Towards a Swahili Historical Ecology: Phytolith-based Analysis in Coastal Eastern Africa since AD 600

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Abstract

This dissertation reconstructs the diachronic implications of ongoing interaction between Swahili peoples and coastal environments in three regions of Tanzania, Eastern Africa since AD 600. Previous archaeological investigations document the presence of Iron Age populations across the coast by this point. Iron Age people of Eastern Africa occupied villages and practiced mixed subsistence economy that featured African grains and animal husbandry. Through time, some villages became entrepôts from which residents managed commercial ties that extended into continental Africa and across the Indian Ocean. I rely on phytolith, soil, and archaeological samples recovered from archaeological contexts to evaluate the change in botanical communities through time that occurred in conjunction with the ongoing application of mixed subsistence economies, urbanization, and other social choices apparent across the regions. The paleoethnobotanical perspectives from this research contribute to a growing literature that frames environmental conditions as contributing to the formation of modern conditions.

I interpret the interaction between coastal peoples and local ecologies through the theoretical framework of historical ecology. This paradigm holds that contemporary environmental conditions reflect the ongoing interaction between cultural, biological, and physical factors. Each constituent is thought to have the capacity to bring about change to the overall system; thus, historical ecology is an interdisciplinary paradigm that requires data from all three (cultural, biological, physical) constituents.

The regions under consideration include Songo Mnara Island, Mikindani Bay, and northern Pemba Island. Archaeologists had previously defined social chronologies, geographic extent, and material expectations from these three sites. The unique social histories and environmental situations apparent in the three regions lead me to expect variability in the interaction between residents and local ecologies. The phytolith-based results from this research demonstrate a homogeneous approach was expressed towards settlement in plant communities and subsequent approaches to plant resource management. This suggests that a general set of socioenviornmental strategies may accompany the social traits shared between coastal peoples since AD 600.

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Chapter One

The Intersection of Swahili Coast Archaeology and Phytolith-Based Paleoethnobotanical Investigations

In this dissertation I reconstruct the diachronic implications of ongoing interaction between Swahili people and coastal environments in three regions of Eastern Africa. The interactions under consideration here extend back to roughly AD 600, the approximate moment when Iron Age agropastoral villages first appeared in coastal regions (Phillipson 1977, 1979). Through time, residents of these agropastoral villages carved out a regional identity that is labeled Swahili. This identity features a broadly similar subsistence economy, technological cache, spoken language, ideology, and affinity for long-distance exchange with continental peers and those from across the Indian Ocean (Phillipson 1976; Nurse & Spear 1985; Horton 1987; Middleton 1992; Horton & Middleton 2000; LaViolette 2005). Archaeological investigations have revealed a range of site- or region-specific expressions of Swahili identity (Chittick 1969, 1977, 1984; Wright 1992; Horton 1996; Fleisher 2003; Wynne-Jones 2005; Pawlowicz 2011). Despite slight variation between archaeological assemblages, the material record confirms that a society with demonstrably African roots has existed in the region since AD 600 (Horton 1987; Chami 1992; Middleton 1992; Allen 1993; Kusimba 1999; Horton & Middleton 2000).

Researchers are starting to investigate the role environmental conditions have played in the creation of region-specific expressions of Swahili identity. The proliferation of environmental perspectives in Swahili archaeology follows a trend common in Eastern and Southern Africa (Robertshaw & Wetterstrom 1989; Schmidt 1990; Schoenbrun 1993, 1998; Huffman 1996; Sinclair & Håkanson 2000; Håkanson 2004; Lane 2004; Antonites & Antonites 2014). The goal of the present research is to add a diachronic environmental perspective to the existing interpretations of social histories available along this coastline. I rely on paleoethnobotanical methodologies to reconstruct environmental conditions, namely plant community composition, through time. This project offers a unique understanding of Swahili decision-making processes, as I situate coastal peoples alongside the plant communities and environmental conditions they experienced. This perspective not only permits a better understanding of interaction between people and local ecologies, it also contributes to the understanding of processes that constitute modern environmental conditions.

I rely on phytolith samples to capture evidence of plant community composition in archaeological contexts. The archaeological regions that I consider in this project are Songo Mnara Island, Mikindani Bay, and northern Pemba. Each of the areas has a unique set of social histories, differential expressions of Swahili identities, and is situated within a variety of modern ecological conditions. The comparative approach allows me to identify site-specific manifestations of plant-resource management as well as evaluate trends in such interaction through time and space.

I use trends apparent in the comparative research to evaluate the following research questions:

- In what ways did local plant communities and plant-use patterns vary along the Swahili coast across time and space?
- Did plant resources contribute to the constitution, manipulation, or expression of site-specific Swahili identities?
 - o If so, did the interaction between Swahili people and plant communities create anthropogenic landscapes with an analytical ability on par with material culture, language, or ideology?
 - o If not, than what was the nature of interaction between Swahili people and available plant resources?
- Was the diachronic change in Swahili identity apparent in the material record reflected in the plant record? Here I am speaking directly towards processes of urbanization, adoption of Islam, shift towards rice production, and altered tone and tenor in long-distance trade.
 - o If so, than in what ways were such changes echoed?
 - If no, than why would plant resource use be insulated from such anthropogenic influence?
- Is phytolith analysis a research method that can produce viable results along the Eastern African coast?
 - Can phytolith indices capture evidence of anthropogenic influences in any demonstrable manner?
 - o What are the successes and limitations of this project?
 - o What would I do differently in the future?

This chapter reviews archaeological and historical literature to introduce the social, material, and environmental factors that constitute Swahili identity. I begin this literature review with a brief presentation of coastal geographies; I then

present perceptions of coastal identity and contrast those from historic documents with information from the archaeological record. The structure of this presentation situates Swahili peoples squarely within a global network of exchange, though does so in a way that preserves agency and authority within Eastern African settlements. When possible, I highlight evidence of subsistence practices, architecture, and local technologies because such factors hold the most direct influence over plant resource management strategies. The discussion of Swahili identity precedes brief introductions of the three regions that I consider in this dissertation. I conclude the chapter with an overview of the chapters that follow.

Archaeology of the Swahili Coast

Swahili people have occupied the coast of Eastern Africa since the first millennium AD. Their coastal communities have a longitudinal extent that covers 2,500 km of Eastern African coastline from Mogadishu in the north to the far south of Mozambique (Figure 1.1). Indications of Swahili identity also spread to adjacent nearshore and offshore islands, including northern Madagascar as well as the Lamu, Zanzibar, and Comoro archipelagos. Proximity to marine resources, including the ability to engage with international economies, is a common denominator of Swahili geography, as few Swahili settlements were founded more than four or five kilometers inland (Horton & Middleton 2000). Never in their nearly 2,000 years of history or 2,500 km of regional extent have Swahili people created a bounded polity or established a geographic capital. Regional polities and capitals were not

necessary for coastal peoples to differentiate themselves from inland and overseas peers in a unified, recognizable manner.

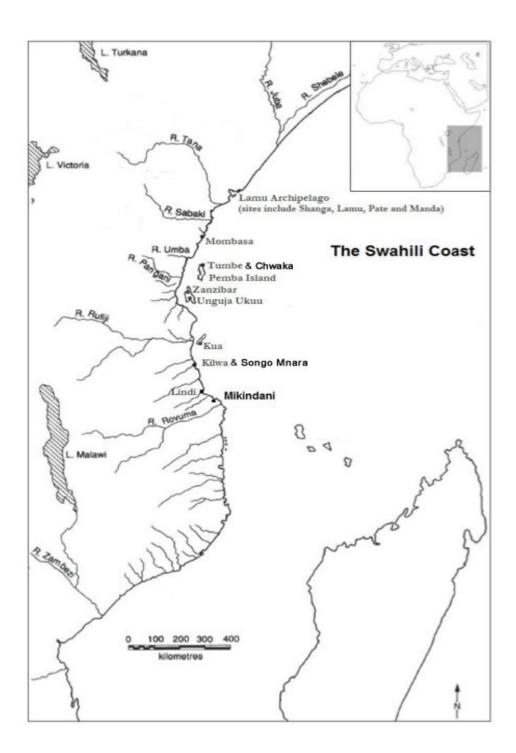


Figure 1.1: The Swahili coast of Eastern Africa. Sites under consideration in bold

A series of towns sprouted up along the Eastern African coastline during the Iron Age beginning in the late-first millennium AD. Residents of these early coastal towns inherited a subsistence economy of mixed farming, iron production and pastoralism (Chami 1994; Abungu 1994/5; Kusimba 1999). Swahili communities did not necessarily represent continuations of agro-pastoral predecessors; I say this because residents committed to the potential of a mercantile orientation through which coastal towns facilitated long-distance trade between Africa's interior and those communities across the Indian Ocean. Evidence suggests that economic engagement influenced community organization after AD 1000 (Horton 1987; Kusimba 1999; Horton & Middleton 2000); those who participated in long-distance commerce did so while maintaining a common coastal cultural assemblage (Chami 1998; Mapunda 2002). Peoples who occupied the coast of Eastern Africa after the mid-first millennium expressed a variety of languages, religions, levels of urbanism, material cultures, and engagement with long-distance mercantile systems.

Expression of these cultural factors varied through space and time, often both. For example, the Swahili language did not exist until about AD 900, roughly 300 years after Swahili lifestyles emerged (Nurse & Spear 1985). Similarly, small groups of coastal people began converting to Islam in the eighth century. By the fourteenth century, virtually the entire population was Muslim (Horton & Middleton 2000). LaViolette (2008) argues that long-held cosmopolitan attitudes had contributed to the cultural and mercantile decisions that constitute Swahili identity.

Engagement with African or Indian Ocean merchants increased exposure to exotic ideas; therefore, the cosmopolitan model links variability between Swahili

people and their communities writ-large. This notion, therefore, creates an interpretation of a coastal culture that encompassed residents of urban entrepôts and surrounding hinterlands, almost all of whom eventually converted to Islam, spoke the Northeast Coast Bantu language of Swahili, contained segments of the social group who engaged in long-distance trade, and eventually felt the influence of predatory empires.

This review considers long-distance commercial engagement exclusively in terms of strategies and connections known to the Eastern African coast. While this treatment permits a better understanding of the factors that contributed to the constitution of Swahili identity, the perspective largely overlooks the ways in which Swahili people may have fit into the Indian Ocean commercial system. Historians have long acknowledged that, in the centuries leading up to 1800, this commercial system was the largest and wealthiest in the world (Wolfe 1982; Lindsay 2006). By describing such interaction as a "system" these historians were drawing on a model of world systems theory pioneered by Wallerstein (1974). Gills and Frank (1992, 1993) and later Beaujard and Fee (2005) both worked to extend Wallerstein's model back several thousand years in order to account for capital accumulation markets and individual enterprise in ancient African and Asian societies.

Previous studies have explicitly described the role of peoples rooted in Africa played in economic systems that extended throughout Europe and the Asias (Geertz 1978; Gell 1982; Piot 1999; Beaujard 2005; Norman 2008). Unfortunately, such analyses have yet to focus explicitly on Swahili peoples, as researchers instead focus on groups in Northern Africa or Madagascar (Beaujard 1985, 1995, 2010).

Archaeological and historic research available from the Eastern African coast has yielded information regarding the ways in which residents of Eastern Africa articulated with economic systems across continental Africa and the Indian Ocean would (Middleton 1961, 1992; Bohannan & Dalton 1962; Horton 1987, 1994; Allen 1993; Walz 2010). The success of studies that have considered markets across the African continent suggests that researchers active along the Swahili coast would do well to better situate Swahili peoples within world economic systems. Such an approach would undoubtedly further the understanding of the ways in which plant resource management strategies changed through time in this region.

Swahili Origins: Local Perception, Colonial Continuation, and Conclusions from Ceramic Evidence

Residents of coastal Eastern Africa do not, nor have they previously, defined themselves as "Swahili" peoples. Instead, groups of coastal people cite geographies or purported exotic origins to define themselves. Myths that purport exotic colonization rely on an assumed kin-based relationship between urban settlements (Freeman-Grenville 1962; Chittick 1974). One such myth, the "Shirazi tradition" holds that members of a single Shirazi (Persian) patriline founded urban settlements across the Swahili coast (Sheriff 2001). The tradition goes on to report that the patriline expanded from Kilwa Kisiwani after AD 1009 (Freeman-Grenville 1962; Freeman-Grenville et al. 2006; Sheriff 2001). Similarly, fourteenth-century travelers who arrived to the coast of Eastern Africa from the Muslim world report that ruling elites of Mogadishu and Kilwa claimed Yemeni origins (Dunn 1989: 125-

128). Such accounts validated colonial perspectives imposed upon the region through the mid-twentieth century.

Reports from colonial administrators perpetuated Shirazi-centric models of coastal expansion (Burton 1893, 1967). Such colonial reports represented some of the only information regarding the coastal regions. For this reason, archaeologists and historians relied on the reports and, in turn, perpetuated Shirazi-centric models of coastal expansion (Kirkman 1957, 1959, 1964, 1966, 1974; Freeman-Grenville 1962a; Tringham 1964, 1975; Ricks 1970; Chittick 1974, 1975, 1984). In this way, perceptions first reported in the fourteenth century acted to reify colonial-era depictions of Swahili as an exotic, non-African entity that had perished before the modern era (Sheriff 1987; Allen 1982, 1993).

The process researchers used to rectify notions of indigenous development began with methodological advancements with which historians critically evaluated the structure of oral traditions (for examples of such methodologies see Vansina (1965) and Miller (1980)). Pouwels (1984) and Spear (1984) both relied on such new methodologies, specifically structural analysis, to reinterpret Shirazi stories. Spear (1984) reconfigured the Shirazi myths of migration, marriage into local populations, and dominating indigenous people, as idioms of changing social attitudes rather than stories of solitary migrations. The result of Spear's (1984) structural analysis depicts Shirazi as a somewhat mobile, Bantu people who settled along the Eastern African coastline and eventually developed distinctive social structures that we now identify as Swahili.

Historian James DeV. Allen (1974, 1981) interpreted the Shirazi traditions as placeholders through which coastal groups invented personal histories. Allen relied on cues from historical linguistics to recast Swahili identity as the outcome of interactions between Bantu-speaking agriculturalists and Cushitic pastoralists who first came together on the northern coast of Kenya. According to this structural interpretation, the two groups collided in "Great Shungwaya" sometime during the ninth century. "Great Shungwaya" is a mythological ninth-century settlement in northern Kenya that is conflated with Shirazi origin (Allen 1993); as the locus of Islamic, Swahili identity all subsequent coastal communities were thought to have sprouted from Shungwaya. Allen (1974, 1981) argued that the expansion from north Kenya is remembered as the Shirazi migrations, where Shirazi was substituted for Shungwaya as external ties came to be valued more than local ones.

Nurse and Spear (1985) published historical linguistic work on Swahili language that identified an indigenous African origin-point for Swahili identity. Linguistic evidence placed Swahili language directly within the Northeast Coast Bantu language family (Nurse & Spear 1985; Spear 2000; Pouwels 2001); influence from Cushitic languages helped to differentiate Swahili from other Bantu languages. The intersection of Northeast Coast Bantu and Cushitic languages seem to have occurred along the Tana River of Kenya; this interaction was emblematic of overlap between subsistence agriculture and pastoral lifeways (Nurse 1983; Nurse & Hinnebusch 1993). The result of the collision between linguistic groups with agricultural and pastoral lifeways was a coastal people that shared a common language and a mixed economy of domestic ungulates, grain cultivation, and iron-

working by the end of the first millennium. Through the course of the past millennium, Swahili speakers have incorporated linguistic influences from Arabic, Portuguese, French, German, and English loan words (Hinnebusch et al. 2000). Historical linguistics, therefore, demonstrates that Swahili peoples incorporated exotic influences into their established lexicon without altering Bantu syntax or verb structures.

Material residues recovered during the mid- to late twentieth century AD further discredited the foreign model of Swahili origins. Chittick (1974, 1984) continued the narrative of exotic Swahili origins; however, upon reevaluation, material residues he reported from Kilwa Kisiwani and Manda were indicative of developmental trajectories that refute exotic origin models. Horton's (1981, 1984, 1994, 1996) archaeological investigations at Shanga, in the Lamu archipelago of northern Kenya, also provided a framework through which coastal archaeologists could evaluate the indigenous development of Swahili identity. This framework explicitly grounded archaeological theories in locally available artifacts rather than textual chronologies. Excavations at Shanga also revealed a developmental sequence for the town that clearly demonstrated indigenous roots of the eventual Swahili town (Horton 1984, 1996, 2001). The incremental expansion at Shanga included the transformation of a typical Bantu communal space into a mosque compound; this transformation shows how Swahili people incorporated Islam, an introduced ideology, into preexisting social structures (Horton 1996: 224-226). Fleisher (2003: 48-49) described the material-based understanding of expansion as a "flipbook-like image of the establishment and growth of Islam and the town" which represented incontrovertible evidence that Shanga had local origins.

Horton's work at Shanga also redefined the ways that coastal archaeologists evaluated local ceramics, as Horton (1984) relied on this artifact class to articulate an evolution of local forms and motifs. Such an approach had previously been reserved exclusively for ceramics that had arrived on the coast of Eastern Africa through trade with the broader Indian Ocean world. The more holistic appreciation of local ceramics allowed archaeologists to connect coastal settlements from the mid-first millennium onwards. Diachronic evaluations of local ceramics have since focused on broadly similar ceramic assemblages labeled as early Tana Tradition (ETT) or Triangular Incised Ware (TIW) (Chami 1992, 1998). These assemblages, which date between AD 600 and 900, encompassed earlier reports of "incised ware" (Soper 1967, 1971), "Wenje Ware" (Phillipson 1979), and "Early Kitchen Ware" (Chittick 1974). Similar ceramic forms and decorative motifs have since been reported from Pate (Wilson & Omar 1997) in northern Kenya, Unguja Ukuu (Horton & Clarke 1985) in Zanzibar, sites throughout northern Pemba Island (LaViolette & Fleisher 1995; LaViolette 1999), Chibuene (Sinclair 1982, 1987) in Mozambique, and Dembeni (Wright 1984) in the Comoros. The broad geographic distribution and restricted time-scale apparent in ETT or TIW ceramics, now extended to sites in the interior as well (Fleisher & Wynn-Jones 2011). This arrangement is indicative of a shared ceramic tradition uniting coast and hinterland until ca. AD 1000.

The geographic diversity included in the list above indicates that archaeologists have excavated ETT assemblages from the lowest levels of Swahili

towns, called stonetowns, as well as hinterland or coastal-hinterland sites. The comparable material culture between stonetowns and hinterland settlements clearly demonstrates that coastal settlements held close ties with one another (Phillipson 1979; Horton 1994, 2001; Sinclair 1991, 1995). This is important to note, as notions of exotic origins explicitly portrayed urban settlements as distinct from non-urban villages. In this way, the material overlap between settlement types supports models of indigenous African origins for Swahili.

Analyses of ETT ceramics further support historical and linguistic evidence that had identified an intersection of pastoral and agricultural peoples along the coastline. Initial evaluation of local ceramics implicitly connected ETT ceramics with those known to pastoral peoples who occupied the region during the Late Stone Age. As I describe below, ceramic analyses were better equipped to identify the location wherein this reported collision might have occurred.

Chami (1994, 1998) was the first to systematically identify morphologic and design overlap apparent through time between ceramic assemblages. This systematic approach allowed for a more nuanced exploration of the origins of local pottery forms and motifs common to the coast between AD 600 and 900. Chami (1992, 1998) labeled such pottery "Triangular Incised Ware" to dissociate the style from Kenyan geographies. Triangular Incised Ware was recovered in the Rufiji Delta of southern Tanzania directly atop Kwale ceramics (Chami 1994). Geographic overlap between these ceramic types led Chami (1994) to identify Kwale ware, and the early-first millennium agricultural communities who produced such ceramics, as the source of subsequent TIW or ETT ceramic traditions.

Archaeologists have recovered Kwale ceramics from many sites in mainland Tanzania (Soper 1967, 1971; Schmidt 1980, 1983; LaViolette & Fawcett 1990; Chami 1992; Pawlowicz 2011) and along offshore islands (Chami 1999, 2000). Similar connections between Kwale ware and TIW or ETT traditions have also been established in the Tanzanian hinterland (Håaland & Msuya 2000) and coastal Kenya (Helm 2000). Fleisher & Wynne-Jones (2011), and Pawlowicz (2011), challenge the notion that ceramic overlap between Kwale ware and the TIW/ETT assemblage is sufficient evidence to attribute the creation of a coastal identity to a single community of farmers in southern Tanzania.

Ceramic traditions recovered in coastal contexts that date between AD 600 and 900 are typically necked jars with globular, thick-walls and incised or punctuated decoration below the lip and above the shoulder of the vessel (Schmidt 1994/5; Sutton 1994/5). Other typical forms of TIW/ETT ceramics include inturned bowls, carinated vessels, and open bowls (Abungu 1989; Håaland & Msuya 2000). Decorations apparent on these ceramics included incised triangles, though bands of oblique or horizontal incisions near the rim are also common (Chittick 1974; Chami 1994, 1998; Juma 2004). The inclusive nature of research regarding TIW/ETT ceramics permits a wide variety of motifs within the ceramic tradition; the researchers cited above have noted many iterations of such diversity. Fleisher and Wynne-Jones (2011) conducted the "Ceramics and Society" project to better understand the diversity encompassed within the corpus of Early Tana Tradition ceramics. The project created a classification system of more than 40 attributes for each sherd in order to evaluate curated assemblages from eight coastal/hinterland

archaeological projects (for attribute figures and descriptions see Fleisher and Wynne-Jones (2011: 258-261, 265).

The *Ceramics in Society* project concluded "ETT is an immensely diverse phenomenon with variation along several axes" (Fleisher & Wynne-Jones 2011: 265). Such diversity was evident in three particular realms: the continuum of decorative motifs characteristic of necked-jars in the region; regional distinctions found in decorations above and below the neck panel of necked-jars; and the presence of a demonstrably uneven and discontinuous distribution of bowl forms (non-necked jars) between coastal sites.

These finds provided new insight into Chami's (1994, 1998) conclusions due to a shared emphasis on decorative motifs found on the neck of necked-jars. Fleisher and Wynne-Jones (2011: 274) identified no statistically significant linear deterioration in expression of neck decoration along the coast. This find suggests that ETT could not necessarily be collapsed full stock into TIW, as the two categories were not synonymous. Ceramic motifs, instead, suggested a "vast interaction sphere in which communities were most in contact with those nearest them, while cognizant of a larger sphere that included all related sites" (Fleisher & Wynne-Jones 2011: 276). As I note in the following section, quantitative investigation of ceramic assemblages was able to speak to the source of regionalism expressed in material assemblages that emerged in the early second millennium AD.

Swahili in the Early to Mid-Second Millennium AD: Introduction to Regionalism

Regional differences became apparent along the Eastern African coast during the early-second millennium AD. The most apparent expressions of regionalism involved settlement size and occupational density; three settlement types are known from this time: rural communities, communities with a limited degree of urbanism, and urban entrepôts. Rural communities exclusively featured earthen architecture while the densely occupied urban entrepôts featured stone-built mosques, tombs, and homes as well as earthen structures (Chittick 1974; Fleisher & LaViolette 1999; Wynne-Jones 2005; Pawlowicz 2011). The former typically covered less than 1 ha while the latter sprawled across upwards of 10 ha. Variable levels of integration into long-distance commercial systems further differentiated these coastal communities in this time period.

The diverse architectural media apparent in the archaeological record suggest that residents of urban settlements performed a heterogeneous set of domestic and commercial tasks in and around the stone-built platforms. A variety of factors likely influenced diverse expressions of settlement strategies and differential levels of urbanism; factors that influenced the indigenous African communities include, but are not limited to, relationships with overseas agents/communities, and distinct ecological opportunities (LaViolette 2008).

Historic accounts recorded that a series of Sultans, autocratic leaders, controlled urban settlements during the early-to-mid second millennium AD (Freeman-Grenville 1962; Chittick 1974; Dunn 1989). Sultans derived influence from a combination of personal mercantile success and Islamic piety (Freeman-

Grenville 1962). Personal influence or success did not translate beyond any given settlement, as each Sultan presided over an autonomous community (Allen 1993: 13). Though potentially autonomous, there was independent, settlement-specific engagement with local and long-distance economies as well as social overlap that created a unified coastal region (Horton 1986, 1994; Horton & Middleton 2000). The historic record holds evidence of competitive, combative rivalries that had existed between Sultans, rivalries that extended to involve entire communities (Velten 1907; Strandes & Kirkman 1961; Freeman-Grenville 1962, 1975, 1991; Tolmacheva 1993; Mazrui 1995; Pawlowicz 2011).

Islamic expressions apparent in the archaeological record of coastal communities seem to have been the responsibility of local leaders. By this I mean that Sultans or other wealthy residents commissioned the construction and maintenance of mosques and tombs. The earliest evidence of Islam in the region was recovered at Shanga, in the Lamu Archipelago of northern Kenya, where a timber mosque was constructed in the eighth century AD (Horton 1996). Residents of Shanga expanded the mosque and eventually replaced the impermanent structure with stone-built architecture (Horton 1996). Chittick (1974) describes a similar process at Kilwa Kisiwani whereby the Great Mosque, a massive stone-built structure constructed after AD 1200, was constructed atop a smaller wooden mosque constructed during the late first millennium (Moon 2005).

Adherence to Islam was also apparent in stone tombs and locally minted coins, both of which typically featured Arabic inscriptions (Horton et al. 1986; Horton & Middleton 2000: 49). Horton and Middleton (2000) interpret the diverse

forms of Early Islamic expressions as indicative of multiple "conversion" moments as well as multiple sources of Islamic influences operating along the coast. Material residues and inscriptions suggest that Shi'ite groups were likely responsible for the initial influence at Shanga and on Pemba Island, while other communities seem to demonstrate affiliation with Sunni or Ibadi expressions of Islam (Horton & Middleton 2000: 51). The argument for incremental conversion moments and early Islamic colonies does not undermine the argument against Shirazi migration myths, as Horton and Middleton (2000) clearly situated Islam in Swahili contexts as an indigenous African interpretation of the global religion. Extensive reviews of Islamic expression in Swahili contexts can be found in Pouwels (1987), Allen (1993), Insoll (2003), and Coquery-Vidrovich (2005).

Surveys of Swahili regions conducted after 1990 provide additional perspective regarding the development of Swahili identity and the diversity of material expressions. LaViolette, Fawcett, and Schmidt (1989) pioneered the process of subsurface survey around Chwaka. Fleisher (2003) surveyed northern Pemba to identify villages. This was followed by efforts LaViolette and Mapunda (1999) that looked to link towns and villages of northern Pemba Island through time and space (LaViolette & Fleisher 1999, 2013). Wynne-Jones (2005) and Pawlowicz (2011) followed with similar research programs as they surveyed the Kilwa region and Mikindani Bay, respectively. The result of such survey programs was a more holistic appreciation of Swahili stonetowns, urban residents, and the people whose surrounding hinterland settlements interacted with urban centers.

Again, the intricacies involved in the development of each community will be detailed during future chapters.

Archaeological and Historical Impressions of Swahili Environments

So what does regionalism and site-specific autonomy mean for the interaction between Swahili people and coastal environments? Up to this point, researchers have largely assumed a direct line between environmental regionalism and diverse socioeconomic pursuits. Much of this thought derives from Middleton's (1992) The World of the Swahili: An African Mercantile Civilization that combined climate patterns, local geologic and geomorphologic characters, and social histories to divide the Swahili coast into six regions (Middleton 1992: 5) (Figure 1.2, Table 1.1). The alignment of material and environmental regionalism spurred an environmental consciousness among coastal archaeologists and historians. I say this to suggest an overreliance on Middleton's environmental perspective (Allen 1993; Horton 1996; Chami 1998; Kusimba 1999; Horton & Middleton 2000; Fleisher 2003; Wynne-Jones 2005; Pollard 2008; Walz 2010; Pawlowicz 2011). While this environmental consideration is important, the application of the six zones relies on potentially problematic combination of (pre)historic human actions with modern environmental conditions. The current project represents an attempt to recast these regional differences in terms of context-specific environmental conditions.

The microbotancal data that I present in this project contributes towards a new perspective on the growing appreciation of environmental conditions in the region. This dissertation articulates with a growing literature that seeks to address

Region	Geographic Extent	Environmental Characters
		Thin strip of fertile coastline that receives little
Benadir	Juba River, Somalia south to Kenyan border	water; less tropical than other Swahili regions
		"Original Swahili heartland" is marginally better
	Somalia-Kenya border south to Tana River,	watered and more fertile than Benadir. Rivers
Visiwani	Kenya	extend this region further inland
		Cliff-bound coastlines that overlook shallow coral
		reefs. Bisects equator and so receives high levels of
Nyali	Tana River south to Kenya-Tanzania border	rainfall
		Most fertile region of coastline due to well watered
	Kenya-Tanzania border south to Rufiji	and productive soils. Area includes many rivers and
Mrima	River; Zanzibar archipelago	mangrove forests
	Rufiji River south to Tanzania-Mozambique	
	border. Songo Mnara Island and Mikindani	Considered "ecologically bereft" due to low levels of
Mgao	Bay lie in this region	rainfall, may be unfair charicature
		Similar to Benadir in that it is a thin strip of fertile
	Tanzania-Mozambique border south to	coastline that receives little water and is less tropical
Kerimba	Kerimba Islands of Mozambique	than other regions

Table 1.1: Middleton's (1992) environmental regions of the Swahili coast

such ongoing interactions. Contemporary research projects typically stress interdisciplinary approaches, a trend which has led to the application of paleoethnobotany (Wright 1992; Walshaw 2005, 2010; Sulas 2010; Pawlowicz 2011), zooarchaeology (Wright 1993; Horton & Mudida 1993), and geoarchaeology (Sulas 2010) across the Swahili coast. These projects are not necessarily restricted to terrestrial contexts. Breen and Lane (2003) identified a discontinuity in the treatment of marine, typically described as "heterogeneous" and terrestrial, typically considered "homogeneous" resources, through time. Pollard (2008) and Pollard et al. (2012) used environmental explorations of intertidal zones in southern Tanzania to combine these two realms. Coral causeways built out into the Indian Ocean between the eleventh and fifteenth centuries were, in his estimation, an attempt by urban populations to expand assumed environmental control beyond

terrestrial boundaries (see Pollard 2008 for array of hypothetical social functions).

Overview of the Research Project

I bring together theories from environmental archaeology and methods from paleoethnobotany in order to evaluate the dialectic interaction between coastal peoples and local plant communities. Archaeologists who integrate environmental conditions tend to layer prehistoric social actions atop modern environmental conditions. Advances in environmental archaeology suggest that such asynchronous layering of social and environmental conditions can be problematic.

Chapter Two presents a brief historiography of environmental archaeology as a way to introduce the theoretical paradigm of historical ecology. The central assumption of historical ecology holds that contemporary ecological conditions are the direct result of ongoing interaction between social action and biophysical conditions. Historical ecology therefore argues that archaeological work in the region situates Swahili social groups within the environments they created, not the biophysical conditions they experienced. With the central tenets of historical ecology in mind, I move the discussion of Chapter Two to a presentation of the environmental histories that address biological and physical conditions known to exist along the coast of Eastern Africa. Chapter Two concludes with a review of known modes of social action, or socioenvironmental interaction, recorded in biological and physical conditions.

I dedicate <u>Chapter Three</u> to a presentation of paleoethnobotany, with a specific focus on phytolith analysis. Phytolith-based archaeological projects

typically yield the long-term ecological data necessary to reconstruct past botanical communities and create a more dynamic understanding of human-environmental interaction in the region. Phytoliths are silica bodies with resilient morphologies diagnostic of the higher-order plants that produce them. These microfossils enter the archaeological record by persisting after organic plant matter decomposes, creating *in situ* residues of plant species. Through time, pedogenic processes create layers of soils with microfossil inclusions that indicate the presence of particular plant types. In undisturbed sediments, such processes result in a chronologic layering of plant communities. Archaeologists and paleoecologists are therefore able to reconstruct the chronologies of plant communities in a given landscape by recovering phytoliths from soils. Chapter Three reviews the history of paleoethnobotany and phytolith analysis; this review provides a platform from which I present the survey, laboratory, and interpretive methodologies at the center of this research project.

The methodologies necessary to recover phytoliths dovetail nicely with historical ecology analyses. As described above, historical ecology requires data from social, biological, and physical sources so that contributions to the landscape can be assigned to each condition. Phytolith samples begin as seven grams of soil separated from archaeological contexts. So the process of collecting phytolith samples combines biological and physical conditions; a series of in-laboratory chemical applications and flotation processes separate the biological from the physical.

I performed the paleoethnobotanical methodologies on phytolith samples recovered from three archaeologically known regions. These include the nearshore island Songo Mnara, in southern Tanzania, which had two periods of occupation, an urban-from-inception stonetown between the fourteenth and sixteenth centuries AD, and a village community since the nineteenth century. I followed the exhaustive archaeological survey of Mikindani Bay, also in southern Tanzania, performed by Pawlowicz (2011) to target areas that had been settled since AD 600. Finally, I surveyed landscapes in and around the AD 600-1000 village of Tumbe and the nearby AD 1050-1500 urban settlement Chwaka, both on the northeastern coast of Pemba Island, in northern Tanzania.

The chapter overview indicates that I dedicate a large amount of this project to literature and methodological review. The literature that I present here addresses general Swahili social chronologies as well as site-specific socioeconomic chronologies; I rely on the discussion of environmental archaeology to maintain the notion of biophysical conditions into the pre-exiting socioeconomic investigations. At the end of Chapters Four, Five, and Six I present a series of interpretations that hypothesize a connection between the recovered phytolith residues and actions of coastal peoples. The interpretations build upon the literature reviews that I present in Chapters One through Three as well as those which open the case study chapters.

Archaeologists had already conducted extensive surveys of Mikindani Bay (Kwekason 2007; Pawlowicz 2011) and northern Pemba Island (LaViolette & Fleisher 1995, 1999; LaViolette 1996; Fleisher 2003). My survey of Songo Mnara

Island broadened the preliminary investigations at the urban settlement on the island (Fleisher & Wynne-Jones 2010).

Chapter Four situates Songo Mnara Island within the broader Kilwa region through a social and environmental literature review. I present known social histories from the region as well as the fourteenth to sixteenth-century AD urban center. The chronological review raises questions that center around environmental implications of an incipient urbanism within the restricted ecologies of an island settlement. Phytolith analysis from this region demonstrates that midsecond-millennium AD immigrants settled landscapes covered in both grass and woody plants on the northern tip of the island. Anthropogenic patterns apparent in this investigation indicate that urbanism and associated hinterland activities led to an increase in the distribution of C3-Pooid subfamily grasses; in limited contexts the percentage of C4-Panicoid grasses also increased in association with human action. Anthropogenic impressions wrought in the fourteenth to sixteenth centuries AD remain tangible through time, as samples from modern contexts maintain evidence of C3-Pooid grass representation and woody plant levels.

Chapter Five highlights the known social and ecological histories of the Mikindani Region of southern Tanzania. The literature reviews highlight social transitions apparent across the region. The social transitions include a move away from sociocultural assemblages typical to coastal Eastern Africa after AD 1000 and a reintegration into long-distance economic systems after 1500. I evaluate environmental implications for such socioeconomic transitions in four known archaeological settlements from the region. I chose to sample these particular

settlements, as the chronologies and ecologies included therein permit the phytolith-based analysis to address physical contexts that include coastal plains, hilltop areas, and valleys and temporal contexts that stretch back to AD 600. The paleoethnobotanical investigations of these four settlements suggest that residents of Mikindani Bay settled plant communities that featured a range of grasses and woody plants. Through time, the socioeconomic strategies of food production enacted in the region prompted either elevated levels of C3-Pooidgrasses or, in other contexts, the prevalence of C4-Panicoid grasses. I discuss the subsistence implications of these anthropogenic influences in the chapter.

In <u>Chapter Six</u> I focus on environmental implications that derive from archaeological sites of Tumbe (AD 750 to 1000) and Chwaka (AD 1050 to 1500) on northern Pemba Island. The chapter includes a review of social and environmental analyses conducted across the northern extent of Pemba Island. Evaluation of previous archaeological investigations focuses on processes of urbanization that connect the two sites under consideration. I also highlight results available from paleoethnobotanical investigations of macrobotanical remains from both Chwaka and Tumbe (Walshaw 2005, 2010). Finally, the presentation of environmental literature explores the diachronic implications of high annual precipitation levels known to reach the island. The phytolith analyses that I conducted on Pemba focus on the interaction between urban and hinterland residents and the plant communities that occupied the well-watered, fertile limestone soils available in the northeastern corner of the island. Plant management strategies that may be

apparent in the phytolith record seem to document slight changes in agropastoral subsistence strategies enacted in the region through time.

I conclude this dissertation with a comparative evaluation of the social and environmental trends apparent in Songo Mnara Island, Mikindani Bay, and northern Pemba Island. The comparative analysis in <u>Chapter Seven</u> links the settlements through time and attempts to align social activities common to the coast with patterns apparent in phytolith residues that transcend geographies. I argue that the phytolith analyses support the notion that a shared symbolic reservoir informed human-environmental interaction across coastal contexts. This shared was apparent in Iron Age contexts, the mid-first millennium AD; region-specific expressions of this remain apparent through AD 1750. In the concluding discussions I also attempt to account for the apparent social preference to settle and maintain grass-covered contexts.

Chapter Two

Historical Ecology: Overview and Application to Coastal Areas in Eastern Africa

In this chapter, I introduce environments of Eastern Africa and discuss the ways in which researchers can access and reconstruct environmental conditions recovered from archaeological contexts. This discussion introduces the subfield of environmental archaeology and presents historical ecology as the particular perspective that motivates analyses presented in this project. In addition to known environmental conditions, I present historical and ethnographic information that documents the ways in which residents of Eastern Africa have engaged with this range of environmental conditions.

Modern approaches to environmental archaeology derive from perspectives pioneered by a group of nineteenth-century naturalists in Denmark (Trigger 2006: 372-374). They identified a correlation between archaeological residues and changes in prehistoric environmental conditions. In an attempt to make sense of this correlation, these "Kitchen Midden" theorists brought archaeological information together with environmental data to create a long-term understanding of social and ecological changes to landscapes of Denmark. Such early investigations relied on cause-and-effect models of change whereby technological advances, namely the Neolithic, Bronze, and Iron Ages, were thought to have permitted prehistoric populations to change local environments rapidly (Trigger 2006). In terms of human histories, the transitions from stone to bronze and bronze to iron

were thought to have opened new environmental resources to exploitation. The additional resources, in turn, led to shifts in environmental conditions.

These perspectives were accepted as progressive for the mid-nineteenthcentury, and largely plausible. These earliest explorations created a theoretical legacy that persisted long into the twentieth century. Trained anthropologists crafted similar cause-and-effect theories through the late 1970s (Steward 1976). Cultural ecology, the foundation of Julian Steward's economic approach to environmental anthropology, represents a bookend to such deterministic modeling of human-environmental interaction. Models from cultural ecology consider environmental conditions as the factors that determine social complexity (Barfield 1997). Much like the theories from the Kitchen Midden group, cultural ecology considered environmental and social changes in large swaths of time and space, though Steward (1950, 1967) applied modern environmental conditions to account for levels of social complexity defined by V.G. Childe (1937, 1969) and E. Service (1962). Anthropologists and archaeologists have since moved away from theories that rely on such deterministic perspectives although popular literature perpetuates such reductive arguments (Diamond 2005, 2011, 2012).

Butzer (1964, 1969, 1971, 1976a, 1976b, 1982) crafted a balanced model of human-environmental interaction through a series of studies that considered social change in a variety of environmental contexts. The theoretical exploration culminated with *Archaeology as Human Ecology* wherein Butzer (1982) presented material residues from archaeological contexts, and environmental residues, as constituents of a shared physical phenomenon. This presentation explicitly linked

social and environmental change, emphasizing interaction rather than one-sided influence. The move towards a balanced treatment of social and environmental influences created space for subsequent theoretical innovations. I view historical ecology as one of the more compelling theoretical perspectives to derive from Butzer's (1982) approach.

Historical ecology reconstructs the ongoing relationships that exist between people and biophysical conditions within a region bound by time and space. Archaeologists define the temporal and geographic boundaries of this region; the social, biological, and physical conditions contained therein constitute a "landscape" (Marquardt & Crumley 1987). Landscapes, in turn, represent the unit of analysis among historical ecologists (Crumley 1994). The research paradigm considers social actions, biological species, and physical conditions to be factors that actively contribute towards the creation of environmental conditions (Balée 1993, 1996; McIntosh et al. 2000). The influences wrought by each category vary with time and space, though the three are linked theoretically as a "heterarchy of hierarchies" wherein each constituent has an ability to bring about change to the system (McIntosh 2005). An archaeologist using this paradigm is tasked with elucidating the factors at work in each particular landscape (Balée & Erickson 2006).

People act with intention, with knowledge of likely outcomes that will result from particular behaviors; for this reason I treat social activities as not entirely equivalent to influences brought about by biological or physical actions. I follow the lead of R. McIntosh (2005: 52) who states that historical ecologists must remain

mindful of concepts like perception while attempting to reconstruct patterned social behaviors in archaeological residues.

R. McIntosh (2005: 50-52) further explains that the historical ecologist must weld together biophysical realities; human exploitation strategies and their perceived motivations; and supernatural, religious, and other forms of "parascientific" explanations of human actions. In this model, biophysical circumstances that spur social change do so because people perceive such changes on individual or group levels. Once acknowledged, actors process biophysical conditions through shared memories of socio-environmental interaction. These memories are thought to motivate social responses to biophysical conditions (Balée 1998).

Historical ecologists argue that such memories constitute a shared "symbolic reservoir" one that stores positive and negative interactions with available biophysical conditions (McIntosh et al. 2000). My use of symbolic reservoir, therefore, strictly follows previous applications in historical ecology investigations. This treatment views environmental stimuli as those with which individuals or communities engage based on a shared, remembered history. The reservoir here does not represent a perfect record of previous human-environmental interactions, but is subjected to loss, perversion, and perception just like any other social norm transmitted through time. Despite such limitations, it follows that the longer the social continuity can be traced in a particular landscape, the more expansive the ecological interaction and the greater the shared symbolic reservoir.

I approach historical ecology from an archaeological perspective. The humanist tack inherent to this perspective further biased my pursuit towards social

influences on environmental change. I rely on social and environmental change through time to further subdivide the analysis of each region into a series of interrelated landscapes. I rely on four postulates of historical ecology to evaluate the interaction between Swahili actors and local environments, drawing from Balée (2006: 76):

- "Much, if not all, of the human biosphere has been affected by human activity."
- "Human activity does not necessarily lead to degradation of the non-human biosphere and the extinction of species, nor does it necessarily create a more habitable biosphere for humans and other life forms and increase the abundance and speciosity of these."
- "Different kinds of sociopolitical and economic systems (or political economies), in particular regional contexts, tend to result in qualitatively dissimilar effects on the biosphere, on the abundance and speciosity of nonhuman life forms, and on the historical trajectory of subsequent human sociopolitical and economic systems (or political economies) in the same regions."
- "Human communities and cultures, together with the landscape and regions with which they interact over time, can be understood as total phenomena."

The introduction to historical ecology that I offer here provides background information necessary to identify the ways in which historical ecology can be applied to archaeological contexts from the coast of Eastern Africa. The information that I present in this chapter also permits the most holistic understanding of human-environmental interaction available to the region.

I begin the presentation of environmental conditions in this region with a historical review of human-environmental interactions since the late 1800s AD. The historical review defines a disconnection between contemporary land management

strategies and those enacted prior to the nineteenth century. These distinct strategies represent the loss of a vast symbolic reservoir that had accumulated across Eastern African coastal ecologies since the early first millennium AD. While modern strategies may not be direct analogs to those that shaped the region prior to 1800, I present information from contemporary contexts because the latter represent the only available evidence of such actions in the region. In an attempt to bracket the data that I present in subsequent chapters, I focus the discussion of modern land management techniques on woodfuel consumption, food production, and grass-covered plant communities.

An Account of Land Management Strategies: Legislation Since 1850

Imperial governments could not apply formal, legislative control over the coast of Eastern Africa until the nineteenth century AD, first on the Zanzibar archipelago and then in continental Eastern Africa via the Berlin Treaty of 1885 (Mittlebeeler 1961; Sanderson 1975; Wolfe 1982). This governance followed a period of unrest between AD 1500-1850 during which Portugal, France, Denmark, England, Holland, and Oman claimed ownership of coastal regions (Alpers 1975; Freeman-Grenville 1975; Wolfe 1982; Sheriff 1987). It is important to note that, prior to the Berlin Treaty, imperial governance was characterized by the construction of forts and garrisons. Such bastions of European control did not lead to any direct changes to environmental resource management strategies (Freeman-Grenville 1975, 1988). I should note, however, that militarized spaces could have permitted the introduction of domestic plants and animals that could have altered

ecological conditions across the region. The primary function of imperial influence was to wrest control of continental and Indian Ocean commerce from indigenous merchants (Freeman-Grenville 1962a).

Swahili people typically abandoned urban centers after control of economic engagement with long-distance commercial systems was transferred to Europeans (Freeman-Grenville 1965; Chittick 1965). For example, urban centers in the Kilwa region and northern Pemba Island suffered from a demonstrable outmigration after AD 1500. Archaeologists assume that, despite the lack of urban centers, the formerly urban populations often continued to work farmland from the same regions unabated once out of the stonetown (Kusimba 1999). My research offers data that permit further exploration of this assumption. As I explain in subsequent chapters, this project raises additional questions regarding the land management strategies enacted during the modern period.

The Berlin Treaty represents a revolution in the ways in which colonial governments could influence the management of environmental resources across sub-Saharan Africa (Suret-Canale 1971; Brett 1973; Comaroff & Comaroff 1991; Taiwo 2010). The treaty divided the Swahili coast among three colonial governments: England took control of Somalia and Kenya; Germany gained control of mainland Tanzania (then Tanganyika); there was an Anglo-German partition of the coast with British protection of the Zanzibar Archipelago, i.e., Unguja and Pemba. Portugal assumed ownership of Mozambique. Buoyed by the Berlin Treaty, colonial governments began to invest in economies and ecologies at local scales throughout the colonies (O'Shea 1917; Standley 1917). As Hurst (2003) documents, the desire

to exploit forest resources triggered investment in forestry institutes in colonies of Eastern African. These institutes were responsible for the identification, exploitation, and maintenance of wood resources in the colonies. Anthropologists and historians have thoroughly assessed the long-standing impacts of colonial conservation campaigns on national and local scales (Feierman 1990; Giles-Vernick 2002; Shetler 2007; Brockington et al. 2008). Rather than dwell on this well-documented topic, I instead want to stress that imperially imposed conservation strategies, which had the effect of driving a wedge between modern populations and the symbolic reservoirs that historical ecology revealed, had accumulated within local landscapes.

The post-independence Ujamaa movement implemented by Tanzania's first president, Dr. J. K. Nyerere, perpetuated negative impacts of colonial-induced loss of land management strategies. The Ujamaa movement (1962-1985) stressed a new version of modernization, one that featured an engineered migration of people out of cities and into villages throughout the country. The governance also actively resettled students across the country in an attempt to create a shared impression of Tanganyikan identity (Nyerere 1969, 1971; Illife 1979; Coulson 1982); this approach to modernization was not implemented on the Zanzibar Archipelago (Sheriff 1987). The villagization movement stressed landscapes across the nation by imposing farming strategies, as local landscapes were expected to support the growing villages throughout the nation (Freyhold 1979; McHenry 1979; Lawi 1985). The increased demand on local ecologies, in turn, led to a decrease in fallow periods as well as accelerated soil degradation and loss of fertility (Lane 2009). Despite the

many social successes of this administration, its land management strategies eventually failed, and the program was abandoned in 1985 after Dr. Nyerere retired as president of Tanzania (Coulson 1982; Collier et al. 1986).

An Account of Land Management Strategies: Woodfuel Accumulation and Consumption

The accumulation and consumption of woodfuel has remained a chore for residents of the coast of Eastern Africa for millennia, as it has in many world regions. People use wood to cook food, fix lime, work iron, fire ceramics, and enter the cash economy through the sale of charcoal (Butz 2013). The transformation of plant resources into a combustible resource alters the type of plant community in a given area and the species contained therein. I use this section to discuss previously identified ecological impacts of woodfuel use and management strategies applied to contemporary contexts.

Schmidt (1975, 1978, 1979, 1995, 1997) explored the long-term ecological impact of woodfuel consumption associated with iron smelting in the Buhaya region of Tanzania. This exploration paved the way for the application of archaeological perspectives to contemporary issues surrounding forestry management strategies (Schmidt 1989). Schmidt's (1994) research identified a shift in botanical community composition at the turn of the first millennium AD (Schmidt 1997: 188-189). This shift involved a conversion of woody scrubland into grass-covered landscapes due to extensive woodfuel consumption involved in iron smelting. Schmidt (1994, 1997) hypothesized that anthropogenic grasslands apparent after

AD 1000 pushed innovation among the Buhaya peoples who quickly derived an iron smelting process largely fueled by grasses.

Researchers working with modern populations continue to search for similar types of interaction between social groups and plant communities because charcoal and firewood remain the staple energy sources throughout the sub-continent (Sunseri 2005, 2006; Arnold et al. 2006; Butz 2013). Modern accounts record a lack of innovation in type of woodfuel species consumed; instead, evidence suggests that contemporary peoples seek woodfuel species with which they have had experience. Due to overexploitation, such species are typically only available in areas with low population densities. People have had success with such strategies because Eastern Africa contains only a few general types of plant communities, including the Zanzibar-Inhambane Coastal Mosaic, Miombo Woodlands, and mangrove forests (Dale 1939; Christiansson 1992; Burgess et al. 1994; Christiansson & Kikula 1996; Burgess et al. 1998; Clarke 1998; Tabor et al. 2010). I define these types of forests later in this chapter.

Butz (2013) recorded evidence of woodfuel transport across Tanzania, in this case facilitated by Maasai women who occupied Miombo woodlands. All the women polled in this survey reported harvesting wood to create charcoal; harvest typically involved the consumption of 20-100L of charcoal per month. The same women would typically sell the charcoal to travelers at bus stops (Butz 2013: 143-144); in this way, hardwood resources from inland Miombo woodlands acted to fuel lifeways throughout the nation. Sale of hardwood resources took place despite 2006 governmental legislation that outlawed the creation or sale of charcoal.

Fagerholm et al. (2012) conducted a similar survey of plant community exploitation strategies on Unguja (Zanzibar) Island. More than 97% of those surveyed reported that they collected firewood; 69% admitted to collecting beyond household needs in an effort to supplement income through export (Fagerholm et al. 2012: 427). These wood consumption and export practices represent part of a heterogeneous approach to landscape management within which residents juggle settlement, subsistence agriculture, and pastoralism. As with the Maasai women, residents of Unguja do not seem overly discouraged by the legal implications of their woodfuel harvest.

Continued reliance on local landscapes to meet woodfuel demands was also apparent on Songo Mnara Island, at Mikindani Bay, and on Pemba Island. I encountered evidence of woodfuel consumption on nearly every survey transect; typically such consumption was obvious through the presence of pits filled with lime or charcoal (Figures 2.1 and 2.2).

An Account of Land Management Strategies: Food Production

I introduce food production and subsistence strategies because such activities have long represented situations through which coastal peoples interact with local plant communities. The importance of such interaction remains important, as roughly 80% of the people in Tanzania rely on agriculture to support their personal livelihoods (Sokoni 2008: 158). This figure includes subsistence farming and agriculture for export; the latter represents 50% of the nation's total Gross Domestic Product. Analysts typically report that agriculture promotes soil erosion, strips endemic fertility from local soils, and leads to an



Figure 2.1: Charcoal production area from Mikindani Bay



Figure 2.2: Lime production pit encountered at Songo Mnara Island

overall degradation of local ecologies (Wagner et al. 1997; Van de Koppel et al. 2002; Slegers & Stroosnijder 2008). Examples of such anthropogenic degradation abound (Lal et al. 1997; Hoffman & Todd 2000; Dougill et al. 2002; Suckall et al. 2014); however, this perspective overlooks food production strategies that maintain or even improve soil conditions (Lutz et al. 1994; Syers 1997). In this section, I present several modern agricultural tactics applied throughout Eastern Africa that are known to improve or at least conserve soil conditions. I also provide an overview of colonial and post-colonial legislation that influenced such strategies. That legislation contributed to the disassociation between modern populations and earlier long-standing approaches to land management strategies.

Lundgren's (1980: 123-126) research in the Usambara Mountains of Eastern Africa compared erosion runoff levels from surfaces that slope down from evergreen forests, highland forests, and small-scale farm plots. Lundgren found that runoff from farm plots contained demonstrably less eroded soil than that measured from forested areas. The research suggests that, in an effort to promote the capture of rainwater, farmers in the Usambara Mountains actively slowed the flow of water over and out of agricultural plots. Actions that contribute to such capture include the sporadic retention of original forest trees, annual crop rotation practices, constant coverage of soil, limited hoe activity, and the addition of compost to active farm plots.

People across Eastern Africa implemented similar strategies to limit soil erosion and retain rainwater. Pike (1938) described raised mounds of dirt constructed to divide farm plots operated by Matengo peoples of the Ruvuma region

in southern Tanzania. The mounds act as small terraces that impede water movement. In this way, Matengo people used iron implements to effectively reduce erosion and trap rainwater. In a similar manner, farmers of the Kondoa region in central Tanzania created a series of check-dams in gullies, contour bunds on hill slopes, and contour planting of xerophytic (arid climate) plants (Lane 2009: 462). British colonists imposed the strategies in response to a catastrophic flood that denuded local landscapes in 1930 (Lane 2009). It is unclear whether such strategies were adopted across British East Africa; however, modern landscapes bear evidence that could be interpreted as an enduring legacy of such legislation (Feierman 1990). Sisal plants, a common xerophytic plant with economic functions, are apparent throughout contemporary landscapes (Hitchcock 1959; Wescott 1984); the same can be said about contour bunds and terraced landscapes (Pike 1938; Brewin 1965).

Sheridan (2004) offered examples of indigenous activities that functioned to maintain soil fertility and facilitate intensive production measures. Surface survey of the mountainous Pare region of northeastern Tanzania led to the identification of hundreds of intake funnels placed across the landscape that predate the nineteenth century (Sheridan 2004). The man-made intake funnels act to direct water from hill-slopes down to agricultural plots. This example aligns with work by Sutton (1984) and Feierman (1992) to demonstrate that pre-colonial farmers were able to combine concepts of crop biology, local geomorphology, and collective social action to create intensive strategies of food production. Evidence of such approaches in pre-modern contexts dismisses the notion that early farmers in the region had relied exclusively on shifting agricultural strategies.

The account of contemporary agricultural strategies clearly showed that farmers throughout Eastern Africa implemented a range of methods to ameliorate the negative impacts caused by their food production practices. The prevalence of such strategies suggests early farming people had the ability to develop such conservation techniques, that such conservation was not necessarily a notion introduced to the region. This informs the way that I approach botanical residues available in the archaeological record, as it provides further evidence of human-induced environmental transformation.

Modern Biophysical Conditions of Eastern Africa

According to historical ecology, modern landscapes represent the culmination of ongoing interaction between people and biophysical conditions. With this in mind, it stands to reason that the biological and physical conditions apparent in coastal Eastern Africa carry evidence regarding the form and nature of their interaction with people. I target this insight to better understand the character of landscapes from which I consider plant remains. With this assumption in mind, I devote this portion of the chapter to a presentation of modern plant, soil, and climatic conditions. I highlight interactions known to have occurred between Eastern African peoples and local environmental conditions.

Botanical Conditions Apparent in Coastal Eastern Africa

Ecological conditions on the Eastern African coast have the potential to support plant communities that range from grassland to tropical dry or very dry

forests (Holdridge et al. 1971; Bullock et al. 1996; Clarke 1998). As the dry to very dry designations suggest, precipitation has a direct influence in the models that define plant communities expected from a given area. Average rainfall along the coast ranges between 500 and 2000 mm yearly; this falls on an area with a mean annual temperature greater than 23° C (Clarke 1998). Plant communities known to the region typically do not reflect the expected, maximum potential. I say this because the Eastern Africa supports approximately 250 distinct patches of forest that, together, account for less than 1% of available geography (Hawthorn 1993; Stubblefield 1994; Huang et al. 2003). I usually encountered scrub and grass cover during the 2011 field season; as I describe in subsequent chapters, the landscapes that I reconstruct bear heavy evidence of grass coverage. For this reason, I bias this discussion towards grass coverage, as grasses represent a more useful set of modern plant communities against which I can evaluate phytolith-based landscape reconstructions of archaeological contexts.

Botanists apply a fluid definition of boundaries that separate "coastline" from "inland" contexts and between geographic boundaries that distinguish botanical ecosystems. The fluid boundaries result in coastal botanical conditions that extend 2,500 km longitudinally and anywhere between 10 and 200 km inland. The deep inland range follows rivers into the continent, as riverine conditions permit mangrove forests to extend far beyond strictly marine areas (Spaulding et al. 2010). The Tana, Rufiji, and Ruvuma rivers mark locations wherein coastal conditions extend furthest into continental Africa. Narrow portions of the coastline typically host vegetation types common to the entire continent. Botanists distinguish five

classes of forest communities in Eastern Africa. These classes further divide into 16 'formations' that represent distinct plant community characters. Three classes of forest community with nine distinct formations occupy coastal areas (Table 2.2) (White 1983: 40, 46). Relevant details of woody plant community types apparent across the coast are found in Table 2.1.

As the review of forested areas suggests, grasses are able to populate most every ecological zone in the region and many of these grasses may play a role in local subsistence strategies (Staples et al. 1942; Greenway 1973). For this reason, botanists and environmental scientists interested in grasses of Eastern Africa rely on a series of environmental zones that document the potential grasses may have to inhabit a given location (Pratt & Gwynne 1977). The zones consider precipitation and local soil conditions to determine the potential of grasses, along with other types of vegetation, to colonize a particular area (Gibson 2009). I present the grassfriendly vegetation zones in Table 2.2. I want to note that Pemba Island falls under Zone II while Songo Mnara Island and Mikindani Bay both occupy Zone IV.

In the discussion that follows, I explicitly highlight plant community types recovered in archaeological contexts. I also draw attention to the ways in which people interact with and alter local plant communities.

Plant Community Expectations: Botanical Survey Results

I conducted a botanical survey of plant species apparent at Songo Mnara
Island and on Mikindani Bay to create a first-hand account of local plant
communities in these areas. I was unable to sponsor a similar survey on Pemba

Class of Forest	Formations			Species Common to
Community	Within Classes	Geographic Extent	Conditions Apparent	Formation
		Common to areas with months-		
		long episodes of low atmospheric		No clear family, genus, or
		humidity. Crowns of trees herein	Scrubland abounds below canopy,	species dominance
Coastal Dry Forest		overlap 10-50 m above ground	limited grass coverage	apparent
	Legume-		One to two legume species	
	Dominated Dry		account for 50-95% of community.	
	Forest	Known throughout coastal region	Colonize edaphic coniditions	Leguminoseae Families
	rorest	Miowi tinoughout coustai region	Catchall for dry forests with less	Legarimoseae rarimes
	Mixed Dry		than 50% legume prevalence.	Upwards of 152 known
	Forest	Known throughout coastal region	Could be anthropogenic	species
	Afromontono		High levels of reinfall available and	No slear family gangs or
	Afromontane	A M	High levels of rainfall available and	,
	Transitional	Arc Mountains in Eastern Africa.	poorly drained soils. Supports	species dominance
	Forest	Canopy > 45 m high	large trees and scrubland	apparent
			Shrub plants from 10 cm to 2 m	
			high dominate. Areas typically	
			disturbed by humans, low	No. 1 Court
			precipitation, attenuated drought	No clear family, genus, or
Eastern African			conditions, wind exposure, or	species dominance
Scrubland		Known throughout coastal region	poor soil conditions typical	apparent
	Impenetrable	NACL COLORS	A Par about to the control	No clear family, genus, or
	Mixed Scrub	Makonde Plateau of southern	Areas disturbed by humans,	species dominance
	Forest	Tanzania	termites, elephants.	apparent
			Shallow, nutrient poor soils that	
			feature degraded coreal	
	Maritime Scrub		limestone. Canopies typically 6-10	1 '
	Forest	Known throughout coastal region	m high	Phillippia mafiensis
			Plant formations with closed	
			canopies that rarely host lianas or	
			grasses. Instead, almost	0
	Brachystegia		exclusvely members of	Brachystegia spiciformis,
	Forest		Brachystegia genera	Brachystegia microphylla
		Coastal regions not limited by		
		water availability so that ambient		No deservative serves and
Eastern African		water is equivalent to mean	Forest canopies feature emergent	No clear family, genus, or
Standing Water Forests		annual rainfall values upwards of	trees between 25 and 35 m high;	species dominance
		1,500 mm	shrubs and lianas persist below	apparent
			Scattered occurrence of large	
			trees along river banks; not	No deservative serves and
		Alamasida Tana Husba Jubba	necessarily specific to coastal	No clear family, genus, or
	Diversity - Fauret	Alongside Tana, Umba, Jubba,	region. Can have thin shrub or	species dominance
	Riverine Forest	Rufiji, and Ruvuma Rivers	herb species under canopy	apparent
	Freshwater		Poorly draining substrates with high levels of standing water at all	Calophyllum or Cocos
		Known throughout coastal ragion	0	
	Swamp Forest	Known throughout coastal region	times	genera predominant Avicennia marina,
				Bruquiera gymnorrhiza,
				Ceriops tagal, Lumnitzera
				racemosa, Sonneratia
			Brackish intertidal areas. Canopy	alba, Rhizophora
	Mangroye		can exceed 25-35 m high. No	mucronata, Xylocarpus
	Mangrove	Known throughout coastal region	undergrowth	1
	Forest	Known throughout coastal region	undergrowth	granatus

Table 2.1: Forest types common to the coast of Eastern Africa. White (1978) and Burgess & Clarke (2000) contributed information to this table

Island and, instead, rely on the account published by Beentje (1990). Botanical community compositions in the three regions demonstrate a clear bias towards woody plant species; see Appendix 1 for the full list of genera and species encountered in this survey (Beentje 1990). For example, grass species combined to represent less than 10% of the assemblage from Mikindani Bay (Pawlowicz et al. forthcoming). A similar woody-plant dominance was also apparent at Songo Mnara Island. I was surprised by the lack of grass species recorded in the botanical surveys that I sponsored and those reported from Pemba.

I was surprised by the finds of this botanical survey because I had conducted satellite and ground-reconnaissance surveys myself in 2008 and 2009. These initial investigations all noted the presence of expansive grasslands in each region (Stoetzel forthcoming). Unfortunately, I am unable to account for this lack of agreement between the botanical survey results and expectations of grass communities. The apparent prevalence of non-grass genera and species diversity could certainly reflect real conditions apparent along the coast. The unbalanced counts could also derive from the fact that a botanist trained to be a forest expert conducted the botanical survey. Further, the grass coverage apparent in satellite or ground survey may be populated by a limited number of grass genera or species.

The discussion of woodfuel consumption across Eastern Africa suggests that contemporary situations echo woodfuel needs apparent in pre-modern situations.

Modern groups benefit from the ability to access remote wooded resources; though the act of woodfuel collection is, in itself, beyond the bounds of contemporary legislation. In this way, decisions enacted on an individual scale are able to clearly

impact local forest resources. These actions, in turn, inform national and international conservation efforts. Legislation that limits the harvest of trees in coastal contexts includes the Marine and Coastal Environmental Management Project in Tanzania; see McLanahan et al. (2005), Kairo et al. (2001), or Suckall et al. (2014) for additional information regarding the application of such laws.

People and Terrestrial Forests: Conservation of Species Diversity

Diverse communities of plants and animals typically occupy forest communities.

People who derive their subsistence needs from a mixture of shifting agriculture and local resources typically target, or even create, areas like forest communities that have high levels of species diversity (Winterhalder 1994). Such areas contain a range of biological resources that, in turn, limit the risk of food procurement because people can assume that some resource will be available at any given time (Winterhalder 1994; Gupta 2005). As a form of insurance against shifting biophysical conditions or social priorities, groups of people in sub-Saharan Africa have long attempted to protect patches of forest resources (Fairhead & Leach 1996; Lentz & Sturm 2001; Giles-Vernick 2002; Laney 2002; McConnell & Sweeney 2005; Chouin 2008). As I detail below, intentional protection of such resources has been achieved through imposed governmental legislation or locally operated "sacred forests." These categories are not necessarily mutually exclusive.

