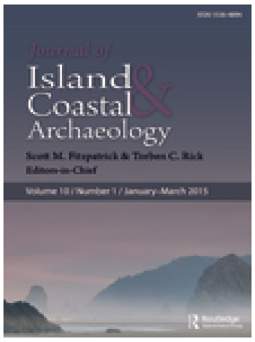

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ABSTRACT

Recent archaeological research has firmly established eastern Africa's offshore islands as important localities for understanding the region's pre-Swahili maritime adaptations and early Indian Ocean trade connections. While the importance of the sea and small offshore islands to the development of urbanized and mercantile Swahili societies has long been recognized, the formative stages of island colonization—and in particular the processes by which migrating Iron Age groups essentially became "maritime"—are still relatively poorly understood. Here we present the results of recent archaeological fieldwork in the Mafia Archipelago, which aims to understand these early adaptations and situate them within a longer-term trajectory of island settlement and pre-Swahili cultural developments. We focus on the results of zooarchaeological, archaeobotanical, and material culture studies relating to early subsistence and trade on this island to explore the changing significance of marine resources to the local economy. We also discuss the implications of these maritime adaptations for the development of local and long-distance Indian Ocean trade networks.

Keywords fishing, Iron Age, Late Holocene, Mafia Archipelago, maritime adaptation, Pre-Swahili

INTRODUCTION

While much research in Africa has focused on the significance of maritime adaptations for models of earlier modern human behavior and out-of-Africa migrations, with particular emphasis on the archaeological evidence from southern Africa (e.g., Marean 2014), the development of coastal economies during the late Holocene has received much less attention (see Blench 2012; Mitchell 2004). In eastern Africa, the importance of the sea—and in particular the small offshore islands that dot the coastline from Lamu in the north to Mafia and Kilwa in the south (Figure 1)—to the development of maritime Swahili trading societies of the second millennium AD has long been recognized (e.g., Fleisher et al. 2015; Horton and Middleton 2000). What is less well understood, however, are the formative stages of these coastal societies, and the long-term processes by which some early terrestrial groups—which in the late Holocene included farmers, pastoralists, and hunter-gatherers—essentially became 'maritime'. Archaeological research over the past two decades clearly points to the offshore islands as key loci for understanding early maritime adaptations by the region's foraging and farming communities, while the presence of Indian Ocean trade goods at several sites offers tantalizing, but as yet unconfirmed links, to precocious maritime trade (see Boivin et al. 2013 for a recent review). Many of these sites remain poorly dated, however, and there are still major archaeological gaps, particularly in the subsistence records of early sites, that prevent proper understanding of these formative coastal adaptations and maritime developments.

Archaeological research on eastern Africa's smaller islands has also been partially eclipsed by studies focused on the larger

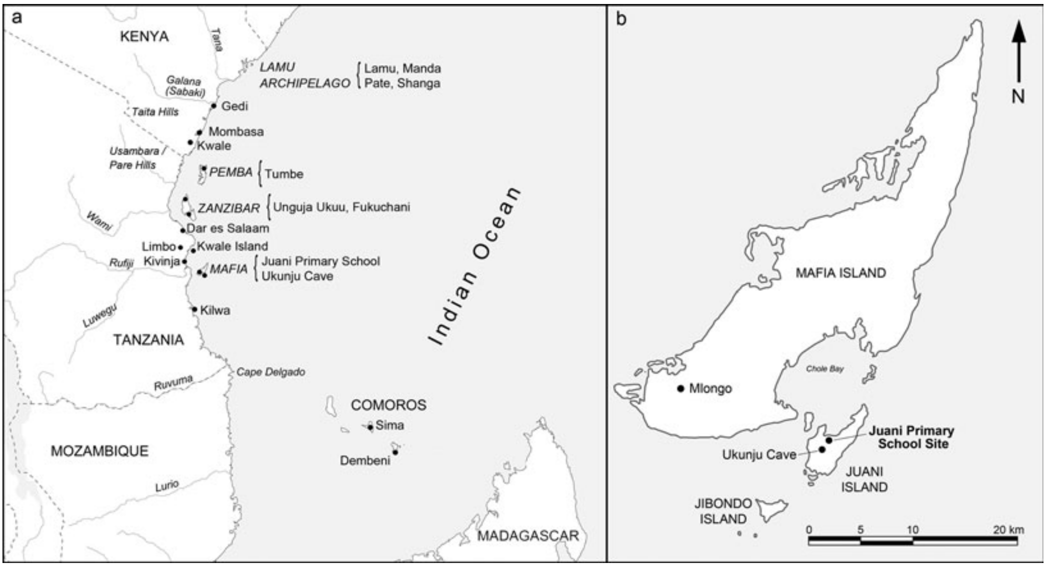

Figure 1. *a) Map of the eastern African coast showing sites mentioned in text; b) map of the Mafia Archipelago showing the location of the Juani Primary School site on Juani Island.*

archipelagoes, particularly Zanzibar, which were major hubs of Swahili and colonial period trade. Yet multi-disciplinary research in other regions of the world, such as the Pacific and Caribbean, has demonstrated that smaller offshore islands are often colonized earlier than those with larger landmasses owing to their greater ecological diversity, particularly resource-rich marine habitats (see Keegan et al. 2008 for discussion). We also know that colonization of small islands can have dramatic impacts on endemic flora and fauna (Masse et al. 2006; Rick and Erlandson 2008; Weisler 2003). Comparative datasets for island colonization, resource exploitation, and the long-term ecological impacts of human occupation of small islands are needed for eastern Africa, to contribute to these global debates.

The aim of this article is to examine evidence for coastal adaptations in eastern Africa during the Early Iron Age (EIA, c. first–sixth centuries AD), when pottery-using, iron-working, farming groups—to whom the ancestors of the Swahili have been traced—first migrated to the eastern African coast and began to settle the small offshore islands. We focus on the results of our recent archaeological investigations at the Juani Primary School site in the Mafia Archipelago, which was one of the few island groups off the eastern African coast to be colonized during this initial Iron Age phase. In contrast, the first secure evidence of the settlement of the Lamu and Zanzibar Archipelagoes, as well the more distant Comoros, dates to no earlier than the seventh–eighth centuries AD (e.g., Crowther et al. 2015; Fleisher and LaViolette 2013; Horton 1996b; Wright et al. 1984, 1992). Our excavations at the Juani Primary School site comprise the first attempt to systematically recover and analyze high-resolution zooarchaeological and archaeobotanical evidence from any coastal EIA site, allowing us to understand more fully how these early farming groups adapted socially and economically to their new littoral setting. The presence of a later, Middle–Late Iron Age (MIA–LIA, c. seventh–fifteenth centuries AD) occupation at the site also provides a useful point of comparison for situating these early adaptations within a longer-term trajectory of island settlement, subsistence, and maritime trade.

The emerging picture suggests that while some EIA populations shifted rapidly to a forager-fisher lifestyle during the initial stages of island and coastal occupation, the intense focus on marine resources was only a short-term adaptation, with a broadening of the subsistence base occurring in the later MIA period. We suggest that this marine foraging adaptation may have been a colonization-phase strategy. Local trade connections in this early phase, based for example on the production and exchange of marine shell disk beads, may have supported the longer-distance Indian Ocean trade networks that emerged during later periods and became a defining feature of Swahili maritime economy and identity.

ARCHAEOLOGICAL CONTEXT: MARITIME TRADE AND ADAPTATION ON THE EASTERN AFRICAN COAST

Eastern Africa's Swahili coast occupies a narrow strip of land extending some 3000 km from the north coast of Somalia to southern Mozambique, incorporating a number of small offshore Indian Ocean islands, including the Lamu, Zanzibar, Kilwa, and Mafia Archipelagoes, as well as the more distant Comoros (Horton and Middleton 2000) (Figure 1). The Swahili region is today characterized by a distinctive coastal culture, which emerged in the last millennium from indigenous roots (Fleisher et al. 2015). The Swahili exploited the monsoon winds and ocean currents to ply the coast and islands in their sewn boats, dhows, and outrigger canoes, acquired raw commodities from the African interior for local, inter-regional, and international trade, and developed a coastal-focused culture defined by complex social, commercial, and urbanized features.

The question of when the Swahili became maritime has recently attracted archaeological attention. One proposal is that this was a relatively late phenomenon dating to the last 1,000 years (Fleisher et al. 2015). While not denying the earlier coastal adaptations of pre- and proto-Swahili groups, Fleisher and colleagues (2015:102) focus on the significant re-orientation of settlement patterns, subsistence, domestic spaces, and material culture in this period as marking the point when "maritimity becomes inextricable from most elements of Swahili life." While the emergence of a complex and urbanized maritime-oriented culture, featuring strong engagement with the wider Indian Ocean world, is undoubtedly unique to the Swahili era, we would argue from new evidence that the Swahili were not the first maritime-focused culture on the eastern African coast. We propose that the Swahili culture needs to be situated within a long-term record of maritime adaptation across the region, one that is neither straightforwardly cumulative nor developmentally continuous. Understanding of this longer-term record is hampered by limited material evidence and a reliance on minimal and ambiguous textual evidence that is only beginning to be remedied by systematic archaeological research.

In addressing the maritime orientation of pre-Swahili groups, it is important to define and distinguish among "coastal use," "coastal adaptations," and "maritime adaptations." For example, Beaton (1995:801–802) and Marean (2014:20) distinguish between *coastal use*, where marine resources are exploited systematically, regularly, and recurrently, but do not necessarily transform lifeways, and *coastal adaptations*, where economies, mobility, and settlement structures have been transformed to revolve around marine environments and the inter-tidal zone in particular. Building on these points, Marean (2014) views *maritime adaptations* as those incorporating marine resource use via boat technology capable of long-distance transport, deep-sea fishing, and whaling. Fleisher et al. (2015) extend this type of definition to include not just maritime resource exploitation, technology, trade, and communication, but also the notion of socio-cultural structures influenced by the maritime environment.

