production within a society.

The location of sites is also an important factor in the success of agriculture or pastoralism. For, example, areas with abundant grasslands may actually not support herds due to the nature of grass and/or soil nutrients. Pastoralism is not common in the DRC due to the higher rainfall and prevalence of tsetse. The only regions where herding is viable in Zambia are within Barotseland, Central and Southern Provinces (Smith, 1992).

Table 3.01 Edible Wild Plants Common to Research Area*

Scientific Name	**Common Name**
Vegetable relishes	
Aloe zebrina	
Amaranthus thunbergii	
Cucumis anguria	
Fruits & Nuts	
Azanza garckeana	
Berchemia discolor	
Cucumis anguria	
Diospyros kirki	
Grewia flavescens	
Rhus spp.	
Sclerocarya caffra	Mungongo nut/fruit
Vanguera infausta	
Ziziphus abyssinica	
Anisophylea sp.	Wild Plums
Uapaka kirkiana	Loquots
Parinarium mobola	Mpundu Fruit
Tubers	
Ceropegia tentaculata	
Commiphora Africana	
Ipomoea shirambensis	

*Based on Denbow (1983)

Table 3.02 Cultivated Plants Common to Research Area*

Scientific Name	Common Name
Cereals	
Sorghum spp.	Sorghum
Eleusine corecana	Finger Millet
Pennisetum typhoideum	Bulrush Millet
Tubers	
Ipomoea batatas	Sweet Potatoes
Coleus esculentus	Livingstone Potatoes
Manihot utilissima	Cassava
Pulses	
Arachis hypogaea	Ground-nuts
Phaseolus spp.	Beans
Voandzeia subterranean	Ground-beans
Vigna unquiculata	Cow-peas
Curcurbits	
Cucurbita spp.	Pumpkins
Citrullus vulgaris	Cattle Melon/Watermelon
Lagenaria sp.	Edible gourds
Cucumis sativus	Cucumbers
Relish Plants	
Hibiscus esculentus	Okra
Sesame orientale	Sesame
Gynandropsis gynandra	Spinach
Fruits	
Carica papaya	Pawpaw
Musa sapientium	Banana
Mangifera indica	Mango

*Based on Denbow (1983)

Table 3.03 Wild Fauna Common to Research Area*

Scientific Name	Common Name
BOVIDAE	
Aepyceros malampus	Impala
Sylvicapra grimmia	Duiker
Raphiceros sharpie	Steenbuck
Tragelaphus strepsiceros	Kudu
Synceros caffer	Buffalo
Taurotragos oryx	Eland
Kobus ellipsiprymnus	Waterbuck
Cephalophus monticola	Blue Duiker
Oreotragus	Klipspringer
Redunca sp.	Common Reedbuck
Tragelapus scriptus	Bushbuck
Alcelaphus buselaphus	Hartebeest
GIRAFFIDAE	
Giraffe camelopardalis	Giraffe
SUIDAE	
Potamochoerus porcus	Bush Pig
Phacochoerus aethiopicus	Warthog
HIPPOPOTAMIDAE	
Hippopotamus amphibious	Hippopotamus
EQUIDAE	
Equus burchelli	Zebra
RHINOCEROTIDAE	
Diceros bicornis	Rhinoceros
ELEPHANTIDAE	
Loxodonta africana	Elephant
HYSTRICIDAE	
Hystrix sp.	Porcupine
MANIDAE	
Manis sp.	Pangolin
THRYNOMYIDAE	
Thrynomys swibderianus	Cane Rat
LEPORIDAE	
Lepus sp.	Hare
PEDETIDAE	
Pedetes capensis	Spring Hare
MUSTELIDAE	
Ictonyx sp.	Polecat
HERPESTIDAE	
Herpestes sp.	Mongoose

Table 3.03 Wild Fauna Common to Research Area* - Continued

Scientific Name	Common Name
MURIDAE	
Rattus	House rat
Saccostomus campestris	Pouched rat
Cricetomys gambianus	Giant rat
FELIDAE	
Acinonyx jubatus	Cheetah
Pathera pardus	Leopard
Panthera leo	Lion
HYAENIDAE	
Crocuta sp.	Hyaena
CANIDAE	
Lycaon pictus	Wild Dog
CERCOPITHECINAE	
Papio cynocephalus	Baboon
Cercopithecus sp.	Vervet monkey
AVES	
Francolinus sp.	Francolin
Numida meleagris	Guinea fowl
REPTILIA	
Crocodiles niloticus	Crocodile
Testudo sp.	Tortoise

***Based on Delany & Happold (1979) and Smith (1983)**

Table 3.04 Domestic Fauna Common to Research Area*

Scientific Name	**Common Name**
Bos taurus	Cow
Capra hirca	Goat
Ovis aries	Sheep
Gallus	Domestic Fowl
Canis familiaris palustris	Domestic Dog

*Based on Denbow (1983)

SITE SPECIFICS

The general overview of climate, flora and fauna given above illustrates the basic environmental similarities for the research area. There are however, variations between sites when the details of microclimates are compared. The following section looks at the regions surrounding each site and summarises the associated geography, climate, flora and fauna. The sites in South Africa are, however, not individually discussed since many of them have been described and published in archaeological reports (See Appendix for References). A broader overview of 'Iron Age' archaeology in South Africa is provided.

Geography

The archaeological sites of Sanga, Katoto, Kikulu and Mulemba-Nkulu run along the Upper Lualaba River in the Upemba depression (altitude 545m) within the Shaba Province in Southeast DRC. All along the river's course are satellite lakes surrounded by marshy grasslands.

Sanga is on the north side of the lake, at 8°10'45"S and 26°29'25"E (de Maret, 1985a). The site of Ingombe Ilede, in the Southern Province in Zambia, is about 200 km north of the Zambezi River, on currently infertile soils. The site is very near the confluence of the Lusitu River with the Zambezi River at the latitude of 16°12'S and longitude of 28°48'E. This region is known as the Middle Zambezi River valley and the altitude of the site is only about 450m above sea level (Fagan *et al.*, 1969)

Climate Today

As discussed earlier, the sites within the research area fall under the same climate classification, but there is a gradient of wetter tropics to the north moving towards drier conditions in the south. Within this region, there is only one rainy season that occurs during the summer months. The Upemba depression of the DRC experiences a summer rainy season running from October through April with an average of 1243.5mm of rain per year. Winters are cool and dry, temperatures during the coldest months of May to August range from 16.8° to 19.3°C. The average daytime temperature in June is approximately 29°C and in October it is 35°C (de Maret, 1985a)

In the valley near the site of Ingombe Ilede, annual rainfall is between 400-600mm, the mean maximum temperature in October is 31°C and the mean minimum temperature for June is 11°C (Fagan *et al.*, 1969).

Flora and Fauna

White (1983) has described and classified the main vegetation type for the African continent. Using White's classification scheme the table below (Table 3.05) summarizes the main vegetation types associated with the environment surrounding the archaeological sites of interest in this dissertation.

Table 3.05 Regional Summary of Vegetation Types within Research Area (Adapted from White, 1983)

SITES	COUNTRY	VEGETATION TYPES
Sanga, Katoto	D.R.C	herbaceous swamp& aquatic vegetation surrounded by *Acacia polyacantha*
Ingombe Ilede	Zambia	*Colophospeurm* mopane woodland and scrub woodland
Various sites	South Africa	*Colophosperum* mopane woodland and Scrub woodland, semi-evergreen bush land

Woodlands are comprised of open stands of trees whose canopy ranges from 8-20 m in height. The canopy is not dense and sunlight usually penetrates through to the understory, which is covered in grasses and shorter woody plants (White, 1983).
The terms scrub, mopane and miombo are used to further qualify the woodlands. Scrub refers to woodland where the tree canopies are less than 8m tall. Miombo is a type of deciduous woodland found within the Zambezian Region, characterized by various species of *Brachystegia*. Finally, Mopane describes woodland dominated by *Colophosperum* mopane (White, 1983; Werger & Coetzee, 1978).

The vegetation surrounding the sites of the Upemba depression in the DRC is quite varied. All of these sites are located near rivers or lakes, and the immediate vegetation has been described as herbaceous swamp and aquatic vegetation (White, 1983). The vegetation in these swampy regions is dominated by papyrus or reeds, and aquatic grasses.

Beyond the reed-swamp, the vegetation is wooded grassland with the woody species dominated by *Acacia polyacantha* and the predominant grasses *Andropogon schirensis* and *Hyparrhenia confines* (White, 1983).

The Ingombe Ilede is both classified as *Colophospermum* mopane woodland and scrub woodland (White, 1983). Along the river near the site of Ingombe Ilede, there are a variety of trees including: *Acacia albida*, *Tamarindus indica* and *Trichilla emetica*, as well as a variety of grasses (Fagan *et al*, 1969; Werger & Coetzee, 1978). Moving away from the river, there are also scattered Acacia and Baobab trees (White, 1983; Fagan *et al*, 1969).

A more general ecological classification of the sites from the research area was established, after proper review of the environment for each country visited. On the basis of similarities in vegetation, climate, as well as rainfall per annum, three biogeographical ecological zones were established for the research area. These zones are listed below:

- Dry Savanna – the low and high veld of South Africa
- Wet Savanna – coastal KZN, South Africa and Zambia
- Forest – the Democratic Republic of Congo (DRC)

Holocene Environment of Research Area

Knowledge of past climates is extremely important in understanding its effects of the surrounding vegetation; "the climatic factors of greatest importance in vegetation development are light, temperature and moisture, all of which vary sub-continentally as well as on a meso-and micro-scale" (Schulze & McGee, 1978). Fluctuations in climate can produce a domino effect in an environment, influencing the types of plants that grow that, in turn influences the organisms they support. The information provided by palaeoclimate reconstruction is often general in nature but will at least provide some idea of the climate trends that might influence the biogeography of a region. The amount of change between today and the environment 1000 years ago does not appear to have been great, but it has also been not studied nearly as extensively as earlier time periods.

Palynological evidence from Central Africa indicates more humid conditions between 10 000 and 5000 BP, favouring forest expansion. But after 5000 BP, there was a drying trend, which, combined with human occupation by 2000 BP., contributed to deforestation and secondary savanna growth in southern DRC. Tyson & Lindesay (1992) have modelled climate change over the last 2000 years in southern Africa. Based on the information from the Cango Cave in the southern Cape of South Africa, temperatures have changed fairly regularly every 300-400 years during the last 2000 years. Change in temperature influenced the amount of rainfall during the rainy season. Areas with summer rainfall, such as the pattern found in this research area, had more rainfall during the rainy season in warmer/wetter periods.

The general seasonal patterns appear to have been the same as they are today.
Huffman (1996) has looked at archaeological evidence in southern Africa to interpret climate change in the region. He argues that 'Iron Age' populations chose their settlements to optimise the practise of both agriculture and pastoralism. In order to practice both types of subsistence strategies, the climate of a settlement site had to be warm and wet enough for cereal production, yet still possess grasslands for grazing cattle. Huffman (1996) concludes that in order for the large 'Iron Age' site of Mapungubwe to have existed where they are found today, the climate **must** have been warmer and wetter than it is today. The time period for the site of Mapungubwe (970-1200 AD) occurs during Tyson & Lindesay's Medieval Warm Epoch (900-1300 AD), a time of warmer and wetter conditions.

Within the research area, the sites that average between 400-600mm of rainfall today may have been more sensitive to changing climatic conditions than sites in higher rainfall areas. Populations from this time period could have experienced drier and colder climatic conditions, which in turn might influence their subsistence strategies.

Using the information about the environment in the research area, it is possible to predict the parameters for subsistence at various sites. Given the high rainfall and presence of tsetse, the sites in the DRC would probably not possess livestock in any great numbers, but could easily obtain subsistence from foraging, hunting and agriculture. The sites from Zambia and South Africa may have had the potential for both agriculture and pastoralism during certain times, although the pastoral aspect would be more conducive or reliable in South Africa due to its topographical features and virtual lack of endemic malaria. Environmental conditions also affect the types of diseases present, which in turn can afflict human and animals.

b) Description of archaeological sites from research area

Introduction

Archaeological history, material culture, settlement structure, evidence for subsistence and osteological remains are all features that archaeology is concerned with when looking at a site. In the previous section, evidence for climate, flora and fauna has been discussed to provide background for the research area in this study. It is, however, important to review the environment in order to better understand the impact of microclimates in each country and at each site, where possible.

In Chapter 1, evidence for the influence from the East and the West of Africa has been discussed in detail with the various migration theories for south-central Africa. In this view, differences in economies at various sites may reflect migration patterns and/or environmental constraints. Below in Table 3.06, is the approximate chronology of the burials analysed in this study.

Table 3.06 Approximate Chronology for Burials in Research Area

COUNTRY	SITE	CHRONOLOGY	SOURCES
DRC	Classic Kisalian (Sanga, Katoto)	900-1300 AD	de Maret, 1985a
	Kabambian A (Sanga)	1300-1500 AD	de Maret, 1985a
ZAMBIA	Ingombe Ilede	1000-1100/ 1300-1400 AD	Fagan *et al*, 1969
SOUTH AFRICA	Various sites	*ca.*500-1800 AD	Morris, 1992a

Site-specific environmental constraints can lead to adaptive shifts that could change a society's economic strategy in order to optimise production. Therefore, varying degrees of foraging, pastoralism and agriculture are suggestive of a community's way to cope in a new environment and/or to optimise production.

The Democratic Republic of Congo (DRC)

At the southern edge of the great forest in the Lower DRC, we see the earliest evidence of a type of agriculture dating between 300 and 100 BC. Carbonised fragments of palm nut (*Elaeis* and *Canarium schweinfurthii*), as well as polished stone tools and ceramics are found in the Ngovo group of sites in the Lower DRC. Although the Ngovo sites lack any evidence of metal use and thus not regarded as part of the 'Iron Age', "this group could very well be evidence for the start of the colonisation of this part of the continent by farmers" (de Maret, 1986: 129).

In the western part of the country, at the site of Sakuzi, the earliest evidence of metal use (iron) has given a radiocarbon date between the mid-first and the early third centuries AD (de Maret, 1986). This site is associated with a group of people known as the Kay Ladio, whose pottery share significant similarities with that of the preceding Ngovo group. Together with evidence for the use of iron, the site of Sakuzi also yielded iron-smelting furnaces, polished stone tools – which could have been used as hoes because of their shape, wear and damage – as well as hearths. Once again as at the Ngovo sites, carbonised remains of the nuts of the oil palm (*Elaeis* sp.) were found in some of the pit features at the site (de Maret, 1986).

Within the Shaba Province in the southeastern part of the DRC – where the 'Iron Age' sites studied in this dissertation are located – the earliest evidence of 'Iron Age' begins around the fourth century AD (de Maret, 1982a, 1982b). Most of the 'Iron Age' knowledge of the late-first millennium AD comes from a series of cemeteries located in the Upemba depression. The beginning of the 'Iron Age' in the Upemba depression is around the 6th century AD and is known as the Kamilambian (de Maret, 1977 and Phillipson, 1993). As previously mentioned (in Chapter 1), archaeological evidence in this area comes from a series of cemeteries, such as Sanga, Katongo, Kikulu, Katoto and Mulemba-Nkulu, to mention a few. The archaeology in this area has revealed a long occupation sequence for all the eleven sites, to date, in an area that stretches up to 100km inside the country towards the southwest. "These sites have provided a sequence of nearly 1 500 years of continuous 'Iron Age' occupation and material for more than forty datations" (de Maret, 1982a: 89). The artefacts associated with the sites, particularly the pottery, and the extensive radiocarbon dates of the cemeteries, have allowed archaeologists to associate pottery types with particular occupation periods (seriation).

Population growth and extensively long periods of occupation – in some cases the area still in use – the deposits have been greatly disturbed. Thus, very little interpretation in the way of actual excavation of habitation or settlement types can be obtained.

All of the skeletal remains studied in this project come from the Sanga and Katoto sites.

Sanga

Sanga is one of the largest cemeteries ever excavated in sub-Saharan Africa, first excavated in 1957 by Professor J. Nenquin and Mr. J. De Buyst – the excavations of which yielded fifty-six graves (Nenquin, 1963). Sanga lies just beyond the extreme southeastern corner of the equatorial forest on the shores of Lake Kisale, in the Upper Lualaba-Zaire river valley. The site is one of the best known 'Iron Age' sites in 'Black' Africa for certain oral traditions have led historians to place the origin of Luba Kingship, to which many kingdoms of central African savannah trace their origins (de Maret, 1977). A year later (1958) after the initial excavations, a further eighty-nine graves were excavated by Professor J. Hiernaux and Mr. J. De Buyst. The third and last campaign excavations were completed in Sanga in 1974 and 1975 by Professor P. de Maret (de Maret, 1977). These last excavations increased the number of graves studied to a total of 176 and have led to a major revision of the 'Iron Age' chronology of the Upemba depression. The three excavators have expressed the 'Iron Age' chronology at Sanga differently, i.e.

Nenquin (1963) proposed the following cultural sequence from the ceramics:

Kisalian, Mulongo and Red Slip

Hiernaux *et al* (1967 in de Maret, 1977):

Kisalian, Mulongo-Red Slip (contemporary)

de Maret (1977):

Early Kisalian, Classic Kisalian and Kabambian A + B (Mulongo and Red Slip cultures renamed into one tradition).

The chronology proposed by de Maret has to date been employed for the 'Iron Age' of this region, the brief details of which are discussed below.

Based on changes in funeral ritual practices and grave goods, four chronological periods have been distinguished within Sanga and surrounding sites of the Upemba valley: Early Kisalian (700 – 900 AD), Classic Kisalian (900 – 1300 AD), Kabambian A (1300 – 1500 AD) and Kabambian B (1500 – 1600 AD) (de Maret, 1977 and de Maret, 1982a).

Early Kisalian

In the Upemba depression, the Kamilambian period precedes the Early Kisalian, which dates between the eighth century AD and the tenth century AD. There are not many graves during this period and the associated grave goods are also not as elaborate as in subsequent occupations (de Maret, 1982a).

Classic Kisalian

The beginning of the tenth century AD saw the evolution of a typology of pottery that was of such high quality that so far remains unique in the ('Early') 'Iron Age' of Africa. This is the period when the Kisalian culture reached its peak and is represented in the largest number of graves known so far (de Maret, 1982a). Material culture associated with the burials was greatly varied and in large quantities.

Kabambian A and *B* (14th – 16th C and 16th – 18th C AD)

This period witnesses a change in preceding Kisalian funerary practices, and marked by a decrease in the quantity of grave goods especially of the iron objects. The pottery is also less elaborate in form and decoration, relative to that of the Classic Kisalian. Appearance of new copper objects, *croisettes*, believed to have been used as currency, distinguishes the Kabambian from the Kisalian culture. Moreover, the Kabambian B is related to the expansion of long-distance trade with the coastal region, indicated by the presence of cowrie shells and glass beads. Around the end of the eighteenth century, an eastward expansion of a new culture, the Luba Lomami, leads to the decline of the Kabambian culture (de Maret, 1977 and de Maret, 1982a).

Subsistence seems to be fairly comparable between the various occupations at Sanga and surrounding sites. Fishing in the numerous lakes and rivers seems to have been, and still is, the primary source of protein. Fish bones have been discovered in pots buried with the dead; while grave goods such as fishhooks and harpoons also indicate exploitation of riverine resources.

Archaeological assemblages also have trilobed braziers, which are fairly unchanged from the ones used to cook fish today. Other faunal remains show the presence of domesticates such as goats and chicken, in addition to a variety of hunted wild animals (de Maret, 1982a). Plant remains are infrequent; however, evidence of agriculture comes indirectly from artefacts such as hoes, grinding stones and calabash-shaped pots.

Katoto

Katoto is the only site that has been systematically excavated, despite the discovery of four other sites with the Katotian tradition. The uniform Katotian tradition (contrary to the four traditions found at Sanga) developed in the opposite direction to the Classical Kisalian society in the north. In 1959, Prof. J. Hiernaux and others unearthed forty-seven graves at Katoto, which dated back to about the twelfth century AD (de Maret, 1982a and Hiernaux *et al*, 1967). This estimated date of the Katotian graves makes it contemporary with the Classic Kisalian tradition, which continued until the fourteenth century AD. Evidence of contemporaneity of these two traditions and possible contact with each other, is found in the presence of Katotian pots in Kisalian graves and vice versa.

The orientation of the body was quite variable in the Katotian funerary practices. The two most frequent positions observed were northwest and east orientation of the head; while many bodies were found in all directions (Hiernaux *et al*, 1967). Another peculiar funerary custom of the Katoto was multiple burials; whereby a man being interred with women and children. Vansina (1966) has interpreted the material culture from these collective graves and suggests that they could be indicative of a burial of a chief – as was seen in the Luba custom. Grave objects from these tombs include ceremonial axes, anvils and a big clapperless bell, which is one of the known common symbols of power and authority among the Bantu speakers (de Maret, 1982a).

The contemporary Katoto and Kisalian traditions were similar, yet had different funerary ritual practices (as mentioned above) and different pottery styles. (de Maret, 1982a). Other artefacts found in the graves at Katoto include copper and iron ornaments, some peculiar pendants with "punched dots", as well as cowrie shells and glass beads from the Indian Ocean trade links.

Summary of the DRC skeletons

A total of thirty-four individuals from Sanga were analysed in this study; the majority (twenty-three) of which was located at the National Museum of Lubumbashi, in the DRC. The data from the Sanga and Katoto skeletons were collected during a museological expedition by Dr. I. Ribot and the author, to curate the skeletal remains from the Upemba depression at the National Museum of Lubumbashi. The skeletal elements of all the individuals were not in very good order when we arrived there at the museum. Most or all of the skeletons had been mixed up and curated by bone type; but fortunately, most of them had accession numbers marked on them. So, it was possible to re-assemble the elements into whole individuals.

The remaining eleven individuals from the site of Sanga were located at the Royal Belgian Institute of Natural Sciences, Anthropology and Prehistory (RBINScAP) in Brussels, Belgium. The majority of the skeletal elements for the individual skeletons were also not curated as whole persons. It was apparent that more skeletal remains from the Sanga were located at the University of Brussels - Belgium, but these were unfortunately not included in the present study.

Altogether a total of fifteen males, ten females and nine juveniles made up the total number of specimens from Sanga graves (Table 3.7; Appendix). All of the twenty-one Sanga skeletons studied at the National Museum of Lubumbashi, DRC belong to the Classic Kisalian period (900–1300 AD); whereas the twelve skeletons analysed at the RBINScAP, Brussels belong to the Early Kisalian period (700 – 900 AD). It is interesting to note that the skeletons excavated by Nenquin in 1957 (classified as Early Kisalian) are housed in Belgium at the RBINScAP. Perhaps, it is not as surprising as they might have been taken from the DRC during colonial times. What is perhaps, even more interesting is that the later remains (belonging to the Kabambian A and B) excavated in 1974 by de Maret are still located in Belgium.

The remains found at the National Museum of Lubumbashi were generally in a good state of preservation: the long bones were mostly broken but mainly complete and little weathering of the elements was observed. This, however, was not the case for the remains located in Belgium; most of which were fragmentary, weathered and incomplete.

Skeletal remains of twenty-one individuals from the site of Katoto were examined in this study (Table 3.07). All of them were located at the National Museum of Lubumbashi, DRC during the time of collecting data from Sanga, as mentioned above. The Katotian sample consisted of five males, eight females and eight juveniles. As previously mentioned, the graves at Katoto have been dated around the twelfth century AD; a period that is contemporaneous with the Classic Kisalian (900-1300 AD).

Just as with the Sanga material from the DRC, the Katoto remains were, in general, well preserved; almost complete and not much weathering of the bones could be seen.

Table 3.07 Summary of specimens from the Democratic Republic of Congo

Site	Juvenile	Male	Female	Total
Sanga	15	10	9	34
Katoto	5	8	8	21
TOTAL	20	18	17	55

Zambia

Evidence of the early iron-using farmers of the Chifumbaze complex is seen to have dispersed southwards in eastern Zambia around the second century AD (Phillipson, 1993). Based on their settlement structures and their ceramics, which have close affinities with Urewe ware in East Africa, these early farmers have been identified as Kalomo culture (Fagan, 1972; Huffman, 1989b & Vogel, 1987).

At Kapwirimbwe near Lusaka, and other settlements in the Zambia/DRC Copperbelt, domestic cattle remains have been found as early as the fifth century AD.

There appears to be more cattle remains, and certainly small stock, in the upper levels of 'Iron Age' sites in southern Zambia around the seventh and eighth centuries AD. Vogel (1987) believes this could be indicating some "enhanced role of cattle within the ecological and perhaps, social systems".

During the early centuries of the second millennium AD, a transition in the focus of some economies can be seen with the arrival of a new group of peoples from the north-west of the Zambezi: Western-Bantu speakers. The newcomers who settled more towards central-western Zambia had formed a medium for the accumulation and exchange of wealth in metal; while cattle served this function in the southeastern regions. Evidence for the 'importance' of metal, represented in the form of copper ingots, has been seen in Late' Iron Age' sites such as Twickenham and Ingombe Ilede (Huffman, 1989b; Phillipson, 1993 & Vogel, 1987). However, it does seem that the influences from both Eastern and Western Bantu cultures were in juxtaposition for most part of the 'Iron Age' in Zambia.

Ingombe Ilede

In 1960, J.H Chaplin conducted a rescue excavation to remove fragmentary remains of eleven human burials that had been unearthed during the construction of a water tower. The water tower was to store water from the Kariba Dam at the Ingombe Ilede mound before pumping it out to villages in the Lusitu region. The site of Ingombe Ilede is situated in the Gwembe or Middle Zambezi Valley, about 4.8 km from the banks of the Zambezi River in the Southern Province of Zambia (Fagan, 1972). The importance of the site lies in its role as a centre of long-distance and local trade in south-central Africa during the 'Iron Age'. In 1961 and 1962, Brian Fagan and others carried out subsequent excavations at the site, during which no less than 35 burials were recovered. A total of 46 skeletons were, therefore, recovered from the excavations at Ingombe Ilede.

The first eleven burials excavated by Chaplin are among the most spectacular burials ever discovered in south-central Africa. The burials were richly decorated with elaborate grave goods such as gold, copper and iron objects, sea shells, glass beads, cotton and bark cloth and amulets. Some of these goods were exotic and not manufactured locally; this strengthens the evidence of the early trading activity with

Arab and Indian traders from the East African coast into the deep interior part of south-central Africa.

The variability of the iron objects found at the site ranges from functional to ornamental; namely, hoes, wire-drawing tools, axes, arrowheads, fish hooks, gongs, razors, rings and bracelets. One of the most remarkable iron objects being the ornamental hoes, which show little or no wear on their surface, believed to have been ceremonial tools (Fagan, 1972). There are no copper deposits in the Middle Zambezi Valley and copper was used for ornamental purposes at the site. Four of the adorned burials had cross-shaped copper ingots at their heads and feet. Similar types of these artefacts have been found in many burials of the Sanga from the Shaba Province of the Democratic Republic of Congo - DRC (de Maret, 1982a & Fagan *et al.*, 1969).

The additional 35 burials discovered to the south of the original burials in 1962, were without the rich grave goods of the 'gold-burials'. Potsherds, animal bones and fresh-water beads are some of the artefacts associated with the other skeletons found at Ingombe Ilede. The extreme difference in the distribution of grave goods at Ingombe Ilede could be indicative of some degree of social hierarchy at the site, with a few individuals controlling the trading activities.

The site of Ingombe Ilede seems to have had two periods of occupation. Radiocarbon dates indicate the first occupation to be between the seventh and eighth centuries, and the second one to be between the eleventh and fifteenth centuries AD. It is, however, not clear to which occupation the 35 unadorned burials belong; while the 'gold-burials' were dated to the second occupation.

The evidence for structures and settlement pattern at the site is scanty, apart from some tenuous mud hut floor from the stratigraphic profile. This is partly because the excavations were primarily an attempt to rescue and exhume the skeletal remains that had already been exposed, and to look for more in the vicinity of the construction work. It could perhaps, be that the individuals were buried outside of the settlement confines, in cemeteries – such as in Western Bantu burial practices. According to Huffman (1989b), the ceramics from Ingombe Ilede have affinities to Western Stream sites such as those in the DRC – Twickenham, Gundu and Naviundu ceramics. Therefore, it is not improbable to assume that the village layout at Ingombe Ilede somehow resembled the Forest Settlement Pattern – with rectangular houses arranged in rows (See Chapter 1 for details).

Pottery and animal bones often preserve well in the ground, the presence of which in an archaeological context is direct evidence for a fraction of subsistence of a particular society or community. Vegetable foods, on the other hand, do not preserve so well in the ground, unless carbonised – which is the case at Ingombe Ilede. Archaeological evidence for farming at the site includes carbonised seeds and fragments of sorghum, as well as a leaf impression of the cereal on a piece of clay associated with the third 'gold-burial'. The presence of a pot shaped in the form of a gourd lends support that gourds were probably cultivated at the site. Artefacts such as hoes, grindstones and rubbers provide indirect evidence for agriculture and possible processing of wild plants, for which there is no archaeological evidence (Fagan, 1972).

The majority, over seventy percent, of the animal bones for each level at Ingombe Ilede is represented by wild faunal remains. Domestic stock is also present, with goat remains dominating the small number of cattle remains. Surprisingly, there are very few fish bones at the site. However, the presence of fishhooks is a reflection of exploitation of fish presumably from the nearby Zambezi and/or Lusitu rivers (Fagan, 1972).

As already mentioned, the site of Ingombe Ilede could be a representation of a burial ground or cemetery, and any archaeological evidence for subsistence represented here is of a limited edition of the economy of the society. Putative conclusions of the economy of Ingombe Ilede may be summarised as a mixed farming subsistence strategy of undependable cultivated crops (due to the drought-prone environment) in addition to hunted and gathered foodstuffs.

Summary of the Ingombe Ilede skeletons

Unfortunately, not all of the 46 skeletons excavated at Ingombe Ilede were analysed in this study. What is even more unfortunate is that certain elements of some individual skeletons have been separately curated at two different institutions: Livingstone Museum in Zambia and remaining parts can be found at the University of the Witwatersrand (WITS) in South Africa.

Altogether, a total of fifteen individuals were studied, all of which were located at WITS, Medical School (Table 3.09; Appendix). They consisted of eight males, two females and five juveniles. Most of the remains were in a poor state of preservation, more especially the juvenile skeletons, which were often not cleaned and fragmentary. In terms of the social status of the Ingombe Ilede human remains analysed in this study, it was not possible to establish whether they were part of the 'gold burials' or the unadorned, 'commoner' burials. This is in part due to the fact that these remains were not associated with any information about their contexts, where they were located or curated (i.e. at WITS, Medical School).

South Africa

A large amount of 'Iron Age' research done in South Africa has focussed on understanding the cultural sequence of the ceramics, in the hope of tracing relationships and movement between parts of sub-equatorial Africa (Maggs, 1984; Huffman, 1989b, 1996; Phillipson, 1995). Although a very controversial and debated topic (Hall, 1987; Vansina, 1995), ceramic typology has provided us (though not conclusive) with some models to work on for the diffusion of people into southern Africa. In this view, I will then briefly discuss the 'Iron age' ceramic sequence in South Africa and then move into settlement patterns, evidence of subsistence and burials recovered over time.

Almost all of the 'Early Iron Age' (EIA) assemblages of southern Africa can be grouped together into the Chifumbaze Complex, which has its roots in East Africa (Phillipson, 1995; Maggs, 1984; Mitchell, 2002). Sites in Kwa-Zulu Natal (KZN) and the Northern Province, dated between the third and fourth centuries AD have yielded pottery of the Matola/Silver Leaves phase of the Kwale branch (part of the Urewe Tradition under the Chifumbaze Complex).