Malagasy legislation severely limited the land available to farmers, for both subsistence and cash crops, in the early 1990s by instituting conservation laws against deforestation and encroachment near nature reserves (Laney 2002).

Eco-			
Climatic	Moisture		
Zone	Index Range	Number	Vegetation and Land Use
			Afro-alpine moorland and grassland, or barren land,
			at high altitude above the forest line; of limited use
Afro-alpine	> 0	I	and potential, except as water catchment
			Forests and derived grasslands and bush lands. The
Equatorial			potential is for forestry, intensive agriculture
to dry sub	4.0		including pyrethrum, coffee and tea at higher
humid	> -10	ll l	elevations
			Land not of forest potential, carrying a variable
			vegetation cover (moist woodland, bush land or
			savannah), the trees characteristically broad-leaved
			(e.g. Brachystegia or Combretum) and the larger
Dry sub			shrubs mostly evergreen. The agricultural potential is
humid to	10 to 20		high, soil and topography permitting, with emphasis
semiarid	-10 to -30	III	on ley farming
			Land of marginal agricultural potential, carrying as
			natural vegetation dry forms of woodland and
			savannah (often an Acacia-Themeda association) but
			including dry Brachystegia woodland and equivalent deciduous or semi-evergreen bush land. This is
Semiarid	-30 to -42	IV	potentially productive rangeland
Scimaria	30 10 42	1 0	
			Land only very locally suited to agriculture, the woody vegetation being dominated by Commiphora, Acacia,
			and allied genera, mostly of shrubby habit. Perennial
			grasses such as <i>Cenchrus ciliaris</i> and <i>Chloris</i>
			roxburghiana can dominate, but succumb readily to
Arid	-42 to -51	V	harsh management
			Rangeland of low potential, the vegetation being
			dwarf shrub grassland, or shrub grassland with <i>Acacia</i>
			reficiens subsp. Misera, often confined to
			watercourses and depressions with barren land
			between. Perennial grasses (e.g. Chrysopogon
			aucheri) are localized within predominantly annual
			grassland; productivity is confined largely to
			unreliable seasonal flushes and grazing systems must
			be based on nomadism. Populations of both wild and
			domestic stock are restricted severely by the
Very Arid	-51 to -57	VI	environment

Table 2.2: Six vegetation zones used by grass-specific researchers of Eastern Africa. Adapted from Boonman (1983: 21)

Conservation laws act to limit the spread of agriculture across modern landscapes; this severely limits the productive potential of farmers who typically applied shifting agricultural strategies. Research indicates that farmers generally responded to the sudden land limitation in one of two ways: the acceptance of introduced technical innovation or continuation of shifting practices made possible by shorter fallow periods. Technological innovation facilitated an increase in production while shortened fallow periods were linked directly linked to decreased food production.

Fairhead and Leach (1996) describe a series of local forest conservation strategies that the Kissidougou of Guinée maintained for several hundred years. The researchers realized that Kissidougou maintained their own methods of conservation that operated outside of the rigors imposed on the region. They imbued their landscape with social meaning; the social environment dictated the types of agriculture practiced in particular years as well as locations of permitted resource extraction. Stands of forest that form in such anthropogenic landscapes represent "sacred forests" or "sacred groves" (Gaisseau 1954; Sheridan 2000; de Jong 2002).

People and Standing Water Forests in Eastern Africa

Residents place high value on ecological resources in and around standing water forests for several reasons. First, the reliable water sources that define these forests are attractive for agricultural production. People also value areas inundated by marine water because these intertidal environments are home to mangrove

forests. As I explain, mangroves are versatile tree species with a broad spectrum of uses that make them attractive for both domestic consumption and international commerce, and did in the pre-colonial past.

Colonial officials described the Rufiji River valley as "agricultural Eldorado" because they witnessed the supremely successful practice of *mlau* agriculture (Marsland 1938). *Mlau* denotes a method of crop production whereby the domestic seed is able to germinate in the ground, and the crop is raised to maturity without rainfall. This specialized agricultural technique requires a high water table and soils that can retain high levels of moisture (Adams & Anderson 1988). Colonial accounts note that the Rufiji River floods annually between mid-April and May, depositing a layer of clay-rich silt 1-6" deep in the area. The silt itself is fertile and the high clay content helps retain water *in situ*. *Mlau* farmers (1) use digging sticks to penetrate the clay topsoil; (2) deposit seeds 4-6" below surface; (3) hoe the entire planted area after germination in order to increase capillary movement of soil moisture; (4) harvest the crop; and (5) hoe and burn remaining weeds to be washed away by subsequent floods (Marsland 1938: 58).

Mlau agriculture is an ideal example of the interplay between biological, physical, and human conditions. Contemporary plant communities that represent standing water forests demonstrate the productivity of particular areas within the Rufiji valley. Residents are thus able to identify areas ideal for mlau agriculture.

Once residents begin mlau production in an area, they depend on two physical factors. First, climate patterns must deliver enough water to flood the river valley.

Next, water must move slowly enough to deposit fine-grained silt and clays that, in

turn, provide soil fertility and consistent moisture levels. The extensive use of digging-stick and iron hoe technologies contribute to elevated levels of erosion. Increased erosion impacts communities downriver or along the coastline, as runoff delivers higher levels of silt, clay, and other soils. The presence of mangrove forests in intertidal fringes of coastal zones may represent another example of interplay between biological, physical, and cultural behavior.

Mangroves are a diverse set of trees and shrubs that grow in marine intertidal zones in tropical and sub-tropical latitudes. As a group, mangroves share several highly specialized adaptations to intertidal conditions, notably exposed breathing roots, support roots and buttresses, and leaves able to excrete salt (Lugo & Snedaker 1974; Tomlinson 1986; Hogarth 2007). Seven species of mangrove populate Eastern Africa. Of these, Swahili people select species with the most appropriate ecological-physiological characteristics to meet specific resource needs. For example, mangroves of the *Rhyzophoraceae* genus develop large numbers of sclerenchyma (dense, rigid vascular tissues) to support the 20m+ tall trunks (Semesi 1998; Dahdough-Guebas et al. 2000). Sclerenchyma-rich trunks are hard, dense, and split easily, all characteristics that make members of this genus an ideal resource for construction poles (maboriti in Swahili) (Lydekker 1919; Curtin 1981; Ewel et al. 1998). Table 2.3 summarizes the ways that coastal peoples use mangroves and how such use relates to ecophysiological characters of individual species.

Mangrove Species	Local Name	Function Within Modern Communities
		bed posts, chair legs, table legs,
		fencing posts, charcoal, firewood,
		serving dishes, boat ribs, mortar and
Avicennia maria mchu		pestal, dishes, drums
		construction poles, roof supports,
		boat paddles, oars, firewood, charcoal,
Bruguiera gymnorrhiza	mkoko wimbi	drums, beehives
		construction poles, paddles, oars,
Ceriops tagal	mkoko mtune	commercial firewood, fishing traps
Lumnitzero racemosa	kikandaa	commercial firewood and charcoal
		canoes, boat ribs, paddles, masts,
		fishing net floats, timber for window
Sonneratia alba	mlilana	and doorframes, charcoal, firewood
		construction poles, charcoal, firewood,
Rhizophora mucronata	mkoko mwenye	fishing traps, weapons
		timber for bed construction, window
Zylocarpus granatus	mkomati	and door frames, charcoal, firewood

Table 2.3: Species name, local name, and social use of mangrove trees in Tanzania (see Dahdough-Guebas et al. 2000)

Physical Conditions of Eastern Africa and the Swahili Coast: Geology

Agriculture is, by necessity, a soil-altering process for several reasons. First, the management of farm plots requires large levels of soil disruption that, in turn, may cause an area to be more susceptible to erosion. Agriculture also results in the discard of large levels of temporary plant matter in an area: seeds are introduced, plants grow, foodstuff removed, waste abandoned and the process repeats. When foodstuff is removed, the nutrients and elements that they absorbed from the soil are also removed from the system. The extreme age of Precambrian soils suggests that anthropogenic impacts would be extracting nutrients from naturally degraded, relatively infertile soils. By presenting geologic histories of Eastern Africa, I am able

to highlight the fact that farmers practicing a shifting strategy of agriculture across the region have done so for millennia.

I begin the geological overview of Eastern Africa roughly 600 million years ago (Ma), a period when the super-continent Pangaea encompassed the entire exposed lithosphere. Precambrian surfaces have been molded by differential uplift and subsidence into a gentle basin-and-swell pattern of large depressions separated by ridges (Kröner 1977). Precambrian soils of Africa, which formed 600 Ma, are typically restricted to the interior or middle of the continent. While a member of Pangaea, the African subcontinent occupied the middle of the super-continent. Tectonic activity that began around 300 Ma eventually split Pangaea; the margins of the fledgling African subcontinent demonstrate a complicated history of inundation, sedimentation, and exposure from 300 Ma until about 8,000 years ago (Mathu & Davies 1996). The description demonstrates that these soils have undergone least 600 Ma of anthropogenic, biological, and physical processes, namely erosion and salinization (Hartshorn et al. 2002).

The Mozambique Belt is a strip of Precambrian soils that runs along the surface of Eastern Africa from Ethiopia and Lake Turkana in the north, south through Mozambique. It is interrupted by volcanic activity deposition in central Tanzania/ Kenya, and coastal sedimentation deposits that form the surface of the entire Eastern African seaboard (Figures 2.4). Episodes of mountain building and associated soil sedimentation, deformation, metamorphism, and uplift occurred across the Mozambique Belt until 450 Ma (Mathu & Davies 1996). Precambrian soils range in age from 600 Ma to 450 Ma. As explained above, long-term exposure

to ravages of erosion and nutrient leeching limits the agricultural potential of soils across the Mozambique Belt.

Approximately 300 Ma ago tectonic activities began to split Pangaea into Gondwanaland and, eventually, the contemporary complement of continents. Initial tectonic activity flooded topographic depressions of Pangea (Hamilton 1982). The result was a series of landscapes pocked by expansive basins of fresh water. These Karoo Basins persisted along the margins of what would become sub-Saharan Africa between 300 and 100 Ma; after 100 Ma subsequent tectonic activities transformed the basins into marine coastline or vast lakes (Johnson et al. 1996; Johnson et al. 2000). The basins trapped eroded soils and harbored freshwater organisms for more than 100 Ma; the high organic components of both such factors manifest as large coal deposits across contemporary Southern Africa (Cairncross 2001). Catuneanu et al. (2005) provide a detailed overview of vast economic potential of coal and the costly, destructive processes necessary to harvest it. The economic importance of coal reserves has spurred extensive research on Karoo basin sediments. In addition to coal, these sediments include a mosaic of sandstones. limestones, marls, shales, coal, and mudstones (Johnson et al. 1996). Considerations of the Karoo basin sediments bring the discussion of geology into the Mesozoic Era: 252 to 66 Ma. Episodes of marine and lacustrine inundation, subsidence, faulting, and other geomorphic processes accumulated since the Mesozoic to create unique soil conditions across the sub-continent.

The African continent was fully formed by 100 Ma. Climate change subjected the continent to varied rainfall and sea levels that rose and fell dramatically until

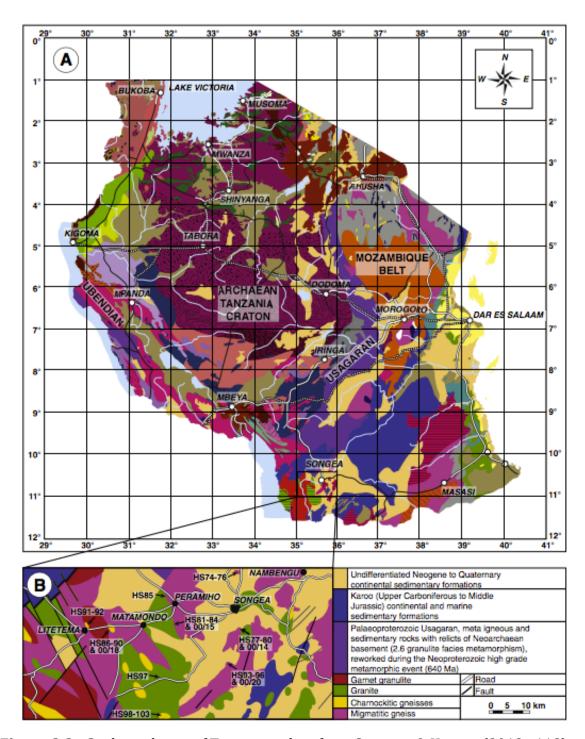


Figure 2.3: Geological map of Tanzania taken from Sommer & Kröner (2013: 118)

both climate and sea levels stabilized into the modern configuration around 8,000 BC (Day et al. 2007). Sedimentation continued during that 100-million-year period.

This created a mosaic of sandstones, limestones, marls, shales, and mudstones to form in coastal contexts (Nicholas et al. 2007). Further inland, the lack of inundation precluded marine sedimentation. Instead, much of the soil turnover and sedimentation resulted from either Karoo basin faulting or riverine/lacustrine activity (Nicholas et al. 2007).

Climatic Conditions in Eastern Africa and the Swahili Coast

Climatic patterns active across contemporary Eastern Africa have remained roughly consistent since the Holocene, which began 12,000 years ago. Climate change and the altered weather patterns that have occurred during the Holocene result from natural processes as well as anthropogenic influences. Recent research identifies regionally specific multi-decadal temperature variation between 0.5 and 1.5° C throughout the Holocene. In this section I aim to identify natural processes that influence climate change both at a global level and specifically in Eastern Africa. The discussion terminates with an overview of anthropogenic global climate change that predates the mid-eighteenth-century Industrial Revolution.

Geography represents a major factor that influences the weather patterns that impact the Swahili coast. The Swahili coast straddles the Equator, ranging from about 2º N to 19º S. Equatorial geography leads me to identify the Intertropical Convergence Zone and Indian Ocean Monsoon as the primary climate systems operating in the region (Figure 2.4, 2.5). Figure 2.6 illustrates known episodes of global climate change known to have occurred during the Holocene. Discussion of these climate systems and known episodes of climate change combines with a brief

overview of the North Atlantic Oscillation and the El Niño Southern Oscillation systems. A barrage of additional factors has been acting concurrently across the globe throughout the course of the Holocene; however, direct impact along the Swahili coast is either too small or too irregular to warrant attention here. The Intertropical Convergence Zone (ITCZ) coincides with an equatorial lowpressure trough and marks the point wherein trade winds from the Northern Hemisphere meet those from the Southern Hemisphere. The convergence of trade winds forces moist air into the atmosphere where it condenses and quickly falls back to the earth. The result of the equatorial trade-wind confluence and lowpressure trough is a disproportionate amount of precipitation falling within 15° of the Equator (Rasmusson & Arkin 1993). Global sea surface temperature influences the amount of warm air available to converge, rise, and fall as precipitation, this results in the formation and position of the ITCZ. As a result, the climate system varies both seasonally and annually. Yearly rainfall variability can be extreme. Precipitation levels are known to vary by as many as 560 cm annually in the eastern Pacific, the most dramatic climate-induced variation on earth (Dunbar 2000).

Indian Ocean Monsoons are typically associated with seasonal, large-scale reversals of surface winds (Hastenrath 1991; Hastenrath & Greischar 1993; Dunbar et al. 1994). Zinke et al. (2005) acknowledge the general trend before asserting that the most important paleoclimatic consequence of such large-scale reversal is tropical and subtropical rainfall. Monsoons develop as an equatorial low-pressure trough, as seen in ITCZ, and transition seasonally into either a northern or southern orientations.

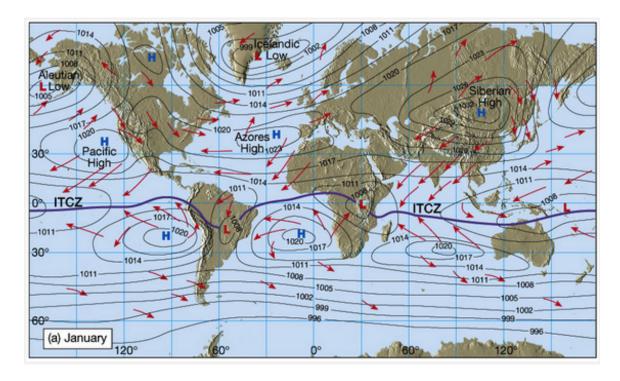


Figure 2.4: Intertropical Convergence Zone, January. From http://www.ux1.eiu.edu/~cfjps/1400/circulation.html, (accessed October 2014)

Monsoon activity across the Indian Ocean has influenced Swahili economy in at least two ways for thousands of years. From June through November, winds blow from Eastern Africa towards South Asia, effectively sweeping warm, wet air from the African sub-continent to South Asia. The result is a prolonged dry season in Eastern Africa including the Swahili coast. The winds reverse December through May, directing warm, wet air to Eastern Africa. Monsoonal delivery of precipitation follows the ITCZ low-pressure trough. Despite variation in intensity and, to a lesser extent, geography, residents of the Swahili coast have depended on the annual recurrence of wet and dry seasons of predictable duration. In this way, monsoon activity influences the type and nature of agricultural food production across the Swahili coast.

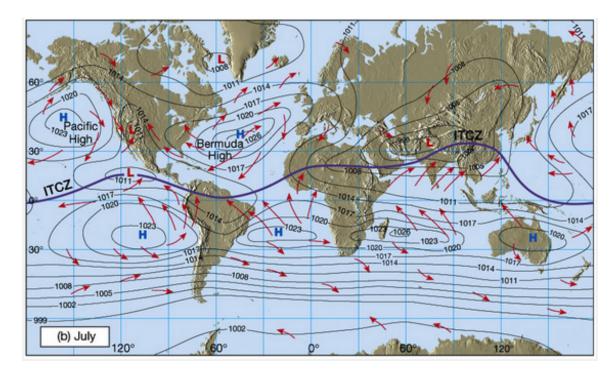


Figure 2.5: Intertropical Convergence Zone, July. From http://www.ux1.eiu.edu/~cfjps/1400/circulation.html, (accessed October 2014)

The *El Niño Southern Oscillation* (ENSO) phenomenon is responsible for most of the known interannual climate variability in the global tropics and subtropics (Dunbar 2000). El Niño occurs when equatorial surface waters in the eastern Pacific and the coasts of South America experience an overall warming trend (Trenberth 1990). The Southern Oscillation refers to the atmospheric component of El Niño variability and tracks sea-level pressure vary between the South Pacific subtropical high and the Indonesian low (Dunbar 2000: 49-50). During ENSO warm water in the western Pacific Ocean creeps eastward toward Peru and Ecuador. The result is a diminished gradient of sea surface temperature along the Equator, weak trade winds, and a pooling of precipitation in the eastern Pacific and across the Americas. Elevated precipitation across the Americas occurs at the expense of Australia, as

drought characteristically grips that continent during years when ENSO conditions are apparent.

Evidence indicates that ENSO clearly impacts interannual variability in temperature and rainfall in regions across the world (Ropelewski & Halpert 1989; Kiladis & Diaz 1989; Trenberth 1990). Cane and Zebiak (1987) provide evidence of teleconnection between sea surface temperature in the Pacific and grain production in Zimbabwe. High temperatures across the southeast Indian ocean/western Pacific Ocean create higher levels of precipitation during the rainy season in eastern Africa. Elevated precipitation, in turn, leads to higher levels of grain production. The influence on global rainfall regimes through time, that clearly occurs due to altered sea surface temperatures across tropical regions of the Pacific associated with ENSO, makes this climatological system the most influential on Holocene climate change.

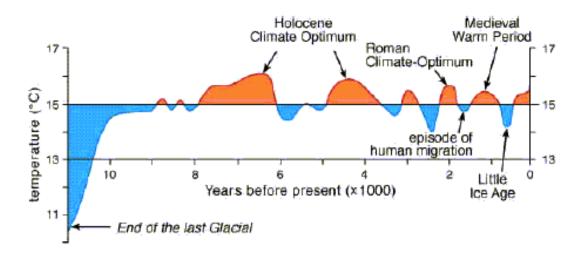


Figure 2.6: Global patterns of climate change in the Holocene. From http://jpenhall.files.wordpress.com/2012/09/holocenetemperatures.png (acessed October 2014)

Palynologic evidence from Lakes Tanganyika (Alin & Cohen 2003), located in the rift valley of Tanzania, and Baringo (Dreise et al. 2004), in rift valley of Kenya, align with soil chemistry analysis of wetland and floodplains in the nearby rift valley (Kiage & Liu 2009) to characterize local impacts of global climate fluctuations in Eastern Africa since the early-first millennium. The analyses all suggest arid conditions prevailed in the region in the centuries leading to AD 1250, with short, water-rich episodes in AD 500-700. The arid conditions apparent in these Eastern African contexts likely derive from the Medieval Warm Period, 800-1270. Dreise et al. note the acute wet episode that immediately followed the Medieval Warm Period caused a dramatic shift in local vegetation, from 20-40% C3-type plants and grasses to 100% C3-type plants and grasses. This sort of shift would be readily apparent in the phytolith record. Wet conditions continued more or less unabated until the Little Ice Age, 1650-1720. Evidence suggests that arid conditions known to the

This information suggests phytolith samples from contexts from AD 600-800 and 1250-1650 should demonstrate relatively high levels of C3-Pooid grasses or woody plants. Archaeological contexts from 800-1250 and after 1650 should, in turn, indicate a prevalence of arid-tolerant C4-Panicoid type grasses.

Concluding Remarks Regarding Environmental Archaeology

The review of archaeological, historical, and environmental research outlined in Chapters One and Two supports the paleoethnobotanical investigation that I present in the remainder of this dissertation. The widespread application of

environmental perspectives evident in this review indicates a shared desire to bring environmental conditions to bear on Swahili prehistory. As I argue throughout this research, modern environments represent the culmination of ongoing interaction between humans and biophysical conditions. My objective for this chapter was to take a first step towards situating Swahili decisions within the environments in which specific actions were performed.

In order to make this point, I broke the presentation of environmental conditions into three sections. First, I defined historical ecology and demonstrated the ways in which I can use this perspective to better understand the ongoing interaction between Swahili people and coastal environments. Second, I provided an overview of social and biophysical conditions recorded in Eastern Africa. Finally, I described contemporary biological and physical conditions. With these objectives accomplished and the research motivation established, I now move to present methodologies necessary to reconstruct three Swahili landscapes.

Chapter Three

Methodological Applications of Paleoethnobotany and Phytolith Analysis in Environmental Archaeology

The sum total of interaction between social acts and biological or physical events accumulates through time to constitute conditions that define modern landscapes, including those of Eastern Africa. To date, archaeologists have applied a range of analytical techniques to gain access to prehistoric environmental conditions of the Swahili coast; techniques include macrobotanical analysis (Walshaw 2005; Pawlowicz 2011), zooarchaeology (Horton & Mudida 1993; Fleisher 2003; Wynne-Jones 2005; Pawlowicz 2011), and geoarchaeology (Sulas 2010a; Pawlowicz 2011). Sulas (2010a) pioneered the application of phytolith analysis to explore Swahili archaeological contexts; she accomplished this analysis through consideration of micromorphological samples taken from Songo Mnara Island. These micromorphological samples exhibited no post-depositional degradation of silica body morphology. With the knowledge that phytoliths from this region could accommodate intensive analysis, Sulas and Madella (2012) undertook a phytolith-specific study of urban areas at Songo Mnara. The initial success of the Sulas's (2010) analysis gave me the confidence to move forward with the present project. Rather than working explicitly in urban areas, I build on their initial work to consider plant community composition from landscapes in three archaeological regions on the Swahili coast.

Phytoliths are a resilient class of opal-silica microfossils that form within or between plant cells (Rovner 1971; Pearsall 1982). Silica bodies coalesce around plant cell walls, this process causes phytoliths to become molds of the plant cells themselves. Plant cell morphologies are sometimes diagnostic to family, genera, or species; therefore, phytoliths have the capacity to be similarly diagnostic (Agnew & Wooler 2001). The analysis of phytoliths that derive from archaeological contexts falls under the subdiscipline of paleoethnobotany. I use this chapter to contextualize my approach to phytolith research, situate the dissertation project within the broader realm of paleoethnobotany, and explain the methodologies I used during excavation, extraction, analysis, and interpretation.

Paleoethnobotany and Phytolith Analysis

Paleoethnobotany is the study of plant residues that derive from archaeological contexts. Plant residues that persist through time include pollen grains, charred wood, seeds, and phytoliths. The study of archaeological plant materials represents a unique perspective of ethnobotany, the interactions between people and plants (Pearsall 2009). V.H. Jones (1941) pioneered the study of ethnobotany at the University of Michigan where he encouraged students to gain experience in anthropological theory combined with the methodologies specific to botanical analyses (Pearsall 1996). The dual instruction empowered paleoethnobotanists with the abilities to understand sociocultural actions as well as interpret any overlap between social uses of plants and plant ecophysiology (Pearsall & Piperno 1990). Contemporary paleoethnobotanists undertake training

similar to that which researchers at the University of Michigan pioneered (Pearsall 2009: 1-3 reports on Jones 1941).

The interdisciplinary rigor of methodologies and interpretations inherent in paleoethnobotany permits researchers to collect data suitable for applications in historical ecology. In this way, paleoethnobotanists can consider the ways in which people use plants for food, fuel, medicine, or ritual; the interaction between plant seasonality and settlement dynamics; the existence of interdependency between people and plants; and the anthropogenic influences enacted on plant communities (Hastorf & Popper 1989).

Plants produce a number of structures that may enter the archaeological record (see Pearsall 2009 for in-depth review). I rely on phytoliths because these opal-silica bodies are resilient markers of former plant communities that undergo relatively little post-depositional movement (Bryant 1993; Piperno 2006). The silica bodies remain in place after a plant expires and decomposes (Mulholland & Rapp 1992; Powers-Jones & Padmore 1993). In this way, phytoliths offer evidence of plant community composition that persists *in situ* through time and space (Piperno 2006).

Why Plants Create Phytoliths

Plants fix energy from sunlight into simple sugars, molecules that store energy. The process takes place in specialized chloroplast organelles that populate leaves and other areas of plants exposed to sunlight. Sugar is transported from chloroplasts to other areas of a plant through osmosis, the passive movement of

water across concentration gradients. Osmosis is only able to deliver sugars to cells and tissues that display a relative concentration deficit (i.e. have less sugar than neighboring cells), as water carries dissolved solutes along into tissues and individual cells. Solutes include simple sugars as well as trace elements like silica. Plant cells rely on trace elements to create a loop of passive diffusion. The loop follows a three-step progression:

- Water carries sugars and dissolved elements, like silica, into tissues.
- Cells consume energy and recycle waste from sugars.
- Cells saturate themselves with trace elements by accumulating silica.

Silica-rich phytolith bodies permit plant cells to super-saturate their tissues, a process which offsets the concentration gradient and encourages the osmotic delivery of water and sugars. In this way, plants are able to transport high volumes of water, sugars, and trace elements across the length of organisms without heavy energy expenditures (Lambers et al. 2008).

The physiological role that phytoliths play within plant cells extends beyond the promotion of passive transport throughout plant structures. The silica bodies also present a rigid architecture that adds structure and support to silica-accumulating plants (Sangster et al. 2001). The silica bodies maintain their shape and size regardless of external factors, namely moments of low water, or turgor, pressure. For this reason, phytolith-rich plant tissues do not collapse in periods of low turgor.

Plants rely on impermeable membranes such as cutin or suberin to saturate tissues, as such membranes present a barrier that water, monosilicic acid, or other compounds cannot cross (Parry & Winslow 1977). Researchers have noted the existence of genetic controls that govern the presence and distribution of fatty, solute-impervious membranes that function to retain water within or between individual cells (Lambers et al. 2008). While this relationship has been recorded (Lambers et al. 2008; Cabanes et al. 2012), Piperno (2006: 15) notes that such genetic mechanisms, and the role they may play in phytolith production are poorly understood. Despite being unable to demonstrate *how* plants stockpile large amounts of silica, researchers have been able to identify active silica accumulation within a variety of grasses (Okuda & Takahashi 1964), barley (Barber & Shone 1966), sugarcane, wheat, rice (Ernst et al. 1995), and sedges (Walker & Lance 1991; Mayland et al. 1993).

Research projects underscore the important role phytolith bodies play in the maintenance of plant life. Chen and Lewin (1969) attempted to cultivate species of grasses that are known to produce phytoliths in a silica-free growth medium. The grass blades and stalks that grew in this medium were pliant and, reportedly, collapsed at the slightest provocation. Similar experiments discovered that phytoliths allow plants to economize and maximize energy capture. In these studies, plants grown in media without silica were unable to produce leafy tissues that did not overlap, and did not block other plant tissues from exposure to sunlight (Okuda & Takahashi 1964). The overlap of leafy structures restricted sunlight

exposure to chlorophyll; this, in turn, reduced the energy potential of individual plants.

Research into plant genetics suggests that some phytolith-producing plants use the silica bodies to protect themselves from herbivores and increase resistance to pathogenic fungi (Piperno 2006). Plants that rely on phytoliths for protection do so by shunting silica bodies toward tissues particularly vulnerable to herbivores, including fruits, flowers, and sap-rich areas of active photosynthesis. Species of the *Zea* and *Cucurbita* genera protect seeds and fleshy fruits with a combination of lignin and phytoliths. These substances complement one another and ultimately create fortified reproductive tissues able to obstruct insect predation and withstand fungal infestation (Marshner 1995; Epstein 1999; Piperno 2006).

The discussion of plant physiology indicates plants typically accumulate phytoliths in leafy tissues, seeds, or fruits. Each of these plant tissues is important for human consumption; thus, we can expect human actions to draw phytolith bodies into the archaeological record. For example, corn and gourds, members of *Zea* and *Cucurbita* genus, protect seeds and fleshy fruits with phytoliths (Marshner 1995; Epstein 1999). People intentionally harvest seeds and fleshy fruits of corn and gourds; this selection therefore increases the likelihood that such human actions are documented in the archaeological record. Impermanent architecture often features large, lush plant leaves as roofing. Leaves of this variety, including palm fronds, often feature heavy phytolith production (Pearsall 2002). Preliminary studies of Swahili contexts identify the presence of coconut palm phytoliths in contexts above head- and footstones of Muslim burials at Songo Mnara (Sulas 2010).

The palm phytoliths provide direct evidence of fourteenth to sixteenth-century Swahili social preferences and actions.

Phytoliths in the Archaeological Record

Archaeologists have targeted phytoliths from archaeological contexts because such ecofacts:

- Require no physical change to ensure long-term durability. The inorganic bodies are stable by nature and, unlike wood, do not require carbonization or any other anaerobic conditions to persist (Rovner 1978).
- Unlike pollen or seeds, phytoliths are not created for mass distribution across a given landscape. For this reason, plant decay simply releases silica bodies directly into the soil rather than into the atmosphere or some other medium for long-distance distribution (Wright 2003).
- All plant cells require high levels of water. For this reason, nearly every cell in a silica-accumulating plant will create a phytolith. This means that every silica-accumulating plant will release huge numbers of the microfossils.

The microscopic size of phytolith bodies subjects them to post-deposition movement. Archaeologists must control for or otherwise identify taphonomic influences that may move the silica bodies horizontally or vertically across a soil column (Pearsall 2009). Jacobson and Bradshaw (1981) classify the range of post-depositional mobility of phytoliths into three categories: plant communities with phytoliths from within 20 m of the collection area; extra local communities where phytoliths are taken to represent a 20-250 m range of plants; and regional phytolith representation whereby silica bodies are thought to represent > 250 m swaths of vegetation. I operate within the regional scale of phytolith analysis as I consider samples in 250 m, or larger, intervals. Regional scale analyses lack some detail, but

capture wide-ranging anthropogenic changes and provide the opportunity to reconstruct large swaths of landscapes.

Phytolith analysts note that wind and water are the factors most likely responsible for horizontal transportation of silica microfossils across a landscape (Bonney 1978; Labouriau 1983). Direct, unimpeded exposure to either factor typically results in high levels of phytolith transport; thus, areas where such contact is possible can only accommodate regional-level reconstructions (Fredlund & Tieszen 1994; DebBsk 1997). Taphonomy represents another factor that led me to a regional-scale analysis; I was reluctant to undertake a sub-regional project because previous analyses were not available to inform the degree of expected post-depositional motion.

Phytoliths are also subject to vertical movement within a soil column. Water drainage, bioturbation, and freeze-thaw action all have the potential to shift silica microfossils after deposition (Rapp & Hill 2006). Researchers who studied phytolith samples from archaeological contexts of sandy substrates of the Florida woodlands (Kalisz & Stone 1984), soil and loess sediments in Central Asia (Madella 1997), and agricultural plots on Pacific islands (Pearsall 1983; Pearsall & Trimble 1984) record situations where taphonomic influences did not threaten stratigraphic position. Additional investigations have confirmed a surprising lack of vertical movement through the comparison of AMS radiocarbon dates taken from phytoliths in stratigraphically distinct layers of soil profiles (Blackman 1969; Rowlett & Pearsall 1993; Piperno & Holst 2004; Kealhofer & Grave 2008). Without the aid of AMS radiocarbon dates, researchers can assume that discrete stratigraphic boundaries

evident between phytolith samples signify a lack of vertical mixing (Rovner 1986; Rosen 2001; Pearsall 2009). This assumption stems from the notion that vertical movement within a soil column would homogenize the phytolith proportions measured within a soil profile (Fredlund & Tieszen 1997a, 1997b). The samples recovered from my analyses demonstrated heterogeneous distribution of phytolith bodies and associated proportions. For this reason, I did not further explore the application of absolute dating methodologies to my samples.

Piperno (2006: 139, 140-184) offers a full review of the ways in which archaeologists typically employ phytoliths. Rather than reiterate her presentation, I now move to present the types of phytolith morphologies that I considered in this project.

Phytolith Morphologies under Consideration in this Analysis

This phytolith research contributes to the growing number of paleoethnobotanical studies that consider archaeological contexts on the Swahili coast of Eastern Africa. Previous investigations tended towards macrobotanical analyses, with a clear emphasis on charred seed remains (Sutton 1987; Walshaw 2005, 2010; Pawlowicz 2011). Charred seeds yield information regarding the type of cultivates or food plants that existed in a given landscape or domestic context (Pearsall 2009: 133-152); charred materials also inform the reconstruction of social structures that involve food and woodfuel procurement or consumption.

Landscapes of coastal Eastern Africa often do not preserve macrobotanical residues intact (Sutton 1987; Robertshaw & Wetterstrom 1989; Wetterstrom 1991). Despite

preservation limitations, paleoethnobotanists have had success with macrobotanical analyses in limited contexts of coastal Tanzania and Kenya.

Chittick (1974: 52) reported sorghum grains atop an excavated house floor. Archaeological investigations on the Comoros Islands identified a broad range of domesticates that shifted through time (Wright 1984, 1992, 1993). Contexts from the ninth to tenth centuries AD there yielded evidence of rice as well as limited representation of millet, coconuts, and beans (Hoffman 1984). Investigation of thirteenth-century AD contexts of the Comoros Islands yielded only coconut and rice (Johnson 1992: 111-114). Similarly, contexts from Madagascar demonstrated the presence of domestic rice and cowpeas in northern areas of the island by the late fifteenth century AD (Wetterstrom & Wright 2007). These combined results pushed my analyses towards the search for phytoliths from the Panicoideae and Chlorideae grass subfamily because these subfamilies include, among many other species of grasses, domestic African grains and Asiatic rice, respectively. I take additional cues about the phytolith morphologies on which I should concentrate from phytolith research on modern plant communities in Eastern Africa.

Mercader et al. (2010: 1955-1956) identifies 45 unique phytolith morphologies from contemporary ecologies in the Niassa Rift of Mozambique. This analysis represents an initial attempt to document comparative reference materials of expected grass types from Miombo woodlands of Eastern Africa (Mercader et al. 2010). Miombo woodlands typically have a single story of Fabaceae tress forming a discontinuous canopy with shrubs, sedges, and heliophytic grasses beneath (Campbell 1996). The reconstructions of phytoliths expected from Miombo

woodlands presented in this analysis suggest that a small subset of Poaceae short cells dominate the assemblage of Miombo woodland grasses (Mercader et al. 2010: 1959-1960); these most prevalent morphologies include particular varieties of Panicoideae grasses and one morphotype typical of Chloridoideae taxa (Mercader et al. 2010: 1963).

The phytolith analyses that created an initial comparative collection of grasses from Miombo-type woodlands followed an analysis of woody plant phytoliths from Miombo woodlands of Mozambique (Mercader et al. 2009). The analysis of woody plants from Miombo woodlands considered 41 plant families, 77 genera, and 90 species of woody plants (Mercader et al. 2009: 94-97). The resulting samples produced 57 distinct phytolith morphotypes common to Miombo woody species of Eastern Africa. Many of these phytolith morphologies are shared between all woody plant families. I rely on the morphologic types that derive from this analysis to inform the woody plant morphologies that I encounter in my samples.

Phytolith investigations of Songo Mnara Island reported the presence of palm trees, as well as many of the grass types already documented in Eastern Africa (Sulas 2010; Sulas & Madella 2012). The existing investigations all motivated me to target a total of six discrete plant types: undifferentiated grasses, Pooideae subfamily grasses, Panicoideae subfamily grasses, Chlorideae subfamily grasses, woody plants, and palm trees. I rely on descriptions of phytolith morphologies from Twiss et al. (1969), Mulholland (1989), Fredlund & Tieszen (1994), Kondo et al. (1994), Alexandre et al. (1997), Piperno (2006), and Pearsall (2009) to classify the phytolith bodies that I encountered during analysis. Furthermore, I relied on the

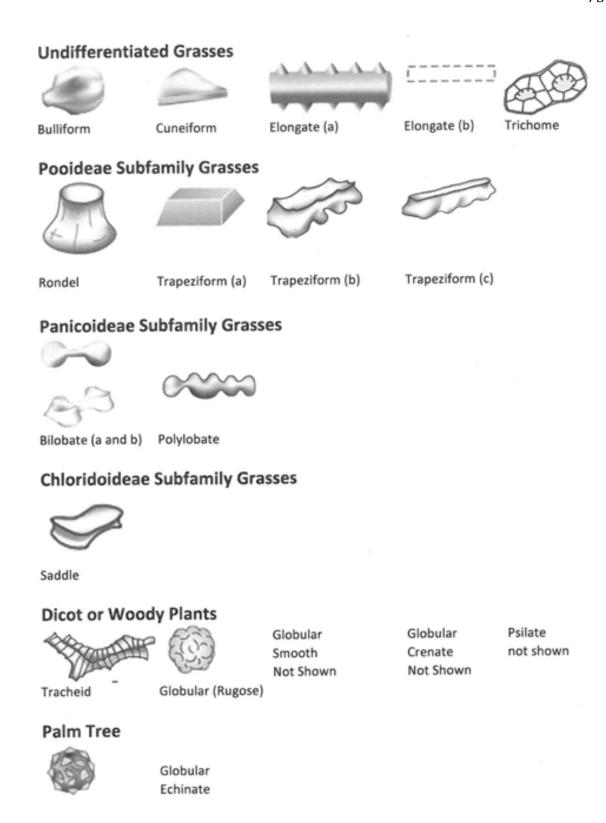


Figure 3.1: Idealized phytolith morphologies that informed this analysis

International Code for Phytolith Nomenclature 1.0 (Madella et al. 2005) to name the morphologies included in this analysis. Figure 3.1 illustrates idealized morphologies of the phytolith, taken from Madella et al. (2005) types that I consider in this analysis. See also Barboni and Bremond (2009: 32-33) for additional illustration of phytoliths morphotypes known to grasses of Eastern Africa.

- Undifferentiated Grasses
 - o Bulliform (Cuneiform)
 - o Elongate
 - o Trichome
- Pooideae Grass Subfamily
 - o Rondel
 - Trapeziform
- Panicoideae Grass Subfamily
 - o Bilobate
 - o Polylobate
- Chloridoideae Grass Subfamily
 - Saddle
- Dicots and Woody Plants
 - Tracheid
 - Psilate
 - Globular
 - Smooth
 - Rugose
 - Crenate
- Palm Tree and Monocots
 - Echinate

Twiss et al. (1969), Mulholland (1989), and Twiss (1992) identify bulliform, elongate, and trichome phytolith types as those typically formed within members of the Poaceae, or grass, family. Phytoliths that derive from this category provide evidence of the presence of grasses in a particular landscape. Bulliform, elongate, and trichome phytolith counts also contribute to index calculations on which I rely to evaluate plant community composition in particular landscapes.

The rondel phytolith type (Mulholland 1989) corresponds to the keeled pyramidal types recorded by Fredlund and Tieszen (1994). Previous researchers all note that this morphotype corroborates with the Pooideae subfamily of grasses (Twiss et al. 1969; Schneider et al. 2009). In a similar manner, trapeziform short cell types are also known to be mainly produced by Pooideae subfamily grasses (Twiss et al. 1969; Mulholland 1989; Kondo et al. 1994; Barboni et al. 1999). Figures 3.2, 3.3, and 3.4 are Pooideae subfamily grass morphologies that I noted from archaeological contexts of Pemba Island.

Twiss et al. (1969) initially reported on phytoliths formed within

Panicoideae subfamily grasses. The morphologies that typically derive from this
subfamily include bilobate short cells (Mulholland 1989; Fredlund & Tieszen 1994;
Kondo et al. 1994; Teerwatananon et al. 2011). Polylobate bodies are also known to
form in species of this subfamily in contexts across Eastern Africa (Barboni et al.
2007; Bremond et al. 2008; Sulas & Madella 2012). Figure 3.5 illustrates an example
of Panicoideae subfamily grass morphologies that I recorded from archaeological
contexts on Pemba Island.

Chloridoideae subfamily grasses are known to produce large proportions of saddle morphotype phytoliths (Twiss et al. 1969; Mulholland 1989; Kondo et al. 1994). Analyses of this morphotype conducted on domestic species of Asiatic rice demonstrate that anthropogenic influences involved with domestication have managed to change its size and shape (Pearsall et al. 1995; Zhao et al. 1998; Gu et al. 2013).

Piperno (2006) and Pearsall (2009) both document that many subfamily, genera, and species of dicots and woody plants produce phytolith morphotypes that include tracheid, psilate, and a range of globular types. Additional analyses demonstrate that more diagnostic analyses are possible (see Mercader et al. (2009). Despite the presence of such diagnostic bodies, I elected to terminate this investigation at the level of plant family. I intended to evaluate the presence of woody plants, as measured by these morphotypes with the Woody Plant Index. However, conflicting reports on the efficacy of this index in Eastern Africa has made me wary of applying this index to evaluate coastal landscapes. Figures 3.6 and 3.7 represent woody plant phytoliths; each example derives from archaeological contexts on Pemba Island.

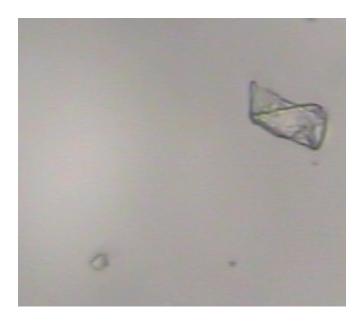


Figure 3.2: Trapeziform and rondel phytolith morphologies, both common to the *Pooideae* grass subfamily



 $\textbf{Figure 3.3:} \ \textbf{Trapeziform phytolith morphology, common to the } \textit{Pooideae} \ \textbf{grass subfamily}$



Figure 3.4: Rondel phytolith morphology, common to the *Pooideae* grass subfamily



Figure 3.5: Bilobate phytolith morphology, common to *Panicoideae* subfamily grasses



Figure 3.6: Globular smooth phytolith, common to woody plants



Figure 3.7: Psilate phytolith, common to woody plants

The presence of palm trees in urban contexts of Songo Mnara led me to include the globular-echinate morphotype of phytolith (Sulas 2010; Sulas & Madella 2012).

Paleoethnobotanical Field Work

The paleoethnobotanical fieldwork that I conducted on Songo Mnara Island, at Mikindani Bay, and on northern Pemba Island resulted in the collection of 1,600 archaeological and 200 modern phytolith samples. This project follows previous studies that first applied phytolith analyses in coastal Eastern Africa (Sulas 2010; Sulas & Madella 2012). I modeled my methodologies on successful applications of phytolith research, namely those presented by Pearsall (2009), Sulas (2010), and Sulas and Madella (2012). In this section I define the four types of fieldwork that I had to conduct in order to reconstruct plant communities from in and around archaeological landscapes. I also note the analytical methodologies that pushed this research forward. The categories of fieldwork and analysis include: phytolith sample collection, phytolith extraction from soil samples, phytolith microscopy, and phytolith interpretation.

Phytolith Collection from Archaeological Contexts

I performed subsurface shovel-test pit surveys at Songo Mnara Island,
Mikindani Bay, and northern Pemba Island to recover phytolith samples from
exposed soil columns. The fieldwork was conducted between June and December
2011. In the case of Songo Mnara, the research I conducted represents the first

archaeological investigation performed outside the stonetown walls (Sulas worked within them). I decided to survey the entire island so that I could ascertain the extent and duration of human activity in the landscapes that surround the fourteenth-to-sixteenth-century AD urban settlement. At Mikindani Bay and on northern Pemba Island I had the opportunity to retrace regional surveys that had been conducted by M. Pawlowicz and J. Fleisher from the University of Virginia, as well as A. LaViolette in the case of northern Pemba. I chose to focus on a subsample of 13 archaeological sites that Pawlowicz (2011) identified across the Mikindani Bay area; similarly, I concentrated my paleoethnobotanical efforts around two settlements on the northeastern coast of Pemba (LaViolette & Fleisher 1995; LaViolette et al. 2000; Fleisher 2003).

I worked with crews of two to three local people and an antiquities official to survey the three regions under consideration. We excavated 50 x 50cm shovel-test pits (STPs) in 250m intervals across the archaeological regions; once excavated, we recovered phytolith samples the profile of each STP. Though the units were small, excavations presented the opportunity to collect archaeological residues alongside phytolith samples. The archaeological materials proved extremely useful; not only did they provide direct evidence of human action in specific locations; the assemblages provided a strong basis for relative chronologies at all three sites. I used the relative chronologies to date the phytolith samples to site-specific social periods. In this way, I managed to successfully chart botanical changes through time and avoid the expense of radiocarbon dating.

I defined a series of transects across the archaeological settlements and excavated STPs at 250 m intervals across each transect. Local geologies determined the depth of each STP, as I excavated until I reached impenetrable obstacles (i.e., fossilized coral and dense clay) or until equipment could not reach additional strata. Once the unit was excavated and artifacts recorded, I cleaned the northern profile of each unit and removed loose sediment to prepare for phytolith sample extraction. I used a trowel to collect samples at 10 cm increments, unless I perceived any change to natural stratigraphy, and proceeded from the bottom of the STP up to ground surface (Figure 3.14). Each sample was composed of at least 20 g of soil; after I ensured proper weight and label, each sample was cached for export to the University of Virginia. The sample collection strategy that I employed in Tanzania allowed for the greatest number of options available for the subsample that I selected for each site. Upon return to the University of Virginia I evaluated the 1,600 phytolith samples that I had collected in the context of my question. In this way, the questions and research goals determined the 300-phytolith sub-sample.

Phytolith Extraction from Soil Samples

I spent the summer of 2010 learning the techniques of phytolith extraction, slide preparation, and analysis in Dr. Pearsall's paleoethnobotanical laboratory at the University of Missouri. I worked alongside Chuck Arrington to create a similar laboratory arrangement in a chemistry lab at the University of Virginia. The result was a state-of-the-field laboratory space wherein I was able to replicate the chemical and mechanical flotation techniques that I learned from Pearsall; the

step-by-step methodologies are available in Appendix 2. I took some time to regain comfort in the chemical methodologies and acquaint myself with the particular characters of the lab equipment in Charlottesville. For this reason, I processed about eight samples every five days for the first few months. Once comfortable, I was able to process 20 samples every 7 days (though I could not access laboratory space on weekends). In all, I completed the phytolith extraction process over the course of 14 months, from December 2012 through February 2014.



Figure 3.8: STP after phytolith samples were removed from northern profile. This particular STP was excavated in Mikindani Bay

Phytolith Microscopy

As with extraction methodologies, I base the phytolith microscopy methods on techniques learned from Dr. Pearsall. I mounted the dry phytolith residues on glass slides with warm Canada balsam tree sap. The tree sap is an ideal mounting medium because it allows for a bit of play when exposed to heat. The 400x light microscope commonly used for phytolith analysis emits large amounts of heat; the heat, in turn, allows for the analyst to manipulate samples and gain three-dimensional perspectives of silica bodies. Such perspectives permit accurate identification of particular morphologies. I used a Fisher Scientific Compound Upright microscope from the Education University 1000 series to analyze each of the phytolith samples (Figure 3.9).

The discussion of phytolith morphologies expected from Swahili contexts that I presented earlier in this chapter informed the microscope analyses. I scanned each sample for 400 individual phytoliths and recorded the morphology of each body as they were encountered. I recorded the raw counts of the 13 potential morphologies on sample sheets and relied on a tally counter to know when I had identified 400 individual silica bodies.

Phytolith Interpretation

I approached the raw morphotype counts that derived from phytolith microscopy in two complementary ways: through the eye test of plant family ratios (Piperno 2006; Pearsall 2009) and vegetation index models (Twiss 1987, 1992; Alexandre et al. 1997; Barboni et al. 1999; Bremond et al. 2008; Barboni & Bremond 2009). The



Figure 3.9: Microscope analysis laboratory arrangement

ratio-based eye-test evaluations of plant community representation give an impression of plant community coverage in particular archaeological contexts.

Unfortunately, it is basically impossible to draw sensible conclusions between such ratios and specific vegetation cover without species-level identification of plant types recorded within archaeological phytolith assemblages (Sulas, pers. comm. 2014). Ratios are difficult to interpret because grasses, woody plants, and monocots metabolize varied levels of water, accumulate silica at different rates, and persist through a variety of lifecycles (Lambers et al. 2008). Such activities cause phytoliths

from each plant type to enter the archaeological record at unequal rates and in unequal proportions (Piperno 2006; Pearsall 2009). The most useful application of plant subfamily ratio data is to compare them with palaeoclimatic data and propose a model of vegetation cover (Sulas 2010; Sulas & Madella 2012; Sulas pers. comm., 2014). I describe results of this strategy in subsequent chapters.

I used vegetation index models to try and ascertain the vegetation signals recorded in raw phytolith counts from my samples. The application of phytolith index models stems from the desire among environmental scientists and botanists to replace a reliance on global vegetation models on local or regional scales (Prentice et al. 1992; Haxeltine & Prentice 1996; Sitch et al. 2003). Twiss (1987, 1992) first proposed that phytolith counts could be used to approximate the coverage of C3 versus C4 grasses. These grasses rely on two different photosynthetic pathways to synthesize sugar: one fixes a three-carbon sugar and the other a four-carbon sugar (Lambers et al. 2008). The photosynthetic pathways influence rates of water consumption; C4 is the more efficient approach and provides greater fitness for arid or warm conditions. Researchers typically assume such factors derive from climatic conditions; it follows that the index that evaluates the prevalence of C3 to C4 grasses is called the Climatic Index (Twiss 1987, 1992; Fredlund & Tieszen 1994; Barboni et al. 1999; Bremond et al. 2005).

Twiss (1987, 1992) defined the Climatic Index to estimate the relative proportion of C3 grasses present in Great Plains of America. The Climatic Index is calculated through the following equation:

Pooid types / (Pooid + Chloridoid + Panicoid types)

High Climatic Index values suggest an abundance of Pooideae subfamily grasses.

This, in turn, suggests an abundance of C3 type grasses. An abundance of C3Pooideae grasses is expected from high altitudes in the tropics (Tieszen et al. 1979;
Livingstone & Clayton 1980) or high altitudes (Twiss 1992). For this reason, high
Climatic Index values are taken to represent cool climates (Barboni et al. 2007). In
the same way, low Climatic Index values are taken to represent warm climates.

The bias towards the climate's role in determining the presence or absence of C3-Pooideae or C-4 Panicoideae grasses causes researchers to overlook the active role that humans can have in the creation of environmental conditions. For this reason, the analyses that I offer represent a new direction in the phytolith-based interpretation of grass coverage. Studies that address the grazing patterns of domestic ungulates-cattle (Doumont et al. 1995; Distel et al. 1995; Ganskopp et al. 1997; Boland et al. 2011) and sheep or goats (Parsons et al. 1994; Illius et al. 1999) demonstrate that the animals are able to subsist on either C3-Pooid or C4-Panicoid subfamily grasses (Hartley 1950; Cooper 1970). Despite the dexterity, these same studies suggest that these domestic animals seem to prefer stands of C3-Pooideae grasses, if available. With this preference in mind, I assume that the introduction of domestic animals to coastal areas of Eastern Africa may have caused agropastoral people to target areas where C3-Pooideae grasses were available. Alternatively, agropastoral populations may have promoted the colonization of coastal environments by C3-Pooideae grasses.

It is important to note that Iron Age populations were agropastoral. The agriculture that helped to support coastal villages established at AD 600 relied

exclusively on African species of grains (Wright 1993; Walshaw 2005; Pawlowicz 2011). Domestic African grains were exclusively members of the Panicoideae subfamily of grasses. For this reason, I view a steep increase in C4-Panicoideae subfamily grasses as potential evidence of agriculture. To wit, I consider both climatologic and anthropogenic influences in order to evaluate the grass composition levels of Climatic Index values apparent through time and space.

I also calculate the Density of Woody Plant Index as a way to reconstruct the type of vegetation coverage that had existed in the archaeological contexts.

Alexandre et al. (1997) were the first to apply the Density of Woody Plant Index;

Bremond et al. (2005a) successfully calibrated this index to forest-savanna type plant communities in Cameroon. The index is calculated by the following equation:

Granular types/ Poaceae types

While this formula has proven to be an effective tool in parts of Africa (Barboni et al. 1999; Barboni & Bremond 2008; Sulas 2010), the efficacy of calibration and interpretation for Eastern Africa is not yet universally accepted (Bremond et al. 2008). Subsequent research should make such interpretation viable. For this reason, I elect to report, but not rely on or otherwise interpret, values from the Density of Woody Plant Index.

Concluding Remarks Regarding Paleoethnobotany and Phytolith Analysis

This chapter has addressed paleoethnobotanical approaches to environmental archaeology writ-large and how such perspectives apply to Eastern Africa. I introduced opal-silica microfossil phytoliths as the class of ecofact through

which I reconstruct botanical communities through time and space in three distinct regions. The chapter also addressed the types of silica body shapes that I searched for during analysis as well as the plant community implications of particular morphologies. Finally, I presented the research methodologies that undergird the data collection, preparation, and interpretation that motivate the data presentation, results, and discussion in Chapters Four, Five, and Six. With this in mind, I now move the discussion to site-specific phytolith expectations, results, and interpretations.

Chapter Four

Songo Mnara Island: An Anthropogenic Landscape in the Kilwa Region

Songo Mnara is a nearshore island of roughly 30 sq. km in the Kilwa region of southern Tanzania (Figure 4.1, 4.2). The island bears evidence of two episodes of occupation: a fully urban community and associated hinterland active between the fourteenth and sixteenth centuries AD; and, a small agricultural village that was founded in the nineteenth century AD and persists through the contemporary period. The research presented in this chapter provides evidence that supports the assumption that these two episodes of occupation fundamentally altered the landscapes of Songo Mnara Island. Further, data derived in this research demonstrate that the varied settlement, socio-political, and economic structures expressed by these distinct populations have produced unique, definable ecological changes. I performed a paleoethnobotanical survey of the island to recover microbotanical, archaeological, geological, and species composition data necessary to support this assumption. The information reported in this investigation of Songo Mnara offers evidence to evaluate research questions specific to the region:

- What was the provenience of subsistence resources that supported the urban community on Songo Mnara Island?
 - Is there microbotanical evidence of food production within the island, or does the phytolith record suggest that the urban center imported subsistence resources from continental resources?
- What strategies did fourteenth-to sixteenth-century inhabitants use to meet the extensive woodfuel demand associated with the construction of stonebuilt architecture, iron smelting, and food production?

- Anthropogenic influences associated with urbanism are typically thought to degrade local environments; did such degradation occur on Songo Mnara Island?
 - If so, did this human-induced degradation contribute to the rapid abandonment of the urban settlement in the sixteenth century?
 - If not, do the phytolith residues record evidence of conservation or fertilization strategies imposed between 1300 and 1500?

Researchers gloss archaeological settlements across the region with the name of the island upon which they were situated (i.e., Songo Mnara Island hosted Songo Mnara stonetown). The Kilwa region supported at least five complementary communities during the 1,500-year history of continuous human occupation (Gray 1951, 1952; Chittick 1961, 1963, 1974; Wynne-Jones 2005, 2007). I describe these communities as complementary because they shared a general material culture but did not require any community to sacrifice social independence or economic autonomy. In this way, the Kilwa region supports Allen's (1993: 13) notion of miji (sing. *mji*). Archaeological evidence from the paleoethnobotanical survey that I performed beyond the urban center of Songo Mnara aligned with those from the fourteenth to sixteenth centuries reported across the region. Such overlap informs the assumption that populations who colonized Songo Mnara arrived on the island from the broader Kilwa region. In an attempt to better understand the phytolithbased landscape reconstructions that I present in this chapter, I first present relevant archaeological, historical, and environmental information known for Songo Mnara Island and the Kilwa region in general.

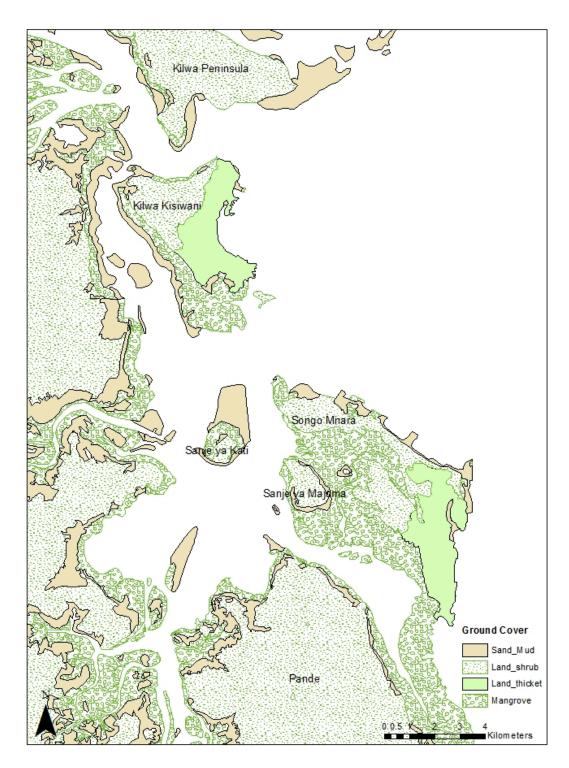


Figure 4.1: The Kilwa region of southern Tanzania. Note the presence of Songo Mnara Island, Kilwa Kisiwani, Sanje ya Majoma, Sanje ya Kati, and the Kilwa peninsula

Songo Mnara Island

The fourteenth- to sixteenth-century urban settlement Songo Mnara demonstrates a level of preservation that is not available in other coastal contexts from Eastern Africa (Figure 4.3) (Kirkman 1964; Garlake1966; Pradines & Blanchard 2005; Pradines 2009). Excavation within and between stone structures revealed sediment profiles with "little vertical complexity" (Fleisher & Wynne-Jones 2010: 2). The lack of vertical complexity permitted a direct association between material remains and fourteenth-to sixteenth-century habitation.

Contemporary populations encounter the stone architecture of this abandoned settlement as they travel from the small port at the fishing village Sanga Rungu to their farms or pastures. Evidence of anthropogenic influences cover the island, yet the archaeological component of my paleoethnobotanical survey indicates that architecture has been restricted to the southern half of the island since the nineteenth century (Stoetzel 2011). The archaeological survey also extended the notion of limited stratigraphic complexity as far as 3 km outside the urban center. I typically recovered artifacts in geologic contexts that were slightly darker than surface fill; the diagnostic nature of these materials allowed me to interpret such darker strata as indicative of fourteenth- to sixteenth-century AD contexts. I also maintained this interpretation in contexts that did not yield material residues.

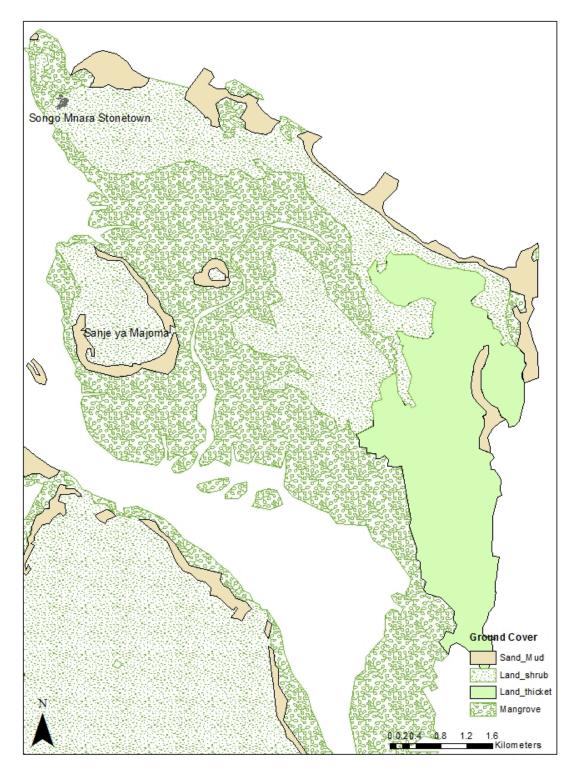


Figure 4.2: Songo Mnara Island. Note the location of the urban center on the northeastern tip of the island

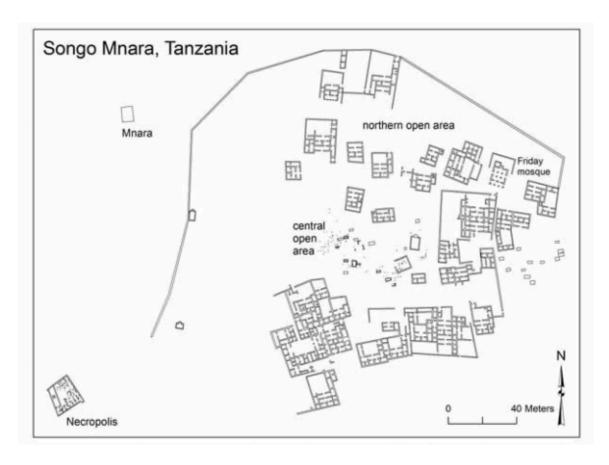


Figure 4.3: Stonetown of Songo Mnara, Tanzania. From Fleisher and Wynne-Jones (2010: 8)

Material Remains From Stone-Built Spaces of Songo Mnara

Pioneering Swahili populations founded a fully urban settlement in the northeastern corner of Songo Mnara Island sometime after 1300. Figure 4.3 illustrates that the earliest architects on the island devised a town plan to structure the built and open areas; a stone wall demarcated the boundaries of this town plan. More than 40 domestic room-blocks, five mosques, and numerous tombs constitute the permanent architecture of this urban community, all of which were abandoned no later than the sixteenth century AD (Kirkman 1964; Garlake 1966; Horton 1991). Pollard et al. (2012) expand the scope of permanent architecture to include

intertidal causeways lining the eastern shoreline of the island. In this section I provide an overview of the lifeways identified within permanent contexts, and identify potential impacts such lifeways may have had on local ecologies.

Archaeological investigations inside the urban contexts of Songo Mnara Island revealed a general domestic economy that included the preparation of domestic grains, cotton thread production, and iron smithing (Fleisher & Wynne-Jones 2012, 2013; Sulas 2010; Walshaw 2010; 2013). Excavation units consistently yielded such material residues, regardless of domestic block or ornamentation of any particular structure. The presence of local ceramics and *jiko* [ceramic oven] fragments, as well as bone and charcoal in domestic contexts suggests that urban residents prepared food on a household (Fleisher & Wynne-Jones 2010, 2013). Domestic contexts bore microbotanical and macrobotanical evidence of edible plant parts (Walshaw 2010, 2013; Sulas & Madella 2012); inedible parts of plants, namely rice rachillae, were also recovered in these domestic contexts (Walshaw pers. comm., 2014). Local ceramics reiterate the household approach to domestic economies, as the decorative motifs apparent on such ceramics varied between domestic structures (Babatunde & Fleisher 2010).