These are important definitions to bear in mind, as the archaeological record of the Swahili coast shows a long history of occupation extending back to the Pleistocene, when hunter-gatherer groups using a microlithic Later Stone Age technology frequented many of the limestone caves in the coastal uplands (Helm 2000b; Shipton et al. 2013). These groups only occasionally exploited coastal resources such as fish and marine shells, the latter not only for economic, but also social purposes (for example, the production of cowrie [Cypraeidae spp.] shell beads). Despite claims for Later Stone Age groups on Juani as well as on the island of Zanzibar (Chami 2004, 2009), re-excavation and re-dating of two key sites has failed to replicate evidence for island colonization prior to the Iron Age. Rather, in the case of Zanzibar, Later Stone Age occupation predates the postglacial sea-level rise that led to the formation of both this island and the Mafia Archipelago by the early Holocene (Crowther et al. 2014; Prendergast et al. 2016; Shipton et al. in press). While occupation of the coast thus seems limited prior to the Iron Age, it is possible that sites might have been inundated by rising seas. Currently, the first clear evidence of permanent and sustained use of the coast, reflecting a specific coastal adaptation, appears in the first millennium AD after the arrival of Iron Age groups. The dominant paradigm is that these Iron Age groups spread to the coast as part of the broader dispersal of Bantu-speaking farmers into sub-Saharan Africa (see de Maret 2013; Holden 2002; Russell et al. 2014).

In coastal eastern Africa, three major chronological and cultural sub-divisions of the Iron Age are broadly recognized[1]: the EIA or pre-Swahili period (c. first–sixth centuries AD), traced archaeologically by the presence of bevel-rimmed Kwale ware ceramics; the MIA or proto-Swahili period (c. seventh–tenth centuries AD) associated with triangular-incised Early Tana Tradition ceramics and the florescence of Indian Ocean trade; and the Late Iron Age or Swahili period (c. eleventh–fifteenth centuries CE), which saw the transformation of many coastal villages into urban centers ruled by a cosmopolitan merchant elite (e.g., Chami 1994; Fleisher and Wynne-Jones 2011; Helm 2000a; Helm et al. 2012; Horton 1996b; LaViolette 2008). Prior to the emergence of urban Swahili "stone towns" in the eleventh century, early coastal communities lived in relatively small, mixed farming settlements dominated by wattle and daub architecture. There is still some debate about the chronological and cultural relationship between these Early and Middle Iron Age groups. Archaeological studies of ceramics and settlement patterns have yet to provide resolution on interpretations of direct continuity (with MIA culture developing from its EIA predescessor; e.g., Chami 1994; Helm 2000b) *versus* discontinuity between culturally discrete populations (Collett 1985; Horton 1996a, 1996b; see also Nkirote M'Mbogori 2015).

The EIA also broadly coincides with the first documentary evidence of Indian Ocean trade in eastern Africa. The first century CE Greco-Roman text, the *Periplus Maris Erythraei* ('The Periplus of the Erythraen Sea'; Casson 1989) describes a thriving trade on the eastern African coast, involving a number of small trading centers that extend as far south as the (so far unidentified) emporium of "Rhapta." Rhapta was described as lying opposite the also unidentified island of "Menouthias"—thought to be either Pemba, Zanzibar, or Mafia. Rhapta would thus be located on the mainland anywhere from the Pangani River to the Rufiji Delta (Baxter 1944; Chami 1999b; Datoo 1970; Horton 1996a:451; Horton and Middleton 2000:33). Here, traders from the Arabian peninsula brought metal objects, including spears, knives, small awls, and different types of "glass stones" (perhaps rock crystal or glass beads), as well as grain and wine, in exchange for ivory, rhinoceros horn, tortoise shell, and possibly nautilus shell (Casson 1989). Although a number of coastal and near-coastal eastern African sites have been identified that date to the EIA, none of these contain any secure evidence of long-distance trade connections (Boivin et al. 2013; Wood 2011). Rather, the majority of archaeological evidence for early Indian Ocean trade in this region dates from the MIA onwards, when the offshore islands in particular became major commercial loci, as seen at large trading ports such as Shanga and Manda in the Lamu Archipelago, Tumbe on Pemba, Unguja Ukuu on Zanzibar, and Kilwa in the Kilwa Archipelago (Chittick 1974, 1984; Fleisher and LaViolette 2013; Horton 1996b; Juma 2004).

Evidence from eastern Africa's offshore islands is particularly crucial in resolving questions surrounding the region's early coastal subsistence, adaptations, and Indian

Ocean trade, given their central role in MIA and later Swahili maritime trade, as well as, more fundamentally, the necessity of maritime seafaring technologies for successful island colonization. However, identified EIA sites are relatively rare on the eastern African littoral (Chami 2003), most likely as a result of sampling or preservation bias rather than actual distribution patterns. Rather, the majority of known EIA sites are located in the mainland hinterland, particularly in the Kwale, Usambara, Pare, and Taita Hills of southern Kenya and northern Tanzania (Chami 1992; Collett 1985; Soper 1967; Walz 2010) (see Figure 1), as opposed to on the islands. This distribution provides few opportunities to examine the early phases of coastal colonization and adaptation by Iron Age groups. One of the main exceptions is the Mafia Archipelago, located some 20 km off the central Tanzanian coast, where a number of EIA sites have been reported since the late 1990s (Chami 1999a, 2000, 2004; Chami and Msemwa 1997a; see also Chami and Msemwa 1997b). While preliminary archaeological investigations have been conducted on a small number of these sites, none have been subjected to the kinds of systematic study needed to fully assess the role of the sea to early society and economy on the eastern African coast. As a result, the region currently lacks an empirically informed model for island colonization, coastal subsistence, and the emergence of maritime adaptations during the EIA.

JUANI PRIMARY SCHOOL SITE, MAFIA ARCHIPELAGO

In order to address questions surrounding pre-Swahili maritime subsistence and trade, we conducted new archaeological excavations at the Juani Primary School site in the Mafia Archipelago, located off the central coast of Tanzania (Figure 1). As its name suggests, the site is located within the grounds of a local primary school at the central northern end of Juani Island, which is a small islet situated to the east of Mafia Island.

Juani, like all islands in the Mafia Archipelago, is very flat and low lying. Its geological substrate comprises upraised coral limestone that has emerged as rocky cliffs along the east coast, though the northern and western sides of the island have more sheltered mangrove-lined coastlines and intertidal flats. The island's vegetation is currently a mosaic of agricultural areas, secondary forests, tidal mangrove swamps, scrubby coastal moorlands, and degraded fallow bush, although the presence of remnant patches of evergreen lowland coastal forest (found all along eastern Africa's coast and on the offshore islands; Burgess and Clarke 2000) suggests that forest environments might have once been more dominant (Greenway et al. 1988). The mangrove swamps provide a rich array of resources, including fish, mollusks, and crustaceans, and wood for charcoal, craft, and building material (Christie 2011). The island also has a rich marine and littoral fauna supported by a range of tropical marine habitats including coral reefs, sea grass beds, mangroves, and inter-tidal flats. The mammalian fauna today is much more depauperate than that of other continental eastern African islands and remarkably lacking in endemics (Walsh 2007). Communities living on Juani today practice a mix of rain-fed agriculture (focused on the cultivation of rice, *Oryza sativa*; cassava, *Manihot esculenta*; bananas, *Musa* spp.; and maize, *Zea mays*), animal husbandry (mainly the keeping of cattle, *Bos* sp.; goats, *Capra hircus*; and chickens, *Gallus gallus*), fishing, and shellfish gathering. The island lacks any large rivers, but has several seasonal and intermittent streams (Greenway et al. 1988). Groundwater aquifers tapped from surface wells provide the main water source for the island's inhabitants.

The Juani Primary School site, also known by its local name, Kisima Jumbe, was first investigated in the 1990s by Felix Chami, whose excavations revealed the remains of a large earth-and-thatch village that was rich in EIA Kwale ceramics and evidence for the exploitation of marine resources such as mollusks, fish, and possibly shark (Chami 1999a, 2000, 2004). Chami's excavations, however, did not involve any archaeobotanical analysis to document the role of agriculture relative to marine and other food sources, and only a small archaeofaunal assemblage was reported, focusing mainly on mollusks, with largely unidentified fish and no tetrapod fauna. The University of Oxford's Sealinks Project returned to the site in 2012 with the aim of recovering higher resolution faunal, archaeobotanical, and material culture data, and situating these within a radiocarbon-based chronological framework for Iron Age occupation at the site.

Our excavations focused on an area in the northern periphery of the site (Figure 2), where a shovel test pit survey located the richest and potentially deepest deposits in a slightly raised area measuring about 50 m across. This area was also where Chami's Trench 1 was excavated in 2000 (Chami 2000). Here we placed four trenches, each 2 × 2 m in size and approximately 20 m apart. Trenches were excavated in controlled stratigraphic sequence using the single context method, with thicker contexts being subdivided into smaller arbitrary units to obtain tighter vertical control for sampling. Bulk samples of at least 30–60 liters per context were processed by flotation (0.3 mm mesh) to recover charred plant remains. All remaining excavated deposits were either dry- (3 mm) or wet-sieved (1 mm, after flotation).

The archaeomalacological samples (analyzed by PF) were identified using a range of published sources (Abbott and Dance 1998; Carpenter and Niem 1998; Richmond 2011; Robin 2008, 2011; Rowson 2007; Rowson et al. 2010) and the nomenclature standardized with reference to the World Register of Marine Species (WoRMS Editorial Board 2016). The Minimum Number of Individuals (MNI) was recorded based on a range of taxon-specific non-repetitive elements (following Harris et al. 2015), in addition to noting the presence of taxa that did not retain diagnostic features necessary for inclusion in MNI counts. Tetrapod fauna (analyzed by MEP) were identified with reference to the collections of the National Museums of Kenya (NMK) in Nairobi. All identified specimens were examined using a 20 × hand lens under strong oblique light to identify surface modifications. Fish remains (analyzed by EQM) were also identified using the osteology collection at the NMK. All elements were included in the analysis and examined for signs of modifications.