The Nkope branch appears around the seventh century until tenth century AD in the Shashe-Limpopo Basin. Nkope ceramics named after the site, Nkope from southern Malawi, have been identified in Schroda, which appears to be intermediate between the Chifumbaze Complex and its successors (Maggs, 1984; Phillipson, 1995).

This region of the African 'Iron Age' was thought to belong entirely to the so-called Eastern Stream of ceramic traditions (Phillipson, 1985). As was the case, however, with sites in Zambia, 'EIA' sites in South Africa have a variety of influences from both the Eastern and Western Stream ceramic cultures. Sites that are contemporary with the later phases of the Urewe Tradition show very close affinities with components of the Kalundu Tradition further northwest, such as those in southern Zambia (Huffman, 1982; Whitelaw & Moon, 1996). Kalundu ceramics have been found in sites like Happy Rest and Klein Africa in northern South Africa, with dates between the fifth and seventh centuries AD (Steyn *et al.*, 1994).

Further evidence for contemporaneity of later phases of Urewe and earlier phases of Kalundu Traditions is seen on the juxtaposition of decoration styles of both traditions on most of the pottery from Klein Africa (Maggs. 1984). Dating to around the fifth century AD, the Lydenburg Head site has yielded the most remarkable series of modelled terracotta human heads, which are believed to be associated with ritual functions such as initiation ceremonies (Inskeep, 1978; Phillipson, 1995). The heads bear great resemblance to the ones used by historic and present-day Venda people during their initiation ceremonies. Sites like Msuluzi, Ndondondwane and Ntshekane in KZN, Klingbeil and Eiland in the Northern Province are representative of later phases of the Kalundu in South Africa, with dates ranging from the seventh to tenth centuries AD (Mitchell, 2002).

Towards the end of the first millennium AD and marking the beginnings of the 'Late Iron Age' (LIA), there appears to be a change in ceramic culture. Both decorative style and the form of ceramics tend to be more localised (Hall, 1990). Schroda, with its Gokomere-Zhizo ceramics dating to the ninth and tenth centuries AD, marks the end of the 'EIA' south of the Limpopo River. Besides its important status as an intermediate between the 'Early' and 'Late Iron Age', it is also the earliest known 'Iron Age' settlement in the Shashe-Limpopo area to yield a substantial number of imported glass beads and locally-made ivory objects, attesting to the Indian Ocean commercial network (Huffman, 1996; Phillipson, 1995).

With the abandonment of Schroda at about 1000 AD, Leopard's Kopje ceramics, believed to be associated with Shona-speaking people, appear in the Shashe-Limpopo region. At K2 (Bambandyanalo), about six kilometres southwest of Schroda, Leopard's Kopje pottery has been found along with large quantities of imported glass beads and more ivory objects than at any other contemporary settlement (Huffman, 1996; Maggs, 1984; Phillipson, 1995).

After about two hundred years of occupation with an estimated population of two thousand people, K2 inhabitants moved and settled around Mapungubwe Hill by about 1220 AD. The occupation of Mapungubwe lasted some fifty years, with a continuation under relatively impoverished circumstances until its decline in the late twelfth century AD (Huffman, 1996; Maggs, 1984; Phillipson, 1995). Based on radiocarbon dates, the decline of the Mapungubwe state is associated with the rise of Great Zimbabwe. Great Zimbabwe, dated between 1250 and 1450 AD, can be seen as a subsequent phase with some developments of characteristics of the Mapungubwe phase, such as the settlement pattern and ceramic typology.

While a lot of attention has been directed towards the impressive site of Great Zimbabwe, farming communities south of the Limpopo were settling in more open areas, adjusting to the problems and possibilities of their new physical and cultural environments. Archaeological evidence is lent support from ethnography, oral history traditions and some written documents during this time. In the high-veld, the first evidence of Sotho/Tswana-speakers is represented by the presence of Moloko ceramics from Icon, in the fourteenth century AD (S. Hall, 1998; Loubser, 1989).

Encouraged by climate change, the fifteenth century sees the first expansion of farmers south of the Vaal River into predominantly grassland areas (Mason, 1974, 1986; Maggs, 1976, 1984; Phillipson, 1995). Meanwhile, north of the Soutpansberg Mountains, the appearance of Khami-style ceramics attributed to the arrival of new Shona dynasties from Zimbabwe, by around 1450 AD. Exchange and interaction between the Sotho/Tswana-speakers on the south of the mountains and the 'new' Shona-speakers was intense (Loubser, 1989; Phillipson, 1995; S. Hall, 1998).

The southernmost settlement of the 'LIA' is represented by sites in coastal Natal, the KZN interior on the foothills of the Drakensberg Mountains and in the Eastern Cape. During the eleventh and twelfth centuries, Blackburn pottery makers, believed to be of Nguni ethnicity, moved to Natal and the Transkei (Huffman, 1989a). Sites that have been attributed to the ancestors of the Zulu-speakers include the thirteenth to fourteenth century site of Moor Park and Nqabeni in the eighteenth century AD (Maggs, 1984; Phillipson, 1995).

Besides the extensive research done on ceramic typology in South Africa, the archaeological evidence of material culture and settlement pattern is impressive. Dated to about 200 AD, the earliest 'Iron Age' settlements in South Africa have been identified by the presence of distinctive pottery, well preserved remains of the bulrush millet (*Pennisetum spp.*) and African millet (*Eleusine spp.*), as well as a gourd (Inskeep, 1978; Hall, 1990). Sites in KZN found along the coastline on the edge of the Costal Dune Forest suggest an important pre-requisite for rich agricultural land and high rainfall (Maggs, 1984; Mitchell, 2002).

At about the mid-first millennium, occupation into the interior parts of the country occurs with larger villages than the earlier ones; but remains to be located near water sources (Hall, 1990; Phillipson, 1995). Evidence of domestic structures is represented burnt daga with stick and thatch impressions, hut floors, granaries, ash middens associated with dung deposits, pits, and iron and ivory workings (Maggs, 1984; Mitchell, 2002).

Archaeological evidence for settlement in the eighth century AD shows larger and numerous stone-built villages indicating an increase in population density. Moreover, evidence of livestock is found from vitrified dung deposits, faunal remains, stock-enclosures and ceramic figurines of animal form suggesting an increasing importance in livestock, particularly cattle, against agricultural produce (Maggs, 1984; Hall, 1990).

The fourteenth and fifteenth centuries saw an expansion of farmers south of the Vaal River, in the Free States. On these later Moloko-phase settlements, spatial boundaries are defined stonewalls that are stylistically different, which become large aggregated towns in the later centuries (S. Hall, 1998; Maggs, 1984; Mason, 1986).

The earliest evidence of farming in South Africa, dated to the end of the second century AD comes from the Shongweni South cave near Durban-KZN; where well-preserved remains of Bulrush millet and African millet, as well as a bottle gourd were found. In addition to the cultigens, other crop plant species that have been identified include: cow peas (*Vigna unguiculata*), ground beans (*Voandzeia subterranean*), as well as varieties of squash (Inskeep, 1978; Maggs, 1984; Phillipson, 1995; Mitchell, 2002).

Foraging for protein sources remained considerably on a wild scale with few domesticates. Sites on the KZN coast, for example, are basically shell middens, reflecting the exploitation of marine protein resources, especially the brown mussel (*Perna perna*). Moving into the second half of the first millennium, more information on economic activities is available from faunal remains of cattle, small stock and domestic dog present at sites.

As in many archaeological sites, indirect evidence for farming comes from objects such as grain bins, grindstones, pottery, and iron artefacts such as hoes. Evidence for domestication of maize only appears after the mid-eighteenth century AD, in South African sites (Clark, 1965).

Because of the socio-structural pattern and funerary practices of Eastern Bantu-speakers (See Chapter 1 for details), no formal cemeteries (with some exception) are found in South Africa during the 'Iron Age'. The majority of the human remains come from isolated graves from 'Iron Age' contexts. Numerous isolated reports on human skeletal remains from 'Iron Age' sites or contexts in South Africa exist for detailed reviews of the burials. Thanks to Morris' Master Catalogue (1992a) that lists the inventories of Holocene human skeletons from South Africa, it has been easier and more practical to draw a large sample of early farmers for the purpose of this study. Because of the numerous sites from which the human remains come, it makes it difficult to discuss the excavation histories and details of the actual burial for each specimen studied. A general overview of burial contexts of the skeletons will, therefore, be provided.

Burial practices among Eastern Bantu-speakers with the CCP are fairly standardised. Men and women are often buried at different places around the settlement: men are usually buried in or close to the cattle kraal and women and children in or around the house (Kuper, 1982; Huffman, 1982). Exceptions such as the elite burials on the summit of Mapungubwe Hill also exist (Mitchell, 2002).

Summary of the South African skeletons

The human remains studied in this project come from five institutions around South Africa, namely; Department of Anatomy – Witwatersrand University (WITS), National Museum in Bloemfontein (NMB), Natal Museum in Pietermaritzburg (PMB), Department of Human Biology - University of Cape Town (UCT) and the Department of Anatomy – University of Pretoria (UP). Only six individuals were studied at UCT, the preservation of which was quite satisfactory. A total of 27 were analysed from the WITS collection. The variability of the state of preservation of these individuals meant that some of the observations could not be done due to extreme weathering and/or fragmentation. A lot of temporary reconstruction had to be done on some skeletal elements in order to get a measurement or observation.

To my disappointment, a substantial number of skeletons from the UP collection was missing or had been reburied. However, I managed to analyse 41 skeletons. Their preservation was also satisfactory, but very incomplete with more crania than post-cranial remains.

It was pleasing to find some recently excavated remains that had not been listed in Morris' Master Catalogue (1992a) when I arrived at PMB. 16 individuals of varying preservation were studied at this museum. Skeletal remains of 10 individuals were analysed from NMB. These remains are probably the best preserved of all the collections studied in South Africa. Although not 100% complete, both crania and post-cranial remains were frequently present for each individual.

Altogether a total of 100 individuals were studied from South Africa (Table 3.08; Appendix)

Table 3.08 Specimens from South Africa

Repository	Juvenile	Male	Female	Total
UCT	3	2	1	6
WITS	7	14	6	27
UP	24	10	7	41
PMB	3	8	5	16
NMB	3	5	2	10
TOTAL	40	39	21	100

Table 3.09 Demographic Profile of Specimens from Research Area (By Biogeographical Zone)

BIOGEOGRAPHICAL ZONE				MALES			FEMALES			
	Infant	Juvenile	SA	YA	OA	MI	YA	OA	MI	Total
Dry Savanna (South Africa)	10	20	7	18	5	8	10	4	2	84
Wet Savanna (S. A & Zambia)	4	3	1	8	6	2	4	1	2	31
Forest (DRC)	9	5	3	10	6	4	12	2	4	55
TOTAL	23	28	11	36	17	14	26	7	8	170

Infants = Birth – 5 years
Juveniles = 5.1 – 15 years
SA = Sub-adults; 15.1 – 20 years
YA = Younger Adults; 20.1 – 40 years
OA = Older Adults; 40.1+ years
MI = Mature Individuals, whose age could not be estimated

Chapter 4: METHODOLOGY

General methodology: selection criteria, aging and sexing techniques

Selection criteria

All isolated and incomplete bony and dental elements were analysed. Individuals were selected on the basis of survival of at least one tooth and/or bone element necessary for measurement or observation of one stress indicator. The preservation and condition of each skeleton examined in this study was also recorded.

Estimation of Sex

Only adult individuals, based on morphological development, were assessed for sex. Determining sex for a juvenile or sub-adult skeleton is difficult because the bony features associated with anatomical sexual dimorphism are usually **not** developed until adulthood. Morphological adulthood is generally reached at about twenty years of age with complete fusion of long bones; and happens later in men than in women (Buikstra & Ubelaker, 1994).

Sexing techniques used for the adult skeleton involve the employment of multiple morphological criteria, which are mostly shape, robusticity and occasionally size variables. Various features of the pelvis, cranium and sometimes post-cranials were used to assess the sex of an individual. On the pelvis, features examined include, the pubis, greater sciatic notch, pre-auricular sulcus and the general morphology of the pelvis. Figures 4.01 and 4.02 illustrate some of these differences between males and females (Buikstra & Ubelaker, 1994).

The pubis with observable differences in the pubic symphysis, sub-pubic concavity and the ischio-pubic ramus between males and females is the most reliable region to indicate sex of a skeleton. The greater sciatic notch appears broader in females and narrower in males. Scarring of the pre-auricular surface, which can be caused by parturition, has been recognised as a typical marker that indicates a female.

Often used as supporting elements to the pelvis or used solely where the pelvis is destroyed or missing, the cranium and mandible offer another dimension in the diagnosis of sex. Robusticity is the key characteristic for the skull and mandible assessment of sex. The nuchal crest, mastoid process, supra-orbital margin, supra-orbital ridge and mental eminence are observed for signs of dimorphism. The emphasis is based on delicate, gracile features for the female, and more robust, well-developed features on the male skull.

In figure 4.03, a score of 1 is typically female, whereas 5 would represent a typical male skull (Buikstra & Ubelaker, 1994). Where the skeleton was incomplete, determination of sex was done using all these features for a more accurate estimate.

Estimation of Age at Death

Teeth, which survive better than bone in the ground, are probably the most accurate method used for estimating age of a skeleton at death, especially that of children. Dental calcification and eruption times for both deciduous and permanent teeth are used as standards in this technique (Ubelaker, 1978) (Figure 4.04). Infants and juveniles are best aged using this method, as the early years are important for the development of dental (and skeletal) tissues. A standard deviation of three months is added as variations in tooth eruption occur in different populations (Ubelaker, 1989).

Because different bones unite at different ages, epiphyseal closure as an age indicator has been employed to age the remains of sub-adult individuals and of children where teeth were not available (Figure 4.05). In adulthood, this method is only useful until the age of approximately 32 years, when the medial end of the clavicle fuses (Buikstra & Ubelaker, 1994; Suchey *et al*, 1984).

The ages of adult skeletons were estimated using information from degenerative changes that take place at certain bone-cartilage joints and symphyses during an individual's lifetime. The Suchey-Brooks (1990) technique, which looks at changes in the pubic symphysis, is so far the most reliable method for aging adult males and females. It is also the most commonly used method, in this study, for aging adult skeletons where cranial remains are unavailable.

Cranial suture closure was also employed in assessing age estimates for adult individuals. However, this method is best used in conjunction with other aging methods, because of the variability of fusion of the cranial sutures.

One rarely used method for estimating age in adult skeletons, in this study, is that developed by Iscan *et al.* (1984). This method examines the metamorphosis in the sternal end of the fourth rib. From an archaeological standpoint, this method is not so reliable because ribs are often very fragmentary and/or not preserved in archaeological contexts.

Patterns and severity of tooth wear, which have also been used to estimate age at death (Brothwell, 1981 and Gustafson, 1950), were not used to age individuals in this study. This is because of the fact that the condition of teeth is generally affected by diet and behaviour or lifestyle.

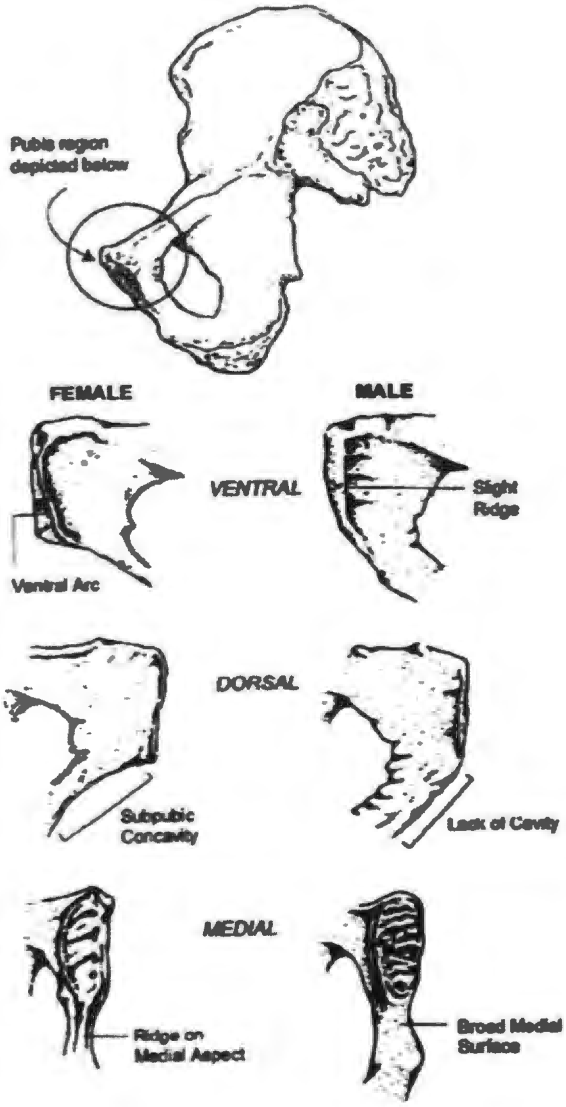


Figure 4.01 Estimation of sex from the pubic symphysis (Buikstra & Ubelaker, 1994: 17)

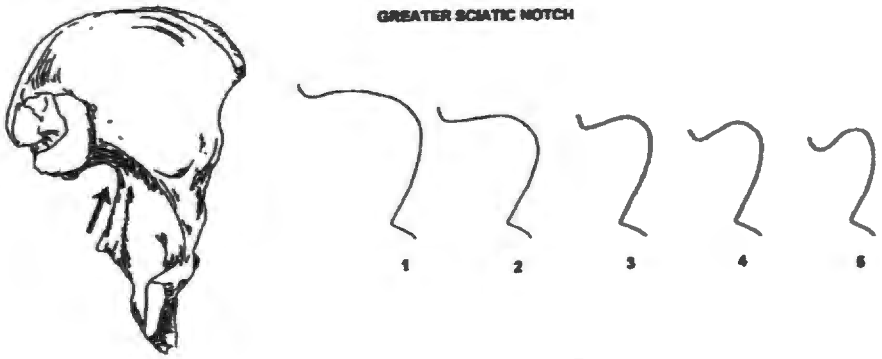


Figure 4.02 Estimation of sex from the sciatic notch (Buikstra & Ubelaker, 1994: 18)

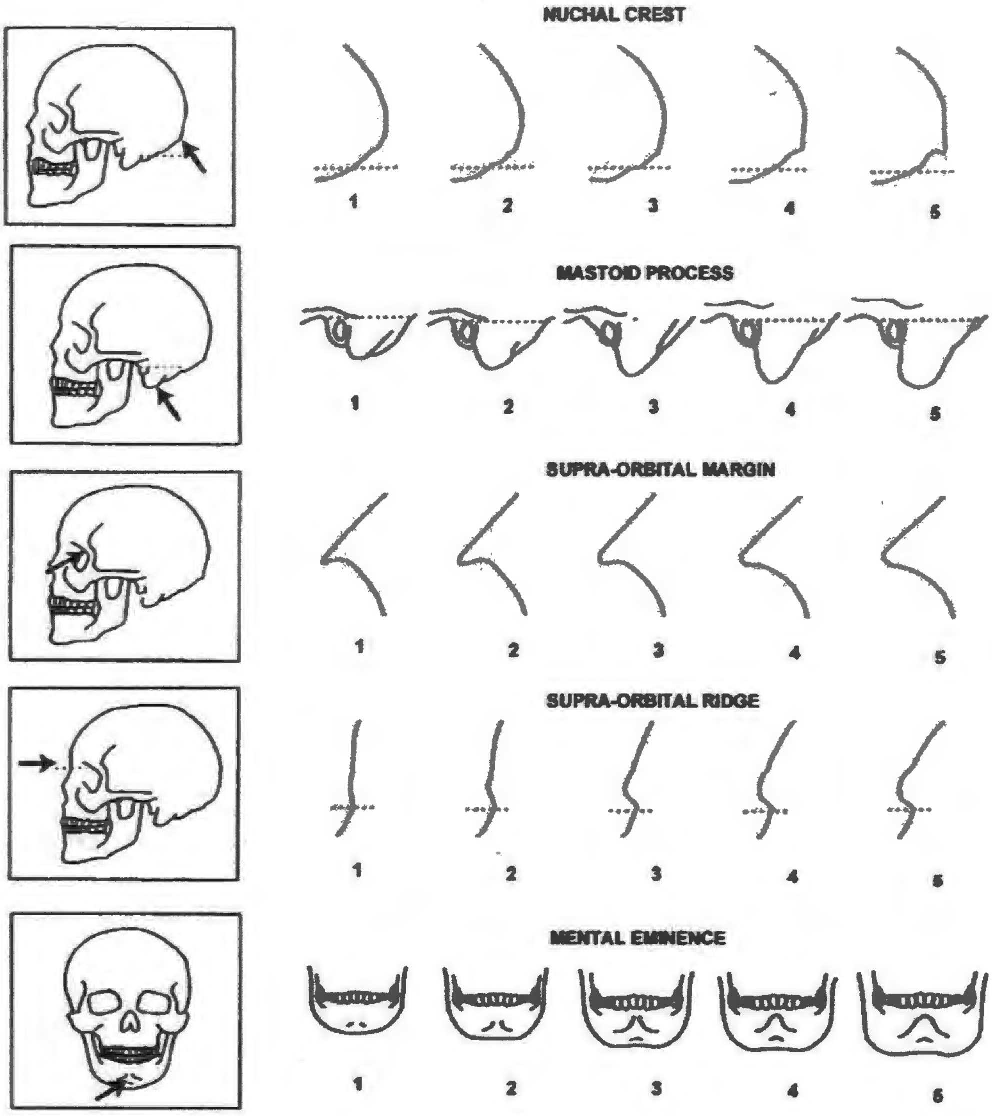


Figure 4.03 Estimation of sex from the skull (Buikstra & Ubelaker, 1994: 20)

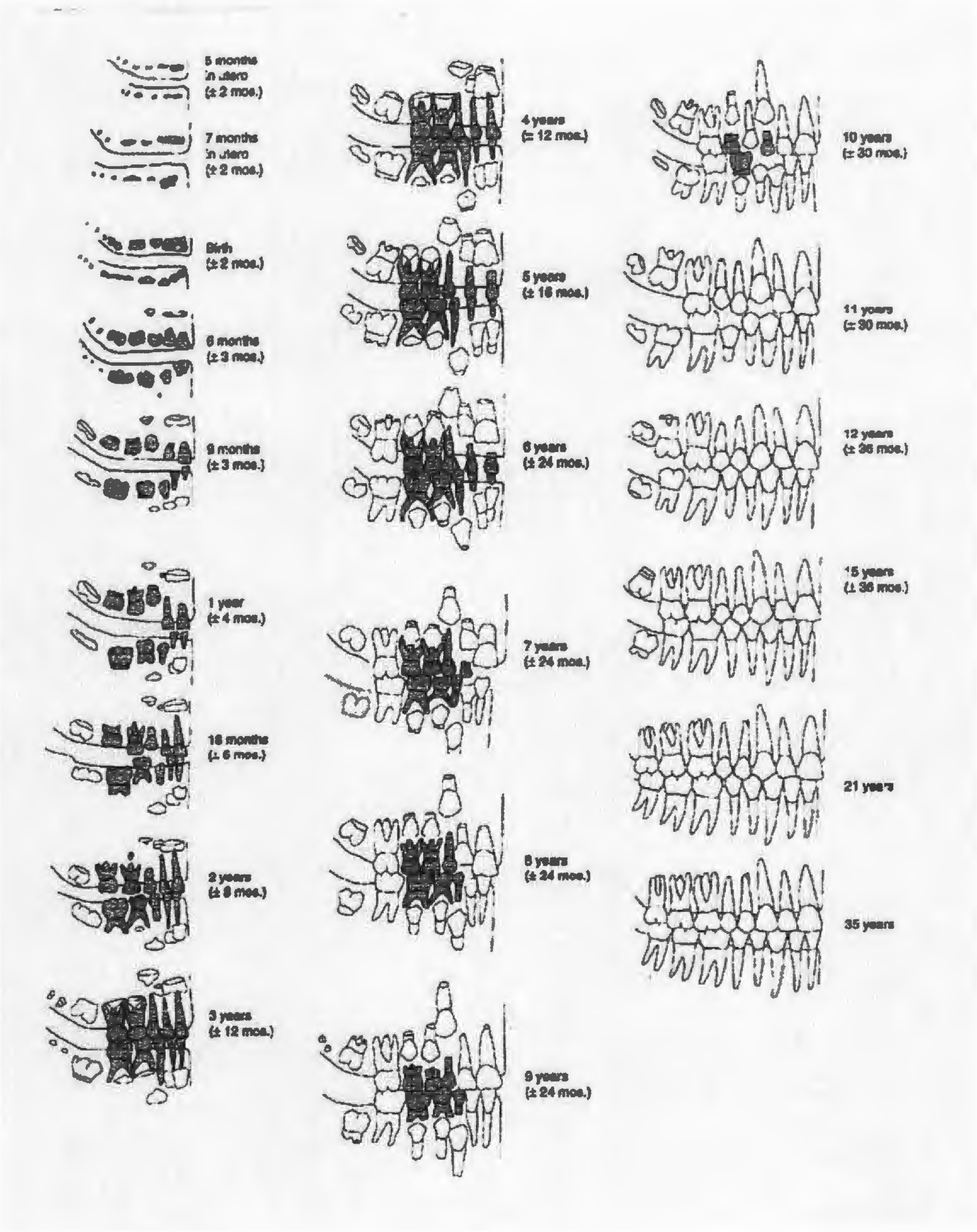


Figure 4.04 Estimation of age – Tooth formation and eruption among Native Americans (Buikstra & Ubelaker, 1994: 51)

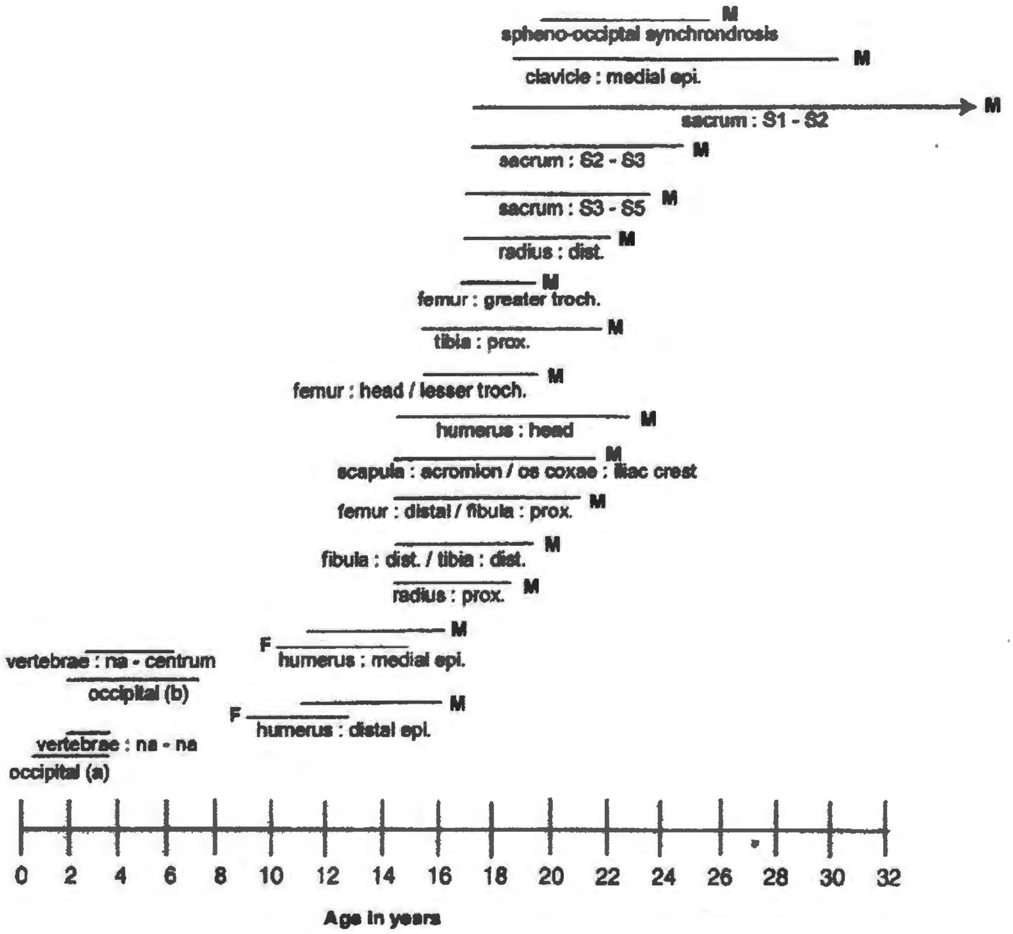


Figure 4.05 Estimation of age from epiphyseal union; M – males, F – females (Buikstra & Ubelaker, 1994: 43)

Age Categories

In order not to mask any age-specific differences when analysing pathophysiological relationships, the sample was divided into age categories. Also, trends between groups of individuals within the same developmental age provide better comparative information than specific ages. Similar age categories as presented in Morris (1984) are utilised in this project. The age categories, in years, are presented as follows:

- Infant: Birth to 5 years
- Juvenile: 5.1 to 15 years
- Sub-adult: 15.1 to 20 years
- Younger adult: 20.1 to 40 years
- Older adult: 40.1 years and above

The age categories are based on the relationship between skeletal changes and chronological age, as described and illustrated above.

Methodology of stress indicators

Macroscopic analysis of non-specific pathological conditions was observed and recorded on all available skeletal and dental elements. Two types of lesions were observed osteologically: resorptive and proliferative, in terms of the response of bone tissue. Resorptive lesions are those that involve the destruction (not necessarily by osteoclastic activity) of bone, for example, porotic hyperostosis. Any evidence of new bone formation that could be the result of the bone's response to infectious disease (periosteal reactions) was recorded as proliferative lesions.

Also, radiographic examination was done on the tibia and/or femur for the assessment of growth recovery lines or Harris lines.

Four non-specific stress indicators were observed for the assessment of the general health status of the skeletal populations under study. The descriptions and identifications of each stress marker are discussed below.

Description and Identification of non-specific pathological conditions

A. Cribra Orbitalia and/or Porotic Hyperostosis

Lesions associated with cribra orbitalia (CO) and porotic hyperostosis (PH) can be identified as porous regions found on the roofs of the eye orbits (Figure 4.06) and on the outer table of the cranium, respectively. On the skull, they are commonly distributed on the frontal and parietal bones, and occasionally on the occipital bone.

Simultaneous thickening of the cranial trabecular bone and thinning of the outer cortical bone usually accompany these porous lesions. As a consequence of the thinning or resorption of the outer compact bone, exposure of the trabeculae of the expanded, coarse cancellous bone is apparent in severe cases (Mensforth *et al.*, 1978; Larsen, 1997) (Figure 4.07).

The aetiology of CO and PH is understood to be related to iron-deficiency anaemia, which in turn causes bone marrow hyperplasia. Two models have been proposed to explain the occurrence of iron-deficiency anaemia: the dietary model and the parasite model (Stuart-Macadam & Kent, 1992). Diets that are either low in iron or contain substances that interfere with the bioavailability of iron in the body are suggested for the dietary model. The parasite model, on the other hand, suggests that the chronic state of hypoferremia (low available iron) could be beneficial to individuals with high parasite loads. This is based on the fact that many pathogens require iron to reproduce and survive (Stuart-Macadam, 1985; 1987; 1989; 1992).

