Southern African Humanities **22**: 89–112 September 2010 Natal Museum

Population history and economic change in the last 2000 years in KwaZulu-Natal, RSA

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ABSTRACT

This paper reports on craniometric and stable isotopic analyses of archaeological human skeletons from KwaZulu-Natal and investigates biological and cultural (dietary) changes associated with the beginnings of a settled agricultural way of life. Through multivariate craniometrics, archaeological specimens were compared to three groups of recent South Africans (Nguni, Sotho-Tswana and Khoesan). Morphological differences, especially for the face, were observed through time: individuals older than 400 AD tended to be closer to groups of Khoesan ancestry; in contrast, remains from the first millennium AD are closer to Sotho-Tswana and Nguni groups. Carbon and nitrogen isotope ratios of bone collagen indicated that pre-400 AD hunter-gatherers ate more marine foods than individuals dating from later times, whose isotopic values are consistent with substantial reliance on African grain crops and domesticated stock. The small sample size and high intra-population variation have made the results difficult to interpret in terms of diachronic phenomena or biological changes (population replacement and gene flow). Nevertheless, these preliminary observations on both morphology and nutrition are consistent with the hypothesis that the Early Iron Age 'package', including agriculture, was introduced by an immigrant 'Negroid' population, possibly corresponding to Bantu speakers. This is the first direct biological anthropological evidence for a major population change at this time. Indigenous Khoesan hunter-gatherers are likely to have been partly assimilated and partly replaced by incoming agriculturists.

KEY WORDS: Later Stone Age, Iron Age, South Africa, KwaZulu-Natal, population diversity, craniometrics, stable isotopes.

The population of South Africa today is unusually diverse. The historical processes that led to this situation are of considerable interest. There is general agreement that the country was occupied by Khoesan hunter-gatherers until shortly after 2000 years ago. At this time, in the eastern and northern parts of the country, we see the introduction of domesticated plants and animals, in conjunction with the first evidence of ironworking and a sedentary settlement pattern. This is accompanied by characteristic pottery styles (Huffman 2007; Klapwijk 1974; Maggs 1980a). Most archaeologists have interpreted this as the archaeological signature of immigrant Bantu-speaking farmers, the southernmost end of a rapid dispersal through central and southern Africa about 2000 years ago (De Maret 1989; Huffman 2007; Phillipson 1994). The genetics of living populations support a model of biological migration and Bantu language expansion (Beleza et al. 2005; Salas et al. 2002; Tishkoff et al. 2009). A few scholars have nevertheless questioned this migration in 'cultural' terms, pointing out that new economies and technologies can be adopted by existing populations, such as local hunter-gatherers and/or pastoralists (Chami 2007; Gramly 1978; Hall 1987). In 1983, Hall and Morris wrote that "It remains quite possible that there was a significant genetic inflow associated with the Iron Age, but it is equally possible that there was greater genetic continuity between the Stone Ages and the Iron Ages than there was

disparity" (1983: 34). At that time, no one had actually examined human remains over the transition period. This paper presents the first such study.

We have studied all available human skeletal remains from KwaZulu-Natal dating within the last 6000 years in order to investigate possible population changes within the region, especially c. 400 AD, the time of the first Iron Age settlement. The specimens are subdivided into three major cultural phases: the Later Stone Age (earlier than c. 400 AD), the Early Iron Age (c. 400 to 1000 AD) and the Late Iron Age (1000 AD to the colonial era).

Three questions are addressed: 1) Do human skeletal remains of the last 6000 or so years from KwaZulu-Natal show morphological change over time of sufficient magnitude that this is likely to have resulted from population replacement? 2) Are the archaeological remains morphologically similar to any particular modern population, suggesting a link with recent agriculturist or hunter-gatherer groups? 3) Are there shifts in diet, and if so, do they parallel any morphological changes observed? These three questions will help us to assess whether there was a transition involving biological change (population replacement and/or assimilation) and cultural change (shift from foraging to farming), or only a cultural change with no biological replacement.

THE ARCHAEOLOGICAL BACKGROUND IN KWAZULU-NATAL

The archaeology of KwaZulu-Natal is now sufficiently well known to show that, as elsewhere in southern Africa, the region was occupied only by stone-using hunter-gatherers until the early centuries of the first millennium AD (Cable 1984; Mazel 1989). Recent excavations of hunter-gatherer sites have not yielded human remains, but elsewhere in South Africa, the later Later Stone Age (LSA) is always associated with Khoesan people.

As in many other areas of southern Africa, in KwaZulu-Natal the earliest evidence of agriculturist communities appears in the early centuries of the first millennium AD (Maggs 1980a; Whitelaw & Moon 1996). Calibrated dates of c. 400 AD identify Mzonjani as the earliest known farming settlement in KwaZulu-Natal. From this time, interactions between farmers and hunter-gatherers are likely to have been complex. Archaeologists have argued that, if small groups of immigrant farmers moved into a landscape already populated by hunter-gatherers, there was likely considerable accommodation. Later demographic intensification favoured the farmers, resulting in eventual marginalisation of hunter-gatherers. However, archaeological and anthropological studies have repeatedly shown that cultural and biological entities do not necessarily coincide (i.e. Barnard 1992; Hodder 1982; Morris 1992a; Rightmire & Van der Merwe 1976), and we expect that economic, cultural and genetic boundaries were fluid.

While evidence from the first phase of the Iron Age in KwaZulu-Natal is still quite sparse, it is already apparent from southern Africa in general that the significant aspects of what has been called the Early Iron Age 'package'—including crop cultivation, livestock herding, iron production, settled village life and distinctive styles of ceramics—were already established. In KwaZulu-Natal the first, or Mzonjani, phase appears to be restricted to coastal areas, extending from the Mozambique border to the area south of Durban. People chose living sites in positions favourable for a range of economic

activities, including slash-and-burn agriculture, small stock herding and iron smelting, while shellfish collecting seems to have contributed a significant part of the diet.

In the second half of the first millennium AD, agriculturist settlement extended further south along the coast, as well as inland up the incised valleys of major rivers such as the Thukela system, reaching altitudes of around 1000 m but remaining in wooded, savanna environments (Maggs 1984). We can thus infer that first interactions between hunter-gatherers and agriculturists in our region would have taken place in coastal or near-coastal settings, but became more widespread during the later part of the first millennium AD. More detailed information from this period shows substantial interchange between LSA and Early Iron Age communities. Agriculturist settlements yield numerous shell disc beads, many of ostrich-egg shell, which must have been introduced from grassland regions, well inland of the area settled by Iron Age people at that time. Also common are LSA-style bone arrow-points and link-shafts, and on some sites, LSA stone artefacts, suggesting that stone-tool-using people spent time in such villages (Maggs 1980b). Likewise, in LSA deposits in rock shelters, some sherds of typical Early Iron Age style occur, sometimes far inland of Early Iron Age settlement (Mazel 1989; Mitchell 2002: 292). This pattern indicates a relatively sedentary agriculturist population interacting closely with more widespread hunter-gatherers.

Early in the second millennium AD, Late Iron Age settlement had extended into some grasslands of the KwaZulu-Natal interior. Some such sites are in naturally defensible positions and have surrounding walls, while the associated material culture no longer includes LSA elements. This may reflect a period of greater competition or conflict. Later in the second millennium, agriculturist settlements become quite dense in these lower-altitude grassland areas, yet even with the arrival of white colonists in the nineteenth century, Khoesan groups still living a hunter-gatherer lifestyle survived in the interior at higher altitude, where the environment was unfavourable for Iron Age farming (Wright & Mazel 2007).

It is during the second millennium AD that we can begin to see archaeological evidence for the material culture associated with ethnic/linguistic groups known today, that is, Nguni-speaking people in KwaZulu-Natal. One view is that these patterns can be traced back to the beginning of the second millennium AD (i.e. Huffman 2004). The evidence becomes compelling in the second half of the millennium when ceramic, settlement pattern and historical sources confirm continuity into recent times (i.e. Maggs 1988).

PREVIOUS BIOANTHROPOLOGICAL WORK

Earlier bioanthropological work attempted to investigate the identity of archaeological human skeletons from KwaZulu-Natal (Brien 1932; Galloway 1934, 1936; King & Chubb 1932; Tobias 1955; Wells 1934), and suggested that a phenomenon of 'hybridization' occurred between different precolonial populations. Unfortunately, early methods were flawed by an overreliance on racial typology and a failure to understand human variation through time and space (Morris 2005). More recently, multivariate studies have provided a much better understanding of population history as seen through changing morphological patterns rather than types (Bräuer & Rösing 1989; Froment 1998; Morris & Ribot 2006; Relethford 2001; Ribot 2004; Rightmire 1970, 1978).

