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Iron Age agriculture, fishing and trade in the Mafia Archipelago, Tanzania: new evidence from Ukunju Cave

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Small-scale excavations were recently undertaken at the site of Ukunju Cave in the Mafia Archipelago, Tanzania, to collect new bioarchaeological and material culture data relating to the site's occupation and the nature of early subsistence and long-distance trade in the region. Our findings suggest that occupation of the cave began during the Middle Iron Age (MIA, seventh to tenth centuries AD), as indicated by the presence of local Early Tana Tradition (ETT)/Triangular Incised Ware (TIW) pottery in the lowest layers above bedrock, as well as small quantities of imported ceramics and glass beads also dating from the mid- to the late first millennium AD. Small assemblages of faunal and botanical remains, including introduced African crops (pearl millet, sorghum, baobab and possibly cowpea) were found in association with these finds, indicating that these MIA communities practised a mixed economy of fishing, domestic livestock keeping and agriculture. In addition, the presence of cotton suggests they may have also been producing fibres or textiles, most likely for local use, but possibly also for long distance trade. Although some quartz artefacts were recovered, we found no evidence of any pre-Iron Age LSA culture at the cave, contrary to previous claims about the site.

Keywords: Middle Iron Age; Tana Tradition/Triangular Incised Ware pottery; African crops; stone tools; Indian Ocean trade; Tanzania

Un travail pionnier visant à l'étude de l'occupation de la côte est-africaine avant l'Âge de Fer a relevé les indices d'une installation de groupes à l'Âge de Pierre tardif et au Néolithique sur plusieurs îles dont Zanzibar, Pemba et Mafia. Il a été proposé que ces occupations étaient associées à des marchandises de l'Océan Indien et des animaux domestiques et qu'elles dataient des derniers millénaires av. J.-C. Ces données ont fait l'objet de beaucoup de controverses et de débats, conduisant certains à remettre en cause la datation des sites, la qualité de la stratigraphie et l'identification des restes bio-archéologiques. Pour résoudre ces problèmes chronologiques, le projet Sealinks a

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récemment mené des fouilles à petite échelle dans la grotte de Ukunju, sur l'île de Juani, Mafia. Un ancien sondage a été ré-ouvert et les sédiments basaux fouillés jusqu'au sol stérile. Nos résultats suggèrent que l'occupation de la grotte commença au cours de l'Âge de Fer moyen (MIA), comme l'indique la présence de poterie de tradition Tana/Triangulaire Incisé (TT/TIW) dans les niveaux les plus bas, ainsi que de petites quantités de céramiques et de perles de verre importées datant de la deuxième moitié du premier millénaire ap. J.-C. Une petite quantité de plantes africaines introduites, y compris du mil, du sorgho, du baobab et peut-être du niébé, a été recueillie en association avec ces objets, ce qui indiquerait que ces communautés MIA cultivaient le mil et peut-être aussi des légumineuses. La présence de coton suggère qu'ils produisaient peut-être aussi des fibres ou des textiles, soit pour une utilisation locale ou pour le commerce sur de longues distances. Bien que certains lithiques en quartz aient été retrouvés, nous n'avons décelé aucune donnée indiquant une occupation de la grotte à l'Âge de Pierre tardif ou au Néolithique.

Introduction

Decades of pioneering archaeological research have firmly established East Africa's offshore islands as important localities for understanding the region's pre-Swahili maritime adaptations and early Indian Ocean trade connections (Horton 1996, in press; Chami and Msemwa 1997a, 1997b; Chami 1999, 2000, 2001, 2004, 2009; Horton and Middleton 2000; Chami and Kwekason 2003; Juma 2004; Sinclair *et al*. 2006; Fleisher and LaViolette 2013). While traditional models held that occupation of the islands of Zanzibar, Pemba and Mafia began with the arrival of iron-working, farming communities in the first millennium AD, more recent findings have been drawn upon to suggest that some islands may have been occupied by stone-tool using groups from the mid-late Holocene, and possibly earlier (Chami 2001, 2004, 2006, 2009, Sinclair *et al*. 2006). It has also been proposed that some of these communities, which have been argued to reflect a previously overlooked 'Neolithic occupation', acquired domestic plants and animals, including species of Asian origin, and were actively engaged in long-distance trade in the last millennia BC (Chami 2004, 2007, 2009; Chami *et al*. 2009). Such a suggestion corresponds to descriptions of trade between the East African (Azanian) coast and regions to the north as described in such Classical sources as the *Periplus of the Erythraean Sea*, argued to date to the first century AD (Casson 1989; see also Horton 1990; Vansina 1997; Chami and Kwekason 2003). The elusiveness of evidence for this trade has meant that such claims have attracted significant attention.

Elements of the 'Neolithic'[1] hypothesis have also come under scrutiny, however, and, in particular, serious issues with proposed chronologies, typologies and faunal identifications have been raised (Sutton 2002; Sinclair 2007; Dueppen 2011; Wood 2011). Beyond these debates, the paucity of systematically collected and analysed evidence for early subsistence, and crop and domestic faunal introductions on the East African coast has also been highlighted (Boivin *et al*. 2013). This has led to serious gaps in our understanding, particularly in relation to the relative roles of marine foods, livestock, agriculture and wild plants in early coastal diets (Horton and Mudida 1993; Breen and Lane 2004), as well as the timing and agency of Indian Ocean biological introductions and inter-island wild animal translocations (Walsh 2007; Fuller and Boivin 2009; Fuller *et al*. 2011; Boivin *et al*. 2013).

As part of a broader archaeological research programme aimed at investigating the origins and development of East Africa's maritime societies and their long-distance connections with the Indian Ocean world (Helm *et al*. 2012; Boivin *et al*. 2013; Shipton *et al*. 2013), the Sealinks Project recently returned to the site of Ukunju Cave on Juani

island, Mafia — originally excavated by Chami in 2000 (Chami 2000, 2004) — to collect new data relating to early settlement, subsistence and trade in the archipelago. Our small-scale excavations emphasised the recovery of high-resolution cultural, archaeobotanical and zooarchaeological evidence, allowing us to begin addressing these research themes. Here we report our preliminary findings from the site, where we re-opened the original main trench (Trench 1) (Chami 2000, 2004) and dug the lowest, unexcavated deposits to bedrock. The results outlined here, while local in focus, inform wider debates about the earliest phases of East Africa's maritime settlement and Indian Ocean engagement.

Environmental context

The Mafia Archipelago lies approximately 120 km south of Dar es Salaam and 20 km off the southern coast of Tanzania, opposite the Rufiji Delta (Figure 1). It is separated from the mainland by a shallow channel that is no more than 50 m deep (Gaudian and Richmond 1990). The archipelago comprises the main island of Mafia, which measures approximately 48 km by 17 km, and a number of smaller islands located to the south and east, including the inhabited islands of Chole, Juani, Jibondo, and Bwejju. Juani, which is the largest of these islands at 8 km by 4 km in size, is located off the south coast of Mafia opposite Chole Bay.

All the islands in the archipelago are very flat and low lying. The basal rock is Pleistocene coral limestone, which is upraised or exposed along the east coasts of both the main island and Juani, forming rocky cliffs and wave-cut platforms in some areas. The east coasts are high-energy environments and lack protected beaches. The northern and western sides of the outer islands have a more sheltered, mangrove-fringed coastline, often with wide limestone flats extending hundreds of meters to the sub-littoral waters (Gaudian and Richmond 1990). The coral rag foundation is covered by sandy, loamy soils (Greenway *et al*. 1988: 199). The islands lack any large rivers, but do have several seasonal and intermittent streams (Greenway *et al*. 1988). Groundwater aquifers tapped from surface wells provide the main water source for the islands' inhabitants.