The visible skeletal manifestations associated with CO and PH have been linked to bone marrow hyperplasia, as above mentioned. "In iron-deficient persons the marrow produces red-blood cells (RBCs) with subnormal haemoglobin content (anaemia). The low level haemoglobin in the blood, however, provides a powerful stimulus to increase RBC production. Thus, "iron-deficient persons have subnormal blood haemoglobin levels but a marrow perpetually expanding in response to the RBC production stimulus" (Aufderheide & Rodriguez-Martin, 1998:246-247).

Moreover, the expanding marrow creates a pressure that is in turn exerted on the tables of the skull. It is this pressure, directed perpendicular to the enveloping table that leads to the pitting or porous appearance observable on the cranial vault (Ponec & Resnick, 1984).

In this study, all individuals with skulls and/or orbit(s) were examined for the presence and severity of CO and PH. Both types of lesions were recorded schematically as occurring either in the eye orbits (CO) or on the frontal and/or parietal and/or occipital cranial bones (PH). The number of individuals in each category was calculated as follows:

- CO – number of individuals based on orbit(s) present; 1 orbit = one half of one individual
- PH – number of individuals based on frontal and/or parietal and/or occipital bones present

Based on Stuart-Macadam (1985: 392), the severity of CO and PH lesions was scored as follows:

1. Light: scattered fine foramina
2. Medium: large and small isolated foramina that have linked to form a trabecular structure
3. Severe: outgrowth in trabecular structure from the normal contour of the outer table

B. Growth Recovery lines or Harris lines

Transverse lines of increased radio-density, that usually occur at the ends of long bones and round or irregular bones, were first described by Harris in 1933 (Larsen, 1997). They have been demonstrated to be the result of slowing or total arrest of bone growth at the growth plate and associated with systemic metabolic insults, such as disease and malnutrition (Ribot & Roberts, 1996; Larsen, 1997; Aufderheide & Rodriguez-Martin, 1998).

During an episodic insult, cartilage deposition is greatly slowed down as cartilage cells (chondroblasts) no longer divide (Aufderheide & Rodriguez-Martin, 1998).

Mineralization of bone at the growth plate continues during the recovery phase following growth arrest. The result is a densely mineralised epiphyseal line that can be seen radiographically (Larsen, 1997; Aufderheide & Rodriguez-Martin, 1998).

Examination of Harris lines (HL) was done by taking X-ray pictures of both the femora and tibiae (left and right) of each individual, when available. The tibia was chosen over the femur when both bones were available and complete, for the assessment of HL. This is because the tibia is the most commonly affected bone, by childhood stress (Aufderheide & Rodriguez-Martin, 1998). The femur was only used when the tibia was unavailable or incomplete.

Only the distal ends of either the tibia or the femur were examined for the presence of HL, as this is an area of rapid growth that is easily affected by line formation (Larsen, 1997; Hunt & Hatch, 1981). The location of the line(s), as well as the total length of the bone under examination, was measured for the calculation of age of the individual at the time of line formation. Byers' (1991) method was employed to estimate age of line formation for each individual.

The skeletal material located at the Department of Human Biology, University of Cape Town (UCT) was X-rayed using the LODOX machine from the same department (UCT). The LODOX machine uses low dose radiation in combination with computer-generated X-rays; the radiographic result is stored as a digital image on a computer programme.

The skeletons, including the Ingombe Ilede remains, housed at the University of the Witwatersrand (WITS), Department of Anatomy were radiographed at the Central Animal Service, at the Medical School (WITS). The X-ray unit employed a Siemans Siregraph C radiograph machine and Konika AX film. The skeletal remains from the Natal Museum were radiographed by Doctor Kauffman and Partners in Pietermaritzburg. Doctors van Dyk and Vennote at the Bloemfontein Medi Clinic assisted with radiographs of the skeletal material from the National Museum, Bloemfontein.

C. Linear enamel Hypoplasia

Linear enamel hypoplasias (LEH) are characterised as deficiencies in the amount or thickness of the enamel (Figure 4.08). Enamel production by ameloblast cells can be disrupted as a result of systemic metabolic insult, just as in skeletal growth. Formation of the macro defect takes place after amelogenic growth is resumed following termination of the stressful period. The hypoplastic groove itself, is basically an incomplete layer of matrix that did not mineralise properly (Goodman & Rose, 1990).

A wide range of environmental factors that have been associated with disruption of ameloblastic physiology include childhood disturbances, weaning, pre-mature birth, malnutrition and even vitamin deficiencies of A, C and D vitamins (Goodman *et al.*, 1980; Larsen, 1997; Aufderheide & Rodriguez-Martin, 1998). Whatever the cause, prolonged or chronic stress may not produce enamel hypoplasias as the lesions have been related to acute, episodic events (Goodman & Rose, 1990; Aufderheide & Rodriguez-Martin, 1998).

Macroscopic observations were done on all maxillary and mandibular permanent teeth available. The permanent canines and second molars were chosen for the analysis of linear enamel hypoplasias (LEH). These teeth were chosen on the basis that they represent the widest range of dental development to assess childhood stresses. Developmentally, the two teeth combined (with some overlapping) represent amelogenic growth (enamel or crown formation) from about six months of age (canines) until about eight years (second molars), when crown formation of these teeth is completed (Ubelaker, 1978).

The severity of the lesions was recorded and measured using digital sliding callipers (criteria from Danforth *et al.* (1994: 92) :

- 1 - Slight: visible only in low incidence lighting
- 2 – Moderate: visible in ordinary room lighting, *ca.* 0.5 to 1.2mm in occluso-cervical width
- 3 – Severe: >1.5mm in occluso-cervical width.

The teeth were also divided into three developmental thirds and the number of incidents recorded for each third. Developmentally, the thirds (occlusal, middle and cervical) correspond to ages of enamel formation, which vary for each tooth type.

Furthermore, because crown formation of permanent canines and second molars overlap between two and six years of age, any insult(s) occurring during this period of a growing individual is likely to be recorded on both teeth. Therefore, to avoid double counting of the same insult on both teeth, the maximum number of insults appearing on **only** one of the two teeth is recorded. The same criterion applies to mandibular and maxillary teeth, as well as the left and right sides of the same tooth type. For instance, if maxillary and mandibular canines of the same individual showed a hypoplastic lesion, only the insult on one of the canines would be recorded. Also, if both left and right canines of the same individual had hypoplasias, only the lesions on either left or right tooth would be recorded as they probably represent the same insults.

The number of individuals was then calculated on the basis of survival of at least one of either the permanent canine or the permanent second molar; counted as one tooth = one individual. This calculation method seemed reasonable since any episode of metabolic insult that may have occurred during any individual's life between about 6 months to 8 years of age could be represented in one of these teeth.

D. Periosteal Bone Lesions (Periostitis)

Skeletal lesions most frequently found on long bone shafts, but can also occur on endo- and ecto-cranial tables of the skull, have been observed on a number of archaeological skeletal remains world-wide. These lesions are seen to be reactions of the bone to non-specific pathological conditions, initially involving the periosteum. Bacterial infection or injury that could lead to the accumulation of agents such as blood and pus may stimulate osteoblastic activity on the periosteum and subsequent deposition of new subperiosteal bone (Mensforth *et al.*, 1978 and Larsen, 1997).
Soft tissue infections, which do not necessarily affect or involve the skeleton, have been associated with localised periosteal elevations (Mensforth *et al.*, 1978).

Macroscopically, these lesions are characterised as osseous plaques with demarcated margins or irregular elevations of bone surfaces.
Unremodelled or active lesions, at the time of death, are observed as loosely organised woven bone on a skeletal element; while healed lesions are incorporated into the normal cortical bone, leaving the surface somewhat inflated (Larsen, 1997) (Figure 4.09).

All cranial and post-cranial skeletal elements were examined for signs of periosteal bone lesions (PBL). The severity of the lesions was recorded as follows:

- 1: pits and striations, with slight elevation of the bone surface
- 2: sheaths of new bone involving proliferation of both endosteal and periosteal bone surfaces.

Also, the status of the lesions at the time of death was recorded as either healed or unhealed, in order to provide some information of morbidity and mortality associated with the lesion. Their anatomical distribution was observed and recorded, to aid in differential diagnoses. This is then represented schematically on the skeleton.

E. Dental Pathology and Condition

Studies of dentition can contribute to dietary reconstructions because patterns of dental wear and dental disease are influenced by the nutritional quality and physical characteristics of food. In the light of this view, it was necessary to assess the dental health of the communities, in this study.

Dental disease processes that were assessed include dental caries, periodontitis, abscesses and antemortem tooth loss (AMTL). Dental attrition was also examined on the permanent dentition of each individual. Most dental pathologies as well as occlusal attrition are directly proportional to age. In other words, dental changes and associated disease processes tend to increase with an increase in age. Due to this fact, only the adult dentition was analysed for signs of dental pathology and rate of occlusal attrition.

A novel approach to calculate the number of individuals based on partial dentition that is typical of archaeological samples, was developed by Peckmann (2002) and utilised in the present study. To give a more accurate and true representation of the sample, "the number of individuals (n) is calculated based on the proportion of the maxilla or mandible present; individuals represented by only one quarter of a maxilla or mandible are counted as one eighth of one individual" (Peckmann, 2002: 79).

E.1. Dental Attrition

Dental wear, though not pathological, has been shown to affect the frequencies of pathology found in the dentition, such as caries and abscesses (Aufderheide & Rodriguez-Martin, 1998). For this reason, dental wear is assessed for each individual with permanent teeth. Since tooth wear is directly proportional to age, it was appropriate to assess only the permanent teeth of adult individuals, both young and old.

Dental attrition can be explained as the loss of hard tissue of a tooth during day-to-day processes of mastication and swallowing, as the teeth come into contact with one another (Aufderheide & Rodriguez-Martin, 1998). Based on scores of dental wear developed by Morris (1984) (Table 4.01), the occurrence and severity of occlusal attrition on adult dentition was analysed. The rate of occlusal wear for each tooth present was scored from 0 to 4:

- 0 = unworn
- 1 = slight wear
- 2 = slight to moderate wear
- 3 = heavy wear
- 4 = extreme wear.

Because teeth wear at different rates posteriorly and anteriorly, posterior and anterior attrition score were calculated for each group.

The anterior attrition score is the average rate of occlusion for the incisors and canines; while posterior attrition score is defined as the average rate of occlusion for the pre-molars and molars. Mean attrition scores were also calculated as the average between anterior and posterior attrition scores.

E.2. Dental Caries

Dental caries or tooth decay is a progressive disease characterised by the focal demineralisation of the inorganic portion (enamel and dentine) and destruction of the organic component of the tooth.

The aetiology of tooth decay is a multifactorial and multibacterial one, but organic acids produced by bacterial fermentation of dietary carbohydrates, is the basis of the process of tooth decay (Larsen, 1997; Aufderheide & Rodriguez-Martin, 1998; Burns, 1999).

Caries appear as foci of eroded regions on the enamel, usually dark-stained from the action of bacteria (Figure 4.10). Obviously, the vulnerability of teeth to decay is related to tooth type. Cusped teeth (molars and premolars) with their grooves and pits provide a haven for bacterial flourish that could result in higher occurrences of carious lesions when compared to flatter teeth (incisors and canines) (Aufderheide & Rodriguez-Martin, 1998).

All permanent teeth present were examined for the presence of caries. Carious lesions were scored present when an area of the enamel was compromised enough to be seen with a naked eye. Carious lesions were characterised by location using the following categories by Morris (1984):

- 1: None
- 2: Interproximal
- 3: Buccal
- 4: Lingual
- 5: Occlusal

There is a significant distortion that moderate to high rates of antemortem tooth loss may have on the accuracy and interpretation of dental caries. This is because a proportion of the teeth lost antemortem will be lost due to severe carious decay (Lukacs, 1995; Kelley *et al.*, 1991). For this reason, the Decayed and Missing Index (DMI) suggested by Kelley and co-workers will be employed to correct for this discrepancy in dental caries. The corrected caries rates is calculated as the sum of carious teeth and teeth lost antemortem, expressed as a percentage of the sum of teeth observed and those lost antemortem (Kelley *et al.*, 1991).

There is one issue, however, with the DMI as applied to non-living populations. The DMI assumes that the majority of antemortem tooth loss is a result of tooth decay; thus, underestimating other factors that may lead to tooth loss (such as periodontal disease, extreme dental wear or intentional tooth extraction) (Kelley *et al.*, 1991).

E.3. Periodontitis

Periodontitis is defined as a chronic, slowly progressive and destructive inflammatory disease process that affects the periodontium. Anatomically, it appears as a horizontal reduction of the alveolar bone or as pocket of bone rarefaction (Figure 4.11). In severe cases, resorption of the socket bone can also lead to antemortem loss of the tooth/teeth involved (Larsen, 1997 and Burns, 1999).

On observation, periodontitis was recorded as either present or absent.

E.4. Abscesses

An inflammation of the pulp cavity, following a spread of bacterial infection at the tooth root, whereby build-up of pus occurs, is referred to as an abscess. Pus accumulation in the pulp cavity can create a pressure that eventually causes destruction and resorption of the surrounding alveolar bone. Dental caries and excessive attrition have been suggested as causality for abscess formation (Aufderheide & Rodriguez-Martin, 1998; Burns, 1999).

Presence of abscesses, as can be seen in alveolar bone destruction, was recorded for all maxillary and mandibular elements present. To avoid misdiagnosis, criteria discussed by Lukacs (1989) were employed for the assessment of abscesses.

"If the location of the abscess was near the apex of the tooth root and the margin of the abscess cavity was rounded with evidence of reactive bone growth, then the individual was scored as having an abscess lesion" (Lukacs, 1989: 271) (Figure 4.12). Location of abscess, when present, was recorded in relation to the affected tooth.

E.5. Antemortem Tooth Loss

As already mentioned, trauma and infectious disease involving the dentition and/or soft tissue (gums) of the oral cavity could lead to loss of a tooth during life. When a tooth is lost antemortem, the alveolar bone begins to resorb resulting in a decrease in the height of the maxilla and/or mandible, at the specific foci (Burns, 1999) (Figure 4.13).

Antemortem tooth loss (AMTL) was assessed on all sockets present for each individual. A tooth was scored as lost antemortem if there was evidence of alveolar bone resorption.

F. Impact of Stress on Skeletal Growth

One of the most important questions to ask is what impact does physiological stress have on the normal growth and development of a person. We know that growth of both skeletal and dental tissues is disrupted or arrested during an episode of acute physiological stress. But to what extent does this disruption affect the individual's capability to reach his or her maximum stature?

In antiquity, growth disruption is usually examined through the study of long bone lengths. I have attempted to answer the above question by reconstructing growth curves of these communities, and to compare diaphyseal lengths of sub-adults.

F.1 Reconstruction of Growth Curves

The femur was used to produce skeletal growth profiles of the groups. Diaphyseal lengths of the femur were measured using an osteometric board and lengths recorded in millimetres. The mean diaphyseal lengths were then plotted against dental age in one-year categories. The mean age (in years) for each individual was calculated from the estimated age range to plot the growth curves of the populations.

F.2 Adult Long Bone Lengths and Stature Estimates

The maximum lengths of the tibia and femur for all adult individuals were measured using an osteometric board and recorded in millimetres. Long bone measurements are utilised in reflecting adult stature and growth in children. The femur measurements are used in the estimation of stature for the different groups. The Feldesman *et al.* (1990) femur stature ratio of 3.745 is employed to calculate stature. This ratio was chosen on the basis of its universal use for any gender and ethnic group (Wilson & Lundy, 1994).

Statistical Methods

The Chi squared test, which is a measure of the level of agreement between a set of observed and expected values, is employed to test for significance of frequency of occurrence, or differences between and within groups. All Chi squared values are significant at $p < 0.05$ level. For all statistical analyses, the data was analysed according to biogeographical zones, i.e. dry savanna, wet savanna and forest zones.
Testing is done using the statistical programmes EPISTAT (for a three-way analysis) and SPSS 11.5 (for a two-way analysis, only).

In the majority of cases, the small sample sizes present in this project suggest a degree of caution when examining the data, as well as their significance.

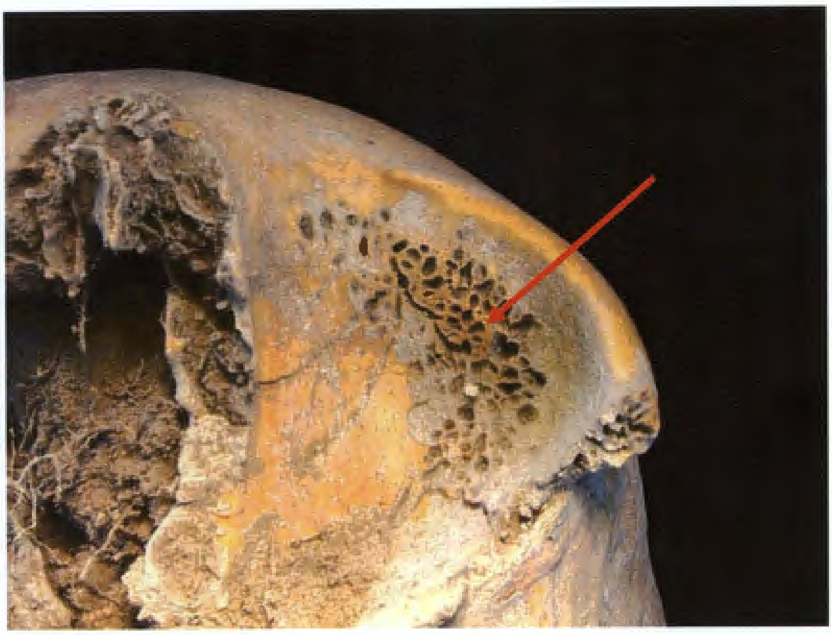


Figure 4.06 Cribra Orbitalia on left orbit

Figure 4.07 Porotic Hyperostosis on parietal bones

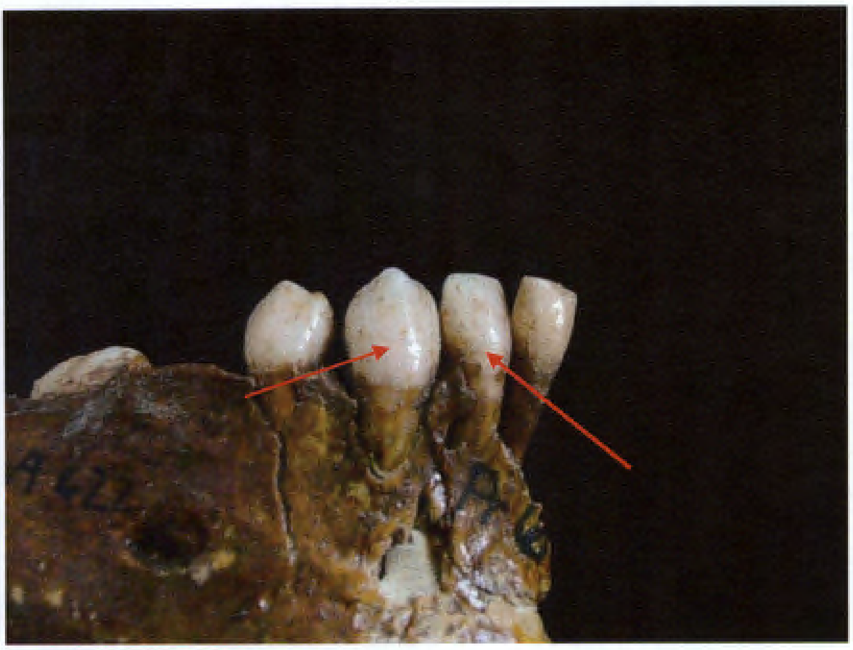


Figure 4.08 Linear Enamel Hypoplasia on mandibular canine and lateral incisor

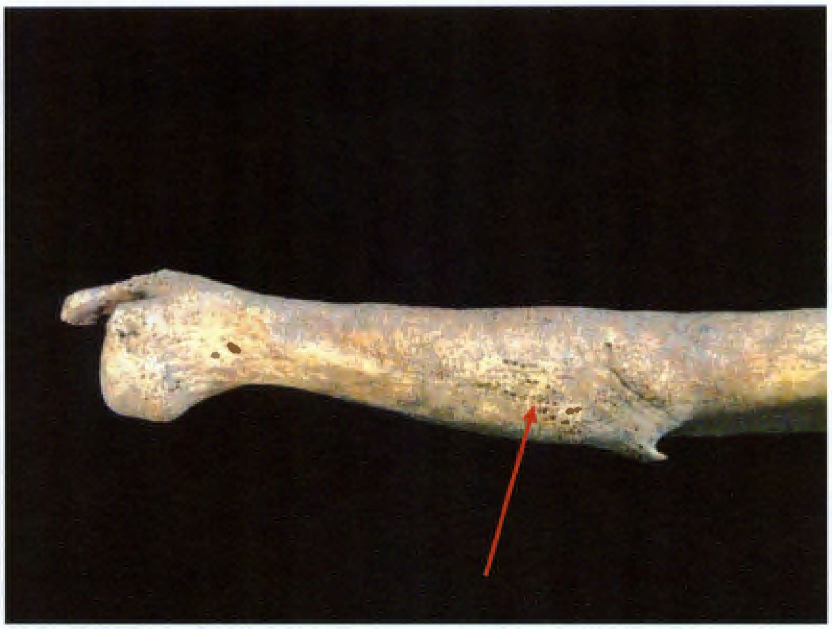


Figure 4.09 Specific periosteal reaction (remodelled) on distal ulna, following fracture

Table 4.01 Numerical Classification and Description of Tooth Wear Categories*

Stages	Incisors and Canines	Molars
0 unworn	No wear	No wear
1 slight wear	Enamel only	Enamel wear and slight dentine exposure on one cusp
2 slight to moderate wear	Slight to moderate dentine exposure	All cusps have slight to moderate dentine exposed, with coalescence of some cusps
3 heavy wear	Large dentine exposure, with rim still present	Dentine fully exposed on occlusal surface, with enamel rim
4 extreme wear	Tooth crown lost, enamel rim also worn, approaching CEJ	Tooth crown lost, enamel rim also worn, approaching CEJ

*Based on Morris, 1984: 185; Table 4.2

Figure 4.10 Dental Caries on maxillary molars and premolars

Figure 4.11 Periodontal Disease – resorbed gum line

Figure 4.12 Abscess – mandibular second molar

Figure 4.13 Antemortem Tooth Loss of mandibular 1st & 2nd molars

Chapter 5: RESULTS

Skeletal and dental pathology was recorded separately for each of the ecological zones. The small sample sizes made the separation of samples into Early versus Late 'Iron Age' not viable. For the majority of the pathological observations males and females were always analysed separately in order not to mask any sex-related differences. Age categories were also kept separate where this was appropriate in the analyses.

Due to the nature of archaeological data, incomplete and fragmentary, sample sizes tend to be small and further decrease with the assessment of each pathological condition. Thus, caution must be exercised when analysing and interpreting results and their limitations must be kept in mind. Though statistical significance may be possible with small samples, the range of variation present prehistorically may **not** be complete.

SKELETAL PATHOLOGIES

Cribra Orbitalia and Porotic Hyperostosis

From all samples in the three ecological regions, only individuals with at least one orbit and/or most of the cranial vault were included in the analysis of cribra orbitalia (CO) and porotic hyperostosis (PH).

Although the aetiologies of CO and PH may be similar, the exact nature of the relationship between orbital lesions and vault lesions remains uncertain (Stuart-Macadam, 1987). Therefore, both CO and PH were analysed separately in this project.

A. Cribra orbitalia

Tables 5.01 to 5.03 show the occurrence of cribra orbitalia (CO) in the dry savanna, wet savanna and forest ecological zones, respectively. For a better representation of the range of variation and for more statistically viable comparisons, age categories were combined into children (infants, juveniles and sub-adults), adult males and adult females (younger and older adults) as the numbers were small.

Females exhibit higher percentages of CO than the males in the dry savanna and in the wet savanna regions, but not in the forest zone. A total of 87.5% of the orbits analysed in the males from the forest sample had CO, with only 46.2% of the females with CO. A three-way Chi^2 comparison of the samples indicates no significant difference in the occurrence of CO between males and females within the regions ($p = 0.479$). There is, however, a significant difference when comparing between males alone in the different regions ($p = 0.019$).

In the dry savanna, it appears that the children are more frequently affected by CO than at either wet savanna or forest zones. A Chi^2 test again shows no significant difference in the frequency of CO between adults and children in the different regions, but the value of 0.057 is very close to the critical level of significance of $p = 0.05$. Overall, the occurrence of CO is highest in the forest zone followed by the dry savanna and lowest in the wet savanna region, but with no statistical significance ($p = 0.785$).

The severity of the lesions was examined for all individual orbits affected with CO. Within all ecological zones the severity of the lesions was mostly medium (Table 5.04). Thirty-one of 50 (62.0%) orbits affected in the dry savanna sample had medium severity; while 14 of 17 affected orbits (82.4%) among the wet savanna individuals and 16 of 22 affected orbits (72.7%) in the forest zone scored medium for severity.

B. Porotic Hyperostosis

As with the analysis of cribra orbitalia, age categories were grouped together for a more statistically viable comparison between adults and children, males and females. The frequency of porotic hyperostosis (PH) for dry savanna, wet savanna and forest zones is shown in Tables 5.05 to 5.07, respectively.

The children in all 3 ecological zones are much less affected by PH than the adult individuals. Although this is quite visible in the percentages, the small sample sizes do not allow the Chi^2 values to reach significant levels ($p = 0.615$) in the comparison of childhood versus adult frequencies.

In the dry savanna zone, the males are more affected with PH than their female counterparts. The difference in affected cranial vaults between males and females in the wet savanna and forest zones is minimal. The difference between males and females in the regions is not statistically significant ($p = 0.438$). But, a significant difference does exist when comparing between females alone, in the three samples ($p = 0.017$).

Once again, the occurrence of PH seems to be generally higher in the forest zone, lower in the wet savanna and lowest in the dry savanna population. When all ages and sexes are pooled to increase sample size, the higher frequency in the forest sample does produce a significant Chi^2 value ($p = 0.018$).

The majority of the affected cranial vaults had lesions of light severity in all the 3 regions (Table 5.08); though more than a third (39.1%) of the affected crania had medium severity of the lesions in the forest region.

C. Harris Lines

Complete tibiae or femora, whose length measurements are known, were ideal to enable the calculation of the age of line formation. However, incomplete tibiae or femora with intact distal ends were also included in the analysis of HL. The age of line formation, however, could not be calculated for individuals with incomplete tibia(e) or femur(ora), but were added to the incidence of HL in the samples.

Since no X-rays were done in the Democratic Republic of Congo (DRC) and in Belgium, the individuals from the forest zone were not included in the analysis of HL. Thus, comparison of the frequency of HL is only possible between individuals from the dry savanna and wet savanna environments.

Table 5.09 presents the list of individuals exhibiting HL, their sex (where available), estimated age at death, number of lines observed, as well as the calculated age of line formation (in years). The wet savanna population has a higher percentage (50.0%) of individuals exhibiting HL than the dry savanna population (20.0%). The average number of lines per person was, however, the same in the two regions (2.3 lines/person). Three out of 5 adult individuals exhibiting HL in the wet savanna sample were males and 2 were females. One male and one female expressed HL in the dry savanna population. The frequency of lines in the dry savanna peaks between thirteen and fourteen years; whereas the highest frequency of lines in the wet savanna is observed between twelve and fifteen years.

D. Linear Enamel Hypoplasia

For estimating the age of hypoplastic band formation, the canines and second molars were divided into three developmental thirds or units, according to the stages of enamel deposition and crown formation. The three units with their corresponding age for each tooth type are presented in Table 5.10.

The results presented here include the juvenile and sub-adult age categories, which have been combined into one category called children in order to make them statistically viable. The younger and older adult age categories were also combined, but sexes were kept separate for the analysis of LEH.

The highest frequency of individuals with hypoplastic lesions on their teeth was found in the dry savanna population (72.3%), followed by individuals from the wet savanna zone (64.3%) and lowest in the forest population (38.5%) (Table 5.11). A Chi^2 test indicates a significant difference in the frequency of LEH when all age and sex groups are combined, in all samples ($p = 0.017$).

The average number of insults per individual is slightly higher in the dry savanna (1.9 insults/person) than in either wet savanna (1.8 insults/person) or forest populations (1.5 insults/person).

Females in the dry savanna exhibit more LEH on their teeth than the males (75.0% vs. 64.7%), but they have a lower average number of insults per individual (1.7 vs. 2.1). The contrary is true for the wet savanna and forest populations; females have lower LEH incidences than their male counterparts and much more insults per person.

Table 5.12 shows the distribution of enamel units affected with hypoplasias and provides the age of formation of the hypoplasias. In all regions, more than two-thirds (>60.0%) of hypoplasias were formed between 2 and 6 years of age; more so in the forest environment (80.0%). Formation of the hypoplasias peaks at the age of 4 and 6 years in the dry savanna (40.0%), as well as in the forest zone (46.7%).

E. Sub-periosteal Bone Lesions

All cranial elements and major long bones of the upper and lower limbs, as well as ribs were examined for signs of sub-periosteal bone lesions (SPBL). Complete and partial skeletal elements were treated and counted as whole units. The left and right sides of paired elements (e.g. long bones) were counted separately.

The affected elements, age distribution and sex divisions for the analysis of SBPL are presented in Tables 5.13, 5.14 and 5.15 for the dry savanna, wet savanna and forest ecological zones, respectively. Analysis of SPBL on all skeletal elements showed highest frequencies of infections on the lower limb long bones, with differences in the regions. The femur followed by the tibia is the most affected bone with sub-periosteal bone lesions. More upper limb long bones are affected by SPBL in the dry savanna (6.9%) than in either wet savanna (2.2%) or forest (0.9%) populations. Infections on the thorax are more prevalent in the forest zone (6.3%) followed by the dry savanna sample (4.2%) and none were found (0.0%) in the wet savanna region, but are generally low in all zones. Generally, very few cranial elements exhibited sub-periosteal bone reactions in all regions.

Overall, the forest population has the highest number of skeletal elements affected by SPBL, lower infection rates in the wet savanna sample and lowest in the dry savanna zone. When comparing between males and females, respectively, the frequency of skeletal elements affected by SBPL seem to increases from dry savanna (22.2% vs. 22.3%) to wet savanna (18.8% vs. 7.4%) to forest populations (34.7% vs. 14.8%). The males in the wet savanna and forest environments are significantly more affected with SPBL than the females (p = 0.001). None of the children in the wet savanna region were affected by SPBL; while 5.2% from the dry savanna and 12.8% from the forest zones showed signs of SPBL on the post-cranial skeletal elements. There are no significant differences in the frequency of SBPL between adults and children in the regions (p = 0.216).

It, therefore, appears that sub-periosteal bone infections are more prevalent in adult males and lowest in children, and are more frequently found on the lower limb long bones than on either upper limb or cranial elements.

DENTAL PATHOLOGIES

For all the analyses of dental pathology and dental wear, the number of individuals was calculated on the basis of a proportion of maxilla or mandible present. Individuals represented by one quarter of a maxilla or mandible were counted as one eighth of one individual.

A. Antemortem Tooth Loss

Since age and sex are important variables in the analysis of antemortem tooth loss (AMTL), younger and older adults; males and females were kept separate. When the age categories are compared, the younger adult individuals, in all three regions, have lower incidences of AMTL than the older individuals (Tables 5.16 to 5.18). Therefore, percent of individuals with AMTL increases with an increase in age in these populations. There is also a difference in the frequency of individuals affected with AMTL (ages and sexes pooled) through the regions; the lowest frequency is found in the dry savanna (34.2%), higher in the wet savanna (63.4%) and highest in the forest zone (72.3%). However, when tooth places are compared, AMTL is highest in the wet savanna (16.1%), followed by the forest sample (8.2%) and lowest in the dry savanna (8.0%).

