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Local animal economies during the nineteenth-century caravan trade along the Lower Pangani, northeastern Tanzania: a zooarchaeological perspective

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ABSTRACT

The expansion of the caravan trade in eastern Africa during the nineteenth century is considered to have had significant ecological, economic and social consequences. While available historical documentary and oral sources provide valuable evidence concerning the scale, timing and spatial extent of these, as well as information about some of the key actors and agents, there remain significant gaps that have the potential to be filled by targeted archaeological research. This paper presents one such study, which aims to establish how influential the expansion of the caravan trade was on local animal economies, with particular reference to a sample of known caravan halts on the northern route on the Pangani River, Tanzania. The results of zooarchaeological analysis of faunal assemblages recovered from four sites suggest that the impacts may have been less than has often been argued by some historians. The study also provides fresh insight on the continuing importance of wild resources, especially rodents, in local diets in the late nineteenth century and on local herd management strategies.

RÉSUMÉ

L'expansion du commerce caravanier en Afrique de l'Est au cours du dix-neuvième siècle est considérée comme ayant eu des conséquences écologiques, économiques et sociales importantes. Les sources historiques documentaires et orales disponibles fournissent des données précieuses concernant l'échelle, le moment et l'étendue spatiale de ces changements, ainsi que des informations sur certains des acteurs et agents clés. Il reste néanmoins des lacunes importantes qui peuvent être comblées par des recherches archéologiques ciblées. Cet article présente une telle étude, qui vise à établir l'influence sur les économies animales locales de l'expansion du commerce caravanier, faisant particulièrement référence à certaines étapes caravanières connues sur la route septentrionale le long du fleuve Pangani, en Tanzanie. Les résultats de l'analyse zooarchéologique des

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assemblages fauniques obtenus sur quatre sites suggèrent que les impacts ont pu être moindres que ce qui a parfois été avancé par certains historiens. L'étude fournit également un nouvel aperçu sur l'importance continue des ressources sauvages, en particulier des rongeurs, dans les régimes alimentaires locaux à la fin du dix-neuvième siècle, et sur les stratégies locales de gestion des troupeaux.

Introduction

The consequences of the expansion of the caravan trade in ivory and slaves in East Africa during the nineteenth century are widely regarded to have been considerable (Beachey 1967; Abir 1968; Rodney 1972; Sheriff 1987; Koponen 1988; Kjekshus 1996). Various legacies of these consequences have received significant scholarly attention, especially the transformations in the organisation of labour (Rempel 1998; Rockel 2006; Pallaver 2012), gender relations (Robertson 1997), production strategies (Beidelman 1982; Håkansson 2008), settlement (Kusimba 2004) and consumption patterns (Prestholdt 2004) triggered by the trade. Several studies have also been undertaken on its impacts on the region's elephant populations (Thorbahn 1979; Håkansson 2004; Coutu *et al.* 2016) and possible changes to local environments (Håkansson *et al.* 2008; Stump and Tagseth 2009). Here, we extend this discussion by examining zooarchaeological evidence from four former caravan halts to assess the effects on local animal economies. We examine the argument that local and regional food production strategies changed in response to demands from the passing caravans (Kimambo 1996), especially as the number and size of caravans increased from *c.* 1840 onward (Koponen 1988).

Thomas Håkansson (1995: 303–304), in particular, has argued that the production of surplus food was most likely generated by both agricultural intensification — including the adoption of new farming strategies notably terracing, irrigation and manuring — and the expansion of farmland often onto marginal areas with low fertility and greater vulnerability to soil erosion (Håkansson 2004: 585–586). Håkansson (2004: 577–578) has also argued, on the basis of the various references to the exchange of ivory for cattle in the available historical sources, that specialised pastoralism may have expanded as a consequence of the stimulus that the ivory trade provided to increase herd sizes. Other scholars have further suggested that agricultural intensification and/or intensification of livestock herding during the nineteenth century initiated or possibly exacerbated soil erosion in certain areas, including along sections of the central caravan route in Ugogo and around Kondoa (Christianson 1981; Sissons 1984).

While the nineteenth century was undoubtedly a period of significant change, there are several significant gaps in the written and oral historical records in terms of detail, chronological precision and the environmental and social consequences of different events (Lane 2010), and it is unlikely that the impacts were entirely uniform across the entire region (Kjekshus 1996). In an effort to provide a finer-scaled analysis and better understanding of local responses, this paper presents the results of a zooarchaeological study of the animal economies of local communities in the Lower Pangani River Basin, northeastern Tanzania, prior to and during the expansion of the caravan trade in the second half of the nineteenth century. Faunal remains retrieved from four

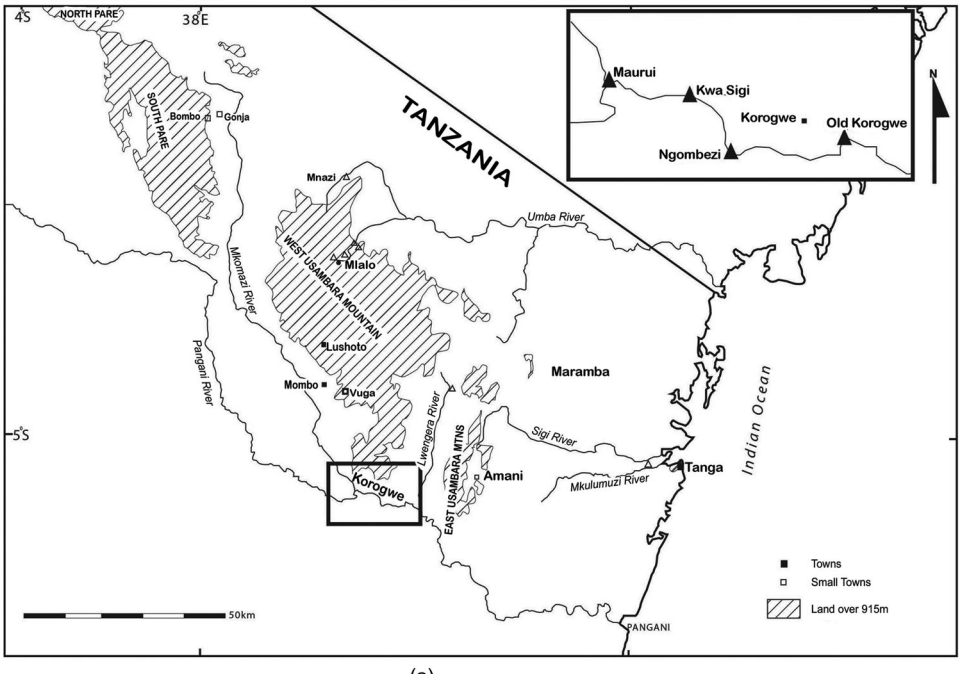
settlements known from written accounts and early cartographic sources to have served as regular caravan halts were analysed to determine possible changes in the exploitation patterns of domestic and wild animals as the caravan trade expanded and whether any of those changes that could be discerned might indicate efforts to increase meat production. The following four sections describe the geographical and historical contexts of the sites, the excavation methods used and the approaches adopted for the analysis of the faunal remains recovered. The results of these analyses are then discussed with reference to various hypotheses concerning the impacts of the caravan trade on local livelihood strategies. The paper concludes by placing these results in a wider regional setting with some recommendations for further research.

Geographical and historical context

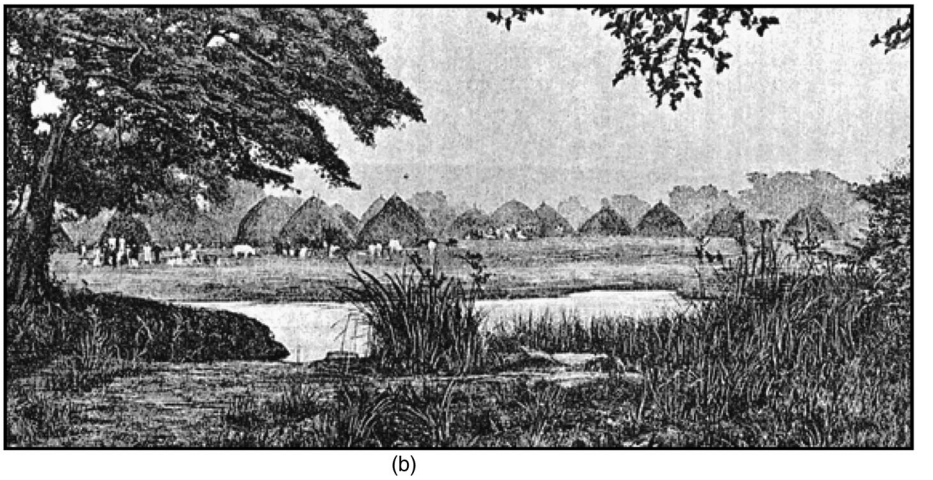
The four sites studied were Ngombezi (05°10'01"S, 38°25'01"E), Maurui (05°08'095"S, 38°23'23"E), Old Korogwe (05°09'25"S, 38°28'38"E) and Kwa Sigi (05°08'08"S, 38°23'58"E). These are all abandoned riparian settlements located along the Pangani River in the current administrative boundaries of Korogwe District, some 110–118 km inland from the Indian Ocean (Figure 1a). The area in which the sites are located lies within the Lower Pangani River Basin (hereafter LPRB), covering the low-lying plain of the Pangani Basin. The LPRB stretches along the western and southern foothills of the West Usambara Mountains and drops gently southeastward towards the Indian Ocean (IUCN 2003). Currently, the semi-arid lowland areas receive between 300 and 800 mm *per annum*, while the high altitude and windward portions of the adjacent Usambara Mountains can receive between 2500 and 3000 mm (IUCN 2003; Kiptala *et al.* 2013). The lowland parts of the LPRB experience warm temperatures throughout the year, reaching 38°C during the dry season (URT 2008).

The climate of the LPRB during the nineteenth century is unlikely to have been substantially different from that of today, although palaeoecological research has identified several periods of significantly reduced rainfall leading to extended periods of drought across eastern Africa during the eighteenth and nineteenth centuries (Bessems *et al.* 2008) that may have impacted communities within the LPRB. Under such conditions, settlements located in proximity to the Pangani River, such as those investigated for this project, may have been better placed to weather climate-induced stress, and may even have had a strategic advantage over those located farther away from permanent water sources. On the other hand, as riparian settlements, they would have been more vulnerable to the effects of extreme flooding, although at none of the excavated sites were any geological or stratigraphic markers of flood events encountered, suggesting that this was a low environmental risk during the time of their occupancy.

Historically, the LPRB has been referred to as 'Zigualand' or 'Usegua' because its main occupants were and still are the Zigua (also spelled Segua, Zegura and Zegula in early sources). The Zigua who inhabited the island settlements investigated for this study, and those currently settled along the Pangani River, called themselves '*Wazigua wa Ruvu*'[1] (the Zigua of the Ruvu River or the Pangani River), referring to their livelihood along that river (Baumann 1891). In his account of Count Teleki's expedition to Lake Turkana, which passed through the Pangani Valley in 1887, Von Höhnel noted, for example, that the 'Wasegua on the Pangani are also sometimes spoken of as the



(a)



(b)

Figure 1. a) The Pangani River Basin in its wider geographical contexts, major topographical features, study sites and other places mentioned in the text (redrawn and modified from Soper 1967: 20); b) a nineteenth-century view of the island of Old Korogwe (after Hans Meyer cited in Bauman 1890).

