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JOURNAL OF AFRICAN ARCHAEOLOGY (2022) 1–19

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Kansyore Fisher-Hunter-Gatherers Abandoned the Northeastern Lake Victoria Shoreline during an Arid Period in the Middle Holocene: A Reconsideration of Dates from Western Kenya with New Radiometric and Faunal Evidence from the Namundiri A Shell Midden, Eastern Uganda

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Abstract

Kansyore pottery-using groups of the northeastern Lake Victoria Basin represent one of only a few examples of 'complex' hunter-gatherers in Africa. Archaeologists link evidence of specialized fishing, a seasonal land-use cycle between lake and riverine sites, and intensive investment in ceramic production to behavioral complexity after 9 thousand years ago (ka). However, a gap in the Kansyore radiocarbon record of the region between ~7 and 4.4 cal ka limits explanations of when and why social and economic changes occurred. This study provides the first evidence of lakeshore occupation during this temporal break at the only well-studied Kansyore site in eastern Uganda, Namundiri A. Within the context of other sites in nearby western Kenya, radiometric and faunal data from the site indicate a move from the lake to a greater reliance on riverine habitats with middle Holocene aridity ~5–4 cal ka and the arrival of food producers to the region after ~3 cal ka.

Keywords

Holocene – climate change – East Africa – complex hunter-gatherers – subsistence specialization – fishing

1 Introduction

Technological elaboration and ownership of resources are thought to signal 'complexity' among Kansyore ceramic-producing fisher-hunter-gatherers in the northeastern Lake Victoria Basin of East Africa during the early and middle Holocene (Dale et al. 2004; Dale 2007; Prendergast 2010; Prendergast & Lane 2010). Kansyore groups made and used large quantities of highly decorated pottery, repeatedly occupied lakeshore and riverine sites, and practiced intensive fishing (e.g., weirs, nets) and diverse hunting strategies (high species diversity) (Robertshaw et al. 1983; Robertshaw 1991). The concept of complexity, in this case, is linked to Woodburn's (1982) notion of delayed-return hunting and gathering, which emphasizes future food availability, reduced mobility, and hierarchical social structures. Globally, archaeologists often point to evidence of seasonal resource-use, sedentism, food storage, and the exploitation of abundant marine environments when identifying complex or delayed-return hunter-gatherers in the past (Arnold 1996; Binford 2001). Archaeologists have also begun to examine diachronic change and local variability among complex hunter-gatherers, drawing attention to factors that influence when, where, and why distinct social and economic systems appear, change, or disappear.

In some cases, researchers link seasonal and longer-term environmental changes to social, economic, and political reorganization among hunter-gatherers, as in temperate Eurasia and North America (Angelbeck & Grier 2012; Wengrow & Graeber 2015) and arid northern Africa (di Lernia 2001; Garcea 2001, 2006; Barich 2013). Studies in Mediterranean Eurasia (Byrd 2005; Munro 2009; Stutz et al. 2009; Maher et al. 2012) and coastal southern Africa (Jerardino 2010, 2012) also highlight the role of changing social dynamics – including rising human populations and increasingly dense, sedentary settlements – in shaping complex hunter-gatherer economic systems. In East Africa, Kansyore scholars recognize temporal variability in ceramic and faunal patterns, with a general trend toward increasingly delayed-return strategies ~8.5–1.5 cal ka (Dale et al. 2004; Dale 2007; Prendergast 2010; Prendergast & Lane 2010). This long record, spanning major climatic and human transformations in the region, provides an ideal opportunity to examine the ways changing environmental conditions and social dynamics affected complex fisher-hunter-gatherer systems in a tropical African lake setting.

Dale & Ashley (2010; Dale 2007) document the gradual adoption of Kansyore pottery production and use in the early Holocene, followed by an abrupt change in ceramic decorative styles after ~4.4 cal ka. On the basis of these ceramic shifts, they define two archaeological phases in the Kansyore sequence – Early ~8.5–7 cal ka and Late ~4.4–1.5 cal ka – with a notable radiometric gap in the record between ~7 and 4.4 cal ka. Scholars have argued broadly that specialized fishing methods (e.g., at rapids) reliant upon delayed-return technologies (e.g., weirs, nets) were integrated into a systematic land-use pattern in which groups cycled seasonally between lakeshore and inland environments over this 7000-year sequence (Robertshaw et al. 1983; Stewart 1991; Marshall & Stewart 1995; Prendergast 2010; Prendergast & Lane 2010). However, due to a lack of reliable dates and well-studied faunal assemblages in the region, it remains unclear when new fishing and site-use patterns associated with increasing social and economic complexity (see Dale et al. 2004; Dale 2007; Prendergast 2010) emerged and whether they can be attributed to Early or Late Kansyore groups.

The timing of this transition has significant implications for understanding processes of change among complex fisher-hunter-gatherers through time. If seasonal cycles between lake and riverine fishing sites occurred only after ~4.4 cal ka, then increases in technological elaboration and delayed-return strategies among Kansyore groups coincided with a period of aridity in East Africa ~5–4 cal ka (Thompson et al. 2002; Garcin et al. 2012; Liu et al. 2017). Elmenteitan pastoralists and Early Iron Age (EIA) farmers moved into the region a little later, after ~3 cal ka (Robertshaw 1991; Lane et al. 2006, 2007; Prendergast 2010; Frahm et al. 2017). Conversely, if seasonal fishing existed prior to ~4.4 cal ka, then patterns of social and economic complexity involving new fishing technologies and seasonal land use emerged during a period of relatively stable climatic conditions, predating major climatic and social changes in the region. Investigating these different scenarios has proven difficult, however. This is, in large part, due to a lack of archaeological data from the major chronological gap between the Early and Late Kansyore Phases, which limits long-term archaeological syntheses.

Here, we present new radiocarbon dates and faunal data from the Namundiri A shell midden in eastern Uganda (Fig. 1). Our findings provide a rare glimpse into Kansyore occupation and subsistence strategies during the chronological break in the record between ~7 and 4.4 cal ka. Situating Namundiri A within the context

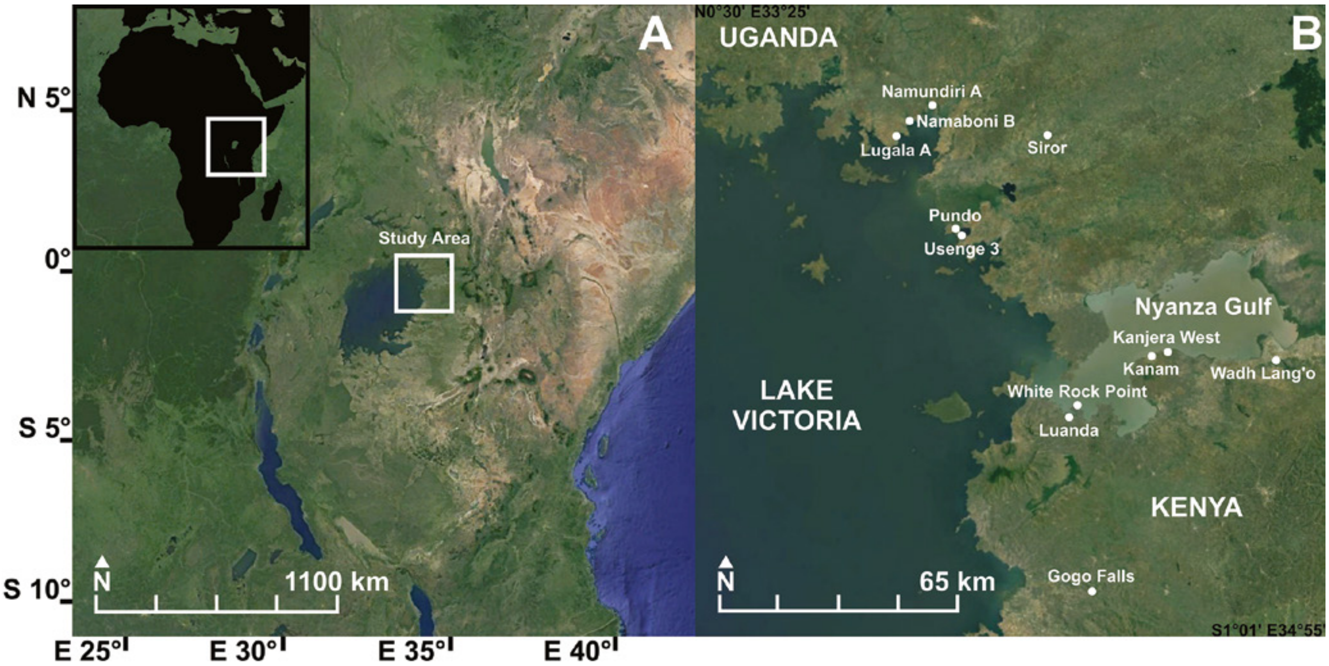

FIGURE 1 A – map of East Africa with study area outlined in white. B – map of the northeastern Lake Victoria Basin with sites mentioned in the text