Sulas and Madella's (2012) micromorphologic analyses captured phytolith evidence of grass-covered landscapes in open areas of the Songo Mnara stonetown. The assemblage was composed almost exclusively of grass leaves and culm morphotypes; the researchers interpret this as potential evidence of animal dung or use of grass fodder in the area. Combined with patches of organic-rich, silt sandy

loam, these grass-leaf phytoliths may document the presence of stabulation in open spaces of the urban settlement (2012: 155).

Analyses suggest that domestic economies also included the production of goods for export. These goods include cotton thread, apparent through the recovery of cottonseeds and spindle whorls (Walshaw 2010, 2013), as well as iron. Worked iron was recovered in domestic and open spaces throughout the urban area; iron deposits typically, but not universally, were associated with high levels of charcoal (Fleisher & Wynne-Jones 2010, 2013). Residents of Songo Mnara exchanged these goods, along with resources obtained from continental Eastern Africa, with merchants from across the Indian Ocean in order to obtain exotic ceramics, fragrant oils, beads, and other such objects. By creating cotton and locally-smithed iron, residents of Songo Mnara altered plant communities to create, or at least further, opportunities for personal economic growth.

These populations also inscribed personal wealth into their landscapes through the construction of stone mosques, tombs, and domestic structures. Exotic ceramics were built directly into the ceilings of domestic structures, uncovered in a *birika* [wash area] of a central mosque, and recorded on a tomb by an early-twentieth century traveler (Dorman 1938); this process literally imbued the stone structures with wealth. Figure 4.4 presents an example of such architecture; in this case, an intact barrel-vaulted room in an expansive room-block contained 121 small, glazed bowls. Thousands of glass beads, copper jewelry, and Kilwa-type coins represent the other exotic materials recovered at Songo Mnara (Walker 1936; Perkins et al. 2014).

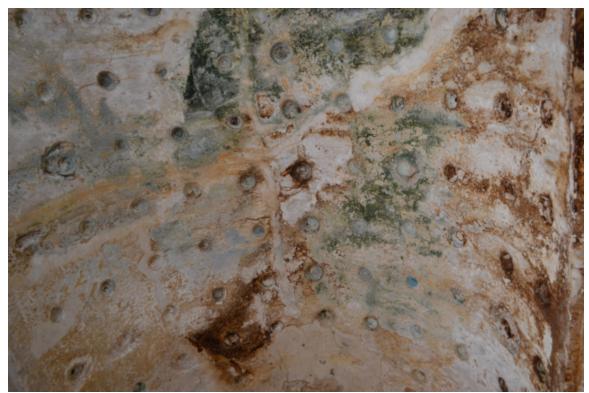


Figure 4.4: Intact barrel-vaulted room in stonetown of Songo Mnara. Each indentation held, or continues to hold, an imported ceramic vessel

Exotic ceramics account for less than 1% of the ceramics recovered within the urban settlement, a low level for a stonetown of this caliber. Peer communities were known to have import percentages between 2% and 6% (Horton & Middleton 2000). I interpret this low representation as evidence of, among other things, extensive local ceramic production; again, such production occurred on the household levels and would have led to the consumption of high levels of woodfuel.

Stone-built architecture relied on quicklime, a malleable medium with a smooth finish (Semple 2007), as a mortar to bind blocks of fossil corals together to create the "stone" architecture referred to above (Garlake 1966). Quicklime is created through a process in which fossil-coral-derived limestone fragments reach temperatures between 800-900°C for upwards of ten hours (Kingery et al. 1988;

Karkansas 2007; Sulas & Madella 2012). For this reason, I assumed that the high volume of stone construction apparent at Songo Mnara taxed local woodfuel resources between AD 1300 and 1500. Phytolith analyses presented here challenge this assumption.

Material Remains from Impermanent Architecture

Survey conducted in open spaces within and beyond the town wall indicates that stone-built architecture was not the exclusive domain of domestic economies on this island. Fleisher and Wynne-Jones (2010, 2013) investigated circular arrays of iron-rich soils noted in geophysical surveys of the urban communities; excavation of these anomalies produced daub and a range of artifacts that closely matched those recovered in stone-built spaces (Welham et al. 2014). Material overlap apparent between the permanent and impermanent contexts suggests that some of these wattle-and-daub structures hosted domestic activities (Fleisher 2014). The investigation of impermanent architecture in urban contexts of Songo Mnara is ongoing; for this reason, further information regarding these contexts will be available in the future.

The paleoethnobotanical survey recovered a limited number of diagnostic artifacts, namely local ceramics, from fourteenth- to sixteenth-century contexts outside the town wall (Stoetzel 2011). Most all of the survey units that yielded more than five artifacts were located within 3 km of the urban center. As Figure 4.6 illustrates, these artifact-rich locations spread away from the urban context to the south and east, tapering out once the easily navigable "shrub" landscapes narrow.

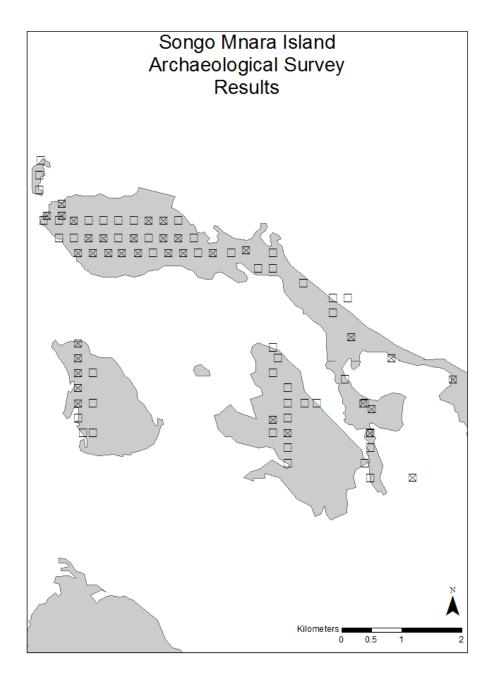


Figure 4.5: Songo Mnara Island archaeological survey results. X denotes artifacts found in the STP

The spatial distribution of chronologically related artifacts across the island suggests that human actions spilled upwards of 3 km away from the urban center. Further, human action beyond the town wall ceased in tandem with the abandonment of Songo Mnara. Research into the non-urban contexts is ongoing, as Pawlowicz performed a more extensive survey of the island in 2013 (M. Pawlowicz, pers. comm. 2013).

I assume that residents of earth-and-thatch communities would have increased the harvest of wood resources. This assumption derives from the fact that these communities consumed similar levels of wood as fuel to prepare food and fire ceramics, two factors which would have amplified the demand on woodfuel resources assumed to have existed on the island. Though impermanent architecture did not require wood-as-fuel, the earth-and-thatch structures did require the harvest of particular wood resources. Prins (1961), LaViolette & Fleisher (1999), and Insoll (2003) all document the construction processes which residents of Eastern Africa follow to create domestic architecture.

The notion of increased consumption could also be applied to agricultural resources. While macrobotanical investigations were not performed beyond the town wall, I use the material overlap between permanent and impermanent contexts to motivate the assumption that residents of earth-and-thatch structures maintained a similar subsistence economy. As I discuss below in subsequent sections, this phytolith-based analysis suggests that such subsistence resources were produced in locally available contexts.

Lifeways of the Kilwa Region

The arrangement of stone-built architecture and open spaces apparent at Songo Mnara suggests that town architects organized their community in a particular manner. This type of intentionality suggests a degree of comfort with stone-built architecture, a comfort that likely resulted from direct experience with the architectural medium. A look at pre-fourteenth-century communities in the Kilwa region indicates that such experience had been readily available, as stone-built communities were constructed at Kilwa Kisiwani and Sanje ya Kati in the centuries that preceded the colonization of Songo Mnara Island.

Island Lifeways of Kilwa Region, AD 300 to 1600

Songo Mnara was one of three urban areas active in the Kilwa region between the fourteenth and sixteenth centuries AD. Sanje ya Majoma was a smaller stone-built community on an island directly adjacent, and likely related, to Songo Mnara. At this point, little research has been conducted at this settlement (Moon 2005; Pradines 2008, 2009; Stoetzel 2011). The same cannot be said of the urban community at Kilwa Kisiwani. Kilwa Kisiwani was considered the "Jewel of the Swahili coast" by AD 1300 (Chittick 1974: 4). Travelers gave Kilwa Kisiwani this designation roughly a century after residents of the stonetown became the primary entrepôt that connected gold from continental Africa with the Indian Ocean commercial system (Kusimba 1999; Horton & Middleton 2000). Prior to economic prominence, Kilwa Kisiwani had been occupied continuously since the early first

millennium. For this reason, communities on this island present an opportunity to trace the socioeconomic trajectory of the region.

Residents of Kilwa Kisiwani converted wealth from the gold trade into five stone-built mosques, 25 stone domestic structures, and an array of exotic materials between AD 1200 and 1500 (Chittick 1974). Material wealth included ceramics and glass delivered from across the Indian Ocean, a monetary system predicated on locally minted copper coins, and a huge amount of local ceramics. While impressive, the lists of materials and number of structures do not adequately capture the opulence of this community. For this reason, I include floor plans of the four largest structures built in this period. Taken together, the Great Mosque (Figure 4.7), Great House (Figure 4.8), Husuni Kubwa (4.9), and intertidal causeways created in these centuries elevated Kilwa Kisiwani to the level of must-see destination for historic travelers (Ibn Battuta et al. 1958; de Almeida 1974; Dunn 2012). This wealth also made Kilwa Kisiwani a target for imperial economic intervention, a phenomenon that occurred early in the sixteenth century.

Kilwa Kisiwani had been a secondary or tertiary mercantile outlet on the southern coast of Tanzania in the centuries that preceded the thirteenth- to sixteenth-century economic fluorescence (Chittick 1968, 1974). By 800, residents of this island had forged economic ties with merchants from across the Indian Ocean to exchange textiles, bronze, mangrove poles, and iron goods for ceramics from the Persian Gulf, Chinese porcelain, and glass from South Asia (Chittick 1974; Freeman-Grenville 1973, 1988; Freeman-Grenville et al. 2006). Long-distance economic

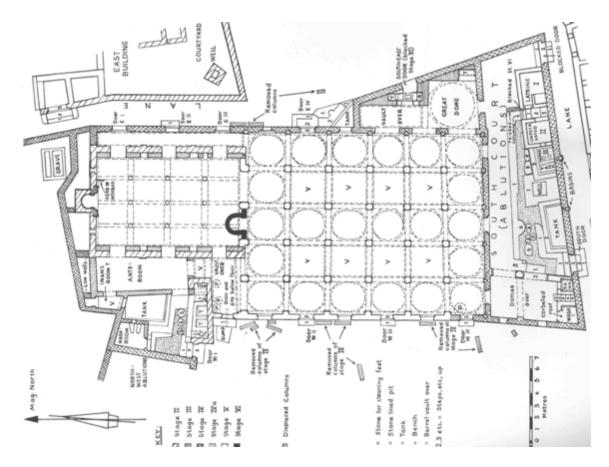


Figure 4.6: Great Mosque of Kilwa Kisiwani, from Chittick (1974)

connections acted to differentiate people in the urban settlement from neighboring peninsular communities. It was during this time that residents of Kilwa Kisiwani first began to practice Islam and also experiment with permanent architecture. Sometime before AD 1000 residents erected a stone mosque atop a wooden Islamic prayer hall (Chittick 1974). The permanent structure facilitated further social differentiation between island and peninsula, as Islam became the dominant religion on the island by AD 1100 (Freeman-Grenville 1958, 1965; Chittick 1963, 1968). Shortly after 1100, a group of people founded a satellite settlement on Sanje ya Kati Island (Moon 2005). Sanje ya Kati featured stone-built architecture and a

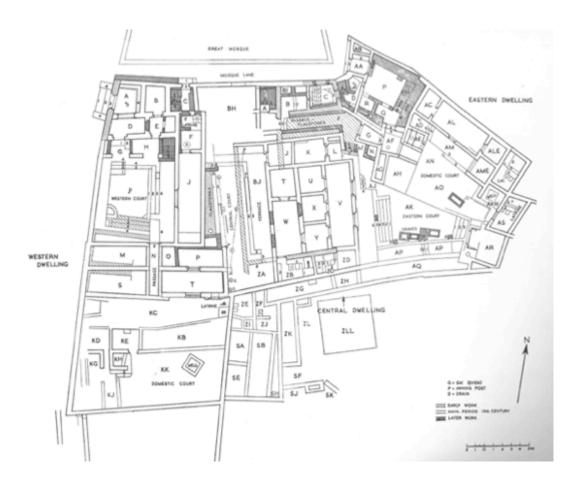


Figure 4.7: Great House of Kilwa Kisiwani, from Chittick (1974)

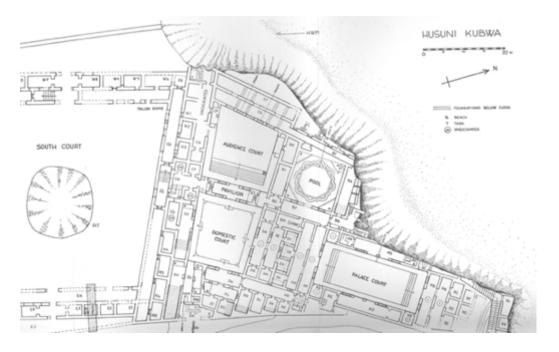


Figure 4.8: Husuni Kubwa from Kilwa Kisiwani, from Chittick (1974)

material culture similar to that of Kilwa Kisiwani; this material culture included local and exotic ceramics as well as Kilwa-type coins. The limited material culture recovered from this site aligned with exotic and local residues typical of the Kilwa region (Moon 2005). In this way, archaeological investigation of nearby island settlements suggests that people in the Kilwa region had already forged long-distance economic entanglements, adherence to Islam, and stone-built architecture prior to the colonization of Songo Mnara Island. Further, the material record indicates that the settlement at Kilwa Kisiwani represents both the initial and most opulent expression of such activities.

Early Iron Age peoples colonized Kilwa Kisiwani by AD 300; the initial residents arrived from the Kilwa peninsula and brought with them an agropastoral subsistence economy and iron-working technologies (Chittick 1974; Wynne-Jones 2005). Island geography did not lead to social differentiation until the ninth century (Chittick 1974). Iron Age villages followed Late Stone Age occupation of the island (Isaac 1971; Chami 2001). A pedestrian survey of the island conducted in conjunction with Chittick's (1974: 254) excavation recovered sandstone and quartz flakes, hand-axes, and crude scrapers. These residues pushed the chronology of Kilwa Island, and the region, back to the final centuries BC. Integration or social overlap between Late Stone Age and Iron Age populations in this area is poorly documented. For this reason, I hesitated to begin the chronology of this island or the region before AD 300.

Peninsular Lifeways of the Kilwa Region AD 300 to 1600

Material residues recovered across the Kilwa peninsula contribute to the understanding of ecological resource exploitation (i.e., explicit soil use or woodfuel harvest) expected in island contexts. Residues from peninsular contexts also add support to the argument that such strategies of resource consumption derive from Early Iron Age populations, as opposed to Stone Age groups. According to previous archaeological and macrobotanical investigations, technologies introduced at this time included iron agricultural implements. African-derived cultivates, iron-working technologies, and unique expressions of earth-and-thatch architecture (Chami 1998; Wynne-Jones 2005). Peninsular residents situated earth-and-thatch communities atop fertile soils and met their subsistence requirements through a combination of shifting agriculture, pastoralism, and the collection of marine resources (Chittick 1974; Wynne-Jones 2005). Archaeological survey of estimates village communities moved across the region on a generation scale (Wynne-Jones 2005); movement permitted renewed access to fresh, fertile soils. The generational timeframe met expectations from experimental archaeological investigation of earth-and-thatch duration (LaViolette & Fleisher 1999). Further, the generational timescale can also help to explain evidence of ecological niche exploration apparent in late-first millennium contexts (Wynne-Jones 2005: 105). The desire to engage with fresh landscapes could have pushed peninsular peoples towards hilltop, plateau, valley, and coastal contexts.

The average settlement size on the peninsula prior to AD 800 was < 1 ha; between AD 800 and 1000 the average size grew to > 3 ha (Wynne-Jones 2005: 100-

109). While settlement size and distribution changed with time, material evidence recovered in peer communities indicates continuous overlap between cultural materials and economic pursuits. This overlap, in turn, implied a diachronic cultural continuity that linked settlements through time in the peninsula and, after AD 800, adjacent islands (Chittick 1974; Wynne-Jones 2005; Pollard 2008). Decorative motifs and vessel forms apparent in local ceramics, including Kwale wares, provide the most convincing evidence of social overlap (Chittick 1974; Wynne-Jones 2005: 101-102; Chami 2006). This evidence indicates that agropastoral communities across the Kilwa peninsula contributed to region-wide exchange spheres.

Reliance on a mixed-agricultural economy persisted throughout the Kilwa peninsula through AD 1600 (Chittick 1974; Wynne-Jones 2005; Pollard 2008). Long-term habitation necessitated episodic reoccupation of particular areas; evidence of permanent settlements was also recorded in several areas of the peninsula after the early-second millennium (Wynne-Jones 2005: 107).

The discussion of peninsular lifeways roots agropastoral subsistence strategies expressed across the Kilwa region to Iron Age communities that arrived in the early- to mid-first millennium. Further, the discussion connects agropastoralism with earth-and-thatch communities. Again, evidence of such communities was apparent within and beyond the stone walls of Songo Mnara. For this reason, I expect the phytolith-based landscape reconstructions to capture evidence of food production on this island. Such evidence would call into question the long-held assumption that peninsular communities exported grains to island-bound urban peoples between AD 1100 and 1500 (Kusimba 1999; Horton &

Middleton 2000). While these communities were clearly interconnected, material correspondence suggests that the relationship to be one of a shared social trajectory rather than one of subsistence exploitation (Wynne-Jones 2005). The common social trajectory was apparent in architectural strategies (stone-built and earth-and-thatch), religion, agropastoral subsistence strategies, and domestic or long-distance economies.

Soils of the Kilwa Region

Socioeconomic strategies from Songo Mnara and the Kilwa region highlight the ways in which local lifeways may have interacted with local geologies. As I report, results from this project offer new insight into soils that covered Songo Mnara. Such insight contributes to a more nuanced appreciation of intentionality in soil exploitation for agriculture and architecture. For this reason, I introduce the geological contexts from which local residents derived subsistence and architectural needs.

The geological information that I present adds an additional degree of detail to existing surveys published by colonial explorers and groups searching for natural gas deposits (Bornhardt 1900; Scholtz 1911; Oppenheim 1916; Nicholas et al. 2006). I trekked through each of the satellite-image-based approximations of geologies and modern vegetation cover reported in Nicholas et al. (2007) (see Figure 4.2). By engaging directly with these landscapes I was able to validate Nicholas et al.'s report and document the ways in which contemporary peoples engaged with such geologies (Figure 4.10).

Geological Processes that Culminate in Soils with Social Functions

The contemporary arrangement of nearshore islands surrounding the Kilwa peninsula is the result of tectonic activity that began 65 million years ago (Ma) and ended roughly 6 Ma (Kent et al. 1971; Geiger et al. 2004). The episode of marine faulting that occurred at 65 Ma inundated what would become the Kilwa region (Nicholas et al. 2006, 2007). The submerged "passive margin" remained tectonically dormant for over 40 million years. Inundation resulted in the deposition of at least a kilometer of clay substrate atop the region (Berrocoso et al. 2010).

Clay deposits constitute the Kilwa Group, a geological formation that consists of a four-tiered set of clay-dominated geological formations. Compressional strike- slip tectonic activity has complicated the vertical stratigraphy of the Kilwa group since 6 Ma. The resulting chronologic and lithostratigraphic arrangements include the Nangurukuru (86-66 Ma), Kivinje (66-47 Ma), Masoko (47-38 Ma), and Pande (38-28 Ma) formations. Table 4.1 reports lithic characters of each Kilwa Group formation (Nicholas et al. 2006); the "Principal Lithology" column is the most important here as the reported qualities represent units against which I compare soils of Songo Mnara in the following analyses.

Nicholas et al. (2007) recorded two additional varieties of geologic outcrops for the Kilwa region: the Mikindani Beds (12-6 Ma) and unconsolidated sands that were formed no later than 180,000 years ago. Tropical weathering processes freed clays and sands up to 20 m below the surface across the Kilwa peninsula (Pearson et al. 2004); such weathering was untenable at Songo Mnara due to the relatively

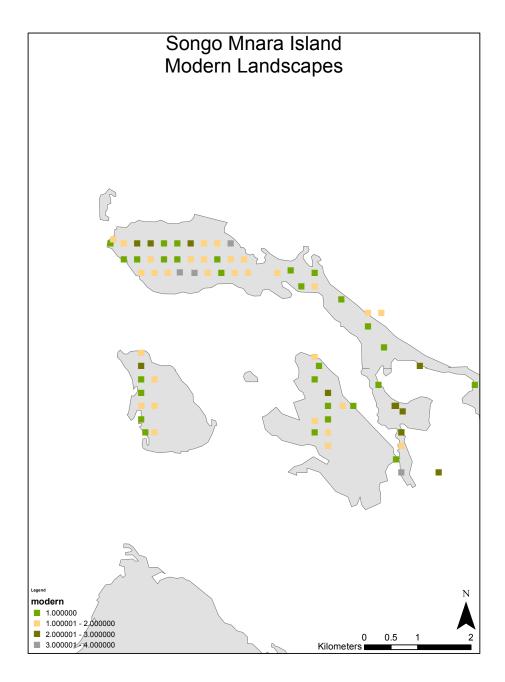


Figure 4.9: Modern uses for the landscapes of Songo Mnara. Green= grassland; Yellow= agriculture; Dark green= dense scrubland; Grey= sand cover

informal group subdivision	age range	Formation	principal lithology (weathered colour)	marker horizons (in chronological order)	characteristic secondary lithologies and facies associations (not necessarily in chronological order)
UPPER	Late Eocene to Early Oligocene	PANDE	soft light olive grey or blue-grey clays mottled with yellowish orange sandy clay	silty/sandy partings	Plant fragments are common throughout; repetitive silty/fine sandy partings come on towards the top White to cream micritic limestones and/or calcarenites are typical, often packed with assorted benthic foraminifera (<1cm in diameter) These limestones are mostly debris flow beds also containing clay rip-up clasts, micritic balls and showing liquifaction, but not graded bedding
	Middle	MASOKO	soft light olive grey clays mottled with yellowish orange	upper benthic foraminiferal limestones	Massive, orange-brown weathering, benthic foraminiferal coquinas, typically dominated by large Nummulites up to 3cm in diameter These limestones are cemented by sparry calcite and often contain well rounded coarse quartz grains Most limestones demonstrate sedimentary structures associated with deposition from a
	Late Paleocene to Early Eocene	KIVINJE	hard/blocky olive grey claystones mottled with yellowish orange sandy clay	Theef is common throughout	turbulent flow; with grading, imbrication and cross-lamination in the foraminifera Sandy partings are common throughout, occasionally developing into thin, partly cemented, calcarenites containing fine quartz sand and a subordinate clay matrix These calcarenites typically contain small benthic foraminifera or biogenic carbonate may be absent A series of massive, orange brown weathering sandy calcarenites are present at the base of the formation at Mpara Hill and the Mkazambo road,
LOWER	Late Cretaceous Santonian to Late Maastrichtian	NANGURUKURU	hard/blocky olive grey claystones mottled with yellowish orange sandy clay	inoceramid beds white sands limonitic sand marker bioturbated turbiditic sandstones	with graded benthic foraminifera & shell debris At least two horizons at the top of this formation yielding abundant inoceramid fragments An interval of repetitive, thin, white to limonitic, unconsolidated sand beds occurs in Maastrichtian below the inoceramid beds A ∼5 m thick, unconsolidated, laterally continuous limonitic sand marker horizon is present in the Upper Campanian with <i>Thalassinoides</i> burrows Throughout this formation sporadic, massive, 10-50cm turbiditic, carbonate cemented, quartz sandstones occur, weathering to an orange-brown Below the Maastrichtian, these sandstones possess characteristic, intensely grazed tops, burrowed / fluted bases and <i>Nereites</i> ichnofacies

Table 4.1: Kilwa Group geologic formation. From Nicholas et al. (2007)

shallow depth of coral rag deposits. Weathering of Mikindani Beds largely resulted in the creation of lateritic soils across the region (McFarlane 1991; Nicholas et al. 2007).

The geological survey of Songo Mnara demonstrates that the Kilwa region is best interpreted as an "Eemian marine platform that has subsequently been

uplifted, with 'Mikindani Beds' as caps to topographic highs potentially having been small islands during the Pleistocene" (Nicholas et al. 2007: 278). The 80,000-year-old Eemian platform overlays or abuts Kilwa Formation clays that are many millions of years older.

Lateritic Mikindani beds cap the topographic peaks throughout the Kilwa region. Fine to coarse, unconsolidated, white or buff sands cover the low-lying areas that exist between the elevated areas. Such sands are often associated with patches of small, isolated fossil reefs that were formed no more than 680,000 years before present (Nicholas et al. 2006, 2007). The surface of Songo Mnara demonstrates the presence of Kilwa formations, Mikindani beds, and patches of sand that derive from degraded fossil reefs.

The preceding discussion demonstrates the manner through which an interplay between social pressures and geologic processes coalesce to create the substrates available throughout Songo Mnara Island. Social actions conducted during both periods of occupation have clearly altered the chemical properties of soils through manual removal of substrates (e.g., to meet architectural demands), the addition of nitrogen from domestic animal excretions, and the removal of nitrogen, potassium, and phosphorus associated with agriculture. My geological survey of Songo Mnara identifies areas that were likely targets for particular socioeconomic use and that continue to be used by modern populations.

Survey of Songo Mnara Island: Paleoethnobotanical, Geological, and Archaeological Results

I conducted the paleoethnobotanical survey of Songo Mnara Island as part of the 2011 field season of the ongoing project overseen by Fleisher and Wynne-Jones. The logistics of this island required that we, upwards of 20 archaeologists and students from the U.S. and U.K., camp on-site. I worked alongside two residents of Songo Mnara Island, Selemani Saffi and Selemani Masoudi. Together, we excavated shovel test pits (STPs) in 250 m intervals; this strategy allowed us to excavate 84 STPs across the island. We terminated each STP by cleaning the north profile and removing debris from the bottom of the unit; I then removed 20 g phytolith samples in 10 cm intervals from the cleaned profile of the unit. This strategy yielded 376 samples. We noticed a trend in the profiles and artifact distribution in these excavation units in that artifacts typically derived from a similar set of geologic strata. This trend allowed me to derive relative dates based on artifacts and strata; the chronology defined three distinct time periods in each STP. We collected phytoliths from basal levels to represent pre-fourteenth-century contexts as these strata did not yield any material residues and underlay artifact-rich contexts. Strata that yielded artifacts were typically slightly darker than basal or uppermost layers. Diagnostic materials from the middle contexts suggest that this darker context was a buried anthropogenic horizon created between the fourteenth and sixteenth centuries. Finally, we collected soil samples immediately below the topsoil, 10 cm below surface, in each STP. I take these strata to represent post-sixteenth-century contexts.

recovered at Songo Mnara Island. The subsample included STPs located within three km of the urban center, again, these units were the most artifact-rich encountered in the island. Further, I included only one sample from each chronological strata. This subsampling strategy resulted in the analysis of 70 phytolith samples recovered in 27 locations (Figure 4.11). I present the results of this analysis on a transect-by-transect basis. Table 4.2 and Figure 4.12 present the results from Transect 100: Table 4.3 and Figure 4.13 account for Transect 101: and finally, Table 4.4 and Figure 4.14 display results from Transect 103. I discuss the results of this research by time period, beginning with the most recent contexts. **Post-1500:** I consider 27 phytolith samples that derive from the post-abandonment era of Songo Mnara Island's history. Each of these samples bore evidence of woodyplant phytoliths, though the presence of such plants varied substantially across the survey universe. I cite substantial variation because woody-plant type phytoliths account for 0.73% of the sample from STP 22 and 51.09% of STP 9. In 11 other samples the woody-plant phytoliths account for 20-30% of identified bodies. The ratios that I cite here likely represent at least three different woody-plant communities in the survey universe. Heavily wooded locations abut those with very low levels of woody plants which, in turn, neighbor locations with moderate levels of woody plants. For this reason, I do not think there is any clear spatial patterning of these three hypothetical plant communities apparent in this context.

I reconstructed landscapes from a subsample of the entire assemblage

While I can say that the value > 1.0% almost certainly documents the presence from a grass-covered landscape, I am unable to define the types of plant communities responsible for the remaining samples. The values could represent

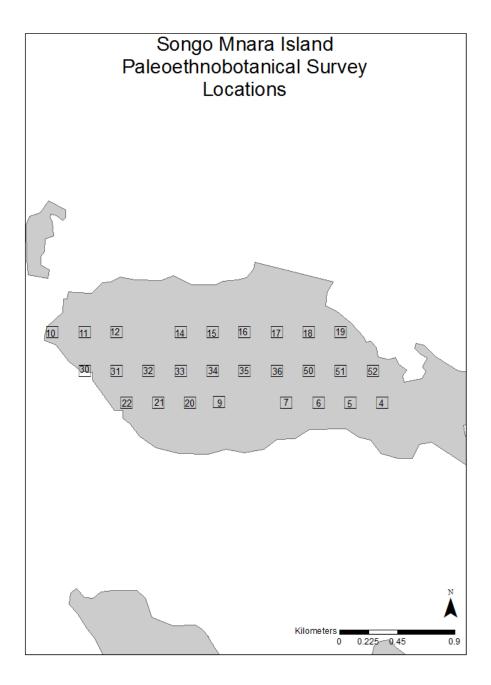


Figure 4.10: Songo Mnara paleoethnobotanical subsample. Black units indicate locations included in subsample

Sample	Transect and STP	Undifferentiate d Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody PLants	Palms	Density of Woody Plants Index	Climatic Index
112.00	100-11	158.00	150.00	80.00	0.00	87.00	0.00	0.20	0.39
114.00	100-12	125.00	152.00	11.00	1.00	142.00	0.00	0.49	0.53
125.00	100-14	172.00	132.00	8.00	0.00	75.00	0.00	0.24	0.42
139.00	100-17	92.00	81.00	109.00	0.00	124.00	0.00	0.44	0.29
149.00	100-19	136.00	20.00	134.00	0.00	113.00	0.00	0.39	0.07
102.00	100-10	79.00	155.00	28.00	10.00	133.00	0.00	0.49	0.57
113.00	100-12	31.00	116.00	23.00	0.00	226.00	40.00	1.32	0.69
121.00	100-14	179.00	184.00	24.00	0.00	9.00	0.00	0.02	0.48
132.00	100-16	138.00	69.00	104.00	0.00	153.00	0.00	0.49	0.22
138.00	100-17	178.00	53.00	100.00	0.00	87.00	0.00	0.26	0.16
142.00	100-18	86.00	63.00	116.00	0.00	131.00	0.00	0.49	0.24
147.00	100-19	99.00	208.00	19.00	0.00	67.00	0.00	0.21	0.64
101.00	100-10	102.00	185.00	22.00	0.00	85.00	18.00	0.28	0.60
106.00	100-11	142.00	105.00	77.00	0.00	111.00	0.00	0.34	0.32
112.00	100-12	183.00	66.00	160.00	0.00	7.00	3.00	0.02	0.16
127.00	100-15	140.00	83.00	190.00	0.00	34.00	0.00	0.08	0.20
131.00	100-16	191.00	95.00	51.00	0.00	101.00	0.00	0.30	0.28
134.00	100-17	274.00	65.00	37.00	0.00	90.00	0.00	0.24	0.17
141.00	100-18	137.00	20.00	107.00	0.00	210.00	0.00	0.42	0.10
146.00	100-19	130.00	142.00	26.00	3.00	80.00	0.00	0.27	0.47

Table 4.2: Raw phytolith counts by plant type, Transect 100, Songo Mnara

different types of woody-plant communities (i.e., scrubland or forest), or simply different degrees of coverage expressed by a particular woody-plant community (i.e., scrubland). I calculated Woody Plant Index values in an attempt to reconstruct the types of woody plants that likely constituted these archaeological landscapes. Unfortunately, interpretation of these calculations is unclear because the index has yet to be accurately calibrated for this region.

Though I am unable to directly identify particular woody-plant communities in the area, researchers have calibrated indexes to accurately interpret grass-community composition (Bremond et al. 2008). For this reason, I present grass

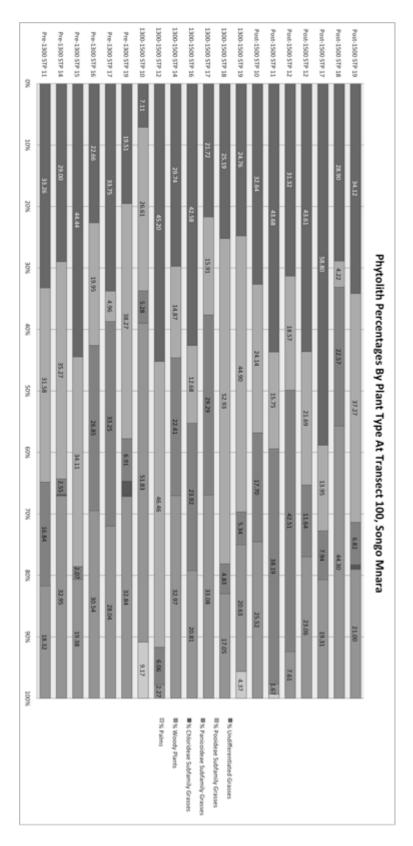


Figure 4.11: Raw phytolith counts by plant type, Transect 100, Songo Mnara

Date Range	Sample	Transect and STP	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies		cntortaeae Subfamily Grass Bodies		Palms	Density of Woody Plants Index	Climatic Index
Pre-1300	179.00	101-5	70.00	93.00	0.00	0.00	143.00	0.00	0.88	0.57
Pre-1300	184.00	101-6	183.00	163.00	0.00	0.00	55.00	0.00	0.16	0.48
Pre-1300	191a	101-7	233.00	119.00	20.00	0.00	46.00	0.00	0.12	0.32
Pre-1300	201.00	101-9	132.00	137.00	31.00	7.00	101.00	0.00	0.32	0.45
Pre-1300	4.00	101-20	165.00	138.00	0.00	0.00	128.00	0.00	0.42	0.46
Pre-1300	8.00	101-21	47.00	110.00	33.00	0.00	193.00	0.00	0.89	0.58
Pre-1300	16.00	101-22	113.00	84.00	53.00	0.00	154.00	1.00	0.62	0.34
1300-1500	175.00	101-4	107.00	159.00	56.00	0.00	81.00	0.00	0.25	0.49
1300-1500	178.00	101-5	60.00	60.00	90.00	15.00	180.00	0.00	0.80	0.27
1300-1500	189.00	101-7	108.00	193.00	37.00	0.00	63.00	0.00	0.19	0.57
1300-1500	7.00	101-21	80.00	90.00	90.00	0.00	140.00	0.00	0.54	0.35
1300-1500	14.00	101-22	105.00	127.00	70.00	0.00	103.00	0.00	0.22	0.42
Post-1500	174.00	101-4	182.00	160.00	69.00	0.00	46.00	0.00	0.11	0.39
Post-1500	177.00	101-5	188.00	12.00	0.00	0.00	198.00	22.00	0.99	0.06
Post-1500	181.00	101-6	90.00	182.00	0.00	0.00	126.00	0.00	0.46	0.67
Post-1500	187.00	101-7	35.00	120.00	145.00	0.00	110.00	0.00	0.28	0.40
Post-1500	198a	101-9	46.00	100.00	0.00	0.00	210.00	55.00	1.44	0.68
Post-1500	2.00	101-20	109.00	129.00	76.00	4.00	106.00	0.00	0.33	0.41
Post-1300	6.00	101-21	201.00	80.00	29.00	7.00	92.00	0.00	0.29	0.28
Post-1500	11.00	101-22	152.00	105.00	24.00	15.00	3.00	110.00	0.01	0.35

Table 4.3: Raw phytolith counts by plant type, Transect 101, Songo Mnara

phytolith results in terms of Climate Index values. The grass communities reconstructed from this context demonstrate a clear tendency towards C4-Panicoid grass prevalence, as 13 locations document such a situation. The remaining samples record an equal presence of mixed-grass communities and communities with C3-Pooid grass communities. While C4-Panicoid subfamily grasses are spread throughout the survey universe, they seem to follow an eastern to southeastern trajectory moving away from the urban center. This pattern loosely aligns with the modern trail that connects the fishing village Sanga Rungu with the modern community on the island.

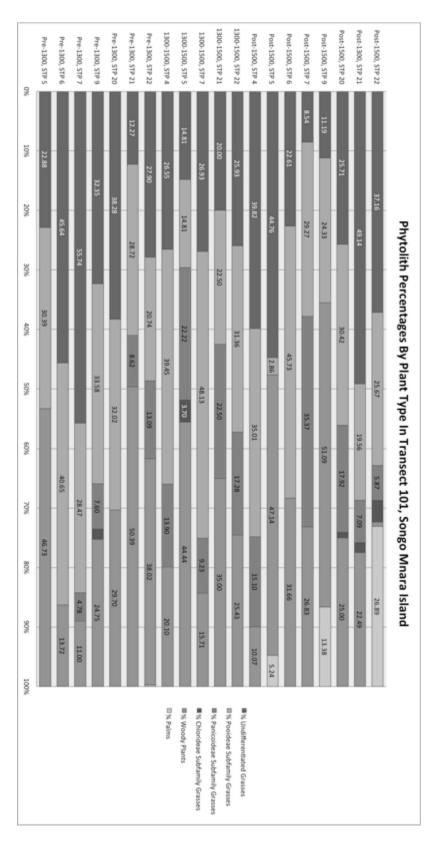


Figure 4.12: Phytolith percentages by plant type Transect 101, Songo Mnara

Date Range	Sample	Transect and STP	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plants	Palms	Density of Woody Plants Index	Climatic Index
Pre-1300	52	103-30	131	174	1	0	107	0	0.3496732	0.5686275
Pre-1300	60	103-31	129	146	8	0	122	0	0.4310954	0.519573
Pre-1300	66	103-32	135	113	70	0	92	0	0.2893082	0.3610224
Pre-1300	70	103-33	88	117	62	8	114	0	0.4145455	0.4285714
Pre-1300	219	103-50	40	103	115	0	175	0	0.6782946	0.3992248
Pre-1300	223	103-51	80	10	110	0	206	0	1.03	0.05
Pre-1300	228	103-52	128	146	0	0	103	0	0.3759124	0.5427509
1300-1500	49	103-30	65	63	16	92	163	0	0.690678	0.2669492
1300-1500	57	103-31	126	13	0	91	0	41	0.3043478	0.4214047
1300-1500	63	103-32	62	75	105	0	255	0	1.0368852	0.3099174
1300-1500	69	103-33	53	185	28	6	112	0	0.4117647	0.6801471
1300-1500	213	103-50	78	133	143	0	71	0	0.200565	0.3757062
1300-1500	222	103-51	109	165	5	0	126	0	0.4516129	0.5913978
1300-1500	227	103-52	128	139	7	0	125	0	0.4562044	0.6347032
Post-1500	48	103-30	115	171	44	0	117	0	0.3545455	0.5181818
Post-1500	54	103-31	102	144	69	4	38	61	0.1191223	0.4514107
Pro-1500	62	103-32	48	168	4	0	168	0	0.7636364	0.7636364
Post-1500	68	103-33	64	175	23	0	137	0	0.5229008	0.6679389
Post-1500	212	103-50	125	90	105	0	101	2	0.2835366	0.28125
Post-1500	221	103-51	85	90	133	0	113	0	0.3668831	0.2922078
Post-1500	225	103-52	84	178	3	0	139	0	0.5245283	0.6716981

Table 4.4: Raw phytolith counts by plant type, Transect 103, Songo Mnara

Beyond any potential correlation between a modern train and C4-Panicoid grasses, I want to draw attention to the fact that this most recent period under consideration documents the presence of mixed-grass, C3-Pooid, and C4-Panicoid grass communities. Researchers who developed the Climate Index assumed that temperature and precipitation heavily influenced the composition of grass communities. Climatic conditions influence Songo Mnara Island equally; therefore, these results suggest factors beyond temperature and precipitation contributed to the varied grass communities. No relationship was apparent in the presence of C3-Pooid grasses and woody plants. As I discuss below, this provides additional

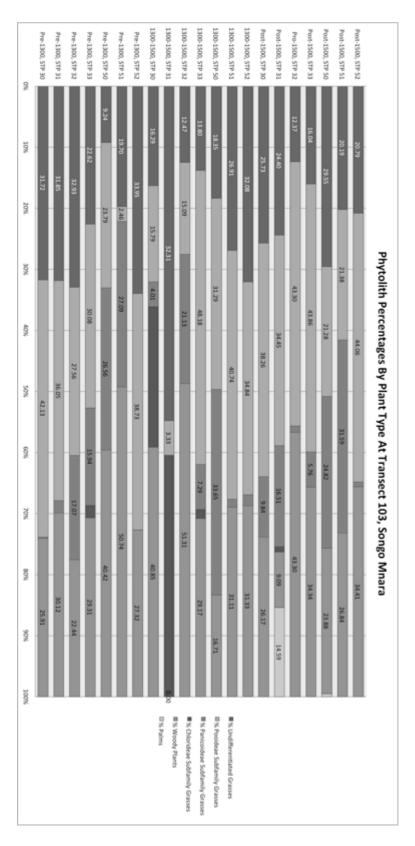


Figure 4.13: Raw phytolith percentages by plant type, Transect 103, Songo Mnara

evidence for the lasting impact of anthropogenic influences on landscapes of this island.

AD 1300-1500: Tenuous spatial patterns were apparent in the woody-plant type phytolith distribution in phytolith samples taken from archaeological contexts that date to the fourteenth to sixteenth centuries. The highest representations of woody-plant phytoliths seemed to cluster in two areas. Five of the six samples nearest the stonetown have woody-plant type phytolith ratios > 35%. In a similar manner, woody-plant type phytoliths account for > 30% of samples from the three furthest contexts under consideration. Ratios of woody-plant type phytoliths identified in the remaining samples account for demonstrably lower levels of the assemblages; though the lowest value is a relatively high 15.71%.

The relatively balanced distribution of woody-plant type phytoliths apparent in samples throughout the survey universe suggests less diversity in woody-plant communities at this time. Further, the cluster of woody plants in contexts directly adjacent to the stone-built community, active during this time period, suggests a relationship between woody plants and urban populations. At this point, I am only able to suggest that the phytolith record bears evidence of at least two types of woody-plant communities (< 20% or > 40% a sample). As before, the lack of an adequately calibrated Woody Plant Index or a more specific level of phytolith morphologic analyses causes me to be unable to definitely identify the types of plants with which urban peoples had engaged.

As before, the presence of C4-Panicoid subfamily grasses outstrips that of mixed-grass communities or those with high levels of C3-Pooid grasses. Of the six

locations with a clear C3-Pooid prevalence in this period, only one was situated within one km of the urban community. The remaining C3-Pooid grass-prevalent locations clustered at the far southeastern end of the survey universe correlate with woody plant areas. Locations with Climate Index values that demonstrate a clear prevalence or even dominance of C4-Pooid grasses clustered towards the center of the island, with a group of three such landscapes in the southwestern corner of the survey universe. The mixed-grass communities occupied most every area with no clear spatial pattern.

As with the grass assemblage from post-1500 contexts, those recorded from archaeological contexts that date between 1300-1500 documents the presence of three distinct grass communities. Plant community models and botanical surveys of modern contexts indicate that arid-tolerant C4-grasses should dominate the island. The prevalence of C3-Pooid grasses in restricted locations led me to look towards anthropogenic and biological influences that may be responsible for this pattern. In this case, these grasses may overlap with woody plant coverage, namely in the southeast corner of the island. Shade from woody plants is known to lower the fitness of C4-Panicoid grasses (Ode et al. 1980), though the same research notes that C4 grasses can accommodate shaded situations. The landscapes can be taken to represent three complementary zones of grasslands, each of which had a clear social function.

Pre-1300: The basal contexts of Songo Mnara Island demonstrate little variation in woody-plant type phytoliths, especially when compared to those reported from subsequent archaeological contexts. Woody-plant type phytolith

bodies accounted for 20-35% of 16 of the 25 available samples. The distribution of woody-plant percentages apparent in the remaining 9 samples aligns with those reported from 1300-1500 contexts. For this reason, I conclude that the earliest contexts considered in this analysis bear evidence of at least two types of woody-plant communities, though the nature of these two communities remains unclear. By this I mean I am unable to determine if the phytolith proportions document difference in type or degree. If I have recorded evidence of a difference in type, then the basal contexts bear evidence of multiple plant communities (i.e., scrubland versus forest). If a difference in degree, then these contexts bear evidence of differential coverage expressed by a single type of plant community (i.e., coverage of scrub within a scrubland).

The spatial distribution of woody-plant phytoliths seems similarly balanced. That said, I want to note that I recorded the highest woody-plant percentages in the center and southwestern corner of the survey universe. During this time period, the woody-plant coverage in contexts directly adjacent to the area that would become the urban settlement was equal to, or slightly below, the levels I recorded in other contexts. This suggests that the urban residents acted to increase the prevalence of woody plants in contexts directly beyond their community. Woody plants could also include valued trees, such as baobab or coconut, which macrobotanical had already identified in domestic contexts of Songo Mnara (Walshaw pers. comm., 2014).

None of the grasslands reported from this context had Climate Index values indicative of C3-Pooid grass coverage. Instead, eight of the samples had a demonstrable C4-Panicoid prevalence and 11 samples were mixed grasslands. This

lack of C3-Pooid grass prevalence differs from each of the more recent contexts, each of which had six locations with C3-Pooid prevalence. The near-equal representation of C4-Panicoid and mixed grasslands resembles that expected from Climate Index calculations from a single time period. I interpret the differential representation of C3-Pooid grasses apparent through time as evidence of anthropogenic influences. As I will explain, human activities known to agropastoral communities can, at times, increase the fitness of C3-Pooid grasses in disturbed landscapes. In addition to this relationship, I will also discuss the potential influences of climate change through time.

Discussion

General Impressions of Woody-Plant Communities Through Time and Space

The phytolith-based landscape reconstructions recorded across the 7.5 sq. km survey universe of Songo Mnara Island suggest that the presence of woody plants vacillated through time and, to a lesser extent, space. The most recent context under consideration suggests relatively low woody-plant type phytolith representation in contexts near the abandoned urban community. Conversely, the highest levels of woody-plant percentages were recorded in areas > 2 km from the Songo Mnara town wall. As I reported above, I believe these values document the presence of three separate types of woody-plant communities on the island. For now, I am comfortable calling these locations: woody-plant rich, woody-plant poor, and intermediate woody plant. A diachronic perspective highlights interesting changes to the arrangement of these woody plant community reconstructions.

The "woody-plant poor" class of landscape was not apparent in the archaeological assemblage from 1300-1500. Samples adjacent to the urban community were rich with woody-plant phytoliths; again, these were locations bereft of woody plants in the post-1500 assemblage. These data suggest Songo Mnara stonetown actually promoted woody-plant coverage. I was surprised by this find, as I had assumed woodfuel requirements necessary to construct the stonetown and maintain local lifeways therein would have prompted residents to clear wooded environments. I propose two potential explanations for this result, though note the lack of detail available here makes me unable to confirm or reject either explanation.

Archaeological investigations confirmed the presence of cotton and cotton-working instruments in domestic spaces of Songo Mnara (Fleisher & Wynne-Jones 2010; Sulas 2010; Sulas & Madella 2012; Fleisher 2013; Walshaw 2013). Cotton is an herbaceous woody plant, one that creates phytoliths of that category. This means that the surprise "woody-plant" coverage may actually document the presence of cotton fields incised into the landscape in order to further economic opportunities for residents of the urban community.

If I assume that the woody plants derive from shrub or forest-type species, rather than the herbaceous cotton, then I can apply these data to interpret patterns in woodfuel consumption. Charcoal deposits and architectural necessities of stone architecture combine to demonstrate that residents of Songo Mnara clearly consumed high levels of charcoal and, therefore, woody plants. The phytolith record suggests that the high level of woody plant consumption was met with an increase of woody-plant prevalence across the local landscape; further, this increase

outstripped levels achieved in a period when the island was abandoned. I posit that this urban community relied on mangrove forests to meet woodfuel needs.

Mangroves are invisible in this phytolith analysis, as these trees occupy intertidal areas and do not produce diagnostic silica bodies. Such trees are highly valued by contemporary peoples for their utility as charcoal and architectural supports (Curtin 1981; Dahdough-Guebas et al. 2000) and were known to be an economic resource in the region back to its Early Iron Age occupation (Chittick 1974).

The woody-plant representation in landscape reconstructions that underlay urban-associated deposits support the notion that human action influenced such vegetation communities. The earliest contexts share a relatively homogeneous distribution of woody-plant type phytoliths as this class accounts for 20-30% of total counts in 16 of 25 samples. Subsequent deposits do not match the broad homogeneity apparent in these earliest contexts. I interpret the diachronic shift towards differentiation in woody-plant communities as evidence that anthropogenic activity influenced vegetative community profiles. Further, the human-induced influences had a lasting impact on these plant communities, as the post-1500 reconstructions and modern records do not align with the pre-1300 homogeneity of woody-plant records.

General Interpretation of Grass Communities Through Time and Space

The elevated representation of C3-Pooid subfamily grasses that occurred in the centuries following AD 1300 is the most important trend in grass community composition on Songo Mnara Island. As I explain in Chapter Two, members of this

grass subfamily are not suited to warm, arid climates, but instead thrive in cool, moist locations. Such adjectives do not apply to Songo Mnara Island and the basal contexts confirm that the island is a poor fit for this grass subfamily. The fourteenth through sixteenth centuries also represent a global warm period, a factor that would be expected to further limit the fitness of C3-Pooid grasses. All this information combines to suggest that human activity was likely responsible for the prominence of this grass subfamily after AD 1300.

Anthropogenic activities relating to the agropastoral subsistence economy known to Iron Age populations on the Kilwa peninsula may have brought about the prevalence of C3-Pooid grasses. Domestic ungulates known to the Swahili communities include cow, sheep, and goat. These animals are able to subsist on a range of grasses, though evidence suggests that the species prefer pastures of C3-Pooid grasses. For this reason, the overlap between an urban community and prevalence of this grass subfamily suggests that local landscapes of Songo Mnara may have been designed to act as pasturage for domestic animals. Extensive zooarchaeological analyses of domestic or open spaces from this urban community are as yet unavailable, though researchers did note the presence of mammal bones (Fleisher & Wynne-Jones 2013: 13). Waste from these animals could act to fertilize pastureland. Soil chemistry analyses report such fertilization.

Subsistence agriculture may also play a role in the creation of grasslands in the region. Domestic African grains, like millet and sorghum, are members of the C3-Pooid grass subfamily. For this reason, locations with high levels of C4-Panicoid-specific phytolith bodies may be indicative of farm plots, as these anthropogenic

spaces would be manufactured to contribute high levels of Panicoid phytoliths.

Macrobotanical remains clearly demonstrate that such C4-Panicoid domesticates were cultivated throughout the region (Walshaw pers. comm. 2014). As I detail in Chapter Two, farmers are known to physically alter local landscapes to retain water and prevent erosion. If such actions had been applied to this region, then water retention could have promoted the fitness of C3-Pooid subfamily grasses.

If this assumption that agropastoral anthropogenic influences were responsible for constitution of grass communities after AD 1300 rings true, then I want to highlight the spatial distribution of the grass communities. The 1300-1500 spatial patterns were as follows: woody plants and mixed grasslands dominated the contexts directly adjacent to the urban center; C3-Pooid subfamily grass prevalence clustered around the far-southwest and central regions of the survey universe; and finally, I recorded C4-Panicoid grass prevalence in the eastern to southeastern contexts of the region. This patterning may document three complementary, socioeconomic landscapes through which residents of Songo Mnara produced domestic grains and animals for consumption and cotton thread for export. Unfortunately, the current level of analytical detail does not allow me to further support this notion. Additional phytolith investigations that distinguish a finer level of grass subfamily detail and explicitly search for evidence of cotton will be able to test this proposed arrangement of socioeconomic landscapes.

The anthropogenic influences suggested AD 1300-1500 grass community reconstructions apparently had a lasting legacy on local landscapes. I say this because the distribution of C3-Pooid subfamily grasses remained at a consistent

level in post-1500 contexts. Residents of the urban community of Songo Mnara, therefore, may have fundamentally changed the profile of grass communities on the island.

What was the provenience of subsistence resources that supported the urban community on Songo Mnara Island?

The phytolith record from fourteenth-to sixteenth-century contexts around Songo Mnara may bear evidence of agropastoralism on the island. I say this because three zones of grass communities seem to emanate from the urban center; two of the three zones likely held subsistence functions for local communities. This interpretation is buoyed by macrobotanical, phytolith, and zooarchaeological reports from the region, as all of these lines of evidence document the presence of domestic plants and animals in the stonetown. This phytolith analysis did not identify grasses below the level of subfamily; thus, I am unable to definitively document whether the C3-Pooid or C4-Panicoid phytoliths that I recovered derive from grasses with clear subsistence functions. Unfortunately, these subfamilies also include over a thousand additional species of grass that hold no socioeconomic function.

If subsequent phytolith analyses that delineate additional details within grass subfamilies support this interpretation, then long-held assumptions regarding urban subsistence patterns will require reinterpretation. Previous archaeologists assumed that peninsular communities exported grains to island-bound urban populations between AD 1100-1500 (Kusimba 1999; Horton & Middleton 2000). Peninsular communities were thought to have exchanged grains for exotic goods, an

act which would also account for the continued presence of foreign materials in peninsular contexts. Without grain export, peninsular communities would have had to manage their own engagement with long-distance economies rather than access exotic goods through urban entrepôts.

What strategies did fourteenth- to sixteenth-century inhabitants use to meet the extensive woodfuel demand associated with the construction of stone-built architecture, iron smelting, and food production?

Models of woody plant presence across the island suggest that the distribution and prevalence of this class of plant increased in conjunction with the urbanism at Songo Mnara. As I explained above, this increased prevalence may represent herbaceous woody-cotton farm plots. An alternative explanation is that land-bound woody plants flourished in association with urbanism because agropastoral activities increased the capacity of local landscapes to retain water. Further, waste from domestic animals may have fertilized these same landscapes.

In terms of woodfuel consumption, I interpret the increase in woody-plant prevalence in conjunction with urbanism as evidence of an intertidal provenience of consumed wood in the region. As I explain above, mangrove trees are a highly valued construction material and make a desired charcoal. I collected charred wood remains from domestic contexts and archaeological lime pits uncovered during the 2011 field season at Songo Mnara. While I have not yet analyzed this charcoal, such analysis would allow me to definitively determine the type of woodfuel consumed by urban residents between 1300-1500.

Anthropogenic influences associated with urbanism are typically thought to degrade local environments; did such degradation occur at Songo Mnara Island?

The preceding discussion highlights that phytolith-based landscape reconstructions from AD 1300-1500 captured evidence of elevated levels of C3-Pooid subfamily grasses and woody plants. As compared with C4-Panicoid subfamily grasses, woody plants and C3-Pooid subfamily grasses require elevated levels of soil fertility and soils with the capacity to retain moisture. Factors that bring about increased levels of soil fertility and moisture retention require shifts in climatic patterns or anthropogenic investment into local soils. I believe that anthropogenic activities brought about the change to woody plant and C3-Pooid subfamily grasses apparent at Songo Mnara Island. I note different methodologies known to Eastern Africa that are able to increase levels of water retention and soil fertility above. If true, the model of anthropogenic investment had a lasting legacy on the local vegetation communities. I say this because the levels of these types of plants remain relatively consistent between the 1300-1500 and post-1500 samples. Shifts in global climate patterns are known in these periods, which would have likely flipped grass community composition in one direction or the other. Again, I cite anthropogenic influence as the factor that precluded the potential climate-based plant community upheaval.

Chapter Five

Mikindani Bay: An Anthropogenic Landscape in Southern Tanzania

Mikindani is a town situated on the southern coast of Tanzania, roughly 50 km north of the Mozambique border (Figure 5.1). Mikindani Bay shelters this town from strong Indian Ocean currents, while a combination of topographic and geologic diversity creates at least five distinct ecological zones in the region (Pawlowicz 2011: 44-46). Archaeological investigations pushed the social chronology of this region back to the last centuries BC, though settled villages were not present until the mid-first millennium AD (Kwekason 2007, 2013; Pawlowicz 2009, 2011, 2012). Material assemblages recovered from these earliest village communities align with those expected from Early Iron Age populations in Eastern Africa (Mitchell, 2002; Phillipson 2005).

Overlap with peer coastal social groups evaporated between the early- to-mid second millennium, during which time residents of Mikindani engaged with continental and far-southern communities (Pawlowicz 2011). This anomaly continued through the late second millennium, at which point residents of Mikindani forged commercial ties with continental peers (Alpers 1975). The resulting access to ivory, gum copal, and human captives helped promote Mikindani to regional prominence. The prolonged settlement history and unique social expressions apparent in this region suggest that a long-standing, unique relationship between residents and local environments has contributed to the modern landscapes.

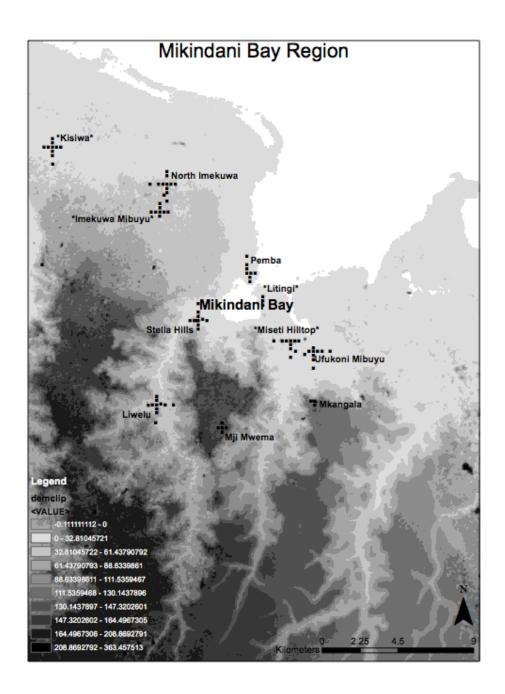


Figure 5.1: Mikindani Bay region of southern Tanzania and extent of paleoethnobotanical survey conducted in the region. Each square represents location of STP

Early Iron Age settlements reported from Mikindani Bay and the Eastern

African coastline featured cereal cultivation, settled village life, iron smelting, and

the use of proto-Bantu languages (Phillipson 2005: 212). Ceramics recovered by Kwekason (2011, 2013) demonstrate that those associated with EIA peoples were not the earliest expressions of local pottery in Mikindani or coastal Eastern Africa in general. Despite apparent differences in Late Stone Age materials, residents of Mikindani shared a material culture with other coastal dwellers until the second millennium AD; evidence also indicated engagement with Indian Ocean commerce (Pawlowicz 2009, 2011). The socioeconomic situation in this region began to change at the turn of the second millennium, as exotic ceramics disappeared and local crafts began to demonstrate affinities with inland and southern communities rather than typical Swahili motifs (Pawlowicz 2009, 2011, 2012; Pawlowicz & LaViolette 2013). Archaeological investigations have demonstrated that residents of Mikindani eventually re-engaged with the Swahili and Indian Ocean worlds during the middle of the second millennium; it is important to note that such reintegration did not occur at the expense of continental ties (Pawlowicz & LaViolette 2013).

Mikindani's economic prominence ended during the early twentieth century. The modern town is best characterized as a cashew- and charcoal-producing satellite of Mtwara, the regional capital of southeastern Tanzania. Movement towards cash crop production has not replaced the local subsistence economy; I say this because much of the area that I covered in 2008 and 2001 field seasons were under active cultivation. With this brief socioeconomic history in mind, I move to present the research questions I assess through phytolith-based landscape reconstructions for this region.

Residents of Mikindani Bay have farmed African cultivates on plots cleared by locally smelted iron implements over nearly two millennia (Pawlowicz et al. forthcoming). The results of macrobotanical investigations suggest that farmers in Mikindani managed to derive subsistence needs within a range of local ecologies; Pawlowicz (2011: 44-46) defines five environmental zones available in the region. Differences in geography, topography, and geology distinguished these zones. I sampled each of these environmental zones and present results from four of the five in this chapter. This decision allowed me to better understand the ways in which prolonged exposure to anthropogenic influences impacted plant communities available in each zone. Specifically, I looked to address the following questions:

- Can phytolith analyses capture evidence of human activity or anthropogenic influences that date back to the Late Stone Age?
- Do plant communities reconstructed from archaeological contexts align with those known to occupy the five modern environmental zones?
 - If so, how did anthropogenic influences shape these varied communities through time?
 - If not, did Iron Age peoples elect to establish villages within a particular type of vegetation?
- Do phytolith samples from the early- second millennium reflect the dramatic social changes known to have occurred during this period? What about the late second- millennium moment of economic prominence?

I organize this chapter to build towards the presentation and evaluation of phytolith-based landscape reconstructions. I begin with a review of relevant archaeological, historical, and environmental literature that defines the Mikindani Bay region. I then introduce the four archaeological regions under consideration.

Sections specific to each region include an overview of archaeological residues recovered from the locations, as such information provides context necessary to evaluate the paleoethnobotanical results. The results of phytolith analyses are also presented in each region. I conclude this chapter by synthesizing the results from the four regions in order to identify trends in the data or patterned behaviors. Such trends allow me to then evaluate the above questions.

Human Histories of Mikindani Bay

Previous researchers classify human histories of Mikindani Bay into seven periods. The histories extend back to at least 300 BC and culminate in the modern period. In this section, I review these seven periods.

Periods One and Two: 300 BC-AD 600

The material assemblage of Mikindani Bay stretches back to 300 BC (Kwekason 2007). The limited residues from this period correlate with stone tool technologies and ceramic motifs common to Late Stone Age (LSA) coastal groups (Pawlowicz 2011: 1, 508-510; Kwekason 2013). Much like LSA groups throughout Eastern Africa, the earliest residues recovered from this region were deposited by small bands of itinerant peoples (Ehret 1998; Mitchell & Whitelow 2005). Archaeological investigations identified two instances of LSA materials in Mikindani Bay (Kwekason 2007; Pawlowicz 2011). Phytolith analysis may offer evidence of anthropogenic influences of plant community change in response to the initial occupation in the region. Such a shift in plant community structure could permit an

understanding of the ways in which anthropogenic influences changed in response to the social shift to EIA villages (Chami & Kwekason 2003; Pawlowicz 2011; Kwekason 2013).

Early Iron Age materials represent the transition to the second period of occupation at Mikindani Bay. Early Iron Age technologies include Kwale ware ceramics, the cultivation of African grains, animal husbandry, iron production technologies, and proto-Bantu languages (Huffman 1989, 2006; Lane 2004; Phillipson 2005). The prevalence of ceramic motifs that align with those common to Kwale wares suggests social overlap between Mikindani and peer coastal communities across Eastern Africa (Pawlowicz 2011). The archaeological contexts that yielded the earliest ceramic traditions do not speak to whether the people who used such vessels were sedentary or nomadic (Kwekason 2013). This likely presents evidence of the initial sedentary villages in the region (Phillipson 2005: 248). Six archaeological sites in Mikindani Bay stretch back to Period Two; the sites all cluster on arable agricultural lands in lowland and coastal plains (Pawlowicz 2011: 510-512).

Environmental investigations did not produce relevant data from Period One archaeological contexts (300 BC to AD 300). Macrobotanical remains recovered through flotation methods from Period Two contexts yield evidence of pearl millet (Pawlowicz 2011: 283), a C4-Panicoid African grain long regarded as a staple of EIA food producing populations (Sutton 1968; 1974; Schmidt 1975). The earliest cultivation of pearl millet corresponded with the occupation of only two

environmental zones: coastal or lowland plains. The attention to pearl millet documents the presence of agriculture in the region by Period Two, AD 300-600.