Although likely once forested with lowland coastal forests, the islands' vegetation currently comprises a mosaic of agricultural areas, secondary forests, tidal mangrove swamps, scrubby coastal moorlands and degraded fallow bush. The mangrove swamps provide a rich array of resources, including fish, shellfish, such as crabs and molluscs, and wood for charcoal extraction, as well as craft and construction materials. They also have a rich marine and littoral fauna supported on a range of tropical marine habitats, including coral reefs, sea grass beds, mangroves, and inter-tidal flats. The contemporary mammalian fauna is much poorer than that of other continental East African islands such as Zanzibar and is notably lacking in endemics, possibly as a result of human activities such as hunting and the clearing of forests (Walsh 2007). Around 30 native mammalian taxa have been recorded on the islands, including wild bush pig (*Potamochoerus larvatus*) and small antelopes such as suni (*Neotragus moschatus*) and blue duiker (*Cephalophus monticola*) (Kock and Stanley 2009).

Site description and previous archaeology

The Ukunju Cave site was discovered by Felix Chami in 2000 during archaeological surveys aimed at investigating the early settlement history of the Mafia Archipelago (Chami 1999, 2000, 2004). It is one of two main caves investigated archaeologically on

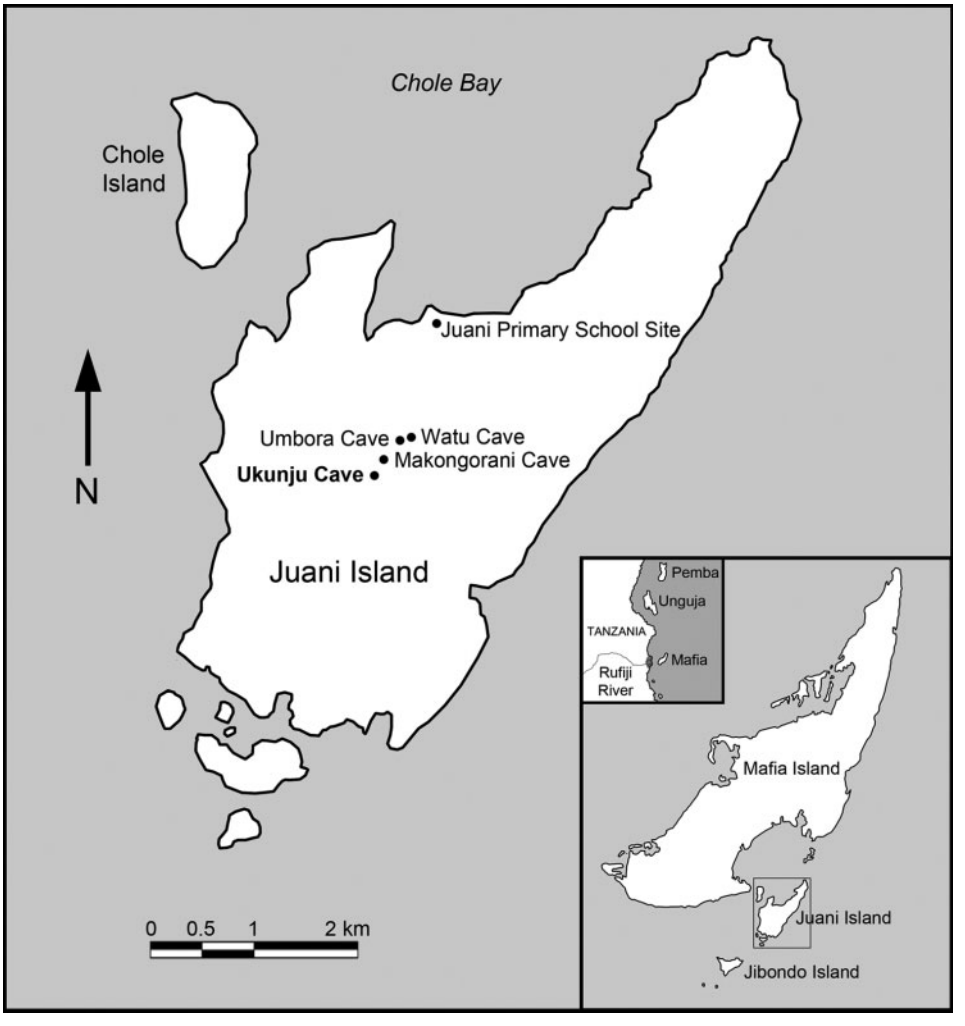

Figure 1. Map of Juani island, Mafia, showing the location of Ukunju Cave and other sites mentioned in the text.

Juani Island by Chami, the other being Kinunda, located 1.8 km to the northeast of Ukunju (Chami 2004). Ukunju is located in the centre of Juani Island (WGS84 Zone 37M 585491E 9115355N; Figure 1) in a large flat expanse of *shambas* (cultivated fields). The shelter is formed by the collapse of a large subterranean limestone sinkhole, currently around 20–30 m in diameter and 2–3 m deep (Figure 2). The central area of the sinkhole is covered in limestone blocks created by the roof fall, as well as by vegetation, while the archaeological deposits are located under a semi-circular overhang at the western and northern ends formed by the roof collapse (Figure 3). The area immediately surrounding the sinkhole is densely forested, possibly in part because the flora is able to access the freshwater lens through the cavernous limestone substrate.

Previous archaeological work at the site saw the excavation of two trenches in the sheltered part of the cave, each measuring 2 × 1 m (Figure 4) (Chami 2000, 2004).

Figure 2. Ukunju Cave, facing north. The site is formed by the collapse of a large limestone sinkhole, creating a large, roughly round subterranean depression with several overhangs.

Trench 1 was excavated in a mounded area in the middle part of the shelter. It reached 180 cm below surface (to judge from the backfill we removed, though Chami (2000) reports a depth of 200 cm) and contained 'a repetitive sequence of soil layers', which led to the suggestion that the mound had accumulated from the excavation of the two depressions on either side, possibly during the seventeenth century (Chami 2000). The artefacts from Trench 1 were therefore not initially considered to be *in situ* (Chami 2000: 210), although a later report argued that they came from a stratified cultural sequence

Figure 3. Ukunju Cave, facing east across the main overhang.