When younger and older adult categories are compared within the samples, there is no significant difference for antemortem tooth loss ($p = 0.559$).

A difference in percentage of AMTL is observable between males and females in all population groups. The males in the dry savanna display a slightly greater AMTL percentage than the females (36.3 % vs. 31.1%). The difference is more obvious in the wet savanna and forest zones; 67.1% of males vs. 47.4% of females and 84.9% of males vs. 57.8% of females, respectively (Table 5.19). No significant differences were, however, found ($p= 0.705$).

In all groups, the pattern of AMTL on posterior versus anterior teeth varies. The most commonly lost teeth are the first molars, the central incisors and the third molars, with varying frequency within the samples (Table 5.20). In the wet savanna and forest regions, the central incisors are more frequently lost than any other tooth type in the adult dentition; while the first molar is frequently lost in the dry savanna. Possibly, dental modification, in the form of tooth extraction and tooth chipping and/or filing, could be a reason for a higher frequency of antemortem loss of the central incisors.

B. Dental Caries

Younger and older adult individuals as well as juveniles and sub-adults were examined for the presence of dental caries. Infants (0 to 5 years of age) were not included in this analysis since no deciduous teeth were affected by dental caries. Therefore, all the data presented here are from the permanent dentition, only.

Tables 5.21 to 5.23 show the summary of the frequency and intensity of caries in the adult dentition, i.e. younger and older adult individuals. The percentage of individuals with carious teeth decreases with an increase in age, in the wet savanna and forest regions. In the wet savanna population, 63.6% of individuals with carious teeth fall into the younger adult category, and 42.1% are older adults. A total of 62.8% of younger adults have caries and 51.2% belong to the older adult category in the forest sample. Also, the average number of carious teeth per mouth decreases as age increases.

When looking at the dry savanna population, however, there is a change from the pattern seen in the wet savanna and forest regions. Younger adult individuals are less frequently affected with dental caries (20.9%) than the older adults (63.6%). The average number of carious teeth per mouth is much higher in the older adult category (2.6 carious teeth/mouth) than in the younger adult group (0.1 carious teeth/mouth), in the dry savanna population. No significant difference exists between the adult age categories in all regions ($p = 0.228$).

The males from the wet savanna and forest zones have a higher frequency of caries than their female counterparts (Table 5.24). This is not true for the dry savanna population. The females have a higher percentage of caries (43.3%) than the males (30.4%) in this group. Comparison for the presence of caries between males and females shows no significant difference ($p = 0.334$), in all groups.

There were no children affected with dental caries in the wet savanna zone; while 30.0% and 35.3% of children had dental caries in the dry savanna and forest regions, respectively. The low frequency of caries in children in all regions, is probably due to fewer numbers of permanent teeth present for examination than one would find in adults.

In general, the forest population has the highest caries frequency (55.4%), followed by the wet savanna group (48.1%) and the lowest caries frequency is found in the dry savanna population (35.5%), when age and sex categories are combined.

Observed caries rate or caries intensity of permanent teeth of adults and children was calculated. When age and sex categories were pooled, differences in caries rates between the various regions are marked (Table 5.24). In the dry savanna region, only 37 of the 1014 teeth (3.7%) observed had carious lesions. Of the 303 teeth observed in the wet savanna sample, 23 (7.6%) of these had carious lesions. A total of 439 teeth were observed in the forest zone, and 36 (8.2%) of these teeth were affected by dental caries.

Since there is relationship between antemortem tooth loss (AMTL) and dental caries rates, the total number of teeth lost antemortem was used to calculate the decayed-and-missing index, for all samples. Using Kelley's *et al.* method (1991), the decayed-and-missing index (DMI) was calculated to correct for caries rates on observed teeth. Overall, when the observed (uncorrected) caries rate is compared to the corrected caries rate (DMI), there are notable differences, for all samples (Table 5.25). For all samples, the decayed-and-missing index (DMI) shows markedly higher corrected caries rates. This is not surprising because the DMI makes an assumption that all teeth (including anterior and posterior) are lost due to dental caries, albeit not all AMTL results from caries.

Almost all teeth affected with carious lesions were posterior teeth, i.e. molars and pre-molars, with the exception in four individuals (Table 5.26). Four anterior teeth (2 incisors and 2 canines) of a younger adult male individual (Sanga-T10b) from the forest zone were affected with caries. Another younger adult male individual (Sanga-T21) from the same region had caries on the left mandibular lateral incisor and adjacent canine. One older adult female (Sanga-T58) in the forest sample had a carious canine, and one juvenile (A*1711) from the dry savanna region had a carie on a central incisor. The most commonly affected teeth were the molars, with slight differences in all groups.

C. Periodontitis

Since periodontitis progresses with age, younger and older adult individuals were analysed separately for the presence of periodontitis.

The overall frequency of periodontitis is highest in the forest-zone individuals (60.6%), lower in the dry savanna (48.9%) and a low of 39.6% in the wet savanna zone (Tables 5.27 to 5.29). A Chi^2 test reveals no significant difference in the regions when age and sex groups are pooled ($p = 0.774$).

When the age categories are analysed separately, very high frequencies of periodontitis are observed in the older adult category. In the dry savanna population, 89.6% of older adult individuals have periodontitis; whereas only 27.7% of the younger adults have this disease. This pattern is similar in the forest zone and in the wet savanna region. A frequency of 88.4% in the older adults versus 47.9% in the younger adults in the forest population is affected with periodontitis. More than double the frequency of periodontitis in the younger adults (20.5%) is found in the older adult group (54.4%), in the wet savanna region. However, no significant difference in the frequency of periodontitis was found, when comparing between younger and older adults in all regions ($p = 0.647$).

Differences between sexes also occur in the different ecological zones. For the population in the dry savanna and forest regions, more males show signs of infection than the females. In the wet savanna, the females present with a higher frequency of periodontitis (47.4%) than the males (37.8%). There was no significant difference between males and females ($p = 0.985$) in all samples.

D. Dental Abscesses

The occurrence of dental abscesses in the adult dentition for the dry savanna, wet savanna and forest zones is shown in Tables 5.30 to 5.32.

The frequency of abscesses appears very similar when all regions are compared; 24.0% for the dry savanna, 30.7% for the wet savanna, and 29.2% for the forest population. Once again, the frequency of abscesses in the adult dentition tends to increase with age, i.e. older adult individuals show more signs of infection than the younger adults.

Compared to a high 37.8% of males with abscesses, none of the females (0.0%) in the wet savanna were affected with dental abscesses. Higher frequencies of abscesses are observed among males than are seen in females, in the dry savanna and forest zones. No significant differences exist between males and females ($p = 0.235$), as well as between younger and older adult categories ($p= 0.286$), in all samples.

E. Occlusal Attrition

The occurrence and severity of occlusal attrition in the adult dentition is analysed and presented in Tables 5.33 and 5.34. Sex and age categories were analysed separately, since patterns of wear in males and females can provide information about differences in diet and/or behaviour between the sexes. Also, since age is directly proportional to tooth wear, younger and older adults were analysed separately. However, because there was only one older adult female in the wet savanna sample, assessment of occlusal attrition was combined into one adult category for the female adult dentition in this group.

In all age and sex groups, the total anterior attrition score is larger than the total posterior attrition score, i.e. anterior teeth show a greater degree of wear than the posterior teeth. This is more obvious in the younger adult category, in all regions. Overall, mean attrition scores are similar in all three zones. Slight differences between males and females are observable for the degree of wear, and there are differences within regions.

In general, both anterior and posterior occlusal attrition increase in the dry savanna, wet savanna and forest environments, as the age of the individual increases.

When comparing age categories within regions, the individuals from the dry savanna zone display a larger mean attrition score in both younger and older adult categories. The females in this sample also show slightly more worn teeth than the males.

In the younger adult group from the wet savanna zone, the males illustrate a greater anterior attrition score (1.8) than the females (1.3). This pattern remains the same in the older adult group of this sample, with an anterior score of 2.0 for the males and 1.3 for the females.

The degree of wear does not greatly differ between younger adult males and females of the forest sample, but females illustrate a slightly higher mean wear score than the males (1.4 vs. 1.0). Then the reverse occurs between the sexes in the older adult category of the forest population.

The incisors show the greatest degree of wear in the younger adult group, followed by the first molar, in all samples. In the older adult category, the first molar is more heavily worn than the incisors. Moreover, the canines seem to be similarly worn as the incisors in the older adult groups, for all regions. The tooth that is least worn is the third molar, for all samples, most probably because it is the last tooth to erupt in the adult dentition. Statistical significance for differences in tooth wear in the samples, has not been found when comparing between younger and older adults ($p = 0.870$), as well as between males and females ($p = 0.929$).

F. Dental Modification

Signs of dental modification of any kind were examined on all anterior permanent teeth as well as anterior-tooth positions present. Since antemortem tooth loss can be caused by severe periodontitis, abscesses and other dental disease processes, individuals with heavily diseased mouths were excluded from the analysis of the tooth extraction practice. Table 5.35 shows the list of all individuals exhibiting signs of tooth extraction, with the specific anterior teeth lost antemortem.

Tooth extraction appears to have been practised in all regions, i.e. in the dry savanna, wet savanna and in the forest zone. In the dry savanna population, only one adult female had her front teeth pulled out antemortem. The number of individuals showing signs of intentional tooth extraction increases in the wet savanna population to five. The five individuals are all males of various ages, but the interesting one is the sub-adult male individual (PMB 2000/11), who could provide a possible indication of the age when the practice was done. Within the forest sample, four adult males and two adult females show signs of intentional tooth extraction.

Tooth chipping and/or filing has also been identified in the samples from the various ecological zones. The practice seems to have been more commonly done in the forest region than in either dry or wet savanna regions (Table 5.36). Nine individuals in the forest sample had their incisors chipped off at both corners to give a characteristic pointy appearance. It is also apparent that this practice was commonly done by females; hence 8 of the 9 individuals with chipped incisors are female. Only one male individual exhibited chipped central and lateral incisors. In the dry savanna, one adult male and three adult females had chipped or filed their incisors on both corners to give a pointy appearance.

A different pattern of tooth filing is seen in one individual from the wet savanna zone. This adult male individual had the mesial corners of his maxillary central incisors filed to give an inverted V-shape appearance.

The details of the pattern of tooth extraction and tooth chipping and/or filing are not very clear, due to the nature of the state of preservation of the remains. Some attempt is, however, made to reconstruct the pattern of tooth extraction and tooth chipping and/or filing (See Figures 6.05 and 6.06, respectively in Chapter 6). In the case of tooth extraction, for example, the clearest picture of the pattern that can be seen is the removal of the maxillary central incisors as well as mandibular central and lateral incisors. What is also notable is that the canines tend to fall out as a factor of progressive alveolar bone loss and not intentionally extracted (Morris, 1993). This has been observed in three individuals, all adults above 30 years at the time of death.

Interestingly, one of the two females (Sanga-T116) from the forest sample exhibited maxillary central and lateral incisors with chipped corners as well as intentional extraction of the mandibular central and lateral incisors. Furthermore, it was noticed that the right upper lateral incisor was not modified at the time of death (around 25 years). Could this be an indication that the mutilation was done in stages? The answer to this question will be attempted in the discussion (See Chapter 6).

The majority of the chipped incisors analysed are maxillary, with the exception of two individuals (Sanga-T8; UP89) who had their mandibular central and lateral incisors chipped and/or filed at both corners. It also appears that all four incisors, central and lateral, were modified (Figure 5.01).

Some of the individuals exhibiting tooth chipping and/or filing were represented by either a maxilla or a mandible. In most cases, the mandibular teeth were either broken post-mortem with only the roots remaining in the sockets or the sockets were altogether broken. The information that can be obtained from the remaining root stumps in the available sockets is at least indicating that the other front teeth were <u>not</u> extracted.

All the four individuals from the dry savanna zone with chipped incisors are represented by a full dentition, i.e. both maxillary and mandibular teeth are present for analysis. The pattern of tooth chipping and/or filing that can be obtained from these individuals is invaluable. Three of the 4 have only the maxillary incisors chipped off at both corners. One individual (UP89) has all incisors chipped at corners, maxillary and mandibular central and lateral incisors.

GROWTH

A. <u>Impact of Stress on Skeletal Growth and Reconstruction of Growth Curves</u>

An attempt to assess the impact of physiological stress on the skeletal growth of these populations was made through comparison of long bone lengths and stature estimation.

The diaphyseal femoral lengths of all individuals under the age of 20 years are illustrated in figure 5.02 for the dry savanna sample. The wet savanna and the forest samples have too few individuals below 20 years. The few 'immature' individuals that are present with measured or known diaphyseal lengths of the femur are between the ages of 0 and 7 years at death. So, growth curves for these populations could not be reconstructed. A normal biological progression of an increase in femoral length as the age increases is illustrated in the growth curve. Any growth spurts, adolescent and juvenile, that occur in normal growth of an individual, were not evident in this graph since there still are few individuals to demonstrate this.

B. <u>Long Bone Length</u>

For the comparison of long bone lengths between the dry savanna, wet savanna and the forest populations, tibial and femoral lengths versus age, are presented in Table 5.37. Since sex is an important factor in stature differences, usually caused by sexual dimorphism, males and females were analysed separately. Length measurements of the femur and tibia are compared between adult males and females in the three populations (Table 5.38). Only the femur was utilised to estimate stature of all adult

individuals, using the Feldesman *et al.* (1990) femur stature ratio of 3.745. The average length between the left and right elements was used.
Table 5.38 presents the mean maximum lengths of the adult femur and tibia, as well the estimated stature for each sample. In all groups, the males are taller than the females, with differences within and between populations. The males (1743.3 mm) and females (1632.1) in the dry savanna are tallest, when comparing between regions; whereas the forest males are the shortest (1671.4 mm) and their female counterparts (1612.6 mm) are taller than the females in the wet savanna (1586.0 mm). When comparing mean long bone lengths, the wet savanna males have the longest tibia (407 mm) than either dry savanna males (387.9 mm) or forest males (379.4 mm). Among females, the tallest female group (1632.1 mm) from the dry savanna also display longer mean femoral and tibial lengths than the females in the other regions.

Differences between male and female stature were also analysed to test for the degree of sexual dimorphism in the populations (Tobias, 1972). Using the mean stature, the group that shows the highest degree of sexual dimorphism between males and females is the wet savanna sample. The males in the wet savanna are 6.78% taller than the females. In the dry savanna population, males are taller than the females by 6.38%; while the smallest degree of 3.52% sexual dimorphism is observed in the forest population.

	Total no.* Individuals with Orbits	No. of Individuals with CO	%
Infants	4.5	3	66.7
Juveniles	9.5	8	84.2
SA	5	2	40.0
YA Males	10	4	40.0
YA Females	6.5	4.5	69.2
OA Males	7	3	42.9
OA Females	2.5	1.5	60.0
CHILDREN*	19	13	68.4
ADULT MALES*	17	8	47.1
ADULT FEMALES*	9	6	66.7
TOTAL	45	27	60.0

SA = Sub-adults
YA = Younger Adults
OA = Older Adults
Children* = Includes infants, juveniles and sub-adults
Adults* = Includes YA, OA
CO = Cribra Orbitalia
Total no. = Number of individuals based on orbits present; 2 orbits = 1 individual

Table 5.01 Occurrence of Cribra Orbitalia – Dry Savanna zone

	Total no.* Individuals with Orbits	No. of Individuals with CO	%
Infants	2	0.5	25.0
Juveniles	2	0	0.0
SA	1	1	100.0
YA Males	3	2.5	83.3
YA Females	3	2	66.7
OA Males	7	4	57.1
OA Females	0	-	-
CHILDREN*	5	1.5	30.0
ADULT MALES*	10	6.5	65.0
ADULT FEMALES*	3	2	66.7
TOTAL	18	10	55.6

SA = Sub-adults
YA = Younger Adults
OA = Older Adults
Children * = Includes infants, juveniles and sub-adults
Adults* = Includes YA, OA
CO = Cribra Orbitalia
Total no. = Number of individuals based on orbits present; 2 orbits = 1 individual

Table 5.02 Occurrence of Cribra Orbitalia – Wet Savanna zone

	Total no.* Individuals with Orbits	No. of Individuals with CO	%
Infants	1.5	1	66.7
Juveniles	0.5	0	0.0
SA	2	1	50.0
YA Males	4	3	75.0
YA Females	6	2.5	41.7
OA Males	4	4	100.0
OA Females	0.5	0.5	100.0
CHILDREN*	4	2	50.0
ADULT MALES*	8	7	87.5
ADULT FEMALES*	6.5	3	46.2
TOTAL	18.5	12	64.9

SA = Sub-adults
YA = Younger Adults
OA = Older Adults
Children* = Includes infants, juveniles and sub-adults
Adults* = Includes YA, OA
CO = Cribra Orbitalia
Total no. = Number of individuals based on orbits present; 2 orbits = 1 individual

Table 5.03 Occurrence of Cribra Orbitalia – Forest zone

DRY SAVANNA	Light	Medium	Severe	Total no. of Orbits Affected	Total no. of Orbits Present
Children*	5	15	5	25	38
Adult Males*	5	9	0	14	34
Adults Females*	4	7	0	11	18
TOTAL	14	31	5	50	90
WET SAVANNA					
Children*	0	3	0	3	10
Adult Males*	0	9	2	11	20
Adults Females*	1	2	0	3	6
TOTAL	1	14	2	17	36
FOREST					
Children*	2	2	0	4	8
Adult Males*	1	9	2	12	16
Adults Females*	0	5	1	6	13
TOTAL	3	16	3	22	37

Children* = Includes infants, juveniles, sub-adults
Adults = Includes YA, OA

Table 5.04 Severity of Cribra Orbitalia

	Total no.* Individuals with Cranial Vaults	No. of Individuals with PH	%
Infants	8	0	0.0
Juveniles	14	3	21.4
SA	6	2	33.3
YA Males	11	10	90.9
YA Females	7	4	57.1
OA Males	7	5	71.4
OA Females	3	0	0.0
CHILDREN*	28	5	17.9
ADULT MALES*	18	15	83.3
ADULT FEMALES*	10	4	40.0
TOTAL	56	24	42.9

SA = Sub-adults
YA = Younger Adults
OA = Older Adults
Children* = Includes infants, juveniles and sub-adults
Adults* = Includes YA, OA
PH = Porotic Hyperostosis
Total no. = Number of individuals based on presence of cranial vault; parietal and/or occipital and/or frontal bone(s) = 1 individual

Table 5.05 Occurrence of Porotic Hyperostosis – Dry Savanna zone

	Total no.* Individuals with Cranial Vaults	No. of Individuals with PH	%
Infants	4	1	25.0
Juveniles	3	0	0.0
SA	1	0	0.0
YA Males	3	2	66.7
YA Females	3	3	100.0
OA Males	7	5	71.4
OA Females	1	0	0.0
CHILDREN*	8	1	12.5
ADULT MALES*	10	7	70.0
ADULT FEMALES*	4	3	75.0
TOTAL	22	11	50.0

SA = Sub-adults
YA = Younger Adults
OA = Older Adults
Children* = Includes infants, juveniles and sub-adults
Adults* = Includes YA, OA
PH = Porotic Hyperostosis
Total no. = Number of individuals based on presence of cranial vault; parietal and/or occipital and/or frontal bone(s) = 1 individual

Table 5.06 Occurrence of Porotic Hyperostosis – Wet Savanna zone

	Total no.* Individuals with Cranial Vaults	No. of Individuals with PH	%
Infants	8	1	12.5
Juveniles	2	0	0.0
SA	3	2	66.7
YA Males	6	6	100.0
YA Females	7	6	85.7
OA Males	6	6	100.0
OA Females	2	2	100.0
CHILDREN*	13	3	23.1
ADULT MALES*	12	12	100.0
ADULT FEMALES*	9	8	88.9
TOTAL	34	23	67.6

SA = Sub-adults
YA = Younger Adults
OA = Older Adults
Children* = Includes infants, juveniles and sub-adults
Adults* = Includes YA, OA
PH = Porotic Hyperostosis
Total no. = Number of individuals based on presence of cranial vault; parietal and/or occipital and/or frontal bone(s) = 1 individual

Table 5.07 Occurrence of Porotic Hyperostosis – Forest zone

	Light	**Medium**	**Severe**
DRY SAVANNA	19	5	0
WET SAVANNA	8	3	0
FOREST	12	9	2
TOTAL	39	17	2

Children* = Includes infants, juveniles, sub-adults
*Adults = Includes YA, OA

Table 5.08 Severity of Porotic Hyperostosis

Individual*	Sex	Age at Death (years)	Type of Bone	Number of Lines^	Age of Line Formation (years)
Dry Savanna zone N* = 35 (20.0%)					
A2855	child	8 - 9	Tibia (L)	1	N/A
A2852	child	8 – 9	Femur (L&R)	2	N/A
A312	child	10 - 12	Tibia (L&R)	6	N/A
UCT328	child	12+	Tibia (L&R)	3	N/A
NMB11	child	~	Femur (R)	1	N/A
*UCT430	male	35 - 45	Tibia (L)	2	~
NMB12	female	25+	Tibia (L)	1	13 – 14
Wet Savanna zone N* = 16 (50.0%)					
PMB80/2.1a	child	6 - 7	Tibia (R)	1	N/A
PMB92/10	child	~	Tibia (L)	3	N/A
*KZ86/1a	child	9+	Femur (R)	4	~
*II/38	male	33 - 42	Tibia (L&R)	4	~
II/17	male	24 - 32	Tibia (L&R)	1	13 – 15
*KZ86/2	male	33 - 42	Tibia (R)	1	~
II/34	female	40+	Tibia (L&R)	1	13 – 15
II/14	female	20 - 23	Tibia (L&R)	3	12 – 14

Individual* = There are no X-rays for individuals from the Forest ecological zone
Individuals exhibiting Harris Lines are from Dry and Wet Savanna zones, only
N* = Total number of individuals with tibia and/or femur

Number of Lines^ = as seen on the tibia or femur. The maximum number of lines was counted and recorded on either the left (L) or right (R) side

*UCT430; *KZ86/1a; *II/38; *KZ86/2 = Exhibit Harris lines, but have no length measurements. Thus, age of line formation cannot be calculated

N/A = Age could not be calculated using Byers' (1991) method

Table 5.09 Individuals exhibiting Harris Lines

Developmental Unit	Age of Crown Formation^ (in years, +/- 6 months)	Tooth Type
Occlusal	0.5 to 2	Canine
Middle	2 to 4*	Canine
Cervical	4 to 6*	Canine
Occlusal	2 to 4*	Second Molar
Middle	4 to 6*	Second Molar
Cervical	6 to 8	Second Molar

*Overlap in crown formation
^Based on Gustafson & Koch (1974)

Table 5.10 Age distribution of crown formation of permanent canines and second molars

Dry Savanna

n*	CHILDREN* 18		MALE 17		FEMALE 12		TOTAL 47	
	No.	%	No.	%	No.	%	No.	%
No. of individuals with LEH*	14	77.8	11	64.7	9	75.0	34	72.3
Avg. no. of insults/individual	1.9		2.1		1.7		1.9	

Wet Savanna

n*	CHILDREN* 3		MALE 7		FEMALE 4		TOTAL 14	
	No.	%	No.	%	No.	%	No.	%
No. of individuals with LEH*	2	66.7	5	71.4	2	50.0	9	64.3
Avg. no. of insults/individual	1.0		1.8		2.5		1.8	

Forest

n*	CHILDREN* 5		MALE 11		FEMALE 10		TOTAL 26	
	No.	%	No.	%	No.	%	No.	%
No. of individuals with LEH*	3	60.0	4	36.4	3	30.0	10	38.5
Avg. no. of insults/individual	1.0		1.3		2.3		1.5	

Children* = Includes juveniles and sub-adults
n* = Number of individuals as represented by one permanent canine and/or second molar present

Table 5.11 Incidence of Linear Enamel Hypoplasia for permanent canines and second molars

Ecological Zone		Total No.*of Insults	Distribution of Enamel Units Affected with LEH							
			0 - 2yrs		2 - 4yrs^		4 - 6yrs^		6 - 8yrs	
		No.*	No.*	%	No.*	%	No.*	%	No.*	%
DRY SAVANNA	Children*	27	3	11.1	8	29.6	12	44.4	4	14.8
	Males	23	3	13.0	2	8.7	11	47.8	7	30.4
	Females	15	2	13.3	7	46.7	3	20.0	3	20.0
	TOTAL	65	8	12.3	17	26.2	26	40.0	14	21.5
WET SAVANNA	Children*	2	0	0.0	1	50.0	1	50.0	0	0.0
	Males	9	1	11.1	4	44.4	2	22.2	2	22.2
	Females	5	1	20.0	1	20.0	2	40.0	1	20.0
	TOTAL	16	2	12.5	6	37.5	5	31.3	3	18.7
FOREST	Children*	3	0	0.0	1	33.3	2	66.7	0	0.0
	Males	5	0	0.0	1	20.0	4	80.0	0	0.0
	Females	7	2	28.6	3	42.9	1	14.3	1	14.3
	TOTAL	15	2	13.3	5	33.3	7	46.7	1	6.7

No.* = Number of hypoplasia(s) in one unit or third
Children* = Includes juveniles and sub-adults
2 – 4yrs^; 4 – 6yrs^ = Enamel/crown formation overlaps in canines and second molars, between 2 and 6 years of age.
Hence, the maximum number of insults is recorded (NOT added) on one of the two teeth, to avoid double count.

Table 5.12 Age of formation of hypoplasias

	MALE			FEMALE			CHILDREN*			TOTAL		
Skeletal Element*	n*	No.	%	n*	No.	%	n*	No.	%	n*	No.	%
Cranial												
Calvarium	21	2	9.5	11	0	0.0	23	1	4.3	55	3	5.4
Mandible	16	1	6.3	12	2	16.7	21	0	0.0	49	3	6.1
Face	21	0	0.0	11	1	9.1	23	0	0.0	55	1	1.8
Post-cranial												
Ribs	5	0	0.0	10	1	10.0	9	0	0.0	24	1	4.2
Humerus	17	1	5.9	22	4	18.2	22	3	13.6	61	8	13.1
Radius	18	1	5.6	21	1	4.8	22	0	0.0	61	2	3.3
Ulna	13	0	0.0	21	2	9.5	19	0	0.0	53	2	3.8
Femur	22	8	36.4	14	6	42.9	2	0	0.0	57	14	24.6
Tibia	19	10	52.6	14	8	57.1	3	1	33.3	56	19	33.9
Fibula	14	4	28.6	10	3	30.0	19	1	5.3	43	8	18.6

Skeletal Element* = All bones treated as whole units.
Left and right sides of paired elements counted separately
Children* = Includes juveniles and sub-adults
n* = Total number of skeletal elements studied

Table 5.13 Summary of sub-periosteal bone lesions – Dry Savanna zone

	MALE			FEMALE			CHILDREN*			TOTAL		
Skeletal Element*	n*	No.	%	n*	No.	%	n*	No.	%	n*	No.	%
Cranial												
Calvarium	11	0	0.0	4	0	0.0	4	0	0.0	19	0	0.0
Mandible	11	0	0.0	3	0	0.0	4	0	0.0	18	0	0.0
Face	11	0	0.0	4	0	0.0	4	0	0.0	19	0	0.0
Post-cranial												
Ribs	8	0	0.0	2	0	0.0	1	0	0.0	11	0	0.0
Humerus	21	1	4.8	6	0	0.0	7	0	0.0	34	1	2.9
Radius	21	1	4.8	4	0	0.0	5	0	0.0	30	1	3.3
Ulna	18	0	0.0	4	0	0.0	3	0	0.0	25	0	0.0
Femur	17	10	58.8	4	1	25.0	4	0	0.0	25	11	44.0
Tibia	17	7	41.2	4	1	25.0	4	0	0.0	25	8	32.0
Fibula	15	3	20.0	3	0	0.0	4	0	0.0	22	3	13.6

Skeletal Element* = All bones treated as whole units.
Left and right sides of paired elements counted separately
Children* = Includes juveniles and sub-adults
n* = Total number of skeletal elements studied

Table 5.14 Summary of sub-periosteal bone lesions – Wet Savanna zone

	MALE			**FEMALE**			**CHILDREN***			**TOTAL**		
Skeletal Element*	n*	No.	%	n*	No.	%	n*	No.	%	n*	No.	%
Cranial												
Calvarium	13	0	0.0	8	0	0.0	7	1	14.3	26	1	3.8
Mandible	11	0	0.0	9	0	0.0	5	0	0.0	25	0	0.0
Face	13	0	0.0	8	0	0.0	7	0	0.0	26	0	0.0
Post-cranial												
Ribs	6	1	16.7	7	0	0.0	3	0	0.0	16	1	6.3
Humerus	16	1	6.3	21	0	0.0	10	0	0.0	47	1	2.1
Radius	13	0	0.0	18	0	0.0	6	0	0.0	37	0	0.0
Ulna	9	0	0.0	12	0	0.0	5	0	0.0	26	0	0.0
Femur	22	16	72.7	22	8	36.4	10	5	50.0	54	29	53.7
Tibia	19	14	73.7	23	7	30.4	9	1	11.1	51	22	43.1
Fibula	13	2	15.4	12	2	16.7	4	0	0.0	29	4	13.8

Skeletal Element* = All bones treated as whole units.
Left and right sides of paired elements counted separately
Children* = Includes juveniles and sub-adults
n* = Total number of skeletal elements studied

Table 5.15 Summary of sub-periosteal bone lesions – Forest zone

Dry Savanna

YOUNGER ADULTS (20.1 - 40 years)

n*	MALE		FEMALE		TOTAL	
	(13)	10.25	(9)	8.25	(22)	18.5
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	13	4.0	9	3.4	22	3.7
No. of individuals with AMTL*	3.5	34.2	1.5	18.2	5	27.0
Avg. no. of teeth lost antemortem/mouth	1.3		1.1		1.2	

OLDER ADULTS (40.1+ years)

n*	MALE		FEMALE		TOTAL	
	(8)	6.625	(3)	3	(11)	9.625
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	33	15.7	17	17.7	50	16.3
No. of individuals with AMTL*	2.625	39.6	2	66.7	4.625	48.1
Avg. no. of teeth lost antemortem/mouth	5.0		5.7		5.2	

Wet Savanna

YOUNGER ADULTS (20.1 - 40 years)

n*	MALE		FEMALE		TOTAL	
	(4)	3.875	(3)	1.625	(7)	5.5
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	7	5.7	8	15.4	15	8.6
No. of individuals with AMTL*	1.875	48.4	1.125	69.2	3	54.5
Avg. no. of teeth lost antemortem/mouth	1.8		4.9		2.7	

OLDER ADULTS (40.1+ years)

n*	MALE		FEMALE		TOTAL	
	(7)	6.375	(1)	0.75	(8)	7.125
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	50	24.6	0	0.0	50	21.9
No. of individuals with AMTL*	5	78.4	0	0.0	5	70.2
Avg. no. of teeth lost antemortem/mouth	7.8		0		7.0	

Forest

YOUNGER ADULTS (20.1 - 40 years)

	MALE		FEMALE		TOTAL	
n*	(7)	5.125	(9)	6.625	(16)	11.75
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	13	7.9	12	5.6	15	4.0
No. of individuals with AMTL*	4.5	87.8	3.25	49.1	7.75	66.0
Avg. no. of teeth lost antemortem/mouth	2.5		1.8		1.3	

OLDER ADULTS (40.1+ years)

	MALE		FEMALE		TOTAL	
n*	(5)	4	(2)	1.375	(7)	5.375
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	10	7.9	10	24.4	20	11.9
No. of individuals with AMTL*	3.25	81.3	1.375	100.0	4.625	86.1
Avg. no. of teeth lost antemortem/mouth	2.5		7.3		3.7	

n* = Number of individuals represented by only one quarter of a maxilla or mandible; counted as one eighth of one individual. Numbers in parentheses are the original numbers of individuals (i.e. represented by any fraction of the mandible or maxilla and counted as one individual).