Waruvu, or dwellers on the river' and that 'most of their villages are on islands', among them the large village of Kwa Mgumi (Von Höhnel 1894: 61). This contrasts with Zigua living inland away from the Pangani River, including those in Handeni District.

The Austrian explorer-geographer Oscar Baumann, who also visited the area in the late nineteenth century, recorded some key features of late nineteenth-century Zigua villages. The island villages on the Pangani River were of considerable size, with ten to 200 'huts' (Figure 1b) and were 'linked with the outside world by a footbridge known as

uraro' (Baumann 1891: 176). Away from the river, most villages were fortified by a palisade or a thick euphorbia hedge. In 1857, for example, the explorers Richard Burton and James Speke stopped at Korogwe, or Kohode as they named it, describing the settlement as a 'normal cultivator's village' … 'surrounded and concealed by a stout palisade of tree-trunks … with low arches formed by inclining the beams'. Inside the palisade were a cluster of 'little, thatched, wattle-and-daub-huts', some round, some square, scattered over 'some hundred yards', with goats, sheep and cattle all stalled nearby (Burton and Speke 1858: 210). Their accounts and those of other European explorers also suggest that fortification became increasingly common during the second half of the nineteenth century when there was an upsurge in inter- and intra-community raiding and heightened competition partly associated with an increased demand for slaves (Lane 2011: 289–301).

Diverse historical sources indicate that the nineteenth-century Zigua subsisted by cultivating crops, animal husbandry, hunting and fishing, augmenting their livelihoods through trade with neighbouring communities, coastal towns such as Pangani and passing caravans (Krapf 1968 [1860]; Farler 1882). They farmed mainly along the banks of the Pangani River and in the valleys (Krapf 1968 [1860]). Maize and sorghum were being cultivated at the time of Baumann's visit, with beans, cassava, sesame, rice and sweet potatoes among the other crops mentioned by different European observers. Fishing and livestock-keeping were also subsistence mainstays (Burton 1872). Baumann (1891) notes that mammalian livestock were taken daily across the Pangani River to graze outside the islands and returned home in the evening, noting that a mix of long-horn and short-horn breeds were kept, as well as fairly large herds of goats but only the occasional sheep.

The accounts by nineteenth-century explorers and missionaries and their accompanying maps (e.g. Burton and Speke 1858; Johnston 1879; Baumann 1891) indicate that the island settlements served as regular halts during the nineteenth century, provisioning passing caravans and providing security in exchange for imported commodities. Some of these, notably cotton cloth, beads and brass wire, were valued as currency (Burton and Speke 1858: 218; Farler 1882: 741). Customarily, as the caravans approached the villages, the caravan traders fired guns to announce their arrival and within a short time the villagers would bring foodstuff and other local products to barter (Burton and Speke 1858; Farler 1882).

Regional, systematic archaeological surveys and targeted excavation have documented multiple sites in the LPRB, some dating to *c.* AD 900–1200 (Walz 2010). The evidence points to the existence of flourishing trade connections between the coast and the interior well before the nineteenth century, as evidenced by the presence of Indo-Pacific glass beads and bivalve marine shells on several sites along the Mkomazi Valley, some 110 km north of Korogwe. As Walz (2010) has argued, the nineteenth-century caravan routes clearly emerged from pre-existing regional trading networks, although the routes may not have been identical. A case in point is the settlement evidence from the four sites that are the subject of this study, which were established between the thirteenth (Maurui) and seventeenth (Ngombezi) centuries AD and were occupied up to the mid-twentieth century when they were abandoned (Biginagwa and Ichumbaki 2018). This contradicts some claims in the historical sources (Erhardt 1853: 30; New 1874: 318; Johnston 1879) that the islands were only first settled during the nineteenth

century to serve as places of refuge for Zigua from Maa-speaking cattle raiders. However, despite their earlier establishment, the stratigraphic distribution of local shell beads and imported glass beads at these sites (Figure 2), particularly the general lack of Indo-Pacific glass beads in the lower excavation levels (Biginagwa 2012), suggests that these sites may have been less connected with the coast than those in the Mkomazi Valley investigated by Walz (2010).

Moreover, when considered along with radiocarbon dates for Ngombezi and Maurui, which have the longest stratigraphic sequences, the change in the stratigraphic distribution of different bead types and the abrupt appearance of European glass bead types provide an effective means of differentiating archaeological deposits formed prior to the caravan trade from those associated with the caravan trade. Thus, a comparison of the faunal remains recovered from the layers associated with both phases should, in principle, provide a means of testing the hypothesis that expansion of the caravan trade triggered a transformation of local animal economies as inhabitants of these settlements sought to intensify meat production for exchange with the passing caravans.

Excavation strategy

Fieldwork took place between 2008 and 2013. All excavations targeted cultural mounds, except at Kwa Sigi, which lacks such features. Deposits were excavated by hand using trowels, according to context subdivided into arbitrary 10-cm-thick spits to monitor variation in finds density with depth. All deposits were dry sieved, predominantly through a 5-mm-wide wire mesh, although a 2.5 mm mesh was used when the deposits were particularly fine to capture smaller finds.

At Ngombezi (the main study site), a 14 × 2 m trench was dug sectioning one of the largest mounds at the site (Figure 3a), reaching a depth of 3.5 m at the highest point of the mound before the natural horizon was reached, and 2.1 m at the edge of the

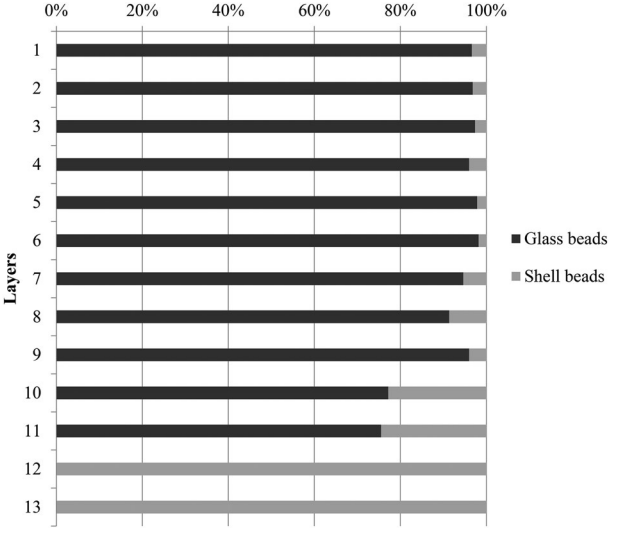


Figure 2. Ngombezi; stratigraphic distribution of glass and non-glass beads.

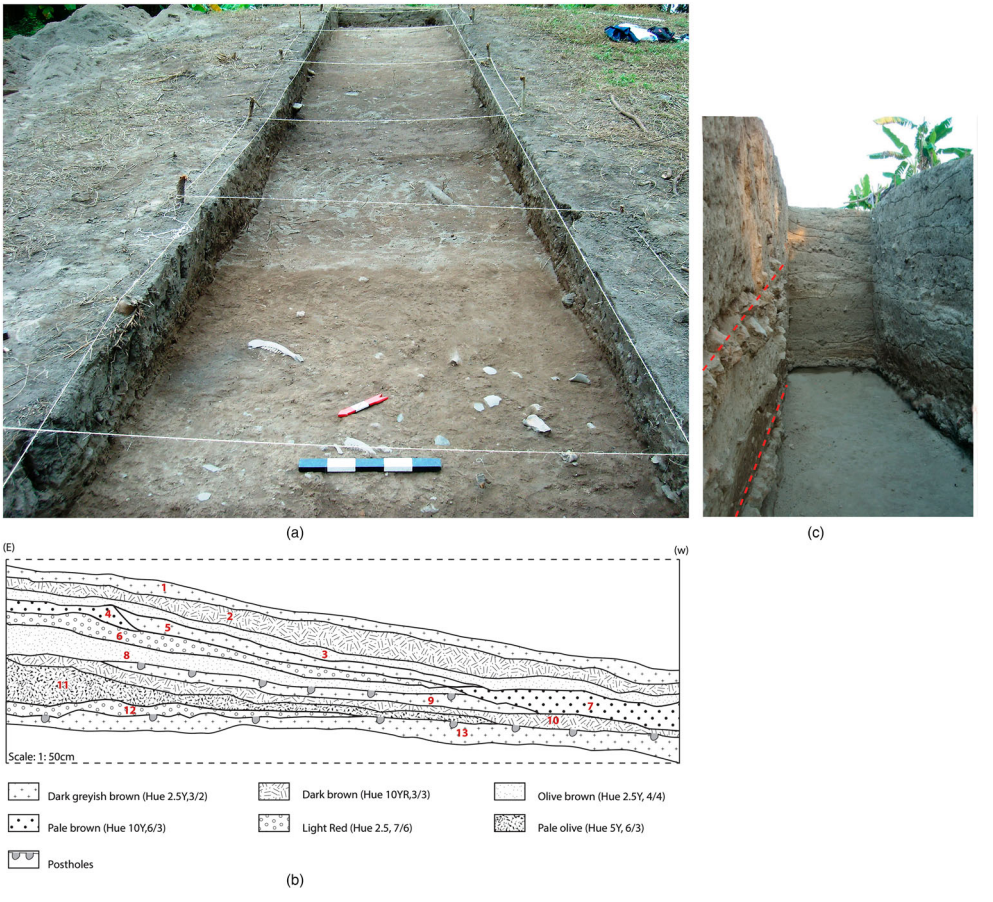


Figure 3. Ngombezi: a) a 2 x 14 m trench in an early stage of excavation (Biginagwa 2008); b) composite section of the south-facing wall of the excavation trench; c) dense layers of house daub (below dotted red lines) projecting from the walls of the excavation trench indicative of settlement phases (photographs: Thomas Biginagwa, 2009).

mound. Thirteen layers were revealed (Figure 3b), representing two distinct phases of settlement activity indicated by a sequence of wattle-and-daub houses built in the initial occupation phase that were subsequently demolished and a further phase of house construction (Figure 3c). A charcoal sample (Wk-25718) from the base of the anthropogenic deposits at 3.30 m below mound surface provided a radiocarbon date of 238 ± 30 BP (1641–1810 cal. AD, using the SHCal20 curve), suggesting that the earliest structures on this island date to between the mid-seventeenth and eighteenth centuries.

