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Colonial-indigene interaction in ancient Nubia
An integrative analysis of stress, diet, and ceramic data

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Abstract: *During the Middle Kingdom Period (2050-1650 BCE), the Egyptian Empire colonized Lower Nubia and constructed multiple fortresses along the Nile. Egyptian soldiers lived in these forts, while indigenous Nubians lived nearby. Written documents suggest this was an environmentally unstable period, characterized by unusually high river floods. In the later Middle Kingdom and after its decline into the Second Intermediate Period and New Kingdom, Egyptians cohabited the fortress space with Nubians. These colonial and post-colonial contexts are compelling and present a distinct opportunity to examine biology, culture, and environment.*

We use an interdisciplinary approach to address the intersection of health (cribra orbitalia*, enamel hypoplasia, stature), food (carbon and nitrogen isotope analysis), and material identities (ceramic assemblage). We found that despite the flooding events, the frequencies of skeletal indicators of physiological stress were not elevated. Social connections with Upper Nubia, evidenced by the ceramic assemblage, may have mitigated some of the health risks during floods. Isotope analysis suggests that Egyptians and Nubians were eating different foods, which may be tied to complex social practices. This study illustrates the importance of interdisciplinary and collaborative bioarchaeological research.*

Key words: environment; physiological stress; carbon and nitrogen stable isotope analysis; Egypt; Nile valley

Introduction

For millennia, the Nile River has been the lifeblood of Egyptian and Nubian civilizations. Changes to normal river flow—both natural and anthropogenic—can drastically impact the lifeways and well-being of Nile Valley inhabitants. Recent dam construction in Sudan, which resulted in mass forced relocation, has demonstrated how riverscape changes can severely affect Nilotic populations (Hafsaas-Tsakos 2011;

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Kleinitz & Näser 2011; Teodoru et al. 2006). Nile disruptions also impacted past populations; ancient Egyptian texts report that Nile flood and drought events caused low agricultural yields, disease, and destruction of property (Ball 1939). Decades of riverine variability are reported during the Middle Kingdom Period and may have contributed to the decline of sociopolitical unity. The Egyptian Second Intermediate Period is characterized by foreign rule and a weak 15th Dynasty in power at Thebes (**Table 1**; Bell 1975; Hassan 1997).

Table 1. Chronology of ancient Egypt and Lower Nubia.

	Egypt	**Lower Nubia**
2050-1650 BCE	Middle Kingdom	C-Group, Egyptian colony
1650-1550 BCE	Second Intermediate	C-Group, Kerma
1550-1050 BCE	New Kingdom	Egyptian colony

Using a bioarchaeological approach, we examine whether the environmental changes of the Middle Kingdom impacted physiological stress in C-Group Nubians. The C-Group people shared a common material and funerary culture and thrived in Lower Nubia, in the region of the First and Second Cataracts, between 2400 and 1500 BCE (Hafsaas 2007; O'Connor 1993; **Figure 1**). Reisner, an early 20th century archaeologist, coined the term C-Group, which was chronologically subsequent to the A- and B-Group cultures (O'Connor 1993; Reisner 1910, 1915; Trigger 1976). The C-Group Nubians had a dynamic relationship with Egypt to the north, and the Upper Nubian state, Kush, to the south. Egypt colonized Lower Nubia during the Middle Kingdom, became sociopolitically fragmented during the Second Intermediate Period, and re-colonized Lower Nubia during the New Kingdom (Shaw 2000; Smith 1991). The C-Group people maintained strong trade networks and a common cultural heritage with Kushite Nubians throughout this time (Bietak 1968; Bonnet 1992; Edwards 2004; Hafsaas 2006; Smith 1997; Williams 1983). We argue that the environmental changes that occurred during the Middle Kingdom cannot be disarticulated from this complex social, political, and economic milieu.

Significant environmental change, associated with food scarcity, limited potable water, and psychosocial stress, can increase morbidity and mortality (Cohen & Armelagos 2013; Roberts & Manchester 2005; Schug 2011). However, it is important to remember that people are not powerless in these scenarios; shifting social networks, advances in technology, and migration are just a few of the examples of cultural knowledge and action that can offset some of the negative ramifications of environmental variability (Armelagos 2003; Cohen & Armelagos 2013; McIntosh et al. 2000). We contextualize the findings of physiological stress with dietary reconstruction and ceramic data in order to shed light on the broader social, political, and economic setting of the C-Group during the Middle to New Kingdom Periods. This multi-method ap-

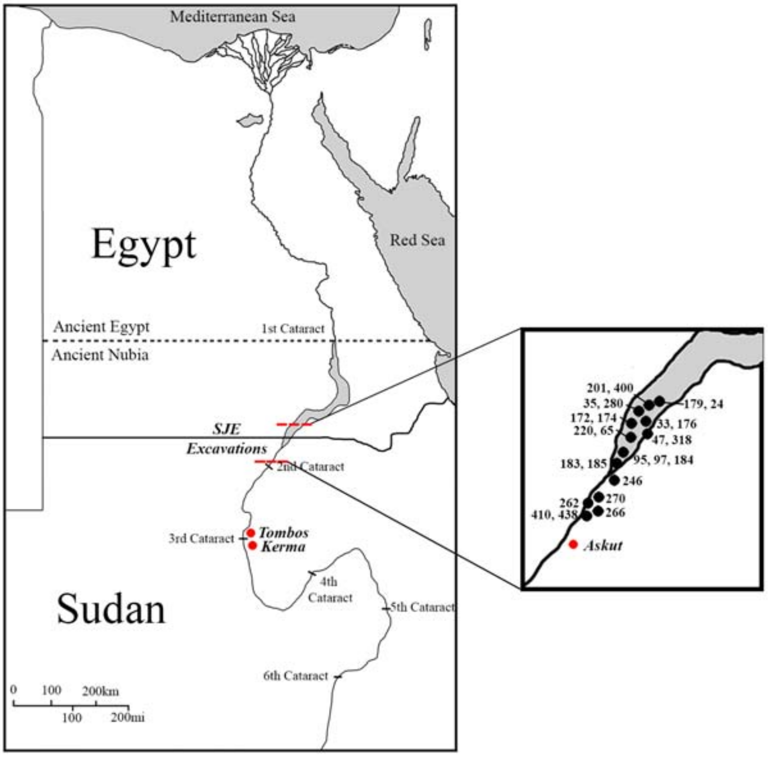

Figure 1. Map of Egypt and Nubia; black dots – sites where skeletal remains included in this study originated; red dots – sites of interest (Säve-Söderbergh 1989; Säve-Söderbergh & Troy 1991).

proach allows for more holistic interpretations of lifeways during and after a period of environmental change.

Archaeological and environmental context

The pharaohs of Middle Kingdom Egypt, likely threatened by the growth and increasing power of Kush (centered at Kerma, Third Cataract), conquered Lower Nubia by 1943 BCE (Edwards 2004; Trigger 1976). A total of 17 fortresses were built between the First and Second Cataracts, all of which were heavily fortified with elaborate defensive structures (Adams 1977). The cataracts, which are defined by imposing rock formations both on land and in the Nile, were ideal points of imperial control because they limited riverine traffic, thereby controlling population movement and trade, and delineated a new imperial border (Bourriau 2000; O'Connor 1993; Smith 1991, 2003b). The fortresses housed an occupying Egyptian army, while local C-Group populations lived outside the fortress walls (Edwards 2004; Smith 1995, 2003b). The C-Group and Egyptian material and funerary culture remained distinct, and archaeological evidence suggests there was limited interaction between these groups during this time (O'Connor 1993; Smith 2003a).