Period Three: AD 600-900

Iron Age technologies spread to cover much of the region in Period Three, AD 600 to 900 (Kwekason 2007). I say this because the number of archaeological sites ballooned during this period from six to 20 (Pawlowicz 2011: 37). Taken together, the 14 new settlements combined to cover each environmental zone, suggesting that populations explored local ecological conditions during the last centuries of the first millennium. Wynne-Jones (2005) noted a similar practice enacted by mid- to- late first- millennium agriculturalists in the Kilwa hinterland, 150 km north; archeological survey of northern Pemba Island also echoes this pattern of environmental exploration (Fleisher 2003). The shared desire to explore available ecologies may, therefore, represent a practice common to Iron Age populations who occupied the coast.

Soil chemistry analyses indicate that land in the region began to show evidence of nutrient depletion during Period Three (Pawlowicz 2011: 512).

Macrobotanical evidence demonstrates that farmers managed to continue pulling subsistence resources from these depleted soils, as local farmers managed to continue despite nutrient depletion (Pawlowicz 2011: 283). Beyond local subsistence, engagement with the Indian Ocean commercial system increased in this period, as the proportion of ceramics and glass beads both increased during this period (Pawlowicz 2011: 513). Local and exotic material cultures identified from

the Late Stone Age through AD 900 link Mikindani with the Swahili and broader Indian Ocean worlds.

Periods Four and Five: AD 900-1500

People in the region discontinued interaction with commercial agents from the Indian Ocean between 900 and 1500; this decision prompted a unique socioeconomic situation. Changes to socioeconomic strategies apparent in this period did not preclude long-distance trade, as local residents forged ties with communities situated deep into the continent and along the far southern coast (Pawlowicz 2009, 2012, 2013). Residents of Mikindani Bay also expanded their investment in local agriculture through the expansion of farm plot coverage. Emphasis on agricultural expansion, the continuation of African cultivates production, and the elevation of continental exchange networks in this period differed from social trajectories typical to peer coastal settlements. Glass beads represent the only class of exotic artifact that overlapped with typical Swahili assemblages recovered in Mikindani Bay during Periods Four or Five (Pawlowicz 2011: 514-516).

Survey results from this period indicate that residents of the Mikindani Bay region chose to maintain extensive agricultural strategies rather than produce food in an intensive manner in any particular environmental zone (Pawlowicz et al., forthcoming). I argue that the choice to maintain a broad approach to agricultural production and botanical community exploitation seems to stem from social preference. I say this because peer coastal communities chose to pursue food

production strategies that differed, slightly, from Iron Age trends (Horton 1996; Fleisher 2003; Wynne-Jones 2005). As I will discuss, the expansive, general approach to food production manifested as a series of identifiable patterns in the phytolith record. I say expansive agriculture because survey recorded the expansion of settlement representation and distribution during this time period.

Macrobotanical analyses of these periods demonstrated a shift in agricultural strategies, as sorghum and cotton residues were recovered alongside pearl millet (Pawlowicz 2011). The previous archaeological investigations recovered assemblages that bore evidence of low-intensity ironworking, agriculture that likely involved shifting strategies, and ceramic production (Pawlowicz 2011). Motifs recorded on local ceramics produced during these periods resemble those found inland near Lake Nyasa or farther south in Mozambique (Kwekason 2013; Pawlowicz 2013).

Period Six: AD 1500-1800

Residents of Mikindani reopened coastal commercial channels between AD 1500 and 1800, a span that correlates with Period Six (Kwekason 2007).

Reintegration into Indian Ocean trade precipitated a two-stepped settlement hierarchy in the region. Socioeconomic hierarchy emerged because engagement with the Indian Ocean commercial system was restricted to the Mnaida Ward.

Renewed engagement with this commercial system led to the emergence of Islam in the area, as residents constructed stone-built mosques in the Mnaida Ward after AD 1500 (Pawlowicz 2011). An array of exotic materials accompanied the ideological

imports as the archaeological assemblages from this period include ceramics from the Persian Gulf, South Asia, and China (Pawlowicz 2011: 519-521).

Archaeological evidence demonstrated socioeconomic and material continuity in settlements outside of Mnaida Ward between AD 900 and 1800. The only change apparent through time was an intensification of iron production (Pawlowicz 2011: 38), though the motivation that spurred elevated levels of production was unclear. Elevated levels of iron production would cause an increase in wood fuel consumption between AD 1500 and 1800.

Macrobotanical investigation from this period yielded pearl millet, sorghum, and cotton (Pawlowicz 2011: 238). This assemblage of cultivars suggests a continuation of subsistence strategies that were first applied to the region by AD 900. In this way, macrobotanical residues support the archaeological finds from areas outside of Mnaida Ward. Villagers who maintained agropastoral subsistence economies likely would have had to actively promote soil fertility and maybe even capture rainwater, strategies which I outline in Chapter Two.

Period Seven: AD 1800-1964

Period Seven spans AD 1800 through 1964, the year during which independent Tanganyika and Zanzibar combined united to form Tanzania (Kwekason 2007; Pawlowicz 2011). The region, specifically the Mnaida Ward, underwent a significant amount of growth and economic expansion in this period. Much of this growth was attributed to an amplified integration into large-scale commercial systems, both across the Indian Ocean and into the African interior

(Pawlowicz 2011: 522). Integration into these economic systems was spurred by the export of enslaved persons, gum copal, ivory, and sisal (Tew 1950; Alpers 1975). Another influence that motivated residents towards economic interaction during this period was imperial activity in the area. A series of imperial influences encouraged commerce in the region. German, and subsequent British, colonialism left the most lasting impression on the local landscape as German powers constructed a fort that overlooks the entire bay, with a clear view of Mnaida ward (Freeman-Grenville 1965, 1988). German colonial rule forced cotton cultivation and hard labor in this region (Zimmerman 1910; Hussein 1969). The fort transferred to British control in 1918.

Colonial governments active in Mikindani Bay demanded a unique assemblage of natural resources from the area. Modern landscapes in Eastern Africa bear evidence of the heterogeneous arrangements that resulted from the varied extractive regimens imposed by imperial powers (Freeman-Grenville 1958, 1965, 1973, 1988). For example, Portuguese demanded maize production to feed soldiers and itinerant merchants (Feierman 1990; McCann 2005); later these same areas yielded sisal rope for British naval endeavors (Hartemink & Wienk 1995; Hartemink 1997).

The material residues of Period Seven suggest that exotic materials were available to residents of the region in nearly every area in the region (Pawlowicz 2011: 522-523). Local ceramics and cultivars also demonstrated a widespread revolution in local economies, as longstanding ceramic traditions were abandoned and maize replaced pearl millet. This transition proved revolutionary because pearl

millet had been the agricultural staple of the region since people first farmed its soils (Pawlowicz 2011: 238). These factors all combine to suggest a disassociation between modern populations and social systems that extend back to AD 300. This disassociation means that, despite overt similarities between modern and reconstructed subsistence economies, such strategies produced unequal or otherwise incomparable ecological consequences.

Existing Environmental Information: Results From Macrobotanical, Soil Chemistry, and Geological Investigations

Macrobotanical Evidence

Charred wood was a ubiquitous ecofact in archaeological contexts throughout the Mikindani region, found in all but one surveyed layer (Pawlowicz 2011: 281). The prevalence of charred wood led to the notion that wood was the typical source of fuel and construction materials across the region. Modern residents also sell charcoal along the highway, an unlawful activity that distributes wood resources of Mikindani across Tanzania. While abundant, charred wood recovered in 2008 and 2011 field seasons was highly fractured (Pawlowicz 2011: 281-282). For this reason, previous research simply noted presence of charred wood and dedicated research efforts to species-level diagnoses only to charred seed remains.

The grain-seed category prominently featured contributions from African grains, namely millet and sorghum. These two classes of African grain accounted for 80 of the 97 seeds that constituted the Mikindani Bay macrobotanical assemblage. Four categories of millet were identified in the assemblage, including: pearl millet,

(Pawlowicz 2011). The apparent ubiquity of millet cultivation in surveyed areas masks the fact that a majority (60%) of millet residues were collected from lowland environments. These lowland areas were the first substrates to host cultivation in the region during the Early Iron Age; In this way, a slight preference to farm pearl millet in lowland areas may indicate continued Iron Age mentalities in these areas.

Region	Volume	Com	P Millet	F Millet	Bulrush	Millet Chf	Rice	Sorghum	Wheat	UNID Chf
Coast	98	0	9	1	0	1	0	1	0	1
Valley	74.5	0	6	1	3	2	0	0	0	1
Ridge	49	1	2	0	1	1	0	2	0	3
Highland	83.5	3	11	1	9	3	0	5	0	1
Lowland	115	0	17	0	0	1	1	3	2	4

Table 5.1: Macrobotanical residue abundance by region. From Pawlowicz (2011: 283)

Macrobotanical results suggest that millet had been the staple grain of Mikindani Bay for nearly two millennia. Change occurred towards the end of the second millennium, when exotic cultivars like rice, wheat, and corn were introduced to the region. Historic documents suggest that colonial intervention was responsible for the eventual usurpation of African grains as subsistence staples in the region.

The "other plants" represent the final category of charred seed remains that Pawlowicz (2011) considered from this region. He identified charred pea remains in archaeological contexts across time and microenvironment, though coastal

contexts had the highest levels of such plants (2011: 285-286). Fruits and nuts were typically recovered in highland contexts and have low representation in coastal

Period	volume	Com	P Millet	F Millet	Bulrush	Millet Chf	Rice	Sorghum	Wheat	UNID Chf
1st Millennium	181	0	15	0	0	2	0	2	2	2
Transition 1st to 2nd	50	0	7	0	2	0	1	0	0	0
1st Half of 2nd Mill.	68	0	6	2	1	1	0	2	0	2
Mid 2nd Millennium	10	0	3	1	2	0	0	1	0	1
Recent	35	4	13	0	7	4	0	4	0	3
Below 2nd Mill.	20	0	0	0	1	1	0	0	0	0
Below 1st Mill.	56	0	1	0	0	0	0	2	0	2

Table 5.2: Macrobotanical residue abundance by time period. From Pawlowicz (2011: 283)

areas (Pawlowicz 2011: 289-290). Taken together, the presence of peas and fruits or nuts suggest communities expressed their local preferences through non-grain cultivates, as coastal communities tended to cultivate peas while highland peers tended towards fruit and nut cultivation.

Soil Chemistry Analyses

Ethnographic records note that land clearance, cultivar harvest, and grass-covered fallow plots are all anthropogenic actions that have the potential to degrade local soils. Pawlowicz (2011) tested whether such degradation occurred in farmed areas of Mikindani Bay; results of this soil chemistry analysis demonstrated that such soils lost nutrients through time. Levels of nitrogen did not decrease in proportions equal to those recorded from other elements necessary for plant growth. For this reason, Pawlowicz reported that agropastoralists likely fertilized

regional landscapes, though the ways in which such fertilization may have been accomplished remains unclear. Evidence for fertilization raises the argument that agropastoral populations in the region understood that their actions degraded local soils.

Geological Conditions of Mikindani

I detailed many of the geological features common to southern Tanzania in Chapters Two and Four of this dissertation. This presentation adds further detail to the previous discussions of the Makonde Plateau as well as the Mikindani Beds, a series of geological formations known to the region. Mikindani Beds are sandstones that formed as many as 23 million years ago (Hartemink & Bridges 1995). These soils have a red- to reddish-brown color, the color characteristics and soil content of these sandstones are known to vary over short distances (Pawlowicz 2011: 267). Further, the Mikindani Beds are thought to have low fertility levels and relatively high levels of acidity.

Soil conditions of Mikindani Bay vary between sandstones of the Mikindani Beds and limestones that derive from 2 million-year-old fossilized corals. Coralderived limestones are common to the coast and share a range of colors with the Mikindani Bed sandstone, though texture clearly distinguishes the two (Hartemink & Bridges 1995; Wenger et al. 2009).

Topography separates the two geologic groups outlined here. Sandstonedominated conditions of the Mikindani Beds are generally restricted to the Makonde Plateau (Hancox et al. 2002) while coral-derived limestones are generally restricted to the coastal margin (Hamilton 1982). Sandy deposits typically fill any crag in the coral rag deposits, resulting in a superficially homogeneous topography that overlays fossil corals in various stages of decomposition. Residents of this region managed to bridge the separation between coastal margin and highland Makonde Plateau, as both areas have been settled and farmed for nearly two millennia.

Survey of Mikindani Bay: Paleoethnobotanical, Geological, and Archaeological Results at Four Sites

I worked alongside a crew of three residents from Mikindani Bay and a representative from the Tanzania Antiquities Directorate between October and September 2011 to gather paleoethnobotanical evidence from the region. We piled into a tuktuk every morning to make our way to the survey location and, once there, excavated a shovel-test pit (STP) at 250 m, 500 m, and 1.5 km increments moving away from the center of 13 settlements identified by Pawlowicz (2009, 2011) (Figure 5.2). This survey strategy allowed us to recover 655 phytolith samples from a total of 103 STPs. We concentrated on 4 of the 13 sites that I surveyed. Once back at the University of Virginia, I was able to create a subsample that considered phytoliths from 102 archaeological contexts. The subsample was selected to reconstruct the ways in which pre-modern residents of this region interacted with plant communities that had surrounded their villages.

The four sites that I chose to study are Imekuwa Mibuyu, Miseti Hilltop,
Kisiwa, and Litingi Channel. These sites cover four separate environmental zones,
range in size from > 1 ha to > 5 ha, and cover all but the second social period. I was
comfortable omitting Period Two because I was unable to recover any

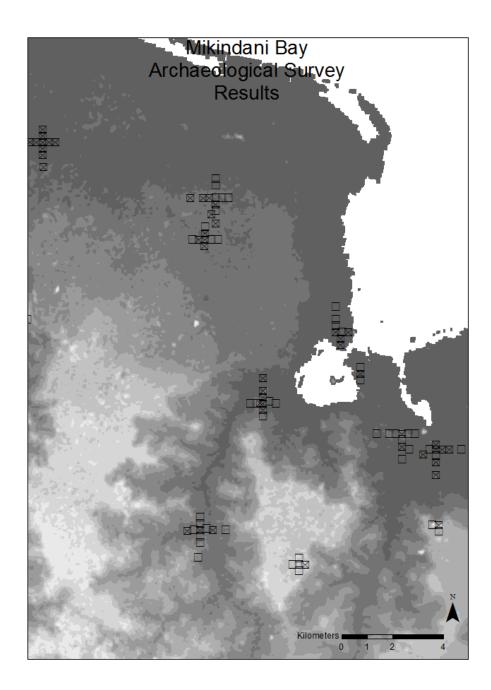


Figure 5.2: Results of archaeological survey conducted at Mikindani Bay. X denotes materials recovered in STP

The presentation that follows differs slightly than those in Chapters Four and Six because I introduce each site in the subsample separately. I include results of the phytolith-based landscape reconstructions in each of the site-specific sections. A archaeological materials that date between AD 300 and 600; without such evidence, I was unable to confidently date phytolith samples from this context. The chronologic overlap apparent between these settlements allows me to evaluate period-specific influences, intraregional variation through time and space, and actions or influences specific to each site.

social period-specific discussion follows during which I synthesize the results from these four areas. I review the methods that I use to interpret these results in Chapter Two.

Imekuwa Mibuyu

The archaeological site at Imekuwa Mibuyu is set within lowland plains that, in 2011, held evidence of shifting agricultural strategies. Plant communities on the plains vacillated between farmland, scrubland, and grassland. I also recorded several instances of burned scrub and grassland as well as active charcoal pits. This information suggests that the modern community is actively engaged in a range of socioeconomic activities including animal husbandry, subsistence agriculture, charcoal production, fishing, and cashew farming. Several of these activities influenced the form of the survey around Imekuwa Mibuyu, including a modern village, a large (approximately 2 ha) cattle enclosure, and a high water table.

During the 2008 field season Pawlowicz (2011: 86) recovered local ceramics, imported ceramics, glass beads, evidence of iron smithing, and daub from houses in this area. I recovered a similar material assemblage in 2011, namely local ceramics and glass beads from South Asia. The area immediately surrounding STP 89 yielded a large surface collection. When judged against classification parameters from Pawlowicz (2011: 334-336), the ceramics display three motifs common to the first millennium AD. The surface sample also recovered one sherd with decorative affinities that date to the second millennium. Subsurface remains from STP 88 articulate with second-millennium ceramics, as they demonstrate the "humped line" and "vertical incisions over impressed band" motifs.

I determined relative dates from the material assemblage as well as the identification of previously recorded geologic strata across this site (Table 5.3); each of the strata contained materials diagnostic to the social periods that I detailed above. I compare the soil stratigraphy that I recorded from STPs with those known to this area in order to further support the relative chronologies which I use to date the phytolith samples of Imekuwa Mibuyu.

Imekuwa Mibuyu: Phytolith Results

The phytolith assemblage considers 24 soil samples taken from 9 STPs. The samples derive from three social-period specific sedimentary contexts: AD 1800-1964 (Period Seven), 1500-1800 (Period Six), and 900-1500 (Periods Four/Five). Table 5.4 presents the raw phytolith counts and index values from this assemblage.

<u>Layer 1</u>: (0-15 cm) very dark grayish-brown sandy loam topsoil; this layer produced many sherds of local pottery including sherds decorated with notched rims and incised crosshatched designs. Because of the intense recent agricultural use of the area some mixing of older and more recent artifacts was expected for this layer.

<u>Layer 2</u>: (15-35 cm) grayish-brown sandy loam; this layer was distinguished from the topsoil by its lighter color and decreased sand content. The layer produced hundreds of local sherds, decorated with notched rims, shell impressions, and stab impressions, as well as several pieces of slag and red beads. With increasing depth the layer became increasingly difficult to excavate as the clay content increased.

Layer 3: (35-90 cm) yellowish-brown sandy clay loam; this layer was distinguished from preceding layers mostly by its increasing clay content. At the time of excavation this clay was dry and solid which slowed progress with the excavation. The layer produced hundreds of sherds of local ceramics, though the greatest concentrations were in the upper levels, falling off thereafter, as well as many chunks of slag. Towards the top of the layer these ceramics were decorated with heavy impressions, often set off within incised lines, as well as notched rims, indicative of an early second-millennium date. A late-first-millennium imported earthenware sherd was recovered from the bottom level of the layer.

Layer 4: (90-170 cm) brownish-yellow sandy clay with mottles of dark brown clay toward the bottom; this layer was exceedingly difficult to excavate due to its high content of dry clay, which eventually prompted the bisection of the excavation. There was evidence of multiple roots through the layer. The layer produced only occasional local sherds, which had likely been brought into the layer through root activity.

Table 5.3: Geologic chronology of Imekuwa Mibuyu area according to preexisting stratigraphic analyses (Pawlowicz 2011: 87)

Figure 5.3 is a histogram that displays raw phytolith values by time period and Figure 5.4 displays relative frequencies of each plant community type as recorded in each STP. Finally, Figure 5.5 indicates the location of each STP to give an impression of the spatial array of these particular contexts spread across the region.

AD 1800-1964: Woody plants account for 22.34% of the overall phytolith assemblage from this most recent archaeological context of Imekuwa Mibuyu. The representation of these bodies was not consistent across the 9 samples, as ratios

Date Range	Sample	STP	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plant Bodies	Density of Woody Plants Index	Climatic Index
900-1500	464	85	163	92	108	0	37	0.102	0.253
900-1500	477	87	93	157	28	0	122	0.439	0.565
900-1500	479	87	133	123	17	0	124	0.454	0.451
900-1500	495	89	158	113	53	0	67	0.207	0.349
900-1500	501	90	109	204	13	1	73	0.224	0.626
900-1500	507	91	93	181	28	0	99	0.328	0.599
900-1500	513	92	134	161	0	9	96	0.325	0.546
900-1500	518	93	134	166	12	0	88	0.282	0.532
900-1500	520	93	149	196	0	0	56	0.162	0.568
900-1500	527	94	104	86	53	0	157	0.646	0.354
1500-1800	463	85	191	139	21	0	49	0.140	0.396
1500-1800	467	86	115	198	15	3	62	0.189	0.604
1500-1800	471	87	126	140	4	0	139	0.515	0.519
1500-1800	483	88	192	95	35	0	79	0.245	0.295
1500-1800	490	89	166	117	55	13	59	0.175	0.346
1500-1800	504	91	93	117	0	0	190	0.905	0.557
1500-1800	510	92	88	149	0	0	163	0.688	0.629
1500-1800	516	93	115	230	20	0	35	0.096	0.630
1500-1800	524	94	173	99	0	5	123	0.452	0.364
1800-1964	460	85	182	117	44	0	57	0.166	0.341
1800-1964	470	87	184	150	24	0	42	0.117	0.419
1800-1964	480	88	130	156	14	0	100	0.333	0.520
1800-1964	489	89	170	135	19	0	76	0.235	0.417
1800-1964	502	91	109	130	0	10	161	0.674	0.544
1800-1964	508	92	120	158	19	0	103	0.347	0.532
1800-1964	514	93	126	154	0	0	120	0.429	0.550
1800-1964	521	94	154	191	0	0	56	0.162	0.554

 Table 5.4: Raw phytolith counts from Imekuwa Mibuyu, Mikindani Bay

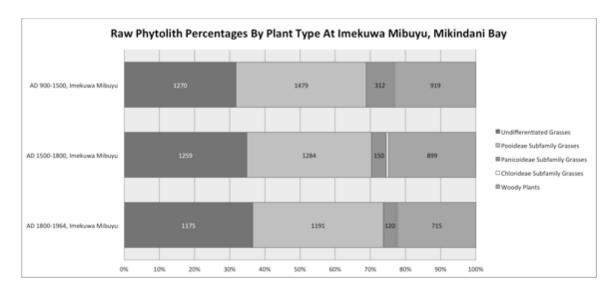


Figure 5.3: Phytolith percentages by plant type from Imekuwa Mibuyu, Mikindani Bay

ranged between 10.5% and 39.27% of phytoliths from particular locations. Unequal representation of woody plants in the phytolith record suggests variability in the vegetation communities from this period wherein different levels of woody-plant coverage were apparent in the locations. It is unclear whether such differentiation manifested as variable woody plant communities (i.e., scrubland to forest), or simply different degrees of coverage expressed by a particular woody plant community. I calculated Woody Plant index levels in an attempt to reconstruct the expected woody plant community from this context; however, interpretation of these values is problematic because this index has not been calibrated for application to coastal regions of Eastern Africa.

While I am unable to speak directly to the prevalence of woody plants versus grasses, the grass-type phytolith body counts do allow for a reconstruction of grass-

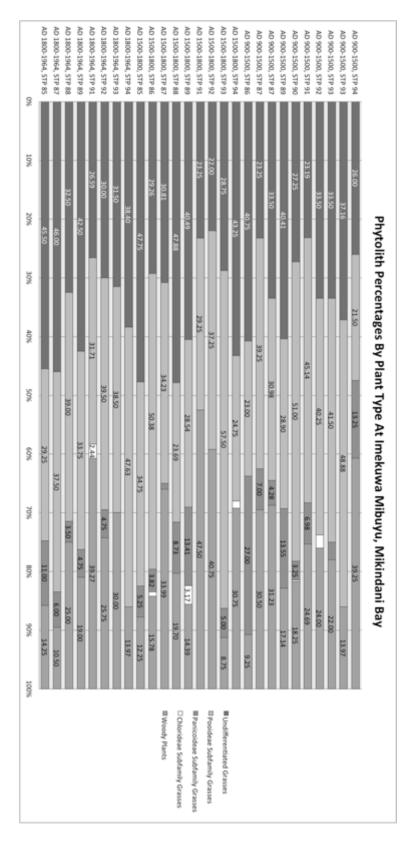


Figure 5.4: Phytolith percentages by plant type recorded in each STP from Imekuwa Mibuyu, Mikindani Bay

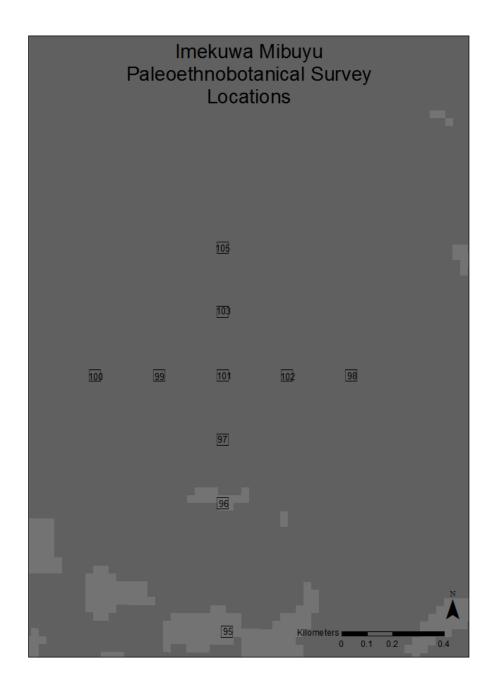


Figure 5.5: Location of paleoethnobotanical samples from Imekuwa Mibuyu area of Mikindani Bay. Shading denotes topographic changes

community coverage. For this reason, I rely first on Climate Index values to interpret the types of grasses apparent in the landscape reconstructions. Eight of the 9 Climate Index values from this period have values that demonstrate the grass communities of this area had equal representation between C-3 Pooid and C-4 Panicoid grasses. The lone exception to the mixed community was a C-4 Panicoid location. By calculating the Climatic Index, I remove any bias in the production or representation of particular grass types based on differential production or distribution of phytolith bodies. This step permits me to avoid any bias in the phytolith record and leads me to conclude that grass communities at this time had a near-equal representation of C3- Pooid and C-4 Panicoid subfamily grasses.

AD 1500-1800: Variability was apparent in the woody plant representation from Period Six contexts of Imekuwa Mibuyu, as ratios range from 8.75% to 47.5% of STP-specific assemblages. Despite large amounts of variation between locations, woody plants combine to represent 25.03% of the total 1500-1800 assemblage. This value is similar to that recorded from earlier and later contexts. As with the Period Seven contexts, variation in woody-plant ratios recorded in these STPs suggests differential woody-plant coverage across the area in this period. Differential coverage may have taken the form of varied woody-plant communities or degree of coverage expressed by a single type of woody-plant community. Again, this is similar to the situations recorded in Period Seven and Periods Four/Five contexts.

Grass-type phytolith bodies differ quite a bit from those identified in Period Seven contexts. The Climate Index values from this period suggest a near equal distribution of mixed grass communities, C3-Pooid-dominated communities, and C4-Panicoid-dominated communities. This shift suggests both a change through time and that a breakdown of grass community composition had been apparent prior to AD 1800. The near equal distribution of C3-Pooid and C4-Panicoid subfamily grasses recorded in this single area suggests that influence beyond climatic conditions had likely influenced these locations. As I discuss in the following section, one influence may have been anthropogenic intervention to create opportunities for the presence of particular types of grasses. Again, the Climatic Index calculation allows for a more nuanced appreciation of C3-Pooid to C4-Panicoid representation, as C3-Pooid bodies clearly dominate any comparison of raw counts.

AD 900-1500: As with the other contexts of this region, wide variation was apparent between the 10 contexts that constitute the Periods Four/Five assemblage of Imekuwa Mibuyu; I say this because percentages rage from 9.25% and 39.25%. The values combine to account for 23.09% of the entire assemblage from this context; again, this representation mirrors that recorded from other archaeological periods reconstructed in this area.

Grass communities from this context demonstrate an equal distribution of mixed-grass communities and those with an definable subfamily prevalence. The assemblage includes five mixed grass locations, two locations with C3-Pooid prevalence, and three samples with C4- Panicoid subfamily grass prevalence. This means residents of Imekuwa Mibuyu who engaged in a wide variety of

socioeconomic activities did so while surrounded by a similar set of grass communities.

Kisiwa

The archaeological site in the Kisiwa area covers a 5 ha stretch of coastal plains situated on the peninsula between Mikindani Bay and Sudi Bay. Modern landscapes in the area bore evidence of shifting agriculture, active farms with sorghum as the primary cultivar, open grasslands, and dense scrubland. Modern anthropogenic influences apparent in the region also included an abandoned compound composed of roughly five large, concrete buildings. The survey crew was unsure of the age or use of this compound; nonetheless, I included an area

<u>Layer 1</u>: (0-23 cm) dark brown sandy loam topsoil; the layer was likely disturbed by agricultural activities. It produced a moderate amount of local sherds, including some with characteristic EIW decorative motifs, and some pieces of slag, as well as some refined earthenware imported ceramics. The former may have been brought up into the topsoil from below.

<u>Layer 2</u>: (23-50 cm) brown sandy clay loam with some red mottles; this layer was distinguished from the topsoil by its lighter color and patches of compact clayrich sediment. It produced many sherds with first-millennium affiliations that became more numerous at greater depth, as well as red beads and shell. The bottom of the layer also had the emergence of the coral feature.

<u>Layer 3</u>: (50-80 cm) reddish-brown sandy clay with some dark brown mottles; the sediment in this layer was very compact where the clay portion had dried and hardened, which made excavating and screening the material more difficult. The layer produced hundreds of local sherds in all three excavation units. It also marked the appearance of a second coral feature.

<u>Layer 4</u>: (80-140 cm) red sandy clay; this layer was extremely compact. The artifact count decreased substantially in the upper levels of this layer, to less than 10 sherds per 10 cm level, and eventually sterile soil was encountered. The coral features remained through the entire unit and actually expanded in size, providing indications that they were natural.

Table 5.5: Geologic chronology of Kisiwa area according to preexisting stratigraphic analyses (Pawlowicz 2011: 89)

immediately beyond construction debris in this survey because the location matched my previously arranged survey coordinates.

Pawlowicz (2011: 89-90) excavated three trenches at Kisiwa. The three units yielded a total of 2,210 local ceramics, 60 pieces of iron slag, marine shell, daub, and loose fossilized coral thought to derive from structural features. The materials were distributed in four sedimentary strata that, in turn, correlate with Periods Three, Four, and Seven. I recovered two diagnostic ceramics from the region, both of which demonstrated motifs popular to the mid- to- late first millennium AD (Pawlowicz 2011, 2013). I rely on these sherds as well as the stratigraphic interpretations published by Pawlowicz (2011: 89) (Table 5.5) to interpret the relative age of the phytolith samples I recovered in 2011.

Kisiwa: Phytolith Results

I excavated nine STPs from the Kisiwa area of Mikindani Bay; I consider 21 samples from these STPs in the assemblage. The assemblage includes samples from three geologic layers with known chronologies: AD 1800-1964 (Period Seven), 900-1200 (Period Four), and 600-900 (Period Three). The periods bear evidence of the influence a shift away from typical coastal behaviors may have had on local plant communities. Table 5.6 presents the raw phytolith counts and index values. Figure 5.6 is a histogram that displays raw phytolith values by time period and Figure 5.7 displays relative frequencies of each plant community type as recorded in the different STPs. Finally, Figure 5.8 indicates the location of each STP excavated in the area to give an impression of the spatial array of these particular contexts.

AD 1800-1964: Woody plants account for 23.83% of the total phytolith assemblage from the 1800-1964 contexts of the Kisiwa area. Representation of woody-plant-type phytolith bodies was relatively consistent throughout this assemblage, although two outliers were present in the 11.06% of STP 100 and 42.25% of STP 97. The overall consistency of woody plant representation apparent in these ratios suggests a relatively consistent type of woody-plant vegetation cover throughout the landscapes from this context in this area. Again, some exceptions to this general continuity do likely exist in the locations highlighted above. As I have stated before, I am unable to interpret Woody Plant Index values in any meaningful manner; for this reason, I am unable to differentiate type of woody-plant coverage that had occupied the reconstructed landscapes.

The grass-type phytolith body counts do allow for a more nuanced reconstruction of variation across landscapes of the Kisiwa area. When compared to values calibrated to grass communities of Eastern Africa, the Climate Index values from 1800-1964 contexts of the Kisiwa area documents a relatively even distribution of four instances of mixed, four instances of C3-Pooid type, and two instances of C4-Panicoid type subfamily grasses. The presence of locations that feature prevalence of both C3-Pooid and C4-Panicoid type grasses in a restricted area requires explanation. Such an explanation is also necessary for contexts that date between 600 and 900.

AD 900-1200: Woody plants account for more than 31% of the overall assemblage collected from contexts that date between AD 900-1200 in the Kisiwa area. Elevated levels of woody-plant type skewed the high percentage

phytoliths in STP 103, the 246 globular bodies identified in the context accounted

Date Range	Sample	STP	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plants	Density of Woody Plants Index	Climatic Index
600-900	534	95	91	216	0	0	93	0.303	0.704
600-900	540	96	144	106	25	0	129	0.469	0.385
600-900 600-900	547 555	97 98	100 112	175 194	0	8	125 94	0.455 0.307	0.636 0.634
600-900	563	99	109	151	3	4	114	0.433	0.574
600-900	570	100	72	155	0	0	173	0.762	0.683
600-900	578	101	215	126	16	0	45	0.702	0.353
600-900	588	102	264	83	25	0	32	0.086	0.223
600-900	594	103	146	140	7	0	92	0.314	0.478
900-1200	531	95	211	74	0	0	115	0.404	0.260
900-1200	536	96	82	168	14	0	154	0.583	0.636
900-1200	542	97	113	136	0	0	143	0.574	0.546
900-1200	552	98	142	138	12	0	114	0.390	0.473
900-1200	559	99	155	142	0	0	103	0.347	0.478
900-1200	567	100	182	178	0	0	40	0.111	0.494
900-1200	574	101	178	157	0	0	66	0.197	0.469
900-1200	585	102	103	109	37	0	145	0.582	0.438
900-1200	593	103	70	74	16	0	246	1.538	0.463
900-1200	598	105	115	131	17	0	137	0.521	0.498
1800-1964	528	95	105	186	7	0	102	0.342	0.624
1800-1964	535	96	105	198	12	0	85	0.270	0.629
1800-1964	541	97	139	92	0	0	169	0.732	0.398
1800-1964	549	98	175	108	29	0	100	0.321	0.346
1800-1964	556	99	105	169	11	0	115	0.404	0.593
1800-1964	564	100	196	150	9	23	47	0.132	0.423
1800-1964	571	101	101	211	27	0	70	0.206	0.622
1800-1964	582	102	170	128	0	0	103	0.346	0.430
1800-1964	589	103	183	139	0	0	78	0.242	0.432
1800-1964	595	105	91	177	0	0	132	0.493	0.660

 Table 5.6: Raw phytolith counts from Kisiwa, Mikindani Bay

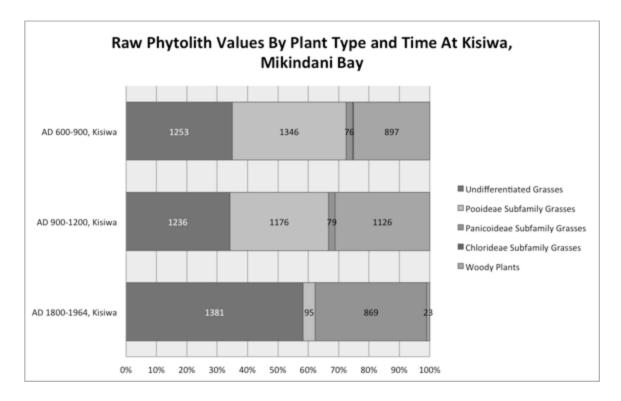


Figure 5.6: Phytolith percentages by plant type recorded from Kisiwa, Mikindani Bay

for 60.59% of the entire sample. Five of the other contexts had woody-plant type phytoliths that accounted for > 30% of the sample. The high representation of woody plants in this assemblage suggests high levels of woody plants in this area. While evidence does not exist with which I can evaluate the type of woody-plant communities that created these levels, the sample from STP 103 was the most heavily wooded in all of Mikindani Bay.

The relatively high proportions of woody plants apparent in this assemblage largely occupied landscapes that featured mixed grassland communities. This evidence is a bit of a surprise, as shade, like that given by a forest or tree canopy, is often associated with the presence of C3-Pooid type grasses. Eight of the 10 Climate

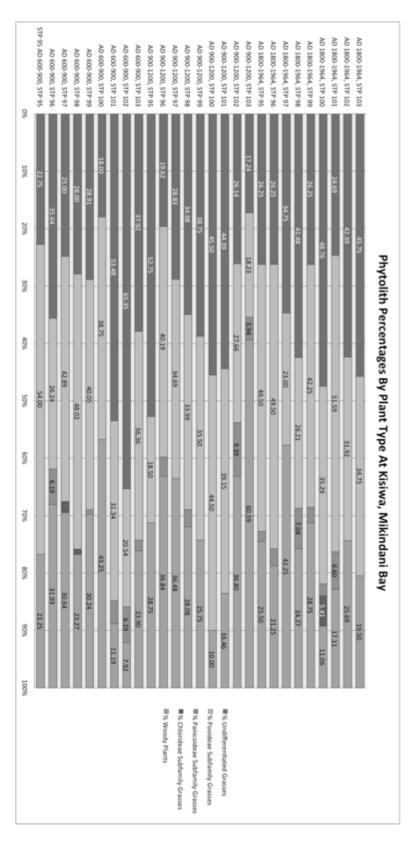


Figure 5.7: Phytolith percentages by plant type from each STP from Kisiwa, Mikindani Bay



Figure 5.8: Location of paleoethnobotanical samples from Kisiwa area of Mikindani Bay. Shading denotes topographic changes

Index values from this context align with mixed grass communities; one example each of C3-Pooid and C4-Panicoid prevalence was identified in the remaining landscape reconstructions. Values from the Climate Index provide more detail than the raw phytolith counts, which are heavily biased towards Pooid grasses.

AD 600-900: Analysis of contexts from this time period recorded a slight decrease in representation of woody plants relative to those noted from Period Four, a shift from 31% to 25.03% of the overall assemblage. The samples suggest a wide degree of variability as two samples had values below 11.5%, three samples fell between 23% and 24%, three samples had values between 30.24% and 31.93%, and one sample was 43.25% woody-plant type phytolith bodies. The clumped sort of variability here suggests several distinct types of woody plant communities may have existed in this area. Unfortunately, I am unable to determine which communities may have this assemblage without additional phytolith analyses in coastal regions of Eastern Africa.

The grassy landscapes apparent in this context differed from those recorded in subsequent centuries. The difference lies in representation of mixed grass communities, which were thought to characterize only two of the reconstructed landscapes. Four of the samples demonstrated a clear prevalence of C3-Pooid grasses while three had a similar prevalence of C4-Panicoid grasses. This information suggests a vast change in grass-community composition between 600-900 and 900-1200, a shift that caused specialized grass types to be replaced by mixed grass coverage. These results are also surprising because the high temperatures and low precipitation levels known to Mikindani Bay led me to expect

C4-Panicoid subfamily grasses to exist at the basal levels of this region. This assemblage clearly indicates that I need to revisit this assumption.

Miseti Hilltop

Miseti Hilltop is an elevated area sandwiched between Mikindani Bay and a coastal plain that terminates into Mikindani Bay. Survey in this area encountered multiple distinct environmental zones due to its varied topography and immediate-coast-adjacent geography. Modern hillside landscapes encountered in this survey bore evidence of active cultivation; contemporary farmers were also active in coastal plains and locations directly adjacent to ocean contexts. The ability of modern residents to farm the three distinct environmental zones made me question whether or not earlier residents acted in a similar manner. For this reason, I made sure that the survey of Miseti Hilltop sampled each available landscape to include contexts of hill slope and coastal plains.

Archaeological investigations of Miseti Hilltop recovered 1,727 local ceramic sherds, iron slag, and evidence of daub spread across the 6 ha site (Pawlowicz 2011: 84-86). The coastal site was occupied between the mid-first and mid-second millennium, as evidence demonstrates occupation during Periods Three, Four, Five, and Seven (Pawlowicz 2011: 85). The archaeological chronology of this site, therefore, documents evidence of the early-second millennium transition towards continental networks. I recovered local ceramics that align with the four occupational periods and associated geological strata identified in 2008 (Table 5.7). I also recovered glass beads from South Asia that date to the early-to-mid second

millennium AD. Such finds complicate Pawlowicz's (2011: 85) description of Miseti Hilltop and Periods Four and Five, as they point to some contacts, however indirect, with coastal commerce.

Miseti Hilltop: Phytolith Results

I analyzed 30 paleoethnobotanical samples collected from 10 STPs surveyed around the Miseti Hilltop area. Materials recovered in this survey combined with reports from previous investigations define relative ages of the three geologic layers under consideration here: AD 1800-1964 (Period Seven), AD 1500-1800

<u>Layer 1</u>: (0-25 cm) dark brown sandy loam topsoil; layer was disturbed from modern agricultural activity. It produced no diagnostic artifacts.

<u>Layer 2</u>: (25-80 cm) light brownish-red sandy clay loam, significant mottling with dark brown, light brown and reddish-yellow sediments; there were very few artifacts from this layer, providing a clear break between the topsoil and cultural material underneath it.

<u>Layer 3</u>: (80-130 cm) dark red sandy clay with a slight brown tint; this layer was distinguished from the preceding layer by its higher clay content and slightly redder color. It possessed a dense concentration of artifacts including local sherds with first-millennium affiliations, slag, and daub.

<u>Layer 4</u>: (85-100) shell midden layer, abundant shell and other artifacts in a light brown sandy clay loam matrix; the midden was contained within Layer 3 but was designated as a layer because of its distinct sediment and because it encompassed more than half of the excavation unit. In addition to shell the midden produced a great deal of charcoal and several large sherds with first-millennium decorative motifs.

<u>Layer 5</u>: (130- 170 cm) reddish-brown sandy clay; this layer was much more compact than Layer 3 and had significant mineral leaching. The only artifacts recovered were from the top level, otherwise the layer was sterile.

Table 5.7: Geologic chronology of Miseti Hilltop area according to preexisting stratigraphic analyses (Pawlowicz 2011: 85)

(Period Six), and AD 900-1500 (Periods Four and Five). Table 5.8 presents raw phytolith counts and index values recorded from this region. Figure 5.9 documents the phytolith percentages of all phytoliths by plant type recorded from this area, while Figure 5.10 is a histogram that details the ratios on an STP-by-STP basis. Figure 5.11 presents the locations of each STP to give an idea of the ways in which plant community composition varied across the region. The results suggest little difference between hilltop, hill slope, and coastal plain locations.

AD 1800-1964: Woody plants account for 28.49% of the total phytolith assemblage from the Period Seven contexts of Miseti Hilltop area. I was initially surprised by to see this coverage was commensurate with that recorded in Kisiwa and Imekuwa Mibuyu areas because I assumed that hill slope would have limited the potential ability of woody plants to colonize such areas. This assumption was incorrect, as woody plants were apparent throughout the area in proportions similar to those recorded in other environmental zones. The overlap apparent in woody plant presence is interesting to note; it may mask the presence of different types of woody-plant communities in the environmental zones that I consider here. The relatively high levels of woody plants apparent in this context apparently did not shade C3-Pooid type grasslands, as none of the samples from this period had Climate Index values that align with this grass. Instead, calculations suggest that C4-Panicoid grasses were prevalent in five locations while an additional five samples had an equal mixture of the two grass subfamilies. The prevalence of C4-Panicoideae type grasses may indicate drought conditions, anthropogenic influences, or some combination of the two.

AD 1500-1800: Woody plants make up 26.55% of the phytolith assemblage from this time period. Outliers balance themselves out to create the overall ratio that reflects values reported through time and space in the Mikindani Bay region. On the high side, outliers include values of 46.39% and 44.25%; the lowest value is 9%. Again, these ratios likely indicate that different types of plant communities likely existed in this area during Period Six; however, I am unable to verify this notion or speak towards which communities or types of species may have been present.

The reconstructed grass communities from this time period demonstrate a C4-Panicoid subfamily representation that matched that reported from Period Seven contexts. The five samples with C4-Panicoid prevalence existed alongside two communities of mixed grasses and one instance of a C3-Pooid subfamily prevalence. Again, these reconstructed grass communities suggest the presence of arid conditions or anthropogenic influences. I say this because C4-Panicoid grasses are able to thrive in warm, water-poor environments. The subfamily also accounts for all domestic African grains known to have been cultivated in the region at this time.

AD 900-1500: The phytolith assemblages from this period do not reflect those reported from the more recent time periods. Between 900 and 1500 woodyplant type phytoliths only accounted for 17.16% of the overall assemblage; this value was clearly impacted by STPs 116, 123, and 122 which had ratios of 4.75%, 7.5%, and 8.65%, respectively. The low level of woody plant coverage suggests that anthropogenic influences enacted in this area did not interfere with woody plant

community coverage. In fact, human activity may have promoted woody plant coverage through time.

Date Range	Sample	STP	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plant Bodies	Density of Woody Plants Index	Climatic Index
900-1500	655	116	28	345	6	2	19	0.050	0.910
900-1500	661	117	185	115	28	8	64	0.195	0.351
900-1500	667	118	128	187	27	7	51	0.149	0.547
900-1500	673	119	153	115	0	0	134	0.500	0.429
900-1500	678	120	123	123	21	0	134	0.502	0.461
900-1500	683	120	162	139	23	0	69	0.213	0.429
900-1500	689	121	135	153	34	0	78	0.242	0.475
900-1500	695	123	137	230	3	0	30	0.081	0.622
900-1500	700	123	151	198	10		34	0.095	0.552
1500-1800	652	116	162	153	44	5	36	0.100	0.426
1500-1800	658	117	80	148	0	0	181	0.794	0.649
1500-1800	659	117	151	112	21	0	116	0.408	0.394
1500-1800	665	118	149	114	54	19	62	0.196	0.360
1500-1800	670	119	205	113	0	0	82	0.258	0.355
1500-1800	677	120	146	104	22	0	128	0.471	0.382
1500-1800	687	121	123	89	5	0	187	0.862	0.410
1500-1800	699	123	241	103	2	0	54	0.156	0.298
1800-1964	650	116	139	92	0	0	171	0.740	0.398
1800-1964	656	117	148	174	0	2	77	0.239	0.540
1800-1964	657	117	70	110	120	0	108	0.360	0.367
1800-1964	662	118	182	130	7	0	88	0.276	0.408
1800-1964	663	118	131	114	5	0	150	0.600	0.456
1800-1964	668	119	141	160	50	1	48	0.137	0.456
1800-1964	674	120	178	111	0	0	111	0.384	0.384
1800-1964	684	121	195	88	33	0	84	0.266	0.278
1800-1964	690	122	169	144	6	0	81	0.254	0.451
1800-1964	697	123	82	74	19	0	226	1.291	0.423

Table 5.8: Raw phytolith counts from the Miseti Hilltop are, Mikindani Bay

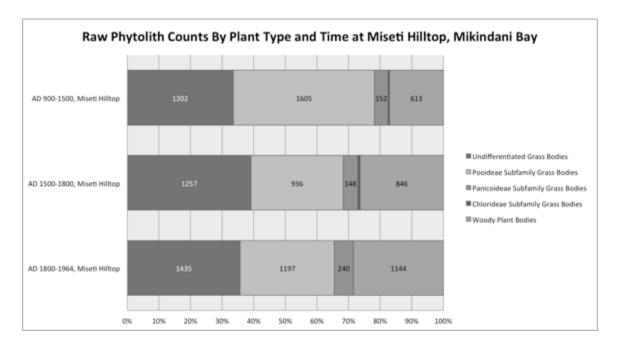


Figure 5.9: Phytolith percentages by plant type from Miseti Hilltop, Mikindani Bay

The grass communities reconstructed from this early period also differed from those recorded above. Only one instance of location with C4-Panicoid prevalence was apparent. Two samples demonstrated C3-Pooid subfamily prevalence while six samples had Climate Index values that suggested an equal mixture of C3-Pooid and C4-Panicoid grasses had populated the area.

Litingi Channel

Archaeological remains recovered in the Litingi area of this region covered less than one ha; this represents the smallest extent of material residues that I considered in this study. I decided to investigate this site because previous investigations recovered a Late Stone Age ceramic sherd in the area (Kwekason 2007, 2013; Pawlowicz 2011: 333). I figured that microbotanical remains from this area would permit me to evaluate the ways in which residents of Litingi Channel

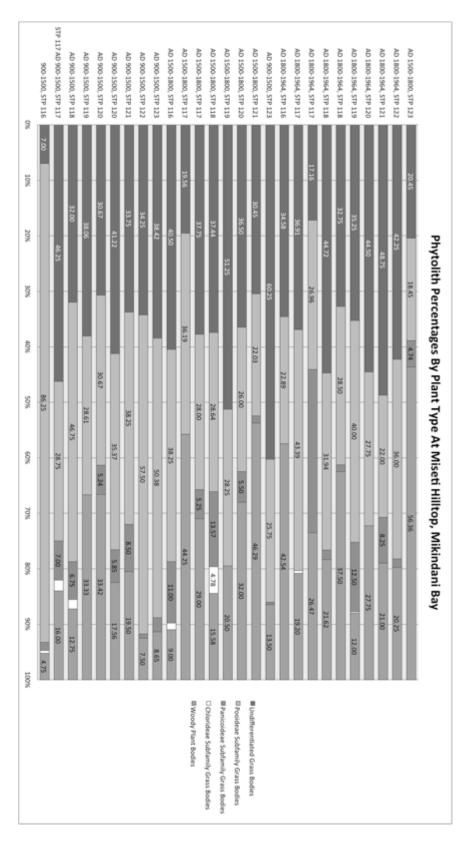


Figure 5.10: Phytolith percentages by plant type from Miseti Hilltop, area of Mikindani Bay

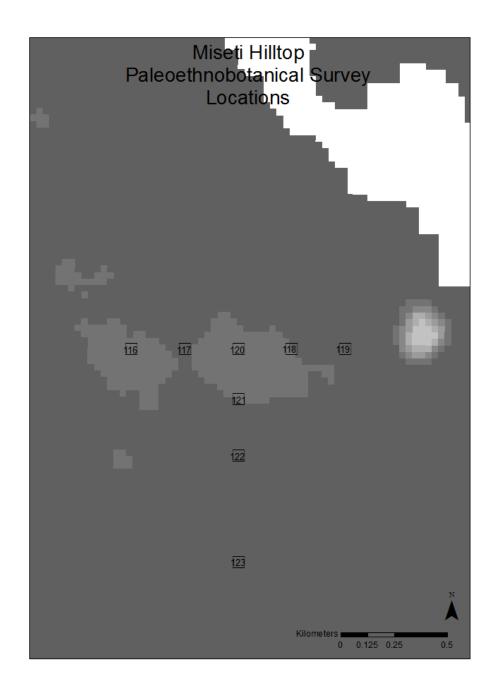


Figure 5.11: Location of paleoethnobotanical samples from Miseti Hilltop area of Mikindani Bay. Shading denotes topographic changes

had interacted with local plant communities as far back as 300 BC. I was especially interested in this information because the interaction between mobile, huntergatherer populations and environments has been difficult to ascertain. Although Litingi Channel yielded low levels of archaeological materials from Stone Age contexts; I figured human actions could have affected local plant communities.

Litingi Channel comprises the far-eastern lip that constricts Mikindani Bay; to accommodate this unique geography I oriented my survey universe on an east-west axis. The result was a survey of coastal scrub, open grassland, and beach sand. Unlike the larger archaeological sites of Mikindani Bay, the material residues recovered at Litingi Channel did not create a range of seriated morphotypes through which I could derive relative dates. The only chronologically significant residue recorded from this region was a ceramic sherd from the Late Stone Age (Pawlowicz 2009, 2011), derived from a heavily eroded context on the edge of this channel.

Litingi Channel: Phytolith Results

The unique geography and restricted size of Litingi Channel resulted in only three STPs in the area. The units contributed a total of seven samples with phytolith residues; these samples did not have a range of relative dates with which I could evaluate relative dates of the microfossils. The lack of chronologic information and the small sample size limit the analytical capabilities of the Litingi Channel assemblage. For this reason, I simply present the assemblage values and the figures that derive from the raw counts in Table 5.10. The analysis of phytolith residues recovered from other LSA sites recorded in this region would allow me to better

address the interaction between these earliest residents and plant communities (Kwekason 2007, 2013).

Date Range	Sample	STP	Undifferentiated Grasses	Pooideae Subfamily Grasses	Panicoideae Subfamily Grasses	Woody Plants	Density of Woody Plants Index	Climatic Index
Late Context	856	147	142	127	46	74	0.23	0.40
Middle Context	859	147	140	74	36	153	0.61	0.30
Late Context	860	148	137	154	10	81	0.27	0.51
Middle Context	863	148	133	53	45	170	0.74	0.23
Late Context	869	149	105	87	65	124	0.48	0.34
Middle Context	871	149	170	119	68	51	0.14	0.33
Early Context	875	149	151	119	11	102	0.36	0.42

Table 5.9: Raw phytolith counts from Litingi, Mikindani Bay

Discussion

General Impressions of Woody-Plant Communities Through Time and Space

Levels of woody-plant type phytoliths recorded in this assemblage suggest a relatively consistent representation of such plants through time across Mikindani Bay. Consistency is evident because woody plants account for about 25% of phytolith assemblages from each area. This consideration masks intra-area variation, though such intra-area variation seems to have occurred in a predictable, uniform manner through time and space. The typical distribution of woody plant representation saw two or three samples in each assemblage with > 40% woody plant phytoliths and another two to three < 15% woody plant phytoliths. I will speak to this area-specific spatial variation in a moment.

Analytical methodologies contribute towards the representation of woodyplant phytoliths in site-specific and regional analyses. I compare one category of
woody-plant phytolith bodies to four different categories of grasses; however, there
is limited evidence that Pooideae, Chlorideae, or Panicoideae subfamily grasses
contribute phytoliths to undifferentiated and subfamily-specific categories.

Phytolith types that comprise the woody-plant class do demonstrate such overlap
between wide varieties of woody plants. For this reason, I do not believe that the
sample strategy was biased towards the capture of grass phytolith morphologies.

That said, if I compare counts of woody-plant phytoliths to those of either
undifferentiated grasses or those diagnostic to particular subfamilies, then the
woody-to-grass representation is nearly equal.

In some cases, a comparison of woody-plant to grass-type phytoliths can be used to distinguish vegetation communities that covered archaeological landscapes (Barboni et al. 1999). Density of Woody Plant Index values would permit this level of reconstruction; however, this index requires region-specific calibration. As Bremond et al. (2008) demonstrate, such calibration is not yet available for the coast of Eastern Africa. Though I am unable to identify particular woody plant communities captured in samples from Mikindani Bay; results clearly suggest that multiple varieties of woody plant communities populated Imekuwa Mibuyu, Kisiwa, and Miseti Hilltops during each time period under consideration. This variation may align loosely with the woody-plant communities that I encountered in 2011. Such communities included light scrubland, cashew plantations, and grasslands with mature trees. Further microbotanical analyses in the region will permit a more

nuanced understanding of the woody-plant vegetation communities represented in this survey.

General Impressions of Grass Communities Through Time and Space

Temporal and geographic patterns were apparent in grass community composition from the landscape reconstructions. As I discuss here, the patterns likely derive from some combination of climatic, biologic, and anthropogenic influences. The earliest grass communities featured more landscapes, four total, with C3-Pooid subfamily prevalence than that recorded from C4-Panicoid or mixed grass communities, which had three and two instances, respectively. The high proportion of C3-Pooid grasses is a surprise in Mikindani Bay because the area is known to be warm, arid, and covered by soils with limited fertility. Such factors should all limit the success of C3-Pooid grasses and, in turn, promote the presence of C4-Panicoid grasses. Consideration of global climate patterns (Chapter Two) suggests that this moment may correspond to a slight episode of global cooling; this factor would help promote C3-Pooid fitness. Despite apparent correlation, the impact of this global climate pattern on the coast of Eastern Africa is, as yet, unclear.

Beyond considerations of climate conditions, I suggest that this distribution of C3-Pooid type grasses and C4-Panicoid type grasses may also derive from influences brought about by other vegetative communities. The C3-Pooid grass subfamilies are known to thrive in shaded areas. While much of the literature regarding this C3-Pooid proclivity relates to shade included by the colonization of such grasses in mountainsides, there is no reason to think that shade from tree

canopies may not also influences the fitness of C3-Pooid grass community colonization. The phytolith record does not support this hypothetical relationship between woody plant coverage and C3-Pooid grasses, as no clear correlation exists between counts of phytoliths from either plant type. Fredlund and Tieszan (1979) found that some Panicoid subfamily grasses have the potential to use C3-phytosynthetic pathways when in chronic shade conditions. This phenomenon may explain the lack of correlation between woody plants and C3-Pooid grasses.

Anthropogenic activities relating to the agropastoral subsistence economy known to Iron Age populations of this region may also contribute to the presence of C3-Pooid and C4-Panicoid grasses. Domestic ungulates known to the Swahili communities include cow, sheep, and goat. These animals are able to subsist on a range of grasses, though evidence suggests that the species prefer pastures of C3-Pooid grasses. For this reason, the prevalence of such grasslands may represent pasturage intended to rear domestic animals. The zooarchaeological record from this region is very limited, no more than 20 identifiable bones, but does document the presence of at least 4 sheep or goats (Pawlowicz et al. forthcoming). Waste from these animals could act to fertilize pastureland. Soil chemistry analyses report such fertilization; it is important to note that such fertilization could support agriculture or even further promote the colonization of C3-Pooid grasses. In this way, the zooarchaeological, soil chemistry, and phytolith records may combine to document direct evidence of this relationship.

Subsistence agriculture may also play a role in the composition of grasslands in the region. Domestic African grains, like millet and sorghum, are members of the

C4-Panicoid grass subfamily. For this reason, locations with high levels of Pooid-specific phytolith bodies may be indicative of farm plots, as these anthropogenic spaces would be manufactured to contribute high levels of Panicoid phytoliths.

Macrobotanical remains clearly demonstrate that such C4-Panicoid domesticates were cultivated throughout the region (Pawlowicz et al. forthcoming). As I detail in Chapter Two, farmers are known to physically alter local landscapes to retain water and prevent erosion. If such actions had been applied to this region, then water retention could have promoted the fitness of C3-Pooid subfamily grasses.

The phytolith analyses of archaeological contexts from 600-900 contribute an additional line of evidence to the zooarchaeological and macrobotanical records, both of which document evidence of human actions that may have altered plant communities in the region. Unfortunately, I was unable to identify direct evidence of Pooid species known to be preferred pasturage or African cultivates. A direct link may be possible with investigations that specifically target such grass types; such specificity did not align with the exploratory nature of this investigation.

While I am unable to confidently account for the prevalence of C3-Pooid grasses, it is important to note that this subfamily and C4-Panicoid subfamily grasses had been prevalent in locations throughout this area in the earliest contexts. This is an important point because such prevalence largely disappeared in AD 900-1500 archaeological contexts. The 19 samples with Climate Index values that suggested mixed grasslands far outstripped the 5 C3-Pooid prevalent samples and 5 samples with C4-Panicoid subfamily prominence.

The turn towards mixed grasslands during this period is interesting, as it coincides with a social transition away from socioeconomic pursuits common to the coastal region. The correlation between grass-community composition and socioeconomic pursuits may be circumstantial, as archaeological evidence suggests little to no change in subsistence pursuits occurred between 900 and 1500. The shift in grass community composition also corresponds with the Medieval Warm Period, a centuries-long episode of global warming. This warm period brought arid conditions to Eastern Africa, conditions expected to bring about increased representation of C4-Panicoid grasses.

It is important to note that soil chemistry analyses recorded an increase in the presence of C4 grasses through time (Pawlowicz 2011). Phytolith residues suggest that this trend may not have been true for to the entire region, as the prevalence of such grasses decreased during Periods Four and Five. The samples here may also be dealing with incongruous chronologies, as soil chemistry samples had a tighter chronology (for detail see Pawlowicz et al. forthcoming).

Grass communities that I reconstructed from the most recent archaeological context demonstrate a wide array of variability between the three areas under consideration. The lack of any trend apparent in grassland composition suggests location-specific anthropogenic influences. I look to human-influences because the three areas all experienced commensurate climatic conditions. This means that local or global climate trends could not account for such change. Unfortunately, the varied imperial, colonial, and local activities known to occur in this period muddle the interpretation of this variability. While I am unable to identify specific

influences or intentions from Period Seven, such discontinuity apparent between areas supports the notion that anthropogenic influences from multiple sources were actively applied to the region after 1800.

Evaluation of Research Questions

Can phytolith analyses capture evidence of human activity or anthropogenic influences that date back to the Late Stone Age?

The discussion of phytolith results from the Litingi Channel area clearly demonstrates that this phytolith analysis did not capture evidence of Late Stone Age human activity in the Mikindani Region. The lack of relevant evidence may accurately document the lack of LSA anthropogenic influences in the area. However, a variety of factors may also contribute to the lack of human-environmental interaction recorded from the area. First, I want to note that the geography of this area limited the number of STPs and samples I collected; further, the sandy geology of this area muddled the recovery and analysis of phytolith residues in the contexts that I did evaluate. For this reason, I do not want to rule out the analytical potential of phytoliths for evaluation of LSA archaeological contexts. That said, future analyses should look to the LSA archaeological contexts identified on the Makonde Peninsula (Kwekason 2007, 2013).

Do plant communities reconstructed from archaeological contexts align with modern vegetation known to the five environmental zones?

Woody plant assemblages reconstructed from the archaeological contexts of this region suggest variation in vegetation community through space (i.e., intra-area and inter-area variability). The tone and tenor of this variation remained consistent

through time, as each area had two to three instances of < 15% and > 40% woodyplant phytoliths in each time period under consideration. While I am unable to directly identify the types of woody plants that constituted the archaeological landscapes, I can look to modern plant communities for additional information. Appendix One documents the results of a modern botanical survey that I conducted in the region with Mr. Canisius Kayombo, a Curator at the herbarium of Forestry Training Institute of Olmotonyi-Arusha, Tanzania. We recorded more than 80 different types of woody plants, the genera and species of which typically colonize water-logged forests, scrubland, and anthropogenic groves filled with coconut palms, cashew trees, or pea plants. Additional phytolith analyses that consider silica body morphologies specific to particular plant species will inform the direct relationship between the finds reported here and particular vegetation communities. Until that information is available, I can only say that variability apparent in the archaeological record seems to align with variation in the modern woody-plant assemblages.

Grass communities apparent in the modern contexts do not align with those noted in the landscapes reconstructed from archaeological contexts.

Reconstructions note several instances of C3-Pooid subfamily grass prevalence in each social period under consideration. The modern assemblage from this region had only one instance of a C3-Pooid type grass. The prevalence of C4-Panicoid grasses apparent in archaeological contexts also does not align with the > 10 modern samples from this subfamily.

I think it is safe to say that anthropogenic activities did manage to influence plant community composition in the region. That said, region-specific influences or patterns are not readily apparent in this paleoethnobotanical record. Additional analyses with more chronologic acuity and phytolith-body specificity will allow a more meaningful calibration of plant community, and anthropogenic, change through time and space.

Do phytolith samples from the early-second millennium reflect the dramatic social changes known to have occurred during this period? What about the late-second millennium moment of economic prominence?

Mixed grasses dominate the archaeological assemblage that dates between 900 and 1500, the time period during which residents of Mikindani Bay forged social ties with far inland and southern communities. This arrangement is different from earlier contexts and those that followed, as 600-900 and 1500-1964 contexts all had high proportions of C3-Pooid or C4-Panicoid prevalent grass communities. Any anthropogenic influence that would target or create mixed grass communities between 900 and 1500 is unclear, as subsistence economies are known to have remained consistent in this period. For this reason, global climate patterns may have also played an active role in the constitution of grass communities at this moment. A pair of globally cool periods occurred in the centuries that led to AD 900 and followed AD 1500; a warm period was known to have occurred during the intervening centuries. These phytolith results suggest that the impact of such global climate patterns on the Swahili coast deserves additional investigation.

I want to point out that the modern period is also a warm one. The high temperatures apparent since 1964 and experienced during my 2011 fieldwork may

have contributed to the overall lack of C3-Pooid grasses noted in the survey of modern plant communities.