AMTL* = Antemortem tooth loss

Table 5.16 – 5.18 Summary of antemortem tooth loss: Age

Dry Savanna

n*	MALE (21) 16.875		FEMALE (12) 11.25		TOTAL (33) 28.125	
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	46	8.6	26	7.2	72	8.0
No. of individuals with AMTL*	6.125	36.3	3.5	31.1	9.625	34.2
Avg. no. of teeth lost antemortem/mouth	2.7		2.3		2.6	

Wet Savanna

n*	MALE (11) 10.25		FEMALE (4) 2.375		TOTAL (15) 12.625	
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	57	17.5	8	10.4	65	16.2
No. of individuals with AMTL*	6.875	67.1	1.125	47.4	8	63.4
Avg. no. of teeth lost antemortem/mouth	5.6		3.4		5.2	

Forest

n*	MALE (12) 9.125		FEMALE (11) 8		TOTAL (23) 17.125	
	No.	%	No.	%	No.	%
No. of teeth lost antemortem	23	7.9	22	8.7	45	8.2
No. of individuals with AMTL*	7.75	84.9	4.625	57.8	12.375	72.3
Avg. no. of teeth lost antemortem/mouth	2.5		2.8		2.6	

n* = Number of individuals represented by one quarter of a maxilla or mandible; counted as one eighth of an individual. Numbers in parentheses are the original numbers of individuals (i.e. represented by any fraction of the mandible or maxilla and counted as one individual).

AMTL* = Antemortem tooth loss

Table 5.19 Summary of antemortem tooth loss: Sex

	DRY SAVANNA (Ages & sexes pooled)	WET SAVANNA (Ages & sexes pooled)	FOREST (Ages & sexes pooled)
Total No.*	896	402	546
I1	10	12	13
I2	10	7	5
C	7	5	2
PM1	6	5	1
PM2	4	5	2
M1	13	11	12
M2	11	13	7
M3	11	7	3
Total	72	65	45

Total No.* = Total number of tooth places observed

Table 5.20 Tooth types lost antemortem

Dry Savanna

YOUNGER ADULTS (20.1 - 40 years)

	MALE		FEMALE		TOTAL	
n*	(13)	10.25	(9)	8.25	(22)	18.5
	No.	%	No.	%	No.	%
No. of carious teeth	1	0.4	5	2.2	6	1.3
No. of individuals with caries	1	9.4	2.875	34.9	3.875	20.9
Avg. no. of carious teeth/mouth	0.1		0.6		0.3	

OLDER ADULTS (40.1+ years)

	MALE		FEMALE		TOTAL	
n*	(8)	6.625	(3)	3	(11)	9.625
	No.	%	No.	%	No.	%
No. of carious teeth	17	11.4	4	5.8	21	9.6
No. of individuals with caries	4.125	62.3	2	66.7	6.125	63.6
Avg. no. of carious teeth/mouth	2.6		1.3		2.2	

Wet Savanna

YOUNGER ADULTS (20.1 - 40 years)

	MALE		FEMALE		TOTAL	
n*	(4)	3.875	(3)	1.625	(7)	5.5
	No.	%	No.	%	No.	%
No. of carious teeth	10	10.9	3	10.7	13	10.8
No. of individuals with caries	2.875	74.2	0.625	38.5	3.5	63.6
Avg. no. of carious teeth/mouth	2.6		1.9		2.4	

OLDER ADULTS (40.1+ years)

	MALE		FEMALE		TOTAL	
n*	(7)	6.375	(1)	0.75	(8)	7.125
	No.	%	No.	%	No.	%
No. of carious teeth	10	7.5	0	0.0	10	6.4
No. of individuals with caries	3	47.1	0.75	0.0	3	42.1
Avg. no. of carious teeth/mouth	1.6		0		1.4	

Forest

YOUNGER ADULTS (20.1 - 40 years)

	MALE		FEMALE		TOTAL	
n*	(7)	5.125	(9)	6.625	(16)	11.75
	No.	%	No.	%	No.	%
No. of carious teeth	18	13.0	8	6.2	26	9.7
No. of individuals with caries	4.5	87.8	2.875	50.0	7.375	62.8
Avg. no. of carious teeth/mouth	3.5		1.2		2.2	

OLDER ADULTS (40.1+ years)

	MALE		FEMALE		TOTAL	
n*	(5)	4	(2)	1.375	(7)	5.375
	No.	%	No.	%	No.	%
No. of carious teeth	3	4.5	6	22.2	9	9.6
No. of individuals with caries	1.375	34.4	1.375	100.0	2.75	51.2
Avg. no. of carious teeth/mouth	0.8		4.4		1.7	

n* = Number of individuals represented by one quarter of a maxilla or mandible; counted as one eighth of one individual. Numbers in parentheses are the original numbers of individuals (i.e. represented by any fraction of the mandible or maxilla and counted as one individual).

Table 5.21 – 5.23 Summary of caries rates in adult dentition: Age

Dry Savanna

	CHILDREN*		MALE		FEMALE		TOTAL	
n*	(24)	10.625	(21)	16.875	(12)	11.25	(57)	28.125
	No.	%	No.	%	No.	%	No.	%
No. of carious teeth	10	3.1	18	4.6	9	3.0	37	3.7
No. of individuals with caries	3.75	35.3	5.125	30.4	4.875	43.3	13.75	35.5
Avg. no. of carious teeth/mouth	2.7		1.1		0.8		1.0	

Wet Savanna

	CHILDREN*		MALE		FEMALE		TOTAL	
n*	(3)	0.875	(11)	10.25	(4)	2.375	(18)	13.5
	No.	%	No.	%	No.	%	No.	%
No. of carious teeth	0	0.0	20	8.9	3	5.9	23	7.6
No. of individuals with caries	0	0.0	5.875	57.3	0.625	26.3	6.5	48.1
Avg. no. of carious teeth/mouth	0		2.0		1.3		1.7	

Forest

	CHILDREN*		MALE		FEMALE		TOTAL	
n*	(6)	2.5	(12)	9.125	(11)	8	(29)	19.625
	No.	%	No.	%	No.	%	No.	%
No. of carious teeth	1	1.3	21	10.2	14	9.0	36	8.2
No. of individuals with caries	0.75	30.0	5.875	64.4	4.25	53.1	10.875	55.4
Avg. no. of carious teeth/mouth	1.3		2.3		1.8		1.8	

n* = Number of individuals represented by one quarter of a maxilla or mandible; counted as one eighth of one individual
Children* = Includes juveniles and sub-adults

Table 5.24 Summary of caries rates

	Uncorrected			Corrected
	No. of caries	No. of observed teeth	Caries rate (%)	DMI (%)*
Dry Savanna	37	1014	3.7	10.2
Wet Savanna	23	303	7.6	25.1
Forest	36	439	8.2	16.7

*DMI = Decayed-and-missing index (Kelley *et al.*, 1991)

Table 5.25 Observed and corrected caries rates: age and sex groups combined

	DRY SAVANNA (Ages & sexes pooled)		WET SAVANNA (Ages & sexes pooled)		FOREST (Ages & sexes pooled)	
Total No.*	1014		303		439	
I1	1	105	0	24	0	41
I2	0	115	0	30	3	44
C	0	124	0	30	4	53
PM1	3	129	3	40	2	58
PM2	5	127	1	44	5	67
M1	9	176	5	53	10	65
M2	10	132	6	43	6	63
M3	9	106	8	39	6	48
Total	37	1014	23	303	36	439

Total No.* = Total number of teeth observed

Table 5.26 Tooth types affected by carious lesions

ECOLOGICAL ZONE	MALES								
	Younger Adults (20.1 – 40 years)			Older Adults (40.1+ years)			Total No. of Males		
	n*	No.*	%	n*	No.*	%	n*	No.*	%
Dry Savanna	10.25	2.625	25.6	6.625	6.625	100.0	16.875	9.25	54.8
Wet Savanna	3.875	0	0.0	6.375	3.875	60.8	10.25	3.875	37.8
Forest	5.125	2.375	46.3	4	4	100.0	9.125	6.375	69.9

ECOLOGICAL ZONE	FEMALES								
	Younger Adults (20.1 – 40 years)			Older Adults (40.1+ years)			Total No. of Females		
	n*	No.*	%	n*	No.*	%	n*	No.*	%
Dry Savanna	8.25	2.5	30.3	3	2	66.7	11.25	4.5	40.0
Wet Savanna	1.625	1.125	69.2	0.75	0	0.0	2.375	1.125	47.4
Forest	6.625	3.25	55.0	1.375	0.75	54.5	8	4	50.0

ECOLOGICAL ZONE	Younger Adults* (20.1 – 40 years)			Older Adults* (40.1+ years)			TOTAL		
	n*	No.*	%	n*	No.*	%	n*	No.*	%
Dry Savanna	18.5	5.125	27.7	9.625	8.625	89.6	28.125	13.75	48.9
Wet Savanna	5.5	1.125	20.5	7.125	3.875	54.4	12.625	5	39.6
Forest	11.75	5.625	47.9	5.375	4.75	88.4	17.125	10.375	60.6

n* = Number of individuals represented by one quarter of a maxilla or mandible; counted as one eighth of one individual
No.* = Number of individuals with periodontitis
Younger Adults* = Includes males and females
Older Adults* = Includes males and females

Table 5.27 – 5.29 Occurrence of periodontitis in adult individuals

ECOLOGICAL ZONE	MALES								
	Younger Adults			Older Adults			Total No. of Males		
	n*	No.*	%	n*	No.*	%	n*	No.*	%
Dry Savanna	10.25	2	19.5	6.625	2.75	41.5	16.875	4.75	28.2
Wet Savanna	3.875	0.875	22.6	6.375	3	47.1	10.25	3.875	37.8
Forest	5.125	1.25	24.4	4	1	25.0	9.125	2.25	24.7

ECOLOGICAL ZONE	FEMALES								
	Younger Adults			Older Adults			Total No. of Females		
	n*	No.*	%	n*	No.*	%	n*	No.*	%
Dry Savanna	8.25	0	0.0	3	2	66.7	11.25	2	17.8
Wet Savanna	1.625	0	0.0	0.75	0	0.0	2.375	0	0.0
Forest	6.625	2	26.7	1.375	0.75	54.5	8	2.75	34.4

ECOLOGICAL ZONE	Younger Adults* (20.1 – 40 years)			Older Adults* (40.1+ years)			TOTAL		
	n*	No.*	%	n*	No.*	%	n*	No.*	%
Dry Savanna	18.5	2	10.8	9.625	4.75	49.4	28.125	6.75	24.0
Wet Savanna	5.5	0.875	15.9	7.125	3	42.1	12.625	3.875	30.7
Forest	11.75	3.25	27.7	5.375	1.75	32.6	17.125	5	29.2

n* = Number of individuals represented by one quarter of a maxilla or mandible; counted as one eighth of one individual
No.* = Number of individuals with abscesses
Younger Adults* = Includes males and females
Older Adults* = Includes males and females

Table 5.30 – 5.32 Occurrence of abscesses in adult individuals

Younger Adults (20.1 – 40 years)

	DRY SAVANNA			WET SAVANNA			FOREST		
	Male	Female	Total	Male	Female*	Total	Male	Female	Total
n*	10.25	8.25	18.5	3.875	2.375*	6.25	5.125	6.625	11.75
I1	2.1	2.0	2.1	2.0	1.3	1.7	1.6	1.7	1.7
I2	1.7	1.8	1.8	1.8	1.5	1.7	1.3	1.7	1.5
C	1.5	1.7	1.6	1.5	1.2	1.4	1.3	1.6	1.5
PM1	1.3	1.6	1.5	1.3	1.1	1.2	1.0	1.4	1.2
PM2	1.4	1.7	1.6	1.2	1.0	1.1	1.0	1.2	1.1
M1	1.7	2.1	1.9	1.9	1.2	1.6	1.3	1.5	1.4
M2	1.3	1.1	1.2	1.5	0.9	1.2	0.9	1.0	1.0
M3	1.1	0.9	1.0	1.0	0.5	0.8	0.8	1.0	0.9
Anterior Attrition Score	1.8	1.9	1.9	1.8	1.3	1.6	1.4	1.7	1.6
Posterior Attrition Score	1.3	1.5	1.4	1.4	1.0	1.2	1.0	1.2	1.1
Mean Attrition Score	1.6	1.7	1.7	1.6	1.1	1.4	1.0	1.4	1.2

n* = Number of individuals represented by a quarter of a maxilla or mandible; counted as one eighth of one individual
Female* = One female of the older adult group was included

Table 5.33 Occlusal Attrition in adult dentition

Older Adults (40.1+ years)

	DRY SAVANNA			WET SAVANNA			FOREST		
	Male	Female	Total	Male	Female*	Total	Male	Female	Total
n*	6.625	3	9.625	6.375	2.375*	8.75	4	1.375	5.375
I1	2.2	2.0	2.1	2.2	1.3	1.8	1.7	3.0	2.4
I2	1.9	2.0	2.0	1.8	1.5	1.7	1.8	1.5	1.7
C	1.8	2.7	2.3	2.0	1.2	1.6	2.3	2.2	2.3
PM1	1.8	2.3	2.1	1.4	1.1	1.3	2.1	2.0	2.1
PM2	2.0	2.2	2.1	1.8	1.0	1.4	2.2	1.8	2.0
M1	2.4	2.3	2.4	2.3	1.2	1.8	3.0	2.5	2.8
M2	1.7	2.5	2.1	1.4	0.9	1.2	2.0	1.0	1.5
M3	1.3	1.4	1.4	1.1	0.5	0.8	1.3	1.0	1.2
Anterior Attrition Score	2.0	2.3	2.2	2.0	1.3	1.7	1.9	2.1	2.0
Posterior Attrition Score	1.9	2.2	2.1	1.6	1.0	1.3	2.1	1.6	1.9
Mean Attrition Score	1.9	2.2	2.1	1.8	1.1	1.5	2.0	1.8	1.9

n* = Number of individuals represented by a quarter of a maxilla or mandible; counted as one eighth of one individual
Female*= One female of the older adult group was included

Table 5.34 Occlusal Attrition in adult dentition

Sample	Individual	Sex	Age at Death (years)	Anterior Teeth Lost Antemortem
DRY SAVANNA	A2235	F	>30	RL I1, I2, C; LL I1, I2, C
WET SAVANNA	KZ86/1b	M	35-40	RU I1; LU I1; RL I1, I2; LL I1, I2
	II/B7/B	M	>55	RU I1; LU I1
	PMB87/12	M	35-45	RU I1; LU I1
	PMB2000/11	M?	<16	RU I1; LU I1; RL I1, I2; LL I1, I2
FOREST	Katoto-T39	M	>40	RL I1, I2, C; LL I1, I2
	Katoto-T50	M	~	RL I1, I2; LL I1, I2
	Katoto-T10	M	~	RL I1, I2; LL I1, I2
	Sanga-T116	F	>25	RL I1, I2, C; LL I1, I2
	Sanga-T58	F	>40	RU I1; LU I1; RL I1, I2; LL I1

RU = Right upper
LU = Left upper
RL = Right lower
LL = Left lower
I1 = Central incisor
I2 = Lateral incisor
C = Canine

Table 5.35 Individuals showing signs of intentional tooth extraction

Sample	Individual	Sex	Age at Death (years)	Chipped &/Filed Anterior Teeth
DRY SAVANNA	A2246	M	25-40	RU I1, I2; LU I1, I2
	UP89	F	24-32	RU I1, I2; LU I1, I2; RL I1, I2; LL I1, I2
	UP88	F	26-32	RU I1, I2; LU I1, I2
	UP132	F	43-58	RU I1, I2; LU I1, I2
WET SAVANNA	II/B5/B*	M	>55	RU I1; LU I1
FOREST	Sanga-T110	M	>55	RU I1, I2; LU I1, I2
	Sanga-T116	F	>25	RU I1; LU I1, I2
	Sanga-T8	F	~	RL I1; LL I1, I2
	Sanga-T83	F	25-40	RU I1, I2; LU I1
	Sanga-T80	F	24-32	LU I2
	Sanga-T88	F?	~16	RU I1, I2; LU I1, I2
	Katoto-T48	F	25-40	RU I1, I2; LU I1, I2
	Katoto-T25	F	25-40	RU I1, I2; LU I1, I2
	Katoto-T21b	F	<40	RU I1, I2; LU I1, I2

RU = Right upper
LU = Left upper
RL = Right lower
LL = Left lower
I1 = Central incisor
I2 = Lateral incisor
*II/B5/B = Exhibit maxillary central incisors filed at mesial corners; inverted V-shape

Table 5.36 Individuals exhibiting intentionally chipped and/or filed incisors

Dry Savanna

	Femur		Tibia	
Age range	n	mean	n	mean
0 - 2	2	109.0	0	
2 - 4	1	172.0	1	144.0
4 - 6	0		0	
6 - 8	0		0	
8 - 10	3	265.2	1	216.0
10 - 12	1	342.0	1	278.0
12 - 14	2	323.8	2	302.0
14 - 16	0		0	
16 - 18	1	373.8	0	
18 - 20	1	404.0	1	350.0
20 - 25	3	466.3	3	388.0
>25	11	446.4	9	385.1

Wet Savanna

	Femur		Tibia	
Age range	n	mean	n	mean
0 - 2	1	88.0	0	
2 - 4	1	150.0	0	
4 - 6	0		0	
6 - 8	1	205.0	1	172.0
8 - 10	0		0	
10 - 12	0		0	
12 - 14	0		0	
14 - 16	0		0	
16 - 18	0		0	
18 - 20	0		0	
20 - 25	1	432.0	1	367.0
>25	4	460.6	4	393.0

Forest

	Femur		Tibia	
Age range	n	mean	n	mean
0 - 2	4	88.50	3	75.30
2 - 4	1	157.00	1	150.50
4 - 6	1	200.00	1	166.00
6 - 8	0		0	
8 - 10	0		0	
10 - 12	0		1	282.00
12 - 14	0		0	
14 - 16	1	442.00	1	318.00
16 - 18	1	408.00	1	366.00
18 - 20	0		0	
20 - 25	3	440.50	3	372.00
>25	11	436.50	10	368.00

Table 5.37 Long bone lengths (tibia and femur) versus age

	DRY SAVANNA	WET SAVANNA	FOREST
MALES			
Femur*			
n	7	6	6
mean (mm)	465.5	454.3	446.3
SD	40.8	23.4	29.3
Stature (mm)	1743.3	1701.4	1671.4
Tibia*			
n	6	4	9
mean (mm)	387.9	407.5	379.4
SD	27.9	14.2	32.6
FEMALES			
Femur*			
n	7	2	8
mean (mm)	435.8	423.5	430.6
SD	14.4	12	17.5
Stature (mm)	1632.1	1586.0	1612.6
Tibia*			
n	6	3	5
mean (mm)	383.8	357.5	358.5
SD	32.5	8.3	16.6

SD = Standard deviation
*Femur = Average of left and right bones
*Tibia = Average of left and right bones

Table 5.38 Long Bone Lengths (Femur; Tibia) for Individuals 20+ years

Figure 5.01 Tooth Chipping and/or Filing of central and lateral incisors

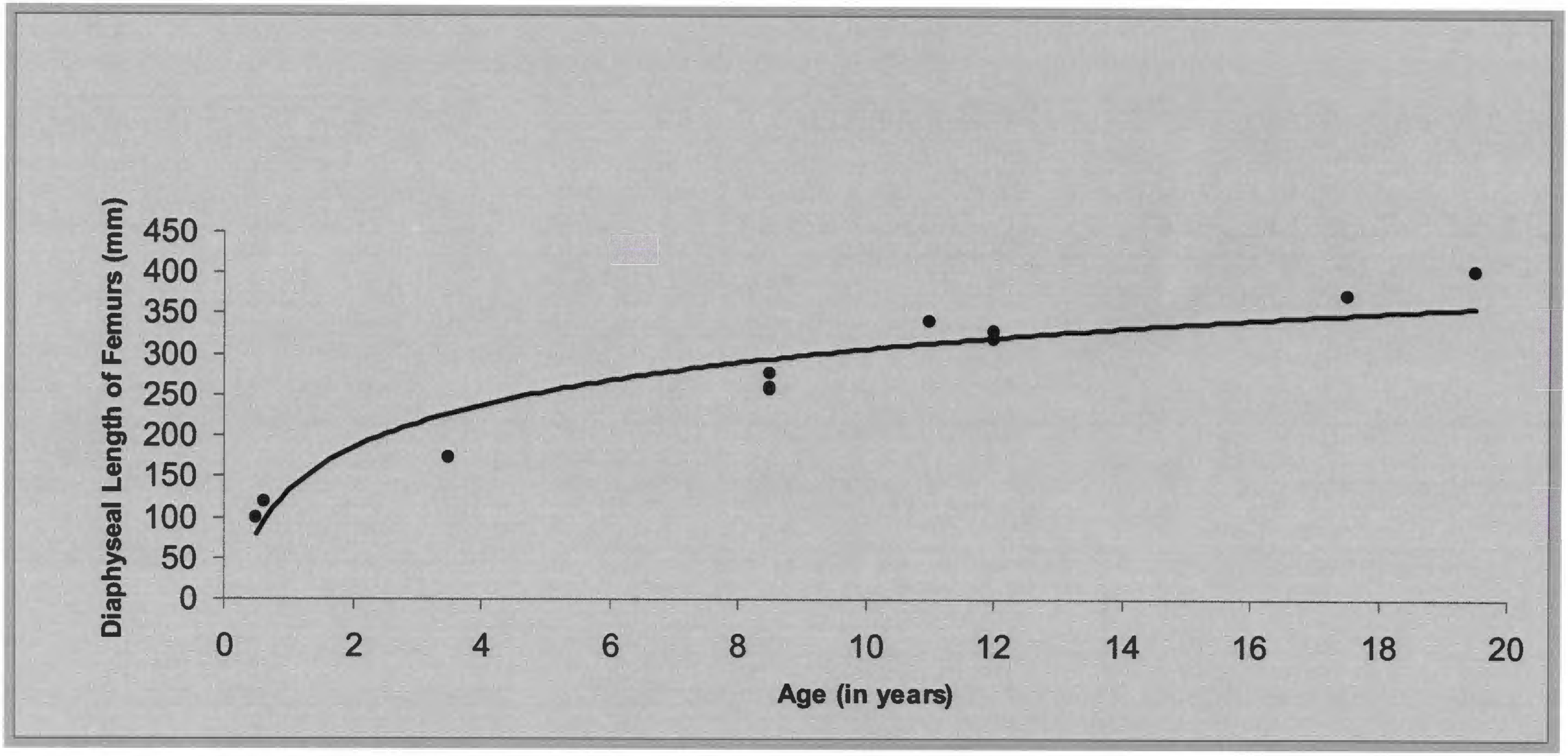


Figure 5.02 Reconstructed Growth Curve of the Dry Savanna population

Chapter 6: DISCUSSION

The relationship between biology, behaviour and the role of the environment is central to bio-archaeology and our understanding of these factors interplay is crucial in unravelling the 'mysteries' of past peoples. The potential to reconstruct and interpret lifeways of past peoples from skeletal remains depends on our ability to correlate morphological characteristics to known patterns of behaviour (Stock & Pfeiffer, 2001; Larsen, 1997, 2002). In terms of palaeopathology, it is about knowledge and understanding of disease processes, their aetiology and most importantly their relationship between physiological and anatomical manifestations. However, this is less frequently the situation in the study of disease processes affecting past human populations. The reasons are firstly, the usual manifestation of disease is physiological and less frequently affects the anatomy. In other words, diseases usually affect the flesh of the body and less frequently involve the skeletal system. Secondly, disease processes that do affect the skeleton tend to leave very similar, non-specific lesions on the skeletal tissues and therefore, make it very difficult to pin a particular skeletal lesion to any specific disease.

Another limitation to palaeopathological research is post-mortem conditions that may alter or damage skeletal remains, i.e. preservation and completeness of skeletal remains as well as curation methods. These factors influence the examination and assessment of disease processes that may have been present on skeletal elements prior to their burial. Sometimes, post-mortem damage or alteration of skeletal remains may even lead to misdiagnosis or incorrect identification of disease processes. However, the use of multiple stress indicators on skeletal and dental tissues can provide a more comprehensive understanding of health and adaptation in the past.

In this chapter, therefore, I attempt to discuss some aspects of health and adaptation of the early farming peoples from southern and central Africa. What were the health issues of agriculturalists or agro-pastoralists in sub-Saharan Africa during the 'Iron Age'? How did this mode of subsistence affect the health and/or lifestyles of the societies that adopted it? Some aspects of health include the following issues:

- **Childhood stress**, i.e. growth insults and growth successes that are related to nutrition and acute metabolic disturbances,

- **Metabolic homeostasis**, which is linked to micronutrient availability, nutrition as well as infectious parasites in the environment,
- **Chronic low-grade infections** that indicate morbidity levels,
- **Dental health** as an impact of dietary environment, which also reflects different lifestyles, and
- **Skeletal growth** as an indication of the impact of stress on growth, in general.

Although not related to health, **dental modification** in the form of tooth extraction, filing and/or chipping is also discussed here since it is an important factor in affecting antemortem tooth loss, which is not dietary or oral-hygiene related.

The above-mentioned issues will be discussed in the light of physiological disruptions from the years of growth and development into adulthood, in order to draw inferences about what life was like for these people; how they adapted to their environments; and what the implications of their lifestyles were on their health and well-being.
Several questions were also raised from the results of this study:

1. Does the pattern of the stress indicators or disease prevalence make sense in terms of the environmental characteristics of the research area?
2. How has 'Iron Age' subsistence modes adapted to their different microenvironments?
3. How have the three different environments affected the health status of these populations?
4. Can we make generalisations about the health status of 'Iron Age' agricultural populations?
5. Does the agricultural economic way of life of these people enhance fertility; and decrease morbidity and mortality or vice versa?

6.1 CHILDHOOD STRESS

The data illuminating physiological disruptions during the years of growth and development come from the examination of Harris lines or growth arrest lines and linear enamel hypoplasias. Both these stress indicators have been shown to demonstrate acute stress episodes for an individual and within a population. The actual causal stimulants for the indicators are, however, not clear. Conditions such as dietary insufficiencies, diseases and even some psychological trauma have been associated with Harris lines (HL) and linear enamel hypoplasias (LEH) (Aufderheide & Rodriguez, 1998; Cohen & Armelagos, 1984; Larsen, 1997, 2002; Ribot & Roberts, 1996).

All Harris lines observed in the dry savanna and wet savanna adult individuals were formed around adolescence. The clustering of the lines between 12 and 15 years of age could be related to the adolescent growth spurt since lines tend to form during periods of greatest rate of growth (Aufderheide & Rodriguez-Martin, 1998). Since it was not possible to calculate the age of formation of the Harris lines using Byers' (1991) method in the juvenile individuals, we can only speculate that the lines were formed in infancy or early childhood, due to the low immunity and susceptibility of children to disease, stress of weaning and/or malnutrition.

The issue of line resorption and persistence is of importance when the assessment of the health status of past populations is of concern. The effects of bone remodelling and loss of bone mineral that begins at about 20 years of age, accounts for the reduction in frequency of HL in older individuals. This might be the case in the dry savanna sample, in which most adult individuals with X-rays exhibit no lines. This is not to say that it is not a possibility these individuals did not experience any acute metabolic insults in their lifetime, but that the lack of lines does not equate a stress-free person. The demographic profile of individuals with X-rays is skewed in the wet savanna sample, with more adult individuals than sub-adults being represented for the assessment of HL. Once again, it is apparent that adult bones do not demonstrate HL as clearly as in children.

Because of this loss of lines in adulthood, there is also a loss of record of any previous stressful events experienced by that individual. Therefore, the absence of HL does not necessarily denote absence of stress in a population. This also means that Harris lines are "relatively more representative of stress history in juveniles than in adults" (Larsen, 1997: 43).

The rate of line resorption is also not a clear feature. In this skeletal series, the line that persisted for the longest period of time is seen in a 40+-year-old female, II/34

from the wet savanna region. The line has remained for a period of about twenty-seven years as it had been formed between the age of thirteen and fourteen years.
The frequency of individuals exhibiting HL is higher in the wet savanna population (50.0%) than in the dry savanna individuals (20.0%). However, the average number of lines per person is the same for both populations, 2.3 lines per individual. In terms of adaptive mechanism, does this then mean that the conditions causing line formation were similar in both regions, but that the dry savanna individuals could cope better in these conditions than the wet savanna people, since more people were affected in the latter group? The answer to this question is not an easy one because of the high degree of frequency variation in relation to individual health history. Also, the lack of close association between Harris lines and disease episodes in both living and archaeological populations make the interpretation of the frequency of lines difficult in the light of adaptive strategy (Aufderheide and Rodriguez-Martin, 1998; Goodman, *et al.*, 1984).

With all the limitations in recording and interpreting Harris lines, it is still important to compare the prevalence of lines in individuals from this study to other populations. Comparison of the results of the present study with previous studies is done in order to get a better insight about stress experience of different populations, which could be related to specific behavioural, environmental and dietary conditions.
When compared to other populations the dry savanna has a comparable frequency of individuals with lines to that from K2 and the wet savanna has the same frequency as that reported for the Oakhurst individuals (Table 6.01). The incidence of growth disruptions per individual is similar to that of the Griqua, Colesberg and Wolmaransstad samples (2.3 lines per person, for both dry and wet savanna): Oakhurst, 3.0 (Patrick, 1989); K2, 0.5 (Steyn, 1994); and Griqua, 2.4, Colesberg 2.0, Wolmaransstad, 2.0 (Peckmann, 2002).
The Oakhurst foragers and the wet savanna agriculturalists appear to have experienced more growth disruptions than any other population group.

Fortunately, the data from dental enamel defects have proven to be much more reliable than that provided by skeletal indicators of stress, i.e. Harris lines. Unless physically destroyed or mutilated in life or in post-mortem, the hard enamel dental tissue does not remodel like skeletal tissue. Therefore, any developmental

disturbances or even intentional modification of the teeth can provide a more reliable record of information about past behaviours.
The occurrence of linear enamel hypoplasias significantly differs between the regional groups in this study; with the highest frequency found in the dry savanna sample and lowest in the forest region. Occurrence of LEH in comparative groups (Table 6.02) shows that the dry savanna sample in this study is comparable to Murphy's (1996) farmers and herders. The population in the forest zone had similar occurrences of LEH as the Toutswe agro-pastoralist (Mosothwane, 2003). Also, the mean number of insults per individual is highest in the dry savanna (1.9 insults per person) and lowest in the forest population (1.5 insults per person). Therefore, not only did more individuals in the dry savanna experience stress episodes than those in the forest region, but that the same individuals had suffered more than one insult in their lives.

The majority of hypoplasias in this study sample cluster in the two to six year age range. A possible causal factor associated with the age of formation of the hypoplasias is the physiological and psychological impact of weaning. Physiologically, this period involves a shift from a relatively stable, nutritious food source (mother's milk) to a potentially less stable, less digestible and less nutritious food (e.g. cereal carbohydrate) (Larsen, 1997). The impact of weaning as a possible stressor in these populations, however, must be cautiously inferred as no stable isotope analyses have been done for the juvenile individuals from these populations.