Archaeobotanical samples (analyzed by AC) were sieved into size fractions and the ≥1 mm fractions were scanned for charred remains (seeds, chaff, etc.) using a stereomicroscope at 10–40 × magnification. Taxonomic identifications of crop remains were made using published criteria (e.g., Giblin and Fuller 2011; Manning et al. 2011) and botanical reference collections at University College London. Nine AMS radiocarbon dates were obtained on identified charred seeds and charcoal fragments to establish an absolute chronology for each of the main occupation phases identified in our excavations. Radiocarbon dated charcoal samples were identified by LPG using standard charcoal analysis procedures, with reference to wood anatomy atlases of flora from Africa and adjacent regions (Fahn and Werker 1986; Fasolo 1939; Neumann et al. 2007). Where possible, charcoal specimens identified to the Rhizophoraceae (mangrove) family were targeted for dating, as species within this group generally do not form large girth trees that may have greater inbuilt age errors.

OCCUPATION PHASES AND DATING

The general stratigraphic sequence at the Juani Primary School site was similar across all trenches, comprising an upper topsoil layer with mixed modern and ancient materials, underlain by a series of reddish-brown sandy silts that contained the bulk of the archaeological finds, transitioning to a fine yellowish-white beach sand containing little to no cultural materials (Figure 3). Within the archaeological sequence, we identified two main occupation phases. The first phase belonged to the EIA and contained a rich assemblage of Kwale ceramics (including some near-complete vessels; Figure 4a–g) in association with a dense midden deposit and very small quantities of slag from iron working. All diagnostic sherds found in this horizon were Kwale (n = 455), though the remaining non-diagnostic sherds (n = 2836) are probably also Kwale based on similar fabric and surface treat-

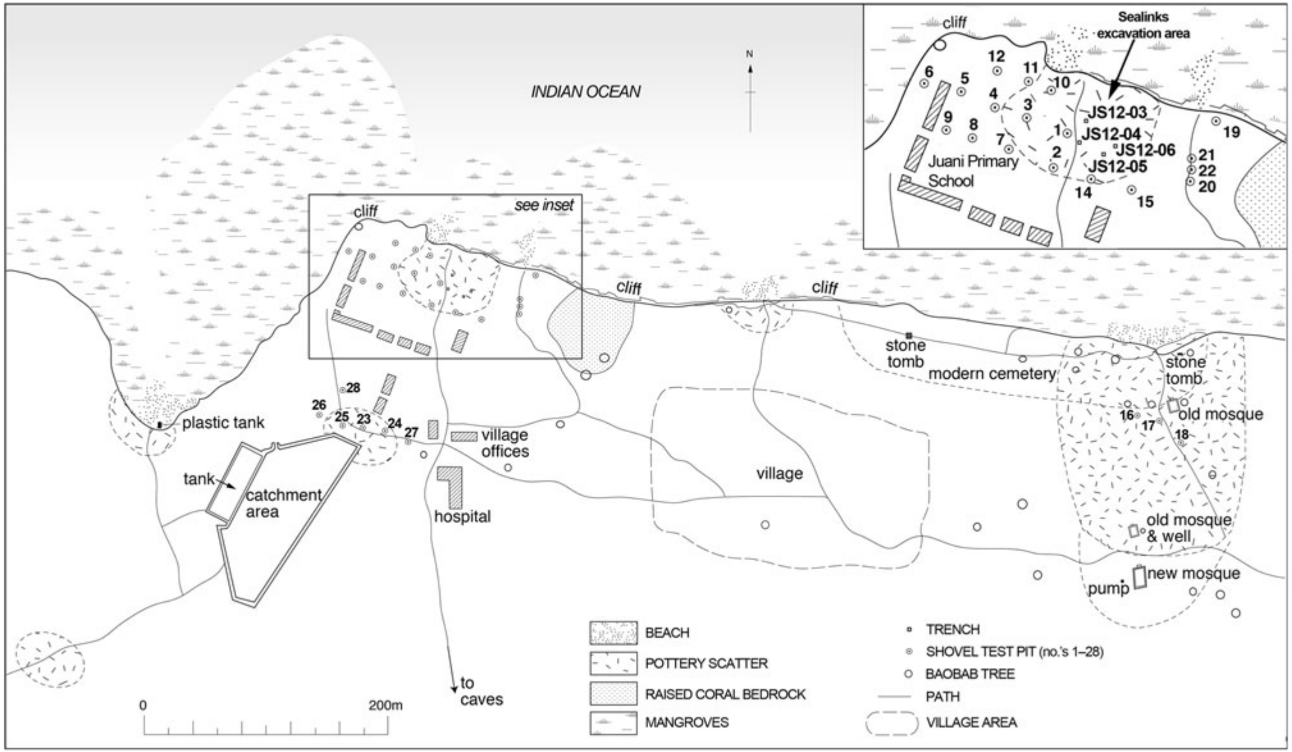

Figure 2. *Plan of the Juani Primary School site, showing the location of the four excavated trenches (JS12-03 to JS12-06) at the north-western boundary of the site, where stratified Kwale-bearing deposits were located. A large pottery scatter was also located at the far eastern edge of the site, near two present-day mosques (one abandoned), but this contained only later ceramics.*

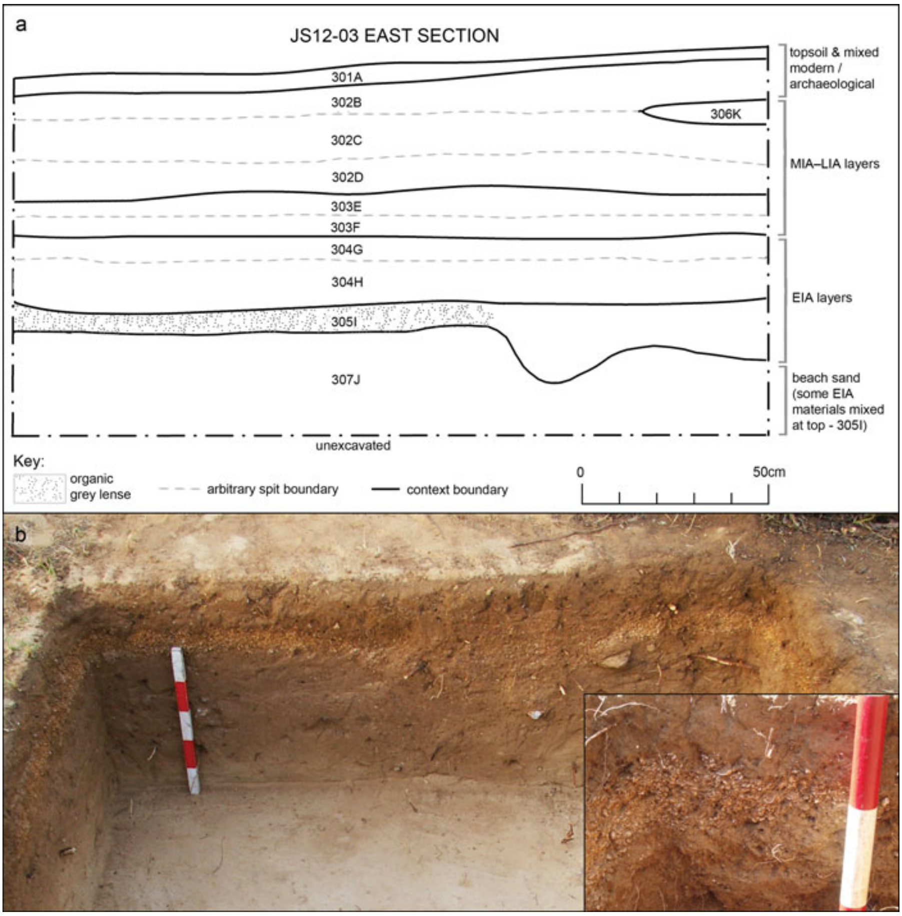

Figure 3. *a) Drawing of trench JS12-03 east section showing representative site stratigraphy and main cultural layers; b) photograph of trench JS12-04 north section showing the dense shell layer (inset), most likely representing a natural accumulation from a storm surge or similar event. Scale = 50 cm.*

ments. No sherds belonging to any other contemporaneous ceramic tradition—eastern African or imported—were identified. While we cannot entirely exclude the possibility that the site's occupants were hunter-gatherers who traded or adopted pottery from Iron Age groups on the mainland, the large quantity of high-quality decorated Kwale sherds (>40 kg in total), found in combination with evidence of iron-working as well as daub structures, are strongly suggestive of an Iron Age cultural affiliation. The Kwale layer was overlain by a Middle–Late Iron Age phase containing a small number of Tana Tradition ceramics (n = 31) (Figure 4h) as well as some Kwale sherds. Given the ~250–400 year hiatus in the radiocarbon dates between the EIA and MIA layers, it seems likely that the Kwale sherds have been incorporated post-depositionally into these later layers. The MIA–LIA pottery assemblage was not as rich as that from the EIA layers, yielding only 35.9% (24.4 kg) of the entire assemblage by weight.