The range of anthropogenic, climatic, and biological factors known to have been active across the Mikindani Bay region clearly demonstrates the importance of perspectives from historical ecology in the area. Additional analysis will be necessary to fully understand the implications of each factor, though the phytolith analysis presented here demonstrates that each constituent clearly deserves further consideration.

Chapter Six

Northern Pemba Island: Reconstructed Landscapes from in and around the Archaeological Settlements Tumbe and Chwaka

Pemba Island, 1000 sq. km, lies 60 km east of the coast of northern Tanzania (Figure 6.1). Travelers have recorded encounters with this island and its residents since the late first millennium AD. Arab travelers who visited during the sixteenth century labeled Pemba the "Green Island" and noted that residents converted their lush environments into a regional "breadbasket" that contributed subsistence resources to nearby urban communities (Horton & Middleton 2000). The material record known to Pemba reveals a rich social history, one that had been overlooked by historic reports that focus on ecological conditions. LaViolette and Fleisher (2009: 433-434) report that communities on northern Pemba played prominent roles in regional economic and religious spheres through the mid-second millennium.

The prolonged social prominence and lush environments combine to make the botanical landscapes of Pemba Island an ideal addition to this project. This chapter builds to a presentation of botanical landscapes that I reconstructed from archaeological contexts in and around the sites Tumbe and Chwaka.

Iron Age agropastoralists first colonized this island during the mid-first millennium (Fleisher & LaViolette 2013). Artifacts recovered from the earliest



Figure 6.1: Pemba Island. Shading indicates changes in elevation. Chwaka and Tumbe are located in upper right corner

archaeological contexts at Pemba are similar to those from peer settlements across coastal East Africa (Fleisher 2003). This shared material assemblage includes an overlap in ceramic form and motif, paleoethnobotanical evidence of the cultivation of African grains, permanent villages, and iron-working technologies (Chami 1998; Phillipson 2005; Fleisher & Wynne-Jones 2011; Fleisher & LaViolette 2007, 2013).

Beyond a material assemblage common to the Eastern African Iron Age, the earliest archaeological contexts of Pemba Island include evidence of engagement with people from the continent and across the Indian Ocean (Fleisher & LaViolette 1999, 2007, 2013; Fleisher 2003; LaViolette & Fleisher 2009). The transition towards an urban, Islamic population reported from Pemba Island is a shift common to communities throughout the Swahili coast (Kusimba 1999; Horton & Middleton 2000; Connah 2013).

I focus my paleoethnobotanical efforts on two adjacent, but chronologically distinct archaeological sites: Tumbe and Chwaka. The earth-and-thatch settlement at Tumbe was active between AD 600 and 1000 (LaViolette & Fleisher 1995); the site covered up to 26 ha, though it is likely that the settlement accrued through time and the broad extent was never simultaneously occupied (Fleisher & LaViolette 2013: 1154). Migrants founded Chwaka several hundred meters outside of Tumbe in 1050 (Fleisher 2003). Through the course of the next five centuries, residents of Chwaka constructed religious and mortuary monuments of stone and another 12 ha of densely packed earthen structures (LaViolette 2008: 40-41). Evidence suggests that migrants from the hinterland populated the stonetown at Chwaka; though the

urban residents apparently continued to work hinterland agricultural plots to meet economic and subsistence needs (Fleisher 2003, in press; Walshaw 2010: 150).

The Sultanate of Oman gained control of the entire Zanzibar Archipelago, which includes Pemba Island, at the turn of the eighteenth century AD (Sheriff 1987). Omani rulers imposed a set of new economic priorities; on Pemba, these priorities saw a shift from the production of food and cotton to a reliance on clove trees as an international cash crop (Troup 1932; Wigg 1937). The Omani Sultanate mandated heavy clove arboriculture across both Unguja and Pemba Islands. This imperial influence elevated the archipelago to the clove capital of the world during the nineteenth and early twentieth centuries (Kirsopp 1926; Crofts 1959). I encountered clove plantations as I traveled through Pemba Island in 2009 and 2011; on each trip I noted that residents managed to grow clove trees directly adjacent to agricultural plots as well as forests tracts.

The unique material expressions recovered on Pemba make the island an ideal venue to consider the long-term implications of interaction between East African peoples and coastal environments. I apply paleoethnobotanical reconstructions of past landscapes to evaluate the following questions specific to northern Pemba Island. The questions include:

- In what ways did plant community management strategies change between the agropastoral village of Tumbe and the densely occupied Chwaka?
 - Does the microbotanical record indicate whether altered subsistence strategies contribute to the anthropogenic legacy post-1500?
- Do the landscapes of northeastern Pemba bear evidence of increased agriculture or animal husbandry during the sixteenth through nineteenth centuries?

• The presence of Ngezi Forest, modern clove plantations, and colonial accounts of forested conditions throughout the island coalesce to create the impression that Pemba has long been a heavily-wooded island. How do such conditions manifest in the microfossil record?

I apply theoretical perspectives from historical ecology (see Chapter 2) and methodologies from paleoethnobotany (see Chapter 3) to evaluate the recursive relationship between residents of northern Pemba and local biophysical conditions. I organize the chapter to build towards a presentation of the results and interpretation of phytolith-based landscape reconstructions. I open with a review of relevant archaeological, historical, and environmental literature that addresses Tumbe and Chwaka as well as the region. I then present the phytolith-based landscape reconstructions. I follow a chronologic approach to this presentation, moving backwards from more recent contexts. Finally, I close the chapter by engaging the above research questions.

Settlement History of Northern Pemba Island

People from continental Eastern Africa appear to have first crossed the Pemba Channel to inhabit Pemba Island soon after AD 600 (Fleisher & LaViolette 2013: 1154). Evidence from previous paleoethnobotanical investigations suggests that the earliest occupants cultivated domestic plants and animals and also derived subsistence needs from marine contexts (Fleisher 2003; Walshaw 2005). Archaeological investigations also suggest an ongoing engagement with regional and long-distance trade networks that connected continental Africa with the Indian Ocean commercial system (LaViolette & Fleisher 2009: 437). The material

pattern of Swahili settlement in Eastern Africa. The material assemblages may resemble those of coastal regions; however, the settlement coverage, in terms of both geography and number of communities, is exceptional. Garlake (1966) noted that Pemba had the highest density of visible stone-built sites available along the Eastern African coast. Sub-surface survey unearthed an additional 33 archaeological sites spread across the northern of the island (Fleisher 2003: 132). The surface and sub-surface settlements known to the region were active between the eighth and eighteenth centuries. The high density of settlements identified in the sub-surface survey prompted Fleisher (2003: 136) to argue that archaeologists had severely underestimated the number of Swahili communities, geographic coverage, and overall number of people who occupied coastal East Africa prior to the eighteenth century.

The dense array of settlements noted by archaeological surveys yielded evidence of socioeconomic and material overlap between the settlements; this overlap was apparent regardless of site size (LaViolette & Fleisher 1995; Fleisher 2000). The sub-surface survey also demonstrated that the majority of the pre-tenth century settlements covered less than 3 ha (Fleisher 2003); previous coastal investigations define such small settlements as field houses, hamlets, or villages (Wilson 1982). Such settlements occupied the full range of ecological conditions available in northern Pemba (Fleisher 2003: 132-134). Inhabitants were known to have abandoned their field houses, hamlets, or villages to settle larger towns sometime during the eleventh century (Fleisher 2003; Fleisher & LaViolette 2013).

I want to note the material overlap apparent between these settlements is not indicative of any sort of settlement ranking system (Fleisher & LaViolette 2013: 1154). Instead, evidence articulates with Allen's (1993) notion of autonomous, yet interrelated settlement systems.

Fourteen of the 47 sites identified across northern Pemba were considered villages, meaning that they were 1-3 ha. Each village-level site had evidence of a marked ranking system that featured elaborate stone-built public mosques and tombs (Fleisher 2003: 140). Early research on the island demonstrated a bias towards these 14 larger sites, likely because such settlements were readily visible on modern landscapes. The larger sites with stone architecture include sixteenth-century site Pujini (LaViolette 1994, 1996; Fleisher et al. 2004), eleventh to fourteenth century Mkia wa Ng'ombe (Buchanan 1932: 18; Horton & Clark 1985: 23-25), eleventh to fourteenth century Mduuni (Horton & Clark 1985: 23), fifteenth-century Msuka Mjini (Horton & Clark 1985: 25), Verani (Horton & Clark 1985: 21), and Chwaka (Fleisher & LaViolette 1999). The hierarchical system sheds light on interactions between residents of a given site as inter-site stratification did not appear until the island became a part of the Omani Sultanate (Sheriff 1987).

Exotic goods recovered across the region suggest that settlements in the region maintained a central role in Swahili and Indian Ocean commercial networks (LaViolette 2008: 27, 34-35). Research at pre-fifteenth-century settlements uncovered a high density of imported goods, including ceramics from the Persian Gulf, South Asia, and China (Fleisher 2003; LaViolette & Fleisher 2009; Fleisher & LaViolette 2013); glass vessels; and copper items. The density of imports recovered

from archaeological contexts that predate 1000 is similar to those reported from at Unguja Ukuu (Juma 2004), located on nearby Unguja Island. Artifact densities from these two settlements trail only those reported from Manda (Chittick 1984), a site on the coast of northern Kenya. The largest cache of coins so far found on the Swahili coast was recovered from tenth- to eleventh-century contexts at Mtambwe Mkuu on Pemba (Horton et al. 1986). The survey recovered more than 2,000 silver and gold coins.

This review highlights the existence of autonomous island populations that were well-integrated into regional and international socio-economic networks between the eighth and eighteenth centuries. A shift in settlement strategies accompanied the transition between the first and second millennia; this shift is responsible for the eleventh-century elaboration in settlement size and complexity and manifest through sites > 3.0 ha. Survey results suggest that populations moved from dispersed field houses, hamlets, and villages to densely occupied towns or urban stonetowns between 1050 and 1500 (Fleisher 2003: 140).

I explore direct evidence of material and social histories through a detailed review of two chronologically distinct settlements: the sprawling village of Tumbe, active between 600-1000, and the stonetown Chwaka, active 1050-1500. These sites demonstrate evidence of regional and international entanglements throughout the course of their occupation (LaViolette 2008). The review of the archaeological history known to these two settlements is followed by a brief review of the environmental history and contemporary conditions apparent across Pemba Island.

Socioeconomic, Settlement, and Subsistence Histories of Tumbe

Tumbe was founded in the seventh century and, by the tenth century, had grown to cover > 20 ha of the northeastern coast of Pemba Island (LaViolette & Fleisher 1995; Fleisher & LaViolette 1999). Archaeological investigations suggest that the entire settlement was never occupied simultaneously; that said, the pockets of habitation share a common material record with no evidence of socioeconomic hierarchy (Fleisher & LaViolette 2009, 2013). Further, the material assemblage from this area directly connects Tumbe to Iron Age communities across Eastern Africa, because archaeologists report agropastoral subsistence strategies that relied on African grains and domestic ungulates (Mwebi 2000; Walshaw 2005); iron working technologies (Mapunda 2003); and Early Tana Tradition ceramics (LaViolette & Fleisher 1995; Fleisher 2003: 228). Households at Tumbe were thought to share a general domestic economy upon which they relied to gain access to exotic trade goods (Fleisher 2003). Access to such goods remained equal across the settlement; however, people who occupied hamlets or farmhouses in the surrounding hinterland could not access such goods. Evidence of bead grinders, which craft shell beads for export, suggests this artifact class had provided residents of Tumbe access to the Indian Ocean commercial system (Flexner et al. 2008). Bead grinders were the only class of local artifact reported from Tumbe but not the surrounding hinterland.

Pearl millet acted as the agricultural staple for residents of Tumbe (Walshaw 2005; 2010). First-millennium farmers supplemented this African grain with legumes, coconuts, fruits, nuts, and a limited amount of Asiatic rice. The list of

macrobotanical finds known to the region helps to craft the expectations that I hold for reconstructed plant communities. In terms of grass communities, I expected C4-Panicoid grasses due to heavy reliance on African grains, C3-Pooid grasses due to the known presence of domestic ungulates, and phytoliths of the Chlorideae grass subfamily due to the reported consumption of exotic rice.

The distribution of villages, hamlets, and farmhouses known to this region may represent a well-articulated example of Iron Age environmental exploration, a practice recorded in the Kilwa (Wynne-Jones 2005) and Mikindani Bay regions (Pawlowicz 2011). The degree of archaeological detail available from the Tumbe area allows researchers to define household economies from this area as highly successful (Fleisher 2003). For this reason, Tumbe is portrayed as an "important trade center on a coastal strip that would become famous for its trade ports, but it was not itself the nascent form of any such place" (Fleisher & LaViolette 2013: 1167).

Socioeconomic, Settlement, and Subsistence Histories of Chwaka

Chwaka emerged on the northeast coast of Pemba Island by 1050 (Fleisher 2003). The site was founded as a 1 to 2 ha village located a few hundred meters from abandoned Tumbe (Fleisher 2000). The modest origins of Chwaka quickly gave way to a densely settled town that covered approximately 12 ha of the northeastern coast, overlooking Micheweni Bay (Walshaw 2010: 150). Regional investigation indicates that the dense populations of Chwaka derived from immigration of rural farming families from the surrounding hinterland (LaViolette &

Fleisher 2009: 445). The settlers continued to rely on earthen domestic structures, though they situated their earth-and-thatch homes in such a way that the corners of these structures nearly touched (LaViolette & Fleisher 2009: 453). The densely packed earthen structures surrounded, eventually, four stone-built mosques and 10 stone tombs. The combination of earth-and-thatch homes and stone-built religious structures represents an atypical approach to urbanism in coastal East Africa (Fleisher 2010). Swahili elites are typically thought to derive their social status from commercial enterprise (Kusimba 1999; Horton & Middleton 2000). An emphasis on Islam undergirds differences apparent in the economic, political, and social structures between Chwaka and other Swahili settlements. The stonetown was abandoned in the early sixteenth century.

The material assemblage of Chwaka represents a shift in degree, but not distribution or kind, from that recovered in and around Tumbe. Exotic materials were restricted to the urban context after 1050, just as foreign materials had been exclusive to towns prior to 1000 (LaViolette & Fleisher 2009). Households managed their own economic entanglements, unencumbered by a class of mercantile elites (LaViolette & Fleisher 2009: 446). Inter-site autonomy was also apparent through a shared access to particular types of goods across northern Pemba (Fleisher 2003: 164, 318, 352), including imported pottery, locally produced iron slag, and spindle whorls.

The wide distribution of spindle whorls, macrobotanical evidence of cotton, and iron slag suggests an increased level of human-environmental interaction at Chwaka. Cotton plants used to create thread for local consumption or export, and

worked with spindle whorls, could have been integrated into a number of farming systems that had already existed in the region (Walshaw pers. comm., 2014). In this way, residents of Pemba had the opportunity to grow cotton and produce cloth with locally available resources.

Iron production requires a heavy investment of woodfuel and the technology is thought to induce a shift in local plant communities (Schmidt 1997). Previous investigations into the relationship between iron production and plant communities in Eastern Africa considered massive furnace technologies (Schmidt 1994, 1997). Iron recovered in coastal contexts after AD 500 suggests that coastal peoples relied on specialized ceramic vessels to produce small amounts of iron (Mapunda 2002). Such specialized vessels likely required a far reduced charcoal investment (Mapunda 2002), though the landscape manipulation apparent between Tumbe and Chwaka would only vary in degree. This is because iron technologies seem to have remained consistent in coastal contexts through 1500.

Household-level production continued to characterize agriculture conducted in and around Chwaka. This is an important note because small-scale agriculture farmers continued despite a demonstrable shift in agricultural cultivate from pearl millet to rice (Walshaw 2005). Farmers at Chwaka had the technologies necessary to cultivate and process Asiatic rice (Walshaw 2005), a variety that thrives in water-saturated environments. A wide subsistence base accompanied rice, as coconut, fruit, nut, and millet taxa were also recovered at Chwaka (Walshaw 2005); Walshaw (2010: 142) notes that drought-tolerant pearl millet reemerged as a popular domesticate between the thirteenth and fifteenth centuries AD. Evidence suggests

that farmers harvested rice and millet in a similar manner, both by hand, because weeds were absent in storage or preparation contexts (Walshaw 2010: 142-143). This means that Swahili residents of northern Pemba adopted a new grain into existing agricultural strategies.

The urbanization process at Chwaka occurred due to migration into the urban community by residents of farmhouses, hamlets, or small villages across the northeast coast of Pemba Island. Migration out of the hinterland created unoccupied, agropastorally viable, landscapes around Chwaka. Macrobotanical analyses suggest that urbanites remained engaged with these open landscapes and produced pearl millet, fruits, nuts, and cotton from the abandoned areas (Walshaw 2010: 145-146). Walshaw (2010: 150) suggests that urbanites may have retained rights to rural land; if so they would have grown multiple taxa within designated landholdings. As I describe below, reconstructed botanical landscapes provide evidence that the rural areas demonstrated little botanical change through time. This suggests that urban populations maintained some connection with the landscapes they had inhabited.

Residents of Chwaka likely used available landscapes to rear domestic animals. Fleisher (2003: 365) reports that faunal remains of domestic animals were recovered in all archaeological layers at Chwaka. Evidence of domestic animals recovered in the archaeological contexts included cows, sheep, and goat; of these, cattle were the most common variety, while sheep and goat were rarely identified (Fleisher 2003: 362). Chicken and house cats also contributed to the domestic

animal collection. It is important to note that fish represent another subsistence source, one which residents of Pemba exploited (Mwebi 2000).

The concentrated, corporate approach to rice production and consumption evident in this area was likely indicative of some level of religious influence active within the community (Fleisher 2003; LaViolette & Fleisher 2009; Walshaw 2010). Fleisher (2003: 415-418) argues that access to Islamic mosques, tombs, and rice-filled feasts represent likely factors that induced rural farmers to migrate into Chwaka. Further, the sociopolitical influence that could stem from providing access to such religious venues may have served as motivation for individuals or households to sponsor the communal creation of such spaces or events.

Biophysical Conditions

A series of faults separated Pemba Island from the African continent during the Pliocene, roughly six million years ago (Bosworth 1989). Extended isolation of Pemba Island, as well as nearby Zanzibar and Mafia Islands, resulted in a surprisingly limited number of endemic plant species (Burgess & Clarke 2000: 137). The island falls into the Zanzibar-Inhambane vegetation group (Clarke 1998), but the species composition of this group is rather limited relative to mainland contexts and even other oceanic island (Gentry 1988; Möller & Cronk 1997; Linder 2001). Human activity may be responsible for the limited rates of floristic endemism at Pemba, as environmental evidence indicates intense anthropogenic influences have been expressed across these offshore contexts (Burgess & Clarke 2000: 142). Such influences could include the systematic distribution of particular plant types

throughout the offshore contexts. Otherwise, botanical surveys of Pemba Island yield only four endemic species of plant (Beentje 1990).

Pemba Island harbors some of the densest tropical forests known to coastal Eastern Africa (Holdridge et al. 1971). Again, the coastal forest and rainforest conditions all fall into the general Zanzibar-Inhambane vegetation group (Clarke 1998; Prins & Clarke 2006). This type of tropical, moist, broadleaf forest can incorporate a wide variety of trees and forest cover (Clarke 1998). That said, Beentie's (1990) botanical survey of Ngezi Forest provides a detailed presentation of plant community types available on northern Pemba Island; I should note that colonial accounts reported similarly forested conditions throughout the island in the early twentieth century. Six vegetation communities are known from areas in and around the forest. While the botanical survey offers direct evidence of Zanzibar-Inhambane coastal forest mosaic, the overall number of species and endemic species apparent in the investigation is indicative of a diminutive expression of the overall forest coastal mosaic variety. The survey identified evidence of anthropogenic disturbances, including forest clearance for timber harvest and hotel accommodations. Thicket and dry forest areas are typically culled to make room for farm plots (Beentje 1990).

I rely on geological characters to predict the nature of plant community cover and accompanied anthropogenic influences for areas of northern Pemba. The surface of Pemba Island features five distinct geologic conditions which were formed as many as 20 million years ago or as recently as 12,000 years ago (Shülter 1997: 249). Soil age typically influences the fertility of an area; one can assume a

negative correlation between soil age and presence of phosphorous, nitrogen, and other limiting elements (Rapp & Hill 2006). The relative youth of exposed soils on Pemba differs dramatically from the sediment structure, and fertility, of continental peers (Schülter 1997). Topographic variation and soil content influence the ways in



Figure 6.2: Soil types of Pemba Island. From Shütler (1997)

which people could use particular areas, as forest conditions were likely restricted to soil type #2 (see Figure 6.2), African cultivates and cash crop plantations (i.e., cotton, clove, coconut) require conditions much different than

rice. The former are likely to exist in the areas with sandstone foundations noted as #2 and, to a lesser extent, the limestone and fossilized coral soils of area #4. Areas with lower elevation, typical to soil type #3, would be better equipped for rice agriculture.

The fecundity of Pemba Island apparent in dense coastal forests or long-productive agricultural fields does not derive from young soils alone. The island also receives upwards of 2000 mm/ year of rainfall on the island, values which rank towards the upper limit of rainfall in East Africa (Burgess & Clarke 2000: 47-50). The high levels of rainfall derive primarily from the Intertropical Convergence Zone (ITCZ) (see Chapter 2 for discussion); this global weather system delivers an average 363 mm per month in March-May and 175 mm per month in November-December (Beentje 1990). The wet conditions apparent during this four-month span are necessary to support coastal forests or intensive agricultural production.

Botanical Expectations of Northern Pemba Island

I rely on Beentje's (1990) survey of the Ngezi Forest to formulate the botanical expectations that I hold for plant communities in and along the northeastern coast of Pemba Island. The Ngezi is a dense, tropical forest reserve that covers 14.4 sq. km and includes 6 separate vegetation areas. Beentje's survey identified a vast array of woody plant species in each of the six ecological contexts; two of these species are endemic to the forest (1990: 7). Of the six types of forest surveyed in this assessment, the *coastal thicket and dry evergreen forest* and *mangrove swamp forest* likely occur in the paleoethnobotanical survey universe. I

noted the geological and environmental conditions that such forests are known to colonize while surveying around Chwaka. See Beentje (1990: 38-49) for full review of dicot plants encountered in the Ngezi Forest.

Coastal thicket vegetation is known to occupy coral rag conditions, much like those found across the eastern coast of Pemba Island. Dominant species include: Sorindeia madagascariensis, Diospyros consolatae, Tamarindus indica, Afzelia quanzensis, Terminalia boivinnii, Cussonia zimmermannii, Antiaris genus, and Olea woodiana (Beentje 1990: 5). When in degraded coral soils, most all of these trees have canopies that terminate between 8 m and 15 m. A quick review of existing literature indicates that phytolith analysts have not defined morphologies particular to any of these dominant species. For this reason, I group coastal thicket vegetation into a single class of general woody plant morphologies.

Clove trees represent an important arboriculture resource for nineteenth and twentieth century residents of Pemba Island. The Sultan of Oman colonized the Zanzibar archipelago during the early nineteenth century and encouraged local farmers in both Unguja and Pemba Islands to convert agricultural plots to locations of clove arboriculture (Sheriff 1987). Imperial pressure propelled the Zanzibar archipelago to be the leading clove producer in the world by the late nineteenth and early twentieth centuries. For this reason, I assume that clove trees were likely present in the survey region after AD 1800. Unfortunately, phytolith morphologies typical of clove trees have yet to be identified. For this reason, I include this consideration of clove trees into the general woody plant phytolith category.

Seven varieties of mangrove trees are known to occupy northern Pemba. The varieties include: *Sonneratia alba, Avicennia marina, Bruguiera* spp., *Rhizophora* spp., *Ceriops* spp., *Lumnitzera* spp., and *Heritiera* spp. (Beentje 1990: 6). None of these trees produces diagnostic phytolith residues; however, their presence indicates a diverse set of plant resources (Dahdough-Guebas et al. 2000).

Previous investigations of plant communities across Pemba Island did not consider, or at least report, on grassland community composition. For this reason, I rely on C3-Pooid and C4-Panicoid grass subfamily lists that I compiled from Songo Mnara Island and Mikindani Bay. I also assume that C3-Pooid grasses should be better represented in this region due to higher levels of forest-canopy derived shade and ITCZ-delivered precipitation.

Survey of Northern Pemba: Paleoethnobotanical, Geological, and Archaeological Results around Chwaka and Tumbe

I collected phytolith samples from across the northeastern extent of Pemba Island with an experienced crew. I rented a house in a nearby town and lived with Hamisi Ali Juma and Salim Seif Yusuf, both of whom work at the local museum in Chake Chake. Abdallah Khamis Ali, the head of Antiquity Division and Curator of the Zanzibar National Museum, also joined us to survey landscapes in and around Chwaka/Tumbe; each of these archaeologists had already worked in the area during previous archaeological projects. Together, we collected phytoliths, artifacts, and soils from a survey universe that radiated northwest, west, southwest, and south four km from the archaeological site of Chwaka. We excavated STPs in 250 m intervals along each of the 4 transects; this spacing produced 59 STPs that also

considered Tumbe and the hinterland surrounding both areas (Figure 6.3). Coarse beach sand was the dominant soil type in the survey universe, this made for rapid excavation and terminal depths that resulted from a physical inability to access deeper strata (Figure 6.4). We collected soil samples from the profile of each unit, moving upwards through the soil profile in arbitrary 10 cm increments, collecting additional samples whenever a natural layer change was evident. This strategy yielded 587 paleoethnobotanical soil samples. Rather than consider each of these samples, I took a subsample of 95 samples that included soils from Tumbe and Chwaka in 28 different STPs. Figure 6.6 illustrates the location and number of each STP under consideration.

The coarse sands of northern Pemba were a poor medium for the preservation of phytolith samples. As I note above, I had to abandon more than 20 samples because they did not contain phytolith residues at levels that I could analyze. A limited phytolith representation forced me to alter my counting strategies in another eight samples. I altered the strategies for those samples because each required more than 45 minutes to identify 200 phytolith bodies, of the 400 individual bodies I typically counted.

I encountered a limited range of plant communities while surveying the region. Cassava farm plots surrounded the ruins of Chwaka during my field season, October and November 2011. The prevalence of cassava likely derived from the season, as rice is typically harvested in July and African grains shortly thereafter (Walshaw pers. comm., 2014). I also noted banana and coconut trees as well as a layer of short grasses throughout active agricultural areas. I encountered several



Figure 6.3: Array of shovel-test pit location across northern Pemba Island. X denotes artifacts recovered from STP



Figure 6.4: Archaeologist Abdallah Ali accesses geologic strata > 100 cm below ground surface

wet-rice farm plots, but did not sample the wet fields. Short grasses covered nearly all of the areas that were not under active cultivation, though I did encounter a limited number of dense stands of trees in the region; again, I assume these trees align with coastal thicket plant communities. The array of plant communities apparent in 2011 was indicative of a heavily managed landscape that provided subsistence and economic needs for modern communities. The ubiquity of sandy soils throughout the survey universe did not lend itself to a nuanced assessment of geologic conditions; therefore, I do not include a unit-by-unit description of local

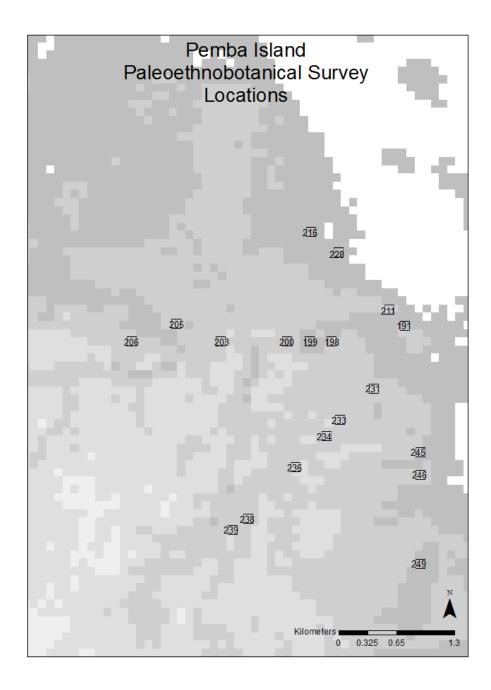


Figure 6.5: Paleoethnobotanical survey of northern Pemba Island. Note location of each STP under consideration in this analysis

geologies. Instead, I offer a blanket statement that the region of northeastern

Pemba that I consider in this analysis was composed of fluvial and/or

estuarine sands that were formed *in situ* the Miocene and Pliocene epochs, roughly

23 million to 6 million years ago (Shülter 1997).

I group the results of paleoethnobotanical and archaeological investigations of northeastern Pemba Island in chronologic order, moving back from the modern period. Artifacts offer relative dates that I apply to phytolith samples recovered from archaeological contexts. Shovel-test pits that I excavated throughout this survey universe yielded high levels of material culture, much of which featured decorative motifs or forms with known date ranges. The date ranges align with one of five social periods defined by Fleisher (2003: 25). The social chronologies important to this study include, starting with the most recent, Period Five (AD 1750-1964), Periods Two and Three (AD 1100-1500), and Period One (AD 750-1000). As I described above, the reconstructed human-environmental interactions known to each of the periods yield three distinct sets of botanical landscape expectations.

Colonial powers controlled Pemba Island during Period Five, namely the Omani Sultanate and the British Government. Omani rulers transformed Pemba into the clove capital of the world during the nineteenth century and the British colonial government furthered the spread of this crop into the early twentieth century. The range of clove arboriculture across the island or the Chwaka/Tumbe region is not well documented. For this reason, I look to woody plant levels recorded in Period Five phytolith samples to determine whether arboriculture was applied in this area (Martin et al. 1987; Martin 1991).

Periods Two and Three cover the occupational history of the stonetown at Chwaka. I oriented the entire survey universe around this abandoned urban center. I expected contexts in and directly adjacent to the urban center to contain high levels of palm and C3-Pooid grasses, as such plant communities correlate with archaeological expectations for a heavily populated area. As I moved toward the hinterland I expected to note the presence of farm plots and fruit, nut, or forest cover; C4-Pooid type phytoliths would account for the former, and woody-plant type phytoliths the latter. I expected high levels of Chloridoid grass bodies to represent domestic storage contexts, as I did not survey locations expected to bear rice production. I did not record evidence of such hypothetical storage areas in association with Chwaka, though I may have in earlier contexts.

Period One encompassed the entire occupation history of Tumbe village. The furthest reaches of the survey universe overlap with the expanse of Tumbe. For this reason, I expect phytolith samples from the final two km of each transect to feature high levels of Pooideae grasses. The social history further suggests that Panicoideae grasses and fruit and nut trees are more likely to be identified in areas closer to Chwaka, as these landscapes were not occupied prior to the second millennium.

I present tables and histograms that result from this analysis on a transect-by-transect basis, as a single histogram could not accommodate the number of samples from this region. Table 6.1 presents raw phytolith counts by plant type from Transect 300, and Figure 6.5 presents the percentages of plant types from this transect. Table 6.2 presents raw counts from Transect 301, Figure 6.6 is a histogram of percentages from the transect. I present the data from Transect 302 in

Table 6.3 and Figure 6.7. Results from Transect 304 are available in Table 6.4 and Figure 6.8. Finally, the phytolith counts from Transect 305 may be found in Table 6.5 and Figure 6.10.

1750-1964: I consider 20 phytolith samples that derive from contexts formed between 1750 and 1964. Each of these samples was relatively rich with woody-plant phytoliths, as the lowest percentage of this type silica body was

Date Range	Transect-STP	Sample	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plant Bodies	Palms	Density of Woody Plants Index	Climatic Index
750-1000	300-190	1107	114	150	7	0	137	0	0.51	0.55
750-1000	300-190	1109	102	145	8	2	143	0	0.56	0.56
750-1000	300-198	1179	103	147	6	27	141	0	0.55	0.52
750-1000	300-199	1188	98	187	11	0	103	0	0.35	0.63
750-1000	300-199	1190	120	162	52	2	64	0	0.19	0.48
1050-1500	300-199	1184	117	149	14	16	103	0	0.37	0.50
1050-1500	300-190	1103	56	198	6	0	140	0	0.54	0.76
1050-1500	300-198	1177	122	149	6	25	105	0	0.38	0.49
Post-1500	300-199	1182	98	72	48	0	183	0	0.84	0.33

Table 6.1: Raw phytolith counts by plant type from Transect 300, Pemba Island

19.25% from STP 236. The remaining samples vacillated between 20% and 35%, with only two instances of woody-plant type phytoliths > 40%. Representation of woody-plant type phytoliths did not seem to vary through space, as the few instances of > 40%, STPs 199 and STP 252, spread across the survey universe. The relatively homogenous values of woody-plants phytoliths recorded in this time period suggests that reconstructed landscapes hosted one, maybe two, types of woody-plant communities. The level of detail I used to classify bodies does not permit further identification of plant community composition. The 20-35%

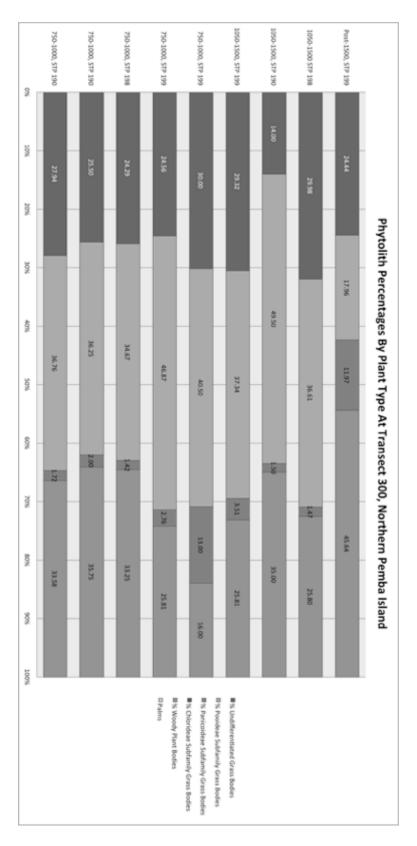


Figure 6.6: Phytolith percentages by plant type in Transect 300, Pemba Island

Date Range	Transect-STP	Sample	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plant Bodies	Palms	Density of Woody Plants Index	Climatic Index
750-1000	301-200	1198	110	118	0	0	166	18	0.73	0.52
750-1000	301-200	1199	21	50	122	0	207	0	1.07	0.26
750-1000	301-203	1223	93	136	4	12	155	0	0.67	0.56
750-1000	301-206	1252	93	174	37	0	96	0	0.32	0.57
750-1000	301-206	1254	132	99	17	1	152	0	0.61	0.40
1050-1500	301-200	1195	55	147	44	0	149	5	0.61	0.60
1050-1500	301-203	1219	133	167	39	0	68	13	0.20	0.49
1050-1500	301-205	1239	129	106	22	0	143	0	0.56	0.41
Post-1500	301-200	1193	138	91	34	0	138	0	0.52	0.35
Post-1500	301-203	1217	102	142	6	0	158	0	0.63	0.57
Post-1500	301-205	1237	64	162	21	0	154	0	0.62	0.66
Post-1500	301-206	1247	169	116	0	0	82	33	0.29	0.41

Table 6.2: Raw phytolith counts by plant type from Transect 301, Pemba Island

representation levels may highlight the presence of clove arboriculture or scrubland; the > 40% values may document a concentrated expression of such plant communities or forest conditions. I look to woody-plant phytolith representation in earlier contexts to further support the arboriculture interpretation.

The 33 palm-type phytoliths that I counted in STP 206 represent an aberration in this time period. I did not record any additional palm phytoliths in the remaining 19 samples from this period. It is unclear whether this 8.25% of palm-type phytoliths indicates the presence of a single frond or an entire tree. That said, the sample does clearly suggest an unequal distribution of palms across the survey universe.

I am able to reconstruct a more nuanced understanding of grass-community composition by calculating the Climate Index, as previous research calibrated region-specific values. Climate Index values document grassy landscapes populated

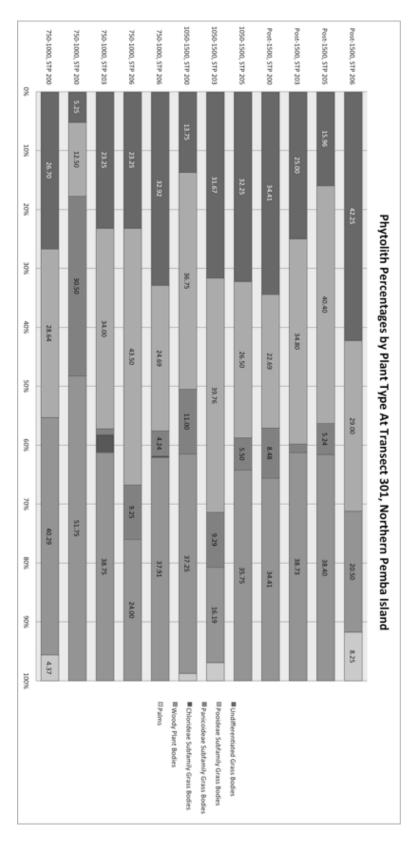


Figure 6.7: Phytolith percentages by plant type from Transect 301, Pemba Island

Date Range	Transect-STP	Sample	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plant Bodies	Palms	Density of Woody Plants Index	Climatic Index
750-1000	302-211	1297	112	89	49	0	150	0	0.60	0.36
750-1000	302-211	1301	153	105	22	0	110	10	0.39	0.38
750-1000	302-212	1309	126	82	86	0	106	0	0.36	0.28
750-1000	302-212	1311	98	108	16	13	165	0	0.74	0.46
750-1000	302-216	1350	91	96	32	8	132	43	0.60	0.42
1050-1500	302-210	1288	85	127	23	0	165	7	0.70	0.54
1050-1500	302-211	1294	153	103	20	0	91	33	0.33	0.37
1050-1500	302-212	1307	135	162	0	0	103	0	0.35	0.55
1050-1500	302-212	1308	186	115	36	0	63	0	0.19	0.34
1050-1500	302-216	1346	80	174	54	0	92	0	0.30	0.56
1050-1500	302-228	1456	148	86	36	0	130	0	0.00	0.00
Post-1500	302-210	1286	158	63	61	0	118	0	0.42	0.22
Post-1500	302-211	1291	13	48	180	0	159	0	0.66	0.20
Post-1500	302-216	1344	142	89	16	0	139	14	0.56	0.36
Post-1500	302-228	1452	97	112	27	27	137	0	0.00	0.00

Table 6.3: Raw phytolith counts by plant type from Transect 302, Pemba Island

by a mixture of C3-Pooid and C4-Panicoid grasses; such mixed grasslands were apparent in 10 of the samples. The investigation of this time period captured two examples of C3-Pooid grassland prevalence and six instances of C4-Panicoid grass prevalence. The heterogeneous record of local grass coverage apparent across the landscape is surprising, as the index expects climatic factors to create a more uniform assemblage of grasses. For this reason, the presence of both C3-Pooid and C4-Panicoid grasses in a single landscape warrants additional investigation. As I will explain, human activity represents one factor that may have contributed towards the constitution of these grass communities.

1050-1500: The phytolith assemblage that aligns with inhabitation of Chwaka included 23 samples. I recorded woody-plant type phytoliths in each of these contexts. This assemblage broadly matches that recorded from the overlaying context, as woody-plant phytoliths account for 20-25% of 15 samples. That said, the

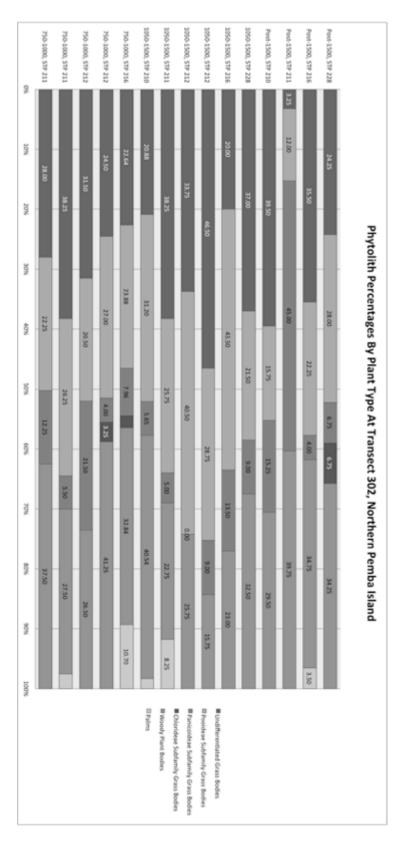


Figure 6.8: Phytolith percentages by plant type from Transect 302, Pemba Island

Date Range	Transect-STP	Sample	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plant Bodies	Palms	Density of Woody Plants Index	Climatic Index
750-1000	304-331	1485	166	156	5	0	73	0	0.32	0.44
750-1000	304-331	1487	143	132	28	0	97	0	0.45	0.54
750-1000	304-332	1495	129	102	34	0	129	6	0.29	0.23
750-1000	304-232	1497	54	45	88	9	54	150	0.49	0.42
750-1000	304-233	1505	67	176	7	0	135	15	0.75	0.44
750-1000	304-237	1531	95	173	15	0	104	13	0.55	0.46
750-1000	304-237	1533	108	121	23	9	139	0	0.42	0.51
750-1000	304-238	1541	38	142	29	0	191	0	0.37	0.60
750-1000	304-238	1543	100	175	15	4	106	0	0.28	0.46
1050-1500	304-231	1481	122	194	4	0	82	0	0.22	0.48
1050-1500	304-332	1492	104	150	20	3	124	0	0.49	0.38
1050-1500	304-234	1508	111	102	18	0	174	0	0.92	0.50
1050-1500	304-234	1512	99	138	16	38	109	0	0.24	0.48
1050-1500	304-236	1521	69	130	72	0	129	0	0.34	0.41
1050-1500	304-236	1523	170	122	8	0	102	0	0.49	0.47
1050-1500	304-237	1527	118	127	24	0	131	0	0.37	0.61
1050-1500	304-238	1537	84	163	74	0	94	0	0.91	0.68
Post-1500	304-233	1498	123	116	15	22	124	0	0.27	0.35
Post-1500	304-233	1498	172	112	34	0	87	0	0.54	0.70
Post-1500	304-234	1509	56	104	48	0	192	0	0.43	0.47
Post-1500	304-236	1519	141	156	26	0	77	0	0.48	0.48
Post-1500	304-238	1534	123	144	14	0	119	0	0.29	0.51
Post-1500	304-239	1545	132	145	30	6	87	0	0.00	0.00

Table 6.4: Raw phytolith counts by plant type from Transect 304, Pemba Island

assemblage does include a sample with < 10% woody-plant phytoliths as well as two samples > 40% of such silica bodies. Though three samples do not make a trend, I do not want to understate the potential importance of this variation. I interpret this array of woody-plant type phytolith to indicate the presence of at least three plant communities: densely-wooded, wooded, and mostly grass-covered landscapes. The mostly-grass class represents a type that was not apparent in 1750-1964 contexts. Again, this could be meaningful because I had assumed a relatively homogenous woody-plant assemblage could provide proxy evidence of clove arboriculture.

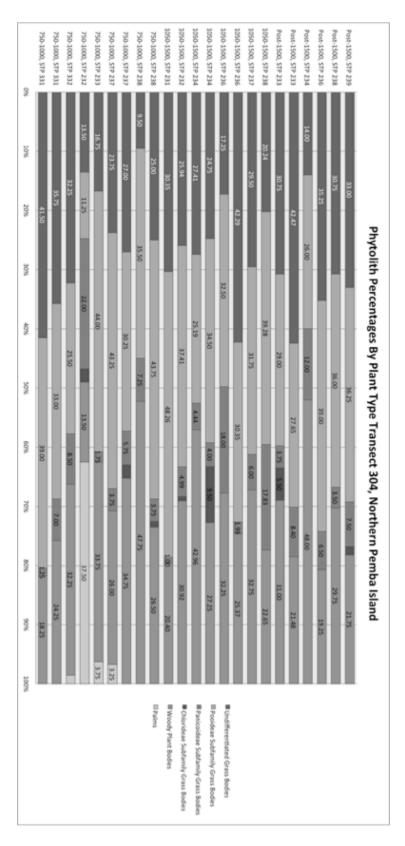


Figure 6.9: Phytolith percentages by plant type from Transect 304, Pemba Island

Date Range	Transect-STP	Sample	Undifferentiated Grass Bodies	Pooideae Subfamily Grass Bodies	Panicoideae Subfamily Grass Bodies	Chlorideae Subfamily Grass Bodies	Woody Plant Bodies	Palms	Density of Woody Plants Index	Climatic Index
750-1000	305-244	1593	95	132	62	54	57	0	0.20	0.38
750-1000	305-245	1603	134	141	23	2	100	0	0.34	0.47
750-1000	305-245	1605	89	191	26	16	78	0	0.25	0.59
750-1000	305-246	1613	64	164	45	0	127	0	0.47	0.60
750-1000	305-246	1615	172	65	14	0	149	0	0.59	0.26
750-1000	305-247	1623	116	145	16	3	120	0	0.43	0.52
750-1000	305-247	1625	86	166	14	0	90	44	0.34	0.62
750-1000	305-248	1635	127	59	40	2	172	0	0.76	0.26
750-1000	305-249	1645	101	127	17	0	156	0	0.64	0.52
750-1000	305-253	1679	160	97	12	3	128	1	0.48	0.36
750-1000	305-253	1681	150	154	6	3	87	0	0.28	0.49
1050-1500	305-245	1599	41	163	118	0	78	0	0.24	0.51
1050-1500	305-246	1609	163	110	2	12	116	0	0.42	0.38
1050-1500	305-247	1619	73	138	19	0	171	12	0.74	0.60
1050-1500	305-249	1639	216	147	0	0	38	0	0.10	0.40
1050-1500	305-252	1662	82	206	0	0	112	0	0.39	0.72
Post-1500	305-245	1596	97	148	31	0	124	0	0.45	0.54
Post-1500	305-256	1606	52	132	53	0	163	0	0.69	0.56
Post-1500	305-249	1636	83	102	50	7	158	0	0.67	0.42
Post-1500	305-252	1660	68	135	25	0	180	0	0.79	0.59
Post-1500	305-253	1672	131	111	8	0	151	0	0.60	0.44

Table 6.5: Raw phytolith counts by plant type from Transect 305, Pemba Island

Phytoliths from palm trees were poorly represented in this assemblage, as I recorded only 30 such silica bodies across the 23 samples. This evidence suggests that palm trees, or fronds from these trees, were available to residents of Chwaka. It is unclear whether the low representation derives from frond-use among people of Chwaka or lack of palm trees themselves.

The prevalence of C3-Pooid grasses in landscapes that correlate with the habitation of Chwaka differs from those associated with Tumbe or the most recent period. Climate Index values from 6 samples demonstrate a clear C3-Pooid prevalence; 5 samples suggest C4-Panicoid prevalence and the remaining 13 were mixed grasslands. The near equal representation of C3-Pooid and C4-Panicoid subfamily grasses suggests that factors beyond temperature or precipitation

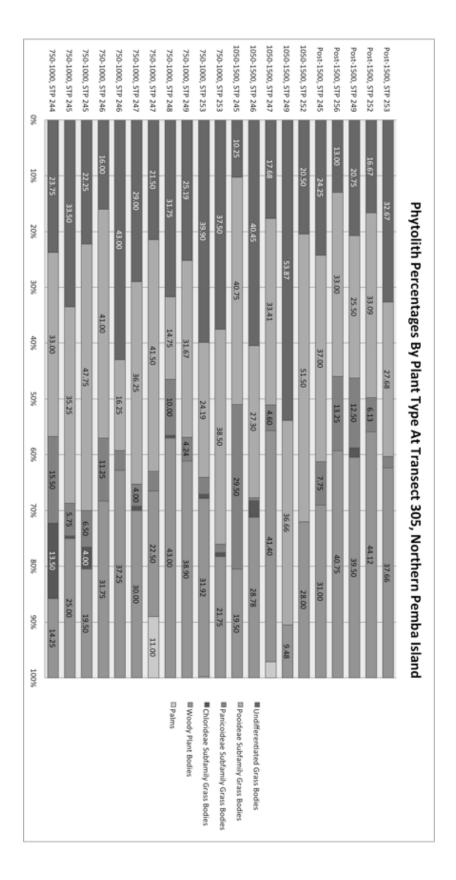


Figure 6.10: Phytolith percentages by plant type from Transect 305, Pemba Island

influenced the grass communities. This period coincides with a slight decrease in woody plant representation, so tree-shade seems an unlikely factor. Instead, I think these samples may have captured evidence of the rural urbanism reported from Chwaka (Fleisher 2003). As I will explain, the C3-Pooid and C4-Panicoid grasses have a role in agropastoral lifeways known to the region at this time. Further, the heavy prevalence of mixed grasslands may index anthropogenic disturbances caused by migration out of the hinterland. Evidence from the terminal levels of this survey muddles any potential correlation between mixed grass communities and human activity or abandonment.

750-1000: I consider 33 samples from 18 STPs from the earliest sedimentary contexts that I could sample from the northeastern coast of Pemba Island. In cases of STPs that bore more than one sample from this period I present the sample from the upper strata first in tables and histograms. The Climate Index values from 21 of the samples indicated the presence of mixed-grassland communities. These samples demonstrated no clear spatial pattern, as they spread throughout the survey area. Ten of the remaining samples bore evidence of C4-Panicoid grass prevalence while only three aligned with C3-Pooid grasses. Taken together, the Climate Index calculations from this time period suggest that C4-Panicoid subfamily grasses far outstripped representation of C3-Pooid grasses prior to habitation at Chwaka. Beyond the relationship between particular grass subfamilies, mixed communities clearly constituted most grasslands in the region.

The representation of woody-plant phytoliths recorded in this context reflects levels reported from the most recent period. I say this because the lowest

recorded percentage, from STP 336, is 13.25% and only three other samples bore less than 20% woody-plant phytoliths. This suggests that the grass-covered landscape reported from contexts that date 1050-1500 was absent in this period.

I want to note that the lowest levels of woody-plant representation from this period occurred alongside aberrant levels of other, often underrepresented, plant types. The 37.5% palm phytoliths recorded in STP 232 far outstripped woody-plant category. Chlorideae subfamily grasses account for 13.5% of the phytolith sample from STP 244, a value nearly equal to the 14.25% of woody-plant type silica bodies. Each of these aberrant samples likely represents some level of anthropogenic intervention. Chlorideae grasses include a species of rice that had been introduced to residents of Tumbe. For this reason, I believe the Chlorideae values apparent in STP 244 may represent additional evidence of rice importation and consumption among residents of Tumbe.

I interpret the high levels of palm phytoliths apparent in STP 232 as evidence of human activity because these levels are orders of magnitude greater than those recorded from other locations or contexts known to Pemba Island as well as the Songo Mnara Island or Mikindani Bay. Ethnoarchaeological investigations by Prins (1961), LaViolette & Fleisher (1999), and Insoll (2003) document that Eastern African peoples rely on palms to create roofs for earthen structures. The sample may have captured evidence of roof-structure, as palm fronds were known to have been incorporated into impermanent architecture in the region. Alternatively, the sample could document natural deposition of fronds from a naturally occurring

palm tree. I think this interpretation is less likely because little evidence of palms was apparent in the other samples.

Discussion

General Impressions of Woody-Plant Communities Through Time and Space

I expected this paleoethnobotanical survey to recover evidence of heavily-wooded conditions from archaeological contexts that date from 750 to 1000 and 1750 to 1964. This assumption stems from colonial reports that describe the region surrounding Chwaka with a vocabulary typically applied to the Ngezi forest region of the island (Ruschenberger 1838; Burton 1893; Fitzgerald 1898; Strickland 1932). In addition to these reports, clove arboriculture was a known economic pursuit across the island in the modern period (Sheriff 1987). The survey did capture high levels of woody-plant type phytoliths, though in a restricted number of contexts. In the assemblage from the most recent period, the high values, > 40% woody-plant type phytoliths, were surrounded by contexts wherein levels of these plant classes vacillated exclusively between 20 and 35% of the sample. The uniform distribution of woody plant phytoliths apparent in these most recent contexts was not as obvious in either of the previous periods.

The generally uniform arrangement of woody-plant phytoliths in 1750-1964 contexts led me to further consider implications of arboriculture. The cultivation of woody plants would require creation of plantations, in this case populated by clove trees, wherein each plant is equally spaced and well maintained. With this in mind, it does not require much analytical maneuvering to accept that arboriculture could

be responsible for the woody plant assemblage from this most recent context. I am not confident in this interpretation without additional investigations that consider phytolith bodies specific to clove trees.

I recorded generally similar ratios of woody-plant type phytoliths in all but three samples from the earliest contexts of northern Pemba Island. The three samples that differed all had woody-plant proportions below 15% of the total sample. The phytolith profiles from these samples suggest unique plant representation in each sample with exceptionally low levels of woody-plant phytoliths. I say that because of exceedingly high levels of palms in one instance and surprisingly high Chlorideae levels in another. As I describe above, the palm prevalence may derive from anthropogenic deposition, as fronds are a known roofing medium for earthen structures. The concentrated Chlorideae grasses also likely derive from anthropogenic activity, as Asiatic rice, a member of this grass subfamily, was apparent in the region during this period. This location could represent a rice storage context, though additional information would be necessary to qualify this interpretation.

I had assumed that residents of the urban community Chwaka would have culled local woody plants around the settlement to meet woodfuel requirements, clear forest conditions for habitation, or create opportunities for agropastoral grass communities to thrive. Grasses are clearly prominent in only one context, STP 212, wherein woody-plants account for only 9% of the total sample. Two samples from this period had woody-plant values > 40%. These help to maintain an average presence of woody plants on par with that recorded from the other time periods.

That said, the eye-test approach does suggest that this assemblage skews a bit lower overall as compared to either other archaeological context from this region. For this reason, samples the may offer some evidence of the anthropogenic influences that I had expected. If true, such influences had far less of an impact than expected.

General Impressions of Grass Communities Through Time and Space

Mixed grass assemblages occurred twice as frequently as those dominated by C3-Pooid and/or C4-Panicoid in each of the archaeological contexts under consideration in this region. The prolonged prevalence of mixed grass communities indicates that anthropogenic, climatic, and biological factors did little to alter or otherwise influence grass community composition on northern Pemba Island since 750. I introduced the ways in which these factors can influence grass-community composition in early discussions, Chapter Two. That discussion focused on communities with a clear prevalence of either C3-Pooid or C4-Panicoid, as these present far more analytical currencies. So, bearing the pervasiveness of mixed grasses in mind, I focus the following discussion on the 32 samples that demonstrate prevalence of a single grass-type community.

The high levels of precipitation and presumed tree cover led me to expect relatively high levels of C3-Pooid subfamilies in the region. This was only the case in archaeological contexts that date between 1050 and 1500. Paradoxically, this was also the time period wherein biological and climatic conditions likely acted to limit C3-Pooid grasses. I say this because the time period included the Medieval Optimum, a period of global warmth that reduced the levels of rainfall delivered to

Eastern Africa. The reduction of expected rainfall likely should have reduced the fitness of short, lush grasses. I also recorded diminished levels of woody-plant phytoliths in this archaeological context. The lack of leafy-shade could have further limited the ability of C3-Pooid grasses to colonize the area.

The negative influences apparent from climatologic and biological factors cause me to consider how anthropogenic influences account for C3-Pooid grass prevalence in this archaeological context. The zooarchaeological record suggests an uptick in levels of domestic ungulates, namely cattle, in association with the urban center Chwaka (Fleisher 2003: 265). Cattle prefer pastures dominated by C3-Pooid grasses. For this reason, the rise in this type of grass apparent between 1050 and 1500 may represent additional evidence for rise in animal husbandry that occurred in conjunction with urbanism in the area (Mwebi 2000). If true, then an increase in animal husbandry would represent an elaboration in the agropastoral subsistence pattern known to the region since AD 750.

The elevated levels of C3-Pooid grasses that coincided with Chwaka occurred as levels of C4-Panicoid subfamily grasses diminished, from 10 samples in 750-1000 to 5 samples in 1050-1500. Macrobotanical evidence can help elucidate the elaboration in pastoralism and concomitant decrease in C4-Panicoid subfamily grasses. Asiatic rice replaced African grains, all of which are species in the C4-Panicoid subfamily, as the staple crop of northern Pemba between 1050 and 1500, though diminished levels of African millets were apparent after 1300 (Walshaw 2005). Evidence suggests that residents of Chwaka cultivated rice in water-saturated areas of the region, areas that could not support the African grasses that I

consider here (Walshaw 2010). If the rural-urban farmers of Chwaka shifted their agricultural attention towards water-logged areas, then wide swaths of hinterland could be converted to pasture. Research projects that search for rice-specific phytolith morphologies in areas that would have supported rice cultivation will further test this hypothesis.

The explanation of change in C3-Pooid grasses through time also addressed changes in C4-Panicoid subfamily grass representation through time. The prevalence of C4-Panicoid grasses apparent in early contexts may represent the application of Iron Age agricultural strategies. At this point, I am unable to clearly define the presence of such agriculture or such strategies. Additional research that considers phytolith bodies specific to African cultivars like pearl millet or sorghum will provide the evidence necessary to conclusively demonstrate the presence of agropastoral lifeways in the area. I include pastoral in that estimation because additional investigations that further subdivide the C3-Pooid grass subfamily are necessary to fully appreciate the potential influence pastoralism may have held over regional grass communities.

In what ways did plant community management strategies change between the agropastoral village of Tumbe and the densely occupied Chwaka?

The emergence of an intra-site social hierarchy, elaboration of population density, and rise of Islam apparent at Chwaka was tied to a shift towards Asiatic species of rice as an agricultural staple in the region. While the staple cultivar involved clearly changed, previous investigations suggest that these social and subsistence transformations did little to alter the ways in which residents of

northern Pemba approached food production. By this I mean that urban households seem to have maintained some responsibility over their subsistence requirements. Ethnoarchaeological investigations suggest that farmers planted and harvested rice by hand, in a manner reminiscent of the processes involved in the production of millets or sorghum (Walshaw 2010). The primary difference between the cultivation of African grains and that of rice is the venue; the shift towards rice agriculture would have required farmers to direct their attention towards waterlogged soils for three-to-four months a year (Walshaw pers. comm., 2014). This acute growing season would have permitted farmers a degree of freedom to devote attention towards other cultivars, domestic animals, or any range of additional actions during the remainder of the growing year.

Iron Age peoples of coastal Eastern Africa relied on shifting agricultural strategies to produce African cultivars on local landscapes. Domestic animals supplemented the grains and combined with fruits, nuts, and marine resources to round out domestic subsistence economy recovered at Tumbe. I bring this up because macrobotanical and zooarchaeological investigations demonstrate continuity in subsistence strategy between Tumbe and Chwaka; as I document above, the only difference being the presence of locally-produced rice at Chwaka. Evidence of botanical and faunal continuity in this region suggests that residents of Chwaka actually may have devoted their attention towards sorghum and pearl millet production in areas of higher elevation surrounding rice plots. Walshaw (pers. comm. 2014) noted such strategies while working with contemporary communities in the region.

The phytolith record from 750-1000 and 1050-1500 provides additional evidence of such continuity between the ways in which villagers of Tumbe and the urban community at Chwaka approached local landscapes. Communities that featured equal proportions of C3-Pooid and C4-Panicoid, mixed grasslands, were far and away the most prominent in either period. The representation of C4-Panicoid grasses, a subfamily that includes domestic African grains, also remained consistent through time. As I explain above, I noted a slight increase in C3-Pooid grasses, the subfamily typically associated with domestic animal pasturage. Elevated levels of this grass may represent an emphasis on animal husbandry made possible because farmers of Chwaka had devised a way to convert previously unworkable areas into water-saturated rice plots. Additional research is necessary to move forward with that explanation. First, phytolith assays need to confidently identify silica bodies from African grains within the C4-Panicoid grass assemblages of these samples; such evidence would clearly document the presence of agriculture in the phytolith record. Similar methodologies are also necessary to clearly articulate the relationship between C3-Pooid grasses and Eastern African pasturage. Finally, a direct relationship between locations of pre-modern rice agriculture and farmers from Chwaka would act to further tie these people to surrounding hinterland contexts.

I included the notion of anthropogenic legacies in this research question because phytolith residues from Songo Mnara Island (Chapter Four) and Mikindani Bay (Chapter Five) correlate with results of modern investigations (Chapter Two) to indicate the agriculture in Eastern Africa can increase soil fertility and water

retention. I interpret the diachronic increase in either C3-Pooid grasses or woodyplants in archaeological contexts as evidence of such a legacy. This type of positive, prolonged impact was not apparent in phytolith record from northern Pemba. The reverse, a negative impact, was also not available in the phytolith record from this region.

Do the landscapes of northeastern Pemba bear evidence of increased agriculture or animal husbandry during the sixteenth through nineteenth centuries?

Phytolith morphologies from archaeological contexts that date between 1750 and 1964 do not contain any clear evidence of an increase in agricultural or domestic animal production. For this reason, the phytolith evidence suggests that the northeastern coast of Pemba Island likely contributed little, if at all, to the title "breadbasket" bestowed upon the island during this period. It is clear that residents had abandoned Chwaka by the sixteenth century, though the material record demonstrates that residents did not evacuate the entire region. Those who remained in the area may have gained access to this inter-coastal exchange by maintaining similar levels of agriculture as that which I reconstructed from landscapes associated with urbanism. This sort of arrangement could suggest that Pemba has long been agriculturally productive; levels of productivity did not seem to wane despite imperial or colonial interference after AD 1500. Additional analyses are necessary to better understand this hypothetical relationship.

It is more likely that this phytolith analysis missed the halcyon days of Pemba-as-breadbasket. I say this because a 250 year gap existed in the archaeological contexts that I could securely date. Many of the historic records

derive from the centuries that I do not sample (see LaViolette & Fleisher 2009: 433-434 for list). Beyond a gap in time period, the survey region that I consider did not consider any areas known to produce rice, the staple grain exported from Pemba in the mid-to-late second millennium. All this goes to say, the exploratory survey methodologies that I employ in the evaluation of northern Pemba do not permit me to responsibly broach this question. Investigations able to target archaeological contexts from 1500 through the modern period as well as locations of known, or assumed, rice production could better address this question. I would suggest a researcher interested in such questions look to the western part of the island, which has higher levels of soil fertility as well as valleys ideal for rice production.

The presence of Ngezi Forest, modern clove plantations, and colonial accounts of forested conditions throughout the island coalesce to create the impression that Pemba has long been a heavily-wooded island. How do such conditions manifest in the microfossil record?

Phytoliths from woody plants were apparent, but seldom dominant in the assemblage from northern Pemba Island. I recorded proportions of woody-plant phytoliths that ranged between 20-35% of the entire sample in most every. I interpreted this proportion to represent a single, broadly similar set of woody-plant conditions. This arrangement remained broadly similar through time and space on the island, with a slight reduction in representation in association with activity at Chwaka.

The general uniformity apparent in the most recent archaeological contexts formed, or even repopulated, the slightly diminished levels of woody plants apparent across northeastern Pemba. While this uniformity may present evidence

of clove arboriculture across these landscapes; unfortunately, though the evidence is far too limited to confidently support this interpretation. Further investigations that specifically consider silica bodies known to forest-type, clove, scrub-type, and herbaceous plants is necessary to adequately tease out the relationships between the woody-plant phytolith assemblage of Northern Pemba.

Chapter Seven

Conclusion: Comparative Analysis of Phytolith Residues Deposited since

AD 600 in Three Regions along the Eastern African Coast

I conclude this investigation of ongoing interactions between Swahili peoples and local plant resources by comparing trends and patterns apparent in phytoliths recovered from three regions of the Eastern African coast. The sites under consideration include Songo Mnara Island, Mikindani Bay, and the northeastern corner of Pemba Island. The data permit me to hypothesize about subsistence and other socioeconomic practices and how they changed over time. Patterns in plant resource management that I present here represent a step towards understanding the relationship between peoples and coastal ecologies that has unfolded since the mid-first millennium AD.

By way of conclusion, I present here an interpretation of socioeconomic and plant management trends in the three settings under consideration. When possible, I recall information regarding the general archaeology and history of coastal Eastern Africa, historical ecology, or paleoethnobotany. The literature reviews and data that I presented in earlier chapters created the opportunity to evaluate the four research questions that motivated this project:

- In what ways did local plant communities and plant-use patterns vary along the Swahili coast across time and space?
- Did plant resources contribute to the constitution, manipulation, or expression of site-specific Swahili identities?