At Maurui, a 2 × 2 m trench was dug at the centre of a prominent cultural mound to a depth of 5.0 m below ground level. Ten distinct layers of deposits were observed. Although no structural remains were exposed, the large quantity of daub recovered indicates the presence of built structures on the island. A charcoal sample (Poz-59494) from the base of the anthropogenic deposits (500 cm) yielded a radiocarbon date of 630 ± 30 BP (1304–1416 cal. AD, using the SHCal20 curve), suggesting initial occupation as early as the fourteenth century. At Old Korogwe, a 2 × 2 m trench was excavated near the

centre of the main mound, reaching a depth of 3.6 m below ground level. Four distinct layers were exposed. No structural remains were observed, but, as at Maurui, the recovery of a limited amount of daub suggests the presence of structures nearby. At Kwa Sigi, eleven 1 × 1 m test pits were dug across the island to sterile deposits at depths of 10–150 cm below ground surface; no traces of structural remains were encountered and the shallowness of the deposits suggests that the site was occupied for a relatively short period; documentary evidence indicates that it was eventually destroyed by a fire in November 1891 (Kisbey 1898; Biginagwa and Ichumbaki 2018: 74).

Faunal analysis

All faunal remains were fully analysed, except those recovered from Maurui, where 25 bags containing 9779 faunal specimens (44% of the total recovered) were sampled across the stratigraphy for analysis. Faunal remains were analysed by TB using reference collections at the Department of Archaeology, University of York (United Kingdom) and the School of Veterinary Science, Sokoine University (Tanzania) under the guidance of Professor Terry O'Connor, and with reference to published identification guides to regional mammalian fauna (Walker 1985) and fish species (Fischer and Bianchi 1984).

In the absence of appropriate reference collections of freshwater fish from the Pangani River, knowledgeable local fishermen, who had lived in the study area for many years, prepared fresh reference materials of different fish taxa to aid and confirm the identification of the archaeological specimens. Once the archaeological fish fauna and reference materials were matched, Swahili and English names were given to the identified fish taxa and checked against a series of published guides (Bailey *et al.* 1978; Skelton, 1994; IUCN 2003; Seegers 2008), as well as a standard internet source (http://fish.mongabay.com/data/Tanzania.htm). Estimating the size of each taxon across the layers would have informed this study of possible diachronic change in mean body size, as it could reflect the age of the fish, environmental changes or human choice (Prendergast and Lane 2010). However, this did not take place because only the large and most durable elements of different taxa survived archaeologically and reconstructions of any trends in changes to body size would thus likely have been biased towards larger taxa.

Taphonomic aspects of the terrestrial fauna were recorded for all of the assemblages, following the six sub-aerial bone-weathering stages proposed by Behrensmeyer (1978). In Stages 0–5, the bones show progressively greater damage. In Stage 6, the bones may not have survived in the archaeological record. Generally, a large proportion of the studied faunal material was in a good state of preservation (i.e. Stages 1 and 2), meaning that other bone surface markers could be examined straightforwardly with the use of a normal hand lens.

The relative taxonomic abundance in the assemblages was derived from the Number of Identifiable Specimens (NISP). This method was chosen over others due to the high level of bone fragmentation in all the samples. The abundance values were thus obtained simply by counting all the identifiable cranial and postcranial material that could definitely be assigned to a particular taxonomic category. To estimate the age of caprines, the method used by Fiona Marshall (1990), who has worked extensively on domestic fauna in East Africa, was followed. However, due to the small sample of caprine dental material, it seemed prudent to limit the number of age classes to five instead of seven

Table 1. Caprine age classes based on dental evidence (adopted and slightly modified from Marshall 1990).

Code	Age group	Descriptors	Approximate age in months
1	Neonate	Not erupted/ unworn deciduous dentition	< 1
2	Young juvenile	DP4 in wear, M1 not erupted	~ 6
3	Old juvenile	M1 in wear, M2 not erupted	=/> 12
4	Adult	M2 in wear, M3 not erupted	=/> 27
5	Aged	Permanent dentition in full wear, M3 fully worn	Over 27

(Table 1). Consequently, this analysis did not separate the age classes of 'young adult' and 'adult' or those of 'aged' and 'very old'. The age of cattle was estimated by examining long bone epiphyses, following the procedure described by Silver (1969; see Table 2).

To determine the possible impact of the expansion of the caravan trade on animal production and exploitation patterns, we first sought to establish whether the occupants of the sites were predominantly hunters or stock-keepers. The approach used by Gifford *et al.* (1980) and Prendergast and Mutundu (2009) in their investigations into much earlier transitions from hunting to herding in eastern Africa was applied. This considers the ratio of domestic stock to wild taxa in faunal assemblages to be a direct measure of the importance of animal husbandry to hunting. A smaller proportion of domestic species compared to wild taxa signifies that communities subsisted predominantly by hunting, while a greater proportion of domestic species signifies a pastoral or agropastoral economy. The dominance of sheep/goats (henceforth 'caprines') in faunal assemblages is further considered to signify a herding economy because it is easier to start a herd with caprines as they require less direct tending than cattle (Mutundu 1999).

Estimations of the age at which domestic stock died were used to infer whether herds were managed in such a way as to produce a surplus that could be traded with the passing caravans. Reid (1996) notes that if the principal concern of herd management is that it should grow then individual animals are allowed to live until the end of their reproductive life. However, most bulls will tend to be slaughtered to reduce competition for food, thereby lessening the stress on cows and their offspring. Faunal assemblages suggestive of this strategy are dominated by the remains of older animals, as indicated by patterns of tooth wear and the fusion of long bone epiphyses. If herds are managed to produce meat, most animals are slaughtered during their prime meat-bearing age — around 12 months in the case of caprines, and 48 months for cattle (Dahl and Hjort 1976: 167). Assemblages revealing this strategy typically have a range of animal age classes indicated by the presence of fused and unfused long bones, as well as teeth at various stages of wear.

Reid (1996) provides three conditions that determine the stages at which bulls are eliminated from cattle herds. First, is the importance of meat in the diet of herders. If the herd is managed primarily to produce meat, most bulls will be allowed to approach their full meat-bearing potential before they are slaughtered, hence a 'late off-take'.

Table 2. Estimated time for cattle long bone epiphyseal closure (after Silver 1969).

Fusing time category	Estimated time	Element involved
Early fusing time	<18 months	Distal humerus; proximal radius
Medium fusing time	2–3 years	Distal tibia; distal metapodials
Late fusing time	3.5 years and above	Proximal humerus; proximal tibia; distal radius; proximal and distal femora

Second, is the ability of the cattle-keeping settlement to consume or advantageously trade meat resources. In such a scenario, there is no need to let an animal grow fully if the settlement is small and cannot utilise all the meat. Third, are the ecological circumstances of a particular place or time. Good access to food and water reduces the need for selective culling, for example. Other socio-economic, cultural and environmental factors can further influence slaughter patterns (Dahl and Hjort 1976; Quinlan *et al.* 2016).

Results

Table 3 and Figure 4 present the general composition of the analysed faunal material, showing that just over half were minimally identifiable (identifiable to skeletal element but not to exact taxonomic unit). These materials were recorded under approximate mammal size classes, one to four, in accordance with Brain (1981) and Bunn and Kroll (1986). Table 3 shows the dominance of medium-sized animals (MM3: approximate body weight 20–80 kg, for example sheep/goats and warthogs). Large animals followed (MM4: approximate body weight 80 kg and above, for example cattle and Cape buffalo). The least represented group was of small animals (MM1 and 2: less than 20 kg, such as rodents and suni/dikdik). However, it should be noted that most of the

Table 3. General composition of the analysed faunal assemblages from all study sites.

Categories	Sub-categories	Ngombezi	%	Old Korogwe	%	Kwa Sigi	%	Maurui	%	TOTAL	%
Maximally	Terrestrial	5075	24.68	859	19.9	192	13.83	2660	27.2	8786	36
Identifiable	Fish	1776	8.63	1290	29.88	475	34.22	743	7.59	4284	
SUB-TOTAL										13,070	
Minimally	MM1	657	3.19	33	0.76	13	0.93	586	5.99	1289	51
Identifiable	MM2	995	4.83	195	4.51	7	0.5	880	8.99	2077	
	MM3	5912	28.75	1270	29.42	297	21.39	2152	22	9631	
	MM4	3325	16.16	347	8.03	325	23.41	1301	13.3	5298	
SUB-TOTAL										18,295	
Non-Identifiable		2823	13.72	322	7.46	79	5.69	1457	14.89	4681	13
TOTAL		**20,563**	**100**	**4,316**	**100**	**1388**	**100**	**9779**	**100**	**36,046**	**100**

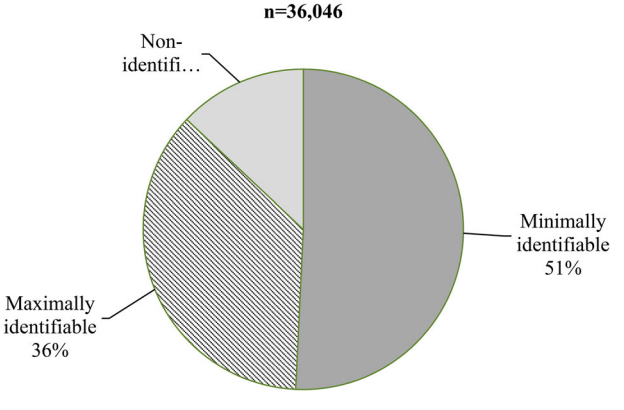


Figure 4. General composition of the analysed faunal materials from all the sites studied.

bones of smaller mammals were less fragmented and so more easily identifiable to specific taxa (Table 3).

The condition of the preserved bones was excellent, with most cortical surfaces intact and visible. This enabled 36.2% of the material to be identified to specific taxa. The good preservation was attributable to the presence of ash dominating the main deposits of the excavated mounds, which may have buffered and preserved the chemistry of the buried bones. The bone surface markers recorded were cuts, burning, and tooth pitting. The proportion of bones with cuts ranged between 5 and 7% across the sites. The incidence of cuts was much higher on skeletal elements of medium-sized (e.g. caprines and gazelle) and large animals (e.g. cattle and hartebeest) than on smaller ones. Most of the specimens that had cuts were flat and long bones, as well as vertebrae pieces. A wild cat (*Felis silvestris*) pelvis from Ngombezi had a cut mark, perhaps indicating it had been skinned for its pelt.

Burn marks occurred on less than 10% of all faunal specimens analysed. They occurred mostly on the long bones, ribs, and phalanges of medium-sized animals. Interestingly, over half of the elephant shrew material had burn marks. Most of these were on mandibles and examples of the tibia and fibula uniquely fused together. Such small mammals were likely roasted whole without being butchered, which probably accounts for the frequency of burn marks associated with this species

Tooth marks were rare, less than one percent. They occurred on various bone elements of small, medium-sized, and large animals. A juvenile elephant (*Loxodonta africana*) tibia from Ngombezi had tooth marks, possibly made by a carnivore.

Table 4 and Figure 5 present the distribution of the maximally identifiable faunal specimens (NISP), up to skeletal elements and specific taxonomic units across the studied sites. From the findings, it can be concluded that the inhabitants of the studied settlements practised similar animal economies, consuming both domestic and wild animals, as well as fish. This further suggests that the environments in which exploitation occurred were similar. The following sections offer interpretations of the domestic and non-domestic components.

Interpretation of the faunal assemblages

Animal husbandry

The inhabitants of Ngombezi, Maurui, Old Korogwe and Kwa Sigi kept domesticated chicken (*Gallus gallus*), sheep/goats (*Ovis aries*/*Capra hircus*) and cattle (*Bos taurus*). Table 4 indicates the overall dominance of chickens, especially at Ngombezi and Maurui, where the largest quantity of faunal remains was retrieved. Caprines followed closely, as they were abundant at all the sites, followed by cattle. This consumption pattern reflects that of African agropastoralists where smaller animals are more frequently consumed than larger ones (Herrero *et al.* 2013).