of other Kansyore sites from different periods in the sequence, we examine the nature of lakeshore versus riverine occupation and subsistence patterns to understand how changing Kansyore land and resource use related to Holocene climatic and social shifts in the northeastern Lake Victoria Basin.

2 Kansyore Archaeology

Chapman (1967) first formally described Kansyore ceramics at Kansyore Island in the Kagera River of western Uganda. Since then, Kansyore materials have been identified at sites in many parts of East Africa, including Kenya (Robertshaw et al. 1983; Robertshaw 1991; Karega-Munene 2002; Lane et al. 2006, 2007; Dale 2007; Dale & Ashley 2010; Prendergast 2008, 2010; Prendergast & Lane 2010), Tanzania (Mehlman 1989; Prendergast et al. 2007, 2014), Uganda (Tibesasa & Jones 2021), and possibly South Sudan (Robertshaw & Mawson 1981). Despite this broad geographic range, most research on reconstructing Kansyore chronological sequences, settlement patterns, and subsistence strategies has been conducted at sites in western Kenya.

2.1 *Kansyore Chronology and Land Use Patterns in Western Kenya*

Despite the relative abundance of research in western Kenya compared to other parts of East Africa, a lack of reliable radiocarbon dates from sites has continued to limit long-term, diachronic understandings of the Kansyore sequence. Most sites in the region were excavated in the 1980s and 1990s when systematic investment in radiocarbon sequences was not prioritized. Potential issues with bone apatite, shell, and bulk dates during this period, including soil carbonate contamination and reservoir effects (Philippsen 2013), as well as the potential for mixing due to bioturbation in long sequences (e.g., Gogo Falls) led to chronological uncertainty at many Kansyore sites (Robertshaw & Collett 1983; Robertshaw 1991; Karega-Munene 2002; Dale & Ashley 2010; Prendergast & Lane 2010). Since then, dam construction on rivers draining into Lake Victoria has threatened or destroyed many sites. Nevertheless, broad correlations among dates, ceramic styles, and settlement patterns in the region are observed.

Researchers identify Early Kansyore ceramics and dates at shell midden sites along the lakeshore, including Luanda, Kanam, Kanjera West, and Pundo (Fig. 1, Table 1). An early Holocene date was also recovered from the Namaboni B shell midden (Tibesasa & Jones 2021), but ceramic analyses have yet to confirm whether its materials can be definitively attributed to the Early Kansyore. Evidence of Late Kansyore occupation is more common at large, open-air sites near inland river rapids including Siror, Gogo Falls, and Wadh Lang'o. Usenge 3 is the only lakeshore site attributed to the Late Kansyore. Siror and Gogo Falls preserve both Early and Late Kansyore ceramics, which are sequenced laterally at Siror and vertically at Gogo Falls. Late Kansyore levels are overlain by Elmenteitan pastoral and subsequent EIA Urewe levels at Gogo Falls (Robertshaw 1991; Karega-Munene 2002) and Wadh Lang'o (Prendergast 2010). Late Kansyore levels at Gogo Falls and Wadh Lang'o also preserve some domestic fauna and the latest Kansyore occupations at Usenge 3 suggest cultural exchange with Urewe pottery-using agriculturalists by ~1.5 cal ka (Lane et al. 2007; Dale & Ashley 2010). Without better chronological controls, however, the contemporaneity of Late Kansyore, Elmenteitan, and Urewe occupations or activities in the region remains unclear.

2.2 *Kansyore Subsistence in Western Kenya*

Similar to findings from Kansyore Island in western Uganda (Chapman 1967; Kyazike 2019), faunal analyses at both Early and Late Kansyore sites in western Kenya indicate heavy fish-use with a secondary emphasis on a diverse range of terrestrial and amphibious mammals (Table 2), reptiles, and birds (Robertshaw et al. 1983; Stewart 1991; Marshall & Stewart 1995; Dale 2007: 141–147; Prendergast 2010; Prendergast & Lane 2010). However, archaeologists document differences in fish taxa at lakeshore versus riverine sites, which may indicate changing fishing and mobility strategies through time. Robertshaw et al. (1983) note that the earliest evidence of Kansyore ceramics were associated with evidence of intensive fishing at lakeshore sites. Evidence from Pundo suggests that Early Kansyore foragers captured estivating lungfish (*Protopterus aethiopicus*) in the swampy fringes of the lake during the dry season (Prendergast & Lane 2010). In contrast, an emphasis on carp and barbels (Cyprinidae) at a Late Phase site, Wadh Lang'o, is best explained by wet season fishing near rapids during the annual spawn (Prendergast 2010). Following Gifford (Robertshaw et al. 1983) and Stewart (1991), Prendergast & Lane (2010; Prendergast 2010) argue that Kansyore foragers moved systematically between the lake and inland rivers to exploit lungfish and carp at different times of the year. However, contemporary riverine and lakeside faunal assemblages required to test this hypothesis are sparse, as are dependable dates for understanding when these behaviors could have emerged. The chronological gap in the Kansyore sequence between ~7 and 4.4 cal ka also raises questions about the timing and

TABLE 1 Summary of dated Kansyore sites in the northeastern Lake Victoria Basin (adapted from Prendergast & Lane 2010). All raw C14 ages recalibrated using the Mix_Curves function in OxCal 4.4 (Bronk Ramsey & Lee 2013). The IntCal20 (Reimer et al. 2020) and SHCal20 (Hogg et al. 2020) atmospheric curves were applied randomly, after similar studies in equatorial Africa (Ranhorn & Tryon 2018; Tryon et al. 2018; Prendergast et al. 2019; Jones et al. 2021; Tibesasa & Jones 2021) and South America (Marsh et al. 2017, 2018)