- If so, did the interaction between Swahili people and plant communities create anthropogenic landscapes with an analytical potential on par with Swahili material culture, language, or ideology?
- o If not, then what was the nature of interaction between Swahili people and available plant resources?
- Was diachronic change in Swahili identity apparent in the material record as reflected in the plant record? Here I am speaking directly to processes of urbanization, adoption of Islam, shift towards rice production, and altered tone and tenor in long-distance trade.
 - o If so, than in what ways were such changes echoed?
 - o If not, then why?
- Is phytolith analysis a research method that can produce viable results along the Eastern African coast?
 - Can phytolith indices capture evidence of anthropogenic influences in any demonstrable manner?
 - What are the successes and limitations of this project?
 - What could I have done differently?

With these motivations in mind, I briefly review paleoethnobotanical data and results from the three coastal regions.

I designed my research to capture phytolith residues from an array of social and environmental contexts available along the Swahili coast. This strategy was both experimental and optimistic, because only one research project had documented the presence of diagnostic phytolith bodies in archaeological contexts of Eastern Africa. Sulas (2010) and later Sulas and Madella (2012) reported the presence of phytoliths in micromorphological samples recovered from domestic and open areas of Songo Mnara stonetown. Without additional evidence from previous

investigations I had no guarantee that the poorly documented soils outside the town wall of Songo Mnara, slightly acidic soils known from Mikindani Bay, or sand-dominated soils of northern Pemba contained viable phytolith residues for analysis.

If they were indeed available, I was unsure whether taphonomic processes in the three areas had induced horizontal or vertical mixing (Rovner 1986; Rosen 2001; Pearsall 2009). Such processes could obscure the chronologic arrangement of, and therefore archaeological utility of phytoliths. To maximize the recovery potential, I sampled a wide range of geographic, geologic, and ecological contexts across the coastal region, reasoning that at least one set of circumstances would bear the phytoliths necessary to conduct research. The only certainty of the project was that it would show whether or not phytoliths from each of the three regions were present or absent, which would have bearing the potential for this kind of analysis on the coast.

I say that my survey strategy was optimistic because if the coastal contexts I sampled contained viable phytolith samples, then I expected the resulting assemblages to record variable plant community composition and change through time. As I describe in the response to the first question, all three of the archaeological regions produced viable phytolith samples. The samples, however, all shared a generally uniform set of phytolith assemblages that documented little variation through time or space. I discuss implications for this uniformity below, and present region-specific interpretations.

I targeted phytolith morphologies known to six separate types of plants in each of the samples considered. The silica bodies from these assemblages aligned

with morphologies known to form within particular plant families and subfamilies (see Chapter Three for a review of notable morphologies). I chose to focus on particular plant families and subfamilies because of the methods employed in earlier phytolith analyses (Sulas 2010; Sulas & Madella 2012), results from macrobotanical investigations (Walshaw 2005, 2010; Pawlowicz 2011), and historical reports from the three regions (Burton 1893). Silica bodies recovered in my analysis had little evidence of physical deformation or silica-body degradation, so that I was able to identify phytoliths to the family- or subfamily- levels.

Taphonomic processes can influence the distribution of phytolith bodies and negatively impact the analytical potential of microbotanical analyses. Post-depositional mixing of phytolith bodies between chronologically distinct archaeological strata manifests as uniform counts and homogeneous phytolith reconstructions apparent through time in particular locations. While this analysis did record a uniform set of plant communities through time and space, such uniformity was only available on assemblage-scale analysis. This means that phytolith records from individual locations demonstrated variation through time, but that such variation occurred in a manner that did not manifest as overarching, assemblage-wide change through time.

My optimism was well rewarded, as phytoliths proved to offer a viable record of environmental and anthropogenic change through time in archaeological contexts across the Swahili coast. As I discuss further below, this exploratory project was able to address some overarching research questions and, in the

process, raise many more. For this reason, I see phytolith analysis to be an engaging and important aspect of Eastern African coastal archaeology for the future.

In what ways did local plant communities and plant-use patterns vary along the Swahili coast across time and space?

This question requires the synthesis of phytolith assemblages available from Songo Mnara Island, Mikindani Bay, and northern Pemba Island. As I review in this response, little difference was apparent in the representation of particular plant types between archaeological contexts. I find that presenting the diachronic perspective necessary for this response to be clearer if woody-plants and grass subfamilies are presented separately, which I do below.

Coastal Trends in Woody-Plant Community Representation

Phytolith samples from the three regions demonstrated little diversity in proportions of woody-plant phytolith bodies through time. Samples wherein woody-plant phytoliths accounted for 20-35% of recorded phytoliths were far and away the most prevalent in each of the contexts; samples with that proportion of woody-plants accounted for > 60% of the total assemblage. Assemblages specific to each archaeological context also universally contained one or two samples with <10% woody-plant phytoliths and another one to two samples with >40% woody-plant phytoliths. This class of silica bodies, therefore, demonstrated that a uniform proportion of woody-plant phytoliths populated Songo Mnara Island, Mikindani Bay, and northern Pemba Island since ca. AD 600. Uniformity of woody-plant representation continued in the assemblages despite a unique set of social histories

and the unique arrangement of environmental conditions available in the three regions.

I interpreted these three classes of proportions to represent distinct types of woody-plant communities. Grass-predominant plant communities aligned with <10% woody-plant samples; I explore the composition of such communities in the next section. I interpreted the most-prevalent 20-35% woody-plant phytolith communities as evidence of lightly "wooded" landscapes. Finally, I took the samples with >40% woody-plant phytoliths to represent heavily "wooded" landscapes. The treatment of "wooded" requires quotation marks because the term implies the presence of large scrub- or tree-type plants. This is not necessarily the case, though such plants may well be represented in the assemblages. The class of phytoliths that I use to define the woody-plant category is known to form within most every sort of dicot plant, including herbs, shrubs, trees, and even lianas. For this reason, the woody-plant communities that constitute these assemblages could derive from most any non-grass or non-palm plant.

The lack of clear differentiation in the woody-plant type in this research means that I was unable to determine whether the proportion-based classes index a change in type, or simply a change in degree of representation of a plant community. A change in type would represent a shift from one type of plant community to another distinct type of plant community; an example of this shift would be from grassland to scrubland or scrubland to forest-cover. Alternatively, a change in degree would note amplification or decrease in representation of woody-plants in a particular plant community. Examples of such change would be an increase in

sporadic tree-coverage in grasslands, or a slight decrease in scrub-type plants in a dense forest (see Chapter Two for a list of potential plant communities that could be involved in such shifts).

The woody-plant assemblages I recorded demonstrate an almost profound level of chronologic and temporal continuity. Each region under consideration here was subjected to a unique level of climatic conditions, and such conditions were subject to varied levels of anthropogenic influences. The fact that such unequal biological, physical, and anthropogenic influences combined to create a near-uniform set of woody-plant landscapes was a complete surprise. I do not think the lack of genus- or species-level clarity in woody-plant community composition diminishes the importance of this trend. Instead, the acknowledgement of this trend should push researchers towards additional, pointed, investigations of woody-plant community composition in archaeological contexts on the Swahili coast.

Coastal Trends in Grass Community Composition

I relied on Climate Index calculations to reconstruct the composition of grassland communities apparent in the landscape reconstructions. As I explained in Chapter Three, this index compares proportions of C3-Pooid and C4-Panicoid subfamily grasses. These grass subfamilies each use different metabolic pathways to synthesize sugars; C3-Pooid grasses capture electromagnetic energy in three-carbon chains while C4-Panicoid grasses create sugars with four-carbon chains. The C4 metabolic pathway consumes less water-per-unit-energy created than does the C3 pathway. For this reason, C4-Panicoid grasses are better equipped to tolerate

warm, arid conditions. Each species of domestic grain from sub-Saharan Africa is a member of the resilient C4-Panicoid subfamily; this means that high levels of C4-Panicoid type phytoliths could document the presence of agriculture in archaeological contexts. C3-Pooid grasses are typically shorter and leafier than their drought-tolerant peers; contemporary research suggests that these shorter grasses are more easily accessible to, and therefore preferred pasturage for, domestic ungulates. For this reason, C3-Pooid type phytoliths may represent the presence of anthropogenic pasture in the archaeological record.

My phytolith assemblages from three regions of the coast document a millennium of relative stasis in grass-community representation. Between AD 600 and 1500 mixed-grass communities occurred twice as often as communities with a clear prevalence of either C3-Pooid or C4-Panicoid communities. Samples that derive from post-1500 archaeological contexts demonstrate a dramatic shift towards C4-Panicoid grass prevalence. C4-Panicoid grass communities expanded at the expense of mixed-grass communities, as the representation of this latter category fell after 1500. The presence of C3-Pooid grasses has remained roughly consistent since 600.

I want to draw attention to the uniform prevalence of C3-Pooid grasslands apparent across the Eastern African coast through time and space. The lush nature of such grasses does not make them an obvious fit for landscapes on the Swahili coast, as quite different levels of annual precipitation fall on soils with limited fertility; see Chapter Three, Table x, for further explanation. As I explained in the region-specific chapters, the distribution of C3-Pooid phytoliths varied through time

across landscapes. This indicates that fertile, well-watered pockets were not responsible for the continued prevalence of such grasses. Instead, I view the uniformity of C3-Pooid representation in archaeological assemblages, regardless of biological or physical influences, to suggest some degree of human intervention.

As it turns out, the proportion of C4-Panicoid type grass communities apparent between AD 600 and 1500 may also derive from a complementary anthropogenic influence. Phytolith assemblages from archaeological contexts that predate 1500 all recorded near equal representation of locations with C3-Pooid and C4-Panicoid prevalence. The number of mixed-grass communities was double that of C3-Pooid and C4-Panicoid combined. I take these phytolith-based landscape reconstructions to represent Swahili creation of grass communities, i.e., that these landscapes derived directly from agropastoral lifeways common to the Eastern African coastline since the mid-first millennium Iron Age.

Subsistence agriculture would have required a consistent representation of C4-Panicoid grasses in these areas, as local residents had been cultivating species of African domestic grains in and around their settlements. Macrobotanical evidence demonstrates the presence of such C4-Panicoid grasses in each of the regions that I consider here (Walshaw 2005, 2010, pers. comm. 2014; Pawlowicz 2011). Iron Age food production strategies included shifting-agriculture strategies. I expect such strategies to have amplified the presence of C4-Panicoid grasses for short periods of time, before the representation diminished (i.e., moved towards mixed-grass communities) as the location fallowed. In this way, the unequal levels of mixed-

grass communities could represent the presence of extensive fallow areas in landscapes where local communities were known to have practiced agriculture.

In a similar manner, the consistent prevalence of C3-Pooid grasses could derive from the pastoral component of food production in Iron Age subsistence strategies. Domestic cows, sheep, and goats consume a range of grasses, though evidence suggests that they prefer C3-Pooid grasses. The potential for such lush grasses could be increased by anthropogenic influences including the manufacture of water-retaining agricultural plots, ungulate-induced fertilization, or other practices that I document in Chapter Two. Again, C3-Pooid representation would diminish (i.e., move towards mixed-grass communities) in areas that were no longer actively used for pasture. In this way, Iron Age agropastoral subsistence strategies may have heavily influenced the composition of grass communities apparent in the reconstructed landscapes from the three regions under consideration.

I interpret the continued application of Iron Age-rooted subsistence strategies, and the grass communities that they influenced, as evidence that coastal communities applied a shared symbolic reservoir to varied biological and physical conditions available at Songo Mnara Island, Mikindani Bay, and northern Pemba Island. As I explained in Chapter Two, historical ecologists hold that communities cache outcomes of socioenvironmental interactions, both positive and negative, within a shared social memory, what some term a "symbolic reservoir" (McIntosh et al. 2000). Community members rely on this information to inform subsequent socioenvironmental interactions; further, people apply aspects of their particular reservoirs to new biophysical conditions that arise through time and space. By

drawing from a common symbolic reservoir in various coastal landscapes, Iron Age peoples managed to produce a shared set of domestic plants and animals in a range of coastal settings. The uniform application of this shared, agropastoral reservoir, in turn, helped to craft a common set of grasslands around their communities. As I document in region-specific chapters, my interpretation draws on macrobotanical, zooarchaeological, and material assemblages to further substantiate the notion of subsistence and material overlap between these three regions.

I do not feel comfortable applying the notion of a symbolic reservoir common to agropastoralists across the coast of Eastern Africa after AD 1500. The shift in C4-Panicoid subfamily grass prevalence after this moment indicates a change, one that correlated with a pair of influences unique to this period: the Little Ice Age and the onset of colonialism.

The Little Ice Age, AD 1650-1800, was the second global climatic anomaly known to limit the delivery of precipitation to the coastal areas of Eastern Africa in this archaeological assemblage; it followed the Medieval Warm Period that lasted from 800-1250 (Alin & Cohen 2003; Driese et al. 2004; Kiage & Liu 2009). By limiting the amount of rainfall in the regions under consideration, I expected the Little Ice Age to induce a shift towards drought-tolerant C4-Panicoid grasses. This shift clearly did occur, though it is notable that, according to my evidence, an accompanying shift did not occur between 800-1250. Some combination of anthropogenic, biological, and physical influences was able, apparently, to insulate coastal landscapes from such a shift during this earlier anomaly. While a millennium of agriculture in the regions may have limited the resilience of coastal

landscapes, I have documented multiple instances of such activities that did not degrade local landscapes universally.

Instead, I view the arrival of colonial influences to the coastal areas as contributing to the rise of C4-Panicoid grasses after 1500. The Portuguese metropole sponsored the construction of a garrison on Kilwa Kisiwani Island in 1506; this was a watershed moment that marked both the militarization of the region and the first wave of European colonialism in Eastern Africa (Freeman-Grenville 1962, 1975, 1991). Swahili people had long engaged with communities across the African continent and throughout the Indian Ocean world. However, such interactions had not afforded non-Swahili people any lasting role in coastal governance. Again, that arrangement changed with the arrival of Portuguese ships. After 1500 coastal peoples were no longer, necessarily, free to apply their long-followed agropastoral subsistence strategies; for this reason, along with climatic reasons and likely others, I mark this as the extent of the hypothetical Iron Age symbolic reservoir, although aspects of it may well have continued to influence decision-making in later centuries.

The discussion of woody-plant prevalence and grass-community composition represents a limited account of the anthropogenic and physical factors that may have influenced landscapes along the Eastern African coastline since AD 600. Phytolith assemblages recovered in the different regions demonstrate that plant communities and associated plant-use patterns underwent little variation through time and space. As I discuss, assemblages recorded in this exploratory project can

steer subsequent research towards a more nuanced understanding of plant community composition from archaeological contexts.

Did plant resources contribute to the constitution, manipulation, or expression of site-specific Swahili identities?

The response to the previous question addressed a large portion of this one, by outlining the ways in which relatively uniform phytolith assemblages may represent direct expressions of Swahili agropastoral subsistence strategies. General overlap in phytolith ratios from multiple assemblages also documents the lack of obvious interactions between plant communities accessible through my analysis, and the lack of site-specific signatures. Despite the lack of obvious intersection, a site-by-site consideration of material expressions and phytolith assemblages allows for the creation of interpretive models. Such models should, in turn, inform subsequent phytolith analyses conducted on the Eastern African coast.

I evaluate this question through a site-by-site review of results as they relate to specific socioeconomic or subsistence exploits. The activities included in this review were specifically applied to the archaeological regions under consideration. That said, the socioeconomic and subsistence practices are thought to be common to the coast in general, such that the activities and models I propose for specific sites could also be applied in other areas.

The incipient urbanism and expansive stone-built architecture of Songo

Mnara necessitated high levels of woodfuel consumption over a short period of time.

Further, the material assemblage at this settlement included spindle whorls which

pre-modern residents of Eastern Africa used to spin cotton fiber into thread for

presumably local consumption as well as export. Communities across Mikindani Bay managed to maintain agropastoral subsistence strategies for well over a millennium, and how they did this is central to my concerns here. Finally, I consider the potential impacts of colonial-induced arboriculture on landscapes of northern Pemba Island.

Phytolith Evidence of the Role of Plants in Social Expressions at Songo Mnara Island

Songo Mnara was an urban community occupied on a small, nearshore island from the fourteenth to sixteenth century (Fleisher & Wynne-Jones 2010, 2013). The urban community was clearly integrated into the broader Kilwa region of southern Tanzania; this area contained at least four other settlements with varied degrees of urbanism, Islamic practice, and engagement with peoples from continental Africa and the Indian Ocean (Chittick 1974). Songo Mnara has some of the best-preserved stone-built architecture in the coastal region; this architecture indicates that over the span of two centuries residents of the island constructed at least 40 domestic room-blocks, five mosques, numerous tombs, and a town wall all of stone (i.e., a combination of coral rag and lime). Excavation in and around these stone-built spaces documented the presence of cotton spinning, ceramic production, food preparation, and iron smithing.

Such activities each had the capacity to alter woody-plant communities in and around this urban community. The production of lime, ceramics, food, and iron requires high levels of woodfuel investment. Spindle whorls suggest that cotton was grown nearby; cotton is an herbaceous plant that is expected to create woody-plant

type phytoliths. Archaeological evidence of woodfuel-consuming socioeconomic activities at Songo Mnara also documented direct evidence of charcoal consumption. Extensive charcoal deposits in addition to the other indicators from this urban community led me to expect a severe decline in levels of woody-plants directly outside the town wall. The phytolith record did not support this expectation. Instead, I recorded a slight increase in woody-plant presence during the two centuries of habitation. I recorded the highest levels of woody-plants in contexts directly adjacent to the urban community.

This slight increase in woody-plant prevalence between AD 1300 and 1500 suggests that residents of Songo Mnara likely did not derive woodfuel resources from adjacent landscapes. I interpret this as indirect evidence of early- to midsecond millennium consumption of mangrove forests to meet local charcoal requirements. Historic reports and contemporary research indicate that mangroves are a class of scrub or tree that have long met a range of domestic functions, including fuel, for coastal populations (Curtin 1981; Dahdough-Guebas et al. 2000). Mangroves are restricted to intertidal areas and do not produce diagnostic phytoliths. For this reason, coastal peoples would be able to rely on such trees to meet woodfuel requirements without any apparent impact on land-bound woodyplant representation. Because they do not produce diagnostic phytoliths, macrobotanical investigation of charcoal from archaeological contexts would be necessary to provide clear evidence of a mangrove-as-fuel interpretation.

The presence of spindle whorls and other materials associated with cotton thread production suggests that this type of woody plant was grown locally at Songo

Mnara Island and northern Pemba Island (LaViolette 2008; Fleisher & Wynn-Jones 2010, 2013; Walshaw pers. comm. 2014). Cotton produces phytoliths common to woody-plants. For this reason, levels of woody plants in second-millennium archaeological contexts may not necessarily reflect a continuation of scrub- or forest-cover despite local urbanism, but may document the harvest and immediate replacement of local scrub- or tree species with cotton. The exploratory nature of this research did not leave room for the inclusion of cotton-specific phytolith morphologies in microscopic analysis, so I am unable to speak directly to the role of cotton beyond this suggestion. Further investigation that considers phytolith morphologies specific to cotton plants would provide definitive evidence of the location of cotton production in the region.

Botanical Contributions Towards Social Expressions at Mikindani Bay

Mikindani is a town situated along the southern coast of Tanzania that has continuously hosted village settlements since the mid-first millennium AD. Residents have long cultivated African grains and reared domestic animals throughout this region. Archaeological investigation indicates that at the turn of the second millennium, residents of Mikindani Bay separated themselves or were otherwise distanced from the typical Swahili social trajectories they were participating in earlier (Pawlowicz 2011). This shift was accompanied by an elaboration and extension of agropastoral subsistence strategies to additional areas in the region; these were the same strategies introduced to the region by Iron Age populations. I interpret this as evidence that the persistent production of C3-Pooid

and C4-Panicoid grasses played important roles in community expressions across Mikindani Bay.

Grass communities in the areas under consideration from Mikindani Bay demonstrated a near equal representation of C3-Pooid and C4-Panicoid subfamily prevalence through 1500. A millennium of food production in the area with limited soil fertility and relatively low levels of precipitation was not possible without anthropogenic intervention. Soil chemistry analyses suggest that nitrogen had been introduced to local landscapes that had been heavily farmed since the early second millennium (Pawlowicz 2011; Pawlowicz et al. forthcoming). Evidence of fertilization raises the argument that agropastoral populations in the region understood that their actions had degraded local soils. Further, this evidence suggests that residents likely understood mechanisms able to mitigate the impact of soil degradation, similar to mechanisms recorded by more recent historic and ethnographic investigations of Eastern Africa.

With region-specific examples in mind, I now revisit the overarching research question. Evidence does seem to support the notion that plant communities contributed to the constitution and manipulation of region-specific identities. Macrobotanical investigations have demonstrated the relationship between Swahili peoples and plant communities since rice became a prominent feature of coastal Islamic practice (Walshaw 2005; 2010). The full extent of such socioenvironmental interaction remains unknown at this point. Subsequent analyses that target phytolith morphologies specific to particular plants (i.e., cotton,

clove, and African grains) are necessary to demonstrate definitively the presence of such interaction.

This exploratory phytolith research has opened many doors regarding the potential role phytoliths may play in archaeological investigations of Swahili contexts. Far more research is necessary to qualify hypothetical interpretations that I present in this project. That said, phytoliths are clearly not on an analytical plane equivalent to material, linguistic, or ideological residues known from the region. Potential for phytolith advancement certainly exists for the coastal region.

Botanical Contributions Towards Social Expressions at Northern Pemba Island

Pemba Island lies 60 km off the coast of northern Tanzania. The fecundity of this island was long renowned and archaeological investigations report that communities first formed on the northern part of the island in the mid-first millennium (Fleisher 2003). These communities played prominent roles in regional economic and religious spheres through the mid-second millennium AD (LaViolette & Fleisher 2009). Macrobotanical evidence suggests that residents followed the Iron Age agropastoral subsistence strategy that I outlined above through the early second millennium, after which locally produced rice became the staple crop of the region (Walshaw 2005, 2010). The role of rice production in this region is well documented; this information led me to search for phytolith morphologies specific to Asiatic species of rice in this assemblage (see discussion of Chlorideae subfamily grasses in Chapter Three). I was unable to record much phytolith-based evidence of

this cultivar. For this reason, I focus this discussion on colonial-induced clove arboriculture.

The Sultanate of Oman gained control of Pemba Island in the early nineteenth century and, among other things, imposed clove arboriculture on local landscapes (Troup 1932; Wigg 1937; Sheriff 1987). Pemba and nearby Unguja Islands quickly rose to become the clove capital of the world. The islands became synonymous with clove production and retain the title "Spice Islands" in many circles (Kirsopp 1926; Crofts 1959).

The uniform distribution of woody-plant type phytoliths apparent in the most recent archaeological contexts analyzed from Pemba Island may represent clove production in the region. Colonial reports and personal experience with these contexts leaves me with the impression that clove plantations were landscapes punctuated by equally spaced clove trees, underlain by grasses, manufactured and maintained by local peoples. This description aligns with the phytolith-based woody-plant reconstructions that I describe from this landscape. While this most recent landscape may reflect clove arboriculture, diachronic perspectives suggest that this colonial venture did not alter the prevalence of woody-plant communities across northern Pemba. Instead, woody-plants maintained a homogeneous representation through village, urban, and colonial influences. This apparent continuity is exceedingly surprising and begs additional investigation. As before, I recommend analyses that build upon my exploratory study employ a methodology that considers phytolith morphologies known to clove and cotton plants.

Was the diachronic change in Swahili identity apparent in the material record reflected in the plant record? Here I am speaking directly towards processes of urbanization, adoption of Islam, shift towards rice production, and altered tone and tenor in long-distance trade.

The phytolith assemblages recovered from archaeological contexts across the Eastern African coastline did not reflect diachronic social changes apparent in material records from the regions. As I described in the responses to previous questions, the three archaeological regions under consideration maintained an interchangeable, uniform set of phytolith assemblages. Such plant-based uniformity persisted in each of the regions despite clear social shifts apparent in the material records recovered in the same archaeological contexts. Proportions of C3-Pooid and C4-Panicoid grasses, each of which may play a role in agropastoral subsistence strategies, remained consistent between AD 600 and 1500; the representation of woody-plant type phytoliths similarly remained consistent between regions and through time. As I outline below, the lack of change apparent in the phytolith record could be an artifact of my research methodologies. Alternatively, the phytolithbased uniformity apparent through time and space may reflect a conservative approach to food production and consumption. The latter interpretation articulates with a burgeoning literature on subsistence production and consumptions patterns recorded in archaeological contexts across the world.

The process of food production and consumption requires individuals and communities to juggle a range of temporal scales as food consumption requires daily attention to processing (Crumley 2000; Ebeling & Rowan 2004; Smith 2006), while agriculture requires seasonal-to-annual attention. Communities that practice shifting agricultural strategies must also account for decades-long fallow patterns

across their local landscapes (Pluciennik 2001; Harrower et al. 2010). The decadeslong processes can impede the rate of change expressed within subsistence strategies because such alterations would also impact long-term settlement strategies and could leave communities at risk of food shortages.

Research also suggests that the daily processes involved in food preparation and consumption may represent a component of social cohesion, a factor which daily reinforces community-wide values and preferences (Hastorf & Johanessen 1993; Gumerman 2002; Janusek 2002; Smith 2006). The cohesion that results from such communal values is also thought to contribute back into long-term, conservative approaches to food production strategies. This interpretation adds another facet to the notion of symbolic reservoir, as the desire for a conservative approach to subsistence strategies could induce individuals and communities to adhere to shared knowledge about particular plants and animals. My exploratory project can only suggest the presence of a symbolic reservoir or notions of social cohesion as expressed through food production. My results are consistent with these suggestions, and hopefully can inform future, less preliminary investigations and analyses. My belief in the power of further phytolith investigations leads me to the final research question.

Is phytolith analysis a research method that can produce viable results along the Eastern African coast?

Songo Mnara Island, Mikindani Bay, and northern Pemba Island all produced extensive deposits of silica bodies with diagnostic morphologies that allowed me to provide baseline environmental reconstructions of all three regions. I was able to

demonstrate that post-depositional processes had not muddled the chronologic orientation of the assemblages. Instead, I was able to derive relative dates confidently for silica bodies from archaeological residues recovered in the same contexts. This project began on a note of somewhat nervous optimism and managed to recover a set of phytolith assemblages that defied expectations in terms of their quality. However, not surprisingly, this project poses more questions than it has answered, and far surpassed those questions with which I began. Further investigation focusing on more specific phytolith signatures could now be undertaken with confidence along the coast based on my preliminary results. I conclude this dissertation with recommendations for future research, and a brief reflection on the different directions that this project might have gone.

Concluding Thoughts

The decision to collect phytolith samples from a wide array of archaeological and environmental contexts was a necessary precaution, as I was not sure if diagnostic silica bodies would be available in contexts across the coast. Fortunately, I was able to identify diagnostic phytoliths from nearly all the contexts that I chose to sample. The subsample provides a representative, though limited, glimpse into the phytolith records of the regions that I consider. I say this because the subsample represented roughly 17% of the available assemblage, as I was able to obtain viable samples from 278 of the 1,645 samples that I collected. Had I known that I would have gotten a near-perfect return on phytolith representation in the archaeological record, I would have tightened my survey strategy and focused more on the

collection of artifacts in association with phytoliths. This might have permitted a tighter chronology of plant community composition through time. The collection of macrobotanical or zooarchaeological residues would have also provided more direct evidence to support the hypotheses I pose regarding agropastoral roles of C3-Pooid and C4-Panicoid grasses.

The more focused excavation strategy would have also limited the time I spent in the field, which would have permitted additional time in the lab. Additional time may have allowed for more experimentation with direct, genus- or species-level identification of phytolith bodies. As it was, the lab processing and microscope analysis took roughly 28 months, from January 2012 through April 2014. This laboratory period followed a six-month field season, June through December 2011.

Future phytolith investigations conducted in Eastern African coastal contexts would do well to look at phytolith bodies that are more diagnostic than family or subfamily levels. My research suggests that intricacies of species that contributed to C3-Pooid and C4-Panicoid grasses apparent in these phytolith records deserve heavy consideration. In particular, consideration of phytoliths specific to millet, sorghum, or other types of domestic African grains would represent an important contribution to phytolith analysis on the coast.

The need for a baseline understanding of plant community composition across the coast of Eastern Africa and within archaeological regions became clear in this conclusion. I made sure to recover phytolith samples from contexts in and around areas of known human habitation and disturbance. While this strategy allowed me to track anthropogenic influences apparent in the numerous regions,

the lack of a base set of expectations complicates the interpretations possible. I say this because I am unable to delineate region-wide impacts of global climate anomalies or even differentiate influences of particular anthropogenic actions. If possible, subsequent research should look to include areas without overt anthropogenic activities, though this is a difficult proposition because such contexts would not have the benefit of relative chronological information.

In conclusion, I hope that this contribution to an emerging historical ecology of the Swahili coast is a building block on which future work, my own and that of others, can rest, and I look forward to the increasing engagement of scholars of Eastern Africa with questions of long-term human-land interaction in this region.

Appendix One

Plants Recorded in Botanical Survey of Songo Mnara Island and Mikindani Bay

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rubiaceae

Plant Genus and Species: *Hymenodictyon parvifolium* Oliv.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Description of Plant: Rare shrub- tree that reaches height of 3.5 m. Bark is brown-

maroon. Leaves turning yellow to green at maturity.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7237 Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Sapotaceae

Plant Genus and Species: *Sideroxylon inerme*

Description of Plant: Abundant; turfed shrub tree up to 3.5 m tall; stem brown with grey tinge; flower buds with pale-white-green corolla. Ovary with brown

stigma.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7236 Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Tiliaceae

Plant Genus and Species: *Grewia glanduloss*

Description of Plant: Rare. Shrub to 2.5 m tall. Bark brown-red tinged grey. Fruit

with dark-brown pubescence.

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7238

Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Erythroxylaceae

Plant Genus and Species: Erythroxylum emarginatum

Description of Plant: Rare-locally occasional. Shrub to 2.8m tall. Twigs red-

maroon shading to grey. Leaves shiny on lower surface.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7239 Date: 2 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Lauraceae

Plant Genus and Species: *Cassytha filiformus*

Description of Plant: Rare-locally abundant. Parasitic herb. Stem turning to

yellow-orange. Perianth pale white. Fruit with pale-brown stigma.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7240 Date: 2 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Anacardiaceae

Plant Genus and Species: *Rhus natalensis* krauss

Description of Plant: Rare-locally abundant shrub to 2.5m tall. Bark red-brown.

Mature leaves shiny greenish-yellowish on lower surface.

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7241 Date: 2 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: Tephrosia sp.

Description of Plant: Locally rare-frequent; sub-erect to 0.8m high. Stem whitish-

green with pink ting. Pods whitish-green with grey-brown stigma.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7242 Date: 2 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Sapindaceae

Plant Genus and Species: Dodonaea viscosa

Description of Plant: Rare. shrub to 2m tall. Bark red-brown. Fruit green-white

turning to whitish yellow.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7243

Date: 2 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Verbenaceae

Plant Genus and Species: Premna obtusifolia

Description of Plant: Rare shrub to 2.4m tall. Bark brown-maroon-purple. Old

and dry fruits dark brown.

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7244

Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Anacardiaceae

Plant Genus and Species: Ozoroa insignis

Description of Plant: Rare-occasional; Shrub-tree to 3.5m tall.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7245 **Date:** 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rubiaceae

Plant Genus and Species: unlisted

Description of Plant: Rare-locally occasional. Shrub to 2m tall. Bark red-maroon

tinged grey. Leaves shiny orange-green. Flowers green-orange.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7246 Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Ebenaceae

Plant Genus and Species: Euclea divinorum

Description of Plant: Locally rare- occasional. Shrub to 2m tall. Bark dark-brown-

purple tinged white-grey patches sterile.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7247 Date: 4 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rhamnaceae

Plant Genus and Species: Colubrina asiatica

Description of Plant: Rare-occasional at transition from bushland to mangrove forest. Tree to 6m tall with 10cm dbh. Twigs yellowish-green. Dry forest dark-

brown.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7249 Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Burseraceae

Plant Genus and Species: Commiphora africana

Description of Plant: Rare-locally occasional. Shrub-tree to 4m tall with 10cm

dbh. Perianth red-maroon.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7248 **Date:** 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Oleaceae

Plant Genus and Species: Olx obtusifolia

Description of Plant: Rare-locally occasional at transition from coastal bushland to mangrove forest. Tree to 5m tall. Bark dark brown-blue-purple. Leaves with red

dots. Flower buds tinged inconspicuous bluish purple ting.

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7250 Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Malvaceae

Plant Genus and Species: Thespesia danis oliv

Description of Plant: Rare at bushland edge. Tree to 5m tall. Bark brown-maroon.

Leaves with orange patches turning to yellow- orange at maturity. Sterile.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7251 Date: 4 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Poaceae

Plant Genus and Species: Eragostis sp.

Description of Plant: Rare grass. Dry. Culm dark brown.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7253 Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Ebenaceae

Plant Genus and Species: *Diospyros fischeri*

Description of Plant: Locally rare to occasional shrub to 2m tall. Bark dark bown-

maroon tinged grey. Leaves tinged dark blue to purple at edge.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7252 Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Cyperaceae

Plant Genus and Species: Fimbristylis obtusifolia

Description of Plant: Abundant at open space within bushland sedge.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7253

Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Poaceae

Plant Genus and Species: unlisted

Description of Plant: Abundant at open space within bushland grass. Dry culm

brow-white.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7255

Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Malaceae

Plant Genus and Species: *Hibiscus tiliaceus*

Description of Plant: Rare-occasional at transition from bushland to mangrove forest. Tree to 7m tall. Bark brown-maroon. Leaves turning to yellow-orange at

maturity. Dry fruit brown-maroon.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7257 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: *Indigofera sp.*

Description of Plant: Rare woody herb to 1m tall. Stem tinged red-maroon.

Leaves tinged inconspicuous red maroon on upper surface. Sterile.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7256 Date: 4 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: Caesalpinia bonduc

Description of Plant: Rare to occasional at transition to mangrove forest. Liana to 2.5m tall. Leaves turning to brown-orange at maturity. Dry pods dark-brown with

red-pink prickly pubescence.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7258

Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Asparagaceae

Plant Genus and Species: Asparagus sp.

Description of Plant: Rare. Tufted herb to 0.4m tall. Leaves whitish-green.

Sterile.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7259 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Opiliaceae

Plant Genus and Species: Opilia amentaceae

Description of Plant: Rare. Liana to 5m high. Leaves shiny orange-green. Sterile. **Habitat:** Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7261 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rubiaceae

Plant Genus and Species: Guettarda speciosa

Description of Plant: Rare at transition from bushland to mangrove forest. Tree to 7m tall with 12cm dbh. Bark brown-maroon-purple. Leaves turning to yellow-orange at maturity. Perianth green-orange-yellow. Stamen white-orange. Pistil orange-green.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring *Sidoxylon inerme, Grewia sp., and Rhus sp.*. **Collector:** C.I. Kavombo and I.M. Stoetzel

Collection No.: 7260

Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Capparaceae

Plant Genus and Species: Maerua angolensis

Description of Plant: Rare. Leaning shrub to 1.7m high. Leaves tinged yellow-

orange. Sterile.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7262 Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rubiaceae

Plant Genus and Species: *Pyschotria sp.*

Description of Plant: Rare. Shrub to 2m tall. Bark brown-grey. Fruit yellowish-

green with dark brown stigma.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7263 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Cyperaceae

Plant Genus and Species: Fimbristylis obtusifolia

Description of Plant: Locally abundant at open bushland. Herb. Leaves yellowish

green. Succulent.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7265

Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Poaceae

Plant Genus and Species: unlisted

Description of Plant: Locally abundant at transition from bushland to mangrove

forest. Grass culm red-pink-green. Glumes grey brown-white-green.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7266

Date: 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Casuarinaceae

Plant Genus and Species: Casuarina equisetifolia

Description of Plant: Locally rare in bushland. Tree to 8m tall with 10cm dbh.

Bark dark-red-brown. Female cones tinged red-brown dust.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7267

Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Tiliaceae

Plant Genus and Species: *Grewia similis*

Description of Plant: Rare. Sub-erect shrub to 2m tall. Bark dark brown-maroon.

Fruit whitish-green with dark brown stigma.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7269

Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rubiaceae

Plant Genus and Species: Oldenlandia herbaceae

Description of Plant: Locally abundant herb. Stem tinged red-maroon. Dry

inflorescence brown.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7268

Date: 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Poaceae

Plant Genus and Species: Pennisetum ciliare

Description of Plant: Locally abundant. Grass glume pale green-white. Awns red-

purple.

Habitat: Miombo Woodland within Sanga Rungu Island. Bushland dominated area

featuring Sidoxylon inerme, Grewia sp., and Rhus sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7270 Date: 2 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Poaceae

Plant Genus and Species: Panicum maximum

Description of Plant: Rare to occasional. Grass to 1.2m tall. Glumes green-white

tinged maroon-purple.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7272

Date: 2 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Amaranthaceae

Plant Genus and Species: Achyranthes aspera

Description of Plant: Rare to occasional. Herb to 0.6m tall. Inflorescence tinged

brown-pink.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7274

Date: 2 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Nyctaginaceae

Plant Genus and Species: Boerhavia coccinea

Description of Plant: Rare to occasional. Leaning sub-erect herb to 0.5m high. Stem red-pink. Leaves tinged red-pink. Perianth green-white with inconspicuous

pink patch.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7273 **Date:** 5 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Bombacaceae

Plant Genus and Species: Adansonia digitata

Description of Plant: Rare tree to 10m tall with 35cm dbh. Corolla white. Stamen

white with brown anthers. Pistil white with brown stigma.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7271 **Date:** 5 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: Rhynchosia minima

Description of Plant: Rare to occasional. Herbaceous climber to 0.5cm high. Stem tinged red-pink with brown pubescence. Corolla yellow-orange with red-maroon,

vertical stripes. Anthers yellow. Filament white. Pistil pale green.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7275 **Date:** 5 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Poaceae

Plant Genus and Species: Exotheca sp.

Description of Plant: Locally abundant. Culm pink-white. Awns red-maroon-

purple.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7277 **Date:** 5 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Euphorbiaceae

Plant Genus and Species: Alchorea laxiflora

Description of Plant: Rare to location. Shrub to 1m tall. Bark green-brown. Young

leaves green-yellow. Perianth green-white. Stamens yellow green-white. **Habitat:** Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7276 **Date:** 5 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Asteraceae

Plant Genus and Species: *Tridax procumbens*

Description of Plant: Locally abundant herb. Anthers yellow. Corolla white. **Habitat:** Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7279 **Date:** 5 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Euphorbiaceae

Plant Genus and Species: Spirostachys venenifera

Description of Plant: Rare to location. Tree to 9m tall with 15cm dbh. Bark

brown-grey. Perianth red-maroon.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7281 **Date:** 5 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Poaceae

Plant Genus and Species: unlisted

Description of Plant: Locally abundant. Culm green-white. Glumes pinkish-green-

white. Awn pale-brown-white.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7280 Date: 5 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Anacardiaceae

Plant Genus and Species: Sclerocarya bierra

Description of Plant: Rare to occasional. Tree to 5m tall. Young twigs red-pink.

Sterile.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7282 Date: 5 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: Crotalaria sp.

Description of Plant: Rare herb. Pods yellow-green with maroon-purple stripe on

upper surface.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7283 **Date:** 5 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: *Indigofera sp.*

Description of Plant: Rare woody-herb. Calyx with dark-brown-purple

pubescence. Corolla pink.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7285 **Date:** 5 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Acanthaceae

Plant Genus and Species: Justicia sp.

Description of Plant: Rare herb. Corolla white.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7284

Date: 5 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Asteraceae

Plant Genus and Species: Vernonia amygdalina

Description of Plant: Rare shrub to 3m tall. Young stems purplish-green with

brown-purple swollen structure. Yong capitulum white and green.

Habitat: Coconut tree plantation with scattered bushland patched. UNESCO

historical site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7286 **Date:** 5 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Loganiaceae

Plant Genus and Species: Strychnos innocua

Description of Plant: Locally rare tree to 7m tall with 18cm dbh. Fruits whitish-

green.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7287 Date: 5 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Caesalpiniaceae

Plant Genus and Species: Tamarindus indica

Description of Plant: Rare in location. Tree to 10m tall with 25cm dbh. Bark dark

brown. Sterile.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeva sp., and Ocnha sp.

Collector: C.I. Kavombo and J.M. Stoetzel

Collection No.: 7289

Date: 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Loranthaceae

Plant Genus and Species: Agelanthus sp.

Description of Plant: Rare parasitic shrub to 0.5m tall. Stem brown-maroon.

Fruits red shading to yellow-orange base.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7288

Date: 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Sapindaceae

Plant Genus and Species: Haplocoelum inopleum

Description of Plant: Locally abundant. Tree up to 8m tall with 18 cm dbh. Bark

dark blue-brown. Sterile.

Habitat: Bushland dominated by Sclerocarva birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7290 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Tiliaceae

Plant Genus and Species: Grewia sp.

Description of Plant: Rare tree to 7m tall. Twigs shiny and dark with blue-brown-

purple lenticels. Sterile.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7291 Date: 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: Vigna unguiculata

Description of Plant: Herbaceaous climber. Mature stem whitish-green tinged

brown.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7293 **Date:** 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Capparaceae

Plant Genus and Species: unlisted

Description of Plant: Frequent to location. Shrub to 2.5m tall. Stem with brown

lenticels.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.I. Kavombo and I.M. Stoetzel

Collection Number: 7292

Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rhamnaceae

Plant Genus and Species: Ziziphus mauritiana

Description of Plant: Rare tree to 6m tall with 10cm dbh. Bark grey-brown sterile. **Habitat:** Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7294 **Date:** 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Euphorbia

Plant Genus and Species: Tragia brevipes

Description of Plant: Rare herbaceous climber. Pubescence green-grey irritating

to touch.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7295 **Date:** 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Sterculiaceae

Plant Genus and Species: *Dombeya burgessiae*

Description of Plant: Locally abundant. Shrub to 1.8m tall. Bark grey-brown.

Sterile.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.I. Kavombo and I.M. Stoetzel

Collection Number: 7297 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Verbenaceae

Plant Genus and Species: Vitex strickeri

Description of Plant: Rare to occasional shrub to 6m tall with 9cm dbh. Twigs

yellowish-brown. Sterile

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7299 **Date:** 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Euphorbiaceae

Plant Genus and Species: Dalechampia parvifolia

Description of Plant: Herbaceous climber to 2m high. Stem with brown-grey

pubescence. Leaves grey on lower surface. Stamen white.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7301 **Date:** 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rubiaceae

Plant Genus and Species: *Oxyanthus zanguebarica*

Description of Plant: Locally abundant. Shrub up to 10m tall. Bark dark brown.

Flower buds whitish-green.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.I. Kavombo and I.M. Stoetzel

Collection Number: 7300 Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Malvaceae

Plant Genus and Species: Hibiscus aponeurosis

Description of Plant: Rare woody-based herb to 1m tall. Fruit with white-green

vertical stripes.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7302 **Date:** 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Malpighiaceae

Plant Genus and Species: Tristellateia africana

Description of Plant: Occasional to location. Sub-woody climber to 5m high. Stem

red-brown with brown lenticels. Dry inflorescence grey-brown-white.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7303 **Date:** 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Celastraceae

Plant Genus and Species: *Maytenus undata*

Description of Plant: Occasional to location. Shrub to 2.5m tall. Bark red-brown.

Flower buds tinged brown.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7305 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Araliaceae

Plant Genus and Species: Cussonia zimmermannii

Description of Plant: Rare tree to 9m tall with 19cm dbh. Bark grey-brown.

Sterile.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7304

Date: 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Sterculiaceae

Plant Genus and Species: Sterculia africana

Description of Plant: Rare tree to 8m tall with 20cm dbh. Perianth yellow-orange

with red vertical stripes. Pistil green.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7306 **Date:** 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Salvadoraceae

Plant Genus and Species: Salvadora persica

Description of Plant: Occasional to location. Ascendant shrub to 4m. Sterile.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7307 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: *Tephrosia sp.*

Description of Plant: Rare to location herb. Stem tinged maroon-purple with grey

pubescence. Pods with blue-maroon-purple ting.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7309 **Date:** 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Meliaceae

Plant Genus and Species: Xylocarpus moluccensis

Description of Plant: Rare at transition from bushland to mangrove forest. Tree to 7m tall with 12cm dbh. Bark brown-grey. Leaves greyish-green on lower surface with dark brown patches.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7308 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: Alysicarpus sp.

Description of Plant: Rare to location herb to 0.9cm. Stem shading to red-brown

base. Dry fruits brown.

Habitat: Bushland dominated by *Sclerocarya birrea*, *Olx obtusifolia*, *Commiphora sp.*,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7310 Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Poaceae

Plant Genus and Species: unlisted

Description of Plant: Rare to location grass. Glumes green-white.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp.,

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7311 **Date:** 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rhizophoraceae

Plant Genus and Species: Rhizophora mucronata

Description of Plant: Tree to 7m tall with 15cm dbh. Bark dark brown-maroon with inconspicuous grey tinge. Fruit brown shading to whitish-green-brown.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7313 **Date:** 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Convolvulus

Plant Genus and Species: *Ipomea pes-caprae*

Description of Plant: Rare to location straggling herb up to 2m long. Stem red-

maroon. Mature leaves turning yellow-orange.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.I. Kavombo and I.M. Stoetzel

Collection Number: 7312 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Rhizophoraceae

Plant Genus and Species: Ceriopsi tagal

Description of Plant: Locally abundant tree to 7m tall with 15cm dbh. Twigs whitish-green-grown with red-brown patches. Fruits shading to brown base.

Habitat: Bushland dominated by Sclerocarya birrea, Olx obtusifolia, Commiphora sp.,

Haplocoelum sp., Sterculia sp., Dombeya sp., and Ocnha sp..

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7314 **Date:** 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Lythraceae

Plant Genus and Species: Pemphis acidula

Description of Plant: Locally abundant at mangrove tree stand edge. Shrub-tree up to 6m tall with 9cm dbh. Bark dark-brown-maroon. Stamen yellow. Fruit tinged

red-maroon-brown. Corolla white.

Habitat: Mangrove forest.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7315 **Date:** 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Loranthaceae

Plant Genus and Species: unlisted

Description of Plant: Rare shrub parasitic on *Ceriops tagal*. Perianth yellow-

orange shading to red-pink. **Habitat:** Mangrove forest.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7317 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Verbenaceae

Plant Genus and Species: Avicennia marina

Description of Plant: Occasional in area. Tree to 10m tall with 25cm dbh. Bark yellow-brown. Twigs white-green-orange. Leaves with grey-yellow tomentose on

lower surface sterile.

Habitat: Mangrove forest.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7316

Date: 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Boraginaceae

Plant Genus and Species: Cordia subcordata

Description of Plant: Rare to location. Tree to 6m tall with 10cm dbh. Twigs green-yellow. Leaves turning to yellow-orange at maturity. Dry fruits dark-brown. **Habitat:** Coastal dry forest directly beyond "necropolis" of UNESCO world heritage

site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7318 **Date:** 3 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Plumbaginaceae

Plant Genus and Species: *Plumbago aphylla*

Description of Plant: Rare to location. Herb to 1m tall. Corolla white.

Habitat: Coastal dry forest directly beyond "necropolis" of UNESCO world heritage

site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7319 Date: 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: Canavalia rosea

Description of Plant: Rare to location. Straggling-climbing herb to 5m high. Stem

with grey-brown pubescence. Pod green-white.

Habitat: Coastal dry forest directly beyond "necropolis" of UNESCO world heritage

site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7321 **Date:** 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Lecythidaceae

Plant Genus and Species: Guettarda speciosa

Description of Plant: Rare to location between transition from dry coastal forest to mangrove forest. Tree to 6m tall with 11cm dbh. Bark dark-brown-maroon. Leaves

shiny yellowish-orange. Fruits tinged red-brown-pink at apex.

Habitat: Coastal dry forest directly beyond "necropolis" of UNESCO world heritage

site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7320 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Fabaceae

Plant Genus and Species: Dalbergia melanoxylon

Description of Plant: Shrub to 4m tall. Bark brown-grey. Sterile.

Habitat: Coastal dry forest directly beyond "necropolis" of UNESCO world heritage

site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7322 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Sterculiaceae

Plant Genus and Species: Waltheria idnica

Description of Plant: Rare to location. Herb to 1m tall. Corolla pale yellow.

Habitat: Coastal dry forest directly beyond "necropolis" of UNESCO world heritage

site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7323

Date: 3 October 2011

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Euphorbiaceae

Plant Genus and Species: Euphorbia hirta

Description of Plant: Herb rare to location. Stem tinged red-pink. Fruit green-

white with red-purple patches.

Habitat: Coastal dry forest directly beyond "necropolis" of UNESCO world heritage

site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7325 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Capparaceae

Plant Genus and Species: unlisted

Description of Plant: Rare to location. Liana to 6m high. Twigs with red-maroon

pubescence. Flower buds with red-maroon pubescence.

Habitat: Coastal dry forest directly beyond "necropolis" of UNESCO world heritage

site.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7324 **Date:** 3 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Lindi Region Kilwa District Songo Mnara Island

Plant Family: Sonneratia

Plant Genus and Species: Sonneratia alba

Description of Plant: Abundant in location. Tree to 10m with 18cm dbh. Perianth

tinged red-pink. Stamens with cream anthers. Overy with pale-white style.

Habitat: Mangrove forest

Collector: C.J. Kayombo and J.M. Stoetzel

Collection Number: 7326

Date: 3 October 2011

Mtwara Region Mikindani District

Plant Family: Malpighiaceae

Plant Genus and Species: Tristellaleia Africana, var. S. Moore

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Rare in the area. Occasional sub-woody climbing herb to 4 m high. Stem red-brown-maroon. Corolla yellow. Anther yellow orange. Stigma

yellowish-white-green.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7328

Date: 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Boraginaceae

Plant Genus and Species: Trichodesma zeylanicum

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Rare in the area. Herb to 0.8 m tall. Stem white-green tinged red maroon stellate with swollen dots that have grey-white pubescence. Corolla are blue-white.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7329 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Euphorbiaceae

Plant Genus and Species: Mildibraedii carpinifolia

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp., Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia*

madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Rare to occasional in the area. Shrub to 2 m tall Mature stem is red-maroon. Leaves yellowish green. Perianth whitish-green with brown-red-maroon.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7330 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Asteraceae

Plant Genus and Species: unlisted

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Rare to area. Herb. Corolla lobes are blue-purple.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7331 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Solanaceae

Plant Genus and Species: Solanum incanum

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Herb. Rare to area. Height to 1 m. Corolla whitish-purple or

vellowish-orange.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7332 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Anacardiaceae

Plant Genus and Species: *Mangifera indica*

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Occasional tree to 8.5 m tall and 28 cm dbh. Rare in area.

Bark is dark brown. Fruit with grey dots. **Collector:** C.J. Kayombo and J.M. Stoetzel

Collection No.: 7333 Date: 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Sapotaceae

Plant Genus and Species: Manilkara mochisia

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Tree to 5 m tall. Rare to area. Bark is orange-red tinged

grey. Sterile.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7334

Date: 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Acanthaceae

Plant Genus and Species: Justicia striata

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Herb. Locally abundant. Strem is greenish-brown. Corolla

white.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7335 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Portulacaceae

Plant Genus and Species: *Tilium sp.*

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Herb, prostrate. Rare. Stem green-white tinged red-maroon.

Calyx red margin.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7336 Date: 6 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Connaraceae

Plant Genus and Species: Rourea coccinea var. Schumach Benth

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp., Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia*

madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Shrub to 1.6 m tall. Rare to occasional in area. Bark redmaroon-purple tinged with grey. Young leaves maroon-purple. Stamen is pale

white.

Collector: C.J. Kayombo and J.M. Stoetzel.

Collection No.: 7338

Date: 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Boraginaceae

Plant Genus and Species: Ehretia amoena

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Shrub-tree up to 5 m tall. Occasional to abundant in area. Bark is grey-brown. Leaves with grey pubescence. Flower buds with grey pubescence.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7339 **Date:** 6 October 2011

Mtwara Region Mikindani District

Plant Family: Bignoniaceae

Plant Genus and Species: Kiggelaria africana

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Shrub to 2 m tall. Rare to occasional in area. Bark is

maroon-grey. Fruit with purplish-green pubescence.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7340 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Sapindaceae

Plant Genus and Species: Deinbollia borbonica

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Shrub to 2.5 m tall. Occasional to area. Bark is grey-brown.

Corolla white. Anther yellow. Fruit with grey pubescence.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7341 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Capparaceae

Plant Genus and Species: *Maerua angolensis*

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Tree. Rare to occasional in area. Twigs green-yellow-brown

with maroon-purple tinge on one half. Fruit whitish-green.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7342 **Date:** 6 October 2011

Forestry Training Institute-Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Sapindaceae

Plant Genus and Species: Lecaniodiscus fraxinifolius

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Shrub-tree to 5 m tall; Bark red-maroon tinged grey. Leaves

yellowish-green. Sterile.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7343 Date: 6 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Ebenaceae

Plant Genus and Species: *Diospyros fischer*, Gurke.

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Shrub to 2 m tall. Occasional presence. Bark is dark-brown-

maroon-purple. Flower buds with grey pubescence.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7344 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Menispermaceae

Plant Genus and Species: Cissampelos mucronata

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Herbaceous climber. Rare to occasional presence. Sterile.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7345

Date: 6 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Asteraceae

Plant Genus and Species: Gutenbergia cordifolia

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Herb to 0.8 m tall. Locally abundant-occasional within fallow

rice patty. Stem green-white tinged red-maroon. Corolla is purple.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7346 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Lamiaceae

Plant Genus and Species: *Basilicum polystachyon* (l.) moench

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Herb. Rare to occasional in area. Stem green-white. Calyz

green-white.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7347 Date: 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Asteraceae

Plant Genus and Species: *Grangea maderspatana* (L.) Poir

Habitat: Circa 5 km north of Mikindani township, Pemba. Transect from west to east. Dry coastal thicket dominated with *Albizia sp., Grewia forbesii, Grewia sp.,*

Maerua angolensis, Thylchium Africana, Turraea floribunda, Salacia madagascariensis, Sideroxylon inerme, and Euphorbia candelabrum.

Description of Plant: Herb. Abundant within abandoned rice paddies. Stem with

grey-white pubescence. Anther yellow.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7348

Date: 6 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Malvaceae

Plant Genus and Species: Sida urens (L.)

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Herb to 0.7 m tall. Rare in the area. Stem is red-maroon.

Corolla yellow with red- maroon tinge. **Collector:** C.J. Kayombo and J.M. Stoetzel

Collection No.: 7349 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Sterculiaceae

Plant Genus and Species: *Melochia corchorifolia* (L.)

Habitat: Circa 10 km north-west of Mikindani township. Area is wooded grassland-

scrubland with underground water area near permanent water well.

Description of Plant: Herb. Rare to occasional in area. Stem is tinged red-

maroon.

Collector: C.J. Kayombo and J.M. Stoetzel

Collection No.: 7350 Date: 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Apiaceae

Plant Genus and Species: Centella asiatica

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Creeping herb up to 3 m. Rare to occasional in area. Stem

tinged red-maroon to purple.

Collector: C.J. Kayombo and J.M. Stoetzel and J.M. Stoetzel

Collection No.: 7351 **Date:** 6 October 2011

Mtwara Region Mikindani District

Plant Family: Moraceae

Plant Genus and Species: unlisted

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Shrub-tree to 5 m tall. Rare in area. Pubescence. Perianth is white with pink, inconspicuous tinge. Fruits tinge maroon-purple with brown-

maroon stigma and style.

Collector: C.J. Kayombo and J.M. Stoetzel and J. M. Stoetzel

Collection No.: 7352 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Aizoaceae

Plant Genus and Species: Glinus lotoides (L.)

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Herb. Locally abundant. Stem with white pubescence.

Succulent.

Collector: C.J. Kayombo and J.M. Stoetzel and J.M. Stoetzel

Collection No.: 7353 Date: 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Cyperaceae

Plant Genus and Species: Schoenoplectus senegalensis

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well.

Description of Plant: Sedge. Abundant at seasonal water logged area.

Collector: C.J. Kayombo and J.M. Stoetzel and J.M. Stoetzel

Collection No.: 7354

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Scrophulariaceae

Plant Genus and Species: *Striga gesnerioides*

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well.

Description of Plant: Herb. Occasional in area. Corolla is red. **Collector:** C.J. Kayombo and J.M. Stoetzel and J.M. Stoetzel

Collection No.: 7356

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Fabaceae

Plant Genus and Species: *Indigofera sp.*

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Herb to 0.9 m tall. Stem is white-green and brown-red. Pod

with white pubescence. Brown stigma.

Collector: C.J. Kayombo and J.M. Stoetzel and J.M. Stoetzel

Collection No.: 7356 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Asteraceae

Plant Genus and Species: Dicoma sessiliflora Ham

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Herb. Rare in area. Stem is red- green with grey-white wooly

pubescence. Capitulum bract with white stripes. Pappus white. Corolla is

vellowish-green.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7357 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Rubiaceae

Plant Genus and Species: *Pentodon pentandrus* (Schum & Thonn) Vatke **Habitat:** Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well.

Description of Plant: Herb. Locally abundant. Leaning-sub-erect. Stem is green-

white tinged red succulent. Corolla is purple.

Collector: C.J. Kayombo and J.M. Stoetzel and J.M. Stoetzel

Collection No.: 7358 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Asteraceae

Plant Genus and Species: Pseudoconyza viscosa

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Herb. Locally rare to occasional occurrence. Capitulum bract

is tinged maroon-purple. Pappus is white purple.

Collector: C.J. Kayombo and J.M. Stoetzel and J. M. Stoetzel

Collection No.: 7359 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Fabaceae

Plant Genus and Species: *Clitoria ternatea* (L.)

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well.

Description of Plant: Herb to 1.2 m tall. Rare in area. Corolla is white.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7360 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Digitaria sp.

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Grass. Locally abundant at ground water area. Culm is

green- white tinged pink. Glumes tinged blue-purple.

Collector: C. I. Kavombo and I. M. Stoetzel

Collection No.: 7361 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: *Rhynchelytrum repens* (Wild) CHubb

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Grass. Locally abundant. Grass culm is tinged red. Glume is

red-pink.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7363 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Fabaceae

Plant Genus and Species: *Indigofera sp.*

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Herb with woody base to 1 m tall. Rare in location. Stem

tinged red-purple. Fruits with brown stigma. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7362

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: *Pennisetum sp.*

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Grass. Rare to occasional in area. Glumes are red-maroon.

Awns are brown-grey.

Collector: C.J. Kayombo and J.M. Stoetzel and J. M. Stoetzel

Collection No.: 7364

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Mtwara Region Mikindani District

Plant Family: Boraginaceae

Plant Genus and Species: Cordia myxa

Habitat: Circa 10 km north- west of Mikindani township. Area is wooded grassland-scrubland with underground water area near permanent water well. **Description of Plant:** Tree to 7 m tall. Rare to the area. Has 200 cm dbh. Bark is

brown-grey. Flower buds are grey-white pubescence. **Collector:** C.I. Kayombo and J.M. Stoetzel and J. M. Stoetzel

Collection No.: 7365 Date: 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Bignoniaceae

Plant Genus and Species: Kigelia africana

Habitat: Transect oriented east to west across soccer pitch. Area dominated by *Magnifera indica, Cocos nucifera, Sorghum bicolar, and Cajanus cajan* communities.

Description of Plant: Tree to 6 m tall. Rare to area. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7366 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Myrtaceae

Plant Genus and Species: *Syzigium cuminii*

Habitat: Transect oriented east to west across soccer pitch. Area dominated by *Magnifera indica, Cocos nucifera, Sorghum bicolar, and Cajanus cajan* communities. **Description of Plant:** Tree to 6.5 m tall. Rare to location. Young twigs tinged

maroon-purple. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7367 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Acanthaceae

Plant Genus and Species: *Justicia striata* (Schum) Benth

Habitat: Transect oriented east to west across soccer pitch. Area dominated by *Magnifera indica, Cocos nucifera, Sorghum bicolar, and Cajanus cajan* communities. **Description of Plant:** Woody herb. Locally abundant. Stem shades to brown-grey.

Corolla is orange-purple.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7368 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Hyparrhenia rufa

Habitat: Transect oriented east to west across soccer pitch. Area dominated by *Magnifera indica, Cocos nucifera, Sorghum bicolar, and Cajanus cajan* communities. **Description of Plant:** Grass up to 2 m tall. Locally abundant. Culm is yellow- green

tinged with brown-purple. Glumes grown-grey. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7369 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Sorghum bicolor

Habitat: Transect oriented east to west across soccer pitch. Area dominated by *Magnifera indica, Cocos nucifera, Sorghum bicolar, and Cajanus cajan* communities. **Description of Plant:** Grass to 2.5 m tall. Glumes dry brown-purple. When fresh

glumes are brown-grey.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7370 **Date:** 6 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Boraginaceae

Plant Genus and Species: *Ehretia littoralis* (Geweke)

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub to 2 m tall. Rare to locality. Bark is grey-brown.

Corolla is green-white. Stamen is white. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7371 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Celastraceae

Plant Genus and Species: *Solacia madagascariensis*

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Tree to 2.5 m tall. Occasional in area. Bark is brown-grey.

Perianth is white-pink.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7372 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Dichapetalaceae

Plant Genus and Species: *Dichapetalum stuhlmannii*

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*. **Description of Plant:** Shrub to 3 m tall. Bark is grey-brown with red lenticels.

Fruit is white- green with brown stigma. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7373 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Euphorbiaceae

Plant Genus and Species: Margaritaria discoidea

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub to 2 m tall. Rare to occasional in area. Bark is grey

with red- maroon dots. Stamen is pale-white. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7374 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Rubiaceae

Plant Genus and Species: Vangueria infausta

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*. **Description of Plant:** Shrub to 3 m tall. Rare to locality. Bark is grey-brown.

Twigs have grey-brown pubescence. Sterile. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7375 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Dichapetalaceae

Plant Genus and Species: Dichapetalum edulis

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Woody herbaceous climber to 3 m tall. Locally abundant.

Bark is brown-red with grey lenticels. Corolla is white.

Collector: C. J. Kavombo and J. M. Stoetzel

Collection No.: 7376 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Euphorbiaceae

Plant Genus and Species: Margaritaria discoidea

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub to 2.5 m tall. Rare to occasional presence in location.

Bark is red-maroon. Lower surface of leaves are greyish-green.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7378 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Sterculiaceae

Plant Genus and Species: Cola clarita

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia.*

Description of Plant: Shrub tree to 3 m tall. Rare to occasional in location. Bark is

tinged brown-grey. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7377 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Passifloraceae

Plant Genus and Species: Schlechteri sp.

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Woody herb to 1 m. Rare to location. Woody bark is grey.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7379 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Annonaceae

Plant Genus and Species: *Monanthotaxis buchananii*

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub to 3 m tall. Bark is brown- maroon with grey-brown

lenticels. Flower buds with brown-red pubescence.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7381 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Sterculiaceae

Plant Genus and Species: Carpodiptera africana

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub tree to 2.5 m tall. Bark tinged grey with red-brown

lenticels. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7381 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Euphorbiaceae

Plant Genus and Species: Manhot esculenta

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub to 1.7 m tall. Abundant in agricultural areas. Young

twigs tinged red-maroon. Young leaves are maroon-purple.

Collector: C. I. Kavombo and I. M. Stoetzel

Collection No.: 7382 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Convolvulaceae

Plant Genus and Species: Bonamia mossambicensis

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Twinning herb to 2.5 m tall. Locally abundant. Stem with

white-brownish pubescence. Corola is whitish-blue-purple.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7383 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Apocynaceae

Plant Genus and Species: *Landolphia kirkii* (Dyer)

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Herbaceous wood that climbs to 3 m high. Rare to occasional

in area. Stem is brown-maroon-purple. Corolla is yellow-white.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7384 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Fabaceae

Plant Genus and Species: Albizia adianthifolia (Schumach) W. F. Wright

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub or liana to 3 m tall. Occasional to area. Mature stem is

brownish-grey.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7385

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Combretaceae

Plant Genus and Species: Anacardium accidentale

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Tree. Bark is dark- brown. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7386 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Flacourtiaceae

Plant Genus and Species: Xylotheca tettensis (Klotzsch) Gilg

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*. **Description of Plant:** Shrub to 1.5 m tall. Occasional to area. Corolla is white

Description of Plant: Shrub to 1.5 m tall. Occasional to area. Corolla is white.