The faunal remains of domesticated animals occurred consistently across the stratigraphy in all the excavated trenches (Figure 6a–c). The only difference was the variation in abundance in the archaeological layers. At Ngombezi, all species were under-represented in Layers 4, 5, 9 and 12, which contained lumps of house daub and pottery but very few faunal remains. At Old Korogwe, there was little evidence of chickens

Table 4. Taxonomic representation by NISP for all the sites studied.

Category	Scientific name	Common name	Ngombezi	Maurui	Old Korogwe	Kwa Sigi	Total	Preferred habitats (after Kingdon 1988)
Domestic	*Ovis aries/Capra hircus*	Sheep/goat (caprine)	1,317	646	100	23	2,086	All human habitats
	Bos taurus	Cattle	548	371	39	17	975	
	Gallus gallus	Chicken	1,531	718	74	19	2,342	
Mammal	*Rattus rattus*	Black rat	6	3	7	1	17	Around human settlements
	Thryonomys swinderianus *Thryonomys gregorianus*	Cane rat	723	265	157	44	1,189	Reed beds and grass areas along rivers and lakes
	Cricetomys gambianus	Giant pouched rat	123	142	6	9	280	Almost all habitats
	?	Unidentified rodent	62	96	388	44	590	?
	Petrodromus tetradactylus *Elephantulus* sp.	Elephant shrew	198	139	22	10	369	Riverine strips/forested river banks
	Dendrohyrax arboreus	Tree hyrax	15	7	1	2	25	Gallery forest, riverine strips
	Sylvicapra grimmia	Bush/common duiker	157	28	24	12	221	Savanna and woodlands
	Neotragus moschatus/ Madoqua guentheri	Suni/Dikdik	11	32	2	2	47	Forests/thickets/ arid adapted
	Aepyceros melampus	Impala	56	36	8	2	102	Deciduous woods, bushlands, 'edge' habitats
	Gazella granti	Grant's gazelle	30	12	3	0	45	Mixed shrub woodlands and savanna plains
	Redunca redunca	Bohor reedbuck		9	7	0	16	Water dependent; flood plains, reed beds
	Potamochoerus porcus	Bushpig	32	6	13	2	53	Forests, riverine habitats with thick cover, reed beds, marshes, mangrove swamp
	Orycteropus afer	Aardvark	7	12	0	0	19	Dependent on abundance of termites
	Alcelaphus buselaphus	Red hartebeest	19	8	1	0	28	Savanna, grassland, woodland
	Hippotragus equinus	Roan antelope		0	1	0	1	Savanna woodland, mixed bush and grasslands
	Syncerus caffer	Cape Buffalo	3	0	0	3	6	Forest, grassy glades
	Loxodanta africana	Elephant	1	0	0	0	1	Lowland forests
	Equus quagga	Common zebra	5	6	0	0	11	Wooded grassland
	Hippopotamus amphibius	Hippopotamus		16	0	0	16	Rivers
	Helogale parvula (dwarf mongoose) *Galerella sanguineus* (slender mongoose)	Mongoose	19	9	2	1	31	Wooded to forest areas/ common where there is an abundance of aardvark and pangolin burrows
	Civettictis civetta	African civet	11	2			13	Wherever there is cover
	Felis silvestris	Wildcat	8				8	?
	Canis familiaris	Dog	1				1	Human settlement

	?	Unidentified carnivore	13	6	3		22	?
	Papio sp.	Baboon	2				2	Woodlands, forests
	Cercopithecus aethiops	Vervet monkey	12	4	-	-	16	Woodland along streams, rivers and lakes
Bird	Aves	Bird	163	87		1	251	?
Reptile	*Varanus niloticus*	Nile monitor lizard	1				1	Permanent river banks and dams
	Stigmochelys pardalis	Leopard tortoise	1		1		2	Coastal plain, bushveld
Fish	*Synodontis* sp.	Catfish [Ngogogo]	298	75	105	39	517	Freshwater
	Clarias sp.	Catfish [Kambale]	234	97	88	46	465	Freshwater
	Oreochromis sp.	Tilapia [Perege]	78	39	10	16	143	Freshwater
	Barbus sp.	Barbels [Kuyu]	43	53	25	9	130	Freshwater
	Anguilla sp.	Eels [Ningu]	12	34	7	-	53	Freshwater
	Taxonomically unidentified		1111	445	1055	365	2976	Freshwater
	TOTAL		**6851**	**3403**	**2149**	**667**	**13,070**	

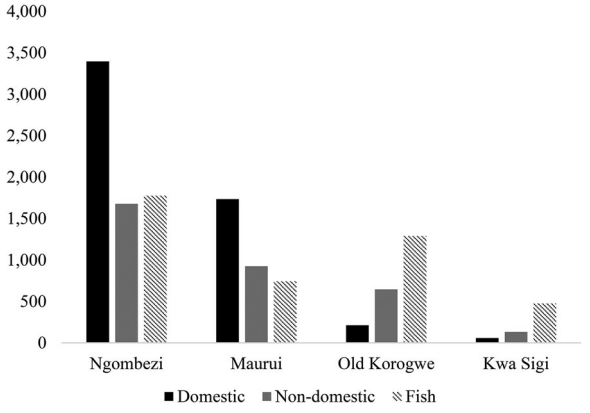


Figure 5. Distribution of the maximally identifiable faunal materials between study sites.

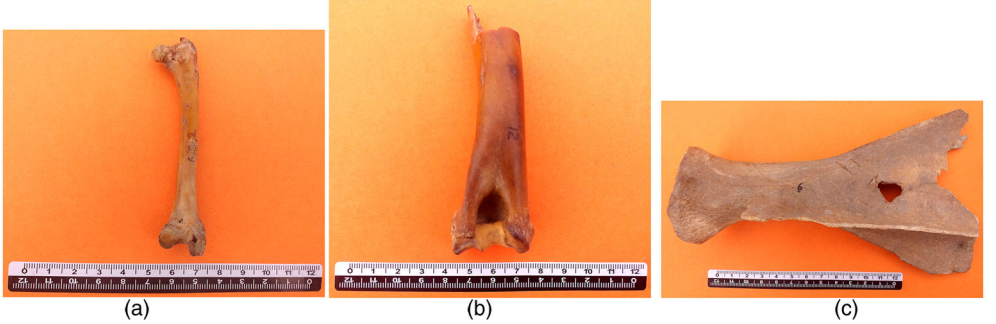


Figure 6. Examples of domesticated animal species recovered in excavation: a) chicken femur; b) caprine humerus; c) cattle scapula.

Layer 1. Only one specimen was recovered from this layer, while cattle and caprines were both present. All domestic stock taxa and a diverse range of non-domestic species were present at both Ngombezi and Maurui in each of the successive pre-caravan, caravan and post-caravan trade phases of settlement. The two settlements also revealed the longest dated archaeological sequences and both yielded a significant quantity of faunal remains.

The representation of body parts and skeletal elements of caprines and cattle is congruent with nineteenth-century eyewitness accounts (Burton and Speke 1858: 199; Johnston 1879: 546), which record that these were herded in the study area (and not acquired from neighbouring pastoralists). This is attested by the presence of both high utility parts (such as scapulae and upper limbs) and low utility ones (such as lower limbs and metapodials) in the analysed assemblages. Skeletal elements of cattle and caprines from all sites occurred in a ratio of 1:2 on average. This suggests that the preservation and recovery of bones was not biased against smaller bones, as might have been expected if they had been subject to different preservation and/or recovery factors.

Mortality profiles

The dental and long bone evidence revealed the age to which caprines and cattle lived before being culled. The examined dental evidence (teeth eruption and stages of wear) revealed the dominance of adult and aged caprines at Ngombezi, together constituting 61.5% (Table 5; Figure 7a). Young and old juveniles constituted 38.4%. No neonates were found. Examination of long bone epiphyseal fusion revealed a close match with the dental evidence, indicating that most caprines at Ngombezi had already reached 24 months and above before they were slaughtered. There was a similar pattern at Maurui, where 82% (n = 27) of the examined jaws revealed that caprines were at least 24 months old before being slaughtered. For cattle, the examined long bone epiphyses showed that over 50% of them lived up to three years or more before being slaughtered (Table 6; Figure 7b). In addition, all five cattle jaws recovered from Maurui showed that the cattle were seven years or older, which is an advanced age for this species (Meado and White 1979; Marshall 1990; Ryan *et al.* 2000).

An important observation needs to be made with regard to Figure 7b, which shows the trend in the ratio of the fused to unfused long bones of cattle, increasing from younger to older cohorts. In principle, the trend should have been in the opposite direction. Since the bones of cattle aged 1–2 years are under-represented in the assemblages, this suggests that cattle of this age group were killed farther away from the settlements. This interpretation corroborates the eyewitness accounts of nineteenth-century travellers (Burton and Speke 1858; Johnston 1879), who observed that livestock from the Ruvu/Pangani Valley were sent to market for sale in the coastal towns of Tanga, Pangani and Saadani; these individuals are likely to have been younger animals.

Generally, the mortality profiles of the domestic animals imply that herds were managed for growth and continuity rather than for the consumption of meat. The culling practices that were uncovered suggest that there was little need to consume domestic stock, something that would have led to the slaughter of young animals. This, in turn, implies that live animals, in particular cattle, had other socio-economic values to the inhabitants of these settlements such as for blood, milk, dung, traction power and symbolic value, rather than for meat. These issues are explored in detail in subsequent sections.

Table 5. Ngombezi: scores for caprine ages using dental evidence.