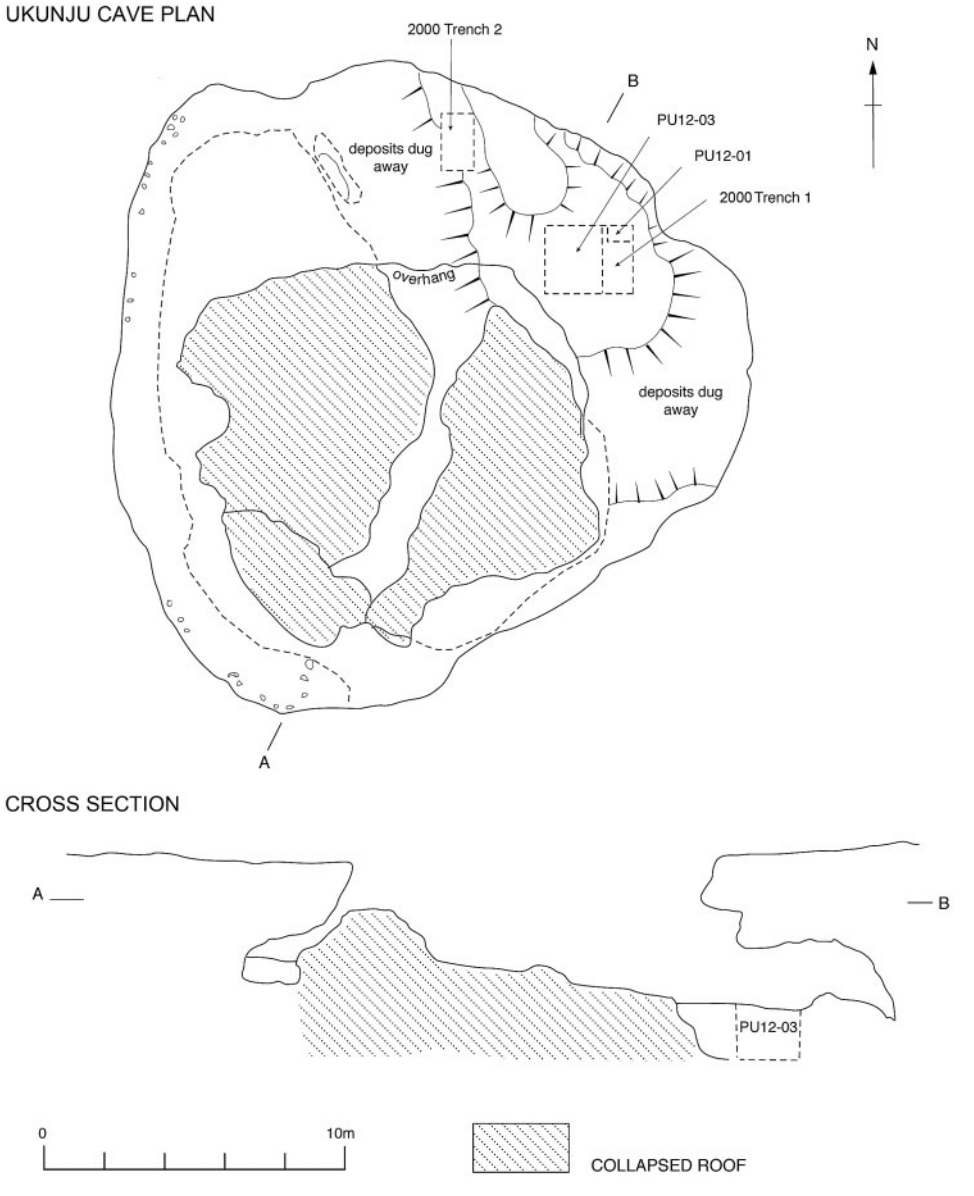

Figure 4. Plan and cross-section of Ukunju Cave, showing location of the Sealinks Project's trenches and the previous excavations.

(Chami 2004). The second trench was placed in a depression on the western side and stopped at 100 cm below the surface when the water table was reached.

The upper contexts of the 2000 Trench 1 contained Swahili and post-Swahili ceramics dating from the thirteenth century AD onwards, while so-called 'Neolithic' pottery and microliths were recovered from the lower levels (90–180 cm) in association with trade goods (glass beads) and the remains of domestic animals (Chami 2004). No local Tana Tradition/Triangular Incised Ware (TT/TIW) ceramics were recovered at the cave, leading to the suggestion that use of the site was abandoned during the Middle Iron Age (roughly

the seventh-tenth centuries AD) (Chami 2000). Early TT/TIW ceramics are commonly found at farming and iron-working settlements across East Africa's coast and hinterland during this period (also referred to as the Middle Iron Working or Early Tana period), often in association with imported ceramics and other Indian Ocean trade goods (e.g., Chami 1994; Horton 1996; Juma 2004; Fleisher and Wynne-Jones 2011; Helm *et al*. 2012). Two radiocarbon dates were obtained from the cave's archaeological deposits, both on *Strombus alatus* (Strombidae) marine shell. One sample from the lowest occupation level in Trench 1 gave an uncalibrated date of 2880 ± 60 BP (Pta-8527), while the other sample (Trench 1, 120-130 cm) gave an uncalibrated date of 2810 ± 60 BP (Pta-8522). Together, these gave a calibrated date range of *c*. 800–400 BC after deduction of the global average surface marine reservoir of *c*. 400 years (Chami 2004: 88–89, 2009: 88). Because an accurate local marine reservoir offset (commonly known as Delta R, which is applied on top of the global correction) has yet to be measured for Mafia, or anywhere along the East African coastline for that matter (cf. Southon *et al*. 2002), these dates must be considered as only broadly indicative. This dating issue is further complicated by the fact that marine reservoirs also vary between shellfish species according to their habitat and dietary preferences (Petchey 2009). Herbivorous and bottom-feeding gastropods such as the Strombidae in particular are considered among the least reliable shellfish taxa for radiocarbon determinations owing to their ingestion of old carbon incorporated into tidal sediments, which can cause them to produce dates that are as much as 500-600 years too old (Petchey *et al*. 2012).

Some 275 stone artefacts were recovered from the previous excavations at Ukunju (Chami 2004: 78). These were made on clear and milky quartz, limestone and chalk and included a range of technological types, including flakes, split nodules and cores. The main raw material and reduction sequences were: i) small rounded beach quartz nodules, approximately 2 cm in diameter, split using a bipolar-on-anvil technique with little secondary reduction; and ii) larger platform flakes made from limestone (Chami 2004: 77). The limestone artefacts were described as heavily weathered and not easily defined and it was conceded that some might be natural rather than cultural in origin (Chami 2004).

The ceramics assigned to Neolithic traditions were described as dark-greyish in colour and having long necks and everted rims, with some bearing decorative motifs similar to those of the first millennium BC Neolithic traditions of the Rift and Nile Valleys (Chami 2004: 76). Some sherds were also described as being tempered with fragments of red ware pottery imported from India or the Mediterranean, while others were considered to be entirely of foreign manufacture (Chami 2004: 76). The latter were identified as a range of imported types that date mainly from the fourth century BC to the fourth century AD, including South Asian Harappan and southern Indian Megalithic Period wares, Early Historic Buddhist monk vessels, Gupta Period red painted wares and Arikamedu basket impressed design wares, among others (Chami 2004). The identification of many of these imported ceramic types has, however, been contested (Sinclair 2007). A single piece of *sgraffiato* dating to between the eleventh and thirteenth centuries was the earliest imported Islamic material found during the excavations (Chami 2000: 211).

Sixty-seven glass beads were recovered from the 2000 excavations, demonstrating long-distance inter-regional trade links. Wood (cited in Chami 2004: 81; see also Wood 2011: 24–25) identified these as types dating primarily to the Islamic or post-Islamic period, including Indo-Pacific (Trade Wind) beads and sixteenth to nineteenth-century Venetian beads. She concluded that none could be definitively identified on morphological grounds as being older than the late eighth or ninth centuries AD. Chami (2004: 81),

on the other hand, maintained that some of the earlier examples from the site were more likely to be Hellenistic or Roman in origin, given their contextual association with early imports, as well as with marine shells dated to the first millennium BC.