A recent study that used stable isotope analysis on the Later Stone Age foraging community of Matjies River Rock Shelter showed that children in this society were weaned between two and four years of age (Clayton, 2002). The results of this study are consistent with other studies of weaning patterns of hunting and gathering societies (Barness, 1987; Cronk, 1989). Furthermore, it has been shown that interbirth interval decreases as fertility rates increase in agricultural societies, which is coupled by a subsequent increase in population size (Buikstra *et al.*, 1986; Dupras *et al.*, 2001). Sedentism, as well as access to a greater abundance of food sources also play a role in this setup. For instance, agricultural populations in North America (Tennessee Valley) weaned their infants some time before the age of two years (Fogel *et al.*, 1989).

Thus, the assumption here is that the agricultural populations in this study would have a similar pattern as that explained above. These transitions, however, are not always uniform among different societies or even among societies with a similar economic strategy. The reason for this is that cultural practices are very influential in childbearing and infant feeding practices.

For the populations under consideration, it is more than likely that peak frequencies of LEH are too late to result from the impact of weaning. Therefore, other stressors such as nutritional insufficiencies and diseases, not necessarily linked to weaning, were likely to be involved during metabolic insults as indicated by the hypoplasias.
Systemic disturbances that could have resulted from nutritional shortages may have existed during rainfall fluctuations and seasonal changes during the 'Iron Age' in southern Africa, probably more so in savanna environments. Analyses of enamel hypoplasias of 'Iron Age' skeletons from K2 and Mapungubwe, South Africa report frequencies of 58.5% and 88.9%, respectively (Steyn, 1994). Infectious diseases, particularly caused by parasites in the environment may have been common among pre-historic populations living in sedentary, densely populated habitats. Developmental enamel defects attributed to induced parasitism on penned sheep lend support to the theory of infectious diseases as a stimulant for enamel hypoplasias (Suckling *et al.*, 1983).

In human societies, a more plausible aetiology of enamel defects could be a combination of nutritional deficiency and infectious diseases, because of the synergistic relationship between these factors (Goodman & Rose, 1991; Mensforth *et al.*, 1978). Malnutrition weakens the immune response; therefore, children that receive inadequate nourishment are more susceptible to infectious diseases (Hühne-Osterloh, 1989; Ismail, 1998; Dittmann & Grupe, 2000).

In terms of functional and adaptive modes of stress, the picture presented by the LEH analysis suggests that the dry savanna children were less resistant to adverse living conditions or that they had a stronger reaction to these conditions when compared to the wet savanna and especially to the forest populations. However, the relationship between the record of developmental stress based on dental defects in sampled individuals and the corresponding health status of the total population remains ambiguous. Growing individuals may perish from acute stresses before their skeletal and dental tissues record these severe systemic disturbances (Cunha *et al.*, 2004). It is therefore, advisable to not be too quick to conclude that a low frequency of developmental stress defects equals stress-free individuals *per se*. A more complete picture of the health status of these populations will be presented after a full discussion of all stress indicators.

6.2 METABOLIC HOMEOSTASIS

Anaemia is probably one of the most intriguing palaeopathological conditions, as evidenced by the skeletal lesions known as cribra orbitalia and/or porotic hyperostosis. It is currently considered one of the most common maladies afflicting humankind (Arthur & Isbister, 1987). Cribra orbitalia and porotic hyperostosis have been observed in many prehistoric skeletal populations from all corners of the world. Records are available from the eastern North America (Mensforth *et al.*, 1978), South America (Ponec & Resnick, 1984), eastern Europe, Croatia (Šlaus, 2000), Greece (Papathanassiou, 2005), South Africa (Morris, 1984; Peckmann, 2002; Steyn, 1994) and many other places.

In a study of porotic hyperostosis among eleven pre-historic populations, Stuart-Macadam (1987) found that the incidence varied from 26.5% to 83.0% in juveniles and 6.6% to 45.0% for adults. Higher frequencies of cribra orbitalia (CO) in juvenile skeletons have been reported at Kulubnarti, Upper Nubia, ranging from 82% to 94% through time (Van Gerven *et al.*, 1995). The frequency of porotic hyperostosis (PH) seems to have increased in skeletal populations from a few cases identified in the Palaeolithic and Mesolithic to many cases in the Neolithic and post-Neolithic. This trend has, however, changed in the twentieth century, with a decrease in the number of reported cases (Stuart-Macadam & Kent, 1992).

In the current study, CO and PH have been found in relatively high frequencies for all population groups under consideration (Tables 5.01 to 5.03; 5.05 to 5.07). So, what makes anaemia one of the most prevalent conditions affecting humankind from pre-historic times to the present? The aetiology of this condition is iron deficiency (both genetic and acquired), but the causes are multifactorial.

First, there is the frequently employed theory of dietary or nutritional deficiencies that occur as a result of diets that are either low in iron or that contain substances that interfere with iron absorption or bioavailability of iron. The deficiency hypothesis has been used to explain the presence of CO and PH in a range of studies from the early twentieth century (Henschen, 1961; Nathan & Haas, 1966; El-Najjar *et al.*, 1975, 1976; Lallo *et al.*, 1977; Mensforth *et al.*, 1978).

Some of the inspiration and perhaps, obsession with the dietary model comes from the quest to assess the impact of adopting an agricultural way of life and economy on human health and quality of life. The relatively new consensus is that, in terms of improvements in the quality and reliability of food supplies, the agricultural economy was less than advantageous when compared to hunting and gathering (Lee, 1968, 1969; Cohen & Armelagos, 1984). With the adoption of an agricultural economy, the tendency has been a heavy reliance on cereals, root crops and vegetables in combination with a poor animal protein supply. Cereal grains, which had become the staple food for most agricultural communities, have very low iron content and contain phytic acid that chelates any iron present, rendering it unusable (Garn, 1992). In addition to this, non-haeme iron that is found in grains and vegetables has a significantly lower absorption rate (5%) when consumed alone, i.e. without meat (Arthur & Isbister, 1987; Dallman, 1986; Holland & O'Brien, 1997).

Moreover, in terms of the assumptions about the security or reliability of domesticated food supplies, ecological studies have shown that the agricultural economy is more vulnerable to failure and therefore more episodes of starvation can be experienced among farmers than in foragers (Cohen & Armelagos, 1984). The extrapolation of these theories and arguments leads to an assumption that agricultural populations can be expected to suffer higher rates of iron deficiency anaemia as a consequence of their dietary habits.

The dry savanna, wet savanna and forest populations in this study primarily followed an agricultural subsistence strategy with some differences at micro-environmental level (See Chapter 3 for details on evidence of subsistence). It is, therefore, not unreasonable to assume that their agricultural dietary habits caused (in part) the high rates of CO and PH observed in these populations. Sorghum and millet were grown as a staple food in sub-Saharan Africa throughout the 'Iron Age' (Murdock, 1959).

Children in these societies, as can be seen today, were likely to have been weaned onto these gruels.

Although archaeological evidence for a possible animal protein supply is available at sites from the research area (at varying quantities), the picture presented by the skeletal pathology suggests that animal consumption was minimal or sporadic; and therefore did not provide sufficient iron to the populations. Support for the skeletal pathology as indicated by the high rates of CO and PH, is provided by stable isotope analyses from previous works, which have demonstrated that 'Iron Age' diets were based mainly on domesticated cereals and that little animal products were consumed (Lee-Thorp *et al.*, 1993; Murphy, 1996).

Different patterns are observed in the rates of CO and PH between males and females in the different regions, especially when comparing between dry savanna and forest populations. In the dry savanna (presumably a patrilineal society), females are more affected by iron-deficiency anaemia than the males (66.7% of females vs. 47.1% of males); whereas in the forest zone (presumed to be a matrilineal society), the reverse is true (46.2% in females vs. 87.5% in males). These results could be suggesting that socio-cultural factors, such as differential access to certain foods and other resources were responsible for the differences in CO/PH percentages between the sexes. According to the Zulu people of South Africa, who also have a patriarchal lineage, foods such as eggs and certain parts of a carcass were not consumed by women and only reserved for the men (personal communications with Mr. S.M. Dlamini, 2005).
An alternative explanation for the low iron status among females is the issue of pregnancy and the general biology of reproductive women through blood loss during menstruation. To compound this problem, most societies in sub-Saharan Africa have an ideology that large families are a sign of wealth and prosperity, hence large families are encouraged (Jordaan, 1991). As a result, multiple pregnancies and short birth intervals are a common phenomenon, which subsequently put women at higher risks of iron-deficiency anaemia. Another interesting and important issue that arises is that of the relationship of sex and anaemia. This issue still needs to be addressed when looking at other possible causes of iron-deficiency anaemia.

We now know that in order to understand the pathogenesis and aetiology of anaemia, we need to have a good knowledge and understanding of iron metabolism (Arthur & Isbister, 1987; Cook, 1990). There can be little doubt that other factors beside dietary deficiencies were also involved in causing the high rates of CO and PH seen in the societies under study (Stuart-Macadam & Kent, 1992). The situation was a complex relationship of environmental, geographical and socio-cultural influences interplay. In fact, Arthur and Isbister (1987) have shown that iron deficiency is more often a result of loss of the normal conservation of iron since "human iron metabolism is a system based on conservation" (*ibid*: 171). Under this notion, dietary deficiency can almost never be the sole reason for iron-deficiency anaemia, because under normal circumstances the body recycles and conserves as much as 90% of the iron available (Stuart-Macadam & Kent, 1992). Other causes of iron deficiency must therefore, be sought after to explain the prevalence of anaemia in past and present populations.

Relatively more recent works by physicians (Olivares *et al.*, 1989; Wadsworth, 1992; Weinberg, 1992) and biological anthropologists (Carlson *et al.*, 1974; Lallo *et al.*, 1977; Stuart-Macadam & Kent, 1992) have demonstrated the crucial association of the adaptability and flexibility of iron metabolism and the body's defence system. It appears that the immune system and iron metabolism are finely tuned with each other (Arthur & Isbister, 1987). Contrary to the view that anaemia is only debilitating to one's health, a new perspective arguing that anaemia may actually be part of a co-ordinated, physiological adaptive response to heavy pathogen loads and inflammatory diseases (Kent *et al.*, 1990; Arthur & Isbister, 1987; Weinberg, 1992; Stuart-Macadam & Kent, 1992).

During an infection or inflammation, the availability of iron for invading micro-organisms is limited by sequestration of circulating iron into storage forms in conjunction with a high presence of unsaturated iron transport proteins, i.e. transferrin and lactoferrin. This state of hypoferremia renders the host a transient advantage of protection against microbial invasion. Thus, "a heavy pathogen load will increase the incidence of parasitic, infectious, viral and fungal diseases, many of which have the effect of reducing the iron status of individuals" (Stuart-Macadam & Kent, 1992:159). In this view, anaemia should not be seen as a pathological condition or disease but as a symptom that signifies an underlying disorder.

Some of the most elaborate works done on the impact of an agricultural way of life, aggregation and sedentism include reviews such as Cohen & Armelagos' (1984) "*Palaeopathology at the Origins of Agriculture*"; Kent's (1986) *"(The) Influence of Sedentism and Aggregation on Porotic Hyperostosis and Anaemia: a case study*"; Kent & Dunn's (1996) "*Anaemia and the Transition of Nomadic Hunter-Gatherers to a Sedentary Lifestyle: Follow-up Study of a Kalahari Community*", among others.
Dunn's (1972) elaborate review on the relationship between cultural-ecological groups, sanitation and intestinal parasitism has provided us with a powerful tool to explain the differences that exist in the prevalence of anaemia between populations. He has carefully examined the effects of sanitation on a general ecological scale and has come up with the following conditions:

a. "Population density and crowding: the larger and denser the population, the more heavily contaminated were their living conditions,
b. Land availability around the village: large tracks of land around the village minimised contamination,
c. Community mobility: the greater the mobility of the community, the cleaner the environment,
d. Subsistence: agriculturalists have more contact with the land and a greater chance of being exposed to soil pathogens,
e. House style: ground level housing as opposed to pile housing meant a greater chance of exposure to pathogens,
f. Domestic animals: these animals can act as scavengers and reduce environmental contamination, and
g. Helminth viability: at cooler, higher elevations the viability of helminth eggs is reduced." (In Stuart-Macadam, 1992: 43).

Agricultural subsistence strategies produced a deterioration of hygienic conditions that was accompanied by population growth, aggregation and an increase in sedentism, all of which created prime situations for pathogen infestation. All population groups in this study practised agriculture and had more or less of the typical characteristics of an agricultural way of life, i.e. sedentism, aggregation, high pathogen loads, poor sanitation, and so on. These characteristics had more than likely put them at higher risks of infectious diseases. The high rates of CO and PH could be linked to their lifestyles and their cultural-ecological environments.

Once again, differences in CO and PH percentages are observed between the different zones in the research area. Individuals, especially in adulthood, in the forest region have substantially higher rates of PH than at either dry or wet savanna zones (Tables 5.05 – 5.07). According to Hengen (1971), the closer the region is to the equator, the higher the incidence of porotic hyperostosis. This observation is probably related to the tropical or semi-tropical climate of the region, which could promote the viability of most pathogens in the environment. The forest zone is closer to the equator than the dry or wet savanna regions; thus, rendering it more prone to higher parasitic infestations.

Moreover, this region has a high prevalence of endemic malaria and the sickle-cell gene (Tobias, 1974; Jenkins, 1977), both of which impact on the iron status of individuals affected (Aufderheide & Rodriguez-Martin, 1998; Feachem & Jamison, 1991; Stuart-Macadam & Kent, 1992). Therefore, within the context of a possible high parasite load in the forest zone, it is postulated that the 'anaemia of chronic diseases' and greater PH frequency would prevail. On the basis of this theory, the state of chronic anaemia can be seen as an indication of the population's attempt to adapt to its environment.

Studies on pre-historic and contemporary populations have shown that children are more susceptible to infection than other age groups, due to their low immunity and thus, have the highest rates of anaemia (Arthur & Isbister, 1987; Wardsworth, 1992). The conclusion from this finding was that skeletal lesions, especially on the cranium, represent the remains of childhood anaemia (Stuart-Macadam & Kent, 1992). This pattern is, however, not the case for the juveniles in this skeletal series. So, what could be causing the inconsistency in the results of this study? High infant mortality rates (these have not been calculated for this study) could be a possible reason for the low frequency of anaemia in children (Henneberg & Steyn, 1994; Mosothwane & Steyn, 2004). Children in these societies may have suffered more virulent acute attacks that resulted in sudden deaths. If this were the case, the body would not have had enough time to elicit any skeletal changes associated with the anaemia. The small sample sizes of juvenile skeletons, especially in the forest and wet savanna regions could have also affected the results of CO and PH.

It is interesting to note that the lesions found on the crania are more frequent in adult individuals than in children. According to Stuart-Macadam (1989), orbital lesions appear to represent the earliest signs of anaemia, while vault lesions tend to be associated with more severe orbital lesions; probably indicating an advanced stage of the anaemic condition. In the context of this study, especially in the forest sample, could vault lesions be indicative of something other than general acquired iron-deficiency anaemia? It is possible that the high prevalence of PH in the forest zone could be related to genetic anaemias like sickle-cell anaemia.

The intensity (i.e. light, medium, and severe) of CO and PH lesions was often found to be light and medium (Tables 5.04 and 5.08). Skeletal remains displaying light lesions suggest that the 'disease process' was in its initial stages when the person died (Grauer, 1993).

The overall frequency of cribra orbitalia in the dry savanna, wet savanna and forest populations is compared to other archaeological samples from the research area. The populations from the comparative data have different subsistence economies that might help to explain the variation of CO prevalence.

- Dry savanna (present study) – agriculturalists with a cattle-based economy
- Wet savanna (present study) – agriculturalists
- Forest (present study) – agriculturalist dependent on riverine resources
- Riet River (Morris, 1984) – hunter-gatherers
- Kakamas (Morris, 1984) – pastoralists
- Oakhurst (Patrick, 1989) – hunter-gatherers dependent on marine resources
- Farmers (Murphy, 1996) – agriculturalists
- Herders (Murphy, 1996) – pastoralists with features in common with agriculturalists
- Griqua (Peckmann, 2002) – pastoralists also growing agricultural products
- Colesberg (Peckmann, 2002) – males are agricultural labour, women are domestic servants in town
- Wolmaransstad (Peckmann, 2002) – males are agricultural labour
- Toutswe (Mosothwane, 2003) – agriculturalists

Based on the expectations of health and morbidity (See Chapter 1) for agricultural and foraging communities, the pattern of higher incidences of CO in agriculturalists as compared to pastoralists and hunter-gatherers is illustrated in the comparative groups Table 6.03). The higher rates of CO evident in the Oakhurst sample are, however, an exception to this trend. Since the Oakhurst population was dependent on marine resources, it is possible that exposure to fish-borne parasites or water contamination or a combination of both may be responsible for the high rates of CO in this community (Patrick, 1989). Arthur & Isbister (1987) speak of high nutrient losses due to diarrhoeal infections having a greater impact in determining the aetiology of CO than a low intake of essential nutrients, especially in growing individuals.

The high rates of cribra orbitalia and porotic hyperostosis found in the dry savanna, wet savanna and forest populations indicates occurrence of iron-deficiency anaemia that is consistent with other agricultural communities. Indeed, the aetiology of iron-deficiency anaemia is multifactorial as indicated by differences observed at micro-environmental scale within the research area. All groups were more than likely exposed to high parasite loads due to sedentism, high-density populations and poor hygiene. Nutritional deficiencies associated with their iron-poor, grain-dependent diets may have exacerbated the problem of iron deficiency.

Endemic diseases such as malaria and genetic disorders like sickle cell, found in parts of sub-Saharan Africa closer to the equator, probably contributed to the high incidences of CO and PH in these communities.

Children fed cow's or goat's milk or weaned onto cereal gruel tend to have high frequencies of iron-deficiency anaemia because of the low iron available in these foods. Socio-cultural factors such as differential access to food and other resources between men and women may have influenced the different patterns of CO and PH between the sexes. Multiple pregnancies may have compounded the problem among the women.

6.3 LOW-GRADE INFECTIONS

Periosteal reactions fundamentally signify an inflammatory response to bacterial infection, traumatic injury and/or vitamin and mineral deficiency. Since periosteal reactive lesions are more often localised than systemic, infection resulting in periostitis is almost never fatal. Thus, periosteal lesions can provide us with useful information on health and morbidity of past populations (Larsen, 1997, 2002; Cohen & Armelagos, 1984; Ortner & Aufderheide, 1991). Furthermore, their prevalence in a population can reflect changing patterns of specific lifeways such as the transition from hunting and gathering to farming (Larsen, 1997).

As with cribra orbitalia and porotic hyperostosis, "the pathogenesis of periosteal reactions can be best understood in terms of the synergistic relationship between (constitutional factors), diet and infectious disease" (Mensforth *et al.*, 1978:48). In other words, individuals poised with nutritional deficiencies or malnutrition are less resistant and more susceptible to infectious disease than well-nourished persons. Conversely, infection worsens the nutritional status of an individual as the body's needs for protein and nutrients increase.

In the previous section on metabolic homeostasis (anaemias), I have reviewed the typical issues associated with a sedentary agricultural way of life. The same issues that are involved in affecting the iron status of an individual can be employed to explain the presence of periostitis in different populations.

From the bioarchaeological record, an increase in the prevalence of periosteal reactions has been observed when populations undergo adaptive shifts from a foraging to a farming subsistence lifestyle (Powell, 1988; Ortner & Aufderheide, 1991; Larsen, 1997; Goodman *et al.*, 1984; Mensforth *et al.*, 1978; Armelagos, 1990). The role of the decline in nutritional quality, the effects of population size increase and sedentism are factors frequently used to explain the increase of periosteal infections among agriculturalists.

However, since periosteal lesions are so common in archaeological specimens, the interpretation of their meaning can be clear only when viewed within the larger cultural and ecological contexts, as well as their association with other stress indicators. For example, Lallo and co-workers (1978) report on a dramatic increase in the incidence of infectious disease in the 13th century AD settlement at Dickson Mounds. The increase in population density (thus, easy transmission of disease) and a heavy reliance on maize (reduced nutritional adequacy) that coincided with the adoption of agriculture are attributed to the increase in infectious lesions in this population (Lallo *et al.*, 1978).

Mensforth and co-workers (1978) are among the first scholars to examine the association of periosteal lesions with other skeletal stress markers, i.e. porotic hyperostosis. Their results showed that periosteal reactions are commonly found in association with porotic hyperostosis, which had important implications for patterns of infant and child morbidity and mortality. Both malnutrition and infectious diseases were finely tuned with each other to invoke stressful conditions for the growing individual (Mensforth *et al.*, 1978).

The high incidence of sub-periosteal bone lesions (SPBL) in the dry savanna, wet savanna and forest zones (Tables 5.13 to 5.15) may be attributable to either localised or systemic or both, infections present in these populations. The presence of infectious disease can be tied to the increased state of sedentism, aggregation and may have been compounded by the increase in emphasis on nutritionally poor foods, i.e. cereal grains that were commonly grown during the 'Iron Age' in sub-Saharan Africa. The semi-permanent and permanent settlements of these societies, for example K2, Mapungubwe, Sanga, Katoto and so on, most probably provided conditions conducive to the maintenance and relatively easy spread of infectious diseases and other factors that led to the increase in skeletal stress lesions.

In the forest region, the incidence of SPBL is highest. This is also coupled with high rates of porotic hyperostosis and cribra orbitalia, which are related to iron-deficiency anaemia most likely of chronic diseases. The explanation of this prevalence can be rested on the fact that the forest region is closer to the equator than either dry or wet savanna zones; thus facilitating the viability of most parasites and pathogens due to its semi-tropical climate. Archaeologically, the Sanga and Katoto sites are some of the largest occupation settlements yet known in sub-Saharan Africa (de Maret, 1985b). Therefore, it is not surprising to find evidence of high infections in this setting of high population density.

Moreover, archaeological evidence for trade links with the East has been found in the majority of sites in the research area (See Chapter 3 for details). The overall high incidence of SPBL in the research area could also be linked to the increase in trade networks and long-distance social contact of these communities with outsiders. It has been postulated that "these contacts may have provided a means for introducing novel pathogens and disease vectors, thus increasing the prevalence of infectious disease" (Larsen, 1997: 86).

The patterning of the SPBL in this study shows that the cranium is much less frequently affected than the post-cranial skeleton. In the post-cranial skeleton, the femur, tibia and fibula are most frequently affected by the reaction (Tables 5.13 to 5.15). Furthermore, post-cranial lesions have been noted to frequently occur alone. This pattern of the lesions suggests that the pathogenesis of the infection resulting in bone reactions was more likely to be a localised one or trauma injuries than a systemic disease process.

However, this does not exclude the possibility of more virulent systemic disease processes to have been problematic in these populations. Seven individuals from the dry savanna region and one sub-adult individual from the forest zone have sub-periosteal reactions involving both cranial and post-cranial skeleton (Table 6.04). On the basis of the distribution of skeletal lesions in treponemal syndromes (adapted from Ortner & Aufderheide 1991: 174-175), the lesions observed in these individuals might be attributable to treponemal diseases such as yaws and syphilis (Figure 6.01). In southern African prehistory, however, there are virtually no reported cases of venereal syphilis (Steyn, 1994). It is therefore more probable that the 'specific' treponemal diagnosis resulting in sub-periosteal bone lesions in the research area could be yaws and endemic syphilis.

In all samples, adult individuals are more commonly affected by SPBL than sub-adult individuals. This is in contrast to the notion that children are more susceptible to infectious diseases than other age groups. Perhaps, the demographic profile of the SPBL could be representing behavioural activity patterns of these communities. In addition, the sex differences observed between males and females in the wet savanna and forest regions could lend support to this assumption. In both regions, the males are appreciably more affected by periosteal lesions than their female counterparts. It is not improbable that males in the wet savanna and forest regions were participating in more physically demanding activities that could have led to more frequent blows to the lower limb (mostly frequently affected area) than the females.

The key to fully understand the pattern of bone lesions among the sexes possibly lies in the knowledge of different roles played by both men and women in these societies;

for example in patrilineal versus matrilineal societies. In pre-historic population, however, this is not always an easy task. Careful use of ethnographic inference does help provide some insight into such socio-cultural characters.

The presence of infectious diseases as indicated by high incidences of sub-periosteal bone lesions in this sample is uncommon to this region as reported in other archaeological populations (Steyn, 1994; Murphy, 1996). For example, Murphy (1996) reports on very low frequencies, i.e. less than 5% for all lower limb long bones, of periosteal lesions for both farmers and herders. The apparent variability and inconsistency of the prevalence of bone lesions is undoubtedly due to interobserver differences in recording methods. Sample sizes and the condition of skeletal remains may also have exacerbated this problem.

In the light of the results of this study, it appears that infectious diseases were a 'real' problem in the lives of these people. The presence of skeletal indicators of infection, both non-specific and specific, is a reflection of disease burden and a general negative impact on adaptation and health of the societies under study. Deterioration of living standards elicited by increased population size, nutrient-poor diets and poor sanitation are the most likely 'culprits' responsible for the relatively high incidence of sub-periosteal bone reactions in these agricultural people.

DENTAL HEALTH

6.4.1 DENTAL OCCLUSAL WEAR

Although dental wear is a normal physiological process rather than a disease, it is necessary to assess this feature when comparing populations on other 'true' dental pathologies, such as caries or abscesses. For example, severe dental wear can predispose a tooth to cariogenesis and possible abscessing; whereas moderate wear can actually be beneficial in deterring caries as it smoothes out the tooth surface where caries usually occur (Powell, 1985; Hillson, 1986; Roberts & Manchester, 1995). Differences in wear severity between populations can, therefore, affect the prevalence of dental pathological conditions within samples. Dental wear can also be used to reflect differences in dietary behaviour and lifestyle between past living populations.

Among human populations worldwide, there has been a secular trend in the reduction in severity of occlusal surface wear (Powell, 1985, Larsen, 1997, 2002). This trend has been greatly attributed to the shift in subsistence strategies, from a foraging to a farming economy. The characteristics of food, such as its consistency and texture as well as the manner in which it is prepared, highly influence the wearing of tooth surfaces. Thus, differences in foodways or subsistence economies would tend to produce different degrees of severity of dental wear. These differences would also be further influenced by localised behavioural characteristics such as cultural practices, age, sex, and oro-facial morphology (Larsen, 1997). With all this said, dental wear 'proves' to offer some of the most comprehensive information to our understanding of masticatory and non-masticatory behaviour in human populations.

In general, foraging populations have more severe dental wear than agricultural societies. The reason for this is that hunter-gatherer diets usually comprise more 'tough', fibrous foods that also contain more exogenous abrasive substances. Foods consumed by agriculturalists on the other hand, tend to be softer and processed to facilitate absorption of nutrients by digestive enzymes (Larsen, 1997).
However, this is not always the case since some processing techniques may actually introduce abrasive elements that encourage tooth wear. For example, Pfeiffer's analyses of skeletal material from the 'Iron Age' agriculturalists in Nigeria have indicated fairly heavy dental wear on the first molars of these people (Pfeiffer, 1988). She attributes this to processing of plant foods (cereal grains) with grinding stones, contributing to the overall grittiness of the diet.

The mean occlusal wear for all samples in this study range from slight to moderate, which is consistent with an agricultural diet (Tables 5.33 and 5.34). Slight differences in the degree of wear exist between age and sex groups, between and within the dry savanna, wet savanna and forest samples.
As far as age categories are concerned, individuals from the dry savanna zone display a larger mean attrition score in both younger and older adult categories. For the younger adults, the dry savanna population has a slightly greater wear (1.7) followed by the wet savanna (1.4) and the least worn teeth are found in the forest population (1.2). This pattern does not continue into the older adult group. The dry savanna older adults still express greater occlusal wear (2.1), but then the forest older adults follow

by 1.9 and lastly the wet savanna individuals with only a 1.5 mean attrition score. In general, anterior, posterior and mean occlusal wear increase with age in all three samples. This is not an uncommon pattern.

It appears that the diet of the forest people was more refined and possibly less gritty than either in the dry or wet savanna. Grinding stones for the processing of grains are commonly found in all three regions. Thus, it is unlikely that the manner of food preparation led to the differences in severity of wear between these populations. Perhaps the reliance on fish and other riverine resources of the forest people predisposed their diet to be less 'tougher' than that of dry savanna and wet savanna peoples. It is also possible that the dry savanna people especially, depended more on vegetables that could have had lot of grit and tough meats either wild or from older domesticated animals (See Chapter 3 for details on subsistence evidence at sites).

In all three samples, the incisors show the greatest degree of wear in the younger adult group, followed by the first molars. In the older adult category, the first molar is more heavily worn than the incisors. Overall, the total anterior attrition score is larger than the posterior attrition score, i.e. anterior teeth show a greater degree of wear than posterior teeth. This is more obvious in the younger adult category in all samples. According to Steyn (1994), the decrease in anterior to posterior wear with age may be related to the initial accelerated rates of anterior wear due to smaller tooth mass. When the anterior teeth are so intensely worn, and are no longer in proper occlusion, the posterior dentition may experience a 'catch-up' period until both anterior and posterior wear is almost equal in the older adults (Steyn, 1994).

A sex difference in occlusal wear is found in the dry savanna, with females showing more tooth wear than the males in both younger and older adult groups. This pattern is reversed in the wet savanna zone. Younger and older adult males in this sample illustrate a greater wear pattern than their female counterparts; the difference being more pronounced in the anterior dentition. The degree of wear does not greatly differ between males and females in the forest sample, but younger females show a slightly higher mean wear score than the younger males. In the older adult population in the forest sample, the males have more occlusal wear than the females.

The sex differences seen in these populations are minimal, but could be important indicators of behavioural variability in tooth use, as well as underpinning the roles played by men and women in different socio-cultural settings. Earlier in this chapter, I spoke about differential access to food and other resources between men and women as highlighted among the contemporary Zulu people of South Africa. In the case of consuming selected parts of a carcass, for example, ethnographic observations note that men had first access to select the most tender choices of meat (such as internal organs, rump area), thus leaving the women with the less-choice, tougher portions. A similar scenario is reported amongst the Kauma foragers (Richards, 1984 in Larsen, 1997). In turn, this distinction along gender lines in masticatory practices may even 'force' women to rely more on agricultural foods that may promote tooth wear.

Alternatively, the higher occlusal attrition among females could simply be a reflection of behavioural activities between men and women. 'Traditionally', women are responsible for food preparation and cooking; while men go out to hunt. In other words, women 'traditionally' spend most of their time around the household and kitchen, whereas men spend less time around the house. This could therefore, imply that women have more time to consume foods like grain cereals that might contain abrasive elements while preparing and sampling it, than their men.

Although the reasons for the sex differences in the pattern and severity of wear can *never* be fully understood in prehistoric populations, their presence may reflect highly variable wear patterns between closely related populations. Interpretation of these results is also tempered by the small sample sizes available for analysis, especially in the wet savanna sample. The range of variation for males and females is therefore not fully represented.

The occlusal wear for the dry savanna, wet savanna and forest populations is compared to other archaeological samples from southern Africa (Table 6.05): Riet River, Kakamas (Morris, 1984); Farmers, Herders (Murphy, 1996); Griqua, Colesberg, Wolmaransstad (Peckmann, 2002).

When comparing mean attrition scores, the groups in this study show similar low scores as the farmers and herders (Murphy, 1996). The Griqua, Riet River and Kakamas sample show the highest wear scores than any other groups. This is probably reflecting differences in subsistence modes: groups inclined to pastoral and hunting and gathering ways display higher wear scores than agricultural groups.