The morphological features of recent and ancient Khoesan populations represent a unique pattern, very different from all other African and worldwide populations, although still fundamentally African in form (Franklin et al. 2010; Howells 1989; Lahr 1996; Ribot 2004). Much of the population-level difference has to do with body size (Harrington & Pfeiffer 2008; Pfeiffer & Sealy 2006) and anatomical differences in vault curvature, flatness of the mid-facial region and projection of cheek bones (Stynder et al. 2007a, b; Stynder 2009). Stynder's recent publications have shown that Khoesan cranial morphology developed during the terminal Pleistocene and early Holocene, supporting the model proposed by Morris (2002). Older crania dated to the Upper Pleistocene, such as Border Cave 1 from KwaZulu-Natal (De Villiers 1973), seem to be morphologically very different from recent Khoesan (Van Vark et al. 1989).

Modern bioanthropological work is done from a holistic perspective incorporating both population dynamics and cultural/ecological overlays, especially in the southern African context (Pfeiffer 2009), but work of this kind has not previously been attempted for the KwaZulu-Natal region. The key problem is the small sample size and poor preservation of human remains from the province. Morris (1992b) lists only 54 skeletons or partial skeletons from KwaZulu-Natal, in contrast to the 380 from the Western Cape. In addition, more than 70 % of these 54 archaeological specimens are juveniles and/or poorly preserved adults. Nevertheless, there are more human remains from KwaZulu-Natal from pre- and post-400 AD contexts than from other parts of southern Africa settled by early farming communities, making it possible to carry out this study.

STABLE ISOTOPIC EVIDENCE FOR DIET

Stable isotope analysis of human bone is an increasingly widely used method of investigating diet in archaeology. Direct chemical and isotopic assessment of bone is independent of more traditional archaeological approaches to dietary reconstruction, which are usually based on the identification of excavated food waste. Unresolved questions about metabolism mean that it is currently not possible to use isotopic techniques to quantify precisely different components of past peoples' diets. One can, however, reliably compare diets across space or through time, as we do below. Stable carbon and nitrogen isotope analyses of bone collagen have been especially successful in distinguishing C_3- and C_4-based foods in human diets (i.e. Van der Merwe & Vogel 1978) and marine and terrestrial foods in the diets of coastal dwellers (i.e. Ambrose et al. 1997; Richards & Hedges 1999; Richards et al. 2003; Schoeninger et al. 1983; Sealy & Van der Merwe 1986, 1988; Tauber 1981).

The ratios of stable carbon isotopes ($^{13}C/^{12}C$) depend on photosynthetic pathways at the base of the food web. All trees and shrubs, and some grasses that favour temperate environments, photosynthesize by means of the C_3 or Calvin-Benson pathway. This discriminates strongly against the heavier ^{13}C isotope, so that C_3 plants have low $^{13}C/^{12}C$ ratios, or very negative $\delta^{13}C$ values (mean $\delta^{13}C$ is -27.1 $\pm$ 2.0 ‰ (O'Leary 1988); see caption to Table 2 for a definition of δ values).

Grasses growing in tropical or sub-tropical climates are adapted to hot and arid conditions. They use the C_4 or Hatch-Slack photosynthetic pathway, which produces higher $^{13}C/^{12}C$ ratios, that is, less negative $\delta^{13}C$ values than C_3 plants

(mean is -13.1 ± 1.2 ‰; O'Leary 1988). This group includes most indigenous grasses in the lower-lying areas of KwaZulu-Natal, as well as the important Iron Age cereal crops such as sorghum and millet (and later, maize). $^{13}C/^{12}C$ ratios in food are passed into the tissues of consumers. In large animals, bone collagen is about 5 ‰ more positive than the diet, so browsing antelope that eat only C_3 trees and shrubs have bone collagen $\delta^{13}C$ of about -22 ‰. Grazing antelope that eat C_4 grasses have values around -8 ‰. In the same way, humans who consume C_3-based foods (fruits, nuts, the meat of browsing animals) will have more negative $\delta^{13}C$ values than their counterparts who rely upon C_4-based foods (sorghum, millet, the meat of grazing animals) (Van der Merwe 1982). In the oceans, photosynthesis in phytoplankton is generally via the C_3 pathway, but macroalgae can be C_3 or C_4 photosynthesizers. On average, the types of marine organisms important in human diets have $\delta^{13}C$ values more positive than those of terrestrial C_3-based foods (see Sealy & Van der Merwe 1986 for values for South African marine food items). If terrestrial C_4-based foods were also consumed, this distinction will be blurred.

Stable nitrogen isotope ratios ($^{15}N/^{14}N$) are also used to distinguish between marine and terrestrial systems. $^{15}N/^{14}N$ (expressed as $\delta^{15}N$, relative to a standard, in the same way as $\delta^{13}C$) is generally lower on land than in the sea (except in areas of low rainfall, which are not relevant in this study). Around the world, animal $\delta^{15}N$ may range from +1 or +2 ‰ to as high as +20 ‰. The spread of values within an ecosystem is, however, much narrower. In temperate, well-watered environments, terrestrial animals generally have $\delta^{15}N$ below 10 ‰. Consumers have $\delta^{15}N$ values 3–4 ‰ more positive than the food they eat (Hedges & Reynard 2007). Humans derive nitrogen only from protein foods, so that nitrogen isotope measurements of human bone track protein-rich foods in the diet. Archaeological applications have focused especially on the importance of marine and terrestrial foods in the diet (Ambrose et al. 1997; Richards & Hedges 1999; Richards et al. 2003; Schoeninger et al. 1983; Sealy 2006).

$\delta^{13}C$ and $\delta^{15}N$ analyses of bone collagen are used here to investigate the diets consumed in life by the inhabitants of KwaZulu-Natal over the past several thousand years. We are particularly interested in comparing diets before and after the adoption of food production.

MATERIALS AND METHODS

The skeletal sample

A total of 26 Late Holocene human skeletons (some of them fragmentary) from 16 sites are included in this study (Fig. 1). Of these, 17 (9 females, 8 males) were suitable for craniometric analysis, that is, they are adult individuals with relatively complete crania from which a sizeable set of measurements can be obtained (see below). Most skeletons were directly dated by means of radiocarbon dates on bone collagen, with the exception of those from secure archaeological contexts. Seven individuals are older than 400 AD, 12 date to between 400 and 1000 AD, and the remaining seven post-date 1000 AD.

Most of the skeletons were accidental finds in sand dunes or shell middens near the coast. Many coastal middens in KwaZulu-Natal contain characteristic Iron Age ceramics and are therefore likely to derive from Iron Age farmers (Hall 1981; Horwitz