	AGE GROUP					
LAYERS	Neonate	Young juvenile	Old juvenile	Adult	Aged	Total
1			1	1		**2**
2			1			**1**
3		3	2	2	6	**13**
4		1				**1**
5		2				**2**
6		1	3	3	3	**10**
7				4	1	**5**
8			1	2	2	**5**
TOTAL	**0**	**7**	**8**	**12**	**12**	**39**
%	**0**	**17.94**	**20.51**	**30.76**	**30.76**	**100**

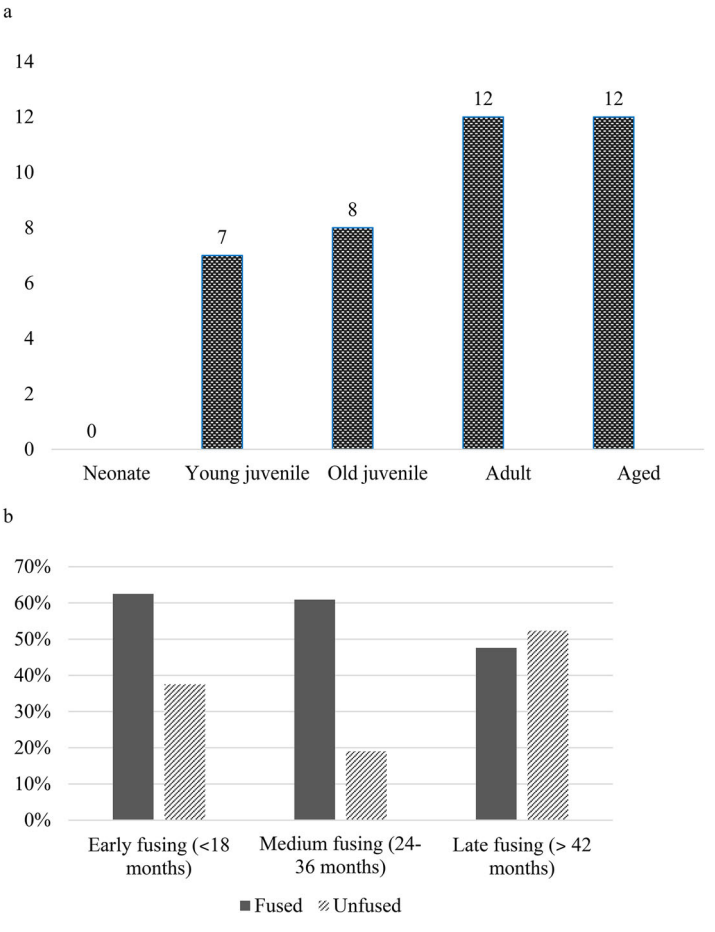


Figure 7. Ngombezi: mortality profiles of domestic stock: a) caprine age profile reconstructed using dental evidence; b) cattle age profile reconstructed using long bone evidence.

Table 6. Ngombezi: scores for cattle ages using long bone epiphyses.

Fusion Phase	Total elements	Total fused	Total unfused
Early (<18 months)	24	15 (62.5%)	9 (37.5%)
Middle (24–36 months)	63	51 (80.9%)	12 (19%)
Late (≥42 months)	86	41 (47.6%)	45 (52.3%)

Hunting

The composition of wild animal species in the faunal assemblages at all four sites is similar (Table 4), suggesting that their inhabitants exploited wild animals in similar ways. This is unsurprising given the location of these islands and their proximity to each other.



Figure 8. Examples of non-domesticated animal species recovered in excavation: a) cane rat mandible; b) giant pouched rat mandible; c) elephant shrew mandible; d) metapodials of antelope species of various sizes (photographs: Thomas Biginagwa, 2011).

Small mammals

Rodents, elephant shrews and hyraxes together formed 73% of the wild mammalian component. Of these, rodents formed the majority of the wild mammalian species consumed (Table 4). The implication of the consumption of small mammals is explored below.

Three rodent taxa were identified: *Thryonomys sp.* (cane rat), *Cricetomys gambianus* (giant pouched rat) and *Rattus rattus* (black rat). Cane rats were the most abundant, constituting 57.2% of rodent material (Figure 8a). Two species of cane rat were identified on the basis of mandible size and mandibular dentition: *Thryonomys swinderianus* (the larger species) and *Thryonomys gregorianus* (the smaller species). The second largest rodent group was the giant pouched rat, which comprised 13.4% of all the rodent material. The giant pouched rat was represented by one species, *Cricetomys gambianus* (Figure 8b). The least represented rodent was the black rat (*Rattus rattus*), at less than 1% of the total amount of rodent material; it is unlikely to have been a food species.

The cane rat and giant pouched rat were consistently distributed across the stratigraphy at Ngombezi, Old Korogwe and Maurui. Black rats appear only in the middle levels and higher up. This suggests that they are a later introduction to the settlements. Prendergast *et al.* (2017) report that *Rattus rattus* arrived in Unguja Ukuu, Zanzibar,

from Southeast Asia between the seventh and eighth centuries AD. The appearance of *Rattus rattus* around the point at which imported European glass beads appear in the sites suggests that their introduction may have been associated with the expansion of trade contacts between coastal and interior communities.

Elephant shrews constituted the second largest group (15%) of small-bodied wild animals consumed at the settlements (Table 4). They were identified through well-preserved dental material and uniquely fused tibiae/fibulae. Two species were identified based on the size of their premolars and canine alveoli (Figure 8c). The smaller taxon (the majority in the assemblages at all the sites) matched well to the four-toed elephant shrew *Petrodromus tetradactylus*. The less abundant species belonged to the larger taxon *Elephantulus* sp. At Ngombezi, elephant shrew remains were recovered from all but Layer 13, while at Old Korogwe and Maurui they were present in all the archaeological layers, although with a slight variation in quantity across them. As discussed below, the environmental conditions of the studied sites and the ecological niches preferred by *Petrodromus tetradactylus* and *Elephantulus* sp. suggest that both were likely procured near the settlements.

Wild ungulates and other larger mammals

Various species of ungulates were represented by 565 skeletal elements (Figure 8d). Nearly half the material (n = 268; 47.4%) belonged to common duiker (*Sylvicapra grimmia*), suni (*Neotragus moschatus*) and dikdik (*Madoqua guentheri*). As listed in Table 4, various medium-sized animal species (n = 235; 41.5%) were also accessible to the inhabitants of the settlements. These comprised impala (*Aepyceros melampus*), Grant's gazelle (*Gazella granti*), bohor reedbuck (*Redunca redunca*), bushpig (*Potamochoerus porcus*) and aardvark (*Orycteropus afer*). Furthermore, a few large ungulate species were also intermittently accessible (Table 4). It is worth noting that all 16 hippopotamus (*Hippopotamus amphibius*) bones were recovered from Maurui. There is a pool at the northern end of Maurui Island formed by swirling water, which today hosts a thriving hippopotamus population and may well have been where the occupants of Mauri hunted these animals in the past.

The stratigraphic distribution of the fauna shows that ungulates of all sizes were almost completely missing in the two uppermost (post-caravan trade) layers at Old Korogwe. Although present across the stratigraphy at Ngombezi and Maurui, they similarly declined in the uppermost two layers at both sites. Such a general decline can be explained by the expansion of human settlements and the associated clearance of forest in areas around the study sites. This inference is supported by the increased presence of rodents in the uppermost layers at both sites. Studies show that the abundance of rodents is accentuated in areas where humans have cleared land to cultivate crops (Ashton 2000; Shenkut *et al.* 2006).

Other terrestrial fauna

The material of most of these was recovered from Ngombezi and Maurui (Table 4), constituting avian fauna (n = 251), various carnivores (n = 75) such as dwarf mongoose (*Helogale parvula*), slender mongoose (*Galerella sanguineus*), African civet (*Civettictis civetta*), wildcat (*Felis silvestris*) and domestic dog (*Canis familiaris*). Non-human primates were also present in the assemblages (n = 18), namely vervet monkey (*Cercopithecus aethiops*)



Figure 9. Examples of fish faunal specimens recovered in excavation (photographs: Thomas Biginagwa, 2011).

and baboon (*Papio* sp.). Monkeys and baboons are still common around the study sites. It is uncertain whether any of these were used as food, although there is some documentary evidence for the consumption of dogs in neighbouring Usambara (Krapf 1860: 225).

Fishing

Taxonomically identified fish fauna constituted 31% (n = 1308) of all the fish bones recovered from all the sites studied (Figure 9). Siluriformes dominated the assemblages, with two main families, namely Mochokidae and Clariidae (Table 7). The catfish of the genus *Synodontis* was the mochokid present in the assemblages. It was identified by its

Table 7. Taxonomically identified fish fauna from all the sites studied by NISP.

Taxa	Ngombezi	Old Korogwe	Kwa Sigi	Maurui	Total	%
Clariidae (cf. *Clarias* spp.)	234	88	46	97	**465**	35.5
Mochokidae (cf. *Synodontis* spp.)	298	105	39	75	**517**	39.5
Tilapiine (cf. *Oreochromis* spp.)	78	10	16	39	**143**	11
Cyprinidae (cf. *Barbus* spp.)	43	25	9	53	**130**	10
Anguillidae (cf. *Anguilla* spp.)	12	7	-	34	**53**	4
Total Site NISP	**665**	**235**	**110**	**298**	**1308**	**100**

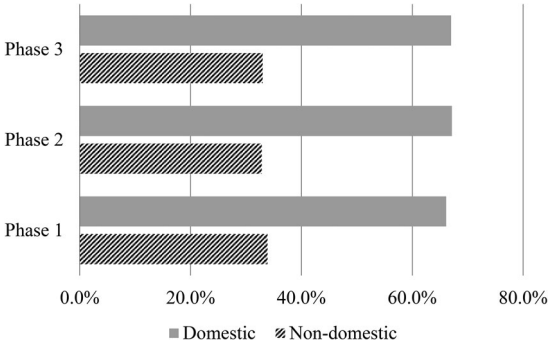


Figure 10. Ngombezi: dietary contribution of domestic and wild animal species per settlement phase excluding fish.

pectoral fin spines, which survive longer in archaeological deposits. Although present in all layers across the sites, the taxon was less abundant in deeper basal levels at Ngombezi and Maurui. This may be due to poor preservation conditions. Skelton (1994) indicates that the taxon is native to the Pangani River and prefers open water. Tamatamah (2007) indicates that *Synodontis* copes well with seasonal changes of habitat because it can eat many types of food.

Clariidae are the second most abundant catfish in the fish assemblages (Table 7). *Clarias* was the only genus identified based on the head bones. It feeds on other small fish, molluscs, detritus and aquatic weeds (Tamatamah 2007). The taxon is also native to the Pangani River and prefers stagnant water (Seegers 2008). Cichlidae rank third in the taxonomically identified fish fauna. The family is represented by the genus *Oreochromis* (cf. *Oreochromis korogwe*). The taxon is found in the Pangani River, thriving in normal riverine habitats. *Oreochromis* has the ability to adapt to an altered hydrology and other changes in river habitats (Lowe 1955).

A few dental specimens were definitively attributed to *Barbus* spp. of the family Cyprinidae. *Barbus* inhabits the deeper stretches of rivers with rocky shores or riparian trees (Skelton 1994). The taxon is naturally distributed and is native to the Pangani River (Banister 1973). Finally, a few fish bone specimens were attributed to the family Anguillidae, which is reported as being common in the Pangani River (Skelton 1994). Although seemingly rare in the analysed assemblages, this may well be due to the low number of easily identifiable elements for this taxon, making recognition of its presence in archaeological fishbone assemblages challenging, rather than reflecting a lack of consumption of the species.

Generally, the quantity of fish bones identified of specific taxa from each excavation unit and layer was relatively small. Furthermore, most fish taxa were under-represented in the basal deposits, probably due to poor preservation conditions. As a result, no significant trend can be claimed for the spatial-temporal distribution of fish fauna in the excavated layers at the studied sites.

Discussion

Domestic livestock were an important component of the livelihood strategies of the inhabitants of Ngombezi, Maurui, Old Korogwe and Kwa Sigi. At the main study site

of Ngombezi, for example, domestic species comprised approximately two-thirds of the meat supply while the non-domestic component formed one-third. However, hunting and fishing significantly supplemented the meat supply. The observed consumption of both domestic and wild resources was consistent throughout all the studied settlements (Figure 10).