In trenches JS12-04 and -05, as well as the southeast corner of JS12-03 (context 306K), a

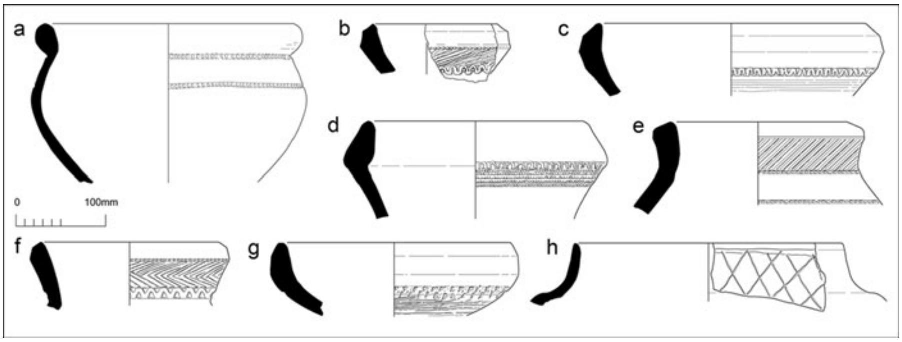

Figure 4. *Examples of local ceramics recovered from the Juani Primary School site: a–g) Early Iron Age Kwale; h) Middle Iron Age Tana tradition. (Contexts: a–b: 304H; c–d: 405E; e–f: 406F; g: 506J; h: 303E).*

5–8 cm thick shell layer was found (Figure 3), composed almost entirely of densely compacted, highly fragmented, and very small (mostly 3–15 mm) marine (e.g., Batillariidae spp. Cerithiidae spp., Columbellidae spp.) and terrestrial (e.g., Cerastidae spp., Subulinidae spp.) gastropods, and small articulated bivalves. Although this context contained some larger, economic taxa (such as *Anadara antiquata*, Fasciolariidae sp., *Modiolus* sp., and Strombidae spp.), the vast majority of the small marine shell taxa recovered from this layer has not been recorded previously as economic species in the region (see below; Christie 2011:314). The layer contained some Tana Tradition as well as plain ceramics, which may have been mixed in. In trenches JS12-03 and JS12-04, the shell layer contained little to no other cultural material, while in trench JS12-05 (in which the layer was thin, and where there also appeared to have been the most stratigraphic mixing, based on anomalous radiocarbon dates on charred seeds, see discussion below) it also bore daub fragments, shell disk beads, and a glass piece. This layer is also delineated by clear stratigraphic changes, which in addition to the paucity of cultural material and significant amounts of non-economic mollusk taxa and fragmented shell, also include a shift from fine brown silts in the adjacent contexts to coarse yellow sand in its sedimentary matrix. Pending further analysis, in line with criteria developed for distinguishing natural and cultural shell deposits (e.g., Attenbrow 1992; Henderson et al. 2002), we currently interpret this layer as most likely representing water-borne deposition via a storm surge or similar natural event.

Both occupations at the Juani Primary School site were probably relatively small-scale. Evidence of daub from all layers points to the former presence in our excavation area of small earth-and-thatch structures typical of Iron Age village settlements and, while not conclusive, are suggestive of permanent, year-round habitation rather than seasonal occupation. Although Christie (2011:139) notes that many of the more common mollusk taxa within the Mafia Archipelago are more abundant during particular seasons, with few exceptions (e.g., *Pinctada* spp.) mollusks would have been available for exploitation throughout the year, a factor also highlighted by Msemwa (1994:174). Similarly, the terrestrial mammals and fish recovered at the site would have been available year-round; however, the small sample sizes do not permit seasonality analysis. This evidence, combined with the pottery- and shell-rich midden deposits we uncovered, suggests our excavations were in a domestic occupation area. Very small quantities of slag were also found (<50 g in total from all four trenches), indicating that iron-working activities were occurring in the vicinity, but that the area of our excavation was not the main locus of these activities. The site's iron-rich lateritic soils would have provided the

Table 1. **AMS radiocarbon dates from the Juani primary school site.**

Trench, context	Material, taxon	Lab no.[a]	^{14}C age BP	Calibrated age range[b] (95.4% probability)	Cultural phase
JS12-03, 303F	Charcoal, Rhizophoraceae	Wk-40967	1153 ± 25	AD 885–990	MIA–LIA
JS12-03, 304G	Charcoal, Rhizophoraceae	Wk-40966	1612 ± 21	AD 420–535	EIA
JS12-03, 304H	Charcoal, Rhizophoraceae	Wk-40965	1604 ± 20	AD 420–540	EIA
JS12-05, 503E	Charred seed, *Vigna* cf. *unguiculata*	Wk-40939	1173 ± 20	AD 875–980	MIA–LIA[c]
JS12-05, 505H	Charred seed, *Vigna* cf. *unguiculata*	Wk-40938	1184 ± 21	AD 775–975	MIA–LIA[c]
JS12-05, 505I	Charred seed, *Vigna* sp.	Wk-40937	1181 + 20	AD 775–975	MIA–LIA[c]
JS12-05, 506J	Charcoal, Rhizophoraceae	Wk-40968	1646 ± 23	AD 385–525	EIA
JS12-06, 604E	Charcoal, *Ziziphus* sp.	Wk-40970	1002 ± 21	AD 1020–1150	MIA–LIA
JS12-06, 607I	Charcoal, Rhizophoraceae	Wk-40969	930 ± 24	AD 1040–1210	MIA–LIA

[a]All radiocarbon dates were obtained from the Waikato Radiocarbon Laboratory, New Zealand using standard pretreatment methods. [b]Radiocarbon dates were calibrated using mixed southern (SHCal13, 70%) and northern (IntCal13, 30%) hemisphere calibration curves to account for the effects of the intertropical convergence zone (ITCZ) on the study area. Calibrations were calculated using OxCal v4.2.4 at 95.4% probability (2σ) and were rounded to 5 years. [c]Seed samples were recovered from EIA contexts; direct dating demonstrates that these are intrusive from overlying MIA layers.

raw material for on-site iron production. Our radiocarbon dates suggest the Kwale occupation may have been quite short, possibly just one or two generations, with all three dates clustering between cal AD 385–540 (Table 1). The later phase appears slightly longer in duration, with dates spanning ca. cal AD 880–1200, though these fall into two main clusters around cal AD 775–990 and cal AD 1020–1210 (Table 1), and could in fact reflect two discrete occupations. These later layers are nonetheless considered here as one phase in light of their shared cultural affiliation.

The following discussion focuses on the results of our zooarchaeological, archaeobotanical and material culture studies relating to subsistence and trade from these two occupation phases (EIA and MIA–LIA). In addition to exploring the changing significance of marine resources to the local economy, we also discuss the implications of these maritime adaptations for the development of local and long-distance Indian Ocean trade networks.

EVIDENCE OF MARITIME SUBSISTENCE ADAPTATIONS

While direct comparison of the relative importance of different food sources to the diet of the Juani occupants is not possible without isotopic studies of human remains, their relative contributions can nonetheless be broadly estimated based on the overall abundance of different plant and animal remains in the archaeological record. What stands out from our data is the overwhelming dominance of marine resources, such as mollusks and fish, at the Juani Primary School site, particularly during the EIA. In comparison, terrestrial food sources were quantitatively minor, with plant and animal domesticates being entirely or nearly absent from the EIA layers. While this pattern may reflect differential deposition and preservation, the general importance of marine resources to EIA subsistence at the site is nonetheless apparent.

Shellfish Remains

By far the most abundant type of subsistence evidence recovered from the Juani Primary School site, for both the Early and Middle–Late Iron Age occupation phases, was shellfish. Previous research on Juani Island has also highlighted the abundance of molluskan faunal remains in Iron Age and later sites (Chami 2004; Christie 2011), with more than 15 taxa recorded, including *Anadara antiquata*, *Cypraea tigris*, *Monetaria annulus*, *Pleuroploca trapezium*, *Nerita textilis*, *Chicoreus ramosus*, *Terebralia palustris*, and *Volema pyrum* as being the most frequently represented (Chami 2000:212, 2004:90; Christie 2011:290). The Juani Primary School molluskan faunal assemblage was not only relatively large (comprising approximately 31.3 kg of shell in total from the four excavation trenches; JS12-03 = 16.9 kg, JS12-04 = 4.7 kg, JS12-05 = 7.7 kg, JS12-06 = 2.1 kg), but also very rich, significantly expanding on the number of taxa noted in previous research, and representing a range of species from marine, terrestrial, and freshwater habitats. It includes taxa used for economic purposes as well as those commonly collected for decorative or ornamental functions, such as Cypraeidae spp. (cowrie), though none of the latter were pierced to suggest that they functioned as beads. Analyses are ongoing to assess if other anthropogenic modifications potentially related to ornament manufacture are evident.

While much of the shell assemblage is still under analysis, owing to its size, the preliminary results from Trench 3 (JS12-03) are reported here. The condition of the shell is moderate, and although they cannot be quantified at this stage, fragmentation and dissolution are apparent to varying degrees throughout the deposit. As the focus here is on comparing trends in mollusk exploitation and discard between cultural phases, the natural shell layer noted in the discussion above (context 306K) has been excluded so as not to skew the data available for the Middle–Late Iron Age. The remaining JS12-03 molluskan assemblage, comprising a total of 89 identified invertebrate categories (e.g., species, genus, or family), is represented by a total of 1838 specimens by MNI, with 1510 MNI in the EIA and 328 MNI in the MIA–LIA contexts. The EIA is dominated by *Nerita* spp. (40.9% MNI), which decreases markedly in abundance in the MIA–LIA (14.0% MNI) (Figure 5a). The distribution of the Cypraeidae spp. (*Cypraea* and *Monetaria* spp.) and the sandflat bivalve *Atactodea striata* demonstrate the inverse pattern, increasing from the EIA (1.7% and 1.9% MNI respectively) into the MIA–LIA contexts (12.5% and 14.6% MNI respectively). Similar patterns of increasing abundance from the EIA to the MIA–LIA are also seen in a number of other taxa (albeit to a lesser degree), notably the sandflat bivalve *Anadara antiquata*, the mangrove gastropod *Terebralia palustris*, and the intertidal/shallow subtidal Strombidae spp. gastropods (Figure 5a).