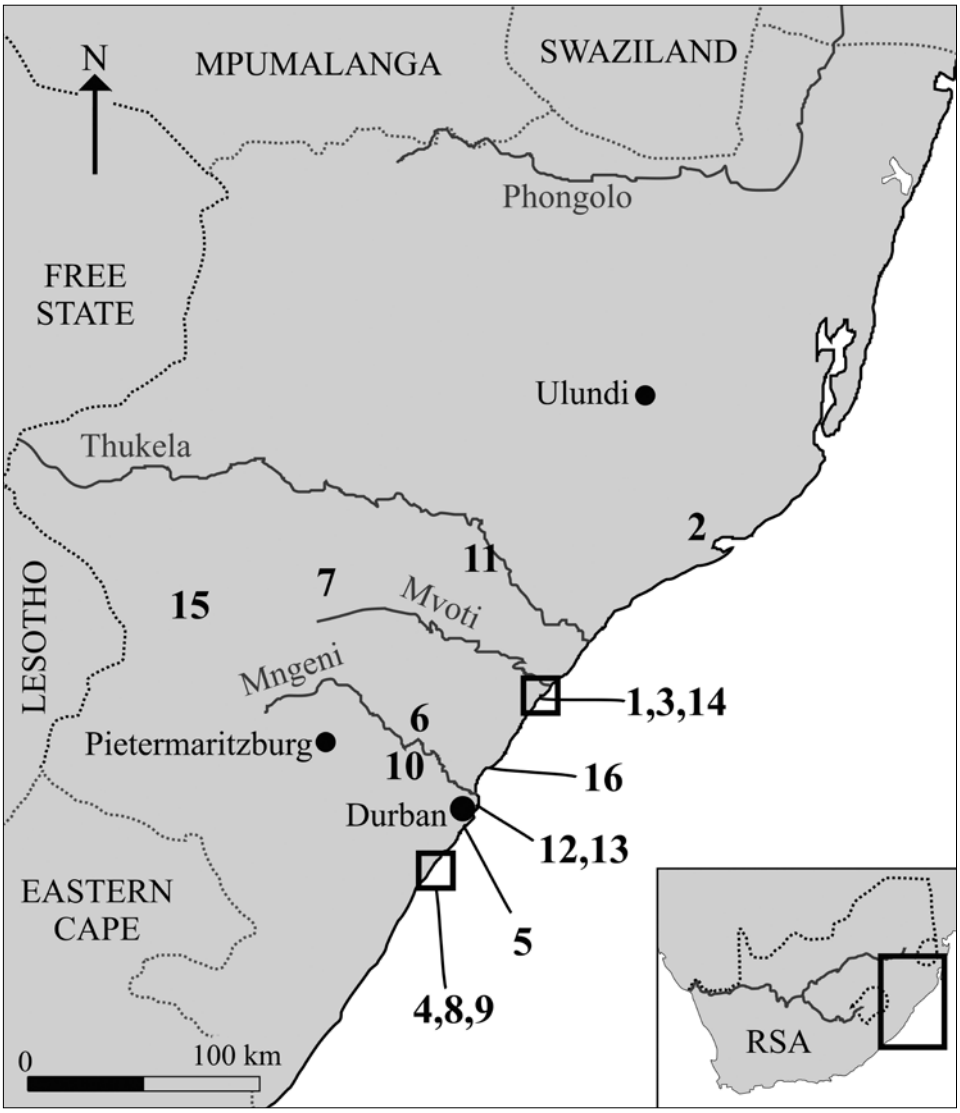

Fig. 1. Map of KwaZulu-Natal with the Late Holocene sites under study. Abbreviations: 1 = Ballito Bay, 2 = Richards Bay, 3 = Tinley Manor, 4 = Doonside, 5 = Illovo Beach, 6 = Nanda, 7 = Mhlopeni, 8 = Widenham, 9 = Umgababa, 10 = KwaGandaganda, 11 = Wosi, 12 = Fynnlands, 13 = King's View, 14 = Thompson's Bay, 15 =Venus (Electrical Station), 16 = Mhlanga Lagoon.

et al. 1991). It is, however, also possible that the principal accumulators were residual hunter-gatherers living in symbiosis with agriculturists (Parkington & Hall 1987).

Ten skeletons were recovered from well-documented archaeological contexts. There are, unfortunately, none from the Mzonjani phase, but those that we have are firmly associated with subsequent phases of the Early Iron Age at the inland sites of Nanda (Morris 1993; Whitelaw 1993), KwaGandaganda (Morris 1993; Whitelaw 1994), Wosi

(Morris 1994; Van Schalkwyk 1994) and Mhlopeni (Maggs & Ward 1984), and with the Late Iron Age at the coastal site of Mhlanga Lagoon (Horwitz et al. 1991).

The comparative craniometric data

The cranial morphology of the archaeological specimens was compared with modern samples drawn from three southern African populations: two modern Bantu-speaking groups consisting of 101 Nguni (Howells 1989, 1996) and 61 Sotho-Tswana (De Villiers 1968; Morris 1992a) individuals, and 131 Khoesan individuals (Howells 1989; Ribot 2002, 2003, 2004).

The Nguni and Sotho-Tswana samples were drawn from the Dart collection of skeletonized cadavers in Johannesburg (De Villiers 1968; Howells 1989, 1996; Morris 1992a). Ethnic identification was based on hospital records and although there may be uncertainty about precise ethnic identity, all of these individuals were from Bantu-speaking populations.

The larger portion (100) of the Khoesan group originated from various collections, which are not well documented in terms of precise geographic origin (Howells 1989; Ribot 2002, 2003, 2004). However, an additional 31 Khoesan specimens were obtained from Morris (1992a). These individuals were recovered in well-documented archaeological excavations along the Riet River in the Northern Cape Province, and date from the seventeenth to nineteenth centuries AD. Early European travellers described these communities as 'Bushmen', although by this time they had domestic animals and pottery (Humphreys 1972; Maggs 1971). Morris (1992a) concluded that the morphological pattern was homogenous and represented a strong Khoesan pattern with very little gene flow from neighbouring contemporaneous Bantu-speaking populations.

TABLE 1

Craniometric variables used in this study

Broad location	**Description of variable**	**Code of Shrubsall (1898)**	**Number of Martin & Saller (1959)**	**Code of Howells (1989)**
VAULT	maximum cranial length (*glabella – opisthocranion*)	L	n°1	GOL
	maximum cranial breadth (between parietals)	B	n°8	XCB
	bistephanic breadth (*stephanion – stephanion*)	St	n°10b	STB
	minimal frontal breadth (between *fronto-temporalia*)	B'	n°9	-
FACE	upper facial length (*basion – nasion*)	LB	n°5	BNL
	lower facial length (*basion – prosthion*)	GL	n°40	BPL
	upper facial height (*nasion - prosthion*)	G'H	n°48	NPH
	bizygomatic breadth (*zygion – zygion*))	J	n°45	ZYB
	bimaxillary breadth (between *zygomaxillare anterior*)	-	n°46	ZMB
	interorbital breadth (*dacryon – dacryon*)	DC	n°49a	DKB
	maximum nasal breadth (*alare – alare*)	NB	n°54	NLB
	nasal height (from *nasion* to nasal roof lowest point)	NH	n°55	NLH
	orbital breadth (*ectoconchion – dacryon*)	O1'	n°51a	OBB
	orbital height (perpendicular to OBB)	O2	n°52	OBH

TABLE 2

Archaeological human and animal remains from KwaZulu-Natal under study: cranial (in mm) and stable isotopic (in ‰) measurements. See Table 1 for abbreviations of cranial measurements. FA: female adult, MA: male adult, A: adult of unknown sex, I: infant, C: child, KF: KwaGandaganda fauna. $\delta^{13}C$ values are calculated as $[(^{13}C/^{12}C_{sample} \div {}^{13}C/^{12}C_{std}) - 1] \times 1000$ ‰, where the standard is VPDB. For $\delta^{15}N$ values, the standard is air. Wt % = weight percentage. Radiocarbon dates in years B.P.

Museum code & ^{14}C date in years BP (laboratory number)	**Species, sex &/ or age category**	**GOL**	**XCB**	**STB**	**WFB**	**BNL**	**BPL**	**NPH**	**ZYB**	**ZMB**	**DKB**	**NLB**	**NLH**	**OBB**	**OBH**	**$\delta^{13}C$**	**$\delta^{15}N$**	**Wt % C**	**Wt % N**	**Atomic C/N**
Ballito Bay C 5900±110 (Pta-5794)	FA	184	134	109	93	-	-	58	-	88	26	26	37	38	31	-15.1	12.5	41.8	14.9	3.3
Ballito Bay B 2940±50 (Pta-5803)	MA	182	136	111	103	94	96	64	131	103	25	28	45	41	28	-13.6	13.3	42.8	15.1	3.3
A635 2532±26 (OxA-V-2064-55)	FA	175	137	109	96	96	93	58.5	120	89	20	28	44	41	31	-14.1	12.8	42.7	15.3	3.3
PMB 91/54 2190±50 (Pta-5772)	MA	187	142	113	99	98	98	59	129	99	23	24	42	37	28	-13.9	11.4	40.8	14.4	3.3
DBN 3062 2110±50 (Pta-5800)	FA	182	142	110	102	94	93	55	-	99	31	22	45	38.5	29	-13.8	14.2	37.9	13.6	3.2
UCT 154 1980±50 (Pta-6968)	FA	172	132	100	88	89	90	53	113	87	18	22	38	36	30	-13.8	11.5	39.8	13.6	3.4
Ballito Bay A 1980±20 (Pta-5796)	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-14.4	11.8	42.8	15.0	3.3
Nanda 86/1 Trench 4 Burial 1	MA	191	135	120	95	107	105	60	128	87	23	29	45	43	37	-9.9	9.2	46.3	12.9	4.2
Nanda 86/1 test sq7	FA	178	132	106	-	-	-	-	136	-	-	-	-	35	37	-	-	-	-	-
Nanda SVP 5	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-19.9	7.4	37.6	12.9	3.4
Nanda 86/1 test sq23	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-11.8	10.2	41.1	14.5	3.3
Nanda 86/1 Trench 4 Burial 2	C; 7-8 yrs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-9.0	9.3	43.1	15.7	3.2
PMB 2000/11	MA	186	130	103	100.5	105	105	70.5	134	104	30	27	49	42	35	-6.6	10.0	44.9	14.4	3.1
A 1071 1320±50 (Pta-6997)	MA	174	123	112	98	100	98	60	126	94	24	28	45	41	29	-14.1	10.0	42.4	14.8	3.4