Site	Area	Phase	Material	^{14}C yr BP	Cal BP (95.4%)	Reference
Luanda	Lake	Early	BA (AMS C14)	8240±245	9720–8459	Robertshaw et al. 1983
			SH (C14)	6740±80	7694–7429	Robertshaw et al. 1983
Namaboni	Lake	?	SC (AMS C14)	7728±36	8588–8412	Tibesasa & Jones 2021
Kanam	Lake	Early	EA (AMS C14)	7400±20	8323–8038	Chritz et al. 2019
Pundo	Lake	Early	WC (AMS C14)	7000±40	7932–7677	Lane et al. 2006
			WC (AMS C14)	6980±60	7930–7696	Lane et al. 2006
			WC (AMS C14)	6880±60	7835–7582	Lane et al. 2006
Kanjera West	Lake	Early	BA (C14)	5845±310	7419–5998	Robertshaw et al. 1983
*White Rock Point	Lake	?	BA (C14)	4015±260	5284–3732	Robertshaw et al. 1983
*Lugala A1	Lake	?	WC (AMS C14)	4718±35	5574–5320	Tibesasa & Jones 2021
*Usenge 3	Lake	Late	WC (AMS C14)	3310±40	3630–3400	Lane et al. 2006
			WC (AMS C14)	3240±70	3632–3252	Lane et al. 2006
			WC (AMS C14)	1560±40	1529–1348	Lane et al. 2006
**Siror	River	Early	SC (AMS C14)	7735±35	8589–8416	Dale 2007
			SC (AMS C14)	7415±35	8342–8039	Dale 2007
			SC (AMS C14)	6405±35	7423–7178	Dale 2007
			WC (AMS C14)	6370±35	7419–7166	Dale 2007
			SC (AMS C14)	6194±47	7246–6943	Dale 2007
		Late	WC (AMS C14)	2905±37	3159–2882	Dale 2007
			SC (AMS C14)	2889±36	3147–2873	Dale 2007
**Gogo Falls	River	Early	BT (AMS C14)	7300±500	9416–7259	Gowlett et al. 1987
			BA (C14)	5805±185	7156–6210	Robertshaw 1991
		Late	WC (AMS C14)	3480±75	3961–3491	Karege-Munene 2002
			WC (AMS C14)	3170±70	3554–3172	Karege-Munene 2002
			WC (C14)	3020±100	3440–2885	Robertshaw 1991
			WC (AMS C14)	2030±65	2131–1750	Karege-Munene 2002
			WC (AMS C14)	2000±70	2097–1742	Karege-Munene 2002
Wadh Lang'o	River	Late	WC (AMS C14)	3850±30	4403–4098	Prendergast 2008
			WC (AMS C14)	3770±35	4236–3984	Prendergast 2008
			WC (AMS C14)	3740±35	4228–3930	Prendergast 2008
			WC (AMS C14)	1989±28	1993–1834	Ashley 2005
			WC (AMS C14)	1950±35	1985–1747	Prendergast 2008

BA = bone apatite; BT = burnt tooth; EA = enamel apatite; OH = obsidian hydration; SC = seed charcoal; SH = shell; WC = wood charcoal
* White Rock Point, Lugala A1, and Usenge 3 discussed in the 'Discussion' section; ** Early and Late Phase deposits are sequenced laterally at Siror and vertically at Gogo Falls.

TABLE 2 Mammals present at Kansyore sites in western Kenya (Robertshaw et al. 1983: 38–41; Dale 2007: 141–147; Prendergast 2010; Prendergast & Lane 2010), categorized by mammalian and bovid size classes used at Namundiri A (after Jones et al. 2018)

Size class	Weight (kg)	Early Kansyore mammals	Late Kansyore mammals
1	0–20	Vervet monkey, dik-dik, small canid, naked mole rat, fruit bat	Vervet monkey, Colobus monkey, civet, cane rat
2	20–60	Grant's gazelle, Thomson's gazelle, Bohor reedbuck, porcupine	Baboon, domestic Goat, Grant's gazelle, Thomson's gazelle, Bohor reedbuck
3	60–100	Warthog, bushpig, bushbuck, aardvark	Hyaena, warthog, bushpig, bushbuck
4	100–500	Giant forest hog, Uganda kob, water-buck, hartebeest, wildebeest	Giant forest hog, zebra, water-buck, hartebeest, wildebeest
5	> 500	Hippopotamus, African buffalo, eland	Hippopotamus, African buffalo

nature of behavioral differences between the Early and Late Phases, in general.

To begin addressing these and other questions, Tibesasa & Jones (2021) conducted archaeological excavations at three new Kansyore sites just over the Ugandan border with Kenya. This study focuses on radiocarbon dates and faunal data from one of these sites, the Namundiri A shell midden, within the context of other Kansyore sites in western Kenya. The geographic and environmental proximity of western Kenya to eastern Uganda, as well as the lack of well-studied sites from neighboring regions, provide the rationale for this analytical framework.

3 Study Area

Lake Victoria is the largest tropical lake in the world, covering 69,485 km^2 (Saundry & Fund 2012). Its catchment, known as the Lake Victoria Basin, spans ~190,000 km^2 between the western Great Rift Valley and the eastern Albertine Rift of East Africa. The northeastern portion of the basin (the focus of this study) encompasses parts of eastern Uganda and western Kenya. The northeastern Lake Victoria Basin is characterized by a mosaic of forests, bushlands, and secondary grasslands (White 1983), which receive ~1200–1600 mm of rainfall per year with peaks during two wet seasons today: the long rains from March–May and the short rains from November–December (Sene & Plinston 1994; Nicholson 1996, 1998). This study uses new data from the Namundiri A shell midden in eastern Uganda, ~4.5 km from the border with western Kenya (Fig. 1), to understand regional land-use and subsistence patterns among Kansyore fisher-hunter-gatherers.

3.1 *Namundiri A*

Namundiri A is located in the modern village of Namundiri A, Busia District, Uganda. The site sits ~50 m north of papyrus swamps that extend into Lake Victoria today (Fig. 2). Situated ~1,145 m above sea level, the landscape surrounding the site slopes gradually toward the lake's edge. More detailed topographic features, such as paleo-shorelines, were difficult to discern due to a dense maize field covering the site at the time of excavations. This also made it difficult to determine the full extent of the site. However, shell and pottery surface scatter indicate an oval shape covering an area of ~25 m in diameter (Fig. 3).

3.2 *Excavations at Namundiri A*

Excavations at Namundiri A were conducted between May and July of 2016 and 2018. The 2016 excavations conducted by R. Tibesasa consisted of a single 2 × 2 m trench (Trench 1; Fig. 3) located near the western edge of the site. This location, next to a walking path through the maize field, was chosen by the landowner to limit crop destruction. Materials from the 2016 excavations have not been fully analyzed and are curated at the Uganda Museum in Kampala.

In 2018, M. Jones and R. Tibesasa codirected the re-excavation and expansion of Trench 1 in order to conduct a fine-grained study of the site's stratigraphy and to collect charcoal for radiocarbon dating. Excavations consisted of a single 2 × 0.5 m trench extension (Trench 1 Extension; Fig. 3) dug in arbitrary 10 cm levels unless depositional changes were encountered. All sediment was sieved through 5 mm mesh to ensure artifact recovery. Two 5 litres sediment samples were collected from each stratigraphic layer for geochemical and paleoethnobotanical analyses. Soil and flotation samples (along with the site's ceramics, lithics, and faunal remains) are currently stored in the Archaeology Section at the Uganda Museum.

3.3 *The Namundiri A Sequence*

The top ~30 cm of the sediments at Namundiri A were composed of heavily mixed agricultural till. This was

FIGURE 2 View from Namundiri A looking SW from the maize field to papyrus swamps leading into Lake Victoria
PHOTO BY MJ, 2016