Comparison of the EIA and MIA–LIA phases at Juani elucidates some important trends. The density of molluskan remains (based on the calculation of approximate deposit or phase volume and indicated by MNI/m^3 of excavated deposit) is comparatively high in the EIA, dropping sharply into the MIA–LIA (Figure 5b). Several measures are used here to examine potential shifts in species diversity through time. Species richness is calculated by the number of taxa present within the sample population, here using both the number of invertebrate categories, as well as the number of taxa

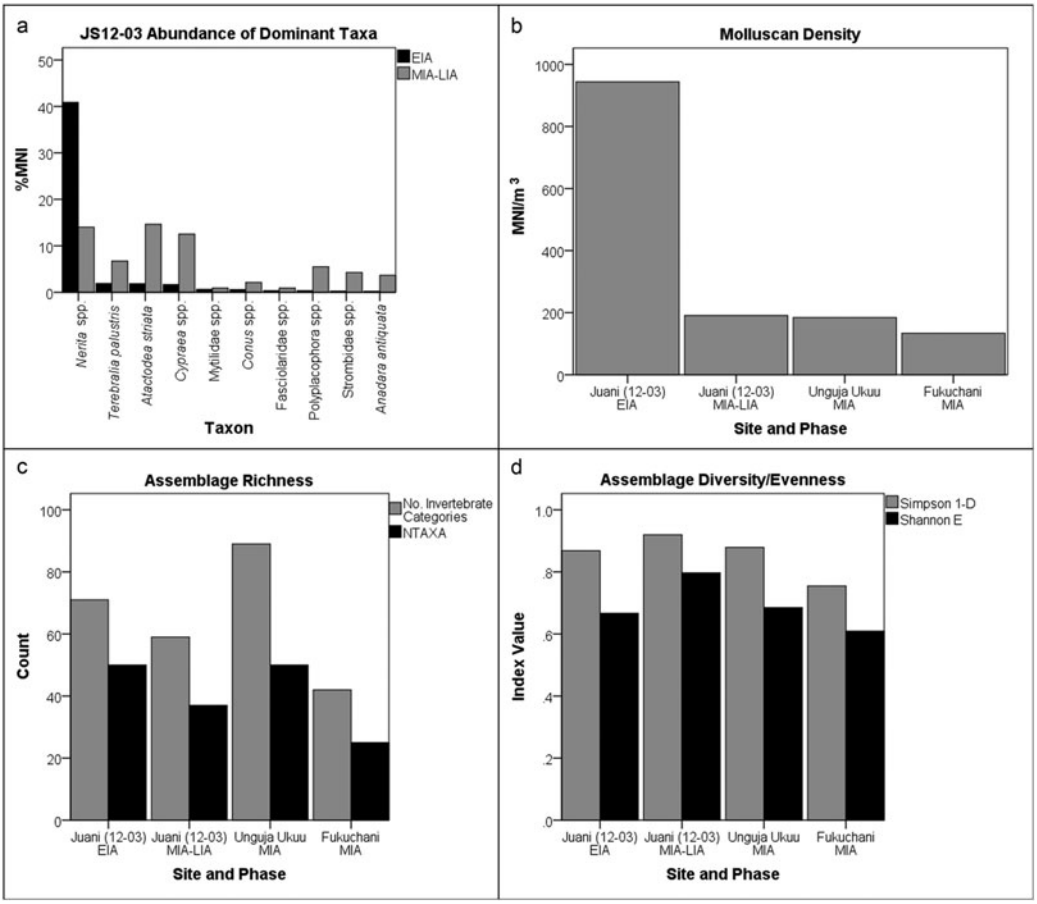

Figure 5. *Shell data from trench JS12-03, comparing EIA and MIA–LIA phases, as well as comparative data from the MIA sites of Unguja Ukuu and Fukuchani on Zanzibar: a) abundance of dominant taxa by % minimum number of individuals (MNI) (JS12-03 only); b) density (MNI/m3); c) species richness (count of invertebrate categories and NTAXA); and d) species diversity (Simpson's 1-D and Simpson's E).*

(NTAXA), whereby these categories are combined to the highest taxonomic level to avoid counting overlapping taxa (Figure 5c). Simpson's Index (1-*D*) and Shannon's measure of evenness (*E*) are common measures of heterogeneity, both of which take into account species richness and relative abundance (Magurran 2004) to indicate the distribution of taxa across populations (dominance or evenness) (Figure 5d). Interestingly given the early dominance of *Nerita* spp., assemblage richness demonstrates a similar trend to that seen in molluskan density, decreasing slightly from the EIA into the MIA–LIA. In comparison, diversity as measured by Simpson's 1-*D* and Shannon's *E* slightly increases from the EIA into the MIA–LIA relative to this decrease in both density and richness. This indicates a comparatively reduced focus on harvesting nearshore mollusks, but even with a slight reduction in the number of species exploited there would appear to be more similar proportions in the range of mollusk taxa exploited, particularly with the reduction in abundance of the dominant *Nerita* spp., from the EIA into the MIA–LIA.

Comparison of the Juani data with preliminary analyses of Sealinks assemblages from two MIA sites on Zanzibar—Fukuchani (a small wattle-and-daub trading village, ca. AD 600–900) and Unguja Ukuu (a large Indian Ocean trading port, ca. AD 650–1000)—also highlight similarities in the lower density of molluskan material discarded during the MIA compared to the Juani EIA (Figure 5b). While Fukuchani and Unguja Ukuu demonstrate location-specific trends in assemblage richness, diversity, and evenness (likely linked to regional resource availability and abundance or local preference), the density pattern across all three MIA sites suggests that the reduced focus on shellfish gathering may have been a widespread economic shift across the broader coastal region in this later period.

Fish Remains

Alongside the foraging of shellfish, the Juani Primary School site produced evidence for fishing, with fish dominating the EIA vertebrate assemblage from all four trenches. Previous excavations at the site (Chami 2004) report small quantities of fish, including 12 "shark fish", without further details. Analysis of the fish remains recovered from the Sealinks excavations produced an assemblage of 292 specimens attributed to family or genus. Only 40% of the total weight of excavated fish bone was identified due to poor preservation. Surface modifications on the fish bones were minimal—six elements identified to at least family had signs of burning. The majority of identified taxa live near or around coral and bay habitats—Lethrinidae (emperors), Serranidae (groupers), Scaridae (parrotfish), and Balistidae (triggerfish) (Figure 6a)—indicating a preference for nearshore fishing.

A number of vertebrae of cartilaginous fish (Chondrichthyes, e.g., sharks, rays) were also found in both EIA and MIA–LIA deposits (35 and 5 NISP [number of identified specimens], respectively). Approximately half of the cartilaginous fish vertebrae in each phase (18 and 3 NISP, respectively) are considered to be likely shark vertebrae based on the presence of well-defined pairs of dorsal and ventral foramina (Kozuch and Fitzgerald 1989). Although more specific identifications have not been possible at this stage, the possibility that there may be shark remains during an EIA occupation is particularly important because other evidence of shark exploitation occurs in late first millennium CE sites (e.g., Badenhorst et al. 2011; Quintana Morales and Prendergast in press; but see Shipton et al. in press) with a marked increase in shark exploitation and offshore fishing in the Swahili region in the second millennium CE (e.g., Horton 1996b:380; Horton and Mudida 1993:679)—a factor advanced by Fleisher et al. (2015) as evidence of the late development of a fully maritime way of life on the eastern African coast. Previous discussions (Anderson et al. 2013) about the interpretation of offshore fishing strategies from fish remains stress the importance of precisely identifying the species involved, since some families, such as the requiem sharks (Carcharhinidae), include nearshore and offshore species. Further analysis may clarify whether the Chondrichthyes specimens from Juani belong to species found closer to shore or in the open sea, signaling different fishing strategies. There was no evidence of fishing equipment in the cultural assemblages from either period to add further clarification.

In the MIA–LIA layers at Juani, there is a marked decrease in the abundance of identified fish remains (43 NISP) compared to the EIA deposits (249 NISP) that may indicate less intensive fish exploitation in the later period, with similar taxa exploited overall. However, this pattern is not mirrored at other MIA sites with comparable datasets of systematically collected fish remains. Large quantities of fish remains from the Sealinks excavations at Fukuchani and Unguja Ukuu demonstrate that fishing was a key economic strategy at these MIA settlements (Figure 6b).

Tetrapod Fauna

In contrast to the fish and shellfish patterns, evidence of domesticated crops (discussed below) and animals, long considered