TABLE 2 *(continued)*

Museum code & ^{14}C date in years BP (laboratory number)	Species, sex &/ or age category	GOL	XCB	STB	WFB	BNL	BPL	NPH	ZYB	ZMB	DKB	NLB	NLH	OBB	OBH	δ^{13}C	δ^{15}N	Wt % C	Wt % N	Atomic C/N
A 1060 1025±35 (OxA-6220)	FA	177	127	98	87	95	97	60	124	-	20	24	46	37.5	34	-11.7	10.1	42.9	15.1	3.3
KwaGandaganda sq25	MA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-11.2	9.6	42.5	15.0	3.3
Wosi Burial 1	FA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-9.3	9.1	42.8	15.3	3.3
Wosi KCM 84/5 Burial 2	C; 7-8 yrs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-7.8	10.1	42.1	14.8	3.3
Wosi KCM 84/5 Burial 3	C; c.4 yrs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-7.9	9.6	42.6	15.0	3.3
A 2120 940±20 (Pta-6108)	FA	174	129	104	95	98	90	65	121	91	21	27	50	39	37	-9.9	8.2	42.7	15.6	3.2
DBN 4381 780±50 (Pta-5789)	MA	184	132	104	101	110	112	65	141	108	27	30	49	42	32	-12.9	9.9	40.7	13.8	3.4
A609 530±45 (Pta-6126)	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-7.4	6.0	43.0	14.6	3.4
DBN 3335 480±50 (Pta-5798)	FA	175	134	119	-	93	91	58	-	-	-	27	40	40	-	-10.4	13.5	42.2	14.5	3.4
PMB 87/12 110±45 (Pta-5769)	MA	-	128	112	101	-	-	66	-	-	27	29	53	43	37	-11.9	12.0	43.0	15.3	3.3
PMB 91/45 140±40 (Pta-5776)	FA	187	137	107	92	105	95	69	-	100	31	31	51	42	30	-7.0	11.0	33.8	10.4	3.8
PMB 90/11 20±45 (Pta-5780)	MA	189	136	112	98	100	99	74	133	86	22	28	55	40	37	-10.1	10.6	42.4	14.4	3.4
Grid 2 E6 Layer 2A	KF cow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-7.2	4.8	42.8	14.8	3.3
Grid 2 E6 Layer 2A	KF ovis/ capra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-9.0	4.7	42.9	15.2	3.3
Grid 2 E6 Layer 2	KF kudu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-21.9	6.1	43.1	15.1	3.4
86/2 G2 Layer 2 E6 Spit 2	KF cow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-8.1	5.4	42.8	14.9	3.4
86/2 G2 Layer 2 E6 Spit 1	KF sheep	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-7.4	5.6	42.9	14.6	3.4

Craniometric methods

Fourteen metric traits commonly used in earlier literature (Howells 1989; Martin & Saller 1959; Ribot 2003; Shrubsall 1898) have been recorded on the cranium: four variables for the vault and ten for the face. All codes are from Howells (1989) and given in Table 1, except for minimal frontal breadth, for which a new code (WFB) was developed here for ease of study. Sliding and spreading calipers were used to take these measurements to the nearest millimetre on both sides.

Each individual variable was standardized into Z-scores (i.e. GOL into Z-GOL), (Howells 1973, 1989; Pietrusewsky 2008), in order to be able to compare them on the same scale. No correction was made for size differences between males and females, as Howells (1973, 1989) and Pietrusewsky (2008) have shown that removal of size-based components has very little impact on the interpretations of craniometric variation and related patterns.

Both univariate and multivariate statistical analyses were performed, using SPSS 11.5 and SYSTAT 8.0. Stem-and-leaf displays and tables for testing skewness were used to check the normality of the sample (Zar 1984). Factor analysis (Principal Components Analysis or PCA) was performed, as it is an appropriate technique to compare a small number of archaeological specimens with larger comparative groups (Pietrusewsky 2008). The approach used has been described in Morris and Ribot (2006).

Three series of variables have been selected: primarily for the vault, Z-GOL, Z-XCB, Z-STB and Z-OBB (Analysis I); primarily for the face, Z-BNL, Z-BPL, Z-NPH, Z-ZYB, Z-ZMB, Z-DKB, Z-NLB, Z-OBB and Z-OBH (Analysis II); and for both the vault and face, Z-XCB, Z-STB, Z-WFB, Z-DKB, Z-NLB, Z-NLH, Z-OBB and Z-OBH (Analysis III). These three sets of variables maximized the number of archaeological individuals that could be included, since some, such as Nanda 86/1 test sq7, were incomplete (Table 2). They also have the advantage of being based on different parts of the cranium, both separately (vault, face) and in combination, as morphological patterns are often complex and need to be explored in detail.

The regression factor scores were investigated through a test of equality of means (one-way analysis of variance) by comparing between and within group variation. This procedure helps to explore the degree of differentiation of the modern comparative samples.

Scatterplots of regression factor scores for factors 1 and 2 were drawn with ellipses of confidence ($p = 0.9$) for each modern sample. This procedure helps to visualize the distribution of the sample in a multivariate space, and allows comparison with the archaeological specimens. In addition, in order to evaluate the closeness of Late Holocene specimens to modern group means, the regression factor scores were also used to compute proximity matrices of squared Euclidean distances.

Stable isotopes

Stable carbon and nitrogen isotope ratios were measured for 26 human skeletons (those for which we present craniometric data, also individuals lacking crania, and juveniles), and five faunal specimens from KwaGandaganda. These latter will provide an estimate of the isotopic values of terrestrial animals in this area during the first millennium AD. Since many of the skeletons were fragmentary, it was not possible to sample the

same skeletal element in every case. Table 2 lists the samples taken. The surfaces of the samples were cleaned by sanding lightly with emery paper. Small chunks of bone were then decalcified in dilute (c. 2 %) hydrochloric acid, rinsed in distilled water, then soaked overnight in 0.1 M sodium hydroxide to remove humic contaminants. Finally, they were soaked in distilled water, changed every day or two, until neutral, then freeze-dried.

Carbon and nitrogen isotope ratios were measured in a Finnigan-MAT 252 ratio mass spectrometer coupled to a Carlo-Erba combustion unit. Samples were weighed into tin capsules, combusted at 1600°C and the resultant gases cleaned on-line in the Carlo-Erba system, before being introduced into the mass spectrometer. Mass spectrometric measurements were made against commercially-available CO_2 and N_2 gases, and related to internationally accepted standards (VPDB for carbon, air for nitrogen) through a number of secondary, in-house standards. The standard deviation of repeated measurements of homogeneous material was 0.2 ‰ or better for both carbon and nitrogen.

RESULTS

Craniometric variation and modern patterns

The results of the craniometric analyses are presented in Tables 3–6 and Figures 2–4. As shown in Table 3, the greatest variation between the three modern samples in the cranial vault (Analysis I) is in the breadth of the vault (factor 1) and breadth of orbits and length of vault (factor 2). In the face (Analysis II), the greatest variation is in the breadth and projection of the face and the interorbital breadth (factor 1), and in the heights of the orbits and upper face (factor 2). When the vault and face are considered together (Analysis III), the greatest variation is in the breadth of the vault (factor 1), and heights of nasal aperture and orbits (factor 2). The variables Z-STB

TABLE 3

Factor loadings after varimax rotation for craniometric analyses, with lowest value for each individual in bold. See Table 1 for abbreviations of cranial measurements.