6.4.2 ANTEMORTEM TOOTH LOSS AND DENTAL CARIES

Since antemortem tooth loss and dental caries are interrelated, it is advisable to discuss the prevalence of both these maladies together. Antemortem tooth loss (AMTL) can result from excessive tooth wear, carious lesions, periodontal disease, trauma and intentional tooth extraction. Exposure of the pulp cavity either through cariogenesis, excessive wear or trauma, can lead to bacterial infection and subsequent abscessing of the surrounding alveolar bone that could result in loss of a tooth (Burns, 1999).

Once again, dietary environment or behaviour has been implicated in the prevalence of AMTL in past and contemporary populations (Cassidy, 1984; Hartnady & Rose, 1991; Larsen, 1997; Patterson, 1984; Walker & Hewlett, 1990). Contrary to the decline in occlusal wear, the shift from a foraging to a farming economy was accompanied by an increase in tooth loss. Both minimal and severe dental wear have been associated with high incidences of tooth loss. Dental wear on its own, however, does not lead to antemortem tooth loss. Other factors such as stagnation of bacteria on the tooth surfaces or periodontal tissues are involved in promoting oro-dental disease processes. For example, in the case of reduced dental wear as observed in many agricultural populations, the grooves or fissures present in the posterior teeth provide ample opportunistic loci for carie-causing bacteria to grow (Larsen, 1997). Thus, dental caries as a disease process are the main cause leading to loss of a tooth; and reduced dental wear only then provide loci for the caries to develop.

Furthermore, since agricultural foods have a high starch or sugar content that often sticks in stagnant areas of the tooth, dental caries are again encouraged through consumption of such foods.

We can, therefore, expect to find high incidences of AMTL in populations that rely on agricultural foods. From the archaeological record, a number of studies have reported high frequencies of AMTL in different settings. In North America, a dramatic increase in AMTL is reported with the shift to farming, especially in maize agriculture (Patterson & Larsen, 1997). Comparisons between pre-historic foragers and farmers show an increase in tooth loss in the latter group. The cause of tooth loss is due mainly to dental caries as a result of the highly cariogenic maize diets in combination with reduced dental wear of posterior teeth. The pre-historic foraging populations also show some tooth loss but much lower than the rates reported for the farmers. The cause for tooth loss in the foragers, however, appears to be due to pulp exposure from extreme tooth wear (Larsen, 1997; Sealy *et al.*, 1992).

Therefore, a pattern for the oro-dental health in agricultural populations is discernable: a decline on occlusal wear accompanied by an increase in carious lesions that subsequently lead to high rates of antemortem tooth loss. This pattern is illustrated in Figure 6.02. The skeletal series of different archaeological populations from the Eastern Woodlands in North America demonstrate a clear increase in dental caries prevalence during the 16th and 17th centuries with the intensification of maize production and consumption (Larsen, 1997). The three forager groups (Archaic, Early Woodland, and Middle Woodland) have less than 7% carious teeth, while the three agricultural groups (Late Woodland, Mississippian and Contact) have dental caries rates over 17% (Larsen, 1997).

Maat and Van der Velde (1987) also report on a negative correlation between attrition rates and dental caries that perpetuate tooth loss. The molars of sailors recovered from a 17th and 18th century Dutch whaling station in the Spitzberg Archipelago indicated that increased wear appears to be associated with fewer caries because of the reduction in stagnation fissures and grooves (Maat & Van der Velde, 1987).

Antemortem tooth loss is high in the dry savanna, wet savanna and forest populations (Tables 5.16 to 5.19). When comparing between individuals in the three regions, the highest percentage of individuals presenting with AMTL is found in the forest zone (72.3%), higher in the wet savanna (63.4%) and lowest in the dry savanna (34.2%). This is not surprising, as occlusal wear was found in exactly the same inverse proportion in these populations: occlusal wear is minimal in the forest sample, slightly more in the wet savanna and slightly heavier in the dry savanna sample.

However, this pattern seems to change when AMTL is observed per tooth places as opposed to individuals. Antemortem tooth loss rates per tooth places are comparable between the dry savanna and forest samples (8.0% and 8.2%, respectively), whereas the rate is doubled in the wet savanna (16.1%). Thus, it appears that the individuals from the wet savanna suffered more tooth loss than those in the dry savanna and forest zones. Moreover, in the dry savanna and forest regions, individuals presenting with AMTL were equally affected (2.6 teeth lost antemortem/mouth), whatever the reasons were.

The results for the AMTL are then correlated to the incidence of dental caries in all samples. Overall, individuals in the forest region are more frequently affected by dental caries (55.4%), followed by those in the wet savanna (48.1%) and the lowest caries frequency is found in the dry savanna (35.5%). This pattern remains the same when looking at carious lesions per tooth, i.e. caries intensity: 8.2% of the total number of teeth observed from the forest sample had caries, 7.6% carious teeth were found in the wet savanna and 3.7% of teeth from the dry savanna were affected. It seems that the forest people were more frequently affected by caries and that the affected individuals also suffered more caries on their dentition than individuals in the dry savanna and wet savanna.

As with occlusal wear, AMTL is higher in the older adult individuals and lower in the younger adults. Therefore, the percentage of individuals with AMTL increases with an increase in age. Also, caries rates in the wet savanna and forest samples are higher in the older adult group and lower in the younger adults. The dry savanna population shows a different pattern; more carious teeth are found among the younger adults, while older adults present with less carious teeth.

There is usually an inverse relationship between AMTL and caries: low AMTL and high caries rates, and higher AMTL with low caries rates. This relationship is usually age dependent; the former pattern often seen in the younger adult group and the latter in the older adult category. Therefore, patterns of AMTL and dental caries in tooth classes may help explain the causes of either AMTL or caries or both.

The number of teeth lost antemortem, as well as that of carious teeth for each tooth type, is illustrated in figures 6.03 and 6.04, respectively. The tooth that is most frequently lost in the forest region is the central incisor followed by the first molar. The first molar is also the most commonly carious tooth, while no incisors were affected by caries. Since AMTL increases with age and caries rates decrease in older adulthood (dry savanna sample only), it is possible that the carious molars found among the younger adults are subsequently lost in older adulthood.

Generally, most teeth affected by carious lesions are posterior teeth probably because of their morphology. This pattern is evident in all samples, with a few exceptions (Table 5.26). Thus, it is less likely that the central incisors in all samples were lost due to dental caries. Ethnographic and archaeological evidence of intentional extraction of incisors has shown that this was a common practice done by numerous groups in sub-Saharan Africa (Morris, 1989, 1993, 1998; van Reenen, 1986; Friedling, 2004). The high losses of the central incisors in this skeletal series can therefore be attributed to intentional removal of these teeth possibly as a cultural practice. Dental modification will be discussed in detail later in this chapter.

Differences in AMTL and caries prevalence between males and females may indicate or further highlight the differences in food consumption between the sexes. In the dry savanna, males display a greater AMTL percentage accompanied by a lower frequency of caries; whereas the females in this sample display a reverse pattern (Tables 5.19 and 5.24). Higher loss of teeth among the dry savanna females may be due to higher consumption of cariogenic plant carbohydrates in comparison to their male counterparts. In this population (a patrilineal society), it is likely that males were consuming more and choicest cuts of meat, while females consumed less meat and more plant carbohydrates. Subsistence behavioural roles between the sexes may have 'enhanced' this pattern. It also seems that the slightly more worn state of the female dentition did not offer much benefit to their predisposition to dental caries and tooth loss.

The wet savanna and forest samples show a different pattern, in which the males have more teeth lost in conjunction to higher caries rates than in the females. In this scenario, it is apparent that males were doing something different from the males in the dry savanna. Perhaps the males in these societies were consuming more plant carbohydrates then the females. It is also possible that this difference highlights occupational differences between the sexes. Extramasticatory behaviours such as using teeth as tools, may lead to trauma and exposure of the pulp cavity, which may result in tooth loss. No evidence of this hypothesis exists for these archaeological populations.

Another less frequently cited reason for differences in dental disease prevalence between males and females is oral hygiene practices. Research work done on some South American native populations showed a higher prevalence of AMTL in females than in males "...In this setting, women of child-bearing age use sap to extract diseased (carious) teeth" (Larsen, 1997: 81). Therefore, it is not so impossible that women in the wet savanna and forest zones were practising some form of oral hygiene.

The type of food consumed and the manner in which it is prepared strongly influence the incidence of caries and AMTL in human populations. For this reason, the dry savanna, wet savanna and forest caries and AMTL rates are compared to other archaeological populations from southern Africa (Tables 6.06 and 6.07). The rate and frequency of AMTL in the dry savanna and forest samples are comparable to those found among the herders (Murphy, 1996). The herders in Murphy's study were not 'specialised' pastoralists with a heavy reliance on meat, but instead had a mixed subsistence economy. All populations in the current study had an agricultural subsistence economy with some varying components. The wet savanna population has similar high AMTL rates as the Colesberg and Wolmaransstad samples from South Africa (Peckmann, 2002). The Colesberg and Wolmaransstad populations were intensive agriculturalists with a heavy reliance on carbohydrates such as wheat, maize and sugar, which are highly cariogenic (Peckmann, 2002). So, it is not surprising that these populations have the highest rates of AMTL probably due to caries.

Caries rates for the present skeletal series fall between the range for Colesberg, 3.8% (Peckmann, 2002) and herders, 9.0% (Murphy, 1996). The relatively lower caries rates found in the Griqua, Colesberg and Wolmaransstad samples are probably related to the high AMTL rates. The Oakhurst marine-resource dependent foragers have surprisingly high rates of dental caries that is inconsistent with most foraging populations (Sealy *et al.*, 1992). The authors of this study attribute the high caries rates to excessive dental wear that caused pulp exposure predisposing the teeth to disease (caries) (Sealy *et al.*, 1992).

The higher frequency of caries in the Riet River hunting and gathering population has been linked to the inadequate amount of fluorine found in the ground water of this area (Morris, 1984). A consistency of a hunter-gatherer or 'specialised' pastoralist diet is apparent in the relatively disease-free condition of the Kakamas people's teeth (Morris, 1984).

The high prevalence of AMTL and caries in the dry savanna, wet savanna and forest samples is consistent with populations subsisting on agricultural products. Socio-cultural factors such as intentional tooth extraction have also played an important role in affecting the dental health of these populations. Differential access to food and other resources probably caused the differences observed between males and females.

6.4.3 PERIODONTITIS AND ABSCESSES

As with dental caries and antemortem tooth loss, periodontal disease markedly increased in populations that have a heavy consumption of plant carbohydrates and processed foods (Cohen & Armelagos, 1984; Hillson, 1986; Larsen, 1997). The high sugar content in most starchy foods, especially if processed, provides a prime environment in the mouth for bacteria to grow and multiply. Softer processed foods exacerbate the problem, as they tend to stick on the teeth and between teeth. Invasion of the oral cavity by bad bacteria may then lead to inflammation of the periodontium and subsequent resorption and destruction of the alveolar bone, i.e. periodontitis (Hillson, 1986).

Since the dry savanna, wet savanna and forest populations practised agriculture and therefore presumed to have consumed great amounts of carbohydrates; I would expect to see a high prevalence of periodontitis in these groups. The overall frequency of periodontitis is relatively moderate for these agricultural groups: highest in the forest sample (60.6%), lower in the dry savanna (48.9%) and lowest in the wet savanna (39.6%). The frequency of periodontitis is fairly similar between males and females in all samples (Tables 5.27 to 5.29), and periodontitis appears to increase with age.

When compared to other agricultural and mixed-economic populations from the Northern Frontier groups from South Africa, the overall frequency of periodontitis in this study series is lower. A high of 94.1% was found in the Colesberg sample, 64.1% for the Griqua and 57.1% for the Wolmaransstad sample (Peckmann, 2002). Once again, the heavy consumption of wheat, maize and sugar in these populations was linked to the decline in their oral health (Peckmann, 2002).

Abscesses are greatly related to dental caries. A carious lesion can open up a path to the pulp chamber leading to bacterial infection around the root area. Pus build-up ultimately creates pressure in the pulp chamber that leads to resorption and destruction of the alveolar bone in that region (Roberts & Manchester, 1995; Aufderheide & Rodriguez-Martin, 1998; Burns, 1999). Probable reasons causing high caries rates in the present skeletal samples are discussed above and should be employed to explain incidences of abscesses.

Individuals presenting with alveolar abscesses are fairly high in all three samples, but also comparable: 24.0% for the dry savanna, 30.7% for the wet savanna and 29.2% for the forest sample. The high incidence of abscesses among the groups is probably related to their high caries occurrence. The rates of abscesses in this study are much higher than that reported for the farmers (6.7%), but more comparable to that of the herders (25.0%) (Murphy, 1996).

On the basis of dental health, it can be concluded that the diet of the dry savanna, wet savanna and forest peoples was highly cariogenic, thus, promoting a generally poor state of dental and oral health. To some extent, their lifestyles possibly contributed to this problem.

6.5 DENTAL MODIFICATION

Dental modification in the form of tooth extraction, filing and chipping has been documented among numerous historical population groups in southern Africa (Morris, 1989, 1993, 1998; van Reenen, 1986; Shaw, 1931; Erlandsson & Bäckman, 1999). Evidence of this practice in prehistory comes from skeletal populations from sites such as K2/Mapungubwe, South Africa (Steyn, 1994); KwaGandaganda and Nanda, South Africa (Morris, 1998); Mtemankhokwe, Malawi (Morris, 1993); Sanga and Mulemba-Nkulu, DRC (Murphy, 1996); Ingombe Ilede and Isamu Pati, Zambia

(Murphy, 1996) and Toutswe, Botswana (Mosothwane, 2003). Though often thought of as a 'thing of the past', recent work by Friedling (2004) reveals that tooth evulsion is still practised by present-day South Africans in the Western Cape.

The oro-dental record of the dry savanna, wet savanna and forest samples provide evidence that tooth extraction, filing and/or chipping were commonly practised by these populations (Tables 5.35 and 5.36). Since the total number of individuals observed is an estimate calculated from all individuals with crania and mandibles, the frequency of dental modification presented is not a true representation of the practice in these populations.

Tooth extraction appears to have been more commonly practised in the wet savanna (26.7%) and in the forest zone (21.7%) than in the dry savanna (3.0%). In the forest zone, tooth filing and/or chipping was even more common (34.8%) than in either dry savanna (12.1%) or wet savanna (6.7%) regions.

Some attempt has been made to reconstruct the pattern of tooth extraction and tooth chipping and/or filing (Figures 6.05 and 6.06). In the case of tooth extraction, for example, the clearest picture of the pattern that can be seen is the removal of the maxillary central incisors as well as mandibular central and lateral incisors. What is also notable is that the canines tend to fall out as a factor of progressive alveolar bone loss and not intentionally extracted (Morris, 1993). This has been observed in three individuals, all adults above 30 years at the time of death.

All the four individuals from the dry savanna zone with chipped incisors are represented by a full dentition, i.e. both maxillary and mandibular teeth are present for analysis. The pattern of tooth chipping and/or filing that can be obtained from these individuals is invaluable. Three of the 4 have only the maxillary incisors chipped off at both corners. One individual (UP89) has all incisors chipped at corners, maxillary and mandibular central and lateral incisors.

A different pattern of tooth filing is seen in one individual from the wet savanna zone. This adult male individual had the mesial corners of his maxillary central incisors filed to give an inverted V-shape appearance.

Tooth extraction was done by both men and women, though only males were found to show signs of the practice in the wet savanna. It is also apparent that tooth filing and/or chipping was commonly done by females; hence 8 of the 9 individuals with chipped incisors are female in the forest sample. Only one male individual exhibited chipped central and lateral incisors. In the dry savanna, one adult male and three adult females had chipped or filed their incisors on both corners to give a pointy appearance.

There is one sub-adult male individual from the wet savanna region (PMB 2000/11) who could provide a possible indication of the age when the practice was done. This individual was between thirteen and sixteen years at the time of death. His age and the presence of incisor evulsion could suggest that the practice was performed before puberty, perhaps as a rite of passage into adulthood. A number of studies also consider the practice to be done during initiation ceremonies as a rite of passage into adulthood or to indicate ethnicity (Morris, 1998; van Reenen, 1986; Friedling, 2004; Shaw, 1931).

Interestingly, one of the two females (Sanga-T116) from the forest sample exhibited maxillary central and lateral incisors with chipped corners as well as intentional extraction of the mandibular central and lateral incisors. This individual also gives an indication that the practice of tooth mutilation was done in stages, possibly due to its painful nature. Her right upper lateral incisor was not modified at the time of death, i.e. around 25 years; while the left lateral incisor was chipped (See Figures 6.06, Style 3).

The archaeological distribution of dental modification may help reflect population movement and tradition in sub-Saharan Africa. However, no attempts are made toward tracing and reconstructing possible pathways of the tradition, in this study. Perhaps, future studies may contribute some information on the use of this trait in sub-Saharan Africa.

6.6 IMPACT OF STRESS ON SKELETAL GROWTH

In osteoarchaeology, growth simply means the progressive incremental changes in size and morphology of skeletal elements, which occur throughout the developmental stages of an individual's lifetime (Scheuer & Black, 2000). Since growth is highly influenced by the environment, patterns of growth can therefore provide good indicators of health and well being of a community or population. Although the genetic predisposition of skeletal growth of an individual cannot be assessed in this study, this aspect of growth must not be overlooked.

Environmental factors such as the synergy between nutritional inadequacy and disease can adversely affect a normal growth pattern, which could lead to growth retardation (Larsen, 1997).

Saunders comments that for environmental stressors to have an effect on skeletal growth, they have to be severe and chronic (Saunders, 1992). This theory, therefore, makes the assumption that acute or episodic stress insults have a less substantial impact on skeletal growth and ultimately stature. Support from studies that look at indicators of acute stress episodes such as Harris lines and linear enamel hypoplasias, also demonstrate the insignificant impact of these stressful periods to skeletal growth (Clark, 1981; Nowak & Pointek, 2002).

On the other hand, chronic malnutrition and chronic infectious disease prevalent in some agricultural societies have been associated with slow growth rates and stunted growth in these populations (Larsen, 1997; Goodman *et al.*, 1984).

Numerous studies of living populations have revealed that "a strong relationship exists between growth suppression in childhood and attainment of adult body size, including terminal height" (Larsen, 1997: 13). In other words, "growth-retarded children should be short-statured adults" (*ibid*: 13). In addition, both archaeological and living populations demonstrate broadly similar patterns of juvenile growth, despite the twentieth-century secular trend of taller statures in industrialised countries and in some developing nations (Saunders, 1992; Ribot & Roberts, 1996). Because of this congruence of growth, it is possible to compare stature differences between past and present populations.

In this study, mean stature estimates for the dry savanna, wet savanna and forest populations are compared to other archaeological and modern populations from southern Africa (Table 6.08). The mean stature estimates for the dry and wet savanna males fall within the tall stature (1700 – 1800 mm) category of the southern African Negro males (Tobias, 1972) and the Colesberg males (Peckmann, 2002). Only a fraction (13.3%) of the males from Tobias' (1972) sample fell into this category. The majority (85.6%) of the southern African Negro males were found to be medium in stature (1600 – 1700 mm), as do the males from the forest region. So, why are the males in the dry and wet savanna taller than the historic southern African males, especially if their genetic origin is assumed to be similar? It is postulated that historic populations experienced more hardship, perhaps related to civil strife during the contact periods with Western groups, than did the 'Iron Age' peoples. This theory is, however, difficult to substantiate.

Comparison within the different population groups in this study show that the forest males are shorter than the dry and wet savanna males. This could be a geo-climatic characteristic: people who live in hot, wet environments tend to be short and robust, while people in savanna environments are usually tall and thin (Hiernaux *et al.*, 1975; Hiernaux, 1977).

All females in this study show higher mean stature estimates than any other female group in the comparative populations. Their mean stature estimates can be included in the Wilson and Lundy's (1994) female 'Negro' range, but only at the higher end of the range. It is interesting to note that the forest females are taller than the wet savanna females: 1612.6 mm versus 1586.0 mm, while the males show the opposite comparison. The very small sample size (two individuals) of the wet savanna females could be causing this anomaly.

Sexual dimorphism is found at a considerable degree, in all samples, more especially in the wet savanna and dry savanna regions. The reduced degree of sexual dimorphism in the forest population may be indicative of increased stress in this population (Tobias, 1972).

As far as the stature is concerned, it seems that the populations in this study were adequately nourished and well adapted to their environments. Alternatively, it could mean that any hardships that these people experienced in their growing years did not affect their terminal heights, and that growth was normal.

Sample	Total no. Individuals with tibia(e)	No. of Individuals with HL	%
Dry Savanna* (present study)	35	7	20.0
Wet Savanna* (present study)	16	8	50.0
Oakhurst (Patrick, 1989)	22	11	50.0
K2 (Steyn, 1994)	43	12	28.6
Griqua (Peckmann, 2002)	135	14	10.4
Wolmaransstad (")	39	4	10.3
Colesberg (")	52	3	5.8

HL = Harris Lines
Dry Savanna* = Includes all 'Iron Age' sites studied in South Africa (SA) from this ecological zone
Wet Savanna* = Includes Ingombe Ilede, Zambia and coastal Kwa-Zulu Natal (SA) sites

Table 6.01 Frequency of Harris Lines in comparative populations

Sample	Total no. Individuals with Teeth	No. of Individuals with LEH	%
Dry Savanna* (present study)	47	34	72.3
Wet Savanna* (present study)	14	9	64.3
Forest* (present study)	26	10	38.5
Farmers^ (Murphy, 1996)	35	28	80.0
Herders^ (Murphy, 1996)	20	13	65.0
Oakhurst (Patrick, 1989)	21	10	47.6
Toutswe (Mosothwane, 2003)	46	14	30.4

LEH = Linear enamel hypoplasia
Dry Savanna* = Includes all 'Iron Age' sites studied in South Africa (SA) from this ecological zone
Wet Savanna* = Includes Ingombe Ilede, Zambia and coastal Kwa-Zulu Natal (SA) sites
Forest* = Includes the sites of Sanga and Katoto, DRC
^Farmers and Herders = Come from various sites in Botswana, Zambia and DRC

Table 6.02 Occurrence of Linear Enamel Hypoplasias in comparative populations

Sample	Total no. Individuals with Orbits	No. of Individuals with CO	%
Dry Savanna* (present study)	45	26	57.8
Wet Savanna* (")	18	10	55.6
Forest* (present study)	18.5	12	64.9
Oakhurst^^	19	12	63.2
Wolmaransstad§	22	11	50.0
Herders**	41	19	46.3
Griqua§	85.5	36.5	42.7
Farmers**	50	18	36.0
Colesberg§	52	18	34.6
Toutswe^	35	6	17.1
Riet River^^^	74	7	9.5
Kakamas^^^	53	2	3.8

Dry Savanna* = Includes all 'Iron Age' sites studied in South Africa (SA) from this ecological zone
Wet Savanna* = Includes Ingombe Ilede, Zambia and coastal Kwa-Zulu Natal (SA) sites
Forest* = Includes the sites of Sanga and Katoto, DRC
**Murphy (1996) = Come from various sites in Botswana, Zambia and DRC
^ Mosothwane (2003)
^^ Patrick (1989)
^^^ Morris (1984)
§Peckmann (2002)

Table 6.03 Occurrence of Cribra Orbitalia in comparative populations

Accession No.	List of all affected skeletal elements
Sanga – T68 (sub-adult)	Tibia, Femur, Cranium, Pelvis
A300 (younger adult male)	Femur, Clavicle, Pelvis, Fibula, Metatarsals
UP 10 (younger adult male)	Cranium, Femur, Fibula
A1836 (older adult female)	Tibia, Pelvis, Sternum, Manubrium, Vertebra
UP 8 (older adult female)	~ Entire Skeleton
A299 (younger adult male)	~ Entire Skeleton
UP 20 (juvenile)	Cranium, Fibula
UP 33 (younger adult female)	Maxilla

Table 6.04 List of individuals with possible treponemal diseases

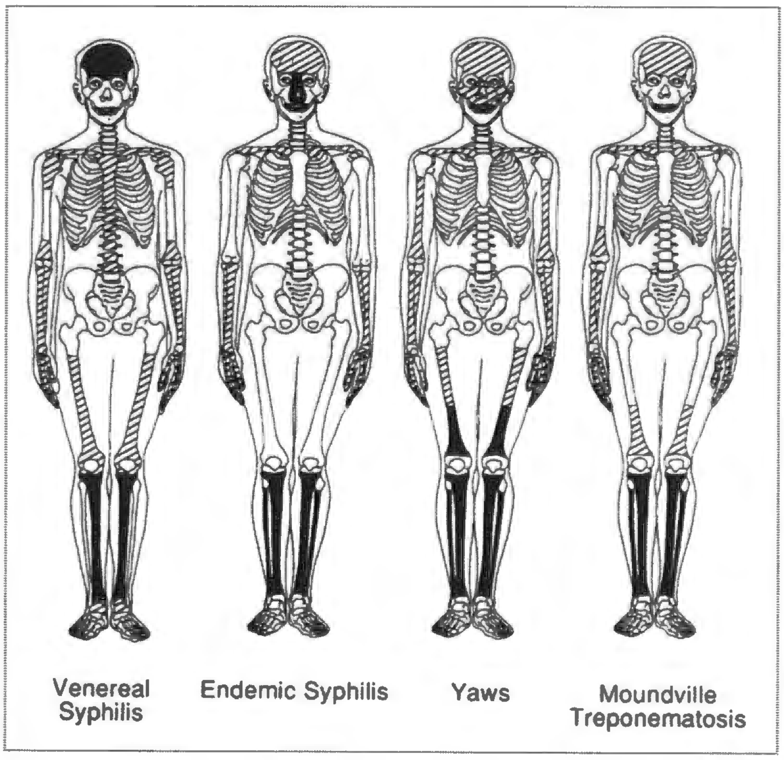


Figure 6.01 Distribution of skeletal lesions of four treponemal syndromes (adapted from Ortner & Aufderheide, 1991). Note: solid shaded areas are those most frequently affected; hatched areas are less often involved.

		Mean Attrition Score		**Source**
Younger Adults	Male	Female	Total	
Dry Savanna*	1.6	1.7	1.7	This study
Wet Savnna*	1.6	1.1	1.4	This study
Forest*	1.0	1.4	1.2	This study
Farmers^	1.3	1.3	1.3	Murphy, 1996
Herders^	1.3	1.5	1.4	Murphy, 1996
Griqua	2.6	2.8	2.7	Peckmann, 2002
Riet River	2.2	2.2	2.2	Morris, 1984
Kakamas	1.8	1.7	1.8	Morris, 1984

Sample		**Mean Attrition Score**		**Source**
Older Adults	Male	Female	Total	
Dry Savanna*	1.9	2.2	2.1	This study
Wet Savnna*	1.8	1.1	1.5	This study
Forest*	2.0	1.8	1.9	This study
Farmers^	1.6	1.9	1.8	Murphy, 1996
Herders^	2.4	1.7	2.1	Murphy, 1996
Griqua	3.1	3.7	3.4	Peckmann, 2002
Riet River	2.6	2.7	2.6	Morris, 1984
Kakamas	2.4	2.8	2.6	Morris, 1984

Dry Savanna* = Includes all 'Iron Age' sites studied in South Africa (SA) from this ecological zone
Wet Savanna* = Includes Ingombe Ilede, Zambia and coastal Kwa-Zulu Natal (SA) sites
Forest* = Includes the sites of Sanga and Katoto, DRC
^Farmers/Herders = Come from various sites in Botswana, Zambia and DRC

Note: Number of individuals are calculated differently in this study, Murphy (1994) and Morris (1984), but similar to Peckmann (2002). Also, posterior attrition scores, and not mean scores, are indicated from Murphy's study (1996).