It was during this Middle Kingdom Period that Nile floods became increasingly unpredictable with a series of very high inundations (Evans 1994; Hassan 1986). Typically, the Nile flooded annually at a moderate level, irrigating and depositing rich alluvium in natural basins along the Nile Valley (Ikram 2009). The flood season, also known as Akhet (inundation), was crucial for ancient Egyptian agriculture and animal husbandry (Bard 2007). When flood levels were either lower or higher than expected, the consequences could be devastating. Bell (1975) reports 28 high floods from 1840-1770 BCE, in which the Nile was on average nine meters higher than modern comparative measurements (Butzer 1976). Due to the confined rocky environment of the cataracts, river water is channeled through a relatively small space, and therefore intense flooding may have impacted the cataract regions more than elsewhere (Butzer 1976). These floods could have proved devastating, washing away levies, decimating grain surplus reserves, and destroying settlements.

The potential impact of Nilotic environmental change is documented in the *Lamentations*, a collection of Ancient Egyptian literature that describes a period of Nile floods and droughts (2250-1950 BCE; Simpson 2003). In addition to noting the lack of drinking water and sufficient foodstuffs, the *Lamentations* detail alterations to the terrain including marsh desiccation, massive dust storms, and encroaching dunes. They discuss some of the biological consequences of such an environment: increased mortality, reduced birth weights, and the presence of rotting corpses in the Nile (Lichtheim 1973). Further, they also touch on social issues that occurred in response to this changing environment; suicide, anarchy, mass migration of starving people, civil war, and plundering of private property, are all reported to have been a direct result of river conditions (Bell 1971; Vandier 1936). Beyond the immediate damage of high Nile levels, Bell (1975) suggests that the floods temporarily worked to Egypt's benefit as canals and levees were constructed, thereby maximizing fertile agricultural land. It was the cessation of these marked floods that may have led to lower yields, cutting off an important source of revenue in agricultural surplus. This environmental stress may have played a role in the decline of the Middle Kingdom and the emergence of a weak Egyptian state in the Second Intermediate Period (Kemp 1983).

As the Egyptian state deteriorated into the Second Intermediate Period, the Egyptians who once garrisoned the fortresses were now expatriates and chose to remain in Lower Nubia. The ex-soldiers and their families formally pledged allegiance to Kush (Edwards 2004; Smith 1995). Archaeologically, there is increased material interaction between the Egyptians and C-Group Nubians. There is a rise in the number of

Nubian ceramics, jewelry, and figurines within the fortresses during the Second Intermediate Period (Smith 2003a; 2003b). At the same time, Egyptian ceramics appear in C-Group domestic contexts (O'Connor 1993; Säve-Söderbergh 1989; Trigger 1976). There are limited written records, however, from the Second Intermediate Period that directly speak to the climate and Nile floods. Butzer suggests that there would have been a period of Nile readjustment that occurred after the pronounced floods of the Middle Kingdom (Butzer 1976). He estimates that the Nile level would have returned to a more fixed state by 1550 BCE, the start of the New Kingdom Period.

The New Kingdom Period is characterized by territorial expansion and colonization (O'Connor 1983; Smith 1991). At the onset of political reunification, Egypt began several campaigns to conquer Kush (Trigger 1976). Within a century, a new Egyptian southern border was established at the Fifth Cataract (Bryan 2000; Smith 2003b). Rather than dispatching military forces to inhabit fortified towns, as was the case during the Middle Kingdom, Egypt implemented a new type of imperial policy in Nubia. Towns were built from the ground up at key locations along the Nile. Egyptian administrators, with elite and specialized titles such as The Viceroy of Kush, were in charge of collecting tribute and maintaining peace (Edwards 2004). Further, Egypto-Nubian cohabitation of these towns was encouraged (Smith 2003b).

Buzon and Smith have researched the complex biological and social entanglements of this period. At the site of Tombos (Third Cataract; 20km north of Kerma), they have found significant skeletal and archaeological evidence to suggest that biological Nubians and Egyptians intermarried and through time created a mixed social identity that is reflected in their burial practices (Buzon 2006a; Buzon et al. 2016; Smith 2003b). With regular Nile floods and a stable climate to facilitate economic growth and political stability, Egypt controlled Nubia for the next 500 years.

Materials

The materials analyzed here originate from the Second Cataract region of Lower Nubia. The human skeletal remains were excavated as part of the Scandinavian Joint Expedition (SJE) to Sudanese Nubia, a salvage project aimed at preserving archaeological material in preparation for the construction of the Aswan High Dam (1963-1964; Säve-Söderbergh 1989). This expedition focused on the region of the modern Egyptian/Sudanese border (**Figure 1**). These remains were categorized as C-Group (i.e., indigenous Nubian) or Pharaonic (i.e., Egyptianized Nubian), based on differing mortuary practices (i.e., burial position, grave goods). Previous bioarchaeological research has conceptualized the C-Group as a single population with a common cultural heritage (Gibbon & Buzon 2016; Godde 2012; Irish & Friedman 2010; Strouhal & Jungwirth 1984); furthermore, several publications have specifically used this collection to address differences between the C-Group and other comparative groups (Beckett & Lovell 1994; Buzon 2008, 2011; Buzon & Bombak 2010; Galland et al. 2016; Irish 2005; Irish & Konigsberg 2007; Johnson & Lovell 1995; Prowse & Lovell 1995; Vagn Nielsen 1970). Collectively the C-Group skeletons span 2000-1500 BCE. The sample was further divided into Middle Kingdom, Second Intermediate Period, and New Kingdom groups based on ceramic seriation, which is well defined in the region and has been supported by ^{14}C dating in multiple publications (Bietak 1968; Gratien 1978, 1986; Hafsaas 2006; Holthoer 1977; O'Connor 1969; Säve-Söderbergh 1989). The Pharaonic skeletons were buried in an Egyptian-style and span 1650-1350 BCE (Vagn Nielsen 1970). The SJE skeletal collection is now housed at the Panum Institute at the University of Copenhagen, Denmark.

The ceramic assemblage discussed here originates from Askut, an Egyptian fortress at the Second Cataract of the Nile (**Figure 1**). It was excavated in 1962-1964 also as part of the Aswan High Dam salvage campaign (Badawy 1964, 1965, 1966). Archaeological evidence indicates it was occupied continuously from the Middle Kingdom to the end of the New Kingdom (Smith 1995). The artifacts originate from midden deposits inside the fort. The collection is remarkable in its completeness, owing to careful excavation and documentation. Unfortunately, this is not characteristic of other fortress excavations; many were either poorly recorded or only concerned with a very limited diagnostic ceramic assemblage and lack any collections of faunal or botanical remains (Smith 1995). Ideally, we would examine the skeletal remains and ceramic assemblage from the same fortress. However, this is not possible at this time; the majority of skeletal remains associated with Askut were not saved and remain unpublished, and the SJE did not focus on habitation excavation.