Variables entered	Analysis I		Analysis II		Analysis III	
	Factor 1	Factor 2	Factor 1	Factor 2	Factor 1	Factor 2
Z-GOL	0.287	**0.801**	-	-	-	-
Z-XCB	**0.876**	0.186	-	-	**0.732**	-0.007
Z-STB	**0.884**	0.057	-	-	**0.842**	-0.016
Z-WFB	-	-	-	-	**0.746**	0.296
Z-BNL	-	-	**0.734**	0.439	-	-
Z-BPL	-	-	0.697	0.421	-	-
Z-NPH	-	-	0.501	0.670	-	-
Z-ZYB	-	-	**0.816**	0.309	-	-
Z-ZMB	-	-	**0.815**	0.070	-	-
Z-DKB	-	-	**0.738**	-0.040	0.605	0.166
Z-NLB	-	-	0.592	0.266	0.394	0.577
Z-NLH	-	-	-	-	0.155	**0.884**
Z-OBB	-0.013	**0.886**	0.568	0.374	0.550	0.534
Z-OBH	-	-	0.005	**0.907**	-0.122	**0.828**

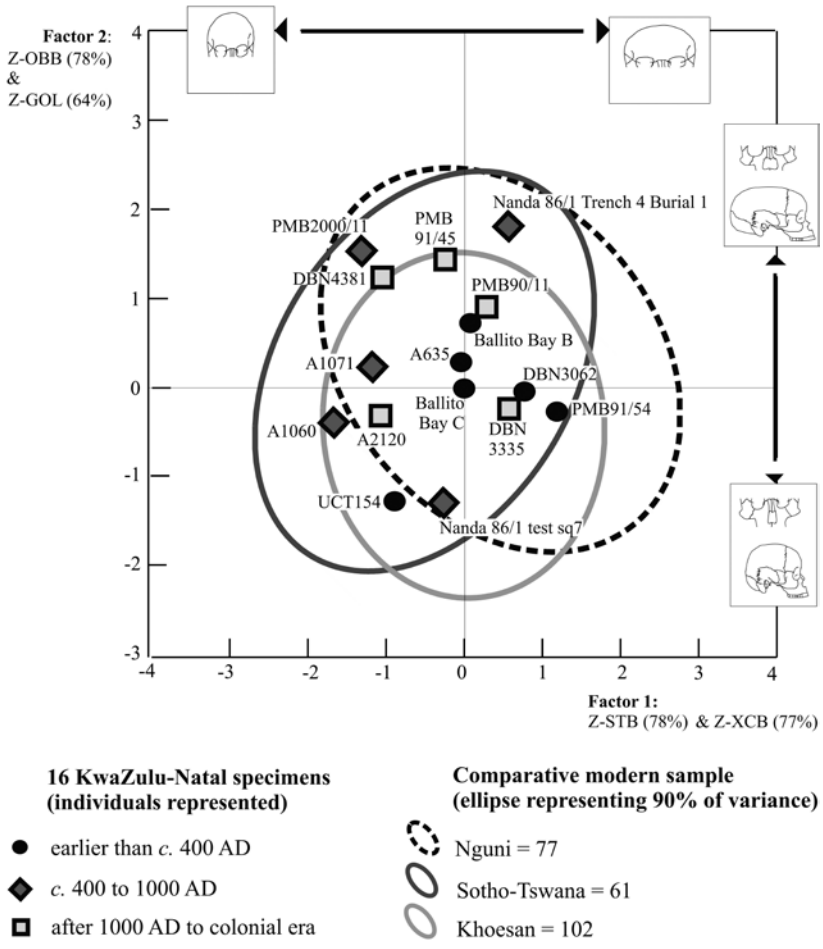

Fig. 2. Factor analysis I using mainly vault (77 % total variance expressed).

TABLE 4

One-way analyses of variance: testing modern group differences on factor scores obtained from the three craniometric factor analyses. Significant differences ($p < 0.001$) between groups ($N \geq 15$) are evaluated with the *post hoc* multiple comparisons tests. Abbreviations: N = sample size; F = one-way test; Sig = level of significance (NS = not significant, $p < 0.05$*, $p < 0.01$**, $p < 0.001$***); L = Levene's test of homogeneity of variances; NG = Nguni (excluded from Analysis III because of small sample size); S = Sotho-Tswana; K = Khoesan.

Analysis number	Factors	N	F	Sig.	L	Groups compared	Significant differences between groups
I	1	240	18.15	***	*	NG, S, K	all groups
	2		15.08	***	NS	NG, S, K	S and K, K and NG
II	1	211	28.23	***	**	NG, S, K	NG and S, NG and K
	2		31.13	***	NS		K and NG, K and S
III	1	104	0.86	NS	**	S, K	no *post hoc* test, as N < 3
	2		33.7	***	NS		no *post hoc* test, as N < 3

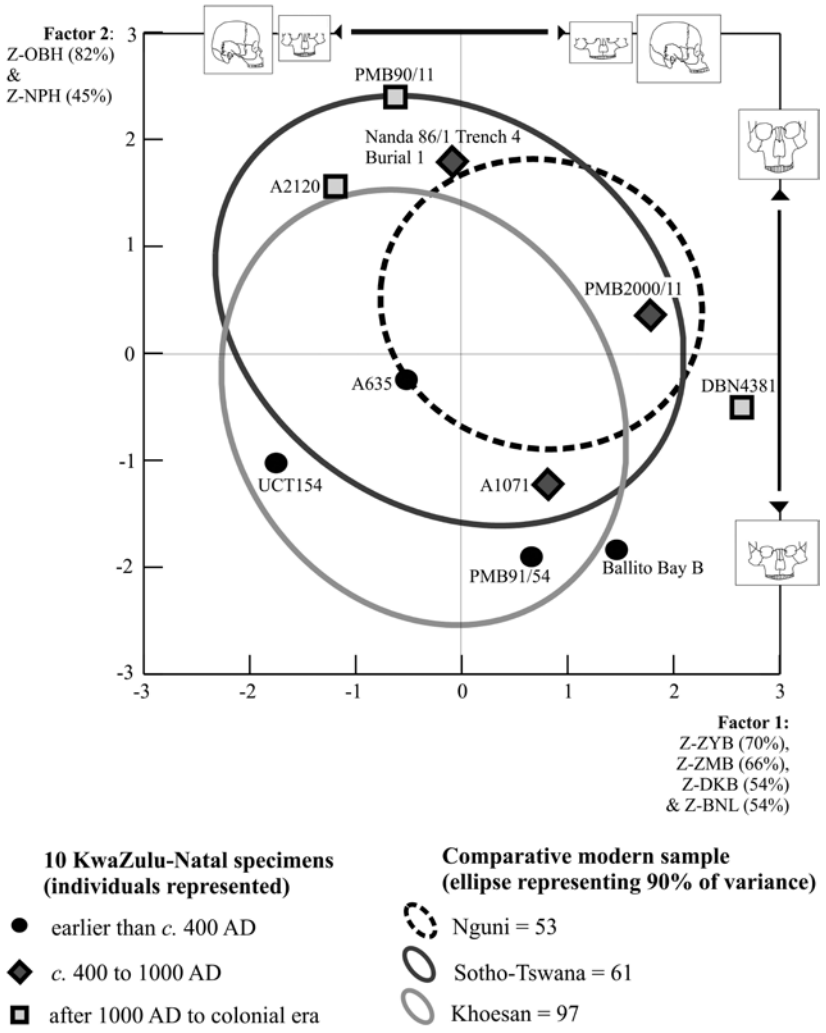

Fig. 3. Factor analysis II using mainly face (64 % total variance expressed).

and Z-XCB (Analyses I and III) and Z-OBH (Analyses II and III) most frequently accounted for the highest percentage of variance. This pattern, in particular for orbital height, has been suggested previously for sub-Saharan African populations (Morris & Ribot 2006).

The tests of equality of means on the regression factor scores (between the comparative modern groups) were always significant at $p < 0.001$ except for factor 1 in Analysis III (Table 4). The F-values were highest for variables related to heights of face, nose and orbits, as in Analysis III (factor 2) and II (factor 2) respectively. The differentiation between Khoesan, Sotho-Tswana and/or Nguni was greatest for these two analyses (Figs 3 & 4), as the degree of overlap decreased in comparison to Analysis I (Fig. 2).