Mortality profiles suggest that caprines and cattle were managed primarily for sustaining the growth of the herd and continuity rather than for immediate consumption. Cattle and caprines were allowed to live to maturity before they were slaughtered. This suggests that there was little pressure to consume domestic animals. The observed herd management strategies and culling practices are similar to those documented among modern agropastoralists in relatively unstressed conditions (Reid 1996), whereby bulls are left to attain maximum weight before being slaughtered (late off-take). For example, the East African zebu attains its maximum weight when about 40 months old; in stress-free conditions cows are left to increase the herd size until they are at least ten years old, which is considered a less productive age (Dahl and Hjort 1976).

Giblin (1992) depicts unstressed environments in the late pre-colonial LPRB, arguing that although a large part of Zigualand experienced drought farming was possible along the banks of the Pangani River and in valleys where moist and fertile land was available (Krapf 1860: 373). Livestock-keeping was also possible because farmers were able to control the growth of woody scrub, a favourable habitat for ticks and parasites, by regularly burning it and clearing trees and could thus regularly allow animals to graze. Additionally, the hunting of wild animals, particularly bushpigs and Cape buffalo (*Syncerus caffer*), helped to reduce the spread of infectious diseases to livestock, as most wild species can carry infectious bovine parasites (Giblin 1992: 19).

Overall, the pressure to consume cattle and caprines was probably insignificant because chickens, wild animals and fish contributed significantly to the meat supply for the inhabitants and perhaps also to that of the caravans. In rural regions in Africa, chickens are kept by almost every household (Kitalyi 1998). They are less expensive to keep as they need less space. Unlike the mammalian stock, chickens can survive periods of drought and famine. They are an important instant supply of meat during an unanticipated shortage of the savoury component of meals, particularly when a family receives unexpected guests. Chickens can withstand a high off-take rate because they reproduce quickly. Explorers who journeyed through East Africa during the height of the caravan trade reported that chickens were among the important items used to provision caravans in exchange for glass beads (Burton 1859: 184).

Similarly, small mammalian fauna, and rodents in particular, likely contributed significantly to the diet at the studied settlements. The assemblages recovered from the four sites possibly represent the largest ratio of rodents to other mammalian species reported thus far from archaeological sites in East Africa, and so warrants more discussion. Importantly, it should be noted that the environment around the study sites (Table 4) must have attracted small mammals, including rodents, which supplied the inhabitants and possibly the caravans with meat. For example, grasscutters, the most abundant rodent species in the assemblages, prefer areas near rivers and streams or marshes due to the presence of edible plants (Opara 2010). Rodents can also adapt to newly deforested areas where food and commercial crops are grown and to secondary savanna resulting from deforestation (Ashton 2000). Rodents have a higher reproduction rate and their

populations can recover quickly in situations of high exploitation (Stahl 1982; Walker 1995). Taking these factors into account, their abundance compared with other members of local fauna in the studied assemblages may thus be due to extractive anthropogenic activities having taken place in the area.

The consumption of rodents by current African populations does not signify subsistence stress (Malaisse 1997) — contemporary Zigua practices in the study area being a case in point — as farmers typically hunt rodents primarily to protect crops and only secondarily as an alternative source of meat (Assogbadjo *et al.* 2005). Nonetheless, Stahl (1982) indicates that approximately 67–76% of a rodent is edible, so they can contribute significantly to the meat diet when they are caught in abundance. In Bénin, a study by Assogbadjo and colleagues (2005) found that more than 53% of the villagers near Lama Forest prefer rodent meat to other wild meat.

The consumption of wild animals also appears to have been quite common across East African farming communities for some considerable time and continues to this day (Driver 2008; Ceppi and Nielsen 2014). Helm (2000), for example, reports a subsistence economy based on exploiting both domestic and non-domestic fauna resources at five Kenyan coastal hinterland, Early to Later iron-working and farming settlements. The inhabitants of three of these settlements namely Mgombani 02 (*c.* AD 775), Chombo 01 (*c.* AD 900) and Mteza 01 (*c.* AD 895) kept a small number of domestic livestock initially, but these were not their main source of meat. Instead, they relied on hunting, fishing and gathering terrestrial snails. Even when animal husbandry became a major occupation at the Middle and Later iron-working and farming settlements of Mtsengo 01 (*c.* 1415) and Mbuyuni 01 (*c.* 1640), hunting wild game and gathering land snails were still practised (Helm 2000: 257; see also Foutch *et al.* 2009 for a similar observation concerning pre-colonial animal economies in the northern Rukwa Valley, Tanzania). Prendergast and colleagues (2017) report rather similar animal exploitation patterns from two mid-first millennium Iron Age farming communities at Fukuchani and Unguja Ukuu in Zanzibar. Inhabitants of these settlements exploited both marine and terrestrial resources throughout; the latter comprising mainly wild fauna, especially small bovids and rodents. As reported here for the Lower Pangani, Prendergast and colleagues also observed an unchanged ratio of wild to domestic animals throughout the occupation of the two settlements, highlighting the continued importance of wild resources long after the transition to farming.

Archaeological assemblages with many large prey taxa could suggest a more plentiful environment than those dominated by small prey taxa. Kusimba (2004), for example, reports a reduction in hunting large to medium-sized game to a reliance on smaller mammals, reptiles and birds during the course the occupation of rock shelters on Mt Kasigau in western Tsavo, southeast Kenya. He interpreted this shift in focus as an indicator of subsistence stress brought about by social and political instability arising from intensification of the regional slave trade and exacerbated by climatic change in the area some 300 years ago.

Despite well-documented social disruptions arising from the intensification of the regional slave trade in the nineteenth century across the Pangani Basin (Giblin 1992), the animal economies of the sites reported here (which were occupied broadly coevally with those on Mt Kasigau) do not seem to have been affected in the same way and the local environment, encompassing open grassland, wooded grassland, savanna woodland,

montane forest, river edges and marshes, appears to have supported a diverse range of wild animals during the nineteenth century and earlier. As Table 4 shows, several ungulates preferring different habitats were available for human exploitation requiring diverse hunting strategies, perhaps ranging from individual to group efforts assisted by dogs (Lynwood 1994; Juwayeyi 2008).

That farmers hunt wild game and also small rodents is not very surprising given the widely attested importance of hunting in pre-colonial East Africa and the damage that wild animals from elephants to cane rats can cause to crops. Horticultural activities in other sub-tropical areas can also lead to an increase in the abundance of small mammals, simultaneously creating enhanced threats to crop harvests and a convenient source of high-quality protein (Speth and Scott 1989: 74). Additionally, some species may have been hunted for other purposes. At the Kibaoni site in the Rukwa Valley, Tanzania, for example, Foutch and colleagues (2009) reported a cut-marked femur of a medium-sized cat (serval (*Leptailurus serval*) or caracal (*Caracal caracal*)). They interpreted this as the product of witchcraft rituals, which are still practised in the area. The remains of a wild cat bearing a cut mark recovered from Ngombezi might have been used for similar purposes, although equally plausible alternative interpretations could be forwarded.

The large quantity of fish bones recovered from the excavations implies that they were abundant and available for consumption, as also reported in the historical sources (Baumann 1891: 177). The occurrence of similar fish taxa at the different sites is not surprising given their proximity to each other along the Pangani River, and the occupants of all four sites seemingly exploited similar aquatic habitats. It is likely that fish species that were present in the Pangani River during the nineteenth century have not fluctuated significantly since then, despite the construction of dams further upstream. Oral information gathered from local residents during the excavations indicated that some fish species are found in large quantities seasonally and others are common all the year round. For example, Ningu (*Anguilla*) and Kuyu (*Barbus*) are available during the hot season. Perege (*Oreochromis*) and Kambale (*Clarias*) are available throughout the year, although more so during the rainy season.

The common fishing methods still employed include the use of basket traps (*migono*) made of thin wooden rods and cord made from palm leaves (Figure 11). These are placed in the river with each basket's opening facing upstream so that the fish flowing with the water are trapped in them. There are also wicker basket traps (*masega*), which are similar to *migono,* but smaller with a wide opening at one end into which the fish swim. The other end is narrow, preventing the fish from turning round. Nets (*kimia* or *lwavu*) are also used, but not frequently. Another method is to build reed fence-traps across the river. Line fishing with hooks is also used, but is less common, and no fishhooks of any description were recovered from the excavations, unlike at coastal sites where fishhooks have been present since at least the mid-first millennium AD (Prendergast *et al.* 2017).

Conclusions

This zooarchaeological study did not detect significant changes in patterns of animal production and exploitation during the height of the nineteenth-century caravan trade at a



Figure 11. Kwa Sigi, Zigua fishing basket (photograph: Paul Lane, 2009).

sample of known caravan staging points in the LPRB of northeastern Tanzania. No clear evidence was recovered that would indicate that either a surplus was intentionally being produced or that there were significant changes to patterns of meat consumption in response to the expansion of the caravan trade, although there was possibly a decline in access to hunted game in the post-caravan trade era. It is unclear whether this was because wild game had been locally extirpated or was more due to the enforcement of game ordinances by the German colonial authorities (the first such ordinance was introduced in 1896), restricting those permitted to hunt legally (Gissibl 2016: 73–96) or a combination of these factors.

Nonetheless, based on the zooarchaeological analysis presented here, it would appear that herds were managed throughout the period of occupation of these riverine sites primarily for growth and continuity rather than for the immediate production of meat. The taxonomic diversity of wild prey consumed at these settlements indicates a focus on small to medium-sized animals, with occasional contributions from larger species. In addition to fish, the supply of wild meat would have supplemented that of domestic animals. Such a widespread consumption of wild resources would thus suggest that if there had been a shortage of meat from domestic livestock at the climax of the caravan trade this was easily met by hunting and fishing.

It is also reasonable to conclude that domestic animals were of other socio-economic and cultural value to the islands' inhabitants, rather than being just a convenient source of meat. Giblin (1992: 34) has noted that livestock functioned in politics and patronage among nineteenth-century Zigua communities. The exchange of livestock strengthened political loyalties and patron-client relations in Zigua farming communities and between Zigua farmers and neighbouring Maasai pastoralists. Importantly, the male heads of Zigua families and clans would win the affection and loyalty of their children by promising them an inheritance in the form of livestock. This helped ward off the competing affection of the mothers' relatives, which was pronounced among the Zigua, among whom descent is traced matrilineally (Giblin 1992: 35). Additionally, cattle in particular were used to pay bridewealth for sons about to marry.

Recent analysis of the archaeobotanical remains recovered from Maurui Island has also revealed continuity in the production and consumption of the main local food crops, notably sorghum (*Sorghum bicolor*) and millet (*Pennisetum glaucum*), throughout the occupation of this settlement and at the apex of the caravan trade (Kawiche 2016). Excavations at the site of Kwa Fungo, another nineteenth-century Zigua village that served as a caravan halt, located roughly 30 km to the southwest of Korogwe, also uncovered evidence for maize (*Zea mays*) consumption, as well as a distinctive local ceramic assemblage that differs from that recovered from the sites discussed here (Lane 2011; Croucher 2015: 220–223). As at Ngombezi, only limited quantities of imported beads or European ceramics were present.