Methods

Skeletal indicators of stress and disease

In line with recent publications, we view skeletal indicators of stress and disease as physiological disruptions that are only part of a much broader concept of health (Mays 2012; Temple & Goodman 2014). We use frequencies of *cribra orbitalia*, porotic hyperostosis, enamel hypoplasia, and measurements of maximum adult femoral length (proxy for stature) as possible indicators of differential environmental constraints, while acknowledging that these skeletal conditions are the product of complex etiologies, phenotypic plasticity, and adaptive resilience (Buzon 2006b; Goodman & Armelagos 1989; Steckel & Rose 2002). *Cribra orbitalia* and porotic hyperostosis have been linked to multiple anemias (e.g., iron-deficiency, hemolytic, megaloblastic), other nutritional deficiencies, and parasitic infection (Lallo et al. 1977; Stuart-Macadam 1992; Walker et al. 2009; Weston 2012; Rivera & Mirazón Lahr 2017). *Cribra orbitalia* and porotic hyperostosis were considered present if macroscopic porosity with coalesced or non-coalesced foramina were present on the superior orbital/ectocranial vault surface(s). Enamel hypoplasia is a deficiency in enamel thickness and is thought to be caused by systemic metabolic stress (Dobney & Goodman 1991; Hillson 2014; Irish & Scott 2015). Hypoplasia was considered present if linear horizontal groove/line and/or labial pits were deep enough to be detected with a fingernail and were present on more than one tooth (Boldsen 2007; Hassett 2013; Krenz-Niedbała & Kozłowski 2013; Steckel et al. 2006). Femoral maximum length can be stunted if persistent childhood nutritional deprivation and disease are experienced (Goodman 1991). An osteometric board was used to assess femoral length. The distributions of age (young adult=20-34; middle adult=35-49; old adult=50+) and sex, as determined by accepted cranial and pelvic morphology methods (Buikstra & Ubelaker 1994:16-20), are presented in **Tables 2-3**. Schrader and Buzon collected the demographic data presented here. Owing to small frequencies of porotic hyperostosis and enamel hypoplasia, a non-parametric Kruskal-Wallis one-way analysis of variance was used to compare frequencies of pathological conditions between multiple time periods (e.g., Middle Kingdom, Second Intermediate Period, New Kingdom; significance level: $p \leq 0.05$). Similarly, a non-parametric Mann-Whitney U was used to compare the presence of pathological conditions between two groups (e.g., Pharaonic New Kingdom and C-Group New Kingdom). ANOVA was used to determine if femoral length measurements, separated by sex, were significantly different between time periods.

Table 2. Sex distribution of skeletons analyzed for physiological stress.

Sex	C-Group			Pharaonic	Total
	Middle Kingdom	Second Intermediate	New Kingdom	New Kingdom	
Female	27	25	25	36	113
Male	20	6	6	29	61
Indeterminate	11	11	16	17	55
Total	58	42	47	82	229

Table 3. Age-at-death distribution of skeletons analyzed for physiological stress.

Age-at-death	C-Group			Pharaonic	Total
	Middle Kingdom	Second Intermediate	New Kingdom	New Kingdom	
Young adult	8	9	6	13	36
Middle adult	5	4	2	7	18
Old adult	6	1	2	10	19
Indeterminate	39	28	37	52	156
Total	58	42	47	82	229

Carbon and nitrogen stable isotope analysis

Carbon and nitrogen stable isotope analysis of bone collagen was used to investigate dietary patterns; this method is well established in the bioarchaeological examination of past foodways (see Ambrose & Krigbaum 2003; Bogaard & Outram 2013; Katzenberg 2000; Lee-Thorp 2008). Carbon ratios ($^{13}C/^{12}C$, expressed as $\delta^{13}C$) can distinguish plants with differing photosynthetic pathways; C_3 plants (e.g., wheat, rice, barley) have $\delta^{13}C$ values ranging between -35‰ and -20‰ and C_4 plants (e.g., sorghum, millet, maize) have $\delta^{13}C$ values from -14‰ to -9‰ (Katzenberg 2000; Tieszen 1991; van der Merwe 1982). Nitrogen isotope ratios ($^{15}N/^{14}N$, expressed as $\delta^{15}N$) reflect the protein component of the diet and increase with trophic level (DeNiro & Epstein 1981; Hedges & Reynard 2007). Animal $\delta^{15}N$ values are 3-4‰ higher than the $\delta^{15}N$ of their diet (Katzenberg, 2000; Schoeninger & DeNiro 1984). The consumption of marine species can result in ^{15}N and ^{13}C enrichment, due to the differing mechanisms of carbon acquisition and nitrogen fixation underwater (Richard & Hedges 1999; Schoeninger et al. 1990; Schoeninger & DeNiro 1984). Freshwater species are also subject to these processes, although the effects are more muted and variable (Schoeninger & DeNiro 1984).

Funerary offerings, artistic depictions, written documents, as well as archaeological, archaeozoological, and archaeobotanical remains indicate that Egyptians depended heavily upon bread and beer, particularly those made from emmer wheat and barley (Alcock 2006; Darby et al. 1977; James 1984; Saffirio 1972; Samuel 1996a, 1996b, 2000; Wilson 2001). Bread and beer were often used as a form of income as well as tax, which is evidenced by large-scale bakeries and breweries (in operation by the Old Kingdom 2600-2150 BCE) and state records (Breasted 1906; Butzer 1976; Murray 2000). The majority of Egyptians did not eat beef, which was considered a food reserved for the elite, but instead relied on pig, sheep or goat to supplement their diet (Ikram 1995, 2000; Romer 1984). Previous stable isotope studies support these findings (**Tables 4-6**). Iacumin et al. (1996) examined 32 individuals from ancient Egypt (5000 BCE – 250 CE) and found that they maintained a C_3-based diet (mean $\delta^{13}C$ values -19.60±0.39‰) and consumed varied protein resources (mean $\delta^{15}N$ values 12.17±0.95‰). Thompson et al. (2005) produced similar findings in an assessment of 55 individuals from ancient Egypt (5500-343 BCE); the authors suggest these Egyptians had a predominantly C_3 diet (mean $\delta^{13}C$ values -19.1±0.7‰) coupled with freshwater fish protein resources (mean $\delta^{15}N$ values 13.2±1.0‰). Other isotopic studies of Egyptian human remains report similar results (Dupras & Schwarcz 2001; Macko et al. 1999; Schwarcz et al. 1999; White et al. 1999; see **Tables 4-6**).

Archaeological and isotopic evidence suggests that Nubians may have depended more upon sorghum, millet, and cattle as mainstays of their diet. While the domestication of sorghum in the Nile Valley is debated, wild sorghum has been found at the

Neolithic site of Um Direiwa and was presumably widely accessible (4800 BCE; Beldados & Constantini 2011; de Wet & Huckabay 1967; Haaland 1987, 1992, 1995, 1999, 2012; Young & Thompson 1999).

Archaeological evidence suggests cattle held an important place in Nubian culture since the Predynastic era (c. 3100 BCE; Wengrow 2001). Cattle were frequently depicted in rock art throughout Nubia (Brandt & Carder 1987; Davis 1984). Cattle hides were often included in funerary contexts (Williams 1991). At Kerma's eastern cemetery, thousands of cattle crania (bucrania) outline the burial tumuli. The largest tumulus is estimated to have had up to 4000 bucrania (Chaix 2001, 2004). As Haa-

Table 4. Data from previous published Nile Valley human stable isotope studies (adapted from Thompson et al. 2005, 2008).