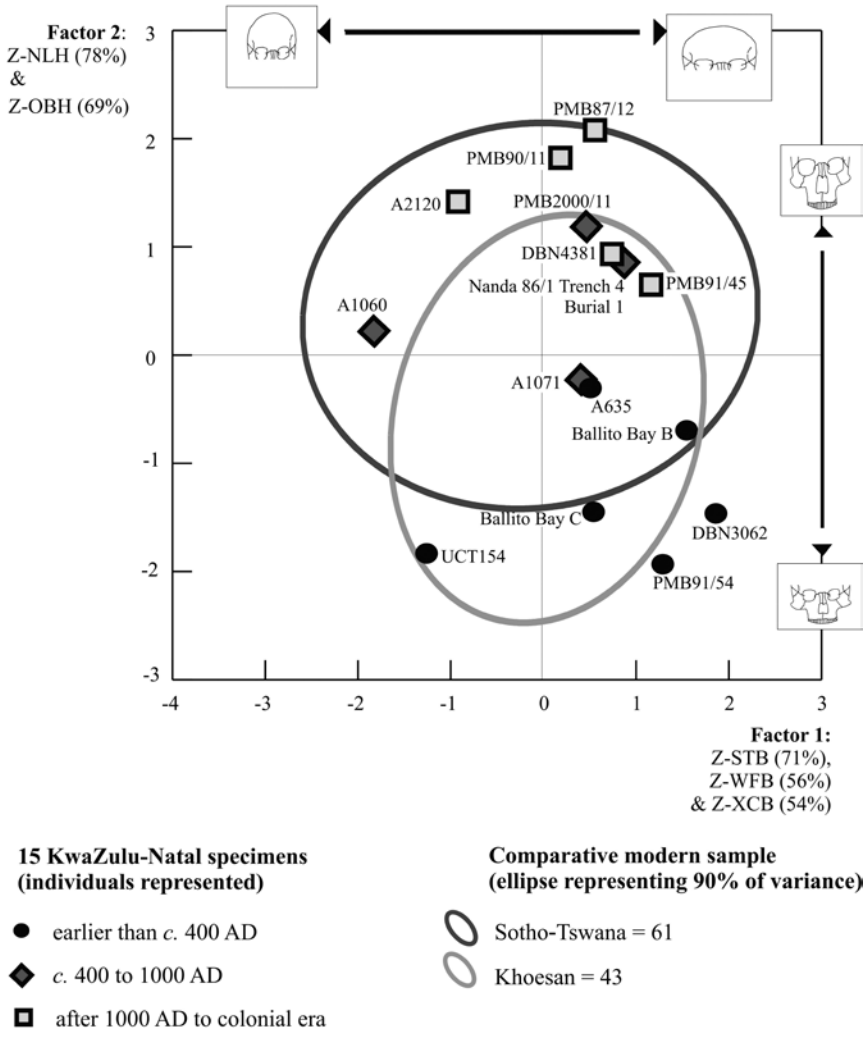

Fig. 4. Factor analysis III using vault and face (61 % total variance expressed).

The *post hoc* multiple comparison tests showed that, within the modern sample, the Khoesan are always the most divergent from the other two South African groups (Sotho-Tswana, Nguni). Khoesan crania tend to be characterized by a short vault and low, flat face with short orbits and low nasal aperture. These features contrast with those of the Sotho-Tswana and Nguni samples, which are less clearly differentiated from each other (Figs 2 & 3).

Moving from Analysis I to III, the archaeological individuals from KwaZulu-Natal are progressively better localized within the variation shown by the modern comparative samples. Testing three series of variables in this way appears to have been a useful procedure in selecting the best measurements to show group affinities, especially by focusing on facial variables (i.e. Z-OBH, Z-NLH, Z-NPH).

TABLE 5

Proximity matrices of squared Euclidean distances (with highlighted lowest value for each individual) derived from the craniometric analyses such as the regression factor scores between specimens from KwaZulu-Natal and comparative means. Abbreviations: I = earlier than c. 400 AD; II = c. 400 to 1000 AD; III = after 1000 AD to colonial era; NG = Nguni (excluded from Analysis III because of small sample size); S = Sotho-Tswana; K = Khoesan.

Specimen code	Phase	Analysis I			Analysis II			Analysis III	
		NG	S	K	NG	S	K	S	K
Ballito Bay C	I	0.754	**0.071**	0.268	-	-	-	3.934	**1.069**
Ballito Bay B	I	**0.327**	0.621	1.307	5.779	7.470	**5.068**	4.036	**2.279**
A 635	I	0.612	**0.045**	0.575	2.087	0.587	**0.079**	0.849	**0.272**
PMB 91/54	I	**0.853**	3.103	1.483	5.645	5.953	**3.024**	7.467	**3.433**
DBN 3062	I	**0.254**	1.761	0.764	-	-	-	7.467	**4.135**
UCT 154	I or II	4.320	2.276	**1.492**	8.492	4.724	**2.227**	6.072	**3.208**
Nanda 86/1 Trench 4 Burial 1	II	**2.216**	3.811	5.259	2.288	**1.789**	5.112	**1.333**	2.822
Nanda 86/1 test sq7	II	3.086	2.245	**0.824**	-	-	-	-	-
PMB 2000/11	II	4.436	**2.312**	5.279	**1.046**	3.543	5.251	**1.044**	3.303
A 1071	II	2.688	**0.445**	1.784	2.888	3.576	**1.957**	0.782	**0.233**
A 1060	II or III	4.974	**1.645**	2.695	-	-	-	**2.854**	4.039
A 2120	III	2.732	**0.537**	1.180	4.943	**2.504**	4.994	**1.676**	4.039
DBN 4381	III	3.183	**1.551**	4.039	**4.405**	8.277	8.885	**1.045**	2.683
DBN 3335	III	**0.290**	1.391	0.417	-	-	-	-	-
PMB 87/12	III	-	-	-	-	-	-	**3.404**	7.362
PMB 91/45	III	1.781	**1.666**	3.531	-	-	-	**1.770**	2.697
PMB 90/11	III	**0.355**	1.078	1.746	5.558	**4.144**	8.328	**2.042**	5.560

Morphological variation and affinities of the Late Holocene KwaZulu-Natal sample

The morphological affinities of the KwaZulu-Natal specimens were assessed according to their distances from the means of the modern samples (Table 5), and more importantly, their positions within the distribution of modern variation (Table 6).

Figure 2 is not very useful here, because there is too much overlap between the modern comparative samples. In Figures 3 and 4, the six specimens older than 400 AD tend to be localized in the lower halves of the scatterplots, where most of the Khoesan variation is located. They are characterized by relatively short vaults and low faces, so that they overlap mainly the 90 % confidence ellipse of Khoesan variation. In Figure 3, Ballito Bay B falls outside all the 90 % confidence ellipses, but is closest to the Khoesan mean according to squared Euclidean distances (Table 5). In Figure 4, DBN 3062 and PMB 91/54 fall outside the 90 % confidence ellipse of the Khoesan variation, but again, are closest to Khoesan according to squared Euclidean distances (Table 6). These individuals show cranial morphology that is quite extreme for both flatness and/or shortness of the face, characteristics of the Khoesan comparative sample.

In Figures 2–4, the eleven post-400 AD specimens do not cluster tightly, although they tend to be close to the Sotho-Tswana according to squared Euclidean distances (Table 5). Four individuals dated to the early (Nanda 86/1 Trench 4 Burial 1, PMB2000/11) and late (DBN4381, PMB9145) phases are close to the means of

TABLE 6

Craniometric similarities of KwaZulu-Natal specimens with comparative groups based on confidence limits of factor scores and distance from modern means. Abbreviations: I = earlier than c. 400 AD; II = c. 400–1000 AD; III = after 1000 AD to colonial era; 0 = not included in 90 % confidence limit; + = included in 90 % confidence limit; ++ = included in 70 % confidence limit; NG = Nguni (excluded from Analysis III because of small sample size); S = Sotho-Tswana; K = Khoesan; CG = closest group identified through the smallest squared Euclidean distances (see Table 5).