The faunal assemblage recovered during the 2000 excavation was dominated by shellfish, but also included some fish, wild mammals and birds. Perhaps most significant, though, was a domestic dog (*Canis familiaris*) tooth found in the lower levels (Chami 2004: 88) that pointed to the presence of pre-Iron Age domesticates of non-African origin on the coast. Although no crop remains were recovered (specialised archaeobotanical recovery methods such as flotation were not employed during the excavation), it has been suggested elsewhere (Chami and Kwekason 2003; Chami 2007: 6) that these pre-Iron Age communities were most likely agricultural, given that they kept domestic livestock such as cattle and chickens, which have been identified at other sites such as Kuumbi and Machaga Caves on Zanzibar (Chami 2001, 2009; although see Sutton 2002, Sinclair 2007 and Dueppen 2011 on the identification and dating of these finds).

Fieldwork methodology

Archaeological fieldwork on Juani Island by the Sealinks Project, carried out in July and August 2012, involved an initial reconnaissance survey to relocate Ukunju and Kinunda Caves. Four main caves were located on the island (Figure 1), one of which was identified as Ukunju based on published site plans and descriptions. Also clearly visible in this cave were the two 2000 trenches, the backfill of which had slumped leaving a clear outline of the units. The wooden pegs used to string out Trench 1 were also still *in situ*, marking the trench corners. The other three caves we visited on Juani appear to be undocumented in earlier reports. One had a small, rectangular (2 × 1 m) excavation dug into its deposits, as well as the remains of several human skeletons on the surface. We also visited two caves on the northeast side of the island, but these were very small and inaccessible. None of the caves we visited matched the published plan of Kinunda (Chami 2004), although we were informed by local people of the presence of several more caves on the island that we were unable to visit.

Two trenches were excavated at Ukunju (Figure 4) during the 2012 field season. The first, PU12-03, was a western extension of the 2000 Trench 1. This trench was dug in order to assess the stratigraphic sequence of the upper cave deposits, which both Chami (2000) and Sinclair (2007) considered to be disturbed. In order to facilitate our excavation, the 2000 Trench 1 backfill was first removed (leaving a 60 cm wide step at the southern end of the trench to aid access) and the walls cleaned, allowing us to follow the stratigraphy of the 2000 trench's western section during our excavation. PU12-03 initially measured 2 × 2 m in size, but was later extended to 2.3 × 2 m by cutting back the northern and southern walls (including in the 2000 trench) by 15 cm each when it became clear that the walls of the 2000 trench were unconsolidated and at risk of collapse. PU12-03 was then stepped on the western side at 65 cm below surface, reducing its area to 2.3 × 1.2 m (Figure 5). Its excavation ceased at 80 cm below surface owing to time constraints on the fieldwork schedule. In total, 1810 litres of sediment were excavated from the trench.

Upon removal of the backfill from the 2000 Trench 1, we realised that the original excavation had not reached bedrock at 180 cm as thought, but had only encountered rock from roof fall, which covered the western part of the trench (see the trench plan in Figure 6). Intact archaeological deposits appeared to be present underneath the rock, as well as in the eastern part of the unit. We therefore excavated a 90 × 60 cm sondage,

Figure 5. Ukunju Cave: PU12-03 and the 2000 Trench 1 at end of excavation (facing north).

designated PU12-01, into the base of these deposits, reaching bedrock at 275 cm below surface (95 cm beneath the base of the previous excavation) (Figure 7). In addition to the sondage (comprising Contexts 103 and 104; see the section in Figure 6), samples of Contexts 97–102 were excavated from a 30 cm wide column in the 2000 Trench 1 north section. This ensured that we had a sample of the full depositional sequence in the cave, from the surface to the bedrock. These sediments, along with those from the sondage, were processed in their entirety by flotation and wet sieving (see below).

Both trenches were hand-excavated in controlled stratigraphic sequence by single context. In some cases, thicker contexts were excavated in smaller arbitrary units to obtain tighter chronological control, although all the results presented here are combined for each context. The majority of excavated deposits from PU12-03 were dry sieved on site using a 3 mm mesh to maximise the recovery of small finds. A sub-sample from each context was also wet sieved using a 1 mm mesh to recover faunal and cultural micro-remains such as fish bones and beads. Owing to the small size of the PU12-01 sondage and column sample, 100% of the sediment from this sondage (214 litres in total) was bagged and processed by bucket flotation using 0.3 mm mesh to recover archaeobotanical remains, after which it was wet sieved with 1 mm mesh to recover cultural materials and other organics (bone, shell, etc.). Flotation and wet sieving were conducted at the beach adjacent to the Juani Primary School using seawater. All the artefacts recovered during the excavations were collected and bagged by archaeological context or spit and described and quantified by material type.

Stratigraphy and archaeological features

PU12-03

The stratigraphic sequence for both trenches is shown in Figure 6. The uppermost cave context, 301, consisted of a very loose grey silt that appeared to be very mixed (wind/water accumulated). Beneath this was a series of cemented medium to light brown clayey

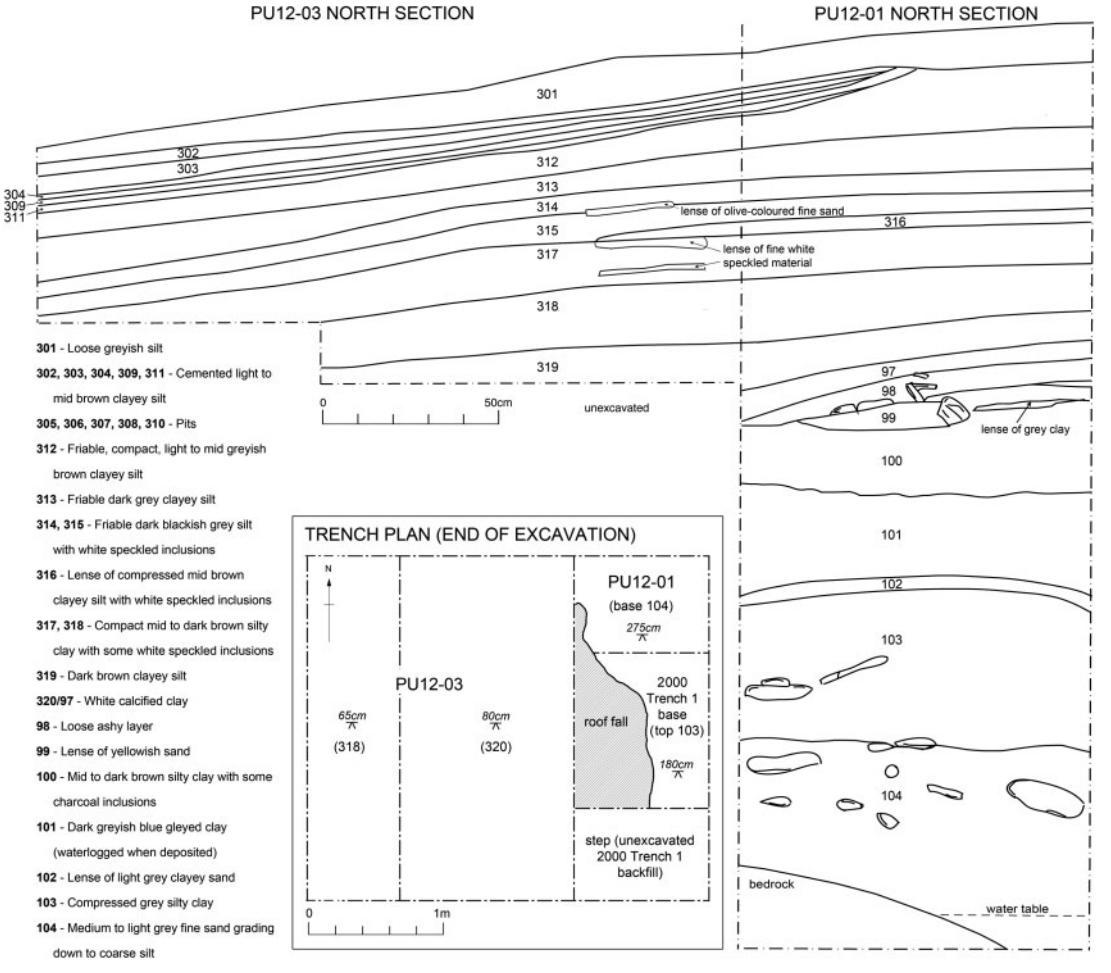

Figure 6. Ukunju Cave: north sections and trench plan of PU12-01 and PU12-03 at end of excavation (inset).