Publication	Site	Period[1]	N	Tissue	$\delta^{13}C$		$\delta^{15}N$	
					Mean	SD	Mean	SD
		Nubian						
White 1993	Wadi Halfa	X-Group	9	Bone collagen	-17.1	1.1		
		X-Group	9	Hair	-16.6	1.9		
		Christian	5	Hair	-16.7	2.3		
White & Schwarcz 1994	Wadi Halfa	Meroitic	31	Bone collagen	-18.1	1.0	12.3	
		X-Group	35	Bone collagen	-17.0	0.8	11.1	
		Christian	24	Bone collagen	-18.7	1.6	10.6	
White & Armelagos 1997	Wadi Halfa	X-Group	27	Bone collagen	-16.9	0.7	11.1	1.2
Iacumin et al. 1998	Kerma	Ancient Kerma	5	Bone collagen	-16.4	1.3	12.2	0.7
		Middle Kerma	4	Bone collagen	-19.7	0.8	13.1	0.9
		Classic Kerma	2	Bone collagen	-20.3		12.1	
		Christian	1	Bone collagen	-13.3		12.1	
White et al. 1999	Wadi Halfa	X-Group-Christian	14	Skin collagen	-18.6			
White et al. 2004	Wadi Halfa	X-Group	46	Bone collagen	-16.9	1.3	11.6	1.3
		Christian	16	Bone collagen	-18.4	2.1	10.4	1.3
Thompson et al. 2008	Kerma	Classic Kerma	48	Bone collagen	-17.7	1.7	13.9	0.7
		Egyptian						
Iacumin et al. 1996	Gebelein	Predynastic	3	Bone collagen	-19.4	0.2	12.2	1.0
		First Intermediate	6	Bone collagen	-19.4	0.3	12.9	0.9
	Asyut	First Intermediate	8	Bone collagen	-19.8	0.4	13.0	1.0
Macko et al. 1999	Unknown	Late Middle Kingdom	9	Hair	-21.5	1.1	14.0	1.1
White et al. 1995	Kharga Oasis	25th Dynasty-Coptic	4	Skin collagen	-20.4	0.6		
		25th Dynasty-Coptic	22	Hair	-19.6	0.5		
Schwarcz et al. 1999	Dakhleh Oasis	L. Ptolemaic-Christian	25	Bone collagen			17.6	1.5
Dupras et al. 2001		Romano-Christian	32	Bone collagen			17.9	1.1
Thompson et al. 2005	el-Badari	Predynastic	3	Bone collagen	-19.2	0.4	12.6	0.4
	Naqada	Predynastic	4	Bone collagen	-18.7	0.2	12.5	1.3
	Hierakonpolis	Predynastic	1	Bone collagen	-20.8		13.4	
	Abydos	12th Dynasty	2	Bone collagen	-18.5	0.1	13.0	0.9
	Gizeh	26th-30th Dynasty	6	Bone collagen	-19.4	0.5	13.9	0.7

[1] X-Group: 350-550 CE; Christian: 500-1400 CE; Meroitic: 350 BCE – 35 CE; Ancient Kerma: 2500-1500 BCE; Middle Kerma: 2050-1750 BCE; Classic Kerma: 1750-1500 BCE; Predynastic: 4950-2950 BCE; First Intermediate Period: 2120-1990 BCE; Late Middle Kingdom: c. 2000 BCE; 25th Dynasty-Coptic: 760 BCE-720 CE; Late Ptolemaic-Christian: 60 BCE-400 CE; 12th Dynasty: 1991-1786 BCE; 26th-30th Dynasty: 662-343 BCE.

land (2012) points out, this would have provided tens of thousands of kilograms of meat for consumption. Many of the bucrania funerary offerings at Kerma exhibited horn deformation, a practice that is likely reinforced with religious significance (Chaix 1996; Chaix et al. 2012). Chaix's analysis of the zooarchaeological remains of Kerma further support the concept that these cattle were being eaten; cattle were a "significant proportion of the animals consumed" within Nubia (Chaix & Grant 1992:61).

Again, the isotopic studies of human remains align well with the archaeological evidence and suggest that Nubians may have had a more substantial C_4 contribu-

Table 5. Data from previous published Nile Valley faunal stable isotope studies (adapted from Thompson et al. 2005).

Publication	Site	Period[1]	Animal	$\delta^{13}C$	$\delta^{15}N$
		Nubian			
Iacumin et al. 1998	Kerma	Middle Kerma	Goat	-22.7	6.7
			Turtle	-15.3	8.6
		Classic Kerma	Goat	-11.0	11.2
Thompson et al. 2008	Kerma	Middle-Classic Kerma	Sheep	-15.0	9.0
			Goat	-16.8	8.3
			Cow	-7.0	12.7
			Dog	-13.6	11.6
		Egyptian			
Dupras et al. 2001	Dakhleh Oasis	Romano-Christian	Pig	-17.4	13.3
			Chicken	-18.4	16.2
			Gazelle	-17.9	13.2
			Cow	-15.1	13.1
			Goat	-15.7	13.4
			Pig	-17.4	13.3
			Donkey	-18.1	13.3
Iacumin et al. 1996	Unknown	18th Dynasty	Ox	-23.2	9.4
Thompson et al. 2005	Mostagedda	Badarian	Sheep	-17.4	8.0
			Pig	-20.9	7.8
			Cow	-15.3	9.6
			Equid	-20.5	4.3
			Camel	-12.3	11.7
			Striped Hyena	-14.1	12.9
	el-Badari	Late Old Kingdom	Sheep	-18.9	6.8
			Pig	-17.6	9.7
			Cow	-15.4	10.9
	Qau	Unknown	Cow	-18.7	7.7
			Dog	-18.0	7.5
	Kharga		Cow	-8.9	10.7
	Unknown		Sheep	-19.5	6.7
			Cow	-12.6	8.0
			Nile Perch	-14.9	5.0
			Hartebeest	-8.1	14.0
			Equid	-16.8	12.9
			East African Buffalo	-19.9	7.7
			Hyena	-15.7	12.8

[1] Romano-Christian: c. 250 CE; 18th Dynasty: 1500-1300 BCE; Badarian: c. 4000 BCE; Late Old Kingdom: c. 2000 BCE; Middle Kerma: 2050-1750 BCE; Classic Kerma: 1750-1500 BCE.

tion than Egyptians. In a study of four Nubian populations, Iacumin et al. (1998; n=22) found a mixed C_3/C_4 diet and proteins likely consisting of caprine, cattle, and freshwater fish. Thompson et al. (2008; n=54) report a mixed C_3/C_4 diet at Kerma with elevated $\delta^{15}N$ values, which may be due to the arid conditions. Isotopic analysis of hair suggests there may also be a seasonal component to trends in C_3 versus C_4 consumption (Schwarz et al. 2004; White 1993).

Owing to small sample sizes, a chronological comparison between time periods, as was done with the paleopathological data, could not be conducted with the isotope data. Instead, individuals who were buried in the C-Group tradition (Middle Kingdom to New Kingdom) are compared to individuals who were buried in an Egyptian tradition (i.e., Pharaonic; New Kingdom). This broad comparison is not intended to reflect the entirety of C-Group or Pharaonic population; rather we use these data to speak to the social context of Lower Nubia during and after the period of Nile River instability discussed above.

Table 6. Data from previously published Nile Valley botanical remains and food.