Specimen code	**Phase**	**Analysis I**				**Analysis II**				**Analysis III**		
		NG	**S**	**K**	**CG**	**NG**	**S**	**K**	**CG**	**S**	**K**	**CG**
Ballito Bay C	I	++	++	++	S	-	-	-	-	0	++	K
Ballito Bay B	I	++	++	++	NG	0	0	0	K	+	+	K
A 635	I	++	++	++	S	+	++	++	K	++	++	K
PMB 91/54	I	++	+	++	NG	0	0	+	K	0	0	K
DBN 3062	I	++	++	++	NG	-	-	-	-	0	0	K
UCT 154	I or II	0	++	++	K	0	0	+	K	0	+	K
Nanda 86/1 Trench 4 Burial 1	II	+	+	0	NG	0	++	0	S	++	+	S
Nanda 86/1 test sq7	II	+	+	++	K	-	-	-	-	-	-	-
PMB 2000/11	II	+	+	0	S	++	+	0	NG	++	+	S
A 1071	II	+	++	++	S	0	+	++	K	++	++	K
A 1060	II or III	0	++	+	S	-	-	-	-	++	0	S
A 2120	III	+	++	++	S	0	++	0	S	++	0	S
DBN 4381	III	++	++	0	S	0	0	0	NG	++	+	S
DBN 3335	III	++	++	++	NG	-	-	-	-	-	-	-
PMB 87/12	III	-	-	-	-	-	-	-	-	+	0	S
PMB 91/45	III	++	++	+	S	-	-	-	-	++	+	S
PMB 90/11	III	++	++	++	NG	0	+	0	S	+	0	S

Sotho-Tswana and/or Nguni, but still fall within the 90 % confidence ellipses of the Khoesan. The variation in the post-400 AD group is higher than that for the pre-400 AD group, although this could be a sample-size effect.

In Figure 2, the five individuals dating between 400 and 1000 AD are scattered across the range of modern variation. They do not show affinities with any particular group. The same applies to the five post-1000 AD specimens. In Figure 3, although the post-400 AD sample is smaller (N = 6), it remains highly variable, especially for the later phase. These specimens tend to cluster in the upper half of the scatterplot, but they also have affinities with all modern groups. One second millennium AD individual (DBN4381) falls completely outside the modern variation, but is closest to the Nguni according to squared Euclidean distances (Table 5). In Figure 4, despite high variability, most of the post-400 AD specimens (six out of nine) are localized in the upper half of the scatterplot, where they overlap mainly the Sotho-Tswana variation. Because of a low nasal aperture as well as low orbits, one 400–1000 AD individual (A1071) is closer to the Khoesan than the Sotho-Tswana (Tables 5 & 6).

Therefore, in comparison with pre-400 AD specimens, individuals from the later first and second millennia AD show more varied cranial features, consistent with the hypothesis of increased genetic diversity. The morphology of these individuals is similar to recent South African Bantu-speaking groups. However, as three specimens (Nanda 86/1 test sq7, DBN3335 and PMB87/12) are incomplete, their cranial morphology should be assessed with greater caution.

Stable isotope results

The results of the stable carbon and nitrogen isotope analyses for faunal and human specimens are listed in Table 2, and plotted in Figure 5. One adult from Nanda had such poorly preserved bone that it was impossible to extract collagen. We have no isotope values for this skeleton (Nanda 86/1 test sq7). Well-preserved bone collagen should contain up to c. 44 % C and 11–16 % N by weight, and have atomic C:N ratio in the range 2.9–3.6 (Ambrose 1990; Van Klinken 1999). All samples in Table 2 meet these criteria except Nanda 86/1 Trench 4 Burial 1, with C:N of 4.2, and PMB 91/45, with C:N of 3.8. These ratios show that there has been some degradation of bone collagen so that the $\delta^{13}C$ and, particularly, the $\delta^{15}N$ measurements may not reliably record the values as they were in life. Since $\delta^{15}N$ for Nanda 86/1 Trench 4 Burial 1 is, however, indistinguishable from the other tightly clustered values for the first millennium AD, we have retained it in the sample. Its $\delta^{13}C$ value also falls within the range of others from that time period.

Four domesticated animals from KwaGandaganda yielded very similar isotope values: $\delta^{13}C$ ranged from -7.2 to -9 ‰, $\delta^{15}N$ from 4.7 to 5.6 ‰. The $\delta^{13}C$ values show that these animals—both cows and ovicaprines—ate mostly C_4 grasses. Ovicaprines are eclectic feeders, and will browse if there are bushes nearby, so the overwhelmingly grass-dominated diet suggests that these were pastured in grassland areas. The fairly low $\delta^{15}N$ values are as expected for a relatively high-rainfall environment. Rainfall at KwaGandaganda today is approximately 870 mm per annum, and fluctuations over the past 2000 years were probably relatively minor.

The single kudu analysed yielded a $\delta^{13}C$ value of -21.9 ‰ and $\delta^{15}N$ of 6.1 ‰. Kudu are browsers, and this $\delta^{13}C$ value confirms an entirely C_3-based diet. The $\delta^{15}N$ value

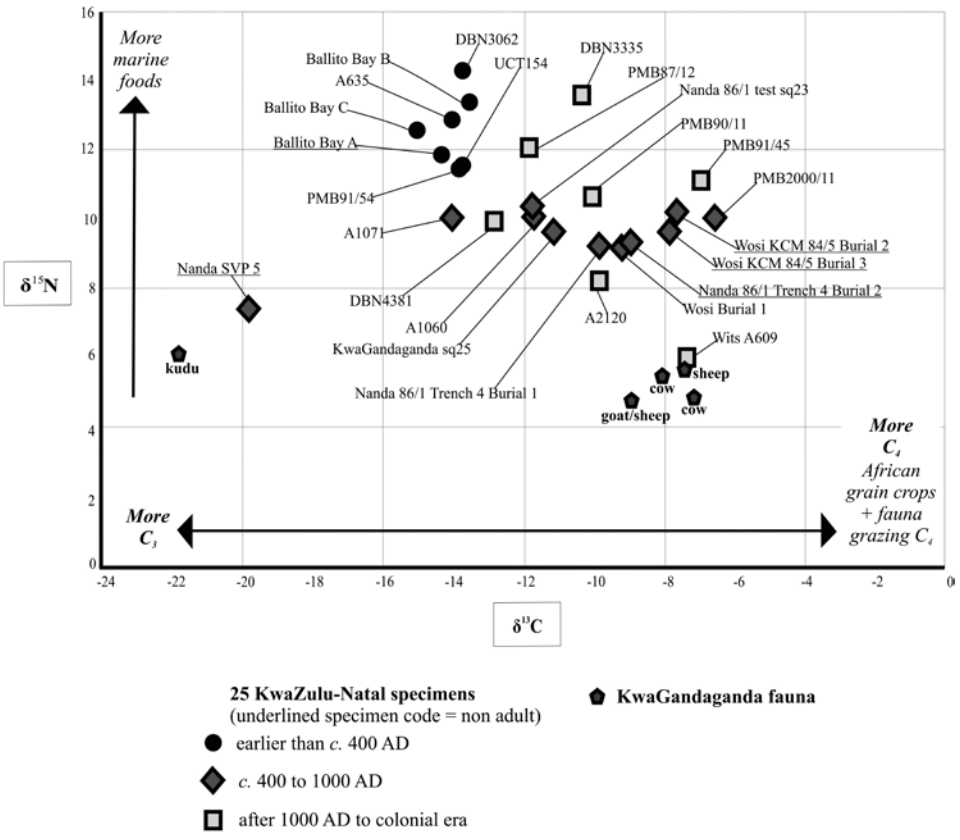

Fig. 5. $\delta^{15}N$ plotted against $\delta^{13}C$ for archaeological animals and humans from KwaZulu-Natal.

is marginally higher than those for the domesticated animals, but it is impossible to tell, on the basis of a single specimen, whether or not this difference is significant. There is some evidence that $\delta^{15}N$ values of browsing antelope tend to be slightly more positive than those of grazers (Codron et al. 2006). Overall, these results conform with our expectations of the likely isotopic patterning in the area. The low $\delta^{15}N$ values, in particular, indicate that terrestrial nitrogen isotope values can clearly be distinguished from marine, so nitrogen isotope ratios in human remains will provide a reliable indicator of terrestrial vs marine inputs into peoples' diets.