Figure 7. Ukunju Cave: Trench PU12-01 at the end of excavation (facing north). The roof-fall at about 180 cm below the surface (at the base of the 2000 Trench 1) is visible in the western half of the trench.

silts, interpreted as a sequence of thin trampled surfaces (Contexts 302, 303, 304, 309, 311), possibly equivalent to the layers thought during previous excavations to have been created by more recent digging to find water (Chami 2000). Contexts 305 (cut)-306 (fill), 307 (cut)-308 (fill) and 310 comprised a sequence of shallow pits and features. Most of the top part of the sequence was heavily bioturbated and displayed evidence of truncation by animal burrowing.

Beneath these contexts was a series of friable, fairly compacted clays and clayey silts (Contexts 312–316). These varied from light through medium and dark grey to black organic silt and contained white calcified speckled inclusions (most likely degraded calcium carbonate from shells), pottery and shells. These contexts had a higher organic content than the overlying layers, suggesting that they might have been formed during a phase of more active human use of the cave. Alternatively, they could simply represent better preservation of naturally accumulated organics, perhaps promoted by a wetter cave environment at the time. There did not appear to be as much bioturbation and mixing as in the overlying contexts.

Contexts 317–319 were a series of compact, lumpy and silty clays of a medium to dark brown colour. They contained occasional white speckled inclusions along with moderate amounts of pottery, shells and limestone pieces. These contexts appear to be

associated with human activity in the cave, possibly occasional or seasonal occupation or refuge. Excavation ceased at Context 320 (Context 97 in PU12-01, see below), which was a cemented and cracked white clayey surface, possibly a floor layer. Several similar 'floor' horizons were visible beneath Context 320 in the exposed south and west sections of the 2000 trench.

PU12-01

The deposits in PU12-01 comprised a typical fining-up sequence. The upper deposits (Contexts 97 [equivalent to Context 320], 98 and 99) were thin layers of sandy clay/silts that were browner and more oxidised towards the top. They were intermingled with ashy, sandy, cemented 'floor' deposits, similar to Context 320 in PU12-03, indicating a possible association with human activity. These graded down into clayier silts with a bluish hue (Contexts 100–102), most likely indicating wet anoxic conditions and gleying. This continued to grade down to coarser silt and finally the basal fining up deposits (103 and 104). The lower 10–20 cm of these deposits was completely inundated by the water table, while the deposits below ~180 cm were wet. The lower sediments also had the appearance of foreshore-like deposits, characterised by well-sorted medium-fine sands and frequent marine shell. Such an explanation, though, would imply marine activity quite a distance inland from the coast. If a network of karstic activity is present throughout the limestone, this scenario could have been possible within the Holocene, when there was a slight rise in sea level. Alternatively, the sandy, marine-like deposits could have formed by active freshwater flow within the karstic system. The limestone bedrock at the base of the trench was very polished by erosion. This could be related to freshwater flow during the initial karstic formation, or by marine tidal activity (for example, at a period of higher sea level). Owing to their thickness, Contexts 103 and 104 were both excavated in three arbitrary spits to maintain tighter stratigraphic control of finds. The levels identified during the previous excavation as containing Neolithic ceramics and stone tools (90–180 cm) (Chami 2000, 2004) appear to correlate with our Contexts 97–102, while the base of the 2000 trench, which was revealed after removal of the backfill, was the top of our Context 103.

Archaeological finds

Cultural material was found throughout the entire depositional sequence, including the lowermost spit of Context 104, which was directly above bedrock (Table 1). The majority of it consisted of locally made earthenware pottery, of which 3238 sherds (40.3 kg) were recovered in total. In PU12-01, all chronologically diagnostic pieces were TT/TIW (Figure 8), which was present throughout the sequence, including the lowermost layer immediately overlying the bedrock. Thirteen diagnostic TT/TIW pieces were recovered from Contexts 103 and 104, which were below the base of the 2000 excavation. Among the TT/TIW assemblage from these lower deposits was a substantial rim of a decorated necked jar with a buff grey paste and red-slip coat over the rim and the upper interior. The upper layers in trench PU12-03 (Contexts 301–311) contained a small number of post-Swahili sherds mixed with some TT/TIW, which fits with the suggestion that these layers are disturbed, possibly having accumulated through post-seventeenth-century digging in the cave (Chami 2000). The middle layers, Contexts 312–320 (where 320 equals Context 97 in PU12-01), contained no chronologically diagnostic sherds, although we noted that the form and fabric of many were generally consistent with TT/TIW. No Early Iron Age

Table 1. Ukunju Cave: finds from PU12-01 and PU12-03 (counts unless indicated otherwise).

	Local pottery											Imported pottery				Other								
Context	**TT/TIW decorated rim**	**TT/TIW hematite rim**	**TT/TIW decorated body**	**Post-Swahili decorated rim**	**Post-Swahili decorated body**	**Plain rim**	**Decorated rim**	**Hematite rim**	**Decorated body**	**Hematite body**	**Plain body**	**Sasanian-Islamic**	**Storage vessel**	**Stoneware**	**Chinese Martabani**	**Bead grinder**	**Copper**	**Glass pieces**	**Glass beads**	**Shell disc beads**	**Stone/steatite bead**	**Quartz pieces**	**Shell (g)**	**Fauna (g)**
Surface																			2					
301								1			7													
302											29								1					
303			1	1	1	5			2		268								3					
304			1			1			1		104												6	6
306			1		1						29												81	82
308																		3						
309				1	1						158								1				28	27
310						1		1			121								1					
311						1			1		45													
312						4			2														11	10
313						4	2	1	4		151													1
314						6			2		198								1				160	134
315						4	1		3		366		1						1					11
316						3		1			211								2	1			11	
317						4					177													
318							2		2		94								2			1	22	
319								2	2		18													
97											8													
98	1					1					39			1	1									
99											8													
100						2			1		6													
101						3					146	1							1					1
102						1					64													
103	1	1	9			11					634	1				1			1	2		16	83	14
104			2			3				6	244						2		10	13	1	60	284	5
Total	**2**	**1**	**14**	**2**	**3**	**54**	**5**	**6**	**20**	**6**	**3125**	**2**	**1**	**1**	**1**	**1**	**2**	**3**	**26**	**16**	**1**	**77**	**686**	**291**