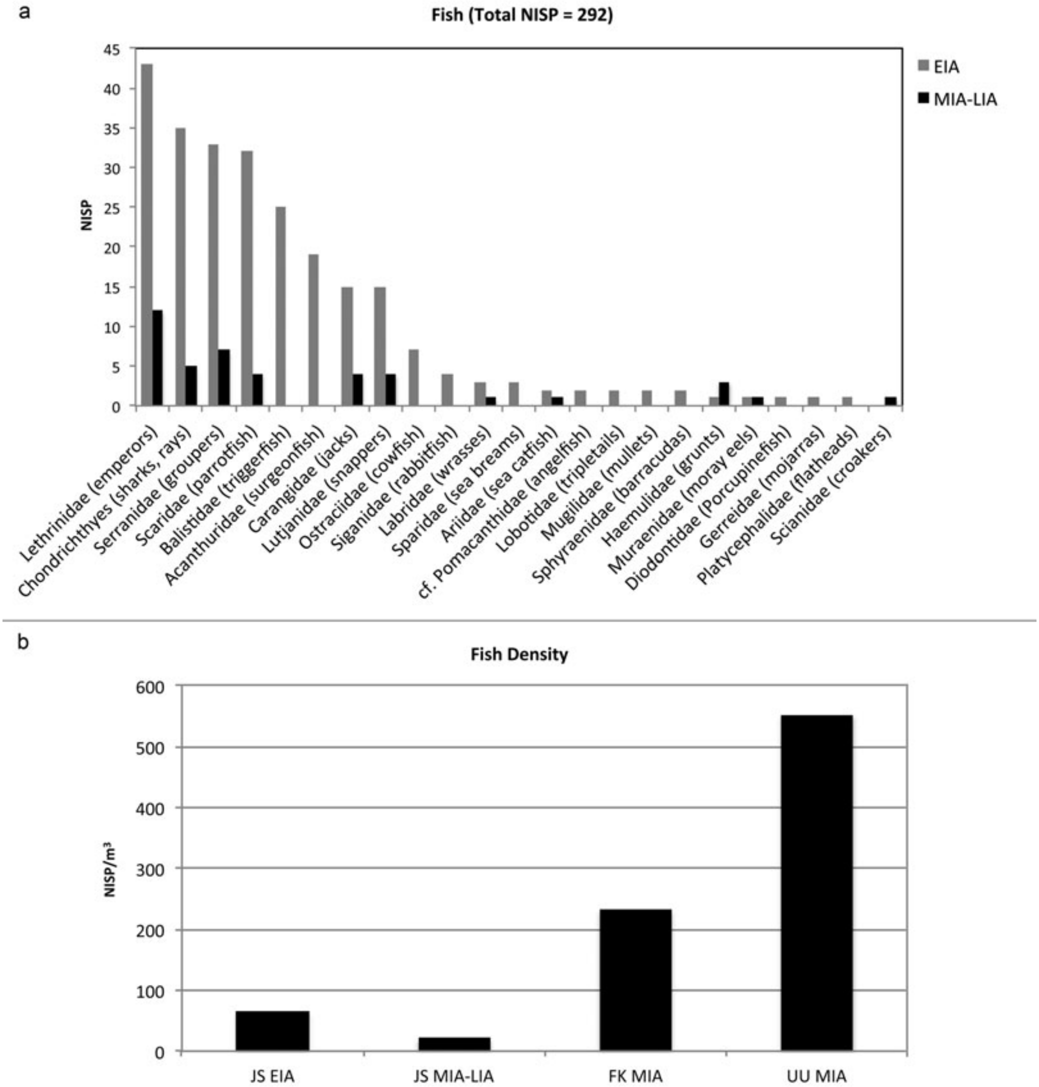

Figure 6. *a) Fish remains (NISP) at the Juani Primary School site (JS), comparing EIA and MIA–LIA phases; b) density of fish remains (NISP/m3) at JS compared to the MIA sites of Fukuchani (FK) and Unguja Ukuu (UU) on Zanzibar.*

key components of the Iron Age "Bantu" package, was near absent from the EIA layers at the Juani Primary School site (Figure 7a). We note, though, that tetrapod vertebrate remains were generally not well preserved in the Juani assemblages, due to high degrees of both diagenetic and recent breakage. This resulted in a low identification rate: only 94 specimens were identifiable to taxon or group across all phases, leaving 73% of the tetrapod assemblage (by weight) unidentifiable. This mirrors the findings of Chami's (2004) excavation, from which not a single tetrapod is reported. In our excavation,

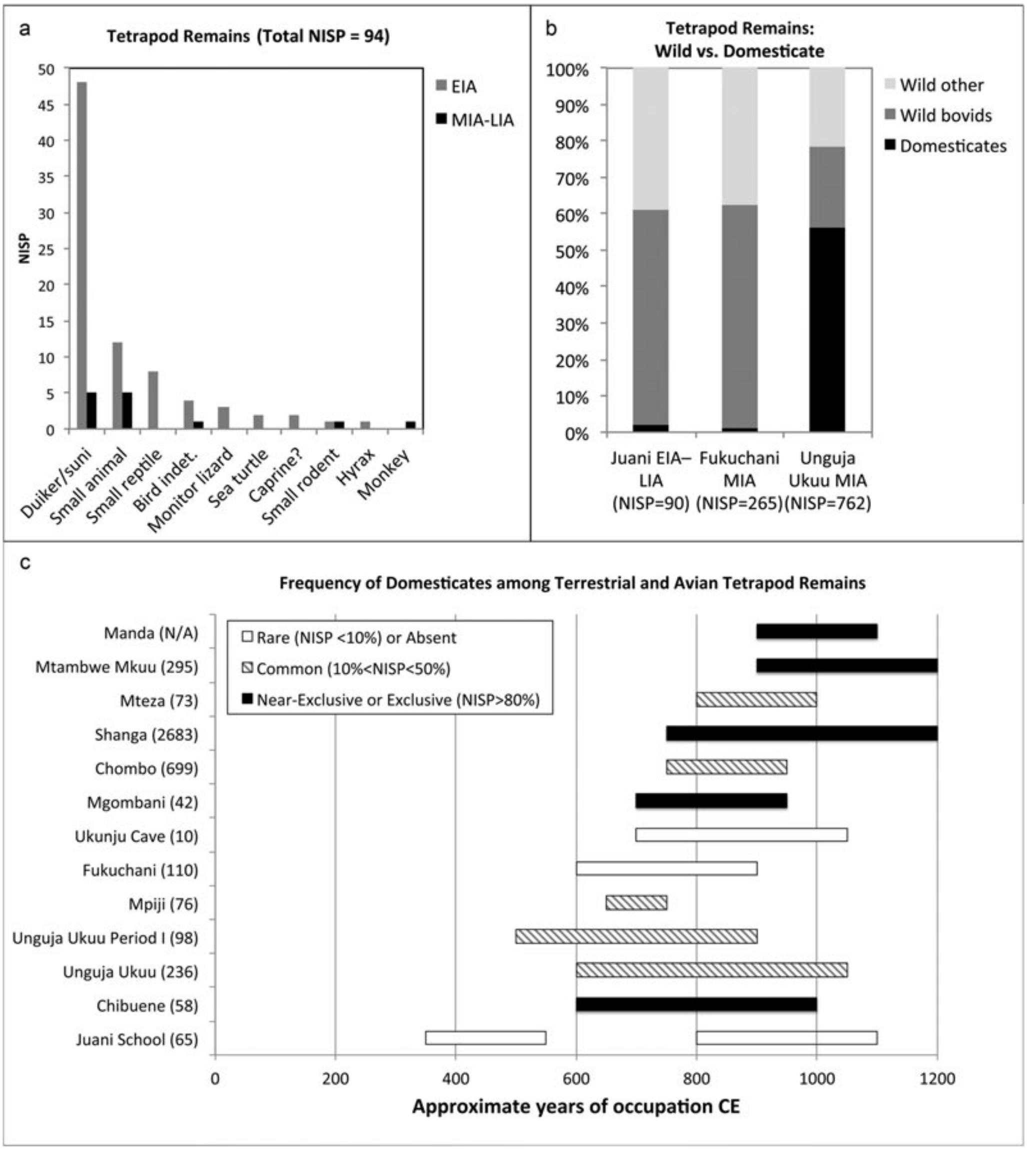

Figure 7. *a) Tetrapod remains (NISP) at Juani Primary School (JS) comparing EIA and MIA–LIA phases; b) wild versus domesticate assemblage compositions for JS compared to Fukuchani and Unguja Ukuu on Zanzibar, excluding birds and specimens only identified to size class, since these could not be distinguished as wild or domestic; c) frequency of domesticates at Early and Middle Iron Age sites on the Swahili coast, expressed as %NISP. Total NISP, shown after each site name, includes terrestrial and avian tetrapods, but excludes human remains, microfauna, and specimens identified at such a general level that it was not possible to distinguish between wild and domestic taxa (e.g., "small mammal," "bird"). For Manda, the faunal assemblage was reported as percentages, without providing total NISP. For Chibuene, only the early (MIA) phase is included here. References for comparative data: Badenhorst et al. 2011; Chami 1994; Chittick 1984; Crowther et al. 2014; Helm 2000a, 2000b; Horton 1996b, in press; Juma 2004. Note that Unguja Ukuu is represented twice: Once from Horton's (in press) and once from Juma's (2004) excavations; for the latter, only fauna from Period I are included.*

both the EIA and MIA–LIA tetrapod assemblages were dominated by wild taxa, particularly blue duiker (*Cephalophus monticola*), while green sea turtle (*Chelonia mydas*) was also present in the EIA. Duiker remains appeared to belong mainly to subadult individuals, whose fragile bones were often highly fragmented; broken cancellous bone that likely derived from sea turtle also dominated the large amount of unidentified bone. A single duiker-sized limb bone was cutmarked, and three specimens also likely belonging to duiker were burnt, but otherwise there is little that can be gleaned about butchery or consumption practices, due to the matrix that obscured surface modifications on most specimens.

Domesticates were absent except for a single, highly fragmented tentative caprine tooth and a caprine-sized mammal bone identified in the EIA layers; given the absence of caprine-sized wild bovids on Mafia, these are probable domesticates. However, considering their fragmentation, caution is stressed. No domestic fauna were identified in the MIA–LIA contexts, though sample sizes are quite small. This pattern contrasts with that seen at the contemporaneous MIA trading port of Unguja Ukuu on Zanzibar, where domestic livestock and wild bovids are equally prevalent in the assemblage; however, it is similar to the pattern at the smaller MIA site of Fukuchani, also on Zanzibar, where livestock are few and suni and duiker are abundant (Figure 7b). Unguja Ukuu, however, is much larger and more cosmopolitan than either Juani or Fukuchani, so it is unsurprising that it has more domesticates. Similarly, urban MIA sites of the Lamu Archipelago, such as Shanga and Manda, have mainly domestic fauna at this time (Chittick 1984; Horton 1996b) (Figure 7c). In contrast, hunting likely remained key to subsistence in some smaller village sites in the MIA, and this was likely the case at the Juani Primary School site.

Additional potential food taxa are represented at the Juani Primary School by only a few specimens: these include Nile monitor (*Varanus niloticus*) and tree hyrax (*Dendrohyrax validus*) in the EIA phase, and a small monkey (*Cercopithecus* sp.) in the MIA–LIA phase. Again, the poor surface preservation and apparent absence of marks means it is difficult to determine if these were related to human subsistence. However, Nile monitor and hyrax have been eaten on Pemba, Zanzibar, and/or Tumbatu Islands in recent times, and monkeys are frequently trapped as vermin on Mafia (Walsh 2007). None of these are consumed as foods on Mafia today.