Table 6.05 Dental Attrition Rates in comparative populations

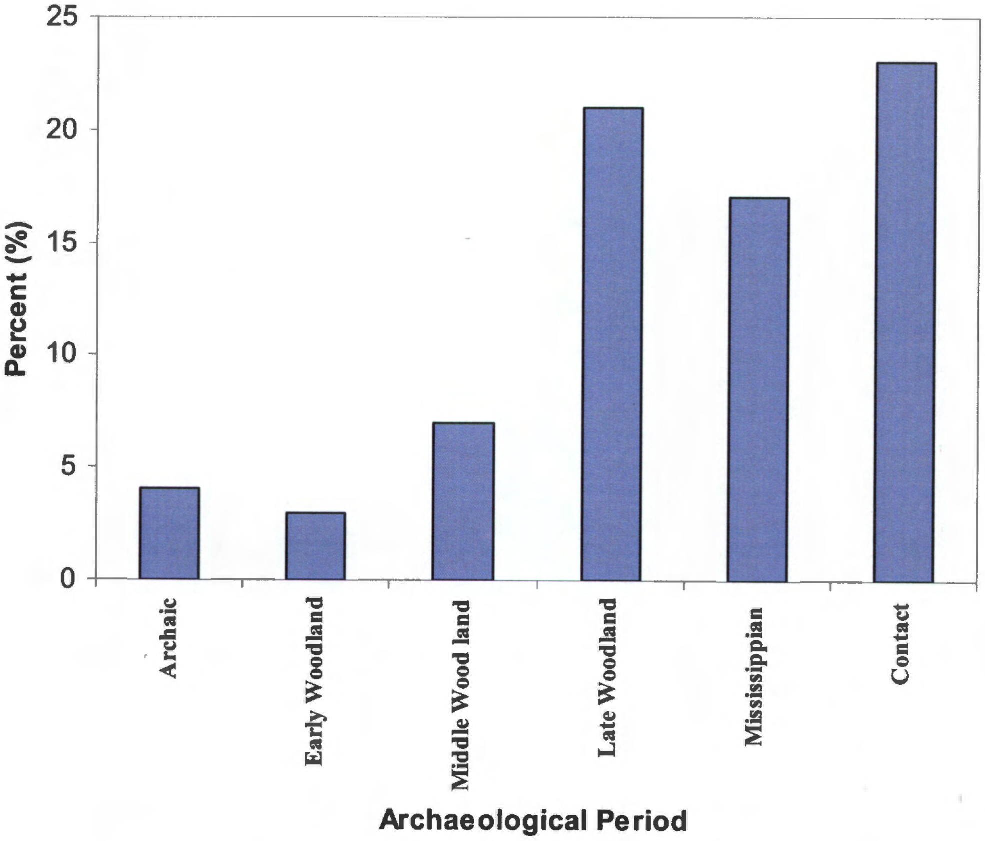


Figure 6.02 Caries rates between foragers and agricultural populations (Modified from Larsen, 1997: 69)

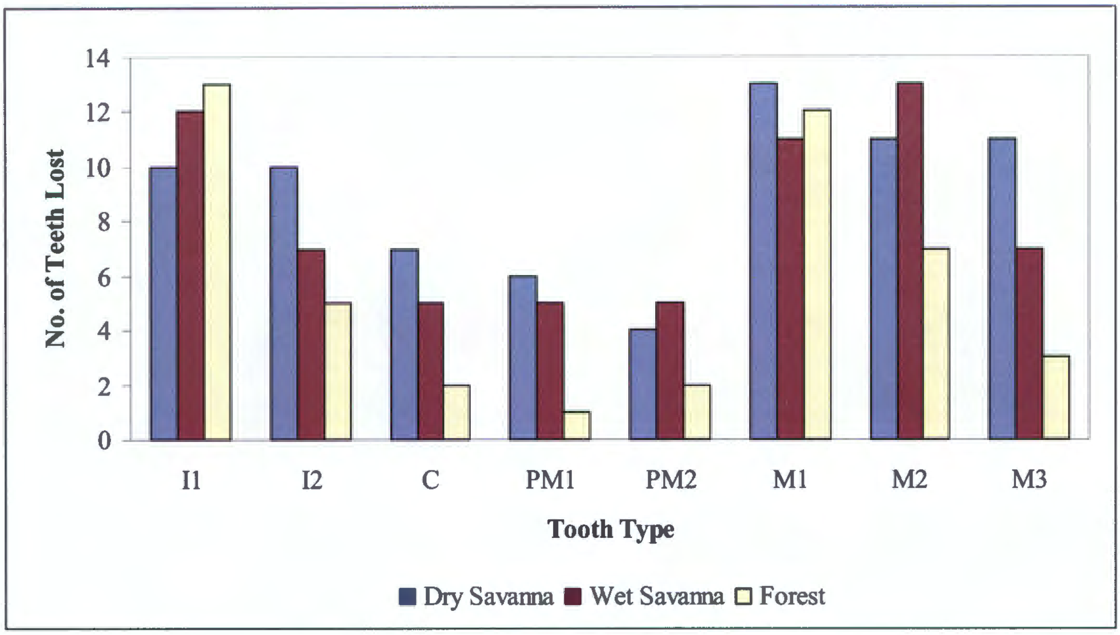


Figure 6.03 Pattern of AMTL

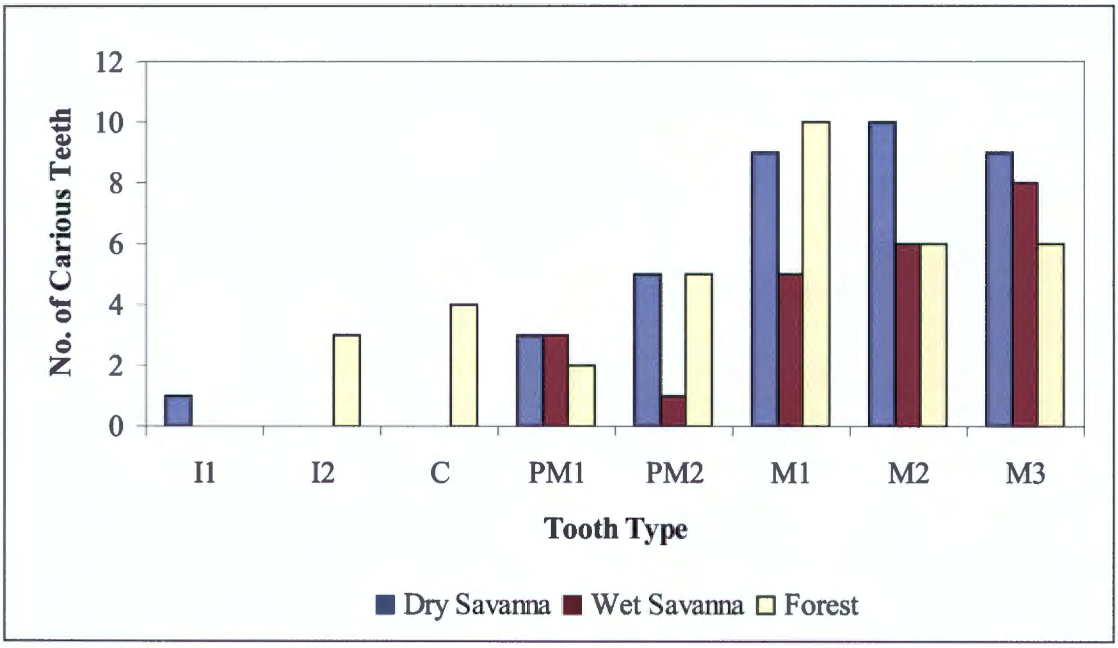


Figure 6.04 Pattern of Caries Occurrence

Sample	AMTL Intensity		AMTL Frequency		Source
	No. of teeth lost antemortem	%	^No. of Individuals with AMTL	%	
Dry Savanna*	72	8.0	9.625	34.2	This study
Wet Savanna*	65	16.2	8	63.4	This study
Forest*	45	8.2	12.375	72.3	This study
Toutswe	7	1.1	4	8.7	Mosothwane, 2003
Farmers**	48	5.0	30	~	Murphy, 1996
Herders**	23	8.0	12	~	Murphy, 1996
Griqua	330	22.1	34	66.0	Peckmann, 2002
Colesberg	201	15.1	26	57.1	Peckmann, 2002
Wolmaransstad	120	18.2	16	76.2	Peckmann, 2002
Riet River	95	6.1	17	35.1	Morris, 1984
Kakamas	54	4.1	7	17.1	Morris, 1984

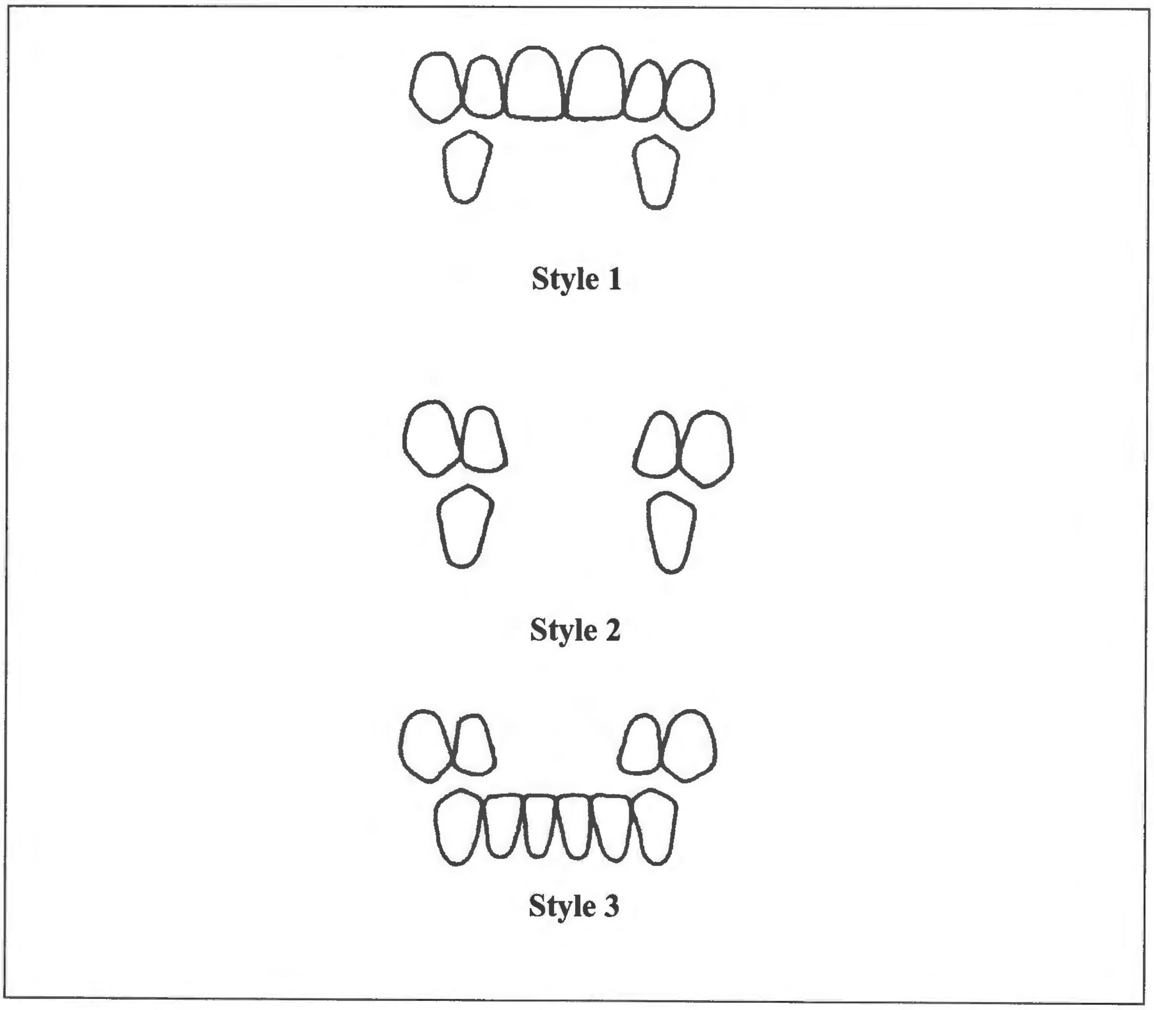
^No. of individuals calculated differently for this study and consistent with Peckmann (2002)
AMTL = Antemortem tooth loss
Dry Savanna* = Includes all 'Iron Age' sites studied in South Africa (SA) from this ecological zone
Wet Savanna* = Includes Ingombe Ilede, Zambia and coastal Kwa-Zulu Natal (SA) sites
Forest* = Includes the sites of Sanga and Katoto, DRC
Farmers/Herders** = Come from various sites in Botswana, Zambia and DRC

Table 6.06 Antemortem Tooth Loss of permanent teeth in comparative populations

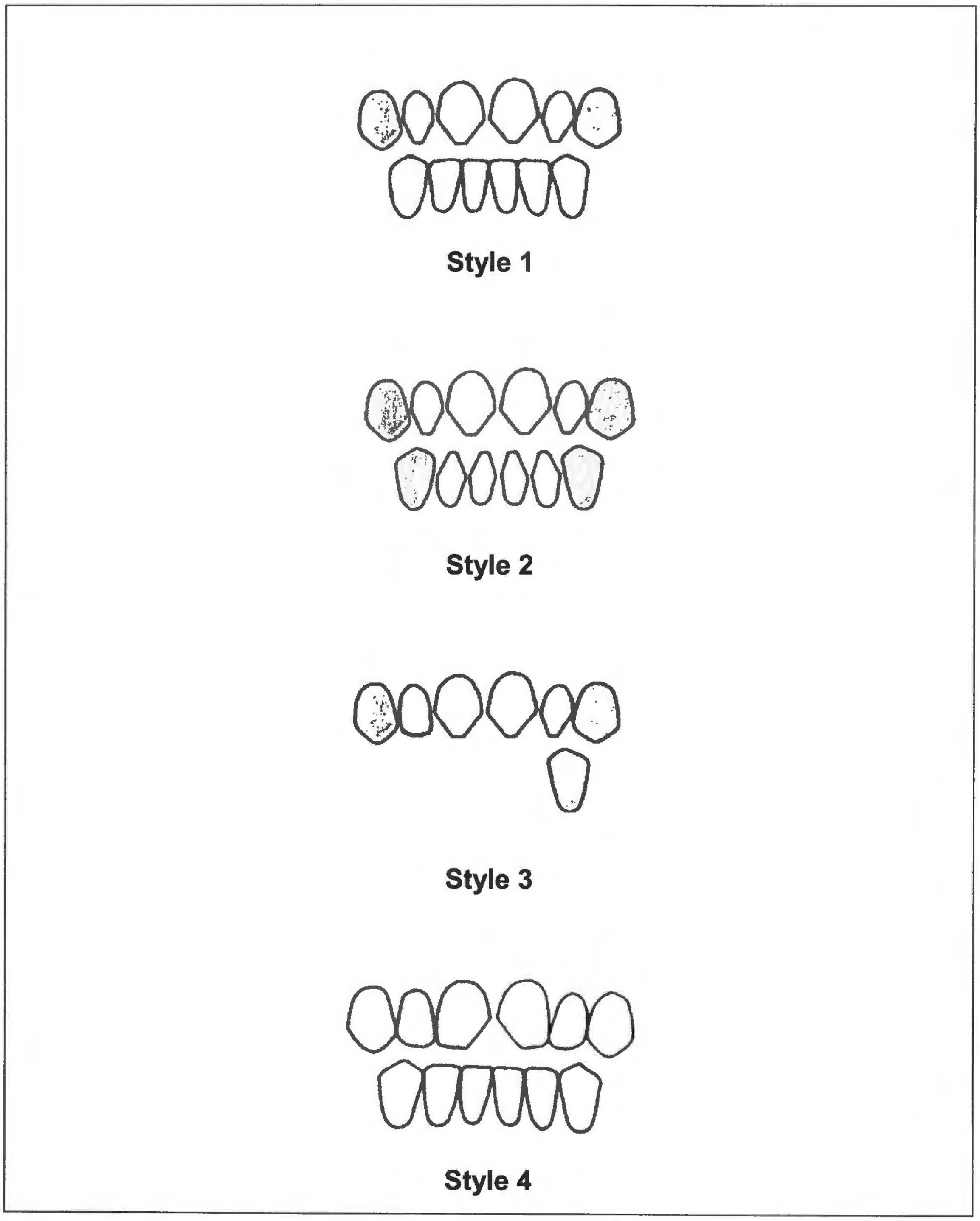
Sample	Caries Intensity		Caries Frequency		Source
	No. of carious teeth	%	^No. of Individuals with caries	%	
Dry Savanna*	37	3.7	13.75	35.5	This study
Wet Savanna*	23	7.6	6.5	48.1	This study
Forest*	36	8.2	10.875	55.4	This study
Toutswe	20	3.4	10	21.7	Mosothwane, 2003
Farmers	39	5.0	16	38.1	Murphy, 1996
Herders	26	9.0	6	46.1	Murphy, 1996
Oakhurst	~	17.7	~	~	Sealy *et al.*, 1992
Griqua	32	2.9	15	29.1	Peckmann, 2002
Colesberg	41	3.8	20	49.4	Peckmann, 2002
Wolmaransstad	29	5.5	11	52.4	Peckmann, 2002
Riet River	46	4.3	19	40.9	Morris, 1992b
Kakamas	13	1.3	8	18.8	Morris, 1992b

^No. of individuals calculated differently for this study and the comparative studies
Dry Savanna* = Includes all 'Iron Age' sites studied in South Africa (SA) from this ecological zone
Wet Savanna* = Includes Ingombe Ilede, Zambia and coastal Kwa-Zulu Natal (SA) sites
Forest* = Includes the sites of Sanga and Katoto, DRC
^Farmers/Herders = Come from various sites in Botswana, Zambia and DRC

Table 6.07 Occurrence of Dental Caries in comparative populations



Figures 6.05 Schematic representation of various styles of tooth extraction



Figures 6.06 Schematic representation of various styles of dental modification

Population Group	Stature Range (mm)	Reference
Males		Present Study
Dry Savanna	1743.3	"
Wet Savanna	1701.4	"
Forest	1671.4	Steyn (1994)
K2	1567.0 – 1731.0	Peckmann (2002)
Griqua	1621.2	"
Colesberg	1558.7	"
Wolmaransstad	1723.8	Tobias (1972)
Southern African Negro (short)	1500.0 – 1600.0	"
Southern African Negro (medium)	1600.0 – 1700.0	"
Southern African Negro (tall)	1700.0 – 1800.0	
Females		
Dry Savanna	1632.1	Present Study
Wet Savanna	1586.1	"
Forest	1612.6	"
K2	1514.0 – 1546	Steyn (1994)
Griqua	1528.3	Peckmann (2002)
Colesberg	1471.8	"
Wolmaransstad	1554.2	"
‘Negro’	1413.0 – 1669.0	Wilson & Lundy (1994)

Table 6.08 Comparative stature data

Chapter 7: CONCLUSION

Based on the evidence from palaeopathology, it has become clearer how human behaviour is influenced by the complex interaction of environmental, cultural and biological factors. The major impetus behind this constant change in human behaviour (even among relatively comparable populations) is the environment, in which we all must adapt in order to survive.

Although most of the sites from the research area have indicated archaeological evidence for the presence of domesticated animals, as well as evidence for agriculture, the proportions of each become critical when refined comparisons are to be made between populations.

If we look at the stress indicators as a continuum, the forest-zone population and the dry savanna peoples are at the opposite ends of this continuum, while the wet savanna population is in the middle of the two.

The population from the forest region has presented with the highest incidences of most of the stress indicators, i.e. five out of the seven (71.4%) stress indicators observed in the forest population were most commonly found in this population. The pattern of the stress indicators observed in the forest population most probably echoes their environmental circumstances, settlement and/or lifestyle, as well as their dietary behaviour. The sites in this region were the most densely populated in the whole of the research area. This probably promoted easy spread of infectious disease that was coupled by highly unhygienic living conditions, as evidenced by high rates of cribra orbitalia, porotic hyperostosis and sub-periosteal bone lesions. Also, due to its geographical, sub-equatorial location, the climatic conditions of the forest region further encouraged the viability of infectious pathogens, in combination with endemic malaria and a high prevalence of sickle-cell anaemia.

Furthermore, their heavy reliance on agricultural foods and less animal protein consumption, which can be linked to the environmental setting, is responsible for the poor oro-dental health, i.e. increased caries rates and periodontitis. The relatively low growth insults observed through enamel hypoplastic defects could be suggestive of a high infant mortality resulting from acute severe attacks that led to sudden death, prior to any dental or skeletal record of the insults.

In terms of terminal heights as an indication of the impact of stress on skeletal growth, the medium stature of the forest people could simply be linked to their genetic predisposition and the role of the geo-climatic environment; and not necessarily an indication of poor health. However, the high incidence of stress experienced by the forest population does suggest that the quality of life of these people was reduced.

In the wet savanna, the situation was slightly different from that seen in the forest region. In this population the occurrence of stress or disease was moderate, i.e. it was neither as high as in the forest region nor as low as in the dry savanna zone. Of the total eight stress indicators analysed in the wet savanna sample, three (37.5%) were found at the highest frequency in this group. Geographically and ecologically, the wet savanna lies in the middle of the forest and the dry savanna regions. Its socio-cultural structure had also been influenced by both west and east African groups. Therefore, it is not surprising that the results from palaeopathology fall in the middle of the two ends of the stress continuum.

The population in the dry savanna has exhibited the lowest overall frequency of the stress indicators, i.e. only one of the eight (12.5%) stress indicators examined was found to be most frequent in this group. The high frequency of enamel hypoplasias suggests that children in this population experienced more acute physiological insults than those in either forest or wet savanna populations. However, these children did survive these insults as the hypoplasias were found predominantly among the adult groups of this sample.

The lowest rates of oro-dental disease such as caries, antemortem tooth loss, abscesses and periodontitis were found in this population. The dietary habits of these people appear to have been quite different from that of the forest peoples. Perhaps, more animal protein from domesticated livestock was consumed and the reliance on agricultural products was less than at any other region in the research area. Their slightly more worn teeth could have benefited them in deterring caries. Chronic infectious disease as indicated by sub-periosteal bone lesions appear to have been less problematic in the dry savanna. Further support for this conclusion comes from the moderate frequencies of cribra orbitalia and porotic hyperostosis.

Sites in the dry savanna have varying settlement density that range from much dispersed settlements to large aggregated towns in the later centuries of the 'Iron

Age'. Thus, their lifestyle and settlement patterns could have influenced the relatively lower incidences of stress and disease. Moreover, the tall terminal stature of the dry savanna people suggests that any physiological disturbances that occurred during developmental ages were not severe enough to negatively impact on their terminal heights.

In general, it appears that the dry savanna people were fairly healthy in comparison to the wet savanna people and more especially to the forest peoples.

Although the results of this study are consistent with other agricultural populations, the variations observed at micro-environmental, socio-cultural levels should not be overlooked. This statement emphasises the fact that all communities and societies have different experiences, regardless of their shared similarities in economic and life ways.

At this point in our research efforts to unearth new evidence about our past, making generalisations about early farming societies from central and southern Africa should be done cautiously and critically. Further research work is therefore encouraged if we are to know as much as there is to know about our past.

In this dissertation, I have tried to provide further insight into the understanding of the lives of early farming populations from central and southern Africa; to the understanding of our past, our heritage.

Currently, sub-Saharan Africa is one of the most 'problematic', poverty-stricken, disease-ridden places on earth. Given Africa's role in the human history and developments in technology and cultural diversity, as well as its rich natural resources, it is ironic that we are at the position we find ourselves today. The challenge for African scientists and political authorities to change this and put Africa on the global map is immense and the implications of which are enormous.

Our role as physical anthropologists is to make a contribution to the wisdom of the past, in which I truly believe may help us to go forward confidently into the future and most importantly to learn from the mistakes of our ancestors. In turn, the wisdom of the past may be used as a powerful tool to help solve political, health and/or social issues currently facing African populations. In order to achieve this, we need to make a concerted effort to engage and share our research work so that it is entered into the public discourse. This is particularly important when research impacts on marginalised, voiceless or vulnerable communities, which in fact, characterises most African populations.

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Appendix: Skeletal Inventories

SOUTH AFRICAN SKELETAL REMAINS

Catalogue No.	Age Category	Sex	Site	Publication*
University of Cape Town		**N = 6**		
UCT 328	Juvenile		Makgwareng	de Villiers, 1972; Maggs, 1976
UCT 431	Sub-adult		Kgopolwe Hill	Rightmire & van der Merwe, 1976
UCT 327	Sub-adult		Makgwareng	de Villiers, 1972; Maggs, 1976
UCT 432	Younger Adult	M	Kgopolwe Hill	Rightmire & van der Merwe, 1976
UCT 430	Younger Adult	M	Nagome Terrace	
UCT 326	Younger Adult	F	Makgwareng	de Villiers, 1972; Maggs, 1976
University of Witwatersrand		**N = 27**		
A 609	Juvenile		Tinley Manor	Wells, 1934b
A 2852	Juvenile		Oliphantspoort	Mason, 1986
A 2855	Juvenile		Oliphantspoort	Mason, 1986
A 312	Juvenile		Krugerskraal	Laidler, 1935a
A 369	Juvenile		Irene Cave	
A 305	Juvenile		Willow Glen	Laidler, 1935a
A 2745	Sub-adult		Phalaborwa	
A 2246	Younger Adult	M	Bedfordview	
A 2233	Younger Adult	M	Wellington Estate	Fichardt, 1960
A 2802	Younger Adult	M	Paardekraal	
A 299	Younger Adult	M	Yellowtree Shelter	Murray, 1933; Wells, 1933b
A 121	Younger Adult	M	Vechtkop	Dart, 1927
A 300	Younger Adult	M	Robinson's Shelter	Murray, 1933; Wells, 1933b
A 2190	Mature Individual	M	near Kinross	
A 1104	Mature Individual	M	Wellington Estate	
A 2232	Mature Individual	M	Wellington Estate	Fichardt, 1960
A 2230	Mature Individual	M	Wellington Estate	Fichardt, 1960
A 233	Mature Individual	M	Heilbron	
A 372	Mature Individual	M	Irene Cave	
A 370	Mature Individual	M	Irene Cave	
A 306	Mature Individual	M	Willow Glen	Laidler, 1935a
A 2245	Younger Adult	F	Bedfordview	
A 2234	Younger Adult	F	Wellington Estate	Fichardt, 1960
A 2235	Younger Adult	F	Wellington Estate	Fichardt, 1960
A 2235a	Older Adult	F	Wellington Estate	Fichardt, 1960
A 1836	Older Adult	F	Wellington Estate	Myers, 1958; Fichardt, 1960
A 2854	Mature Individual	F	Oliphantspoort	Mason, 1986
University of Pretoria		**N = 41**		
UP 74	Infant		Malle	
UP 82	Infant		K2	
A* 1721	Infant		K2	Galloway, 1959; Gardiner, 1963
UP 19	Infant		K2	Eloff, 1979
UP 24	Infant		K2	Eloff, 1979
UP 22	Infant		K2	Eloff, 1979
UP 21a	Infant		K2	Eloff, 1979
A*1710	Infant		K2	Galloway, 1959; Gardiner, 1963
A*1707a	Infant		K2	Galloway, 1959; Gardiner, 1963
A*1707b	Infant		K2	Galloway, 1959; Gardiner, 1963

UP 146	Juvenile		Toit's Kraal	
A* 1711	Juvenile		K2	Galloway, 1959; Gardiner, 1963
A* 1719	Juvenile		K2	Galloway, 1959; Gardiner, 1963
UP 10a	Juvenile		Greefswald	
UP 15	Juvenile		K2	
UP 20	Juvenile		K2	Eloff, 1979
UP 21c	Juvenile		K2	Eloff, 1979
A* 621	Juvenile		Mapungubwe	Fouche, 1937; Galloway, 1937
A* 622a	Juvenile		Mapungubwe	Fouche, 1937; Galloway, 1937
A* 1708	Juvenile		K2	Galloway, 1959; Gardiner, 1963
A*1707c	Juvenile		K2	Galloway, 1959; Gardiner, 1963
A*1706b	Juvenile		K2	Galloway, 1959; Gardiner, 1963
UP 138	Sub-adult		Hamilton	
UP 145	Sub-adult		MAP 26	
UP 139	Younger Adult	M	Pilansberg	
UP 3	Younger Adult	M	Greefswald	
UP 4	Younger Adult	M	Witkoppenhills, Vrede	
UP 10	Younger Adult	M	Greefswald	
UP 12	Younger Adult	M	Welgegund, Pelindaba	Voigt, 1973; de Villiers, 1973a
UP 18	Younger Adult	M	K2	Eloff, 1979
UP 25	Younger Adult	M	Greefswald, K1	
UP 30	Younger Adult	M	K2	
UP 1	Older Adult	M	Happy Rest	
UP 73	Older Adult	M	Malle	
UP 33	Younger Adult	F	Phalaborwa	
UP 88	Younger Adult	F	Laaste Phalaborwa	
UP 89	Younger Adult	F	Laaste Phalaborwa	
UP 95	Younger Adult	F	Pilansberg	
UP 132	Older Adult	F	Ben Alberts	
UP 8	Older Adult	F	Derdepoort, Pretoria	
UP 2	Mature Individual	F	Happy Rest	
Natal Museum, Pietermaritzburg		**N = 16**		
PMB 80/2.1a	Juvenile		Mhlopeni, KZN	Maggs & Ward, 1984; de Villiers, 1984
KZ 86/1 a	Juvenile		Nanda	
PMB 2000/11	Sub-adult			
PMB 87/12	Younger Adult	M	Thompsons Bay, KZN	
PMB 90/11	Younger Adult	M	Mhlanga Lagoon	Horwitz, Maggs & Ward, 1991
PMB 97/08	Younger Adult	M		
KZ 86/2	Younger Adult	M	KwaGandaganda	
KZ 86/1 b	Younger Adult	M	Nanda	
PMB 91/45	Older Adult	M	Estcourt	
PMB 91/54	Older Adult	M	Tinley Manor	
PMB 94/12	Mature Individual	M		
PMB 70/25	Younger Adult	F		
PMB 75/64	Younger Adult	F		
PMB 90/17	Younger Adult	F		
PMB 80/2.1b	Mature Individual	F	Mhlopeni, KZN	Maggs & Ward, 1984; de Villiers, 1984
KZ 86/1 c	Mature Individual	F	Nanda	
National Museum of Bloemfontein		**N = 10**		
NMB 1590	Juvenile		Buispoort, Zeerust	van Hoopen & Hoffman, 1935
NMB 1	Sub-adult		Douglas	

NMB 25	Sub-adult		Brandfort	
NMB 93	Younger Adult	M	Brandfort	
NMB 1571	Younger Adult	M	Buispoort, Zeerust	van Hoopen & Hoffman, 1935
NMB 29	Older Adult	M	Brandfort	
NMB 1227	Older Adult	M	Harrismith	
NMB 1616	Older Adult	M	Brandfort	
NMB 12	Younger Adult	F	Vegkop, Heilbron	
NMB 1433	Younger Adult	F	Goemansberg	

*Publication from Morris, 1992a

ZAMBIAN SKELETAL REMAINS N = 15

Catalogue No.	Age Category	Sex	Site	Publication
II/23	Infant		Ingombe Ilede	Fagan *et al.*, 1969
II/26	Infant		Ingombe Ilede	"
II/33	Infant		Ingombe Ilede	"
II/13	Infant		Ingombe Ilede	"
II/31	Juvenile		Ingombe Ilede	"
II/38	Younger Adult	M	Ingombe Ilede	"
II/B4	Younger Adult	M	Ingombe Ilede	"
II/17	Younger Adult	M	Ingombe Ilede	"
II/15	Older Adult	M	Ingombe Ilede	"
II/12	Older Adult	M	Ingombe Ilede	"
II/B7/B	Older Adult	M	Ingombe Ilede	"
II/B5/B	Older Adult	M	Ingombe Ilede	"
II/14	Younger Adult	F	Ingombe Ilede	"
II/34	Older Adult	F	Ingombe Ilede	"
II/21	Mature Individual	M	Ingombe Ilede	"

DRC SKELETAL REMAINS N = 55

Catalogue No.	Age Category	Sex	Site	Publication
Sanga-T90	Infant		Sanga	de Maret, 1985a
Sanga-T102	Infant		Sanga	"
Sanga-T73	Infant		Sanga	"
Sanga-T74	Infant		Sanga	"
Sanga-T105	Juvenile		Sanga	"
Sanga-T49	Juvenile		Sanga	"
Sanga-T10c	Juvenile		Sanga	"
Sanga-T68	Sub-adult		Sanga	"
Sanga-T88	Sub-adult		Sanga	"
Sanga-T118	Younger Adult	M	Sanga	"
Sanga-T10b	Younger Adult	M	Sanga	"
Sanga-T21	Younger Adult	M	Sanga	"
Sanga-T86	Younger Adult	M	Sanga	"
Sanga-T140	Younger Adult	M	Sanga	"
Sanga-T111	Younger Adult	M	Sanga	"
Sanga-T112	Younger Adult	M	Sanga	"
Sanga-T53a	Younger Adult	M	Sanga	"
Sanga-T18	Younger Adult	M	Sanga	"
Sanga-T29	Older Adult	M	Sanga	"

Sanga-T110a	Older Adult	M	Sanga	de Maret, 1985a
Sanga-T62	Older Adult	M	Sanga	"
Sanga-T10a	Older Adult	M	Sanga	"
Sanga-T55	Mature Individual	M	Sanga	"
Sanga-T6	Mature Individual	M	Sanga	"
Sanga-T76	Younger Adult	F	Sanga	"
Sanga-T83	Younger Adult	F	Sanga	"
Sanga-T116	Younger Adult	F	Sanga	"
Sanga-T80	Younger Adult	F	Sanga	"
Sanga-T58	Older Adult	F	Sanga	"
Sanga-T65	Older Adult	F	Sanga	"
Sanga-T19	Mature Individual	F	Sanga	"
Sanga-T15	Mature Individual	F	Sanga	"
Sanga-T42	Mature Individual	F	Sanga	"
Sanga-T8	Mature Individual	F	Sanga	"
Katoto-T59	Infant		Katoto	"
Katoto-T51	Infant		Katoto	"
Katoto-T61	Infant		Katoto	"
Katoto-T31	Infant		Katoto	"
Katoto-T22	Infant		Katoto	"
Katoto-T21c	Juvenile		Katoto	"
Katoto-T24	Juvenile		Katoto	"
Katoto-T37	Sub-adult		Katoto	"
Katoto-T23	YA Younger Adult	M	Katoto	"
Katoto-T49	Older Adult	M	Katoto	"
Katoto-T39	Older Adult	M	Katoto	"
Katoto-T50	Mature Individual	M	Katoto	"
Katoto-T10	Mature Individual	M	Katoto	"
Katoto-T62	Younger Adult	F	Katoto	"
Katoto-T60	Younger Adult	F	Katoto	"
Katoto-T48	Younger Adult	F	Katoto	"
Katoto-T57	Younger Adult	F	Katoto	"
Katoto-T25	Younger Adult	F	Katoto	"
Katoto-T20	Younger Adult	F	Katoto	"
Katoto-T21b	Younger Adult	F	Katoto	"
Katoto-T63	Younger Adult	F	Katoto	"