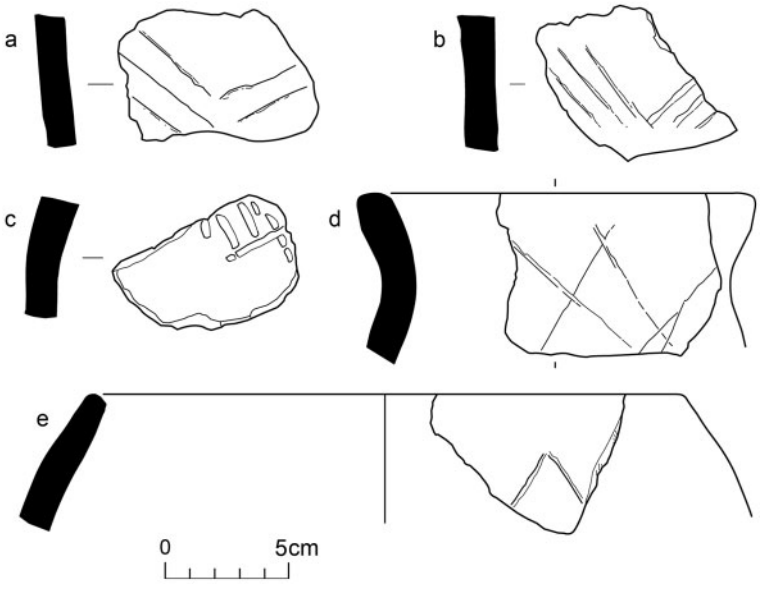

Figure 8. Ukunju Cave: examples of TT/TIW pottery (a: Context 303; b: Context 304; c: Context 306; d: Context 98; e: Context 103).

Kwale ceramics were recovered. Context 103 was the richest layer overall, containing 656 sherds, while the lower contexts in general (those from PU12-01) were most abundant with pottery in terms of both the number and weight of ceramics recovered per unit sediment (Figure 9), suggesting that occupation of the site was initially more intensive than during later phases.

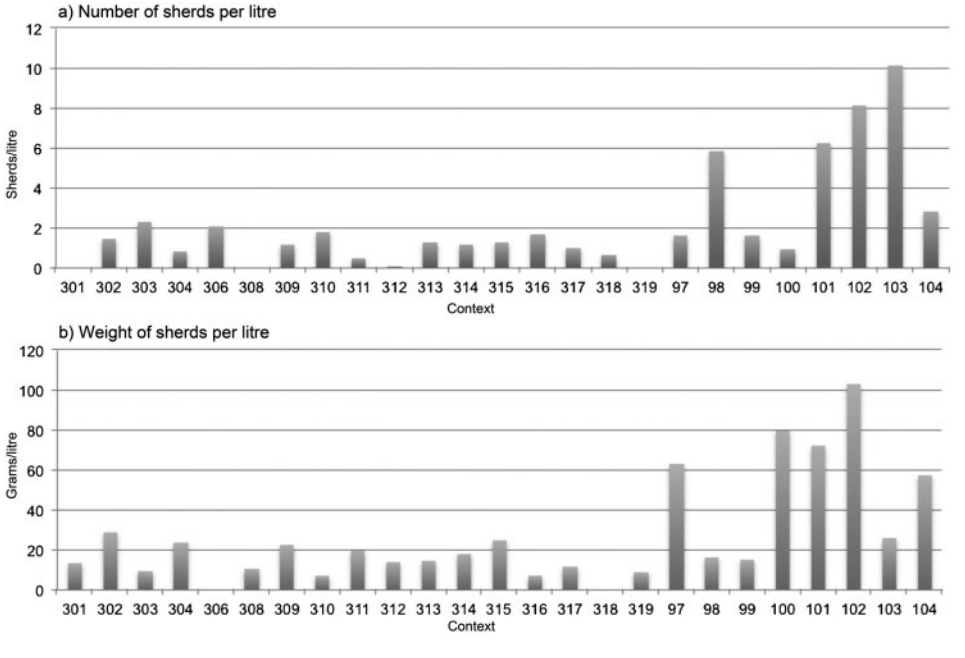

Figure 9. Ukunju Cave: density of sherds per context.

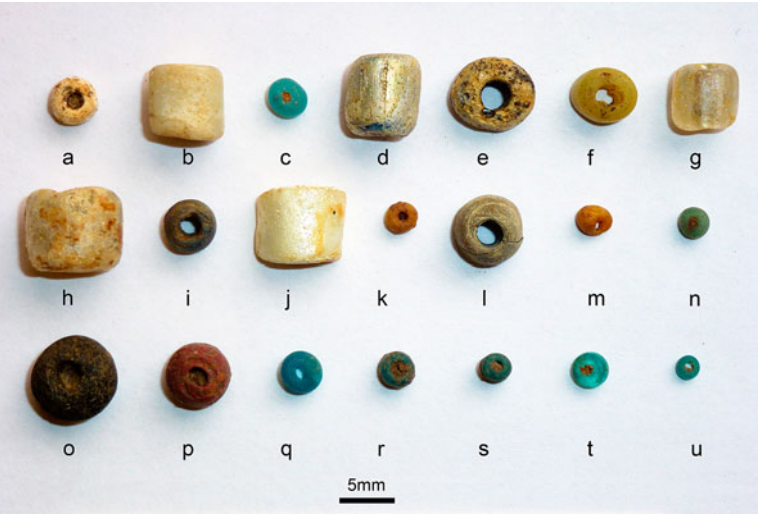

Figure 10. Ukunju Cave: examples of glass beads from PU12-03 and PU12-01 (a-b: surface; c: Context 302; d-f: Context 303B; g: Context 309; h: Context 310; i: Context 314; j: Context 315; k: Context 316; l-m: Context 318; n: Context 101; o: Context 103; p-u: Context 104).

Four sherds of imported ceramics were found in PU12-01. These included two fragments of Sasanian-Islamic pottery from Contexts 101 and 103, and a fragment of a Chinese Martabani jar and an unglazed stoneware vessel, both from Context 98. The Martabani sherd has a pale olive green glaze on the exterior and a handle, which is typical of forms dating to the eleventh century onwards (Horton 1996). No ceramic imports were recovered from PU12-03. While the dating is imprecise from such a small assemblage, the presence of Sasanian-Islamic pottery from Context 103 suggests a date after the seventh century (Horton 1996; Fleisher and LaViolette 2013), bracketed by the eleventh-

Figure 11. Ukunju Cave: shell beads from PU12-01 (top row: Context 103; bottom three rows: Context 104).

Figure 12. Ukunju Cave: examples of bipolar flakes from PU12-01, Context 104.

century Chinese stoneware in Context 98. Given that the local pottery is all typically TT/TIW, a date at the end of the first millennium AD for the lowest levels that were sealed below the base of the earlier excavations (Contexts 103 and 104) and probably also Contexts 101–102 would be a reasonable estimate. The overlying contexts (312–100) are most likely Late Iron Age in date (eleventh-fifteenth centuries), with mixed Post-Swahili layers (301–311) at the top of the sequence.

The excavations yielded a modest assemblage of beads, including 26 of glass (Figure 10), 16 of shell discs (8 whole, 5 fragments; Figure 11), and one of stone/steatite. The shell and stone beads were concentrated in the lowest contexts (103 and 104), while the glass beads appeared relatively frequently throughout the full sequence; a ceramic bead grinder made on local clay was also recovered from Context 103. Typological assessment of the glass beads indicates that the assemblage does not include any that are unequivocally indicative of trade in the Greco-Roman period. Several beads (Figure 10a, b, d and j) are of European origin (probably Venetian) and are representative of the earliest types of European beads found on Africa's eastern coast. Most of these were recovered from Contexts 310 and above, which are associated with Post-Swahili ceramics. Two others (Figure 10g and h), which are also from the upper/Post-Swahili layers, could also be European in origin and are related to a similar bead found in Trench 1 (0–10 cm) in the 2000 excavations. Likewise, beads i and l shown in Figure 10 are similar to examples from the 140–150 cm level in the 2000 Trench 1 and are probably of Indian origin. Five of the beads found in the lowest excavated level (Context 104) (Figure 10q–u), are comparable to many found at Unguja Ukuu on Zanzibar, which dates to between the seventh and tenth centuries, suggesting that they may be considerably older than the other beads in the Ukunju assemblage, but they are not Greco-Roman and instead probably come from South Asia. Only two metal pieces were found in the Ukunju excavation, both of them very small, non-descript pieces of copper. Both were recovered from Context 104. The only glass pieces (N = 3) were recovered from Context 308.