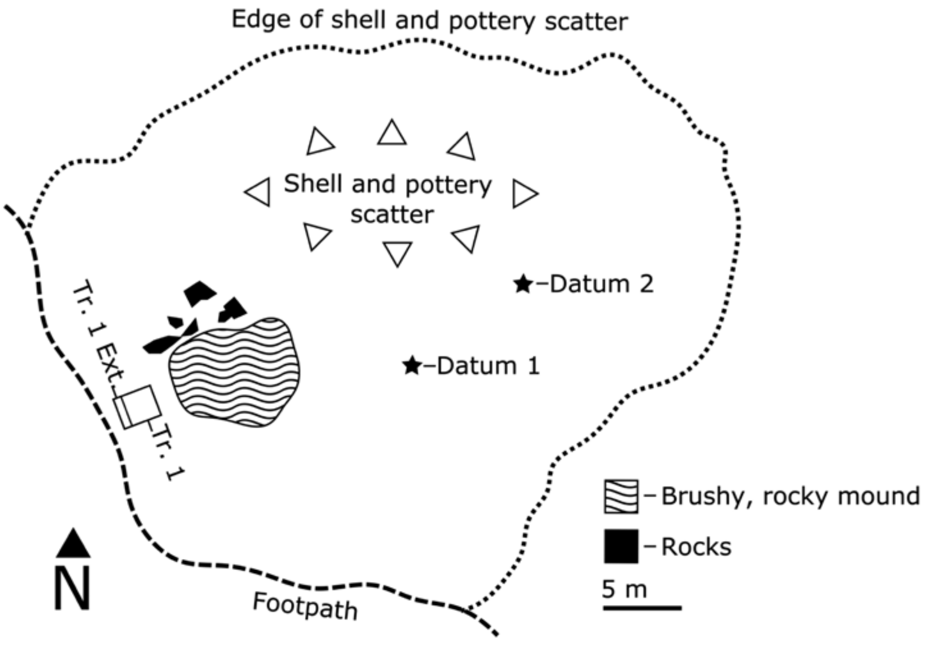

FIGURE 3 Site map of Namundiri A
REPRODUCED FROM TIBESASA & JONES 2021

followed by ~1 m of midden-like archaeological deposits (Fig. 4). Large amounts of shellfish, animal bones, and pottery were recovered from these sediments, along with small numbers of crude, quartz lithics and lithic debris as well as a few bone points similar to those identified by Robertshaw et al. (1983) at other shell midden sites. The density of artifacts began to taper off midway through the ~1 m of archaeological deposits before reaching a layer of sterile, beach-like sand. A summary profile with radiocarbon dates and soil descriptions is provided in Fig. 5.

4 Materials and Methods

This study uses radiometric and faunal data to investigate the occupational chronology and associated subsistence

FIGURE 4 Trench 1 Extension, SW profile
PHOTO BY MJ, 2018

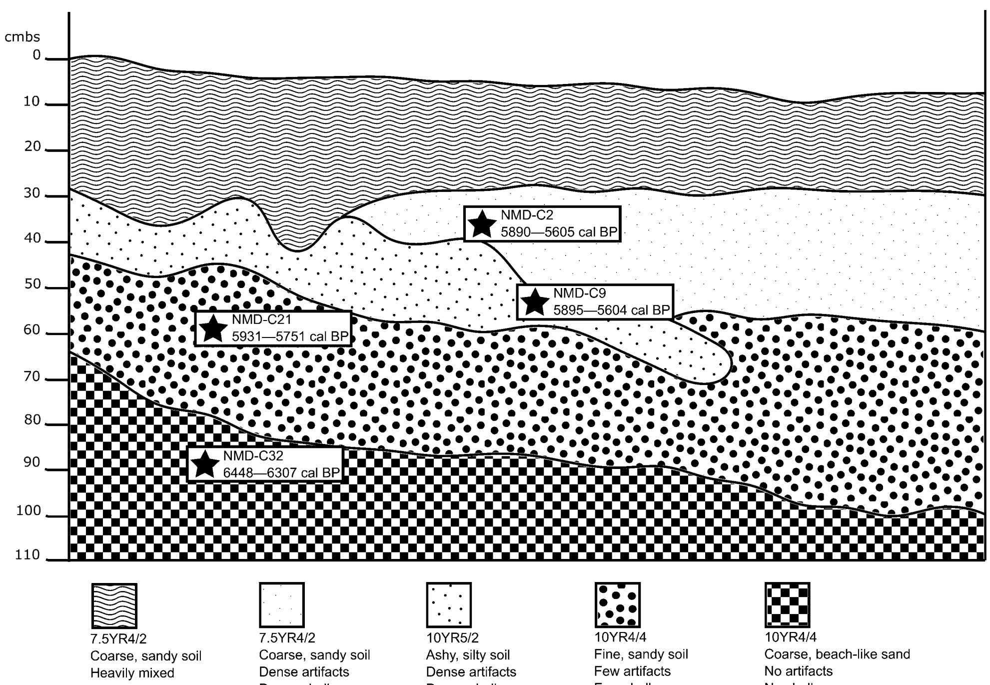

FIGURE 5 Trench 1 Extension, drawing of SW profile with positions of dated charcoal samples (cmbs = centimeters below surface)

strategies practiced at the Namundiri A shell midden in eastern Uganda. We obtained AMS radiocarbon dates from recovered charcoal samples and information related to hunting and fishing behaviors from well-preserved archaeological animal bones.

4.1 *Dating Methods*

In 2018, we sampled charcoal from throughout the site's sequence and recorded the precise spatial and depositional context of each specimen. Once documented, all specimens were exported to Washington University in St. Louis for sample selection and preparation. We collected a total of 30 charcoal specimens from the Trench 1 Extension. Since no carbonized seeds were obtained, we selected four wood charcoal samples to process for AMS radiocarbon dates from distinct depositional layers distinguished mainly by soil color and texture to investigate the full extent of occupation at Namundiri A. Samples near the boundaries of layers were preferentially selected to examine possible changes in site use. Once selected, samples were shipped to the AMS Laboratory at the University of Arizona for AMS radiocarbon analysis. The remaining 26 samples are curated in the Zooarchaeology Lab at Washington University in St. Louis. Funding for additional dates is currently being pursued. All remaining undated charcoal will be sent back to the Archaeology Section at the Uganda Museum to be stored with the rest of the materials from the site.

4.2 *Faunal Methods*

Faunal analyses on material from the 2018 excavation at Namundiri A were conducted by one of us (MJ) in the Archaeology and Osteology labs at the National Museums of Kenya (NMK) in Nairobi to make use of their extensive comparative collections. Identification references for African fauna were also used, including Gentry (1978), Peters (1988, 1989), and Walker (1985). We sorted, quantified, and identified the fauna following zooarchaeological methods used in similar studies in East Africa (Robertshaw et al. 1983; Stewart 1991; Marshall & Stewart 1995; Prendergast 2010; Prendergast & Lane 2010). For this study, we focused on all identifiable specimens that could be classified to class or lower (Gifford & Crader 1977). The assemblage was highly diverse, but largely dominated by fish. Mammals were the second most common taxa identified. To maximize the analytical potential of the mammalian assemblage, we sorted all mammal bones that could not be identified beyond class into five size categories following Jones et al. (2018, Table 2). Unidentifiable bovid bones were also sorted into size classes. In addition to fish and mammal bones, small numbers of reptile and bird remains were recovered. We quantified the assemblage by Number of Identifiable Specimens (NISP) and Minimum Number of Individuals (MNI) (Klein & Cruz-Uribe 1984: 24–32; Reitz & Wing 1999: 191–200). We used NISP measures for basic descriptions of the assemblage and both NISP and MNI values for secondary faunal analyses.

We calculated taxonomic frequencies at Namundiri A and other Kansyore sites in western Kenya with available faunal data attributed to the Early or Late Phase of occupation (see Table 3). Information on Early Kansyore hunting and fishing patterns were available from Luanda, Kanam, Kanjera West, and Pundo (Robertshaw et al. 1983; Prendergast & Lane 2010). Wadh Lang'o was the only Late Phase site with adequate faunal data for this analysis (Prendergast 2010). We measured fish versus non-fish taxa to examine basic subsistence strategies at all six sites using both NISP and MNI. We also calculated the frequencies of identified fish taxa by MNI to investigate differential patterns of fish-use between sites. We grouped all identified fish taxa by order so that datasets from different sites were comparable. Four main orders were identified: Lepidosireniformes (lungfishes), Siluriformes (catfishes), Perciformes (perch-like fishes), and Cypriniformes (carps and barbels). The following formula was used to calculate frequencies (following Reitz & Wing 1999: 200–202): $Xn / Yn = Z_X n$, where Xn = NISP or MNI of faunal materials attributed to subgroup X at site n; Yn = NISP or MNI of total ID specimens at site n; $Z_X n$ = relative frequency of subgroup X at site n.