Charred Macrobotanical Remains

Despite intensive archaeobotanical sampling (33 samples comprising 1732 liters of sediment were processed, including 1030 liters from EIA layers), only a small quantity of identifiable crop remains was recovered at the Juani site (Table 2). Despite the overall low recovery rates, however, significant differences were detected between the EIA and MIA–LIA phases, with all crop remains appearing to derive from the latter. Although a small number of seeds were recovered from the upper EIA layers, direct AMS dates on a sample of these demonstrate that they have been stratigraphically displaced from the overlying MIA deposits (Tables 1 and 2).

The absence of crops in the EIA layers at Juani is at odds with direct evidence for the spread of the full suite of African cereals and pulses—sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine coracana*), and cowpea (*Vigna unguiculata*)—to at least as far as Rwanda in the eastern African interior during this same period (Giblin and Fuller 2011). Sorghum and pearl millet have also been reported from EIA sites in Mikindani on the southern Tanzanian coast (Pawlowicz 2011). This combined evidence demonstrates that migrating early farming communities most likely carried crops with them to eastern Africa, including to the coastal region. The absence of any EIA crop evidence from Juani therefore strongly suggests a major reconfiguration of this subsistence strategy, either upon reaching the offshore islands or before, with the abandonment of crops (and possibly also livestock) in preference for a maritime foraging strategy.

Table 2. **Archaeological seeds remains identified at the Juani primary school site in each occupation phase.**

Identified plant taxa	MIA–LIA	EIA
Liters of sediment processed and analyzed	180[a]	1030
Crops		
Sorghum bicolor (sorghum), seed	1	
Vigna cf. *unguiculata* (cf. cowpea), cotyledon	1	2[b]
Vigna sp. (probably cowpea), cotyledon		7[b]
Adansonia digitata (baobab), seed/seed fragment	3	
cf. *Adansonia digitata* (baobab), testa fragment	4	
cf. *Adansonia* sp. (baobab)/*Gossypium* sp. (cotton), testa fragment	4	
Weeds/other[c]		
Brachiaria sp., seed	p[d]	
Ficus sp., seed		p
Dicot, cf. *Acacia* sp., seed		p
Aizoaceae, seed	p	
Euphorbiaceae, seed		p
Poaceae-type, tuber		p
Portulacaceae type, seed	p	
Rhamnaceae, seed		p
Unidentified fruit stones	p	

[a]Only 180 liters of the 802 liters processed from the MIA–LIA layers have been analyzed to date. [b]Direct radiocarbon dates on three seeds recovered from EIA contexts indicate they are intrusive from overlying MIA layers. Given that all such seeds were recovered from within 10–15 cm under the MIA layers, we infer that all crop remains are likely to be from this later phase. [c]Preliminary identifications and quantifications of weed/other taxa; many seeds remain unidentified owing to limited local reference material. [d]p = present.

During the MIA, on the other hand, we see evidence at the Juani site of crops such as cowpea, sorghum, and baobab (*Adansonia digitata*), all of which are of African origin, but were originally domesticated in regions outside of eastern Africa (Boivin et al. 2013; Giblin and Fuller 2011) and were thus introduced to the island. Currently, the earliest evidence for all these domesticated crops in coastal eastern Africa is in MIA contexts associated with Tana Tradition pottery, where they have been identified at various hinterland, coastal, and island sites across the region (Crowther et al. in press; Helm et al. 2012; Walshaw 2010), including at the site of Ukunju Cave on Juani, located 1.5 km from the school (Crowther et al. 2014). At the Juani Primary School site, we also see evidence of culinary features commonly associated with cereal processing in the form of three ceramic-lined earth ovens, referred to locally as *mofa*. These are widespread across coastal eastern Africa in the MIA–LIA (Chittick 1974; Fleisher and LaViolette 2013; Horton 1996b) and are thought to have been used for baking millet bread. Dates on charcoal from the fill of these ovens place their use in the eleventh–twelfth century cal AD (Table 1: Wk-40969, Wk-40970).

Our preliminary analyses of the charred wood assemblages (targeted at identifying samples for radiocarbon dating, see Table 1) indicate the presence of mangrove (Rhizophoraceae) taxa in both the Early and Middle Iron Age layers, providing further evidence of the incorporation of coastal resources into the economy. Presumably these taxa were used for fuel/firewood, though we might also speculate upon other likely uses including for construction, tools, and furniture, which are common uses of mangrove by Swahili communities today. Further anthracological analysis (so far largely under-developed in eastern Africa; see Schmidt 1997) would be useful to explore the economic uses of mangrove and other woody taxa at the site.

ISLAND COLONIZATION, SUBSISTENCE STRATEGY-SWITCHING, AND A NON-LINEAR EMERGENCE OF MARITIMITY

In many respects, the overall patterns apparent in the Juani archaeological assemblage appear more consistent with an adaptive strategy facilitating occupation of coastal and island environments, rather than a long-term linear trajectory of increasing maritimity. In eastern Africa, it has often been assumed that marine resources were secondary in importance to terrestrial foods in coastal diets until at least the seventh century AD (i.e., MIA), with earlier coastal communities practicing only opportunistic harvesting of marine products (Breen and Lane 2003:475) rather than extensive or even systematic exploitation (as in the Beaton [1995] and Marean [2014] definitions highlighted above). The archaeological data from Juani is nonetheless indicative of a fairly rapid local adaptation to a nearshore marine environment involving an initial systematic focus on wild, readily available resources (especially fishing and shellfish gathering) in place of agriculture and domesticates, and reflecting a specific coastal adaptation during this phase of island colonization and occupation (similar to that proposed for many of the Remote Pacific islands and island southeast Asia (e.g., Anderson and O'Connor 2008; Bulbeck 2008).

The Juani EIA midden assemblages are clearly dominated by marine foods, particularly mollusks but also fish. Wild terrestrial fauna appear to have been a secondary food source. Remains of domesticates are rare and unconfirmed in the case of animals, and non-existent for food crops, suggesting these were not key components of EIA subsistence at the site. In the following MIA period, as populations across the broader coastal and offshore island region became larger and more established, they also became more reliant on food production (agriculture and domesticated animals). Although hunting and trapping continued, livestock—together with marine resources—came to dominate many of the larger MIA–LIA sites in the Zanzibar and Lamu Archipelagos, as shown by a recent review of Swahili zooarchaeology (Quintana Morales and Prendergast in press) (see also Figure 7c). By contrast, at Juani Primary School, we see the rapid transformation in the EIA of inland Bantu-speaking agriculturalists into coastal fisher-foragers with an effective subsistence economy based on shellfish gathering and marine fishing as opposed to agriculture and animal husbandry.

As noted above, direct comparison of the dietary contributions of the various plant and animal resources discussed here are difficult in the absence of isotopic analyses, however the data presented here highlight the shifting abundance, density and, importantly, species diversity within and between the plant, fish, tetrapod, and invertebrate assemblages through time. In combination with evidence from Sealinks excavations at Unguja Ukuu and Fukuchani, these data provide an indication of relative dietary contributions from the EIA into the MIA–LIA. Future research involving a comparison of the Juani faunal assemblages through meat weight estimation would provide another line of evidence regarding the contribution of the marine and terrestrial resources to the diet.

While evidence remains limited, we suggest that this form of opportunistic subsistence adaptation enabled both colonization of offshore islands and perhaps the expansion of populations down the coast, with significant food production (crops, domesticates) being re-introduced once population sizes increased and connections to the mainland were more established. As noted above, the apparent reduction in marine resource use at the Juani site from the EIA into the

MIA also highlights that there was not a long-term, linear trajectory towards a maritime adaptation or increasing "maritimity." Occupation of offshore islands and use of coastal resources occurred as a result of fluid and dynamic behaviors, with the EIA perhaps representing a short-term adaptation during colonization, which appears to have been followed by a decreasing emphasis on marine resources during the MIA, and as Fleisher et al. (2015) argue, a subsequent intensification in maritime adaptations after AD 1000. Flexibility in the adoption of coastal and maritime adaptations (i.e., strategy switching) would also have facilitated broader processes of coastal dispersal, in particular with maritime subsistence adaptation potentially enabling the rapid movement of EIA populations down the eastern African coast and into southern Africa, where many coastal EIA sites similarly feature large shell middens (e.g., Morais 1988; Sinclair et al. 1993).

Evidence of EIA Maritime Trade

The *Periplus of the Erythraean Sea*, cited above, is notable for its discussions of Classical era trade on the eastern African coast, but also for its mention of the maritime societies that inhabited the region. While it describes communities some 300 years earlier than those we have found at Juani, the similarities with the kind of lifestyle evidenced in the EIA archaeology at the Juani Primary School are striking. The coastal eastern African societies briefly described in the *Periplus* are observed to possess both dugout canoes and sewn boats that are "used for fishing and catching turtles" (Casson 1989:59–60, PME 15). While direct evidence for the use of boats is lacking from the Juani site, such evidence is unlikely to preserve. Instead, we can draw on the findings of possible offshore resources like shark in the faunal assemblage from the site to suggest that boats were used in the EIA. Indeed, the initial colonization of Juani Island, probably not long before the Juani Primary School EIA site was established, would have demanded at least the kinds of simple boat technology described in the *Periplus*. Meanwhile, evidence for both fishing and capturing sea turtles is clear in the Juani EIA faunal assemblage. The *Periplus* further describes that the coastal forager-fisher communities of the region also had baskets for catching fish, instead of nets (Casson 1989:60, PME 15), which "they fasten[ed] across the channel opening between the breakers" (Schoff 1912:28). Possibly similar traps, called *mgono*, were still being employed on Pemba in the 1920s (Ingrams 1931:64; Schoff 1912:95 plate; see also Quintana Morales and Horton 2014).