A number of quartz artefacts (N = 77) were also recovered from the cave's deposits. Once again, these were concentrated in the lowest contexts (103 and 104), with a single piece also occurring in Context 318. More than half the pieces showed signs of bipolar flaking (Figure 12), but all were simple flakes with no retouch and there were no formal tool types present. Cortex on the larger flakes indicates that they were struck from small rounded quartz pebbles, which can be found in the vicinity of the cave and on nearby beaches. The presence of very small pieces (<1 g) and angular shatter indicates on-site production. Such an expedient technology occurs as a baseline component in many lithic traditions, particularly the Later Stone Age of southern and eastern Africa (Ambrose 2002; Villa *et al*. 2012). All the stone tools were found in association with local Middle Iron Age ceramics and mid– to late first-millennium AD imports. There was no evidence

Table 2. Ukunju Cave: taxonomic representation of faunal remains (NISP) per context.

Taxon	313	315	101	103	104	Total
Non-fish						
Animal size 3, cf. *Chelonia mydas*		2				2
Caprine (*Ovis*/*Capra*)				2		2
Muridae (rats, gerbils, mice)				1		1
Small rodent					3	3
Small snake				1	1	2
Micro-animal (possible bird or bat)				2	2	4
Mammal size 0.5-1 (hyrax-sized)	1				3	4
Mammal size 1-2 (duiker-sized)				4		4
Total non-fish NISP	**1**	**2**	**0**	**10**	**9**	**22**
Fish						
Acanthuridae (surgeonfish)				1		1
Albulidae (bonefish)				1		1
Lethrinidae (emperors)			1	1		2
Mullidae (mullets)					1	1
Ostraciidae (cowfish)					1	1
Scaridae (parrotfish)		1		4	8	13
Serranidae (groupers)					1	1
Not identified	1			41	92	134
Total fish NISP	**1**	**1**	**1**	**48**	**103**	**154**

in our excavations of the pre-Iron Age stone tool industry, including artefacts made on limestone, described previously at the site.

The faunal assemblage at Ukunju Cave is very small, with just 22 terrestrial and 20 fish specimens identified (Table 2). Of the identified terrestrial specimens, many belong to quite small animals that are unlikely to be related to human activity at the site: they include a very small snake, a murid rodent and a similarly small animal that might be either a bird or a bat. Two of the animals at the site, however, were likely brought in by the occupants: these are a probable sea turtle in Context 315 and a domestic caprine in Context 103, each represented by two specimens. One small mammal limb shaft had been burnt, and another bore rodent gnaw marks, but otherwise no bone surface modifications are visible, despite good cortical preservation. A total of 154 fish remains (3.6 g) were recovered, but these were mostly unidentified spine fragments. A high frequency of burning (37%) was evident from the coloration of the fish fragments, including dark brown, black, grey and white, which could indicate human use. Twenty specimens were identified to at least family level, 13 of which were single teeth of the family Scaridae (parrotfish) probably representing three individuals in Contexts 103, 104 and 315 respectively (Table 2). The other identified remains were mostly vertebrae of a mix of inshore species. One interesting piece found was the scale of a cowfish (Ostraciidae). These fish are covered in hard scales and secrete a toxin and are therefore not commonly eaten, although they have been found at some Swahili sites (Horton and Mudida 1993; Fleisher 2003; Quintana Morales 2012). Shell was also recovered, mainly from Contexts 103 and 104, but its analysis is still ongoing.

Like the faunal remains, the archaeobotanical assemblage recovered from Ukunju Cave was very small and generally poorly preserved. There was very little charred material of any kind (including charcoal) in the analysed contexts (97–104) and those pieces present displayed a high degree of fragmentation, abrasion and rounding. As with all other cultural remains, the richest archaeobotanical assemblage was found in Context 104, where it was

Table 3. Ukunju Cave: taxonomic representation of archaeobotanical remains (NISP) per context.

Taxon	97	98	99	100	101	102	103	104 upper	104 base	Total
Pennisetum glaucum (pearl millet), seed						2			1	**3**
cf. *Pennisetum glaucum*, seed						1				**1**
Pennisetum sp., seed						1				**1**
Vigna sp. (legume), cotyledon						1				**1**
Vigna cf. *unguiculata* (cowpea), seed						1				**1**
Sorghum sp., husk									6	**6**
Adansonia digitata (baobab), seed frag								1		**1**
cf. *Adansonia digitata*, testa frag									7	**7**
Gossypium sp. (cotton), funicular seed cap						3				**3**
cf. *Gossypium* sp., testa frag					2	1	2			**5**
Hibiscus sp. *sensu lato*, seed						2				**2**
Cyperaceae, seed									1	**1**
Indet seed/seed frag		1			11	16	5	1	11	**45**
Total NISP	**0**	**1**	**0**	**0**	**13**	**28**	**7**	**2**	**26**	**77**

concentrated at the base of the context, as well as in Context 102 (Table 3). A total of 77 charred plant specimens (other than charcoal, which was not quantified or analysed) were found, the majority of which were unidentified seeds, seed fragments and nutshell fragments (N=45). Among the identified pieces were the remains of several crops (Figure 13), including three pearl millet (*Pennisetum glaucum*) and two tentative pearl

Figure 13. Ukunju Cave: archaeobotanical crop remains from PU12-01: a) pearl millet (*Pennisetum glaucum*) grain from two views (left: lateral, right: dorsal), apical end damaged (Context 102); b) pearl millet grains enclosed in lemma and palea (Context 102); c) sorghum (*Sorghum bicolor*) husks (lemma/palea) (Context 104); and d) cotton (*Gossypium* sp.) seed funicular caps (Context 102).

millet caryopses, two *Vigna* sp. fragments, one of which is mostly likely cowpea (*Vigna* cf. *unguiculata*), six sorghum (*Sorghum bicolor*) glumes and a baobab (*Adansonia digitata*) seed fragment. In addition to these subsistence crops, three cotton (*Gossypium* sp.) seed funicular caps (Figure 13d), as well as possible cotton testa fragments, were found; both are typical residues of crop processing for textile production (Fuller 2008). All the identified crops are of African origin, but were originally domesticated in regions outside East Africa (Giblin and Fuller 2011; Helm *et al*. 2012; Boivin *et al*. 2013) and were thus introduced to Juani Island, although wild African cotton (*Gossypium herbaceum*) may have been locally available. Likewise, it cannot be determined with confidence that the two legumes, identified as *Vigna* sp. and *Vigna* cf. *unguiculata*, are domesticated crops, given that wild species of *Vigna* (including the wild sub-species of cowpea, *V. unguiculata* [L.] Walp. ssp. *dekindtiana* (Harms) Verdc.) are widespread across Sub-Saharan Africa (Giblin and Fuller 2011). Currently, the earliest evidence for all these domesticated crops in coastal East Africa is in Middle Iron Age (or transitional Early/Middle Iron Age) contexts associated with TT/TIW pottery, where they have been identified at various sites in Kenya (Helm *et al*. 2012; Shipton *et al*. 2013), on Pemba (Walshaw 2010) and in another, as yet unpublished, Sealinks excavation on Zanzibar. We note, however, that very few Early Iron Age sites have yet been tested archaeobotanically (cf. Giblin and Fuller 2011).