Taphonomic analyses included documentation of surface modifications of all animal bones (excluding teeth) from Namundiri A (following Behrensmeyer 1978). We

TABLE 3 Dated early and late Kansyore sites with faunal assemblages. For this study, we focus on the five sites with quantitative taxonomic data (NISP and MNI) for both fish and non-fish remains

Site	Location	Phase	Faunal data	Total NISP (MNI)	References
Luanda	Lake	Early	Yes	2217 (330)	Robertshaw et al. 1983
Kanam	Lake	Early	Yes	211 (42)	Robertshaw et al. 1983
Pundo	Lake	Early	Yes	8235 (234)	Prendergast & Lane 2010
Kanjera West	Lake	Early	Yes	454 (64)	Robertshaw et al. 1983
Usenge 3	Lake	Late	Incomplete	3992 (–)	Lane et al. 2007
Siror	River	Early	No	–	–
		Late	Incomplete	–	Dale 2007
Gogo Falls	River	Early	No	–	–
		Late	Incomplete	–	Stewart 1991; Karega-Munene 2002
Wadh Lang'o	River	Late	Yes	8649 (175)	Prendergast 2010

TABLE 4 AMS radiocarbon dates from Namundiri A; all samples run in the University of Arizona AMS Laboratory. Dates were calibrated using OxCal4.4 (Bronk Ramsey & Lee 2013) on a randomized mixed curve using IntCal20 (Reimer et al. 2020) and SHCal20 (Hogg et al. 2020)

Lab#	Sample#	Material	^{14}C yr BP	Cal BP (95.4%)
X34535	NMD-C2	Wood charcoal	5017±24	5890–5605
X34534	NMD-C9	Wood charcoal	5023±44	5895–5604
X34533	NMD-C21	Wood charcoal	5132±24	5931–5751
X34536	NMD-C32	Wood charcoal	5628±24	6448–6307

also analyzed mammalian body part representation to examine patterns of bone loss, following Thompson & Henshilwood (2011).

5 Results

The four AMS radiocarbon dates obtained from Namundiri A were sampled from upper and lower portions of the sequence to examine site use through time (Table 4, Fig. 5). Dates suggest people occupied Namundiri A ~6.4–5.6 cal ka. The earliest date (6448–6307 cal BP) was sampled near the boundary between the lowermost archaeological deposits at the site and sterile sediments, suggesting a reasonable age for the earliest occupations at Namundiri A. Although the other three dates were sampled from distinct depositional layers, they showed considerable temporal overlap (5931–5751 cal BP, 5895–5604 cal BP, and 5890–5605 cal BP). This suggests that either the different layers identified during excavations were deposited over a relatively short timeframe between ~5.9 and 5.6 cal ka or the charcoal samples moved throughout the sequence following deposition. Due to clear agricultural mixing in the upper ~30 cm, we were unable to date the most recent deposits at the site.

5.1 *The Fauna from Namundiri A*

We recovered a total of 7,444 bones from the Trench 1 Extension at Namundiri A (Table 5), of which 69.0% (NISP = 5136/7444) could be identified to class or lower. Fish bones dominated the identifiable assemblage (86.9% NISP; 87.1% MNI). African lungfish was the most common fish taxon identified (26.8% NISP; 59.3% MNI). Cichlid (21.7% NISP; 24.7% MNI) and catfish (13.2% NISP; 16.0% MNI) bones were also present.

Namundiri A also preserved a diversity of non-fish taxa. The mammals (12.5% NISP; 9.7% MNI) from the assemblage indicate hunting in diverse environments, including forested (e.g., vervet monkey, giant forest genet, and giant forest hog), grassland (e.g., African elephant, warthog, plains zebra, and eland), and more well-watered habitats common along the shores of Lake Victoria (e.g., common hippopotamus, waterbuck, and Bohor reedbuck). Reptile and bird bones were also recovered at low frequencies (< 1% NISP; 3.2% MNI). No domestic fauna was identified at the site.

Contextual and bone modification data from Namundiri A suggested that most, if not all, of the fauna was deposited by people. All bones were recovered from a dense, open-air midden context in close association with other artifacts including pottery and lithics. Burning was observed on fish, mammal, and reptile bones from the site and cut and chop marks were observed on mammalian specimens. Carnivore gnawing was present on a medium bovid distal tibia, but we assumed this was the result of post-depositional activities and not evidence of carnivores bringing bones to the site.

5.2 *Taxonomic Frequencies*

The high frequency of fish bones at Namundiri A was consistent with other Kansyore sites in western Kenya (Fig. 6), including Luanda, Kanam, Kanjera West, and Pundo. At Wadh Lang'o, fishes were slightly less pronounced.

Although overall patterns of fish-use were high across Kansyore sites, variation existed in the composition of fish taxa (Fig. 7). At Namundiri A, lungfishes dominated, followed by perch-like fishes and catfishes. Lungfishes were also the most common fish taxa at Kanam and Luanda. At Kanjera West, catfishes were more common than lungfishes. Perch-like fishes were the most common fish taxa at Pundo, which was also the only lakeshore site that preserved carp and barbel bones. At Wadh Lang'o, carps and barbels were the most common taxa found.

5.3 *Bone Weathering and Body Part Representation*

The fauna from Namundiri A was generally well-preserved. Most of the bones (89.3%, NISP = 6618/7415) exhibited stage 1 weathering (Behrensmeyer 1978): no cracking or minor cracking on the outer layer of bone. A smaller percentage (10.7%, NISP = 797/7415) showed signs of stage 2 weathering: more extensive cracking on the outer layer of bone. Although mammalian NISP values were low (Table 6), body part representation showed a greater number of dense elements (e.g., teeth) and fewer spongy (cancellous) bones at the site. Although this pattern suggested some degree of preservation bias, it was not considered a major hindrance to the broad faunal interpretations made in the study.

TABLE 5 Species representation at Namundiri A

General	Taxon	Common Name	NISP (MNI)
Mammals	*Chlorocebus* spp.	Vervet monkeys	2 (2)
	Cercopithecidae	Old World monkeys	2 (–)
	Primates 1	Primates < 20 kg	1 (–)
	Genetta cf. *victoriae*	Giant forest genet	2 (1)
	Loxodonta cf. *africana*	African elephant	1 (1)
	Hippopotamus cf. *amphibious*	Common Hippopotamus	7 (1)
	Equus cf. *quagga*	Plains zebra	1 (1)
	cf. *Hylochoerus meinertzhageni*	Giant forest hog	4 (1)
	Phacochoerus spp.	Warthogs	1 (1)
	Suidae 3	Pigs 60–100 kg	2 (–)
	Syncerus caffer cf. *caffer*	African buffalo	7 (1)
	cf. *Taurotragus oryx*	Eland	3 (2)
	Tragelaphus cf. *scriptus*	Bushbuck	2 (1)
	Tragelaphini	Spiral-horned bovines	3 (1)
	Kobus cf. *ellipsiprymnus*	Waterbuck	13 (2)
	Kobus spp.	Kobs	1 (–)
	Redunca cf. *redunca*	Bohor reedbuck	1 (1)
	Reduncinae	Kobs and reedbucks	1 (–)
	Neotragini	Dwarf antelopes	3 (1)
	Bovidae 1	Bovids < 20 kg	2 (–)
	Bovidae 2	Bovids 20–60 kg	3 (–)
	Bovidae 3	Bovids 60–100 kg	5 (–)
	cf. *Smutsia gigantea*	Giant pangolin	1 (1)
	Mammal 1	Mammals < 20 kg	2 (–)
	Mammalia 2	Mammals 20–60 kg	7 (–)
	Mammalia 3	Mammals 60–100 kg	5 (–)
	Mammalia 4	Mammals 100–500 kg	3 (–)
	Mammalia, indet.	Indeterminate mammals	559 (–)
Reptiles	Testudines	Turtles and tortoises	1 (1)
	Crocodylus cf. *niloticus*	Nile crocodile	2 (1)
	Varanus spp.	Monitor lizards	7 (1)
	Serpentes	Snakes	7 (1)
	Reptilia, indet.	Indeterminate reptiles	11 (–)
Birds	Aves, indet.	Indeterminate birds	3 (2)
Fishes	*Protopterus* cf. *aethiopicus*	Marbled lungfish	1195 (96)
	Bagrus spp.	Bagrus catfishes	31 (10)
	Clarias spp.	Walking catfishes	427 (16)
	Siluriformes	Catfishes	129 (–)
	Cichlidae	Cichlid fishes	968 (40)
	Fish, indet.	Indeterminate fishes	1711 (–)
	TOTAL		**5136 (186)**