Anther is yellow. Filament are green-white. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7387 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Fabaceae

Plant Genus and Species: Millettia lasianth (Dunn)

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*. **Description of Plant:** Woody climbing plant to 2 m high. Locally abundant to

occasional. Pods tinged red-maroon patches with brown pubescence.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7388

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Combretaceae

Plant Genus and Species: Pteleopsis myrtifolia

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*. **Description of Plant:** Shrub tree to 5 m tall. Locally occasional to abundant.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7390 Date: 7 October 2011

Mtwara Region Mikindani District

Plant Family: Sapindaceae

Plant Genus and Species: Blighia unijugata

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub-tree to 5 m tall. Occasional to area. Young leaves

tined pink-purple.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7391 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Dilleniaceae

Plant Genus and Species: Tetracera littoral

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Shrub-liana to 2 m high. Rare to occasional in the location.

Bark is red-brown. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7392 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Digitaria sp.

Habitat: Combretaceae

Plant Genus and Species: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia*

casteneifolia.

Description of Plant: Grass. Rare to area. Glumes tinged grey.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7393 Date: 7 October 2011

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: *Sp.*

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*. **Description of Plant:** Climbing grass to 1 tall. Locally abundant. Glumes are

brown-white.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7394 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Eragrostis sp.

Habitat: Transect located along road that connects town with cashew grove and pineapple field. Disturbed thicket land dominated with *Cola sp., Combretum sp., Grewia sp., Dichapettum sp., Xylotheca tettensis,* and *Hugonia casteneifolia*.

Description of Plant: Grass. Locally rare to frequent. Leaf blade is tinged maroon-

purple.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7395 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Sorghum arundinaceae

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Grass to 1 m tall. Rare to area. Culm is green-white. Glume

is brown-white. Awns are maroon-red. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7396 Date: 7 October 2011

Mtwara Region Mikindani District

Plant Family: Lamiaceae

Plant Genus and Species: *Hyptis suevecteris* (Poit)

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Herb to 1 m tall. Locally abundant in area. Stem is greenwhite with grey-white pubescence. Corolla is purple. Plant emits minty smell.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7397 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Arecaceae

Plant Genus and Species: Cocos nucifera

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia.*

Description of Plant: Palm tree to 25 m tall, features 30 cm dbh. Abundant in

coconut field. Bark is grey-brown. Leaves are tinged yellow-orange.

Collector: C. J. Kavombo and J. M. Stoetzel

Collection No.: 7398 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Acroceras zizanioides (Kunth) Dandy

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Grass to 1 m tall. Locally abundant in swampy areas of field.

Culms on plant is greenish-white. Glumes are pale-green-white.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7399 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Saccharum officinarium

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Grass to 2.5 m tall. Abundant in local sugar cane field. Culm

on plant is whitish- red. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7400 Date: 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Verbenaceae

Plant Genus and Species: Lippia nodiflora (L.) Rich

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Herb. Stem is whitish-green. Inflorescence bract is tinged

maroon- purple. Corolla is white.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7401 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Asteraceae

Plant Genus and Species: *Launaea cornuta* (Oliver & Hiern) C. Jeffrey **Habitat:** Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia.*

Description of Plant: Herb to 0.7 m tall. Rare to area. Capitulum white-green with

pink tinge. Damaged plant produces milky latex.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7402

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Ochnaceae

Plant Genus and Species: Ochna mossambicensis

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Shrub to 2.5 m tall. Rare to area. Bark is yellow-brown. Calyz is red-maroon. Young leaves are shiny yellowish-green tinged red-pink.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7404 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Mimosaceae

Plant Genus and Species: Leucaena leucocephala

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Tree to 6 m tall. Pods are green-yellow with red-brown dots.

Collector: C. I. Kavombo and I. M. Stoetzel

Collection No.: 7403 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Adiantaceae

Plant Genus and Species: Acrostichum aureum (L.)

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Fern to 3 m tall. Abundant in swamp areas.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7405 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Cyperaceae

Plant Genus and Species: Cyperus sp.

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Tree to 1.4 m tall. Locally abundant at swamp area. Culm is

whitish-green. Glumes are brown-white-green. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7406 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Fabaceae

Plant Genus and Species: *Vigna unguiculata*

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia.*

Description of Plant: Herbaceous climber to 1 m high. Locally abundant. Pods are

tinged brown-maroon-purple.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7407 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Convolvulaceae

Plant Genus and Species: *Ipomea sp.*

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Herbaceous climber. Locally abundant. Corolla is yellow-

orange.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7408 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Poaceae

Plant Genus and Species: Eragrostis sp.

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Grass. Locally abundant. Culm is white-green. Glumes are

whitish-pink.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7410 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Malvaceae

Plant Genus and Species: Sida sp.

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Herb to 0.5 m. Rare to area. Corolla is vellow.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7411

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Cucurbitaceae

Plant Genus and Species: Cucurbita maxima

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of

fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp,*

Dichapetalum sp and pteleopsis myritifolia. **Description of Plant:** Herb. Corolla is yellow. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7412 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Solanaceae

Plant Genus and Species: Capscum sp.

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp,*

Dichapetalum sp and pteleopsis myritifolia.

Description of Plant: Herb to 1 m tall. Fruit is white-green.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7413 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Euphorbiaceae

Plant Genus and Species: *Phyllanthus sp.*

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Shrub to 2 m tall. Occasional to frequent in area. Bark of

shrub is brown-green. Fruits turning dark maroon-blue-purple.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7414

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Celastraceae

Plant Genus and Species: *Salacia madagascariensis*

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of

fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp,*

Dichapetalum sp and pteleopsis myritifolia.

Description of Plant: Shrub- liana up to 6 m tall. Occasional to abundant in area.

Leaves are yellowish- green on lower surface. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7415 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Fabaceae

Plant Genus and Species: *Albizia sp.*

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Tree to 7 m tall with 20 cm dbh. Rare to area. Young leaves

are yellowish-green. Perianth is green- yellow-white.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7416

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Passifloraceae

Plant Genus and Species: Passiflora foetida (L.)

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Herbaceous climber to 1 m tall. Rare to area. Calyx has

green- white pubescence. Fruit with vertical green-white stripes.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7417 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Oleaceae

Plant Genus and Species: Jasminum meyeri-johannis

Habitat: Area between church and radio tower, situated towards valley that features coconut field. Area had been clear anthropogenic disturbance in form of fire. Species dominant to the area include *Xylothecca sp, Grewia s, Combretum sp, Dichapetalum sp* and *pteleopsis myritifolia*.

Description of Plant: Herbaceous climber. Rare to area. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7418 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Apocynaceae

Plant Genus and Species: Catharanthus roseus (L.) G. Don

Habitat: Personal garden.

Description of Plant: Herb to 0.5 m tall. Stem is whitish-green. Corolla is creamy-

white. Damaged plant produced milky latex. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7419 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Capparaceae

Plant Genus and Species: Cleome gynandra

Habitat: Personal garden.

Description of Plant: Grass. Rare cultivate. Stem is whitish-green tinged red-

purple. Fruit with brown stigma.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7421 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Verbenaceae

Plant Genus and Species: Stachytarpheta urticifolia

Habitat: Personal garden.

Description of Plant: Ornamental shrub to 1.5 m tall. Corolla is dark-blue.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7423 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Apiaceae

Plant Genus and Species: Polyscias guilfoylei

Habitat: Personal garden.

Description of Plant: Shrub to 1.7 m tall. Leaves with yellow-orange tinge near

margins. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7424 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Portulacaceae

Plant Genus and Species: Corbichonia decumbens (Forsk) Exell

Habitat: Personal garden.

Description of Plant: Herb common to cultivation. Rare to area. Stem is succulent.

Fruit has brown-grey stigma.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7425 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Euphorbiaceae

Plant Genus and Species: Acalypha sp.

Habitat: Personal garden.

Description of Plant: Herb common to cultivation. Perianth is whitish-green.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7426 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Solanaceae

Plant Genus and Species: Solanum melongena

Habitat: Personal garden.

Description of Plant: Herb to 0.6 m tall. Twigs tinged blue-purple with greybrown pubescence. Corolla white-blue-purple. Anthers are green-yellow.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7428

Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Annonaceae

Plant Genus and Species: Annona sp.

Habitat: Personal garden.

Description of Plant: Tree to 6 m tall. Bark is brown-purple. Pistile is white

enclosed by retails.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7429 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Araliaceae

Plant Genus and Species: Polyscias fruticosa (L.) Harms

Habitat: Personal garden.

Description of Plant: Shrub to 1 m tall. Stem tinged bluish-purple. Sterile.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7433 **Date:** 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Amaranthaceae

Plant Genus and Species: Amaranthus hybridus

Habitat: Personal garden.

Description of Plant: Herb to 0.4 m tall. Stem is whitish-green. Perianth is

whitish- green.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7435 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Fabaceae

Plant Genus and Species: Vigna unguiculata (L.) Walp (Swahili) Kunde

Habitat: Personal garden.

Description of Plant: Herb to 1 m. Corola whitish-green. Anthers white-yellow.

Filament white. Pods feature brown stigma. Damaged plant smells sweet.

Collector: C. J. Kayombo and J. M. Stoetzel

Collection No.: 7436 Date: 7 October 2011

Forestry Training Institute- Olmotonyi Herbarium

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Flora of Tanzania

Mtwara Region Mikindani District

Plant Family: Musaceae

Plant Genus and Species: Musa sp.

Habitat: Personal garden.

Description of Plant: Banana tree to 1.9 m tall. **Collector:** C. J. Kayombo and J. M. Stoetzel

Collection No.: 7437 **Date:** 7 October 2011

Forestry Training Institute-Olmotonyi Herbarium

Appendix Two

Phytolith Extraction Methodologies

- 1. Pour phytolith samples into mortar and pestle, grind, and pass through a 2mm screen.
- 2. Weigh out 7 grams of soil and place in an already labeled 50mL centrifuge tube.
- 3. Add 1% Alconox solution to the 40ml mark of centrifuge tube, shake sample overnight.
- 4. Centrifuge each sample @ 2,500rpm for 2 minutes in order to rinse Alconox. Repeat this rinse two more times by adding distilled water (dH20) to 50ml.
- 5. After 3rd rinse, add 10mL of Hydrogen Peroxide (H2O2) to each sample. Let stand for 10 minutes. Add dH2O to 50mL and rinse. Again, decant into sink.
- 6. Add 10ml of 10% HCl to each sample, place samples in hot water bath.
- 7. Add a 1:1 mixture of Hydrochloric acid (HCl) and Nitric acid (HNO3). I typically add roughly 30-35ml of this "strong acid" to each centrifuge tube. Reactions continue in the hot water bath for 90 minutes. If reaction is not through at this point I repeat step 7. Add dH20 to 50ml and rinse in centrifuge 2 minutes @ 2,500rpm. Decant into chemical waste container.
- 8. Return the samples to hot water bath and add 20ml of Schultze solution to each centrifuge tube. Schultze solution is a combination of 20g Potassium Chloride (KCl) with 150ml HNO3. Samples should be exposed to Schultze for at least 20 minutes or up to 2 hours, depending on if/when the liquid becomes bright yellow. Add dH20 to 50ml and rinse centrifuge 2 minutes @ 2,500 rpm. Decant into chemical waste bin. Done with hot water bath.
- 9. Add 10ml of a 1:10 Potassium Hydroxide (KOH): dH2O solution to each sample. Let sit 5 minutes. Add dH2O to 50ml and rinse in centrifuge 2 minutes @ 2,500rpm. Decant into chemical waste bin.
- 10. Add 1% Alconox solution to 40ml in each centrifuge tube and shake overnight.
- 11. Rinse in centrifuge by adding dH20 to 50ml and spinning in centrifuge 2 minutes @ 2,500ml three times.

- 12. Replicate labels on new centrifuge tubes. Strain remaining residues from old tube through 250-micron screen and into new tube with matching label. Add dH20 to 50ml, rinse in centrifuge 2 min @ 2,500 rpm, and return sample to original tube. The new tube will be final place of deposit for the phytolith samples.
- 13. Add 10ml of heavy liquid Lithium MetaTungstate, altered to have specific gravity of 2.3, to each sample and centrifuge 5 minutes @ 3,000 rpm. Decant into the new centrifuge tube made for step 12. Repeat this process, again decant into new centrifuge tube. Once complete, the original centrifuge tube can be discarded as "remainder".
- 14. Add dH20 to 50ml and centrifuge 10 minutes @ 3,500 rpm. Decant all but 10-15ml of the liquid (save this liquid for LMT recycle process). Repeat the step by adding dH20 to 50ml and centrifuging 10 minutes @ 3,500 rpm. This time, decant all but 5ml of liquid.
- 15. The liquid that remains here contains all archaeological phytoliths from the original 7 grams of soil. Let the sample dry before microscope mounting and analysis.

Appendix Three

Phytolith Log

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight
1	101-20	0	7.5YR33	SM	yes	
2	101-20	10	7.5YR33	SM	yes	
3	101-20	20	7.5YR33	SM	yes	
4	101-20	30	7.5YR33	SM	yes	
						64
5	101-21	0	2.5YR33	SM	yes	
6	101-21	10	2.5YR33	SM	yes	
7	101-21	20	2.5YR36	SM	yes	
8	101-21	30	2.5YR36	SM	yes	
9	101-21	40	2.5YR36	SM	yes	
						80
10	101-22	0	5YR44	SM	yes	
11	101-22	10	5YR44	SM	yes	
12	101-22	20	5YR44	SM	yes	
13	101-22	30	5YR44	SM	yes	
14	101-22	40	2.5YR36	SM	yes	
15	101-22	50	2.5YR36	SM	yes	
16	101-22	60	2.5YR36	SM	yes	
						133
17	102-23	0	7.5YR61	SM	no	
18	102-23	10	7.5YR61	SM	no	
19	102-23	20	7.5YR61	SM	no	
20	102-23	30	10YR72	SM	no	
21	102-23	40	10YR72	SM	no	
22	102-23	50	10YR72	SM	no	
23	102-23	60	10YR72	SM	no	
24	102-23	70	10YR72	SM		-
25	102-23	80	101 R/2 10YR72	SM	no	
	102-23	80	101 K/2	SIVI	no	170
26	102-24	0	7.5YR44	SM		170
			·}		no	
27	102-24	10	7.5YR44	SM	no	ļ
28	102-24	20	7.5YR44	SM	no	ļ
29	102-24	30	7.5YR44	SM	no	ļ
30	102-24	35	7.5YR44	SM	no	
20.	102.25	ļ	53721	G) 1		69
30a	102-25	0	5Y31	SM	no	ļ
31	102-25	10	5Y31	SM	no	
32	102-25	20	5Y31	SM	no	ļ
33	102-25	25	2.5Y42	SM	no	
34	102-25	35	2.5Y42	SM	no	
35	102-25	45	2.5Y42	SM	no	
		ļ	<u> </u>	 		117
36	102-29	0	GLEY1610Y	SM	no	ļ
37	102-29	5	GLEY1610Y	SM	no	
38	102-29	15	7.5YR41	SM	no	
39	102-29	25	7.5YR41	SM	no	
40	102-29	35	7.5YR41	SM	no	
41	102-29	45	7.5YR82	SM	no	

Weight	CM (yes or no)	Region	Context	Depth (cm)	Transect and STP	Phytolith Sample
	no	SM	7.5YR82	55	102-29	42
	no	SM	7.5YR82	65	102-29	43
	no	SM	7.5YR82	75	102-29	44
	no	SM	7.5YR82	85	102-29	45
	no	SM	7.5YR82	90	102-29	46
227						
	no	SM	GLEY18N	0	103-30	47
	no	SM	7.5YR54	5	103-30	48
	no	SM	7.5YR43	15	103-30	49
	no	SM	7.5YR43	25	103-30	50
	no	SM	7.5YR34	35	103-30	51
	no	SM	7.5YR34	45	103-30	52
106						
	no	SM	7.5YR46	0	103-31	53
	no	SM	5YR46	10	103-31	54
***************************************	no	SM	5YR46	20	103-31	55
	no	SM	5YR46	30	103-31	56
	no	SM	2.5YR36	40	103-31	57
	no	SM	2.5YR36	50	103-31	58
	no	SM	2.5YR36	60	103-31	59
	no	SM	2.5YR36	70	103-31	60
150						
	yes	SM	7.5YR44	0	103-32	61
	yes	SM	7.5YR44	10	103-32	62
	yes	SM	5YR46	20	103-32	63
	yes	SM	5YR46	30	103-32	64
	yes	SM	5YR46	40	103-32	65
	yes	SM	5YR46	50	103-32	66
110			***************************************			
	yes	SM	7.5YR44	0	103-33	67
	yes	SM	7.5YR44	10	103-33	68
	yes	SM	5YR34	20	103-33	69
	yes	SM	5YR34	30	103-33	70
65	-					
	no	SM	7.5YR44	0	103-34	71
	no	SM	5YR44	10	103-34	72
	no	SM	5YR44	20	103-34	73
	no	SM	5YR44	30	103-34	47a
	no	SM	5YR44	40	103-34	75
	no	SM	5YR44	50	103-34	76
	no	SM	5YR44	60	103-34	77
125	-					
	yes	SM	7.5YR44	0	103-35	78
	yes	SM	7.5YR44	10	103-35	79
		SM	5YR44	20	103-35	80
	yes	SM	5YR44	30	103-35	81
	yes	SM	5YR44	40	103-35	82
	yes yes	SM	5YR44	50	103-35	83

Weight	CM (yes or no)	Region	Context	Depth (cm)	Transect and STP	Phytolith Sample
110						
	yes	SM	7.5YR44	0	103-36	84
	yes	SM	5YR44	10	103-36	85
	yes	SM	5YR44	20	103-36	86
	yes	SM	5YR44	30	103-36	87
	yes	SM	5YR44	45	103-36	88
91						
	no	SM	Lime Pit	0	100-10	100
	no	SM	2.5YR36	10	100-10	101
	no	SM	7.5YR34	20	100-10	102
	no	SM	7.5YR34	30	100-10	103
	no	SM	7.5YR34	40	100-10	104
87						
	no	SM	7.5YR33	0	100-11	105
	no	SM	7.5YR33	10	100-11	106
	no	SM	7.5YR44	20	100-11	107
	no	SM	7.5YR44	30	100-11	108
	no	SM	7.5YR44	40	100-11	109
	no	SM	7.5YR44	50	100-11	110
	no	SM	7.5YR44	60	100-11	111
	no	SM	7.5YR44	70	100-11	112
113						
	yes	SM	7.5YR33	0	100-12	111
	yes	SM	10YR36	10	100-12	112
	yes	SM	10YR36	20	100-12	113
	yes	SM	10YR36	30	100-12	114
63	, es	5.11			100 12	
	no	SM	7.5YR33	0	100-13	116
	no	SM	7.5YR44	10	100-13	117
	no	SM	7.5YR44	20	100-13	118
47	110	SIVI	7.31144	20	100-13	110
47	no	SM	7.5YR34	0	100-14	119
		SM	7.5YR34	10	100-14	120
	no				100-14	
	no	SM	5YR46	20		121
	no	SM	5YR46	30	100-14	122
	no	SM	5YR46	40	100-14	123
	no	SM	5YR46	50	100-14	124
102	no	SM	5YR46	60	100-14	125
103		C) f	a comes	<u>,</u>	100.15	107
	no	SM	7.5YR33	0	100-15	126
	no	SM	7.5YR33	10	100-15	127
	no	SM	7.5YR33	20	100-15	128
	no	SM	7.5YR33	30	100-15	129
53						
	no	SM	GLEY155GY	0	100-16	130
	no	SM	GLEY155GY	10	100-16	131
	no	SM	GLEY155GY	20	100-16	132

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight
133	100-17	0	7.5YR44	SM	yes	
134	100-17	10	7.5YR44	SM	yes	
135	100-17	20	7.5YR44	SM	yes	
136	100-17	30	7.5YR44	SM	yes	
137	100-17	40	7.5YR44	SM	yes	
138	100-17	50	5YR46	SM	yes	
139	100-17	60	5YR46	SM	yes	
						115
140	100-18	0	7.5YR44	SM	yes	
141	100-18	10	7.5YR44	SM	yes	
142	100-18	20	7.5YR44	SM	yes	
143	100-18	30	5YR46	SM	yes	
144	100-18	40	5YR46	SM	yes	
						59
145	100-19	0	n/a	SM	no	
146	100-19	10	n/a	SM	no	
147	100-19	20	n/a	SM	no	
148	100-19	30	n/a	SM	no	
149	100-19	40	n/a	SM	no	
						55
150	101-1	0	GLEY17N	SM	yes	
150a	101-1	2	10YR42	SM	no	
151	101-1	5	GLEY1510Y	SM	yes	
152	101-1	15	10YR42	SM	yes	
153	101-1	25	10YR42	SM	yes	
154	101-1	35	10YR42	SM	yes	
155	101-1	40	10YR42	SM	yes	
156	101-1	50	10YR81	SM	yes	
157	101-1	60	10YR81	SM	yes	
158	101-1	70	10YR81	SM	yes	
159	101-1	80	10YR81	SM	yes	
						177
159	101-2	0	GLEY17N	SM	no	
161	101-2	10	10YR42	SM	no	
162	101-2	20	10YR42	SM	no	
163	101-2	30	10YR42	SM	no	
164	101-2	40	10YR42	SM	no	
						84
165	101-3	0	7.5YR51	SM	yes	
166	101-3	10	7.5YR51	SM	yes	
167	101-3	20	7.5YR51	SM	yes	
168	101-3	30	7.5YR51	SM	yes	
169	101-3	40	10YR82	SM	yes	
170	101-3	50	10YR82	SM	yes	
171	101-3	60	10YR82	SM	yes	
172	101-3	70	10YR82	SM	yes	
						154
173	101-4	0	5YR44	SM	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight
174	101-4	10	5YR44	SM	no	
175	101-4	30	5YR34	SM	no	
						48
176	101-5	0	5YR44	SM	yes	
177	101-5	10	5YR44	SM	yes	
178	101-5	20	5YR44	SM	yes	
179	101-5	30	5YR34	SM	yes	
						51
180	101-6	0	7.5YR33	SM	yes	
181	101-6	10	7.5YR33	SM	yes	
182	101-6	20	7.5YR33	SM	yes	
183	101-6	30	7.5YR33	SM	yes	
184	101-6	40	5YR34	SM	yes	
185	101-6	50	5YR34	SM	yes	
						97
186	101-7	0	10YR44	SM	yes	
187	101-7	10	10YR33	SM	yes	
188	101-7	20	10YR33	SM	yes	
189	101-7	30	5YR34	SM	yes	
190a	101-7	40	5YR34	SM	yes	
191a	101-7	50	5YR34	SM	yes	
						104
192a	101-8	0	5YR44	SM	yes	
193a	101-8	10	5YR44	SM	yes	
194a	101-8	20	5YR44	SM	yes	
195a	101-8	30	5YR44	SM	yes	
196a	101-8	40	5YR44	SM	yes	
						77
197a	101-9	0	7.5YR46	SM	yes	
198a	101-9	10	7.5YR46	SM	yes	
199a	101-9	20	5YR44	SM	yes	
200	101-9	30	5YR44	SM	yes	
201	101-9	40	5YR44	SM	yes	
						86
190	104-40	0	10YR71	SM	yes	
191	104-40	10	10YR32	SM	yes	
192	104-40	20	10YR32	SM	yes	
193	104-40	30	10YR32	SM	yes	
						72
194	104-41	0	GLEY18N	SM	yes	
195	104-42	0	10YR32	SM	no	
196	104-42	10	10YR32	SM	no	
197	104-42	20	10YR32	SM	no	
198	104-42	30	10YR32	SM	no	
						68
202	104-43	0	10YR33	SM	no	
203	104-43	10	10YR33	SM	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight
204	104-43	20	10YR33	SM	no	
205	104-43	30	10YR55	SM	no	
						76
206	104-44	0	10YR33	SM	no	
207	104-44	10	10YR33	SM	no	
208	104-44	20	10YR33	SM	no	
209	104-44	30	10YR55	SM	no	
210	104-44	40	10YR55	SM	no	
						94
211	103-50	0	10YR46	SM	yes	
212	103-50	10	10YR46	SM	yes	
213	103-50	20	10YR46	SM	yes	
214	103-50	30	5YR46	SM	yes	
215	103-50	40	5YR46	SM	yes	
216	103-50	50	5YR46	SM	yes	
217	103-50	60	5YR46	SM	yes	
218	103-50	70	5YR46	SM	yes	
219	103-50	80	5YR46	SM	yes	
			•			207
220	103-51	0	7.5YR46	SM	yes	
221	103-51	10	7.5YR46	SM	yes	
222	103-51	20	7.5YR46	SM	yes	
223	103-51	30	5YR46	SM	yes	
						65
224	103-52	0	7.5YR46	SM	no	
225	103-52	10	7.5YR46	SM	no	
226	103-52	20	7.5YR46	SM	no	
227	103-52	30	5YR46	SM	no	
228	103-52	40	5YR46	SM	no	
						89
229	103-53	0	10YR71	SM	no	
230	103-53	10	10YR62	SM	no	
231	103-53	20	10YR83	SM	no	
232	103-53	30	10YR83	SM	no	
233	103-53	40	10YR83	SM	no	
234	103-53	50	10YR83	SM	no	
235	103-53	60	10YR83	SM	no	
						145
236	106-54	0	7.5YR33	SM	yes	
237	106-54	10	7.5YR33	SM	yes	
238	106-54	20	7.5YR33	SM	yes	
239	106-54	30	5YR34	SM	yes	<u> </u>
240	106-54	40	5YR34	SM	yes	
241	106-54	50	5YR34	SM	yes	
271	100-54	30	31K34	JIV1	yes	117
242	107-56	0	5YR58	SM	Vac	11/
242	ļ				yes	<u> </u>
	107-56	10	5YR58	SM	yes	
244	107-56	20	5YR58	SM	yes	<u>.l</u>

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight
245	107-56	30	5YR58	SM	yes	
246	107-56	40	5YR58	SM	yes	
247	107-56	50	5YR58	SM	yes	
248	107-56	60	5YR58	SM	yes	
						136
249	107-57	0	10YR72	SM	no	
250	107-57	10	10YR56	SM	no	
251	107-57	20	10YR56	SM	no	
252	107-57	30	10YR56	SM	no	
			<u> </u>			75
253	107-55	10	10YR34	SM	yes	
254	107-55	20	10YR34	SM	yes	
255	107-55	30	10YR34	SM	yes	
256	107-55	40	10YR34	SM	yes	
257	107-55	50	10YR56	SM	yes	<u> </u>
					-	115
258	107-58	10	7.5YR56	SM	yes	
259	107-58	20	7.5YR56	SM	yes	
260	107-58	30	7.5YR56	SM	yes	
261	107-58	40	5YR46	SM	yes	
262	107-58	50	5YR46	SM	yes	
263	107-58	60	5YR46	SM	yes	
203	10, 50		5110.0	5	<i>y</i> 60	134
264	107-59	10	7.5YR41	SM	yes	
265	107-59	20	7.5YR41	SM	yes	
266	107-59	30	7.5YR41	SM	yes	
267	107-59	40	7.5YR41	SM	yes	
207	10, 3,		7.511011	5111	yes	
268	110-60	10	7.5YR41	SM	yes	94
269	110-60	20	7.5YR41	SM	yes	
270	110-60	30	7.5YR41	SM	yes	
271	110-60	40	7.5YR41	SM	yes	
272	110-60	50	7.5YR41	SM	yes	
273	110-60	60	7.5YR41	SM	yes	
274	110-60	70	7.5YR62	SM	yes	
2/4	110-00	70	7.51 K02	5101	yes	159
275	110-61	10	7.5YR41	SM	VAC	137
			7.5YR41 7.5YR41	SM SM	yes	
276 277	110-61	20 30	<u> </u>	SM	yes	
211	110-61	30	7.5YR41	SM	yes	70
770	110.62	5	CLEVIAL	CM	* ^	78
278	110-62	. 	GLEY16N	SM	no	
279	110-62	20	10YR32	SM	no	
280	110-62	30	10YR32	SM	no	
281	110-62	40	10YR32	SM	no	
282	110-62	50	10YR32	SM	no	120
202	110.05	10	1077754	G3.5		120
283	110-65	10	10YR54	SM	no	
284	110-65	20	10YR54	SM	no	<u> </u>

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight
285	110-65	30	2.5YR48	SM	no	
286	110-65	40	7.5YR68	SM	no	
287	110-65	50	10YR54	SM	no	
						152
288	110-66	10	10YR53	SM	no	
289	110-66	20	10YR53	SM	no	
290	110-66	30	10YR53	SM	no	
						80
291	110-67	10	10YR41	SM	no	
292	110-67	20	10YR41	SM	no	
293	110-67	30	10YR41	SM	no	
294	110-67	40	10YR41	SM	no	
295	110-67	50	10YR41	SM	no	
						136
296	110-69	10	10YR52	SM	no	
297	110-69	20	10YR52	SM	no	
298	110-69	30	10YR52	SM	no	
						72
299	110-71	10	10YR31	SM	no	
300	110-71	20	10YR31	SM	no	
301	110-71	30	10YR31	SM	no	
302	110-71	40	10YR46	SM	no	
303	110-71	50	10YR46	SM	no	
	110 / 1		1011110	5.1.1		112
304	110-72	10	10YR31	SM	no	
305	110-72	20	10YR31	SM	no	
306	110-72	30	10YR31	SM	no	
307	110-72	40	10YR46	SM		
308	110-72	50	101 R46	SM	no no	
300	110-72	30	1011040	Sivi	110	122
200	110.72	10	10YR31	CM	***	122
309	110-73		}	SM	no	
310	110-73	20	10YR46	SM	no	(2
211	110.74	10	103/1021	CM		62
311	110-74	10	10YR31	SM	no	
312	110-74	20	10YR31	SM	no	
313	110-74	30	10YR46	SM	no	
						74
315	110-78	10	7.5YR33	SM	no	
316	110-78	20	7.5YR33	SM	no	
317	110-78	30	7.5YR33	SM	no	
318	110-78	40	7.5YR33	SM	no	
						98
319	106-79	10	2.5YR53	SM	no	
320	106-79	20	2.5YR53	SM	no	
321	106-79	30	2.5YR53	SM	no	
322	106-79	40	2.5YR46	SM	no	
323	106-79	50	2.5YR46	SM	no	
324	106-79	60	2.5YR46	SM	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight
						176
325	106-80	10	10YR64	SM	no	
326	106-80	20	10YR64	SM	no	
327	106-80	30	10YR64	SM	no	
328	106-80	40	10YR64	SM	no	
329	106-80	50	10YR64	SM	no	
						105
330	106-81	10	7.5YR53	SM	no	
331	106-81	20	7.5YR53	SM	no	
332	106-81	30	7.5YR53	SM	no	
333	106-81	40	7.5YR54	SM	no	
						93
334	106-82	10	7.5YR41	SM	yes	
335	106-82	20	7.5YR41	SM	yes	
336	106-82	30	2.5YR42	SM	yes	<u> </u>
337	106-82	40	2.5YR42	SM	yes	
			<u> </u>		-	109
338	106-83	10	10YR46	SM	no	
339	106-83	20	10YR46	SM	no	
340	106-83	30	10YR46	SM	no	<u> </u>
341	106-83	40	10YR46	SM	no	
-						91
342	106-84	10	7.5YR56	SM	yes	
343	106-84	20	7.5YR51	SM	yes	
344	106-84	30	7.5YR51	SM	yes	
345	106-84	40	7.5YR51	SM	yes	
346	106-84	50	7.5YR51	SM	yes	<u> </u>
347	106-84	60	7.5YR71	SM	yes	<u> </u>
348	106-84	70	7.5YR71	SM	yes	
349	106-84	80	7.5YR71	SM	yes	ļ
350	106-84	90	7.5YR71	SM	yes	
550	100-04	70	7.5110/1	5141	yes	207
1682	107-48	10	10YR52	SM	no	207
1683	107-48	20	101R52 10YR52	SM	no	ļ
1684	107-48	30	101 R32	SM		<u> </u>
	. 	÷		SM	no	<u> </u>
1685	107-48 107-48	40 50	10YR72 10YR72		no	<u> </u>
1686		<u> </u>		SM SM	no	ļ
1687	107-48	60	10YR72	SM	no	
1688	107-48	70	10YR72	SM	no	-
1689	107-48	80	10YR72	SM	no	
1690	107-48	90	10YR72	SM	no	100
1701	107.40	1.0	7.577551	G) 1		196
1691	107-49	10	7.5YR51	SM	no	
1692	107-49	20	7.5YR51	SM	no	ļ
1693	107-49	30	7.5YR51	SM	no	
1694	107-49	40	7.5YR51	SM	no	77; 7742

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
460	200-86	10	7.5YR56	Mik-Imekuwa	no	19
461	200-86	20	7.5YR56	Mik-Imekuwa	no	20
462	200-86	30	7.5YR56	Mik-Imekuwa	no	20
463	200-86	40	7.5YR68	Mik-Imekuwa	no	20
464	200-86	50	7.5YR68	Mik-Imekuwa	no	20
465	200-86	60	7.5YR68	Mik-Imekuwa	no	20
466	200-86	70	7.5YR68	Mik-Imekuwa	no	18
467	200-86	80	7.5YR68	Mik-Imekuwa	no	15
468	200-86	90	7.5YR68	Mik-Imekuwa	no	18
469	200-86	100	7.5YR68	Mik-Imekuwa	no	18
470	200-87	10	10YR61	Mik-Imekuwa	yes	17
471	200-87	20	10YR64	Mik-Imekuwa	yes	19
472	200-87	30	10YR64	Mik-Imekuwa	yes	19
473	200-87	40	10YR64	Mik-Imekuwa	yes	19
474	200-87	50	10YR64	Mik-Imekuwa	yes	20
475	200-87	60	10YR64	Mik-Imekuwa	yes	20
476	200-87	70	10YR64	Mik-Imekuwa	yes	20
477	200-87	80	10YR64	Mik-Imekuwa	yes	21
478	200-87	90	10YR64	Mik-Imekuwa	yes	19
479	200-87	100	10YR64	Mik-Imekuwa	yes	19
480	200-88	10	10YR44	Mik-Imekuwa	yes	21
481	200-88	20	10YR44	Mik-Imekuwa	yes	20
482	200-88	30	10YR44	Mik-Imekuwa	yes	21
483	200-88	40	10YR58	Mik-Imekuwa	yes	19
484	200-88	50	10YR58	Mik-Imekuwa	yes	21
485	200-88	60	10YR58	Mik-Imekuwa	yes	20
486	200-88	70	10YR58	Mik-Imekuwa	yes	17
487	200-88	80	10YR58	Mik-Imekuwa	yes	19
488	200-88	90	10YR58	Mik-Imekuwa	yes	
489	200-89	10	10YR43	Mik-Imekuwa	yes	20
490	200-89	20	10YR54	Mik-Imekuwa	yes	18
491	200-89	30	10YR54	Mik-Imekuwa	yes	18
492	200-89	40	10YR54	Mik-Imekuwa	yes	21
493	200-89	50	10YR54	Mik-Imekuwa	yes	17
494	200-89	60	10YR54	Mik-Imekuwa	yes	19
495	200-89	70	10YR54	Mik-Imekuwa	yes	17
496	200-90	10	7.5YR56	Mik-Imekuwa	yes	19
497	200-90	20	5YR46	Mik-Imekuwa	yes	20
498	200-90	30	5YR46	Mik-Imekuwa	yes	21
499	200-90	40	5YR46	Mik-Imekuwa	yes	20
500	200-90	50	5YR46	Mik-Imekuwa	yes	21
501	200-90	60	5YR46	Mik-Imekuwa	yes	20

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
502	200-91	10	10YR56	Mik-Imekuwa	no	21
503	200-91	20	10YR56	Mik-Imekuwa	no	20
504	200-91	30	7.5YR86	Mik-Imekuwa	no	21
505	200-91	40	7.5YR86	Mik-Imekuwa	no	20
506	200-91	50	7.5YR86	Mik-Imekuwa	no	21
507	200-91	60	7.5YR86	Mik-Imekuwa	no	19
508	200-92		10YR54	Mik-Imekuwa	no	16
509	200-92		10YR54	Mik-Imekuwa	no	18
510	200-92		7.5YR58	Mik-Imekuwa	no	20
511	200-92		7.5YR58	Mik-Imekuwa	no	20
512	200-92		7.5YR58	Mik-Imekuwa	no	17
513	200-92		7.5YR58	Mik-Imekuwa	no	21
514	200-93	10	10YR54	Mik-Imekuwa	yes	24
515	200-93	20	10YR54	Mik-Imekuwa	yes	26
516	200-93	30	10YR43	Mik-Imekuwa	yes	22
517	200-93	40	10YR43	Mik-Imekuwa	yes	27
518	200-93	50	10YR68	Mik-Imekuwa	yes	25
519	200-93	60	10YR68	Mik-Imekuwa	yes	20
520	200-93	70	10YR68	Mik-Imekuwa	yes	22
					, , , , , , , , , , , , , , , , , , , ,	
521	200-94	10	7.5YR44	Mik-Imekuwa	yes	21
522	200-94	20	7.5YR44	Mik-Imekuwa	yes	18
523	200-94	30	7.5YR44	Mik-Imekuwa	yes	20
524	200-94	40	7.5YR44	Mik-Imekuwa	yes	20
525	200-94	50	7.5YR44	Mik-Imekuwa	yes	20
526	200-94	60	7.5YR44	Mik-Imekuwa	yes	21
527	200-94	70	7.5YR44	Mik-Imekuwa	yes	15
321	200-54	70	7.511044	Wik-inickawa	yes	13
528	201-95	10	2.5Y48	Mik-Kisiwa	VAC	20
529	201-95	20	2.5Y48		yes	20
				Mik-Kisiwa	yes	·
530	201-95 201-95	30 40	2.5Y48	Mik-Kisiwa	yes	20
531	201-95	40 50	2.5Y48 2.5Y48	Mik-Kisiwa	yes	20 19
				Mik-Kisiwa	yes	-
533	201-95	60	2.5Y48	Mik-Kisiwa	yes	21
534	201-95	70	2.5Y48	Mik-Kisiwa	yes	21
525	201.06	10	57/D 47	Ma va		21
535	201-96	10	5YR46	Mik-Kisiwa	yes	21
536	201-96	20	2.5Y48	Mik-Kisiwa	yes	20
537	201-96	30	2.5Y48	Mik-Kisiwa	yes	21
538	201-96	40	2.5Y48	Mik-Kisiwa	yes	20
539	201-96	50	2.5Y48	Mik-Kisiwa	yes	20
540	201-96	60	2.5Y48	Mik-Kisiwa	yes	20
541	201-97	10	2.5YR48	Mik-Kisiwa	yes	19
542	201-97	20	5YR44	Mik-Kisiwa	yes	19

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
543	201-97	30	5YR44	Mik-Kisiwa	yes	16
544	201-97	40	5YR44	Mik-Kisiwa	yes	18
545	201-97	50	5YR44	Mik-Kisiwa	yes	19
546	201-97	60	5YR44	Mik-Kisiwa	yes	20
547	201-97	70	5YR44	Mik-Kisiwa	yes	20
548	201-97	80	5YR44	Mik-Kisiwa	yes	
549	201-98	10	5YR46	Mik-Kisiwa	yes	19
550	201-98	20	5YR46	Mik-Kisiwa	yes	20
551	201-98	30	5YR46	Mik-Kisiwa	yes	20
552	201-98	40	5YR46	Mik-Kisiwa	yes	20
553	201-98	50	5YR46	Mik-Kisiwa	yes	20
554	201-98	60	5YR46	Mik-Kisiwa	yes	20
555	201-98	70	5YR46	Mik-Kisiwa	yes	19
556	201-99	10	5YR46	Mik-Kisiwa	yes	21
557	201-99	20	5YR46	Mik-Kisiwa	yes	19
558	201-99	30	5YR46	Mik-Kisiwa	yes	22
559	201-99	40	5YR46	Mik-Kisiwa	yes	21
560	201-99	50	5YR46	Mik-Kisiwa	yes	19
561	201-99	60	5YR46	Mik-Kisiwa	yes	21
562	201-99	70	5YR46	Mik-Kisiwa	yes	19
563	201-99	80	5YR46	Mik-Kisiwa	yes	20
564	201-100	10	7.5YR58	Mik-Kisiwa	yes	19
565	201-100	20	7.5YR58	Mik-Kisiwa	yes	20
566	201-100	30	7.5YR58	Mik-Kisiwa	yes	19
567	201-100	40	7.5YR58	Mik-Kisiwa	yes	20
568	201-100	50	7.5YR58	Mik-Kisiwa	yes	19
569	201-100	60	7.5YR58	Mik-Kisiwa	yes	20
570	201-100	70	7.5YR58	Mik-Kisiwa	yes	20
					1	
571	201-101	10	5YR58	Mik-Kisiwa	yes	20
572	201-101	20	5YR58	Mik-Kisiwa	yes	20
573	201-101	30	5YR58	Mik-Kisiwa	yes	20
574	201-101	40	5YR58	Mik-Kisiwa	yes	21
575	201-101	50	5YR58	Mik-Kisiwa	yes	21
576	201-101	60	5YR58	Mik-Kisiwa	yes	19
577	201-101	70	5YR58	Mik-Kisiwa	yes	19
578	201-101	80	5YR58	Mik-Kisiwa	yes	17
579	201-101	РОТ	POT	Mik-Kisiwa	yes	·
580	201-101	POT	POT	Mik-Kisiwa	yes	
581	201-101	POT	POT	Mik-Kisiwa	yes	
501	201 101	101	101	INDIWE	, , , ,	
582	201-102	10	5YR48	Mik-Kisiwa	Vec	20
583	201-102	20	5YR48		yes	20
583 584	201-102	30	5 Y R 4 8 5 Y R 4 8	Mik-Kisiwa Mik-Kisiwa	yes yes	20 19

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
585	201-102	40	2.5Y48	Mik-Kisiwa	yes	20
586	201-102	50	2.5Y48	Mik-Kisiwa	yes	20
587	201-102	60	2.5Y48	Mik-Kisiwa	yes	20
588	201-102	70	2.5Y48	Mik-Kisiwa	yes	21
589	201-103	10	7.5YR58	Mik-Kisiwa	yes	20
590	201-103	20	7.5YR58	Mik-Kisiwa	yes	21
591	201-103	30	7.5YR58	Mik-Kisiwa	yes	20
592	201-103	40	7.5YR58	Mik-Kisiwa	yes	18
593	201-103	50	7.5YR58	Mik-Kisiwa	yes	20
594	201-103	60	7.5YR58	Mik-Kisiwa	yes	19
595	201-105	10	7.5YR46	Mik-Kisiwa	yes	18
596	201-105	20	7.5YR46	Mik-Kisiwa	yes	18
597	201-105	30	7.5YR46	Mik-Kisiwa	yes	18
598	201-105	40	5YR46	Mik-Kisiwa	yes	18
599	201-105	50	5YR46	Mik-Kisiwa	yes	21
600	201-105	60	5YR46	Mik-Kisiwa	yes	19
601	202-106	10	7.5YR58	Mik-Mgao	yes	21
602	202-106	20	7.5YR58	Mik-Mgao	yes	21
603	202-106	30	7.5YR31	Mik-Mgao	yes	19
604	202-106	40	7.5YR58	Mik-Mgao	yes	18
605	202-106	50	7.5YR58	Mik-Mgao	yes	20
606	202-107	10	7.5YR46	Mik-Mgao	yes	19
607	202-107	20	7.5YR46	Mik-Mgao	yes	14
608	202-107	30	7.5YR46	Mik-Mgao	yes	21
609	202-107	40	7.5YR46	Mik-Mgao	yes	21
610	202-107	50	7.5YR46	Mik-Mgao	yes	20
611	202-107	60	7.5YR46	Mik-Mgao	yes	19
612	202-107	70	5YR46	Mik-Mgao	yes	19
613	202-107	80	5YR46	Mik-Mgao	yes	18
614	202-108	10	10YR46	Mik-Mgao	yes	20
615	202-108	20	10YR46	Mik-Mgao	yes	20
616	202-108	30	10YR46	Mik-Mgao	yes	21
617	202-108	40	7.5YR46	Mik-Mgao	yes	21
618	202-109	10	7.5YR46	Mik-Mgao	yes	25
619	202-109	20	7.5YR46	Mik-Mgao	yes	22
620	202-109	30	5YR46	Mik-Mgao	yes	25
621	202-109	40	5YR46	Mik-Mgao	yes	25
622	202-109	50	5YR46	Mik-Mgao	yes	22
623	202-110	10	10YR56	Mik-Mgao	yes	21
624	202-110	20	10YR56	Mik-Mgao	yes	20

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
625	202-110	30	10YR56	Mik-Mgao	yes	20
626	202-110	40	10YR56	Mik-Mgao	yes	20
627	202-110	50	10YR56	Mik-Mgao	yes	19
628	202-112	10	10YR56	Mik-Mgao	yes	20
629	202-112	20	10YR56	Mik-Mgao	yes	20
630	202-112	30	10YR56	Mik-Mgao	yes	20
631	202-112	40	10YR56	Mik-Mgao	yes	21
632	202-112	50	10YR56	Mik-Mgao	yes	21
633	202-112	60	10YR56	Mik-Mgao	yes	21
634	202-113	10	5YR58	Mik-Mgao	no	20
635	202-113	20	5YR58	Mik-Mgao	no	20
636	202-113	30	5YR58	Mik-Mgao	no	20
637	202-113	40	5YR46	Mik-Mgao	no	21
638	202-113	50	5YR46	Mik-Mgao	no	20
639	202-113	60	5YR46	Mik-Mgao	no	19
640	202-114	10	5YR58	Mik-Mgao	no	19
641	202-114	20	5YR58	Mik-Mgao	no	21
642	202-114	30	5YR58	Mik-Mgao	no	19
643	202-114	40	5YR46	Mik-Mgao	no	19
644	202-114	50	5YR46	Mik-Mgao	no	21
645	202-114	60	5YR46	Mik-Mgao	no	20
	202.115	10	2.537.42	Mil Mir.		10
646	203-115	10	2.5Y42	Mik-Mitengo	no	18
647	203-115	20	2.5Y42	Mik-Mitengo	no	21
648	203-115	30	2.5Y42	Mik-Mitengo	no	21
649	203-115	40	2.5Y42	Mik-Mitengo	no	21
650	203-115	50	2.5Y42	Mik-Mitengo	no	
650	203-116	10	10YR62	Mik-Mitengo	no	21
651	203-116	20			no no	18
652	203-116	30	10YR62 7.5YR63	Mik-Mitengo Mik-Mitengo	no no	19
653	203-116	40	7.51 R63 7.5YR63	Mik-Mitengo	no no	19
654	203-116	50	7.51R63 7.5YR63	Mik-Mitengo	no	14
655	203-116	60	7.51R63 7.5YR63	Mik-Mitengo	no	20
	_00 110	~~~~~				1
656	203-117	10	7.5YR66	Mik-Mitengo	no	18
657	203-117	20	7.5YR53	Mik-Mitengo	no	20
658	203-117	30	7.5YR53	Mik-Mitengo	no	21
659	203-117	40	7.5YR58	Mik-Mitengo	no	20
660	203-117	50	7.5YR58	Mik-Mitengo	no	20
661	203-117	60	7.5YR58	Mik-Mitengo	no	21
662	203-118	10	7.5YR53	Mik-Mitengo	no	20
663	203-118	20	7.5YR53	Mik-Mitengo	no	22

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
664	203-118	30	7.5YR53	Mik-Mitengo	no	21
665	203-118	40	5YR56	Mik-Mitengo	no	20
666	203-118	50	5YR56	Mik-Mitengo	no	20
667	203-118	60	5YR56	Mik-Mitengo	no	21
668	203-119	10	7.5YR66	Mik-Mitengo	no	19
669	203-119	20	7.5YR66	Mik-Mitengo	no	21
670	203-119	30	7.5YR66	Mik-Mitengo	no	19
671	203-119	40	5YR56	Mik-Mitengo	no	17
672	203-119	50	5YR56	Mik-Mitengo	no	21
673	203-119	60	5YR56	Mik-Mitengo	no	20
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674	203-120	10	10YR42	Mik-Mitengo	yes	21
675	203-120	20	10YR42	Mik-Mitengo	yes	19
676	203-120	30	10YR42	Mik-Mitengo	yes	21
677	203-120	40	7.5YR46	Mik-Mitengo	yes	21
678	203-120	50	7.5YR46	Mik-Mitengo	yes	20
679	203-120	60	7.5YR46	Mik-Mitengo	yes	18
680	203-120	70	7.5YR46	Mik-Mitengo	yes	20
681	203-120	80	7.5YR46	Mik-Mitengo	yes	20
682	203-120	90	7.5YR46	Mik-Mitengo	yes	20
683	203-120	100	7.5YR46	Mik-Mitengo	yes	18
684	203-121	10	10YR62	Mik-Mitengo	no	21
685	203-121	20	10YR68	Mik-Mitengo	no	20
686	203-121	30	10YR68	Mik-Mitengo	no	20
687	203-121	40	10YR68	Mik-Mitengo	no	20
688	203-121	50	10YR68	Mik-Mitengo	no	21
689	203-121	60	10YR68	Mik-Mitengo	no	21
	202 122	10	10VD 52	MCL MC		24
690	203-122	10	10YR53	Mik-Mitengo	yes	24
691	203-122	20	10YR53	Mik-Mitengo	yes	24
692	203-122	30	10YR53	Mik-Mitengo	yes	21
693	203-122	40	10YR53	Mik-Mitengo	yes	23
694	203-122	50	10YR53	Mik-Mitengo	yes	24
695	203-122	60	10YR53	Mik-Mitengo	yes	
695a	203-123	10	2.5Y51	Mik-Mitengo	no	20
696	203-123	20	2.5Y51	Mik-Mitengo	no no	22
697	203-123	30	2.5Y64	Mik-Mitengo	no	23
					no	
698	203-123	40	2.5Y64	Mik-Mitengo	no	22
699	203-123	50	2.5Y51	Mik-Mitengo	no	23
700	203-123	60	2.5Y64	Mik-Mitengo	no	25
701	204-125	10	10YR43	Mik-Stella Hills	yes	21
702	204-125	20	10 T K 43	Mik-Stella Hills		23
702	204-125	30	101 K43 10YR43	Mik-Stella Hills	yes yes	23

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
704	204-125	40	10YR43	Mik-Stella Hills	yes	20
705	204-125	50	10YR54	Mik-Stella Hills	yes	20
706	204-125	60	10YR54	Mik-Stella Hills	yes	22
707	204-125	70	10YR54	Mik-Stella Hills	yes	20
708	204-125	80	10YR54	Mik-Stella Hills	yes	12
709	204-126	10	7.5YR53	Mik-Stella Hills	yes	20
710	204-126	20	7.5YR56	Mik-Stella Hills	yes	12
711	204-126	30	7.5YR56	Mik-Stella Hills	yes	22
712	204-126	40	7.5YR56	Mik-Stella Hills	yes	20
713	204-126	50	7.5YR56	Mik-Stella Hills	yes	21
714	204-126	60	7.5YR56	Mik-Stella Hills	yes	21
715	204-126	70	7.5YR56	Mik-Stella Hills	yes	19
716	204-127	10	5YR56	Mik-Stella Hills	yes	17
717	204-127	20	5YR56	Mik-Stella Hills	yes	19
718	204-127	30	5YR58	Mik-Stella Hills	yes	24
719	204-127	40	5YR58	Mik-Stella Hills	yes	21
720	204-127	50	5YR58	Mik-Stella Hills	yes	23
721	204-127	60	5YR58	Mik-Stella Hills	yes	17
722	204-128	10	7.5YR58	Mik-Stella Hills	yes	24
723	204-128	20	7.5YR58	Mik-Stella Hills	yes	24
724	204-128	30	5YR58	Mik-Stella Hills	yes	23
725	204-128	40	5YR58	Mik-Stella Hills	yes	23
726	204-128	50	5YR58	Mik-Stella Hills	yes	21
727	204-128	60	5YR58	Mik-Stella Hills	yes	20
728	204-128	70	5YR58	Mik-Stella Hills	yes	21
729	204-128	80	5YR58	Mik-Stella Hills	yes	19
730a	204-128	90	5YR58	Mik-Stella Hills	yes	20
730	204-129	10	5YR56	Mik-Stella Hills	VAC	18
731	204-129	20	5YR56	N. C. H. 17711	yes yes	18
732	204-129	30	5YR56	Mik-Stella Hills Mik-Stella Hills	yes	20
733	204-129	40	7.5YR46	Mik-Stella Hills	yes	21
734	204-129	50	7.5YR46	Mik-Stella Hills	yes	20
735	204-129	60	5YR56	Mik-Stella Hills	yes	15
736	204-129	70	7.5YR46	Mik-Stella Hills	yes	22
737	204-129	80	7.5YR46	Mik-Stella Hills	yes	16
738	204-130	10	7.5YR44	Mik-Stella Hills	no	22
739	204-130	20	7.5YR44	Mik-Stella Hills	no	19
740	204-130	30	7.5YR44	Mik-Stella Hills	no	22
741	204-130	40	5YR46	Mik-Stella Hills	no	22
742	204-130	50	5YR46	Mik-Stella Hills	no	17
743	204-130	60	5YR46	Mik-Stella Hills	no	19

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
744	204-131	10	10YR46	Mik-Stella Hills	yes	24
745	204-131	20	10YR46	Mik-Stella Hills	yes	22
746	204-131	30	7.5YR58	Mik-Stella Hills	yes	21
747	204-131	40	7.5YR58	Mik-Stella Hills	yes	19
748	204-131	50	7.5YR58	Mik-Stella Hills	yes	17
749	204-131	60	7.5YR58	Mik-Stella Hills	yes	16
750	204-131	70	7.5YR58	Mik-Stella Hills	yes	18
751	204-132	10	10YR61	Mik-Stella Hills	no	24
752	204-132	20	10YR41	Mik-Stella Hills	no	26
753	204-132	30	GLEY245PB	Mik-Stella Hills	no	32
754	204-132	40	GLEY245PB	Mik-Stella Hills	no	31
755	204-132	50	GLEY245PB	Mik-Stella Hills	no	32
756	204-133	10	5YR53	Mik-Stella Hills	no	21
757	204-133	20	5YR58	Mik-Stella Hills	no	21
758	204-133	30	5YR58	Mik-Stella Hills	no	21
759	204-133	40	5YR58	Mik-Stella Hills	no	23
760	204-133	50	5YR58	Mik-Stella Hills	no	19
761	204-133	60	5YR58	Mik-Stella Hills	no	19
762	204-133	70	5YR58	Mik-Stella Hills	no	17
702	201 133	, ,	31100	THIR Stella IIIIIs	110	*/
763	204-134	10	7.5YR54	Mik-Stella Hills	no	23
764	204-134	20	7.5YR74	Mik-Stella Hills	no	24
765	204-134	30	7.5YR74	Mik-Stella Hills	no	20
766	204-134	40	7.5YR74	Mik-Stella Hills	no	20
767	204-134	50	7.5YR74	Mik-Stella Hills	no	21
768	204-134	60	7.5YR74	Mik-Stella Hills	no	19
700	204-134	00	7.5110/4	wiik-Stella Hills	110	17
767a	204-135	10	7.5YR46	Mik-Stella Hills	no	22
767a 768a	204-135	20	7.5YR46 7.5YR46	Mik-Stella Hills		20
769		30			no	20
	204-135		7.5YR58	Mik-Stella Hills	no	·
770	204-135	40	7.5YR58	Mik-Stella Hills	no	22
771	204-135	50	7.5YR68 7.5YR68	Mik-Stella Hills	no	25
772	204-135	60 70		Mik-Stella Hills	no	21
773	204-135	70	7.5YR68	Mik-Stella Hills	no	21
774	205 126	10	10VD66	Mile North Involution		22
774	205-136	10	10YR66	Mik-North Imekuwa	yes	23
775	205-136	20	10YR62	Mik-North Imekuwa	yes	24
776	205-136	30	10YR62	Mik-North Imekuwa	yes	21
777	205-136	40	10YR62	Mik-North Imekuwa	yes	24
778	205-136	50	10YR62	Mik-North Imekuwa	yes	21
779	205-136	60	10YR62	Mik-North Imekuwa	yes	25
780	205-136	70	10YR62	Mik-North Imekuwa	yes	22
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781	205-137	10	10YR74	Mik-North Imekuwa	no	25
782	205-137	20	10YR68	Mik-North Imekuwa	no	25

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
783	205-137	30	10YR68	Mik-North Imekuwa	no	15
784	205-137	40	10YR68	Mik-North Imekuwa	no	20
785	205-137	50	10YR68	Mik-North Imekuwa	no	22
786	205-137	60	10YR68	Mik-North Imekuwa	no	24
787	205-137	70	10YR68	Mik-North Imekuwa	no	23
788	205-138	10	7.5YR58	Mik-North Imekuwa	yes	22
789	205-138	20	7.5YR58	Mik-North Imekuwa	yes	21
790	205-138	30	7.5YR58	Mik-North Imekuwa	yes	24
791	205-138	40	7.5YR58	Mik-North Imekuwa	yes	23
792	205-138	50	7.5YR58	Mik-North Imekuwa	yes	23
793	205-138	60	7.5YR58	Mik-North Imekuwa	yes	21
794	205-138	70	7.5YR58	Mik-North Imekuwa	yes	18
795	205-138	80	7.5YR58	Mik-North Imekuwa	yes	18
796	205-139	10	5YR58	Mik-North Imekuwa	no	24
797	205-139	20	5YR58	Mik-North Imekuwa	no	23
798	205-139	30	2.5YR46	Mik-North Imekuwa	no	15
799	205-139	40	2.5YR46	Mik-North Imekuwa	no	20
800	205-139	50	2.5YR46	Mik-North Imekuwa	no	24
801	205-139	60	2.5YR46	Mik-North Imekuwa	no	21
802	205-139	70	2.5YR48	Mik-North Imekuwa	no	23
803	205-139	80	2.5YR48	Mik-North Imekuwa	no	25
804	205-139	90	2.5YR48	Mik-North Imekuwa	no	24
805	205-139	100	2.5YR48	Mik-North Imekuwa	no	22
806	205-140	10	5YR56	Mik-North Imekuwa	no	24
807	205-140	20	5YR56	Mik-North Imekuwa	no	18
808	205-140	30	5YR56	Mik-North Imekuwa	no	22
809	205-140	40	5YR56	Mik-North Imekuwa	no	21
810	205-140	50	5YR56	Mik-North Imekuwa	no	21
811	205-140	60	5YR56	Mik-North Imekuwa	no	22
812	205-140	70	5YR56	Mik-North Imekuwa	no	21
813	205-141	10	5YR56	Mik-North Imekuwa	no	23
814	205-141	20	5YR56	Mik-North Imekuwa	no	20
815	205-141	30	5YR44	Mik-North Imekuwa	no	14
816	205-141	40	5YR44	Mik-North Imekuwa	no	18
817	205-141	50	5YR44	Mik-North Imekuwa	no	22
818	205-141	60	5YR44	Mik-North Imekuwa	no	19
819	205-142	10	5YR68	Mik-North Imekuwa	yes	24
820	205-142	20	5YR68	Mik-North Imekuwa	yes	25
821	205-142	30	5YR68	Mik-North Imekuwa	yes	24
822	205-142	40	5YR58	Mik-North Imekuwa	yes	25
823	205-142	50	5YR58	Mik-North Imekuwa	yes	24
824	205-142	60	5YR58	Mik-North Imekuwa	yes	22

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
825	205-142	70	5YR58	Mik-North Imekuwa	yes	24
826	205-142	80	5YR58	Mik-North Imekuwa	yes	24
827	205-143	10	7.5YR68	Mik-North Imekuwa	yes	23
828	205-143	20	7.5YR68	Mik-North Imekuwa	yes	21
829	205-143	30	5YR58	Mik-North Imekuwa	yes	21
830	205-143	40	5YR58	Mik-North Imekuwa	yes	16
831	205-143	50	5YR58	Mik-North Imekuwa	yes	20
832	205-143	60	5YR58	Mik-North Imekuwa	yes	22
833	205-143	70	5YR58	Mik-North Imekuwa	yes	22
834	205-143	80	5YR58	Mik-North Imekuwa	yes	20
835	205-143	90	5YR58	Mik-North Imekuwa	yes	
836	205-144	10	7.5YR58	Mik-North Imekuwa	yes	22
837	205-144	20	7.5YR58	Mik-North Imekuwa	yes	19
838	205-144	30	7.5YR58	Mik-North Imekuwa	yes	21
839	205-144	40	5YR58	Mik-North Imekuwa	yes	22
840	205-144	50	5YR58	Mik-North Imekuwa	yes	22
841	205-144	60	5YR58	Mik-North Imekuwa	yes	23
842	205-144	70	5YR58	Mik-North Imekuwa	yes	21
					-	
843	205-145	10	5YR46	Mik-North Imekuwa	no	
844	205-145	20	5YR46	Mik-North Imekuwa	no	
845	205-145	30	5YR46	Mik-North Imekuwa	no	
846	205-145	40	5YR46	Mik-North Imekuwa	no	
847	205-145	50	5YR46	Mik-North Imekuwa	no	
848	205-145	60	5YR46	Mik-North Imekuwa	no	
849	205-145	70	5YR46	Mik-North Imekuwa	no	
850	205-146	10	5YR46	Mik-North Imekuwa	no	22
851	205-146	20	5YR46	Mik-North Imekuwa	no	15
852	205-146	30	5YR46	Mik-North Imekuwa	no	19
853	205-146	40	5YR46	Mik-North Imekuwa	no	24
854	205-146	50	5YR46	Mik-North Imekuwa	no	19
855	205-146	60	5YR46	Mik-North Imekuwa	no	20
856	206-147	10	5YR58	Mik-Litingi	no	
857	206-147	20	5YR58	Mik-Litingi	no	
858	206-147	30	7.5YR58	Mik-Litingi	no	
859	206-147	40	7.5YR58	Mik-Litingi	no	
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860	206-148	10	7.5YR42	Mik-Litingi	yes	†
861	206-148	20	7.5YR42	Mik-Litingi	yes	
862	206-148	30	7.5YR42	Mik-Litingi	yes	
863	206-148	40	10YR73	Mik-Litingi	yes	
864	206-148	50	10YR73	Mik-Litingi	yes	<u> </u>
865	206-148	60	10YR73	Mik-Litingi	yes	+