Discussion

Although our excavations at Ukunju Cave were on a relatively small scale, their implications for understanding Mafia's settlement history and external contacts are broad. Most significantly, we found no evidence of any pre-Middle Iron Age occupation and long-distance trade at the site. The earliest cultural horizons that we observed at the cave, which include deposits located directly on the bedrock, contained Middle Iron Age Tana Tradition/TIW potsherds, which date regionally from the seventh century AD (Fleisher and Wynne-Jones 2011). A ceramic bead grinder made on local clay was also found near the base of the excavation and such finds are typically found across coastal East Africa in MIA/Tana Tradition contexts (Horton 1996; Flexner *et al*. 2008).

While a small number of simple quartz bipolar flakes were found at the base of the sequence, the pre-Iron Age stone tool industry previously described at Ukunju appeared to be completely absent from our excavation. It is apparent, however, that the earliest occupants of the site possessed elements of both Iron Age ceramic and, to a lesser extent, Later Stone Age lithic traditions. It is also notable that quartz flakes, as well as unflaked pieces, were recovered during recent Sealinks excavations from Iron Age contexts at the nearby Juani Primary School Site (first investigated by Chami [1999, 2000]), as well as at Unguja Ukuu on Zanzibar (Crowther *et al*. 2012), suggesting that their production and use could have been contemporary with, or even the product of, Iron Age cultures, although interaction with stone tool-using people (communities of which have been shown to have co-existed with Middle Iron Age farming groups elsewhere on the East African coast; Helm *et al*. 2012) cannot be ruled out.

While we were unable to replicate previous findings of pre-Iron occupation at Ukunju, our results have nonetheless produced a range of new data relating to the early occupation of the Mafia Archipelago and its connections with both the East African coast and the wider Indian Ocean world. It has previously been observed that evidence of MIA occupation is extremely rare on Mafia (Chami 2000, 2004; Wynne-Jones 2006; Christie 2011), leading to suggestions that there might have been an occupational hiatus on the archipelago during this period. The presence of TT/TIW pottery at Ukunju demonstrates

that the occupation sequence of the archipelago was largely continuous from the EIA through to the Post-Swahili period. Recent excavations by the Sealinks Project at the nearby Juani Primary School site, located only 1.5 km (30 minutes walk) to the north, also identified a well-stratified MIA horizon containing TT/TIW pottery, domestic remains such as *mofa* ovens and midden debris, crop remains (including sorghum and possible evidence of cowpea) and small quantities of Indian Ocean trade goods, including glass beads and Middle Eastern ceramics similar to those found at Ukunju (Crowther *et al*. 2012). This evidence, along with the presence of crop remains at Ukunju, indicates at least small-scale occupation of the archipelago by agricultural Tana Tradition communities. Small quantities of TT/TIW pottery have also been reported at Kinunda Cave on Juani (Chami 2004: 90) and on neighbouring Chole Island (Christie 2011), which is accessible from Juani by foot at low tide.

The lack of features such as hearths, along with the scarcity of organic layers and economic plant and animal remains, suggests that Ukunju Cave was probably used on an occasional, rather than a permanent, basis. It may have been used as a refuge or shelter, perhaps seasonally or during bad weather, with the main settlement(s) located elsewhere, such as at the Juani Primary School site. The presence of a small quantity of crop seeds and glumes derived from pearl millet and sorghum, which are major pan-African cereals, as well as baobab and burnt fish bones, indicates that some food-preparation activities and possibly also crop-processing for fibre or textile production took place at the Ukunju site, perhaps whilst the cave was used as a shelter during the cultivation of local fields. Use of the cave appears to have continued into the Post-Swahili period, although the much lower density and diversity of finds compared to the TT/TIW layers suggests that this was an even more ephemeral occupation or was associated with different activities. These Post-Swahili levels, located in Contexts 301–311, contained a number of decorated and undecorated sherds that may have been discarded as the cave was visited for water collection.

Kwale ceramics were absent from our excavations at Ukunju and, although a very small number of them were recovered in the 2000 excavation (Chami 2000), their rarity at the cave is notable, given the presence of a large EIA occupation site at the Juani Primary School site only a short distance away (Chami 1999, 2000, 2004; Crowther *et al*. 2012). Archaeological excavations at a number of cave sites across East Africa's coast and islands, including several in the southern Kenyan coastal hinterland, Mapangani and Watoro caves on Pemba, and Kuumbi, Machaga and Mwanampambe caves on Zanzibar have also found Kwale ceramics to be absent or extremely rare (Chami 2003, 2009; Sinclair *et al*. 2006; Chami *et al*. 2009; Helm *et al*. 2012; Shipton *et al*. 2013; Sealinks Project unpublished data). The first substantive evidence for the use of these caves by Iron Age communities, or by foragers in contact with such groups, occurs in the Middle to Late Iron Age, as signalled by the presence of TT/TIW pottery. Chami (2003: 6–8) suggests that both Ukunju and Machaga Caves might not have been habitable during the Early Iron Age, when the climate may have been wetter and the water table higher. It is also possible that the sinkhole forming Ukunju Cave simply did not exist until the Middle Iron Age. This scenario could be evaluated through future geoarchaeological assessment.

Conclusion

The long-term settlement history of the Mafia Archipelago has attracted much attention in recent years, but has received little empirical investigation since initial surveys and excavations over a decade ago. Our re-excavation of Ukunju Cave has not only clarified

the long-term cultural sequence of the site, but also offered new evidence to suggest that the archipelago has been continuously occupied since the Early Iron Age and was not abandoned during the Middle Iron Age as once suggested. We discovered that the original 2000 excavation at Ukunju did not reach bedrock as previously reported and found a further 95 cm of stratified, archaeologically-rich deposits below the basal deposits of the 2000 trench. These deposits preserved quantities of TT/TIW ceramics, shell and glass beads, Middle Eastern, South Asian and Chinese imports and African crop and faunal remains, with all chronologically diagnostic pieces dating to the late-first/early-second millennia AD. Although a small number of quartz flakes were found in association with the basal TT/TIW ceramics, we found no evidence to suggest that there was a pre-Iron Age occupation at Ukunju.

A key aim of the Sealinks excavations on Juani was to collect new bioarchaeological data relating to the subsistence practices of the archipelago's occupants, including faunal and archaeobotanical remains. While the assemblages recovered were limited in size, they provide the first evidence for the introduction of agriculture to the archipelago and support models that suggest coastal Middle Iron Age communities practised a mixed fishing-farming subsistence regime. Our overall project aims to provide a much-needed absolute chronology for the archipelago's cultural sequence and for the arrival of these crops and domesticated animals through a comprehensive radiocarbon dating programme. Some of these studies are still in progress, but it is anticipated that in the near future they will provide further novel insights into the nature of subsistence, maritime adaptations and inter-regional trade in the Mafia Archipelago.

Note

1. Although the term Neolithic has been applied in coastal East Africa to refer to pre-Iron Age ceramic and stone-tool using, farming groups (e.g. Chami 2001, 2004, 2006, 2007, 2009; Chami and Kwekason 2003), it has yet to receive widespread application outside this literature.

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