Publication	Site	Period[1]	Sample	$\delta^{13}C$	$\delta^{15}N$
		Nubian			
Iacumin et al. 1998	Kerma	Ancient Kerma – Classic Kerma	Acacia beans	-24.6	1.7
			Barley seeds	-23.1	9.1
			Dum palm	-23.8	8.9
		Egyptian			
Iacumin et al. 1996	Thebes	New Kingdom	Egg yolk	-22.1	13.8
			Bread	-22.7	12.5
			Wheat seed	-22.6	8.3
			Pomegranate seed	-24.2	3.4
			Leaf	-25.7	17.0
Schwarcz et al. 1999	Kellis	Late Ptolemaic – Early Roman	Wheat		16.1
			Broad bean		12.1
			Barley		14.4
			Grape		16.7
			Olive		18.8
			Date		14.9
			Fig		17.8
			Doum nut		11.7
Dupras et al. 2001	Kellis	Romano-Christian	Wheat	-22.9	
			Barley	-23.3	
			Fava bean	-23.1	
			Grape	-22.1	
			Olive	-21.9	
			Date	-22.2	
			Doum nut	-26.3	
			Fig	-23.8	
			Millet	-9.9	

[1] New Kingdom: 1550-712 BCE; Late Ptolemaic – Early Roman: 60 BCE – 100 CE; Ancient Kerma – Classic Kerma: 2450 – 1450 BCE; Romano-Christian: c. 250 CE.

Human rib bones were sampled for isotope analysis. As non-specific stressors, pathological conditions, and wasting can impact isotope values (Fuller et al. 2005; Katzenberg & Lovell 1999; Mekota et al. 2006; O'Connell et al. 2012), individuals without physiological stress indicators present were sampled for isotope analysis. Schrader prepared all samples according to the modified Longin (1971) technique (Garvie-Lok 2001). Sample preservation was assessed from atomic C/N ratio, %C, %N, and collagen yield, using accepted values (Ambrose 1990; DeNiro 1985; van Klinken 1999). Stable isotope analysis was conducted by the Biogeochemical Analytical Service Laboratory at the University of Alberta using a EuroEA Elemental Analyzer (EuroVector) coupled with an Isoprime Mass Spectrometer (GV Instruments). Instrument precision was $\pm 0.1‰$ for $\delta^{13}C$ and $\pm 0.2‰$ for $\delta^{15}N$. Mann-Whitney U was used to test for significant differences between the C-Group and Pharaonic isotopic data.

Ceramic assemblage

We analyzed the frequency of Nubian versus Egyptian cooking vessels through the Middle Kingdom, Second Intermediate, and New Kingdom Periods at Askut (**Figure 2**). The stylistic characteristics of Nubian ceramics are distinct from Egyptian ceramics and both are well studied (Bourriau et al. 2000; Gratien 1978; Lacovara 2000; Smith 2003a; Williams 1983). The Egyptian cooking pottery from Askut was thrown on a wheel with the exception of bread molds D and H which were molded on a conical wooden form. In contrast, all of the Nubian pottery is handmade, making it easy to differentiate between the two. All of the pottery uses a chaffy Nile Silt clay, with the exception of Egyptian cooking pots with shapes A and B, which are made of a special sandy Nile Silt fabric characteristic of the Nile Delta. The B shape is eventually imitated in the more usual chaffy fabric in the later Middle Kingdom. All of the sherds show evidence of sooting consistent with cooking. Note that the Nubian pots are more elaborately decorated, which also points to distinctive and meaningful traditions. These motifs tie Askut's Nubian pottery most closely to the Kerma culture, but with some affinities to the Nubian C-Group and Pan Grave cultures as well (Smith 1995). Cooking vessels, including pots and bread molds, would have been used in the kitchen and were directly involved in food preparation. While Smith (1995, 2003a, 2003b) has previously examined other vessel types as well (serving, storage), we elect to focus on cooking vessels due to their association with daily life. Rarely leaving the kitchen, cooking vessels may have reflected a social arena controlled by women at a household level, representing an identity rooted in the family, but also perhaps creating a sense of solidarity between households with Nubian women through the medium of foodways (Smith 2003a). Smith has previously argued that this could be an indicator of intermarriage between Egyptians and Nubians; there is evidence to suggest that food preparation was a gendered female activity in the ancient Nile Valley, with women producing and using the ceramic vessels associated with cooking. Smith suggests that the increase of Nubian-style pottery in Egyptian contexts may be indicative of Nubian wives marrying Egyptian men (1995, 2003a, 2003b). There are an increasing number of Nubian vessels in domestic contexts through the Middle Kingdom, Second Intermediate, and New Kingdom Periods. More than 16,000 sherds originating from reliable contexts at Askut were visually examined by Smith and then categorized by cultural affiliation (Egyptian, Nubian), temporal period (Middle Kingdom, Second Intermediate, New Kingdom; see Smith 1995, 2003b). The sherds were counted and the proportion of Egyptian to Nubian ceramics was assessed diachronically.

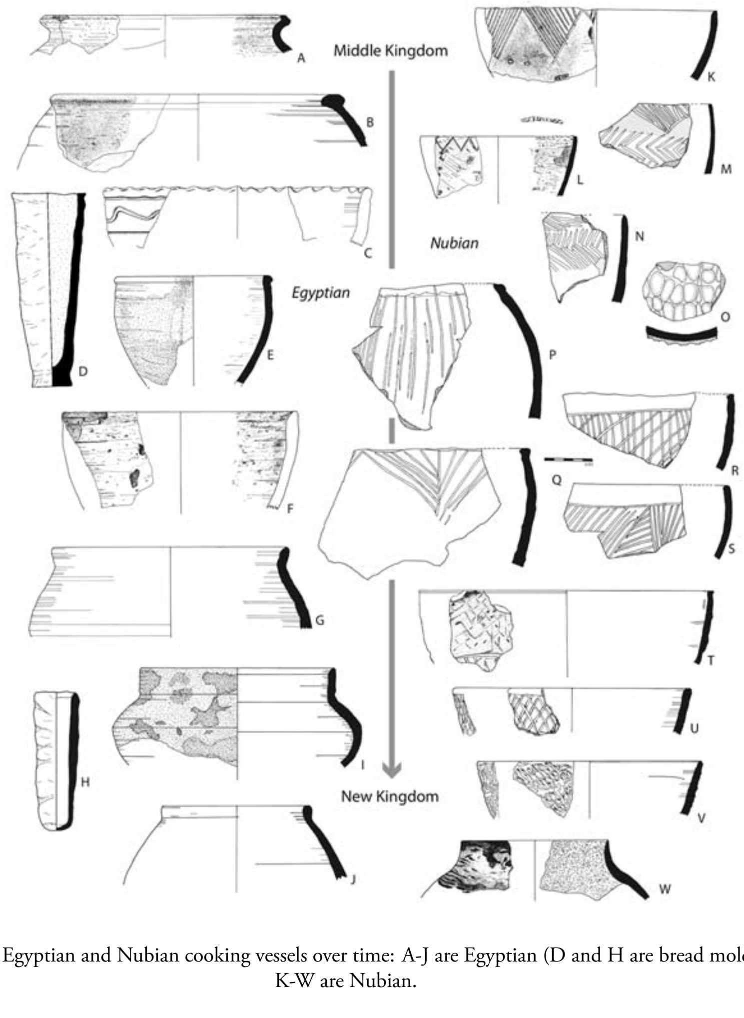

Figure 2. Egyptian and Nubian cooking vessels over time: A-J are Egyptian (D and H are bread molds), K-W are Nubian.