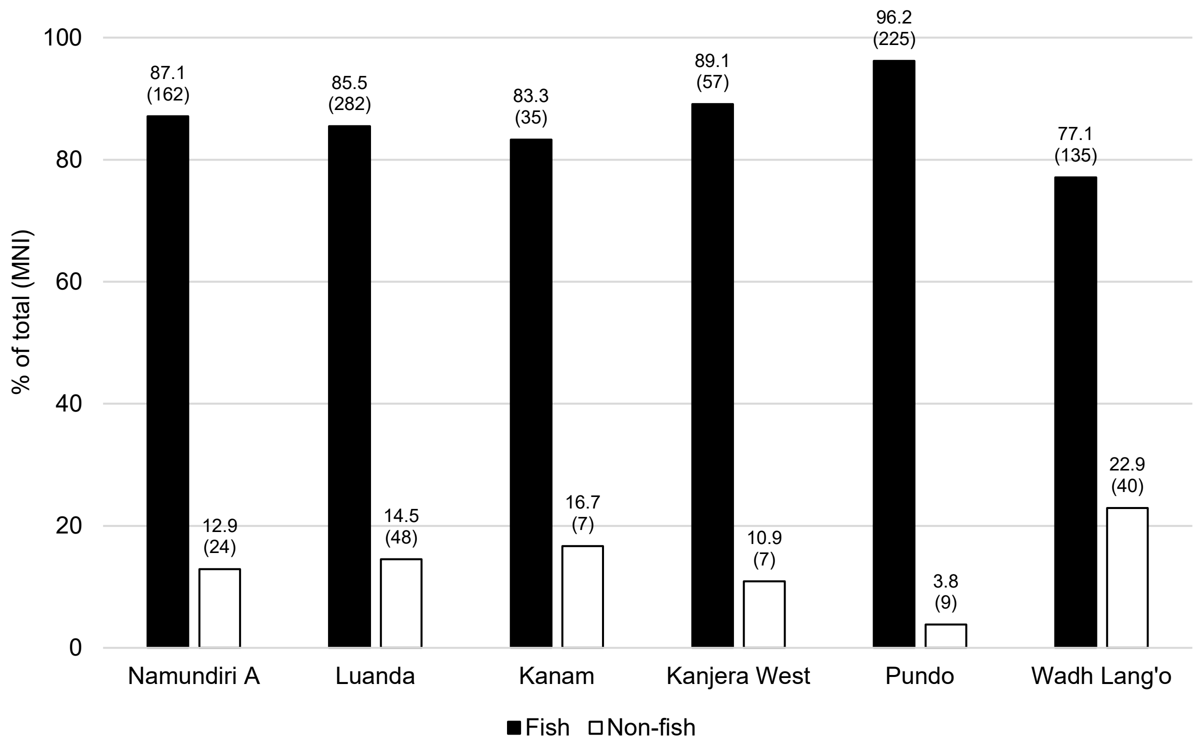

FIGURE 6 Relative frequencies of fish and non-fish bones from Namundiri A and other Kansyore sites in western Kenya by MNI
ROBERTSHAW ET AL. 1983: 38–41; PRENDERGAST 2010; PRENDERGAST & LANE 2010

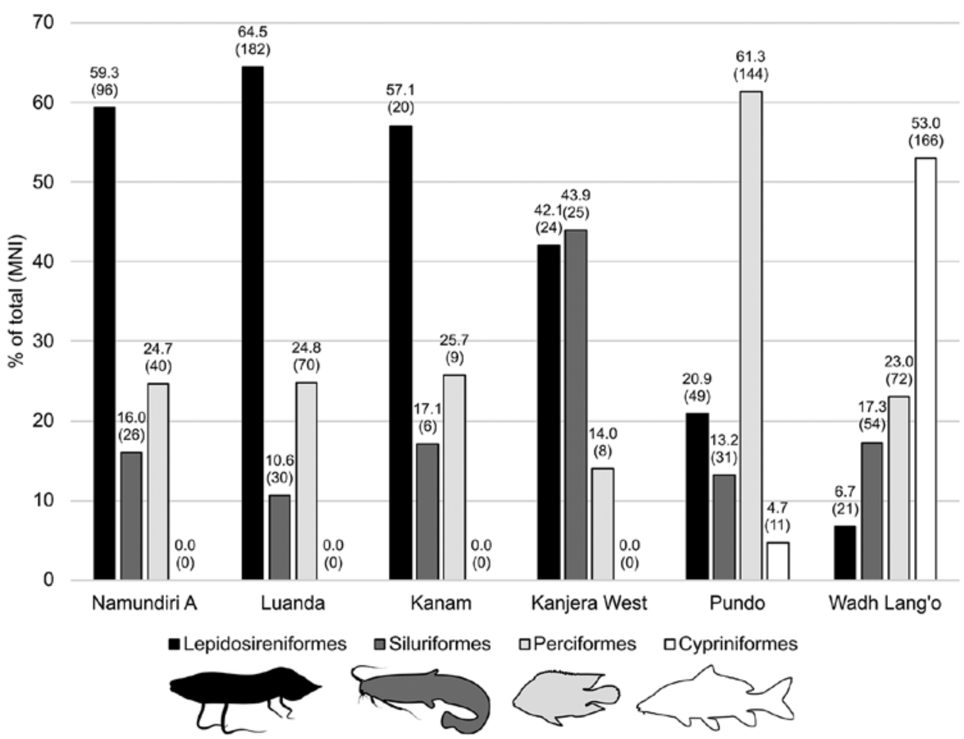

FIGURE 7 Relative frequencies of Lepidosireniformes (lungfishes), Siluriformes (catfishes), Perciformes (perch-like fishes), and Cypriniformes (carps and related fishes) at Namundiri A and other Kansyore sites in western Kenya by MNI
ROBERTSHAW ET AL. 1983: 38–41; PRENDERGAST 2010; PRENDERGAST & LANE 2010

TABLE 6 Mammalian body part representation at Namundiri A (following Thompson & Henshilwood 2011)

Element	NISP
Tooth	28
Cranial	6
Mandible	4
Vertebra	13
Rib	2
Pelvis	–
Scapula	4
Humerus	1
Radius/Ulna	3
Femur	3
Tibia/Fibula	3
Patella/Sesamoid	1
Carpal/Tarsal	7
Metapodial	6
Phalanx	4

6 Discussion

The new AMS radiocarbon dates from Namundiri A reveal that fisher-hunter-gatherer groups used the site between 6448–6307 cal BP and 5890–5605 cal BP. These findings provide the first definitive evidence of Kansyore occupation in the Lake Victoria Basin during the chronological gap between ~7 and 4.4 cal ka. Investigating whether Kansyore groups from this "missing" middle period relied on lakeshore and/or riverine habitats helps understand the trajectory of complex social and economic systems including specialized fishing strategies centered around seasonal landscape use and technological elaboration. In doing so, these finding provide the first opportunity to begin to synthesize the entire ~7000-year Kansyore sequence in ways that account for climatic and social factors in shaping complex fisher-hunter-gatherer systems over time.