In neither case, however, is the archaeobotanical information sufficient to assess whether the inhabitants of these sites sought to intensify agricultural rather than livestock production as a response to the trading opportunities provided by passing caravans. Such agricultural intensification certainly happened elsewhere — the best example being at the southern end of Lake Baringo (Anderson 1989; Petek 2018) — and has also been suggested for parts of the eastern Pare Mountains bordering the Pangani River Valley (Håkansson 2008). Further comparative studies of other caravan staging posts along the Pangani corridor beyond those reported here are clearly needed so as to place the Waruvu island settlements around Korogwe in a broader regional perspective. Walz (2010), for example, reports on several such sites to the north of Korogwe, which, based on the materials recovered, he considered could have been linked directly with the coast via trade for many centuries before the arrival of the Portuguese. Moreover, as Håkansson (2004, 2008) notes, the historical sources suggest that Maasai communities, in particular, were able to increase their herds in response to the economic opportunities provided by the expanding caravan trade. Further archaeological investigation of these issues needs to examine pastoralist sites alongside those of farming communities.

The findings of our study do raise questions, however, about the frequency and volume of caravans that actually passed through this landscape. Far from being as numerous and voracious in their demand for supplies as has sometimes been assumed, it is possible that the Lower Pangani route was only infrequently used by caravans during the height of the caravan trade. This may explain, for example, why there was little pressure on the local inhabitants to intensify food production. Contemporary nineteenth-century published sources certainly demonstrate the shifting nature of the various trade routes. In one, for example, the Reverend J.P. Farler (1882: 740), who was stationed at the Magila Mission in Usambara, observed that 'lately caravans to the

Masai country and the Victoria Nyanza have taken a new route via Magila, instead of following the valley of the Luvu [Pangani]. This has been done to escape the extortions of Semboja, chief of the Wakilindi, who resides at Mazindi, and levies tribute on the caravans both going and returning'.

It is perhaps also appropriate to re-examine some of the assumptions (including our own) that commonly underlie estimates of the demands that passing caravans made on the communities they camped among over the course of their long journeys to and from the interior. In a description of the arrival of a caravan at Njemps at the southern end of Lake Baringo on 27 December 1887, which was by then a common terminus for caravans emanating from Pangani, Von Höhnel (1894: 24) records that the members of this particular caravan 'had subsisted for more than three months on a handful each of dhurra or eleusine and were about to undertake the return journey to Miansini without any store of provisions with them'. He commented further that the 'hardships connected with the bringing of ivory down to the coast are very great', implying that such shortage of food supplies may have been quite common and due to a 'thoughtless want of preparation' (Von Höhnel 1894: 27).

That latter remark probably needs to be taken with a grain of salt (and a few paragraphs earlier Von Höhnel describes the diet of his own expedition as being short on carbohydrates and mostly comprising meat from wild and domestic animals) and more reflective of the challenges that caravans may have faced trying to provision themselves. That communities living along the trade routes drove a hard bargain is attested by the frequency with which they rejected certain trade goods, especially particular types of glass beads, even when such goods had been in demand a year or so previously (see Pallaver 2009 and Prestholdt 2004 for wider discussion and specific examples). This certainly seems to have been the case with the inhabitants of the two Njemps settlements at the time of Count Teleki's visit (Petek 2018). According to Von Höhnel (1894: 5) they were by now 'quite spoiled by the constant and long visits they receive from caravans' and had become 'very exacting about what they will take in payment for their wares'. For example, they would 'have nothing to do with glass beads' and trade goods had to be used to obtain even 'the very smallest quantity of grain', while they traded ivory only for cattle, demanding also 'a considerable tribute' on top of these payments.

In contrast to the evidence from Baringo, Mgombere's (2017) recent archaeobotanical study of two caravan halts at Mang'ua and Kikole in southwestern Tanzania found no evidence for specialisation in the production of food crops at these sites during the era of the caravan trade. Instead, various crops, including finger millet, pearl millet, maize, rice, coconuts, legumes and cotton, were cultivated and consumed, as in previous centuries. In her study of Ujiji, the caravan terminus on Lake Tanganyika for the central caravan route and at Uvinza, a salt production site, also on the central route, Wynne-Jones (2010) similarly found more evidential support for continuities rather than widespread changes in social practices during the height of the caravan trade. For example, there was limited evidence for imported trade goods (such as ceramics and glass beads) providing a significant source of wealth or power. Instead, Wynne-Jones found that the power of local élites continued to derive from their control over salt production and that the caravan trade did not have a particularly transformative impact on those seeking power and authority. Emerging archaeological findings such as these should

serve, perhaps, as a caution against assuming that the nineteenth-century caravan trade was universally transformative across all East Africa. As argued here, if these narratives remain untested, they are likely to mask the complexity and dynamism of local practices.

Note

1. Or simply Waruvu; also rendered in some sources as Ruvu, Rufu, Luvu and, rarely, Luffa.

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Contributions

TB co-designed the research, undertook data collection and faunal analyses, drafted the original manuscript and contributed to its revision and editing. PL conceived and co-designed the research, obtained funding and contributed to the writing and editing of the manuscript.

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References

Abir, M. 1968. "Caravan trade and history in the northern parts of East Africa." *Paideuma* 14: 103–120.
Anderson, D.M. 1989. "Agriculture and irrigation technology at Lake Baringo in the nineteenth century." *Azania* 24: 84–97.
Ashton, A. 2000. "Ecology of rodent communities in agricultural habitats in eastern Sierra Leone: cocoa groves as forest refugia." *Tropical Ecology* 41: 127–142.
Assogbadjo, A.E., Codjia, J.T.C., Sinsin, B., Ekue, M.R.M. and Mensah, G.A. 2005. "Importance of rodents as a human food source in Benin." *Belgian Journal of Zoology* 135: 11–15.
Bailey, R.G., Churchfield, S., Petr, T. and Pimm, R. 1978. "The ecology of the fishes in Nyumba ya Mungu reservoir, Tanzania." *Biological Journal of the Linnean Society* 10: 109–137.
Baumann, O. 1891. *Usambara and Seine Nachbargebiete*. Berlin: D. Reimer.
Beachey, R. 1967. "The East African ivory trade in the nineteenth century." *Journal of African History* 8: 269–290.
Behrensmeyer, K. 1978. "Taphonomic and ecologic information from bone weathering." *Palaeobiology* 4: 150–162.
Beidelman, T. 1982. "The organization and maintenance of caravans by the Church Missionary Society in Tanzania in the nineteenth century." *International Journal of African Historical Studies* 15: 601–623.
Bessems, I., Verschuren, D., Russell, J.M., Hus, J., Mees, F. and Cumming, B.F., 2008. "Palaeolimnological evidence for widespread late 18th century drought across equatorial East Africa." *Palaeogeography, Palaeoclimatology, Palaeoecology* 259: 107–120.
Biginagwa, T.J 2012. "Historical archaeology of the 19th century caravan trade in north-eastern Tanzania: a zooarchaeological perspective." PhD diss., University of York.
Biginagwa, T.J. and Ichumbaki, E.B. 2018. "Settlement history of the islands on the Pangani River, northeastern Tanzania." *Azania: Archaeological Research in Africa* 53: 63–82.
Brain, C.K. 1981. *The Hunters or the Hunted: An Introduction to African Cave Taphonomy*. Chicago: University of Chicago Press.
Bunn, H. and Kroll, M. 1986. "Systematic butchery by Plio-Pleistocene hominids at Olduvai Gorge, Tanzania." *Current Anthropology* 29: 135–149.
Burton, R.F. 1859. "The Lake Regions of Central Equatorial Africa." *Journal of the Royal Geographical Society of London* 29: 1–454.
Burton, R.F. 1872. *Zanzibar: City, Island, and Coast*. London: Tinsley.
Burton, R.F and Speke, J. 1858. "A coasting voyage from Mombasa to the Pangani River; visit to Sultan Kimwere; and progress of the expedition into the interior." *Journal of the Royal Geographical Society of London* 28: 188–226.
Ceppi, S.L. and Nielsen, M.R. 2014. "A comparative study on bushmeat consumption patterns in ten tribes in Tanzania." *Tropical Conservation Science* 7: 272–287.
Christianson, C. 1981. *Soil Erosion and Sedimentation in Semi-Arid Tanzania: Studies of Environmental Changes and Ecological Imbalance*. Uppsala: Scandinavian Institute of African Studies.
Coutu, A.N., Lee-Thorp, J.A., Collins, M.J. and Lane, P.J. 2016. "Mapping the elephants of the 19th century East African ivory trade with a multi-isotope approach." *PLoS ONE* 11 (10): e0163606b.
Croucher, S.K. 2015 *Capitalism and Cloves: An Archaeology of Plantation Life on Nineteenth-Century Zanzibar*. London: Springer.
Dahl, G. and Hjort, A. 1976. *Having Herds: Pastoral Herd Growth and Household Economy*. Stockholm: University of Stockholm, Department of Social Anthropology.

Driver, J. 2008. "Models for zooarchaeologists from modern bushmeat studies." In *Animals and Archaeology: Archaeozoological Papers in Honour of Ina Plug*, edited by S. Badenhorst, P.J. Mitchell and J. Driver, 21–33. Oxford: Archaeopress.
Erhardt, J. 1853. "Journal containing an account of my journey to Usambara and back and of three months stay with the king of the country, Kimeri, from the 9th of August to December 1853." *Church Missionary Society Microfilm CA5/09/16*,35.
Farler, J.P 1882. "Native routes in East Africa from Pangani to the Masai country and Victoria Nyanza." *Journal of the Royal Geographical Society of London* 4: 730–742.
Fischer, W. and Bianchi, G. 1984. *FAO Species Identification Sheets for Fishery Purposes: Western Indian Ocean (Fishing Area 51)*. Rome: FAO.
Foutch, A.E., Steele, T.E. and O' Brien, C.J. 2009. "Faunal analysis from Kibaoni, a late precolonial Pimbwe village in Rukwa Valley, Tanzania: first reconstructions of cultural and environmental histories." *Azania: Archaeological Research in Africa* 44: 257–267.
Giblin, J. 1992. *The Politics of Environmental Control in North-Eastern Tanzania, 1840–1940*. Philadelphia: University of Pennsylvania.
Gifford, D., Isaac, G.L. and Nelson, C. 1980. "Evidence for predation and pastoralism at Prolonged Drift, a Pastoral Neolithic site in Kenya." *Azania* 15: 57–108.
Gissibl, B. 2016. *The Nature of German Imperialism: Conservation and the Politics of Wildlife in Colonial East Africa*. Oxford: Berghahn.
Håkansson, T.N. 1995. "Irrigation, population pressure, and exchange in precolonial Pare, Tanzania." *Research in Economic Anthropology* 16: 297–324.
Håkansson, T.N. 2004. "The human ecology of world systems in East Africa: the impact of the ivory trade." *Human Ecology* 32: 561–591.
Håkansson, T.N. 2008. "The decentralized landscape: regional wealth and the expansion of production in northern Tanzania before the eve of colonialism." In *Economies and the Transformation of Landscape*, edited by L. Cligget and C. Pool, 239–266. Walnut Creek: AltaMira Press.
Håkansson, T.N., Widgren, M. and Börjeson, L. 2008. "Introduction: historical and regional perspectives on landscape transformation in north-eastern Tanzania, 1850–2000." *International Journal of African Historical Studies* 41: 369–382.
Helm, R.M. 2000. "Conflicting histories: the archaeology of the iron-working, farming communities in the central and southern coast region of Kenya." PhD diss., University of Bristol.
Herrero, M., Grace, D., Njuki, J., Johnson, N., Enahoro, D., Silvestri, S. and Rufino, M. 2013. "The roles of livestock in developing countries." *Animal* 7: 3–18.
IUCN. 2003. *The Pangani River Basin: A Situation Analysis*. Nairobi: IUCN.
Johnston, K. 1879. "Notes of a trip from Zanzibar to Usambara in February and March 1879." *Journal of the Royal Geographical Society of London* 1: 545–558.
Juwayeyi, Y. 2008. "Human and animal interaction on the Shire Highlands, Malawi: the evidence from Malowa rock shelter." In *Animals and People: Archaeozoological Papers in Honour of Ina Plug*, edited by S. Badenhorst, P.J. Mitchell and J. Driver, 83–93. Oxford: Archaeopress.
Kawiche, K. 2016. "Archaeobotanical evidence of crop production during the nineteenth century caravan trade in Lower Pangani, north-eastern Tanzania." MA diss., University of Dar es Salaam.
Kimambo, I. 1996. "Environmental control and hunger in the mountains and plains of nineteenth century north-eastern Tanzania." In *Custodians of the Land: Ecology and Culture in the History of Tanzania*, edited by G. Maddox, J. Giblin and I. Kimambo, 71–95. London: James Currey.
Kiptala, J.K., Mohamed, Y., Mul, M.L., Cheema, M.J.M. and Van der Zaag, P. 2013. "Land use and land cover classification using phenological variability from MODIS vegetation in the Upper Pangani River Basin, Eastern Africa." *Physics and Chemistry of the Earth, Parts A/B/C* 66: 112–122.
Kisbey, W. 1898. "The burning of Kwa Sigi village." *African Tidings* 7(109).
Kitalyi, A.J. 1998. *Village Chicken Production Systems in Rural Africa: Household Food Security and Gender Issues*. Rome: FAO.
Kjekshus, H. 1996. *Ecology Control and Economic Development in East African History: The Case of Tanganyika 1850–1950*. Oxford: James Currey.