Results

Skeletal indicators of stress and disease

Skeletal analysis indicates that, despite notably high Nile floods, there was no significant increase in osseous indicators of physiological stress over time (**Tables 7-8**). No statistical differences between *cribra orbitalia*, porotic hyperostosis, enamel hypoplasia (Kruskal-Wallis: χ^2=1.464, p=0.481; χ^2=1.080, p=0.583; χ^2=0.199, p=0.905, respectively), or maximum femoral length (ANOVA female: F=0.362, p=0.700; male femur length data did not include any Second Intermediate Period or New Kingdom individuals) were found between the Middle Kingdom, Second Intermediate, and New Kingdom Periods. Furthermore, no statistical differences in skeletal indicators of stress were found between the contemporary New Kingdom, C-Group, and Pharaonic samples (Mann-Whitney U: *cribra orbitalia*: U=1274.5, p=0.186; porotic hyperostosis: U=1404.5, p=0.595; enamel hypoplasia: U=76.5, p=0.670; ANOVA: female maximum femoral length: F=0.054, p=0.822).

Table 7. Indicators of physiological stress.

Indicator	**C-Group**						**Pharaonic**	
	Middle Kingdom		**Second Intermediate**		**New Kingdom**		**New Kingdom**	
	%	**n/N**	**%**	**n/N**	**%**	**n/N**	**%**	**n/N**
Cribra orbitalia	10.34%	6/58	19.05%	8/42	10.64%	5/47	18.45%	17/92
Porotic hyperostosis	0.00%	0/58	2.38%	1/42	2.13%	1/47	1.09%	1/92
Enamel hypoplasia	5.17%	3/58	4.76%	2/42	6.38%	3/47	3.26%	3/92

Table 8. Maximum adult femoral length.

Sex	**C-Group**									**Pharaonic**		
	Middle Kingdom			**Second Intermediate**			**New Kingdom**			**New Kingdom**		
	mean	**SD**	**N**	**mean**	**SD**	**N**	**mean**	**SD**	**N**	**mean**	**SD**	**N**
Female	421.9	26.2	8	428.4	13.5	8	427.5	10.6	2	421.8	16.8	8
Male	456.6	17.2	10							443.6	13.8	9

Carbon and nitrogen stable isotope analysis

Stable isotope ratios indicate subtle, yet meaningful, differences in dietary patterns. The Pharaonic sample exhibited low δ^{13}C (-20.2±0.2‰) and δ^{15}N (11.7±0.8‰) mean values, compared to the C-Group sample, and is suggestive of a C_3 diet (**Figure 3**; **Table 9**). The C-Group data is similar to the Kerma data, falling within the variation of Kerma's δ^{13}C and δ^{15}N values (-17.7±0.6‰, 13.2±0.4‰). Independent t-tests indicate that there is a statistically significant difference between C-Group and Pharaonic samples, for both $\delta^{13}C$ (U=0.5, p=0.008) and $\delta^{15}N$ (U=2.0, p=0.017).

Table 9. Stable isotope data.

Sample	Time period[1]	Sex[2]	Age[3]	Culture	$\delta^{13}C$	$\delta^{15}N$	C:N	%C	%N
95:171	1600-1500 BCE	F	MA	C-Group	-17.8	13.5	3.3	28.5	9.9
201:8	1550-1500 BCE	F	YA	C-Group	-16.9	12.8	3.5	32.1	10.7
266:81	2100-1600 BCE	M	OA	C-Group	-17.9	13.2	3.5	36.7	12.1
266:101	2100-1600 BCE	M	OA	C-Group	-18.5	13.7	3.5	33.2	11.0
270:17	1650-1600 BCE	F	A	C-Group	-17.3	12.7	3.4	32.3	11.0
183:31	1475-1400 BCE	M	MA	Pharaonic	-20.2	11.2	3.4	43.2	15.0
183:114	1475-1400 BCE	F	MA	Pharaonic	-20.1	12.2	3.5	32.9	11.0
400:11B	1475-1425 BCE	F	MA	Pharaonic	-20.6	12.0	3.4	41.4	14.4
400:15	1475-1425 BCE	M	OA	Pharaonic	-20.2	12.7	3.1	34.3	13.0
400:18A	1475-1425 BCE	F	MA	Pharaonic	-20.1	10.7	3.5	32.0	10.7

[1] Time period based on ceramic seriation (see Bietak 1968; Säve-Söderbergh 1989; Säve-Söderbergh & Troy 1991).
[2] M = Male, F = Female.
[3] YA = Young adult (20-34), MA = Middle adult (35-49), OA = Old Adult (+50), A = Adult.

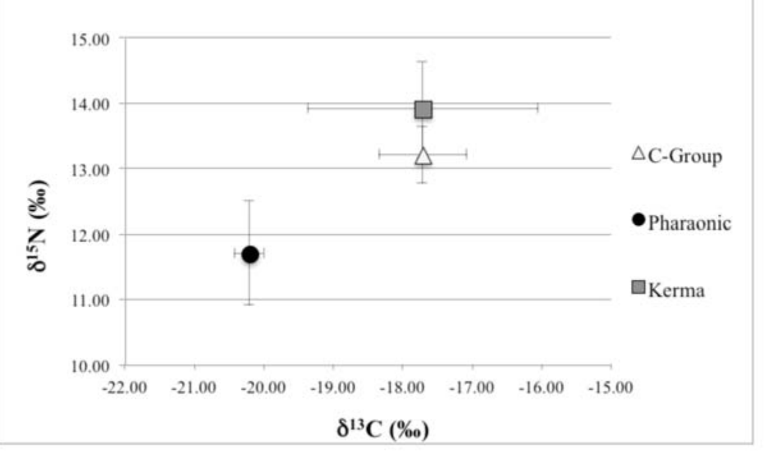

Figure 3. Carbon and nitrogen stable isotope data.
Data are given as the sample mean and 1SD (error bars).

Ceramic assemblage

The ceramic assemblage at Askut varied considerably between the Middle Kingdom, Second Intermediate, and New Kingdom Periods (**Figure 4**). There is a steady increase in Nubian cooking vessels at Askut through time. During the militaristic Middle Kingdom, Nubian cooking ceramics were limited (38% overall; 132/350 sherds) however, cooking vessels were overrepresented compared to the overall percentage of Nubian pottery at the site (3-5%, 3% overall, 222/7473). In the Second Intermediate Period we see an increase in the frequency of Nubian cooking vessels (61%; 28/46 sherds, the proportion of Nubian pottery overall increasing to 12%, 74/542), which is not altogether surprising considering the coexistence of Egyptian expatriates and C-Group and/or Kerma Nubians. What is most notable is the further increase in Nubian cooking vessels (84%; 232/396 sherds, with Nubian pottery decreasing to 9% overall, 376/3571) during the New Kingdom, when Egypt again conquers Nubia and reestablishes control over the fortress. The pattern was consistent across the fortress, with the exception of the largest residence, the house of Meryka (**Figure 5**). About a third of the associated cookpots were still Egyptian (31%, 10/32) and there were fewer Nubian serving vessels than in other contexts across the fortress/settlement (2% vs. 5% elsewhere). This suggests a more Egyptian character to the cuisine compared to other households. A similar pattern appears in the Middle Kingdom with the large mansion at the southern end of the Main Fort (labeled by Badawy the "Commandant's Quarters") having a smaller percentage of Nubian cooking pottery (22%, 10/45) than the residential "barracks" area to the north (42.5%, 113/266; the large gridded structure to the east was a granary). As the focus of settlement shifted into the Southeast Sector, the new elite residence where an ancestor named Meryka was venerated retained a degree of Egyptian emphasis, even though Nubian style vessels still outnumber Egyptian in the cooking assemblage. As noted above, the approach to colonial policy during the New Kingdom, characterized by coexistence and cultural entanglement, was much different in the Middle Kingdom, which was at least initially more confrontational.