It should be noted that a single date (5284–3732 cal BP) from White Rock Point also hints at possible middle Holocene site use (Robertshaw et al. 1983), but the 1552-year age range and concerns about the susceptibility of bone apatite to contamination make it difficult to confidently interpret the site's age within the broader Kansyore chronology. A date (5574–5320 cal BP) from Lugala A1 in eastern Uganda also shows middle Holocene Kansyore activity near the lakeshore (Tibesasa & Jones 2021). However, the scarcity of archaeological materials from Lugala A1 suggests only ephemeral occupation and limits more robust chronological or behavioral interpretations.

6.1 *Subsistence Strategies at Namundiri A*

The diverse non-fish faunal assemblage at Namundiri A is dominated by mammals (95.4% NISP; 75.0% MNI). Taxonomic diversity among the mammalian assemblage suggests hunters between ~6.4 and 5.6 cal ka targeted a wide range of animals characteristic of wooded and more open environments, as well as wetter habitats closer to the lake's edge. Mammals present at the site include primates, genets, elephants, hippopotamuses, zebras, wild hogs, a range of wild bovids, and pangolins. Turtles, crocodiles, monitor lizards, snakes, and birds were also recovered. Taxa identified at other Early and Late Phase Kansyore sites in the northeastern Lake Victoria region suggest similar hunting patterns throughout the Holocene (Robertshaw et al. 1983; Prendergast 2010; Prendergast & Lane 2010).

Fish remains (86.9% NISP; 87.1% MNI) comprise most of the Namundiri A assemblage. Large numbers of lungfish bones indicate a lake-based fishing strategy more akin to the Early, rather than Late, Kansyore Phase. Considered within the context of Early Phase sites in Kenya (e.g., Luanda, Kanam, and Kanjera West), evidence from Namundiri A suggests that Kansyore fishers focused intensively on lungfish in muddy habitats along the lake's edge from ~8.5 cal ka to at least ~5.6 cal ka. Considering the available data, regional comparisons of lakeshore and riverine sites provide evidence that these strategies had potentially changed by ~4.4 cal ka.

6.2 *Changing Kansyore Occupation Patterns*

From early on, archaeologists working in the northeastern Lake Victoria Basin observed that Kanysore pottery-producing groups seemed to focus heavily on lake-based fishing and hunting during the early Holocene (Early Phase) and used more inland riverine environments in later periods (Late Phase) (Robertshaw et al. 1983; Robertshaw 1991). However, Gifford (Robertshaw et al. 1983) and Stewart (1991; Marshall & Stewart 1995) suggested that faunal data from Kanyore sites pointed to a more integrated lake/river mobility and subsistence system throughout the Kansyore sequence. Building on these earlier studies, Prendergast (2010) and Prendergast & Lane (2010) compared fishing patterns among lake and riverine faunal assemblages to argue that Kansyore groups methodically cycled between dry season lakeshore fishing sites and wet season camps near inland rapids. This argument linked seasonal subsistence and specialized land-use patterns to delayed-return fishing technologies (e.g., nets and weirs) and fisher-hunter-gatherer complexity over time. Due to a lack of reliable radiocarbon dates and the limited geographic range of excavated sites in the region, however, it remained unclear when and why these strategies emerged. Only three Kansyore riverine sites have undergone systematic archaeological investigation: Gogo Falls, Siror, and Wadh Lang'o. Although sample sizes remain small and reliable radiocarbon dates from Kansyore sites are rare, a closer examination of the Namundiri A dates with those from other sites in the region offers new perspectives on Kansyore land-use and subsistence patterns through time.

Sites with dates that precede ~7 cal ka are found near rivers and along the lakeshore (Table 1). Sites that date after ~4.4 cal ka are almost exclusively found at open-air sites along rivers. Given the scarcity of lakeshore sites in the middle and later Holocene, evidence for contemporaneous river and lake use in the Late Kansyore period ~4.4–1.5 cal ka is not robust. This suggests that a seasonal round may have existed during the Early Phase, but not in later periods. Early Kansyore riverine fauna from Gogo Falls and Siror have not been studied in detail and could provide data for testing this hypothesis in the future.

Evidence of an increased focus on rivers and away from the lake during the Late Kansyore Phase coincides with observed rainfall fluctuations and increasing aridity ~5–4 cal ka, as well as the arrival of food producers to the region after ~3 cal ka. It is therefore possible that processes of change among Kansyore land-use and subsistence practices related to climatic and social transformations in the northeastern Lake Victoria Basin during the middle and later Holocene. It should be noted, however, that middle and later Holocene paleoclimatic and archaeological data from throughout the northeastern Lake Victoria Basin are scarce. As a result, the following discussion includes evidence of environmental and cultural changes south of the Nyanza Gulf (Gogo Falls is ~160 km southeast of Namundiri A) during later time periods than this study is explicitly concerned. These data provide the best contextual information currently available for understanding and interpreting Late Phase Kansyore occupation patterns and subsistence strategies in the northeastern Lake Victoria Basin.

6.3 *Climate and Kansyore Land Use and Subsistence*

Across northern and eastern Africa, researchers document increased rainfall beginning ~12 cal ka with a return to more arid conditions ~5 cal ka (Thompson et al. 2002; Garcin et al. 2012; Liu et al. 2017). In the Lake Victoria Basin, middle Holocene aridity occurred gradually and was characterized by increased rainfall seasonality (Beuning et al. 1997; Johnson et al. 2000; Stager & Johnson 2000; Talbot & Lærdal 2000). The timing and effects of this transition on lake and inland environments, however, varied across the lake (Stager & Johnson 2000), which would have affected Kansyore groups differently depending on local conditions.

Terrestrial leaf waxes preserved in a lake core located ~75 km SW of Namundiri A indicate a period of gradual drying throughout the northern Lake Victoria Basin (including the northeastern portion) ~9–4 cal ka (Berke et al. 2012). Stager et al. (1997, 2003) also document increasingly bimodal rainfall between ~8–5 cal ka in diatom records from Pilkington Bay and the Damba Channel in Uganda, ~75 km W of Namundiri A. As aridity and seasonality peaked in the middle Holocene, site locations in the northeastern basin suggest that Kansyore foragers mostly left the lakeshore and focused their occupation inland near river rapids. The reasons for this are unknown, but environmental changes may have influenced Late Kansyore choices to reduce lakeshore foraging.

Fossil pollen from northern Lake Victoria (Berke et al. 2012) and Pilkington Bay (Kendall 1969) indicate that terrestrial vegetation near the lake began transitioning from predominantly trees and shrubs (Moraceae) to grasses (Poaceae) with peak aridity and seasonal rainfall ~5–4 cal ka. Increasing C4 isotopic ratios after ~4 cal ka from Kansyore sites around the Nyanza Gulf of western Kenya (Chritz et al. 2019), including particularly strong signatures from ~2000-year-old pastoral levels at Gogo Falls (Chritz et al. 2015), suggest grasslands continued to expand into the later Holocene in certain areas. In the middle and later Holocene, this would have reduced the abundance of forest-dwelling fauna available to some Late Kansyore hunters. Although the effects of aridity on aquatic lakeshore environments at Lake Victoria are less clear, it is possible that populations of fish species found in swamp environments, such as lungfish, also decreased with aridity after ~5 ka. Fewer animal and fish resources would have made the lake less attractive to Kansyore foragers, perhaps encouraging them to leave altogether. This interpretive scenario can be interrogated through comparative carbon and oxygen isotopic analyses of fauna from Kansyore sites dating to periods before and after ~5–4 cal ka, which will provide a more detailed picture of the changing lakeshore and inland environments on which Kansyore hunters and fishers once relied.