The seven human skeletons (some very fragmentary) dated to 1980 BP or earlier have $\delta^{13}C$ from -13.6 to -15.1 ‰, $\delta^{15}N$ from 11.4 to 14.2 ‰. One individual (Ballito Bay A) is a juvenile. Stable isotope values for juveniles are not necessarily directly comparable with those of adults, but in this case the results plot within the cluster of adult values, and it seems reasonable to treat this individual simply as another member of the set. As can be seen from Figure 5, these seven points cluster closely—remarkably so, considering that the dates range across approximately 4000 years. $\delta^{13}C$ values tend to be more negative and $\delta^{15}N$ more positive than those for later humans. In other words, peoples' diets in the period pre-dating 400 AD included less C_4-based food

and more ^{15}N-enriched food, very likely seafood since all of these earlier individuals are from coastal sites.

The human skeletons that post-date 1980 BP have more variable isotope ratios, perhaps partly because of the larger sample size. Overall, they have rather positive $\delta^{13}C$ values (from -7.0 to -14.1 ‰, with a single outlier at -19.9 ‰), $\delta^{15}N$ from 6.0 to 13.5 ‰. The individual with the anomalous $\delta^{13}C$ value was a three-month-old infant from Nanda (Morris 1993—the youngest person analysed (Nanda SVP 5)). During its short life, this child clearly consumed isotopically different (more C_3-based) foods compared with those eaten by most people. Its nitrogen isotope value, too, is unusual—at 7.4 ‰, it is lower than any of the other first-millennium AD skeletons. Children of this age whose principal food is mother's milk typically have $\delta^{15}N$ values several per mil higher than adults in the same population, because they are effectively one trophic level higher than their mothers (Clayton et al. 2006; Fuller et al. 2006; Herring et al. 1998). Such anomalous carbon and nitrogen isotope ratios cannot be interpreted without further research. This infant is not included in our discussion of the rest of the group.

The remaining 16 individuals ate substantial quantities of C_4-based foods (with the possible exception of A1071 from Widenham, which has the most negative $\delta^{13}C$ value of the group). It is difficult to infer, from analyses of bone collagen alone, the relative importance of C_4 crops (such as sorghum and millet) and animal products (i.e. milk and meat from domesticated animals that ate C_4 grasses, such as those from KwaGandaganda). It is clear, however, that the diets of this group were significantly different from those of the group pre-dating 400 AD (for carbon, Mann-Whitney Z-value is 3.52, $p<0.00044$; for nitrogen, Mann-Whitney Z-value is 3.21, $p<0.00132$).

Individuals from the first millennium AD exhibit a range of $\delta^{13}C$ values, but have uniform $\delta^{15}N$ of 9–10 ‰. Juveniles (two aged 7–8 years at death, and one aged four) have $\delta^{15}N$ and $\delta^{13}C$ values within the ranges seen for adults, so as for Ballito Bay A above, they are treated as members of the set. Given that the animals analysed yielded $\delta^{15}N$ of 5–6 ‰, and diet-consumer spacing is 3–4 ‰, values of 9–10 ‰ indicate that the protein component of the diet is likely to have come from terrestrial animal foods such as domestic stock. Most of the first millennium AD skeletons are from Wosi, Nanda, KwaGandaganda and Mhlopeni, none of which are on the coast, so readily available foods were mostly terrestrial, with more consistent $\delta^{15}N$ than those available to coastal dwellers. This group includes at least one woman, two men and several juveniles. Two skeletons in this time range derive from coastal sites (A1071 from Widenham and A1060 from Umgababa). These have $\delta^{13}C$ values of -14.1 and -11.7 and $\delta^{15}N$ of 10.0 and 10.1 respectively. The $\delta^{13}C$ values lie at the negative end of the range for the first millennium AD, but the $\delta^{15}N$ values cluster with the others.

Skeletons from the second millennium AD have much more variable $\delta^{15}N$. The most positive values (12.0 and 13.5 ‰) come from individuals from coastal sites (Thompson's Bay and King's View): people who ate more seafood than individuals from sites further inland. Not all skeletons from the coast, however, reflect significant amounts of marine food: A2120 from Ballito Bay, dated to 940 BP, has a $\delta^{15}N$ value of only 8.2 ‰. Wits A609 from Tinley Manor has even lower $\delta^{15}N$, at only 6.0 ‰, but these bones were heavily glued and this result may be less reliable than the others.

DISCUSSION AND CONCLUSION

Craniometric analysis of archaeological skeletons from KwaZulu-Natal has shown that individuals older than 400 AD show similarity to groups of Khoesan ancestry, while specimens from the later first and second millennia AD show progressively more similarities with recent agricultural groups (Sotho-Tswana, Nguni). Small sample size precludes statistical testing of differences between periods, but observations on individual skeletons suggest that change was progressive. When cranial and facial variables are considered together (Fig. 3), the six pre-400 AD skeletons lie at one end of the range of variation, and three of the post-1000 AD individuals lie at the other. The limited size of our archaeological skeletal series means that it surely underestimates the true variability, but the results reported here already indicate an extremely high level of diversity through time.

Temporal fluctuations in levels of diversity within a region may be caused by one or more of a number of micro-evolutionary processes, that is, environmental influence, genetic drift, gene flow, and others (Relethford 2001). Rapid increases in variation usually result from gene flow, as would have been the case if farming was, indeed, brought to KwaZulu-Natal by an immigrant non-Khoesan population. Between 400–1000 AD, the archaeological context strongly suggests economic and cultural interaction between groups (Maggs 1980b; Mazel 1989). The evidence presented here shows that gene flow also took place. As agricultural populations grew in the second millennium AD, Khoesan morphology became less visible. Sample sizes are, at present, too small to be able to evaluate suggestions of additional later immigrations (Huffman 2004, 2007).

Isotopic analysis of archaeological skeletons older than 400 AD show that these individuals ate appreciable quantities of marine foods, as might be expected for coastal hunter-gatherers.

Most skeletons dating between 400 and 1000 AD came from savanna environments in incised river valleys (Nanda, Wosi, Mhlopeni, KwaGandaganda) and ate varying amounts of C_4-based (agricultural) produce, with little or no marine food. Two individuals are from coastal sites (Widenham, Umgababa). A1071, from Widenham, is an outlier in terms of its $\delta^{13}C$ value (-14.1 ‰), which is the most negative of the group dating to the later first millennium AD), and in cranial shape. In Figures 3 and 4, A1071 clusters most closely with the pre-400 AD hunter-gatherers. It differs from the pre-400 AD group mainly in its lower $\delta^{15}N$ value (10 ‰). This individual is likely to have been of Khoesan ancestry, and to have lived on the fringes of (or outside) the early farming society, with minimal access to agricultural products.

Skeletons from the last 1000 years derive from several different environments. Their stable isotope values are varied, and provide evidence for mixed subsistence strategies, incorporating both agricultural produce and marine resources.

The morphological and dietary evidence presented here is in agreement with the majority view among archaeologists and bioanthropologists: that farming was brought to South Africa by an immigrant population. The simultaneous appearance of domesticated stock, grain agriculture, settled village life, iron smelting and the manufacture and use of a particular style of pottery strongly suggests population movement, rather than simply the transmission of a new way of life among previously established communities. Direct bioanthropological evidence for genetic inflow at this time has been lacking up to now, but is provided in the craniometric analyses reported

in this paper. Our evidence is also consistent with genetic work showing that, although the economy and culture of Khoesan hunter-gatherers was largely replaced by Iron Age agriculturists in the summer rainfall parts of South Africa, Khoesan genetic material continues to form a significant part of the gene pool of modern South Africans (Salas et al. 2002; Schuster et al. 2010). And as observed previously (Hall & Morris 1983; Rightmire & Van der Merwe 1976), biological processes of population change and cultural (including dietary) shifts were undoubtedly complex. A number of questions about population replacement and/or assimilation remain to be answered, that is, the extent to which rates of change varied geographically and chronologically. With a larger number of archaeological skeletons, it would be possible to obtain a more detailed picture of this important aspect of southern African history.

ACKNOWLEDGEMENTS

We would like to thank Gavin Whitelaw and Val Ward for help in accessing museum specimens and for providing relevant information. William W. Howells's comparative craniometric data, available online, formed an essential part of this project. We thank John Lanham and Ian Newton for help with the stable isotope analyses. The radiocarbon dates and isotopic analyses were supported by grants from the Natal Museum, the University of Cape Town and the Foundation for Research Development/National Research Foundation of South Africa. The craniometric work of Isabelle Ribot was funded by postdoctoral fellowships from the University of Cape Town (Health Sciences Faculty) and the Claude Leon Foundation.

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