Discussion

In Egypt and Nubia, regions that were circumscribed by increasingly arid deserts over the course of the second millennium BCE, discussions of human-environment interaction are inherently centered upon the Nile River. Unexpected and oftentimes uncontrollable changes to the water level and associated sedimentary deposits can have significant repercussions for local populations. Interestingly, despite written documentation of floods and agricultural deficits during the Middle Kingdom Period, *cribra orbitalia*, porotic hyperostosis, enamel hypoplasia, and maximum femoral length did not statistically differ between the climatically variable Middle Kingdom and the more stable Second Intermediate and New Kingdom Periods. This suggests that these individuals coped well with adverse environmental conditions and depleted agricultural surplus, avoiding the negative impacts that such conditions might predict.

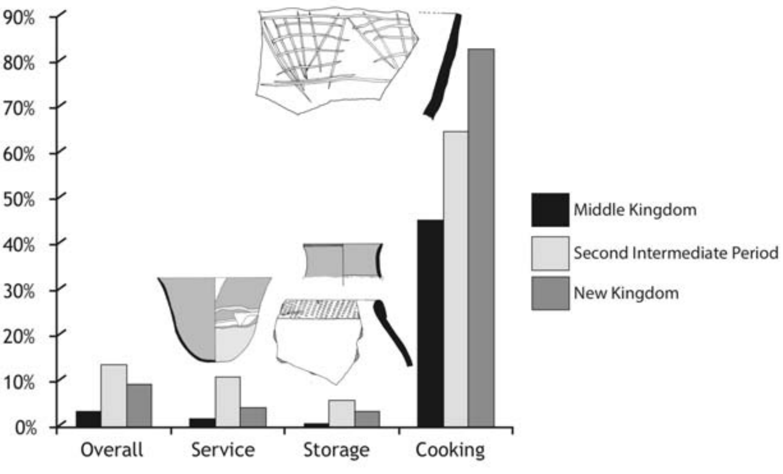

Figure 4. Overall percentages of Egyptian and Nubian cooking, service and storage vessels by period at Askut. The pottery illustrated is all Nubian from Second Intermediate Period contexts.

We argue that the environmental changes that occurred in the Middle Kingdom are complexly interwoven and cannot be separated from the political, economic, and social spheres. Perhaps connections with Kerma, the capital city of Kush, may have aided C-Group Nubians during environmentally challenging times. By leveraging the archaeological context (i.e., ceramic and isotopic data; DeWitte & Stojanowski 2015), we can better understand how the political, economic, and social factors may have played a role in physiological stress outcomes.

Significant sociopolitical events occurred in Lower Nubia during the 2nd millennium BCE. After Middle Kingdom fortress construction and militaristic colonization of the First-Second Cataract region, there was little material interaction between the C-Group and Egyptian communities (Edwards 2004; O'Connor 1993; Smith 1995). In the later Middle Kingdom, the fortress system shifted from rotating garrisons that enforced Egyptian occupation to colonists who were more embedded in the social and physical landscape (Edwards 2004; Säve-Söderbergh 1989). The fact that Egyptians actively chose to remain in this frontier zone in the Second Intermediate Period, after the deterioration of the empire, is meaningful; as discussed above, migration—initiated by either political or environmental influences—is an alternative to remaining stationary in unfavorable conditions. Collectively, the data presented here suggest that not only did C-Group Nubians fair well during the period of environmental crisis, but that they solidified ties between Egyptian expatriates in Lower Nubia and with Kush in Upper Nubia. Traces of these social networks, which were ini-

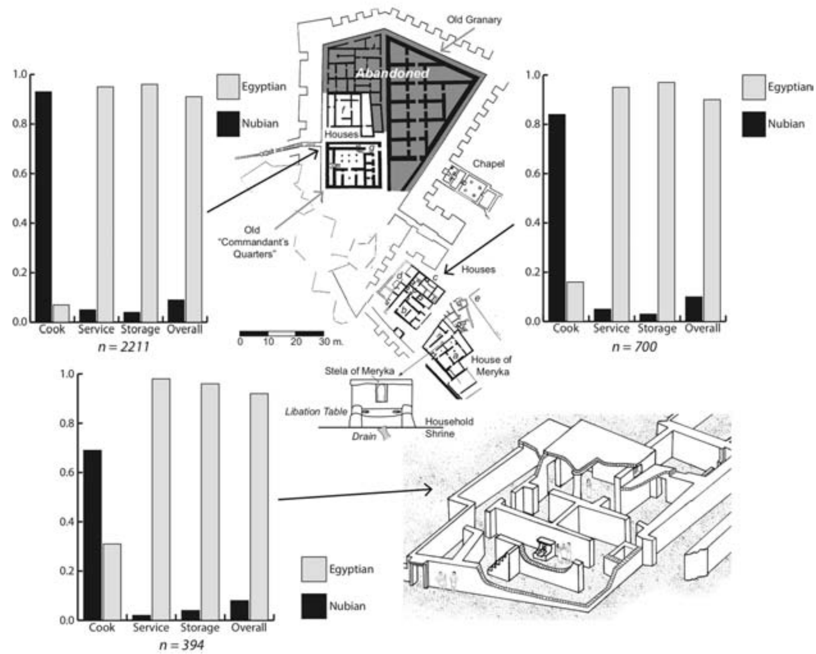

Figure 5. Proportions of Egyptian and Nubian vessels by area during the New Kingdom at Askut. Three zones are represented: the remaining area of the Main Fort still occupied; a group of houses in the northern Southeastern Sector; and the large mansion of Meryka to the south.

tiated during the Middle Kingdom, persist through the Second Intermediate Period and into the New Kingdom Period, despite Egyptian recolonization. The archaeological data suggest there were strong ties between the C-Group Nubians, Egyptian expatriates, and Kushite Nubians.

As the Middle Kingdom transitioned into the Second Intermediate Period, perhaps triggered by an intersection of environmental, social, and political change, the lines between C-Group, Kerma, and Egyptian groups became more blurred. We see a dramatic increase in the presence of Nubian cookpots from the Middle Kingdom (38%) to the Second Intermediate Period (61%) at Askut, suggesting that Egyptian expatriates were interacting with and living amongst C-Group and Kerma peoples. As noted above, the increase in Nubian cookpots within the fortress walls may indicate intermarriage between Egyptians and Nubians. There is also an increase in Kushite-style pottery at Askut during the Second Intermediate Period (Smith 2003b). This archaeological evidence of increasing cultural entanglement to the south is supported by hieroglyphic inscriptions from Buhen (another First-Second Cataract fortress), which formally state that the Egyptian expatriates living in and around the fortresses pledged their allegiance to the Ruler of Nubian Kush at Kerma (Säve-Söderbergh 1949). Collectively, these data suggest that C-Group Nubians may have been extending social ties not only to Egyptian expatriates (and vice versa), but also Kushite Nubians, with whom the Egyptians were also interacting (Smith 2003a, 2003b).

During the New Kingdom Period, Nubia was again conquered by Egypt; the Egyptian expatriates and C-Group Nubians of the fortresses were now under the leadership of the pharaoh. Kush was overthrown and new imperial towns were constructed throughout Upper Nubia. At Askut, there is a further increase in the frequency of Nubian cookpots (84%), which suggests continued interaction and intermarriage between Egyptians and Nubians. The increase in Nubian-style ceramics is particularly interesting when paralleled with the previous instance of colonization (Middle Kingdom), when there is a distinct separation of Egyptian and Nubian sites/artifacts. The cultural entanglement that began in the late Middle Kingdom continued into the colonial New Kingdom. At Tombos, cranial metrics and strontium isotope data indicate that both Egyptians and Nubians lived in this colonial space and likely reproduced (Buzon 2006a; Buzon et al. 2016). Further, paleopathological indicators of nutritional deficiency and infectious disease are minimal and instances of interpersonal violence are few (Buzon 2014; Buzon & Richman 2007).