Despite the obvious parallels between the small-scale, maritime-adapted societies described in the *Periplus* and those revealed in the Juani excavations, our high-resolution recovery methods at the site failed to provide any clear archaeological evidence for the thriving trade that the *Periplus* also references. The vast majority of foreign trade goods recovered from the Juani site, including most of the glass beads and all glass pieces and imported pottery, was found in the MIA–LIA layers and thus dates to the main period of intensive and well-documented Indian Ocean trade. The only exception to this trend in our excavations was a very small number of glass beads ($n = 2$) that were recovered from the uppermost EIA layer in trench JS12-03. Given that this layer of trench 3 was stratigraphically superimposed by MIA deposits that also contained glass beads ($n = 8$), we are cautious about their EIA association. Like the crop remains also found in these upper EIA layers, but radiocarbon dated to the MIA, it is likely that these small beads moved down from the overlying sandy deposits. Chemical testing of the glass beads is underway to trace their types and proveniences, which may shed further light on this chronological issue.

Notably, all other occurrences of foreign trade goods (glass beads, glass pieces, and imported ceramics, usually in extremely small quantities) at coastal EIA sites in eastern Africa also derive from deposits that immediately underlie Middle or Late Iron Age occupations (e.g., Chami 1999b, 2003). Reviewing this broader evidence, it is difficult to reconcile the archaeological record—thus far silent on EIA inter-regional trade—with the *Periplus'* descriptions of long-distance trade. While this could be the result of a number of factors, including preservation and archaeological visibility, we also note that our radiocarbon dates place the EIA occupation on Juani in the late fourth century AD at the earliest, some three centuries after the events described in the *Periplus*. The identity of these early traders thus remains a mystery, though it has been suggested that they might not have been iron-working communities as widely thought, but perhaps mobile foragers and/or pastoralists that occupied the coast before the arrival of Iron Age groups (see also Boivin et al. 2013).

While evidence for long-distance trade was lacking, the EIA deposits at the Juani site did, however, feature a large assemblage of mollusk shell beads (Figure 8), including 60 finished disks, two drilled disk roughouts, and nine undrilled disk blanks, pointing to their local manufacture. In addition, a further 19 finished disks, two drilled disk roughouts, 33 possible disk blanks, and a single cylinder were found in the MIA–LIA layers. Owing to varying degrees of corrosion, most identifying shell landmarks have been eroded or obscured, precluding the positive taxonomic identification of the majority of the assemblage. However, several examples were identified as marine bivalves, probably *Anadara* sp. The cylinder bead appears to be made on a large cowrie shell. Just over half of the assemblage (n = 71, 56.3%) was recovered from EIA layers, including in the lowermost contexts. Accepting that a small amount of mixing may have occurred between the upper EIA and lower MIA layers, it is still likely that a significant proportion of the assemblage is from the EIA occupation phase. Interestingly, none of the bead grinders commonly found on Proto-Swahili sites that are thought to be used for shell disk bead manufacture (e.g., Flexner et al. 2008; Horton 1996b), were found at Juani, suggesting that a different manufacturing process might have been used.

The finding of these shell beads alongside evidence of their local manufacture in the EIA is significant for several reasons. First, they are the only known mollusk shell disk beads securely associated with EIA Kwale occupation, making them also among the earliest examples of this bead type on the coast. It is noteworthy, however, that a single shell disk bead was found with Kwale pottery on Kwale Island, located ca. 35 km northwest of Juani, but owing to the lack of evidence elsewhere for EIA shell bead manufacture, was considered by the excavators to be intrusive (Chami and Msemwa 1997b:55). All other known examples of mollusk shell disk beads in the region date from the MIA period, when the production of this bead type was a major household industry at pre-Swahili sites, particularly on the offshore islands (e.g., Flexner et al. 2008; Horton 1996b; Juma 2004). The Juani assemblage thus provides the first clear evidence that this practice extends back chronologically to the EIA, and may hint at the formation of a 'maritime' identity among these colonizing populations and the attendant socio-cultural transformations associated with their maritime adaptations.

Second, the presence of these shell beads raises questions as to their role in local trade and society. Shell bead production during the MIA is widely viewed as a mechanism of local rather than long-distance Indian Ocean trade—the beads are thought to have been produced by coastal pre-Swahili "middlemen" for trade with communities in the eastern African hinterland and interior, in exchange for the raw materials that were coveted by Arab and Indian traders (e.g., Fleisher and LaViolette 2013; Horton 1996b). Some have argued that this local trade may have tapped into networks that formed much earlier, such as during the EIA, which in turn may have exploited the established networks of indigenous foragers and pastoralists who occupied the region for thousands of years prior (e.g., Boivin et al. 2013; Shipton et al. 2013; Wright 2005). We propose that the Juani beads may have also been manufactured for local trade and exchange, though we suggest that a key motivation was to form and maintain social networks (possibly similar to social gifting and alliance maintenance seen in the Torres Strait (e.g., McNiven 1998, 2015) rather than solely to acquire novel trade goods (though this too might have been a purpose). Archaeological research in other regions, such as the Pacific, has shown that such networks were crucial to ensuring the successful exploration

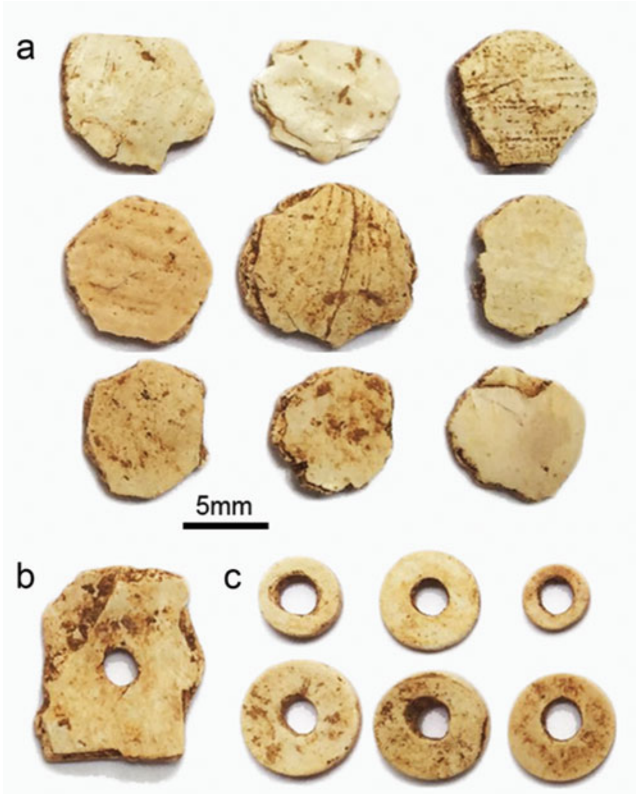

Figure 8. *Mollusk shell disk beads from Early Iron Age layers, showing different stages of manufacture: a) undrilled blanks; b) drilled roughout; and c) finished beads. (Contexts: a: 304G; b–c: 406F).*

and colonization of new island landscapes (e.g., Kirch 1988), and they may have played a similar role for migrating eastern African Iron Age groups. Until more systematic research is conducted at other EIA sites on the coast and islands to establish if shell beads were traded in this way, our proposal remains hypothetical, but we note that it is consistent with evidence of local interaction among mainland EIA communities who appear to have traded iron, copal (resin), and other goods (Chami 1992; see also discussion in Crowther et al. 2015). It is also noteworthy that pierced cowrie shells have also been found at EIA sites in Rwanda, demonstrating evidence of coast–interior links at this time (Giblin et al. 2010).

CONCLUSION

The near absence of systematic zooarchaeological research on pre-Swahili assemblages, in particular from smaller offshore islands where ready access to rich littoral ecosystems may have encouraged or facilitated a more marine-focused lifestyle (see Keegan et al. 2008) has constrained models for the development of maritime adaptations in this region. While the analysis of the Juani assemblage offers only the first step in addressing this lacuna, the results nonetheless imply that maritime-focused societies were potentially established as early as the EIA on eastern Africa's small islands, but also that an initial focus on marine resources subsequently shifted in favor of a more mixed agricultural-hunting-foraging-fishing lifestyle in the MIA. The emergence of the maritime-oriented societies of the later Swahili period was accordingly the result of an adaptive process that was neither linear nor continuous. Instead, early coast-dwelling peoples adopted components of a maritime-oriented lifestyle in a fluid and dynamic way that involved an active response to new environmental opportunities and challenges. Maritime subsistence, colonization, trade, and expansion were all possibilities that were suitable at particular times and places. The flexibility in adaptive behaviors that we observe may have enabled, and encouraged, an expansion of coastally settled EIA populations thousands of kilometers south. This hypothesis, however, will remain speculative until further research and basic data collection is carried out.

This study also re-asserts the need for greater consideration of small islands in regional models for Iron Age settlement, trade, and migration. Our data highlight the possibility that Early Iron Age settlers may have preferentially targeted small offshore islands, such as those in the Mafia archipelago, owing to their ecological diversity, including access to rich marine resources suitable for supporting subsistence, trade, and other social activities. Future research should also seek to understand the long-term environmental impacts of these activities on the region's small islands, which although perhaps ecologically and geographically attractive for early settlement and trade, are typically also more susceptible to over-exploitation than islands with larger landmasses (e.g., Masse et al. 2006; Weisler 2003). The comparatively higher-intensity exploitation of marine resources in the EIA and potential resulting resource depression might well have played a role in the EIA-MIA economic transition described here, though this hypothesis cannot be addressed without additional research. Such research would clarify the potential for human impacts on nearshore environments during the early phase of island colonization and occupation (e.g., Butler 2001; Giovas et al. 2010; Giovas et al. 2016; Morrison and Hunt 2007). The findings presented here demonstrate the exciting potential for archaeological science and systematically collected data on early subsistence to challenge and transform our understanding of the importance of small offshore islands in eastern African prehistory.

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END NOTE

1. While the use of labels such as "Early-," "Middle-," and "Later Iron Age" on the eastern African coast is seen by some as problematic owing to their implied cultural associations (e.g., Chami 1994), we employ them here for chronological and terminological simplicity.

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