In addition to environmental changes, preservation or sampling biases associated with middle and later Holocene lake level fluctuations could have also influenced the observed lack of Late Phase lakeshore sites in the northeastern basin. Lake Victoria is a shallow lake that Beverly et al. (2019) argue dried out completely during particularly arid periods in the terminal Pleistocene ~18–14 cal ka. Although lake level data is not available for the middle and later Holocene, it is possible that the shoreline retreated with increased aridity ~5–4 ka. If Kansyore groups moved further into the basin following the lake's edge at this time, then Late Phase lakeshore sites could have been submerged or washed away due to fluctuating lake levels in the later Holocene. The small amount of paleoclimatic and lake level data available from this period does not clearly support or deny this scenario. Stager et al. (2003) argue that lake levels rose minimally ~4 cal ka, followed by a gradual shallowing trend after ~2.7 cal ka. This resulted in ~3 m of beach deposits around the lake's margins. Berke et al. (2012) show slightly greater variability in hydroclimate over the last ~3000 years, which may have resulted in lake level fluctuations. It is unclear, however, whether these patterns caused enough change to affect the visibility of Late Kansyore sites along the lakeshore. More robust information about middle and later Holocene lake level changes in the northeastern Lake Victoria Basin is therefore needed to adequately test this hypothesis.

Another, not mutually exclusive, hypothesis is that the use of nets and weirs by Late Kansyore fishers (see Prendergast 2010) increased catch efficiency during the wet season carp spawn along river rapids, thereby reducing people's need for lungfish and other lakeshore resources at the time. This would suggest that other motivating factors, beyond environmental, may have also drawn Late Kansyore groups away from the lake.

6.4 *Social Change and Late Kansyore Land Use*

The Late Kansyore Phase overlapped with the arrival of Elmenteitan pastoralists ~3–2 cal ka (Karega-Munene 2002; Lane et al. 2007; Prendergast 2010) and Urewe EIA farmers ~1.5 cal ka (Ashley 2005; Lane et al. 2006, 2007) in the Lake Victoria Basin of western Kenya. Interactions with these new communities may have influenced Kansyore occupation patterns at this time. Archaeological sequences at Gogo Falls (Karega-Munene 2002) and Wadh Lang'o (Lane et al. 2006, 2007) indicate a period of interaction between fisher-hunter-gatherers and incoming herders followed by the replacement of Kansyore materials with pastoral Elmenteitan assemblages after ~2 cal ka and Urewe levels ~350 years ago. Based on the presence of caprine bones at Wadh Lang'o, Prendergast (2010) suggests that Kansyore foragers acquired domesticated animals from early herding groups as early as ~4.4 cal ka. Direct dates on the bones from Wadh Lang'o are needed to test this early date. At Usenge 3 and Gogo Falls, Karega-Munene (2002) and Lane et al. (2007) argue that domestic faunal remains indicate the management of small herds by Late Phase Kansyore groups in the later Holocene. Chritz et al. (2015) also suggest that mixed wild and domestic fauna in Elmenteitan levels at Gogo Falls reflect continued interactions and exchange between pastoralists and neighboring fisher-hunter-gatherers near the end of Kansyore occupation in the basin. However, stratigraphic issues and a lack of fine-grained chronological control at Gogo Falls limit interpretations. The lack of domesticated fauna at Siror after ~3 ka (as well as in western Uganda at Kansyore Island [Kyazike 2019]) also suggests that patterns of herder/forager interactions varied from place to place. Despite these discrepancies, it is clear that the integration of domesticated animals influenced changing Kansyore economic systems and, potentially, land-use strategies in some areas.

Beginning ~1.7 cal ka, archaeologists observe a reoccupation of the Nyanza Gulf shoreline by Urewe-producing farming communities (Lane 2004; Ashley 2005, 2010; Lane et al. 2006, 2007; Dale & Ashley 2010). It is unclear what caused this ~3000-year break in the archaeological record after ~5.6 cal ka or why people started to settle by the lake again in the later Holocene. Whatever the reasons, the data suggest that the arrival of these new groups impacted Kansyore lifeways in some parts of the northeastern basin. Archaeologists document interactions among Late Phase fisher-hunter-gatherers and early Urewe farmers at the Usenge 3 lakeshore site, where ceramic evidence suggests Kansyore potters were learning to imitate EIA Urewe pottery styles by ~1.5 cal ka (Ashley 2005; Lane et al. 2007; Dale & Ashley 2010). Greater reliance on domesticated animals, including the first evidence of cattle at a Kansyore site, is also observed at Usenge 3 at this time. Based on increasing ceramic densities and the presence of fauna associated with settled communities (e.g., giant elephant shrew, *Rhynchocyon chlysopygus*), Lane et al. (2006) argue that EIA influences among Late Kansyore foragers coincided with denser, more sedentary occupations at the site. Longer-term occupations, often by larger groups of people, are a common indicator of hunter-gatherer complexity worldwide (Williams 1987; Arnold 1996; Rick et al. 2005; Garcea 2006; Boethius 2017).

6.5 *Fisher-Hunter-Gatherer Complexity in the Northeastern Lake Victoria Basin*

An increasingly intricate picture of Kansyore land use and subsistence intensification tied to both climatic and social factors in the northeastern Lake Victoria Basin offers new perspectives on temporal variability among delayed-return or complex hunter-gatherers, broadly. The rise of complex Kansyore systems and their eventual dissolution, as people either assimilated to Elmenteitan pastoral or Urewe farming lifeways or else disappeared, is less straightforwardly associated with changing climatic conditions than observed in parts of Eurasia (Wengrow & Graeber 2015), North America (Angelbeck & Grier 2012), and northern Africa (Barich 2013; di Lernia 2001; Garcea 2001, 2006). This is evidenced by Early Kansyore communities' gradual adoption of the production, use, and discard of substantial numbers of elaborately decorated pots, and intensive site re-use during the generally humid, climatically stable early Holocene. However, changing occupation patterns and delayed-return fishing technologies among Late Phase fisher-hunter-gatherers coincide with increased aridity and rainfall seasonality in the middle and later Holocene, suggesting greater sensitivity to local climate patterns than argued by archaeologists in southern Africa (Jerardino 2010, 2012) and the Levant (Byrd 2005; Maher et al. 2012; Munro 2009; Stutz et al. 2009).

Evidence of interactions among Kansyore groups and incoming early food producers are integral to the story of Late Phase fisher-hunter-gatherer complexity in the northeastern Lake Victoria Basin, further reinforcing the significance of externally or internally generated social shifts. Altogether, these findings strengthen previous research suggesting that the Kansyore archaeological tradition represents an especially interesting, multifaceted case of complex tropical fisher-hunter-gatherers in Africa. The limited number of excavated and well-dated sites, however, restricts the granularity of temporal and landscape shifts. To remedy this, the identification and excavation of new Kansyore sites, as well as continued research at recently discovered sites like Namundiri A and Namaboni B in eastern Uganda and legacy sites in western Kenya, are necessary. This work is particularly urgent given the pace and extent of site destruction due to shell and sand mining along the lakeshore (Tibesasa & Jones 2021). Renewed research in the northeastern Lake Victoria Basin will clarify the roles that climatic and cultural changes played in influencing Kansyore social and economic systems during the Holocene, thereby significantly boosting understandings of the processes affecting fisher-hunter-gatherer social and economic variability in tropical lake settings, broadly.

Acknowledgements

Funding for this research was provided by the Wenner-Gren Foundation (MJ grant #9544), Washington University in St. Louis (MJ), the University of Pretoria (RT), and the National Institute of Humanities and Social Sciences in South Africa (RT). Dr. Ceri Ashley and Professor Fiona Marshall aided in project development and provided interpretive insights and advisory support. Fieldwork logistics and research goals were developed with help from Professor Nabalegwa Muhamud Wambede and Dr. Turyabanawe Loy of Kyambogo University. The Uganda Museum and Dismas Ongwen provided institutional support. We would also like to thank our amazing field team, Melkia Arinaitwe, Charles Muzira, Zenobia Kibetenga, Godfrey Wamutu, Charity Twikirize, Agnes Twijukye, Oliver Nafula, Isaac Wafula, Betty Nagira, Moses, and Douglas, as well as the people of Namundiri village for making this work possible.

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