Amidst this New Kingdom cultural coexistence, there are Nubians who actively maintained indigenous funerary and dietary practices, despite recolonization. In the First-Second Cataract region, C-Group burials (flexed, mudbrick superstructure) persisted into the New Kingdom (Säve-Söderbergh 1989; Säve-Söderbergh & Troy 1991). At Tombos, some individuals were buried in similar Nubian traditional burial practices (flexed, Nubian burial bed; Smith 2003b). This suggests that indigenous Nubians exercised agency in either maintaining Nubian cultural practices or adopting new Egyptian practices.

The isotope data suggest that dietary habits may have varied between the C-Group and Pharaonic samples. Individuals who were buried in the C-Group tradition had a diet that closely resembled the Kerma culture in Upper Nubia, which likely had sorghum, millet, or other C_4 plant contribution (**Table 4**). Previous isotopic investigations have suggested that Nubians may have consumed a higher proportion of C_4 plants than Egyptians (Iacumin et al. 1998; Thompson 2008). The Pharaonic sample, on the other hand, is more suggestive of an Egyptian C_3 diet (e.g., wheat, barley). Alternatively, C-Group individuals could have been consuming terrestrial mammals that were grazing on C_4 plants (Ambrose & DeNiro 1986; Fuller et al. 2012; Pechenkina et al. 2005). Regardless, there seems to be a significant difference in the foods consumed and/or grazing/herding practices between those individuals who identified as C-Group versus Egyptianized Pharaonic. Nitrogen values from the C-Group sample ($\delta^{15}N$ mean value 13.2±0.4‰), may be indicative of ungulate, caprine, or freshwater fish consumption (see **Table 5**). Faunal $\delta^{15}N$ values reported by Thompson et al. (2008) indicate that sheep and goat from contemporary Kerma fall within the suggested trophic range (3-5‰ below human values) of potential dietary resources (Bocherens & Drucker 2003). Nilotic fish may also explain C-Group δ^{15}N values; however, isotopically analyzing ancient fish bones has proven difficult due to poor preservation (Chaix 1980; Thompson et al. 2008). Nitrogen values for the Pharaonic sample (δ^{15}N mean value 11.7±0.79‰) are lower than the C-Group sample, and may also reflect the consumption of herbivores. When compared to the faunal data (**Table 5**), the Pharaonic δ^{15}N mean value is 3-5‰ higher than goat and turtle (Iacumin et al. 1998; Thompson et al. 2008) However, nitrogen values, in particular, are problematic as (1) there are gaps in local food web data (particularly fish), (2) the arid environment could be influencing results. Arid-adapted animals excrete ^{15}N-depleted urine, thereby enriching other tissues (Ambrose & DeNiro 1986). This enrichment is passed along the trophic chain when consumed (Heaton 1987; Schwarcz et al. 1999). It is also possible that manuring practices impacted δ^{15}N (Sołtysiak & Schutkowski 2018). Owing to the fact that the sample size included in this study is limited, these interpretations are tentative. We present data on a few individuals from the C-Group and Pharaonic cultures, which may indicate a cultural association with foods consumed. However, further isotopic investigations will have to be conducted in order to make more definitive conclusions.

We have demonstrated that the environmental changes that occurred during the Middle Kingdom did not significantly impact the frequency of skeletal indicators of physiological stress assessed here. These indicators are not solely a product of environment, however; social, political, and economic factors can all affect physiological stress outcomes (Armelagos 2003; Cohen & Armelagos 2013; McIntosh et al. 2000). The Second Cataract fortress context illustrates why we need to examine skeletal remains in conjunction with the archaeological record in order to thoroughly address the lived experience of ancient populations. While the frequency of skeletal indicators of physiological stress did not change with time, there are sociopolitical and socioeconomic systems that may have compensated for environmental instability. For example, the Egyptians and Nubians who were living in the fortresses may have relied on social networks and extended family ties, both local as well as farther abroad (i.e., Kush), in times of need. The ceramic data, which indicate intermarriage and coexistence within the fortress system as well as socioeconomic ties with Kush, certainly support this hypothesis. Dietary and funerary data suggest that some Nubians maintained indigenous cultural traditions despite recolonization. C-Group Nubians may have actively chosen to continue eating Nubian foods, whereas Egyptianized Nubians (Pharaonic) may have opted for a more Egyptian diet. Similarly, some Nubians, both in Upper and Lower Nubia, were buried in a traditional Nubian style and rejected Egyptian burial practices.

The data presented here are limited, however. The skeletal remains examined in this paper originate from multiple sites and differing time periods (**Figure 1**). Despite sharing a similar material and funerary culture, it is possible that people at these varying sites experienced environmental change differently. The sample sizes from each site are too small to address them independently. Further, the Pharaonic samples post-date the C-Group samples. Thus, if dietary differences exist between these populations it could be due to a shift in subsistence practices. Owing to the fact that this skeletal collection is the product of a salvage excavation, preservation of the material is less than ideal. This has resulted in a large number of individuals with indeterminate sex and age, which has restricted our ability to conduct sex/age analysis of pathological conditions. Similarly, subadult skeletons were not retained for curation in the collections. With subadult skeletons, we would be able to speak to the non-survivors of environmental change (Bennike et al. 2005; DeWitte & Stojanowski 2015; Saunders & Hoppa 1993). Lastly, we are also faced with the fact that the sites excavated by the Scandinavian Joint Expedition are now under water due to the construction of the Aswan High Dam. One direct impact is the inability to go back to these sites for further analysis; for example, a more detailed study of the local food web is impossible. Rather, we have to rely on nearby contemporary sites, such as Kerma, to infer what people in the First to Second Cataract region may have ate.

Conclusion

Our research calls into question the negative effects of environmental change, namely high Nile floods during the Middle Kingdom and the return to normal flooding during the Second Intermediate Period, by combining skeletal indicators of physiological stress with an examination of social dynamics in Nubia during this transition. What is most striking about the data presented here is the consistency of *cribra orbitalia*, porotic hyperostosis, enamel hypoplasia, and maximum femoral length through time. We suggest that contextualizing the paleopathological data with archaeological interpretations of isotopic and ceramic data allows for a more nuanced view that takes into account how the consequences of environmental stress can be mitigated. Through the diachronic examination of cooking vessels, we note that intermarriage was likely occurring between the Egyptians and Nubians in the fortresses. Further, the ceramic data support the argument that there were networked connections between Upper and Lower Nubia. These findings reflect complex social webs that could have compensated for some of the consequences of environmental and sociopolitical change. The dietary data suggest that while the Pharaonic and C-Group samples chose differing foodways associated with different social identities, which are reflected both in funerary practice as well as foods consumed, this distinction did not impact rates of physiological stress between the groups. These findings reinforce previous research that indicates Egypto-Nubian cultural entanglement and relatively peaceful coexistence during this time. Using a multidisciplinary and collaborative framework, we have broken from an environmentally deterministic assumption and conclude that the fortress populations were agents who actively chose to intermarry, interact, and maintain both cross-cutting and separate social identities in the face of environmental change (Buzon 2012; Smith 2010).

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