Koponen, J. 1988. *People and Production in Late Pre-Colonial Tanzania: History and Structures*. Uppsala: Scandinavian Institute of African Studies.
Krapf, J. 1860 [1968]. *Travels, Researches, and Missionary Labours During an Eighteen Years' Residence in Eastern Africa*. Abingdon: Frank Cass and Co.
Kusimba, C.M. 2004. "Archaeology of slavery in East Africa." *African Archaeological Review* 21: 59–88.
Lane, P.J. 2010. "Developing landscape historical ecologies in eastern Africa: an outline of current research and potential future directions." *African Studies* 69: 299–322.
Lane, P.J. 2011. "Slavery and slave trading in eastern Africa: exploring the intersections of historical sources and archaeological evidence. In *Slavery in Africa: Archaeology and Memory*, edited by P.J. Lane and K.C. MacDonald, 281–314. Oxford: Oxford University Press
Lowe, R.H. 1955. *New Species of Tilapia (Pisces, Cichlidae) from Lake Jipe and the Pangani River, East Africa*. London: British Museum (Natural History).
Lynwood, F. 1994. *Rodent Pest Management in Eastern Africa*. Rome: FAO Plant Production and Protection Paper 123.
Malaisse, F. 1997. *Se Nourrir en Forêt Claire Africaine: Approche Ecologique et Nutritionnelle*. Wageningen: CTA Spore 75.
Marshall, F. 1990. "Cattle herds and caprine flocks: early pastoral strategies in south-west Kenya." In *Early Pastoralists of South-Western Kenya*, edited by P.T. Robertshaw, 205–260. Nairobi: British Institute in Eastern Africa.
Meadow, S. and White, J. 1979. *Structure of the Herd and Determinants of Offtake Rates in Kajiado District in Kenya, 1962–1977*. London: Overseas Development Institute.
Mgombere, C. 2017. "Archaeological evidence of crop economies practiced along the nineteenth century caravan route in southern Tanzania." MA diss., University of Dar es Salaam.
Mutundu, K. 1999. *Ethnohistoric Archaeology of the Mukogodo in North-Central Kenya: Hunter-Gatherer Subsistence and the Transition to Pastoralism in Secondary Settings*. Oxford: British Archaeological Reports.
New, C. 1874. "Journey from the Pangani, via Wadigo, to Mombasa." *Journal of the Royal Geographical Society of London* 19: 317–323.
Opara, M. N. 2010. "Grasscutter: the haematology and major parasites." *Research Journal of Parasitology* 5: 214–223.
Pallaver, K. 2009. "'A recognized currency in beads.' Glass beads as money in 19th-century East Africa: the central caravan road". In *Money in Africa*, edited by C. Eagleton, H. Fuller and J. Perkins, 20–29. London: British Museum.
Pallaver, K. 2012. Muslim communities, long-distance trade and wage labour along the central caravan road: Tanzania, 19th century. *Storicamente* 8 (2012): 20. https://storicamente.org/pallaver_tanzania
Petek, N. 2018. *Archaeological Perspectives on Risk and Community Resilience in the Baringo Lowlands, Kenya*. Uppsala: Department of Archaeology and Ancient History, Uppsala University.
Prendergast, M.E., Buckley, M., Crowther, A., Frantz, L., Eager, H., Lebrasseur, O., Hutterer, R., Hulme-Beaman, A., Van Neer, W., Douka, K. and Veall, M.A. 2017. "Reconstructing Asian faunal introductions to eastern Africa from multi-proxy biomolecular and archaeological datasets." *PLoS ONE* 12(8): e0182565.
Prendergast, M.E. and Lane, P.J. 2010. "Middle Holocene fishing strategies in East Africa: zooarchaeological analysis of Pundo, a Kansyore shell midden in northern Nyanza (Kenya)." *International Journal of Osteoarchaeology* 20: 88–112.
Prendergast, M.E. and Mutundu, K. 2009. "Late Holocene zooarchaeology in East Africa: ethnographic analogues and interpretive challenges." *Documenta Archaeobiologiae* 7: 203–232.
Prendergast, M.E., Quintana Morales, E.M., Crowther, A., Horton, M.C. and Boivin, N.L. 2017. "Dietary diversity on the Swahili coast: the fauna from two Zanzibar trading locales." *International Journal of Osteoarchaeology* 27: 621–637.
Prestholdt, J. 2004. "On the global repercussions of East African consumerism." *American Historical Review* 109: 755–781.

Quinlan, J., Rumas, I., Naisikye, G., Quinlan, M. and Yoder, J. 2016. "Searching for symbolic value of cattle: tropical livestock units, market price, and cultural value of Maasai livestock." *Ethnobiology Letters* 7: 76–86.
Reid, D.A.M. 1996. "Cattle herds and redistribution of cattle resources." *World Archaeology* 28: 43–57.
Rempel, R. 1998. "Trade and transformation: participation in the ivory trade in late 19th-century East and Central Africa." *Canadian Journal of Development Studies* 19: 529–552.
Robertson, C.C. 1997. "Gender and trade relations in central Kenya in the late nineteenth century." *International Journal of African Historical Studies* 30: 23–47.
Rockel, S. 2006. *Carriers of Culture: Labour on the Road in Nineteenth-Century East Africa*. Oxford: James Currey.
Rodney, W. 1972. *How Europe Underdeveloped Africa*. London: Bogle-L'Ouverture Publications.
Ryan, K., Munene, K., Kahinju, S.M. and Kunoni, P.N. 2000. "Ethnographic perspectives on cattle management in semi-arid environments: a case study from Maasailand." In *The Origins and Development of African Livestock: Archaeology, Genetics, Linguistics, and Ethnography*, edited by R.M. Blench and K.C. MacDonald, 462–477. London: Routledge.
Seegers, L. 2008. "The fishes collected by G.A Fischer in East Africa in 1883 and 1885/86." *Zoosystematics and Evolution* 84: 149–195.
Shenkut, M., Mebrate, A. and Balakrishnan, M. 2006. "Distribution and abundance of rodents in farmlands: a case study in Alleltu Woreda, Ethiopia." *SINET: Ethiopian Journal of Science* 29: 63–70.
Sheriff, A. 1987. *Slaves, Spices and Ivory in Zanzibar: Integration of an East African Commercial Empire into the World Economy 1770–1873*. London: James Currey.
Silver, I.A. 1969. "The ageing of the domestic animals." In *Science in Archaeology*, edited by D. Brothwell and E.S. Higgs, 283–302. London: Thames and Hudson.
Sissons, J. 1984. "Economic prosperity in Ugogo, East Africa, 1860–1890." PhD diss., University of Toronto.
Skelton, P. H. 1994. "Diversity and distribution of freshwater fishes in East and southern Africa." *Annales du Musée Royal de l'Afrique Centrale Sciences Zoologiques* 275: 95–131.
Speth, J.D. and Scott, S.L. 1989. "Horticulture and large-mammal hunting: the role of resource depletion and the constraints of time and labor." In S. Kent (ed.), *Farmers as Hunters: The Implications of Sedentism*, edited by S. Kent, 71–79. Cambridge: Cambridge University Press.
Stahl, P. 1982. "On small mammal remains in archaeological context." *American Antiquity* 47: 822–829.
Stump, D. and Tagseth, M. 2009. "The history of pre-colonial and early colonial agriculture on Kilimanjaro: a review." In *Culture, History and Identity: Landscapes of Inhabitation in the Mount Kilimanjaro Area, Tanzania*, edited by T. Clack, 107–124. Oxford: Archaeopress.
Tamatamah, R.A. 2007. "Environmental flow assessment (EFA) Wami River Basin, Tanzania: aquatic ecology component of the Wami River EFA study. Literature review for BBM workshop." Unpublished report, Wami-Ruvu Basin Water Office, Morogoro, Tanzania.
Thorbahn, P.F. 1979. "The pre-colonial ivory trade of East Africa: reconstruction of a human-elephant ecosystem." Ph.D. diss., University of Massachusetts.
URT (United Republic of Tanzania). 2008. *Korogwe District Investment Profile*. Dar es Salaam: Government Printer.
Von Höhnel 1894 *Discovery of Lakes Rudolf and Stefanie* Vol. II. London: Longmans, Green and Co.
Walker, N.J. 1995. *Late Pleistocene and Holocene Hunter-Gatherers of the Matopos: An Archaeological Study of Change and Continuity in Zimbabwe*. Uppsala: Societas Archaeologica Upsaliensis.
Walker, R. 1985. *A Guide to Postcranial Bones of East African Animals*. Norwich: Hylochoerus.
Walz, J.R. 2010. "Route to a regional past: an archaeology of the Lower Pangani (Ruvu) Basin, Tanzania, 500-1900 C.E." PhD diss., University of Florida.
Wynne-Jones, S. 2010. "Lines of desire: power and materiality along a Tanzanian caravan route." *Journal of World Prehistory* 23: 219–237.