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
866	206-148	70	10YR73	Mik-Litingi	yes	
867	206-148	80	10YR73	Mik-Litingi	yes	
868	206-148	90	10YR73	Mik-Litingi	yes	
0/0	207.140	10	7.5VD.(4	MCL Trickers		
869	206-149	10	7.5YR64	Mik-Litingi	no	
870	206-149	20	7.5YR64	Mik-Litingi	no	
871	206-149	30	7.5YR53	Mik-Litingi	no	
872	206-149	40	7.5YR53	Mik-Litingi	no	
873	206-149	50	7.5YR53	Mik-Litingi	no	ļ
874	206-149	60	5YR68	Mik-Litingi	no	
875	206-149	70	5YR68	Mik-Litingi	no	
379	207-155	10	10YR63	Mik-Ufukoni Mibuyu	yes	24
380	207-155	20	10 T R 63	Mik-Ufukoni Mibuyu		24
381	207-155	30	10 T R63		yes	20
382	207-155	40	10 T R63	Mik-Ufukoni Mibuyu Mik Ufukoni Mibuyu	yes	20
				Mik-Ufukoni Mibuyu	yes	
383	207-155	50	10YR68	Mik-Ufukoni Mibuyu	yes	22
384	207-155	60	10YR68	Mik-Ufukoni Mibuyu	yes	23
385	207-155	70	10YR68	Mik-Ufukoni Mibuyu	yes	21
386	207-155	80	10YR68	Mik-Ufukoni Mibuyu	yes	21
387	207-155	90	10YR68	Mik-Ufukoni Mibuyu	yes	23
388	207-155	100	10YR68	Mik-Ufukoni Mibuyu	yes	25
394	207-157	10	7.5YR44	Mik-Ufukoni Mibuyu	no	24
395	207-157	20	7.5YR44	Mik-Ufukoni Mibuyu	no	24
396	207-157	30	7.5YR44	Mik-Ufukoni Mibuyu	no	24
397	207-157	40	7.5YR44	Mik-Ufukoni Mibuyu	no	20
398	207-157	50	7.5YR44	Mik-Ufukoni Mibuyu	no	18
399	207-157	60	7.5YR44	Mik-Ufukoni Mibuyu	no	22
400	207-157	70	7.5YR44	Mik-Ufukoni Mibuyu	no	24
401	207-158	10	10YR54	Mik-Ufukoni Mibuyu	yes	20
402	207-158	20	10YR54	Mik-Ufukoni Mibuyu	yes	21
403	207-158	30	10YR54	Mik-Ufukoni Mibuyu	yes	23
404	207-158	40	10YR54	Mik-Ufukoni Mibuyu	yes	21
405	207-158	50	10YR54	Mik-Ufukoni Mibuyu	yes	20
						118
406	207-159	10	7.5YR66	Mik-Ufukoni Mibuyu	yes	23
407	207-159	20	7.5YR66	Mik-Ufukoni Mibuyu	yes	20
408	207-159	30	7.5YR66	Mik-Ufukoni Mibuyu	yes	20
409	207-159	40	7.5YR66	Mik-Ufukoni Mibuyu	yes	24
410	207-159	50	7.5YR66	Mik-Ufukoni Mibuyu	yes	24
411	207-159	60	7.5YR66	Mik-Ufukoni Mibuyu	yes	23
412	207-159	70	7.5YR66	Mik-Ufukoni Mibuyu	yes	20
						164
389	207-156	10	2.5Y56	Mik-Ufukoni Mibuyu	yes	
390	207-156	20	2.5Y51	Mik-Ufukoni Mibuyu	yes	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
391	207-156	30	2.5Y56	Mik-Ufukoni Mibuyu	yes	
392	207-156	40	2.5Y68	Mik-Ufukoni Mibuyu	yes	
392	207-156	50	2.5Y68	Mik-Ufukoni Mibuyu	yes	
						111
413	209-161	10	2.5Y63	Mik-Pemba	yes	
414	209-161	20	7.5YR46	Mik-Pemba	yes	
415	209-161	30	7.5YR52	Mik-Pemba	yes	
416	209-161	40	7.5YR42	Mik-Pemba	yes	
417	209-161	50	7.5YR42	Mik-Pemba	yes	
						114
418	209-162	10	7.5YR58	Mik-Pemba	yes	
419	209-162	20	7.5YR58	Mik-Pemba	yes	
420	209-162	30	7.5YR58	Mik-Pemba	yes	
421	209-162	40	7.5YR58	Mik-Pemba	yes	
422	209-162	50	7.5YR58	Mik-Pemba	yes	<u> </u>
423	209-162	60	7.5YR58	Mik-Pemba	yes	
424	209-162	70	7.5YR58	Mik-Pemba	yes	
						151
425	209-163	10	10YR73	Mik-Pemba	yes	
426	209-163	20	10YR73	Mik-Pemba	yes	
427	209-163	30	10YR73	Mik-Pemba	yes	
428	209-163	40	7.5YR56	Mik-Pemba	yes	
429	209-163	50	7.5YR56	Mik-Pemba	yes	
430	209-163	60	7.5YR56	Mik-Pemba	yes	
431	209-163	70	7.5YR56	Mik-Pemba	yes	
					<i>J</i>	170
432	209-164	10	7.5YR58	Mik-Pemba	no	
433	209-164	20	7.5YR58	Mik-Pemba	no	
434	209-164	30	7.5YR58	Mik-Pemba	no	<u> </u>
435	209-164	40	7.5YR58	Mik-Pemba	no	
436	209-164	50	7.5YR58	Mik-Pemba	no	
437	209-164	60	7.5YR58	Mik-Pemba	no	
438	209-164	70	7.5YR58	Mik-Pemba	no	
430	207-104	70	7.511050	WIK-1 CHIOG	110	156
439	209-165	10	7.5YR64	Mik-Pemba	yes	150
440	209-165	20	7.5YR64	Mik-Pemba	yes	+
441	209-165	30	7.5YR64	Mik-Pemba	yes	
442	209-165	40	7.5YR64	Mik-Pemba	yes	
443	209-165	50	7.5YR64	Mik-Pemba		
444	209-165	60	7.5YR68	Mik-Pemba	yes	
445	209-165	70	7.5YR68	Mik-Pemba	yes	
446	209-165				yes	
		80	7.5YR68	Mik-Pemba	yes	
447	209-165	90	7.5YR68	Mık-Pemba	yes	100
440	200.166	10	7 53/0 (2	Mil- Danil		188
448	209-166	10	7.5YR63	Mik-Pemba	no	-
449	209-166	20	7.5YR58	Mik-Pemba	no	
450	209-166	30	7.5YR58	Mik-Pemba	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
451	209-166	40	7.5YR58	Mik-Pemba	no	
452	209-166	50	7.5YR58	Mik-Pemba	no	
453	209-166	60	7.5YR58	Mik-Pemba	no	
454	209-166	70	7.5YR58	Mik-Pemba	no	
						156
455	209-167	10	7.5YR44	Mik-Pemba	no	
456	209-167	20	7.5YR44	Mik-Pemba	no	
457	209-167	30	7.5YR44	Mik-Pemba	no	
458	209-167	40	7.5YR44	Mik-Pemba	no	
459	209-167	50	7.5YR44	Mik-Pemba	no	
						114
955	209-168	10	10YR31	Mik-Pemba	no	
956	209-168	20	10YR31	Mik-Pemba	no	
957	209-168	30	10YR31	Mik-Pemba	no	
958	209-168	40	10YR31	Mik-Pemba	no	
959	209-168	50	10YR31	Mik-Pemba	no	
						106
960	209-169	10	5YR68	Mik-Mji Mwema	no	
961	209-169	20	5YR68	Mik-Mji Mwema	no	
962	209-169	30	2.5Y68	Mik-Mji Mwema	no	
963	209-169	40	2.5Y68	Mik-Mji Mwema	no	
964	209-169	50	2.5Y68	Mik-Mji Mwema	no	
965	209-169	60	2.5Y68	Mik-Mji Mwema	no	
966	209-169	70	2.5Y68	Mik-Mji Mwema	no	
967	209-169	80	2.5Y68	Mik-Mji Mwema	no	
						176
968	209-170	10	5YR68	Mik-Mji Mwema	yes	
969	209-170	20	5YR68	Mik-Mji Mwema	yes	
970	209-170	30	2.5Y68	Mik-Mji Mwema	yes	
971	209-170	40	2.5Y68	Mik-Mji Mwema	yes	
972	209-170	50	2.5Y68	Mik-Mji Mwema	yes	
973	209-170	60	2.5Y68	Mik-Mji Mwema	yes	
974	209-170	70	2.5Y68	Mik-Mji Mwema	yes	
975	209-170	80	2.5Y68	Mik-Mji Mwema	yes	
						213
976	209-171	10	5YR68	Mik-Mji Mwema	yes	
977	209-171	20	5YR68	Mik-Mji Mwema	yes	
978	209-171	30	2.5Y68	Mik-Mji Mwema	yes	
979	209-171	40	2.5Y68	Mik-Mji Mwema	yes	
980	209-171	50	2.5Y68	Mik-Mji Mwema	yes	
981	209-171	60	2.5Y68	Mik-Mji Mwema	yes	
982	209-171	70	2.5Y68	Mik-Mji Mwema	yes	
983	209-171	80	2.5Y68	Mik-Mji Mwema	yes	<u> </u>
						189
984	209-172	10	5YR68	Mik-Mji Mwema	yes	<u> </u>
985	209-172	20	5YR68	Mik-Mji Mwema	yes	
986	209-172	30	2.5Y68	Mik-Mji Mwema	yes	1

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
987	209-172	40	2.5Y68	Mik-Mji Mwema	yes	
988	209-172	50	2.5Y68	Mik-Mji Mwema	yes	
989	209-172	60	2.5Y68	Mik-Mji Mwema	yes	
990	209-172	70	2.5Y68	Mik-Mji Mwema	yes	
991	209-172	80	2.5Y68	Mik-Mji Mwema	yes	
						207
992	209-173	10	5YR68	Mik-Mji Mwema	yes	
993	209-173	20	5YR68	Mik-Mji Mwema	yes	
994	209-173	30	2.5Y68	Mik-Mji Mwema	yes	
995	209-173	40	2.5Y68	Mik-Mji Mwema	yes	
996	209-173	50	2.5Y68	Mik-Mji Mwema	yes	
997	209-173	60	2.5Y68	Mik-Mji Mwema	yes	
998	209-173	70	2.5Y68	Mik-Mji Mwema	yes	
999	209-173	80	2.5Y68	Mik-Mji Mwema	yes	
				· · · · · · · · · · · · · · · · · · ·		
875a	211-174	10	10YR31	Mik-Mkangala	no	
876	211-174	20	10YR31	Mik-Mkangala	no	
877	211-174	30	10YR31	Mik-Mkangala	no	
878	211-174	40	10YR31	Mik-Mkangala	no	
879	211-174	50	10YR63	Mik-Mkangala	no	
889	211-174	60	10 T R 63	Mik-Mkangala		
881	211-174	70	10 T R63	Mik-Mkangala	no	
882	211-174	80	10 T R 63		no	
	211-1/4	00	101103	Mik-Mkangala	no	176
883	211 175	10	7 5VD 16	Mile Mleangala	n o	176
	211-175	10	7.5YR46	Mik-Mkangala	no	<u> </u>
884	211-175	20	7.5YR46	Mik-Mkangala	no	
885	211-175	30	5YR46	Mik-Mkangala	no	
886	211-175	40	5YR46	Mik-Mkangala	no	
887	211-175	50	5YR46	Mik-Mkangala	no	
888	211-175	60	5YR46	Mik-Mkangala	no	
889	211-175	70	5YR46	Mik-Mkangala	no	_
890	211-175	80	5YR46	Mik-Mkangala	no	
891	211-175	90	5YR46	Mik-Mkangala	no	
						200
892	211-176	10	5YR44	Mik-Mkangala	no	ļ
893	211-176	20	5YR44	Mik-Mkangala	no	_
894	211-176	30	5YR44	Mik-Mkangala	no	
895	211-176	40	5YR44	Mik-Mkangala	no	
896	211-176	50	5YR44	Mik-Mkangala	no	
897	211-176	60	5YR44	Mik-Mkangala	no	
898	211-176	70	5YR44	Mik-Mkangala	no	
						131
899	211-177	10	5YR44	Mik-Mkangala	no	
900	211-177	20	5YR44	Mik-Mkangala	no	
901	211-177	30	5YR68	Mik-Mkangala	no	
902	211-177	40	5YR68	Mik-Mkangala	no	
903	211-177	50	5YR68	Mik-Mkangala	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
904	211-177	60	5YR68	Mik-Mkangala	no	
905	211-177	70	5YR68	Mik-Mkangala	no	
906	211-177	80	5YR68	Mik-Mkangala	no	
						177
907	211-178	10	5YR44	Mik-Mkangala	no	
908	211-178	20	5YR44	Mik-Mkangala	no	
909	211-178	30	5YR68	Mik-Mkangala	no	
910	211-178	40	5YR68	Mik-Mkangala	no	
911	211-178	50	5YR68	Mik-Mkangala	no	
912	211-178	60	5YR68	Mik-Mkangala	no	
913	211-178	70	5YR68	Mik-Mkangala	no	
914	211-178	80	5YR68	Mik-Mkangala	no	
•••••						177
915	211-179	10	10YR42	Mik-Liwelu	yes	·
916	211-179	20	10YR42	Mik-Liwelu	yes	
917	211-179	30	10YR42	Mik-Liwelu	yes	<u> </u>
918	211-179	40	10YR42	Mik-Liwelu	yes	
919	211-179	50	10YR64	Mik-Liwelu	yes	
920	211-179	60	10YR64	Mik-Liwelu	yes	
921	211-179	70	10YR64	Mik-Liwelu	yes	
922	211-179	80	10YR64	Mik-Liwelu	yes	
923	211-179	90	10YR64	Mik-Liwelu	yes	
•••••						202
924	211-180	10	10YR42	Mik-Liwelu	no	
925	211-180	20	10YR42	Mik-Liwelu	no	
926	211-180	30	10YR42	Mik-Liwelu	no	
927	211-180	40	10YR42	Mik-Liwelu	no	
928	211-180	50	10YR42	Mik-Liwelu	no	
929	211-180	60	10YR42	Mik-Liwelu	no	
930	211-180	70	10YR42	Mik-Liwelu	no	
931	211-180	80	10YR42	Mik-Liwelu	no	
751	211-100	00	101 K42	MIK-LIWCIU	10	178
932	211-181	10	10YR53	Mik-Liwelu	VAC	170
933	211-181	20	10 TR53	Mik-Liwelu	yes	
934	211-181	30	10 T R 53	Mik-Liwelu	yes	
					yes	
935	211-181 211-181	40 50	10YR53	Mık-Lıwelu Mik-Liwelu	yes	
936		50 60	10YR53	Mik-Liwelu	yes	-
937	211-181	60 70	10YR53	Mik-Liwelu	yes	-
938	211-181	70	10YR53	Mik-Liwelu	yes	-
939	211-181	80	10YR53	Mik-Liwelu	yes	<u> </u>
940	211-181	90	10YR53	Mık-Lıwelu	yes	<u> </u>
0.41	211 102	10	7.53/0.62	M(1 T : 1		
941	211-182	10	7.5YR63	Mik-Liwelu	no	
942	211-182	20	7.5YR46	Mik-Liwelu	no	
943	211-182	30	7.5YR46	Mik-Liwelu	no	
944	211-182	40	7.5YR46	Mik-Liwelu	no	
945	211-182	50	7.5YR46	Mik-Liwelu	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
946	211-182	60	7.5YR46	Mik-Liwelu	no	
947	211-182	70	7.5YR46	Mik-Liwelu	no	
948	211-183	10	7.5YR46	Mik-Liwelu	yes	
949	211-183	20	7.5YR46	Mik-Liwelu	yes	
950	211-183	30	7.5YR46	Mik-Liwelu	yes	
951	211-183	40	7.5YR46	Mik-Liwelu	yes	
952	211-183	50	7.5YR46	Mik-Liwelu	yes	
953	211-183	60	7.5YR46	Mik-Liwelu	yes	
954	211-183	70	7.5YR46	Mik-Liwelu	yes	
1695	212-184	10	10YR51	Mik-Likwelu	no	
1696	212-184	20	10YR51	Mik-Likwelu	no	
1697	212-184	30	10YR51	Mik-Likwelu	no	
1698	212-184	40	10YR51	Mik-Likwelu	no	
1699	212-184	50	10YR51	Mik-Likwelu	no	
1700	212-184	60	10YR51	Mik-Likwelu	no	
1701	212-184	70	10YR51	Mik-Likwelu	no	
1702	212-184	80	10YR51	Mik-Likwelu	no	
1703	212-184	90	10YR51	Mik-Likwelu	no	
1704	212-185	10	7.5YR54	Mik-Liwelu	no	
1705	212-185	20	10YR44	Mik-Liwelu	no	
1706	212-185	30	10YR44	Mik-Liwelu	no	
1707	212-185	40	10YR44	Mik-Liwelu	no	
1708	212-185	50	10YR44	Mik-Liwelu	no	
1709	212-185	60	10YR44	Mik-Liwelu	no	
1710	212-185	70	10YR44	Mik-Liwelu	no	
1711	212-185	80	10YR44	Mik-Liwelu	no	
1712	212-185	90	10YR44	Mik-Liwelu	no	
1713	212-186	10	10YR44	Mik-Liwelu	no	
1714	212-186	20	10YR44	Mik-Liwelu	no	
1715	212-186	30	10YR44	Mik-Liwelu	no	
1716	212-186	40	10YR44	Mik-Liwelu	no	
1718	212-186	50	10YR44	Mik-Liwelu	no	
1719	212-186	60	10YR44	Mik-Liwelu	no	
1720	212-186	70	10YR44	Mik-Liwelu	no	
1721	212-186	80	10YR44	Mik-Liwelu	no	
1722	212-186	90	10YR44	Mik-Liwelu	no	
1723	212-187	10	7.5YR53	Mik-Liwelu	no	
1724	212-187	20	7.5YR53	Mik-Liwelu	no	
1725	212-187	30	7.5YR53	Mik-Liwelu	no	
1726	212-187	40	7.5YR53	Mik-Liwelu	no	
1727	212-187	50	7.5YR53	Mik-Liwelu	no	
1728	212-187	60	7.5YR53	Mik-Liwelu	no	†

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1729	212-187	70	7.5YR53	Mik-Liwelu	no	
1730	212-187	80	7.5YR53	Mik-Liwelu	no	
1731	212-187	90	7.5YR53	Mik-Liwelu	no	
351	207-151	10	10YR63	Mik-Ufukoni Mibeyu	yes	
352	207-151	20	10YR63	Mik-Ufukoni Mibeyu	yes	
353	207-151	30	10YR53	Mik-Ufukoni Mibeyu	yes	
354	207-151	40	10YR53	Mik-Ufukoni Mibeyu	yes	
355	207-151	50	10YR53	Mik-Ufukoni Mibeyu	yes	
356	207-151	60	10YR54	Mik-Ufukoni Mibeyu	yes	
357	207-151	70	10YR54	Mik-Ufukoni Mibeyu	yes	
358	207-151	80	10YR54	Mik-Ufukoni Mibeyu	yes	
359	207-151	90	10YR54	Mik-Ufukoni Mibeyu	yes	
360	207-151	100	10YR54	Mik-Ufukoni Mibeyu	yes	
2/1	207.152	10	7.57/0.57	NOT THE LOCAL		
361	207-152	10	7.5YR56	Mik-Ufukoni Mibeyu	no	
362	207-152	20	7.5YR56	Mik-Ufukoni Mibeyu	no	
363	207-152	30	7.5YR56	Mik-Ufukoni Mibeyu	no	
364	207-152	40	7.5YR56	Mik-Ufukoni Mibeyu	no	
365	207-152	50	7.5YR56	Mik-Ufukoni Mibeyu	no	
366	207-152	60	7.5YR56	Mik-Ufukoni Mibeyu	no	
367	207-153	10	7.5YR52	Mik-Ufukoni Mibeyu	yes	
368	207-153	20	7.5YR52	Mik-Ufukoni Mibeyu	yes	
369	207-153	30	7.5YR52	Mik-Ufukoni Mibeyu	yes	
370	207-153	40	7.5YR52	Mik-Ufukoni Mibeyu	yes	
371	207-153	50	7.5YR56	Mik-Ufukoni Mibeyu	yes	
372	207-153	60	7.5YR56	Mik-Ufukoni Mibeyu	yes	
373	207-153	70	7.5YR56	Mik-Ufukoni Mibeyu	yes	
374	207-154	10	10YR74	Mik-Ufukoni Mibeyu	yes	
375	207-154	20	10YR64	Mik-Ufukoni Mibeyu	yes	
376	207-154	30	10YR64	Mik-Ufukoni Mibeyu	yes	
377	207-154	40	10YR64	Mik-Ufukoni Mibeyu	yes	
378	207-154	50	10YR64	Mik-Ufukoni Mibeyu	yes	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1100	300-190	10		Pemba- Chwaka	yes	
1101	300-190	20		Pemba- Chwaka	yes	
1102	300-190	30		Pemba- Chwaka	yes	
1103	300-190	40		Pemba- Chwaka	yes	
1104	300-190	50		Pemba- Chwaka	yes	
1105	300-190	60		Pemba- Chwaka	yes	
1106	300-190	70	***************************************	Pemba- Chwaka	yes	
1107	300-190	80		Pemba- Chwaka	yes	
1108	300-190	90		Pemba- Chwaka	yes	
1109	300-190	100	***************************************	Pemba- Chwaka	yes	
			***************************************			196
1147	300-195	10	7.5YR72	Pemba-Chwaka	no	
1148	300-195	20	7.5YR72	Pemba-Chwaka	no	
1149	300-195	30	7.5YR52	Pemba-Chwaka	no	•••••
1150	300-195	40	7.5YR52	Pemba-Chwaka	no	
1151	300-195	50	7.5YR52	Pemba-Chwaka	no	
1152	300-195	60	7.5YR52	Pemba-Chwaka	no	
1153	300-195	70	7.5YR52	Pemba-Chwaka	no	
			•••••			139
1154	300-196	10	7.5YR72	Pemba-Chwaka	no	
1155	300-196	20	7.5YR72	Pemba-Chwaka	no	
1156	300-196	30	7.5YR72	Pemba-Chwaka	no	
1157	300-196	40	7.5YR31	Pemba-Chwaka	no	
1158	300-196	50	7.5YR31	Pemba-Chwaka	no	
1159	300-196	60	7.5YR31	Pemba-Chwaka	no	
1160	300-196	70	7.5YR72	Pemba-Chwaka	no	
1161	300-196	80	7.5YR31	Pemba-Chwaka	no	
1162	300-196	90	7.5YR31	Pemba-Chwaka	no	
1163	300-196	100	7.5YR31	Pemba-Chwaka	no	
						184
1164	300-197	10	7.5YR54	Pemba-Chwaka	yes	
1165	300-197	20	7.5YR54	Pemba-Chwaka	yes	
1166	300-197	30	7.5YR54	Pemba-Chwaka	yes	
1167	300-197	40	7.5YR54	Pemba-Chwaka	yes	
1168	300-197	50	7.5YR54	Pemba-Chwaka	yes	
1169	300-197	60	7.5YR54	Pemba-Chwaka	yes	
1170	300-197	70	7.5YR54	Pemba-Chwaka	·	
1170	300-197	80	7.5YR54	Pemba-Chwaka	yes	
		90		Pemba-Chwaka	yes	***************************************
1172	300-197	100	7.5YR66	. 	yes	
1173	300-197	100	7.5YR66	Pemba-Chwaka	yes	201
1174	200 100	10	10VD44	Dombo Chyralia	No.	201
1174	300-198	10	10YR66	Pemba-Chwaka	yes	
1175	300-198	20	10YR66	Pemba-Chwaka	yes	•••••
1176	300-198	30	10YR66	Pemba-Chwaka	yes	
1177	300-198	40	10YR66	Pemba-Chwaka	yes	
1178	300-198	50	GLEY15N	Pemba-Chwaka	yes	
1179	300-198	60 70	GLEY15N	Pemba-Chwaka	yes	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
						110
1181	300-199	10	7.5YR53	Pemba-Chwaka	yes	
1182	300-199	20	7.5YR53	Pemba-Chwaka	yes	
1183	300-199	30	7.5YR53	Pemba-Chwaka	yes	
1184	300-199	40	7.5YR53	Pemba-Chwaka	yes	
1185	300-199	50	7.5YR53	Pemba-Chwaka	yes	
1186	300-199	60	7.5YR53	Pemba-Chwaka	yes	
1187	300-199	70	7.5YR53	Pemba-Chwaka	yes	
1188	300-199	80	7.5YR53	Pemba-Chwaka	yes	
1189	300-199	90	7.5YR53	Pemba-Chwaka	yes	
1190	300-199	100	10YR43	Pemba-Chwaka	yes	
1191	300-199	110	10YR43	Pemba-Chwaka	yes	
						200
1192)2 301-200 10 7.5YR31 Pemba-Chwaka		no			
1193	301-200	20	7.5YR31	Pemba-Chwaka	no	
1194	301-200	30	7.5YR31	Pemba-Chwaka	no	
1195	301-200	40	7.5YR31	Pemba-Chwaka	no	
1196	301-200	50	7.5YR31	Pemba-Chwaka	no	***************************************
1197	301-200	60	7.5YR31	Pemba-Chwaka	no	
1198	301-200	70	7.5YR31	Pemba-Chwaka	no	
1199	301-200	80	7.5YR31	Pemba-Chwaka	no	
1200	301-200	90	7.5YR31	Pemba-Chwaka	no	
						169
1201	301-201	10	7.5YR46	Pemba-Chwaka	no	***************************************
1202	301-201	20	7.5YR46	Pemba-Chwaka	no	
1203	301-201	30	7.5YR31	Pemba-Chwaka	no	••••••
1204	301-201	40	7.5YR31	Pemba-Chwaka	no	••••••
1205	301-201	50	10YR83	Pemba-Chwaka	no	***************************************
						108
1206	301-202	10	7.5YR71	Pemba-Chwaka	yes	
1207	301-202	20	7.5YR71	Pemba-Chwaka	yes	
1208	301-202	30	7.5YR71	Pemba-Chwaka	yes	
1209	301-202	40	7.5YR71	Pemba-Chwaka	yes	
1210	301-202	50	7.5YR71	Pemba-Chwaka	yes	
1211	301-202	60	7.5YR71	Pemba-Chwaka	yes	
1212	301-202	70	7.5YR71	Pemba-Chwaka	yes	***************************************
1213	301-202	80	7.5YR71	Pemba-Chwaka	yes	
1214	301-202	90	7.5YR71	Pemba-Chwaka	yes	
1215	301-202	100	7.5YR71	Pemba-Chwaka	yes	
1213	301-202	100	7.511(1	1 cinoa-Chwaka	yes	201
1216	301-203	10	7.5YR71	Pemba-Chwaka	no	201
1217			no			
	***************************************	30		Pemba-Chwaka		•••••
1218	301-203	·	7.5YR71	·	no	
1219	301-203	40	7.5YR71	Pemba-Chwaka	no	
1220	301-203	50	7.5YR71	Pemba-Chwaka	no	
1221	301-203	60	7.5YR71	Pemba-Chwaka	no	
1222 1223	301-203	70 80	7.5YR71 7.5YR71	Pemba-Chwaka Pemba-Chwaka	no no	•••••

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1224	301-203	90	7.5YR31	Pemba-Chwaka	no	
1225	301-203	100	7.5YR31	Pemba-Chwaka	no	
						190
1226	301-204	10	10YR54	Pemba-Chwaka	no	
1227	301-204	20	10YR54	Pemba-Chwaka	no	
1228	301-204	30	10YR54	Pemba-Chwaka	no	
1229	301-204	40	10YR54	Pemba-Chwaka	no	
1230	301-204	50	10YR54	Pemba-Chwaka	no	
1231	301-204	60	10YR54	Pemba-Chwaka	no	•••••
1232	301-204	70	10YR72	Pemba-Chwaka	no	•••••
1233	301-204	80	10YR72	Pemba-Chwaka	no	***************************************
1234	301-204	90	10YR54	Pemba-Chwaka	no	
1235	301-204	100	10YR54	Pemba-Chwaka	no	
						188
1236	301-205 10 10YR64 Pemba-Chwaka		yes	***************************************		
1237	301-205	20	10YR64	Pemba-Chwaka	yes	
1238	301-205	30	10YR64	Pemba-Chwaka	yes	
1239	301-205	40	10YR64	Pemba-Chwaka	yes	
1240	301-205	50	10YR64	Pemba-Chwaka	yes	
1241	301-205	60	10YR64	Pemba-Chwaka	yes	
1242	301-205	70	10Y52	Pemba-Chwaka	yes	
1243	301-205	80	10YR52	Pemba-Chwaka	yes	***************************************
1244	301-205	90	10YR52	Pemba-Chwaka	yes	
1245	301-205	100	10YR52	Pemba-Chwaka	yes	
1243	301-203	100	101102	1 Ciliba-Cilwaka	yes	193
1246	301-206	10		Pemba-Chwaka	no	
1247	301-206	20		Pemba-Chwaka	no	•••••
1248	301-206	30		Pemba-Chwaka	no	
1249	301-206	40		Pemba-Chwaka	no	
1250	301-206	50		Pemba-Chwaka	no	***************************************
1250	301-206	60		Pemba-Chwaka	<u> </u>	***************************************
1251	301-206	70		Pemba-Chwaka	no	
1253	301-206	80		· 	no	
1253	301-206	00		Pemba-Chwaka	no	
1254		100		Pemba-Chwaka	по	
1255	301-206	100		Pemba-Chwaka	no	107
1257	201 207	10		D = 1 - Cl = 1		197
1256	301-207	10		Pemba-Chwaka	no	
1257	301-207	20		Pemba-Chwaka	no	***************************************
1258	301-207	30		Pemba-Chwaka	no	
1259	301-207	40		Pemba-Chwaka	no	
1260	301-207	50		Pemba-Chwaka	no	
1261	301-207	60		Pemba-Chwaka	no	
1262	301-207	70		Pemba-Chwaka	no	
1263	301-207	80		Pemba-Chwaka	no	
1264	301-207	90		Pemba-Chwaka	no	
1265	301-207	100		Pemba-Chwaka	no	
						180
1266	301-208	10	7.5YR68	Pemba-Chwaka	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1267	301-208	20	7.5YR68	Pemba-Chwaka	no	
1268	301-208	30	7.5YR68	Pemba-Chwaka	no	
1269	301-208	40	7.5YR68	Pemba-Chwaka	no	
1270	301-208	50	7.5YR68	Pemba-Chwaka	no	
1271	301-208	60	5YR68	Pemba-Chwaka	no	
1272	301-208	70	5YR68	Pemba-Chwaka	no	
1273	301-208	80	5YR68	Pemba-Chwaka	no	
1274	301-208	90	5YR68	Pemba-Chwaka	no	
1275	301-208	100	5YR68	Pemba-Chwaka	no	
						165
1275	301-209	10	7.5YR31	Pemba-Chwaka	no	
1276	301-209	20	7.5YR58	Pemba-Chwaka	no	
1277	301-209	30	7.5YR58	Pemba-Chwaka	no	
1278	301-209	40	7.5YR58	Pemba-Chwaka	no	
1279	301-209	50	7.5YR58	Pemba-Chwaka	no	
1280	301-209	60	7.5YR58	Pemba-Chwaka	no	
1281	301-209	70	7.5YR31	Pemba-Chwaka	no	
1282	301-209	80	7.5YR31	Pemba-Chwaka	no	
1283	301-209	90	7.5YR31	Pemba-Chwaka	no	
1284	301-209	100	7.5YR31	Pemba-Chwaka	no	
						192
1285	301-210	10	10YR31	Pemba-Chwaka	yes	
1286	301-210	20	10YR31	Pemba-Chwaka	yes	
1287	301-210	30	10YR31	Pemba-Chwaka	yes	
1288	301-210	40	10YR31	Pemba-Chwaka	yes	
1289	301-210	50	10YR31	Pemba-Chwaka	yes	
1207	301-210	30		1 ciliba-cilwaka	yes	95
1291	301-211	10	10YR63	Pemba-Chwaka	VAC	73
1291	301-211	20	101 R63	Pemba-Chwaka	yes	
1292	301-211	30	10 T R 63	Pemba-Chwaka	yes	
1293	301-211	 	101 R63	Pemba-Chwaka	yes	
1294		40		· 	yes	
	301-211	50	10YR63	Pemba-Chwaka	yes	
1296	301-211	60	10YR42	Pemba-Chwaka	yes	
1297	301-211	/0	10YR42	Pemba-Chwaka	yes	
1298	301-211	80	10YR42	Pemba-Chwaka	yes	
1299	301-211	90	10YR42	Pemba-Chwaka	yes	
1300	301-211	100	10YR63	Pemba-Chwaka	yes	
1301	301-211	110	10YR63	Pemba-Chwaka	yes	
1302	301-211	120	10YR63	Pemba-Chwaka	yes	
						223
1303	301-212	10	10YR42	Pemba-Chwaka	yes	
1304	301-212	20	10YR42	Pemba-Chwaka	yes	
1305	301-212	30	10YR42	Pemba-Chwaka	yes	
1306	301-212	40	10YR63	Pemba-Chwaka	yes	
1307	301-212	50	10YR63	Pemba-Chwaka	yes	
1308	301-212	60	10YR63	Pemba-Chwaka	yes	
1309	301-212	70	10YR63	Pemba-Chwaka	yes	
1310	301-212	80	10YR63	Pemba-Chwaka	yes	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1311	301-212	90	10YR63	Pemba-Chwaka	yes	
1312	301-212	100	10YR63	Pemba-Chwaka	yes	
						195
1313	301-213	10	10YR53	Pemba-Chwaka	no	
1314	301-213	20	10YR53	Pemba-Chwaka	no	
1315	301-213	30	10YR31	Pemba-Chwaka	no	
1316	301-213	40	10YR31	Pemba-Chwaka	no	
1317	301-213	50	10YR31	Pemba-Chwaka	no	
1318	301-213	60	10YR53	Pemba-Chwaka	no	
1319	301-213	70	10YR53	Pemba-Chwaka	no	
1320	301-213	80	10YR53	Pemba-Chwaka	no	
1321	301-213	90	10YR53	Pemba-Chwaka	no	
1322	301-213	100	10YR53	Pemba-Chwaka	no	
				185		
1343	302-216	10	7.5YR62	Pemba-Chwaka	yes	
1344	302-216	20	7.5YR62	Pemba-Chwaka	yes	
1345	302-216	30	7.5YR31	Pemba-Chwaka	yes	
1346	302-216	40	7.5YR31	Pemba-Chwaka	yes	
1347	302-216	50	7.5YR31	Pemba-Chwaka	yes	
1348	302-216	60	7.5YR31	Pemba-Chwaka	yes	
1349	302-216	70	7.5YR31	Pemba-Chwaka	yes	
1350	302-216	80	7.5YR31	Pemba-Chwaka	yes	
1351	302-216	90	10YR72	Pemba-Chwaka	yes	
1352	302-216	100	10YR72	Pemba-Chwaka	}	
1332	302-210	100	101 K/2	r eniba-chwaka	yes	188
1353	302-217	10	10YR68	Pemba-Chwaka	no	100
				. 	no	
1354	302-217	20	10YR68	Pemba-Chwaka	no	
1355	302-217	30	10YR68	Pemba-Chwaka	no	
1356	302-217	40	10YR41	Pemba-Chwaka	no	02
1250	202.210	10	7.5VD.50	P 1 C 1		83
1359	302-218	10	7.5YR52	Pemba-Chwaka	no	
1360	302-218	20	7.5YR52	Pemba-Chwaka	no	
1361	302-218	30	7.5YR52	Pemba-Chwaka	no	
1362	302-218	40	7.5YR52	Pemba-Chwaka	no	
1263	302-218	50	7.5YR71	Pemba-Chwaka	no	
1364	302-218	60	7.5YR71	Pemba-Chwaka	no	
1365	302-218	70	7.5YR52	Pemba-Chwaka	no	
1366	302-218	80	7.5YR52	Pemba-Chwaka	no	
1367	302-218	90	7.5YR52	Pemba-Chwaka	no	
				158		
1368	302-219	10	10YR63	Pemba-Chwaka	no	
1369	302-219	20	10YR63	Pemba-Chwaka	no	
1370	302-219	30	10YR63	Pemba-Chwaka	no	
1371	302-219	40	10YR63	Pemba-Chwaka	no	
1372	302-219	50	10YR63	Pemba-Chwaka	no	
1373	302-219	60	10YR63	Pemba-Chwaka	no	
1374	302-219	70	10YR63	Pemba-Chwaka	no	
1375	302-219	80	10YR63	Pemba-Chwaka	no	

302-219 302-219 302-220 302-220 302-220 302-220 302-220 302-220	90 100 10 20 30 40	10YR63 10YR63 10YR42 10YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	no no	185
302-220 302-220 302-220 302-220 302-220	10 20 30	10YR42 10YR42	Pemba-Chwaka	no	185
302-220 302-220 302-220 302-220	20 30	10YR42			185
302-220 302-220 302-220 302-220	20 30	10YR42			
302-220 302-220 302-220 302-220	30				
302-220 302-220	- 		Pemba-Chwaka	no	
302-220	40	10YR42	Pemba-Chwaka	no	
	40 10YR76 Pemba-Chwaka no		Pemba-Chwaka	no	
302-220	50	10YR76	Pemba-Chwaka	no	
	60	10YR76	Pemba-Chwaka	no	
302-220	70	10YR76	Pemba-Chwaka	no	
302-220	80	10YR76	Pemba-Chwaka	no	
302-220	90	10YR76	Pemba-Chwaka	no	
					174
302-221	10	7 5YR 52	Pemba-Chwaka	no	
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				<u> </u>	
	-		Pemba-Chwaka	no	
302-221	100	7.5YR71	Pemba-Chwaka	no	
					193
302-222	10	10YR66	Pemba-Chwaka	no	
302-222	20	10YR66	Pemba-Chwaka	no	
302-222	30	10YR66	Pemba-Chwaka	no	
302-222	40	10YR53	Pemba-Chwaka	no	
302-222	50	10YR53	Pemba-Chwaka	no	
302-222	60	10YR53	Pemba-Chwaka	no	
302-222	80	10YR66	Pemba-Chwaka	no	
					137
302-223	10	10YR53	Pemba-Chwaka	no	
302-223	20	10YR53	Pemba-Chwaka	no	
302-223	30	10YR53	Pemba-Chwaka	no	
302-223	40	10YR31	Pemba-Chwaka	no	
302-223	·		Pemba-Chwaka	 	
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332 225 100 101 ROT 1 CHIDU-CHWARA IIO		no	190		
202.224	10	7.53/0.50	Dow't - Ch 1		189
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	·			no	
	·		·	no	
302-224	40	7.5YR31	Pemba-Chwaka	no	
	302-221 302-221 302-221 302-221 302-222 302-222 302-222 302-222 302-222 302-222 302-222 302-222 302-223 302-223	302-221 20 302-221 30 302-221 40 302-221 50 302-221 60 302-221 80 302-221 80 302-221 90 302-221 100 302-222 20 302-222 20 302-222 30 302-222 50 302-222 50 302-222 80 302-223 10 302-223 20 302-223 20 302-223 30 302-223 50 302-223 50 302-223 70 302-223 90 302-223 90 302-223 100 302-224 20 302-224 20 302-224 20 302-224 40	302-221 20 7.5YR52 302-221 30 7.5YR52 302-221 40 7.5YR52 302-221 50 7.5YR41 302-221 60 7.5YR41 302-221 80 7.5YR41 302-221 80 7.5YR71 302-221 90 7.5YR71 302-222 10 10YR66 302-222 20 10YR66 302-222 30 10YR66 302-222 40 10YR53 302-222 50 10YR53 302-222 80 10YR66 302-223 10 10YR53 302-223 20 10YR53 302-223 20 10YR53 302-223 40 10YR53 302-223 50 10YR53 302-223 50 10YR31 302-223 50 10YR31 302-223 50 10YR62 302-223 90 10YR81	302-221 20 7.5YR52 Pemba-Chwaka 302-221 40 7.5YR52 Pemba-Chwaka 302-221 50 7.5YR41 Pemba-Chwaka 302-221 60 7.5YR41 Pemba-Chwaka 302-221 70 7.5YR41 Pemba-Chwaka 302-221 80 7.5YR41 Pemba-Chwaka 302-221 80 7.5YR41 Pemba-Chwaka 302-221 90 7.5YR71 Pemba-Chwaka 302-221 100 7.5YR71 Pemba-Chwaka 302-221 100 7.5YR71 Pemba-Chwaka 302-222 20 10YR66 Pemba-Chwaka 302-222 20 10YR66 Pemba-Chwaka 302-222 30 10YR66 Pemba-Chwaka 302-222 40 10YR53 Pemba-Chwaka 302-222 50 10YR53 Pemba-Chwaka 302-222 80 10YR66 Pemba-Chwaka 302-222 80 10YR66 Pemba-Chwaka 302-223 20 10YR53 Pemba-Chwaka 302-223 20 10YR53 Pemba-Chwaka 302-223 30 10YR53 Pemba-Chwaka 302-223 50 10YR51 Pemba-Chwaka 302-223 50 10YR62 Pemba-Chwaka 302-223 80 10YR62 Pemba-Chwaka 302-223 90 10YR81 Pemba-Chwaka 302-223 90 10YR81 Pemba-Chwaka 302-224 20 7.5YR52 Pemba-Chwaka 302-224 20 7.5YR52 Pemba-Chwaka 302-224 20 7.5YR52 Pemba-Chwaka 302-224 30 7.5YR52 Pemba-Chwaka 302-224 20 7.5YR52 Pemba-Chwaka 302-224 20 7.5YR52 Pemba-Chwaka 302-224 30 7.5YR51 P	302-221 20 7.5YR52 Pemba-Chwaka no 302-221 30 7.5YR52 Pemba-Chwaka no 302-221 40 7.5YR52 Pemba-Chwaka no 302-221 50 7.5YR41 Pemba-Chwaka no 302-221 60 7.5YR41 Pemba-Chwaka no 302-221 70 7.5YR41 Pemba-Chwaka no 302-221 80 7.5YR41 Pemba-Chwaka no 302-221 90 7.5YR71 Pemba-Chwaka no 302-221 100 7.5YR71 Pemba-Chwaka no 302-222 10 10YR66 Pemba-Chwaka no 302-222 20 10YR66 Pemba-Chwaka no 302-222 30 10YR66 Pemba-Chwaka no 302-222 40 10YR53 Pemba-Chwaka no 302-222 50 10YR53 Pemba-Chwaka no 302-223 10 10YR66 Pemba-Chwaka

302-224 302-224 302-224 302-224 302-224 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225	60 70 80 90 100 10 20 30 40 50 60 70 80	7.5YR31 7.5YR31 7.5YR31 7.5YR72 7.5YR72 7.5YR72 7.5YR51 7.5YR51 7.5YR51 7.5YR42 7.5YR42 7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka	no no no no no yes yes yes yes yes yes	198
302-224 302-224 302-224 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225	80 90 100 10 20 30 40 50 60 70 80	7.5YR31 7.5YR72 7.5YR72 7.5YR51 7.5YR51 7.5YR51 7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	no no yes yes yes yes yes yes yes yes	198
302-224 302-224 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225	90 100 10 20 30 40 50 60 70	7.5YR72 7.5YR72 7.5YR51 7.5YR51 7.5YR51 7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	no no yes yes yes yes yes yes yes	198
302-224 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225	100 10 20 30 40 50 60 70 80	7.5YR72 7.5YR72 7.5YR51 7.5YR51 7.5YR51 7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	yes yes yes yes yes yes yes	198
303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225	10 20 30 40 50 60 70	7.5YR51 7.5YR51 7.5YR51 7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	yes yes yes yes yes yes	198
303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225	20 30 40 50 60 70 80	7.5YR51 7.5YR51 7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	yes yes yes yes yes	198
303-225 303-225 303-225 303-225 303-225 303-225 303-225 303-225	20 30 40 50 60 70 80	7.5YR51 7.5YR51 7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	yes yes yes yes yes	
303-225 303-225 303-225 303-225 303-225 303-225 303-225	30 40 50 60 70 80	7.5YR51 7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	yes yes yes yes	
303-225 303-225 303-225 303-225 303-225 303-225	40 50 60 70 80	7.5YR42 7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka Pemba-Chwaka	yes yes yes	
303-225 303-225 303-225 303-225 303-225	50 60 70 80	7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka	yes yes	
303-225 303-225 303-225 303-225 303-225	60 70 80	7.5YR42 7.5YR42 7.5YR42	Pemba-Chwaka Pemba-Chwaka	yes	
303-225 303-225 303-225	70 80	7.5YR42		}	
303-225 303-225	80			Voc	
303-225		7.5YR42		yes	
	00		Pemba-Chwaka	yes	······
303-225	90	7.5YR61	Pemba-Chwaka	yes	
	100	7.5YR61	Pemba-Chwaka	yes	
					197
303-226	10	10YR52	Pemba-Chwaka	ves	
303-226		10YR52	Pemba-Chwaka	<u> </u>	
	·			}	
			-	}	
				†	
	·		·}	†	
	·				
			-	}	
303-220	00	1011070	1 cmoa-cmwaka	yes	154
202 227	10	7 5VD21	Damba Chwaka	no	
	·		·	}	
				}	
				}	
			·}	<u> </u>	
	·		· 	}	
				}	
			· } ·····	no	
	·			no	
	·	7.5YR31	Pemba-Chwaka	no	
	·		÷	no	
	· ·····		Pemba-Chwaka	no	
303-227	120	7.5YR31	Pemba-Chwaka	no	
					224
303-228	10	7.5YR31	Pemba-Chwaka	yes	
303-228	20	7.5YR31	Pemba-Chwaka	yes	
303-228	50	7.5YR31	Pemba-Chwaka	yes	
303-228	60	7.5YR31	Pemba-Chwaka	yes	
303-228	70	7.5YR31	Pemba-Chwaka	yes	
303-228	80	7.5YR31	Pemba-Chwaka	yes	
303-228	90	7.5YR31	Pemba-Chwaka	yes	
					143
	303-226 303-226 303-226 303-226 303-226 303-226 303-226 303-226 303-227 303-227 303-227 303-227 303-227 303-227 303-227 303-227 303-227 303-227 303-227 303-228 303-228 303-228 303-228 303-228	303-226 10 303-226 20 303-226 30 303-226 40 303-226 50 303-226 60 303-226 70 303-226 80 303-227 10 303-227 20 303-227 20 303-227 50 303-227 50 303-227 60 303-227 70 303-227 80 303-227 90 303-227 100 303-227 110 303-227 120 303-228 10 303-228 20 303-228 50 303-228 70 303-228 80 303-228 90	303-226 10 10YR52 303-226 20 10YR52 303-226 30 10YR32 303-226 40 10YR32 303-226 50 10YR76 303-226 60 10YR76 303-226 70 10YR76 303-227 10 7.5YR31 303-227 20 7.5YR31 303-227 20 7.5YR31 303-227 40 7.5YR31 303-227 50 7.5YR31 303-227 60 7.5YR31 303-227 70 7.5YR31 303-227 80 7.5YR31 303-227 90 7.5YR31 303-227 100 7.5YR31 303-227 110 7.5YR31 303-228 10 7.5YR31 303-228 20 7.5YR31 303-228 50 7.5YR31 303-228 60 7.5YR31 303-228 60 7.5YR31	303-226 10 10YR52 Pemba-Chwaka 303-226 20 10YR52 Pemba-Chwaka 303-226 30 10YR32 Pemba-Chwaka 303-226 40 10YR32 Pemba-Chwaka 303-226 50 10YR76 Pemba-Chwaka 303-226 70 10YR76 Pemba-Chwaka 303-226 80 10YR76 Pemba-Chwaka 303-227 10 7.5YR31 Pemba-Chwaka 303-227 20 7.5YR31 Pemba-Chwaka 303-227 30 7.5YR31 Pemba-Chwaka 303-227 40 7.5YR31 Pemba-Chwaka 303-227 50 7.5YR31 Pemba-Chwaka 303-227 60 7.5YR31 Pemba-Chwaka 303-227 70 7.5YR31 Pemba-Chwaka 303-227 80 7.5YR31 Pemba-Chwaka 303-227 100 7.5YR31 Pemba-Chwaka 303-227 100 7.5YR31 Pemba-Chwaka 303-2	303-226 10 10YR52 Pemba-Chwaka yes 303-226 20 10YR52 Pemba-Chwaka yes 303-226 30 10YR32 Pemba-Chwaka yes 303-226 40 10YR32 Pemba-Chwaka yes 303-226 50 10YR76 Pemba-Chwaka yes 303-226 60 10YR76 Pemba-Chwaka yes 303-226 70 10YR76 Pemba-Chwaka yes 303-226 80 10YR76 Pemba-Chwaka yes 303-227 10 7.5YR31 Pemba-Chwaka no 303-227 20 7.5YR31 Pemba-Chwaka no 303-227 30 7.5YR31 Pemba-Chwaka no 303-227 50 7.5YR31 Pemba-Chwaka no 303-227 60 7.5YR31 Pemba-Chwaka no 303-227 70 7.5YR31 Pemba-Chwaka no 303-227 90 7.5YR31 Pemba-C

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1479	304-331	20	10YR42	Pemba-Chwaka	no	
1480	304-331	30	10YR42	Pemba-Chwaka	no	•••••
1481	304-331	40	10YR42	Pemba-Chwaka	no	
1482	304-331	50	10YR42	Pemba-Chwaka	no	••••••
1483	304-331	60	10YR42	Pemba-Chwaka	no	
1485	304-331	80	10YR42	Pemba-Chwaka	no	
1486	304-331	90	10YR82 Pemba-Chwaka no		no	
1487	304-331	100	10YR82 Pemba-Chwaka no		no	
						166
1488	304-332	10	10YR42	Pemba-Chwaka	yes	
1489	304-332	20	10YR42	Pemba-Chwaka	yes	
1490	304-332	30	10YR42	Pemba-Chwaka	yes	
1491	304-332	40	10YR42	Pemba-Chwaka	yes	
1492	304-332	50	10YR68	Pemba-Chwaka	yes	•••••
1493	304-332	60	10YR68	Pemba-Chwaka	yes	
1494	304-332	70	10YR68	Pemba-Chwaka	yes	
1495	304-332	80	10YR68	Pemba-Chwaka	yes	
1496	304-332	90	10YR68	Pemba-Chwaka	yes	
1497	304-332	100	10YR71	Pemba-Chwaka	yes	
		100		Tomou Chivana	,,,,,	197
1498	304-233	10	GLEY13N	Pemba-Chwaka	no	
1499	304-233	20	GLEY13N	Pemba-Chwaka	no	
1500	304-233	30	GLEY13N	Pemba-Chwaka	no	
1501	304-233	40	GLEY15N	Pemba-Chwaka	}	
1502	304-233	50	GLET15N GLEY15N	Pemba-Chwaka	no	
1502	304-233	60	GLET 15N GLEY15N	Pemba-Chwaka	no	
				}	no	
1504	304-233	70	GLEV15N	Pemba-Chwaka	no	
1505	304-233	80	GLEV15N	Pemba-Chwaka	no	
1506	304-233	90	GLEY17N	Pemba-Chwaka	no	
1507	304-233	100	GLEY17N	Pemba-Chwaka	no	
1500	201.201	- 60		5 1 61 1		187
1508	304-234	60	7.5YR41	Pemba-Chwaka	no	
1509	304-234	10	7.5YR71	Pemba-Chwaka	no	
1510	304-234	20	7.5YR71	Pemba-Chwaka	no	
1511	304-234	30	7.5YR41	Pemba-Chwaka	no	
1512	304-234	40	7.5YR41	Pemba-Chwaka	no	
1513	304-234	50	7.5YR41	Pemba-Chwaka	no	
						118
1514	304-235	10	GLEY1510Y	Pemba-Chwaka	no	
1515	304-235	20) GLEY1510Y Pemba-Chwaka no		no	
1516	304-235	30	GLEY18N	Pemba-Chwaka	no	
1517	304-235	40	GLEY18N	Pemba-Chwaka	no	
1518	304-235	50	GLEY18N	Pemba-Chwaka	no	
						98
1519	304-236 10 GLEY13N Pemba-Chwaka no		no			
1520	304-236	20	GLEY18N	Pemba-Chwaka	no	
1521	304-236	30	GLEY18N	Pemba-Chwaka	no	
1522	304-236	40	GLEY18N	Pemba-Chwaka	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1523	304-236	50	GLEY18N	Pemba-Chwaka	no	
						103
1524	304-237	10	7.5YR42	Pemba-Chwaka	no	
1525	304-237	20	7.5YR42	Pemba-Chwaka	no	
1526	304-237	30	7.5YR42	Pemba-Chwaka	no	
1527	304-237	40	7.5YR42	Pemba-Chwaka	no	
1528	304-237	50	7.5YR42	Pemba-Chwaka	no	
1529	304-237	60	7.5YR42	Pemba-Chwaka	no	
1530	304-237	70	7.5YR42	Pemba-Chwaka	no	
1531	304-237	80	7.5YR78	Pemba-Chwaka	no	
1532	304-237	90	7.5YR78	Pemba-Chwaka	no	
1533	304-237	100	7.5YR78	Pemba-Chwaka	no	
						188
1534	304-238	10	7.5YR52	Pemba-Chwaka	no	
1535	304-238	20	7.5YR52	Pemba-Chwaka	no	
1536	304-238	30	7.5YR52	Pemba-Chwaka	no	
1537	304-238	40	7.5YR52	Pemba-Chwaka	no	
1538	304-238	50	7.5YR52	Pemba-Chwaka	no	
1539	304-238	60	7.5YR68	Pemba-Chwaka	no	
1540	304-238	70	7.5YR68	Pemba-Chwaka	no	
1540	304-238	80	7.5YR68	Pemba-Chwaka	no	
1542	304-238	90	7.5YR68	Pemba-Chwaka	no	
1543	304-238	100		÷	,	
1343	304-236	100	7.5YR68	Pemba-Chwaka	no	107
1545	204 220	10	10YR62	Damba Chyvalra	200	197
1545	304-239	10		Pemba-Chwaka	no	
1546	304-239	20	10YR62	Pemba-Chwaka	no	
1547	304-239	30	10YR42	Pemba-Chwaka	no	
1548	304-239	40	10YR42	Pemba-Chwaka	no	
1549	304-239	50	10YR42	Pemba-Chwaka	no	
1550	304-239	60	10YR42	Pemba-Chwaka	no	
1551	304-239	70	10YR42	Pemba-Chwaka	no	
1552	304-239	80	10YR42	Pemba-Chwaka	no	
1553	304-239	90	10YR53	Pemba-Chwaka	no	
1554	304-239	100	10YR53	Pemba-Chwaka	no	
						203
1555	304-240	10	10YR52	Pemba-Chwaka	no	
1556	304-240	20	10YR52	Pemba-Chwaka	no	
1557	304-240	30	10YR52	Pemba-Chwaka	no	
1558	304-240	40	10YR52	Pemba-Chwaka	no	
1559	304-240	50	10YR52	Pemba-Chwaka	no	
1560	304-240	60	10YR62	Pemba-Chwaka	no	
1561	304-240	70	10YR62	Pemba-Chwaka	no	
1562	304-240	80	10YR62	Pemba-Chwaka	no	
1563	304-240	240 90 10YR62 Pemba-Chwaka no		no		
1564	304-240	100 10YR62 Pemba-Chwaka no		no		
						192
1565	304-241	10	7.5YR52	Pemba-Chwaka	no	
1566	304-241	20	7.5YR52	Pemba-Chwaka	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1567	304-241	30	7.5YR68	Pemba-Chwaka	no	
1568	304-241	40	7.5YR68	Pemba-Chwaka	no	
1569	304-241	50	7.5YR68	Pemba-Chwaka	no	
1570	304-241	60	7.5YR68	Pemba-Chwaka	no	
						117
1571	304-242	10	7.5YR53	Pemba-Chwaka	no	***************************************
1572	304-242	20	7.5YR53	Pemba-Chwaka	no	***************************************
1573	304-242	30	7.5YR53	Pemba-Chwaka	no	***************************************
1574	304-242	40	7.5YR53	Pemba-Chwaka	no	
1575	304-242	50	7.5YR53	Pemba-Chwaka	no	
1576	304-242	60	7.5YR53	Pemba-Chwaka	no	
1577	304-242	70	7.5YR53	Pemba-Chwaka	no	
1578	304-242	80	7.5YR63	Pemba-Chwaka	no	
1579	304-242	90	7.5YR63	Pemba-Chwaka	no	
1580	304-242	100	7.5YR63	Pemba-Chwaka	no	
						191
1581	304-243	10	10YR51	Pemba-Chwaka	no	
1582	304-243	20	10YR68	Pemba-Chwaka	no	***************************************
1583	304-243	30	10YR68	Pemba-Chwaka	no	
1584	304-243	40	10YR68	Pemba-Chwaka	no	
1585	304-243	50	10YR68	Pemba-Chwaka	no	
1586	304-243	60	10YR68	Pemba-Chwaka	no	
1300		- 00		1 cmoa-chwaka	no	119
1587	304-244	10	10YR53	Pemba-Chwaka	no.	119
1588	304-244	20	101 K53	Pemba-Chwaka	no	
					no	
1589	304-244	30	10YR53	Pemba-Chwaka	no	***************************************
1590	304-244	40	10YR53	Pemba-Chwaka	no	
1591	304-244	50	10YR53	Pemba-Chwaka	no	
1592	304-244	60	10YR53	Pemba-Chwaka	no	
1593	304-244	70	10YR66	Pemba-Chwaka	no	
1594	304-244	80	10YR66	Pemba-Chwaka	no	
1595	304-244	90	10YR66	Pemba-Chwaka	no	
						174
1596	305-245	10	10YR52	Pemba-Chwaka	no	
1597	305-245	20	10YR52	Pemba-Chwaka	no	
1598	305-245	30	10YR52	Pemba-Chwaka	no	
1599	305-245	40	10YR52	Pemba-Chwaka	no	
1600	305-245	50	10YR52	Pemba-Chwaka	no	
1601	305-245	60	10YR52	Pemba-Chwaka	no	
1602	305-245	70	10YR52	Pemba-Chwaka	no	
1603	305-245	80	10YR52	Pemba-Chwaka	no	
1604	305-245	90	10YR72	Pemba-Chwaka	no	
1605	305-245	100	10YR72	Pemba-Chwaka	no	
						189
1606	305-246	10	10YR62	Pemba-Chwaka	no	***************************************
1607	305-246	20	10YR62	Pemba-Chwaka	no	
1608	305-246	30	10YR62	Pemba-Chwaka	no	
1609	305-246	40	10YR62	Pemba-Chwaka	no	

hytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g
1610	305-246	50	10YR62	Pemba-Chwaka	no	
1611	305-246	60	10YR66	Pemba-Chwaka	no	
1612	305-246	70	10YR66	Pemba-Chwaka	no	
1613	305-246	80	10YR66	Pemba-Chwaka	no	
1614	305-246	90	10YR66	Pemba-Chwaka	no	
1615	305-246	100	10YR66	Pemba-Chwaka	no	
						200
1616	305-247	10	7.5YR31	Pemba-Chwaka	no	
1617	305-247	20	7.5YR31	Pemba-Chwaka	no	
1618	305-247	30	7.5YR31	Pemba-Chwaka	no	
1619	305-247	40	7.5YR72	Pemba-Chwaka	no	
1620	305-247	50	7.5YR72	Pemba-Chwaka	no	
1621	305-247	15-247 60 7.5YR72 Pemba-Chwaka no				
1622	305-247	70	7.5YR72	Pemba-Chwaka	no	
1623	305-247	80	7.5YR72	Pemba-Chwaka	no	
1624	305-247	90	7.5YR72	Pemba-Chwaka	no	
1625	305-247	100	7.5YR72	Pemba-Chwaka	no	
						189
1626	305-248	10	10YR51	Pemba-Chwaka	no	
1627	305-248	20	10YR51	Pemba-Chwaka	no	
1628	305-248	30	10YR51	Pemba-Chwaka	no	
1629	305-248	40	10YR51	Pemba-Chwaka	no	
1630	305-248	50	10YR63	Pemba-Chwaka	no	
1631	305-248	60	10YR63	Pemba-Chwaka	no	
1632	305-248	70	10YR63	Pemba-Chwaka	no	
1633	305-248	80	10YR63	Pemba-Chwaka	no	
1634	305-248	90	10YR63	Pemba-Chwaka	no	
1635	305-248	100	10YR63	Pemba-Chwaka	no	
1033	303-240	100	101103	1 cmoa-chwaka	110	189
1636	305-249	10	7.5YR53	Pemba-Chwaka	no	107
1637	305-249	20	7.5YR53	Pemba-Chwaka	<u> </u>	
1638	305-249	30	7.5YR53	Pemba-Chwaka	no	
1639	305-249	40	7.5YR53	Pemba-Chwaka	no	
1640	305-249	50		Pemba-Chwaka	no	
·····	305-249	·	7.5YR31		no	
1641	305-249	60	7.5YR31	Pemba-Chwaka	no	
1642		70	7.5YR31	Pemba-Chwaka	no	
1643	305-249	80	7.5YR31	Pemba-Chwaka	no	
1644	305-249	90	7.5YR31	Pemba-Chwaka	no	
1645	305-249	100	7.5YR31	Pemba-Chwaka	no	106
1646	205.250	1	10370.72	D. d. Cl. d		186
1646	305-250	10	10YR52	Pemba-Chwaka	no	
1647	305-250	20	10YR52	Pemba-Chwaka	no	
1648	305-250 30 10YR52 Pemba-Chwaka no					
1649	305-250					
1650	305-250	50	10YR56	Pemba-Chwaka	no	
1651	305-250	60	10RY56	Pemba-Chwaka	no	
1652	305-250	70	10YR65	Pemba-Chwaka	no	

Phytolith Sample	Transect and STP	Depth (cm)	Context	Region	CM (yes or no)	Weight (g)
1653	305-251	10	10YR71	Pemba-Chwaka	no	
1654	305-251	20	10YR52	Pemba-Chwaka	no	
1655	305-251	30	10YR52	Pemba-Chwaka	no	
1656	305-251	40	10YR52	Pemba-Chwaka	no	
1657	305-251	50	10YR52	Pemba-Chwaka	no	
1658	305-251	60	10YR81	Pemba-Chwaka	no	
1659	305-251	70	10YR81	Pemba-Chwaka	no	
1660a	305-251	80	10YR81	Pemba-Chwaka	no	
1661a	305-251	90	10YR81	Pemba-Chwaka	no	
1662a	305-251	100	10YR81	Pemba-Chwaka	no	
			***************************************			187
1660b	305-252	10	10YR52	Pemba-Chwaka	no	
1661b	305-252	20	10YR52	Pemba-Chwaka	no	
1662b	305-252	30	10YR52	Pemba-Chwaka	no	
1663	305-252	40	10YR52	Pemba-Chwaka	no	
1664	305-252	50	10YR52	Pemba-Chwaka	no	
1665	305-252	60	10YR52	Pemba-Chwaka	no	•••••
1666	305-252	70	10YR52	Pemba-Chwaka	no	•••••
1667	305-252	80	10YR66	Pemba-Chwaka	no	
1668	305-252	90	10YR66	Pemba-Chwaka	no	
1669	305-252	100	10YR66	Pemba-Chwaka	no	
1670	305-252	110	10YR66	Pemba-Chwaka	no	
1671	305-252	120	10YR66	Pemba-Chwaka	no	
			•••••			234
1672	305-253	10	10YR62	Pemba-Chwaka	no	
1673	305-253	20	10YR62	Pemba-Chwaka	no	
1674	305-253	30	10YR62	Pemba-Chwaka	no	
1675	305-253	40	10YR71	Pemba-Chwaka	no	
1676	305-253	50	10YR71	Pemba-Chwaka	no	
1677	305-253	60	10YR71	Pemba-Chwaka	no	••••••
1678	305-253	70	10YR71	Pemba-Chwaka	no	
1679	305-253	80	10YR71	Pemba-Chwaka	no	
1680	305-253	90	10YR71	Pemba-Chwaka	no	***************************************
1681	305-253	100	10YR31	Pemba-Chwaka	no	
		1	***************************************	†		195

Appendix Four

Shovel Test Pit Log

Transect	STP	Easting	Southing	Cultura IMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
100	10	0560425	9000550	no	GLEY285 BP	2.5YR36	7.5YR34	7.5YR34	7.5YR34	rag	rag	rag	rag	rag	rag	rag	10m from ocean; open grass; lime pit.
100	11	0560675	9000550	no	7.5YR33	7.5YR33	7.5YR44	7.5YR44	7.5YR44	7.5YR44	7.5YR44	7.5YR44	rag	rag	rag	rag	Dense scrub w/ rag outcrop.
100	12	0560925	9000550	yes (ceramic @ 5cm continues)	7.5YR33	10YR36	10YR36	10YR36	rag	rag	rag	rag	rag	rag	rag	rag	Immediately outside sorghum plot.
100	13	0561175	9000550	no	7.5YR33	7.5YR44	7.5YR44	rag	rag	rag	rag	rag	rag	rag	rag	rag	Open btwn sorghum & scrub.
100	14	0561425	9000550	no	7.5YR34	7.5YR43	5YR46	5YR46	5YR46	5YR46	5YR46	rag	rag	rag	rag	rag	Open field punctuated by small trees; wait high grass.
100	15	0561675	9000550	no	7.5YR33	7.5YR33	7.5YR33	7.5YR33	rag	rag	rag	rag	rag	rag	rag	rag	Pasture btwn scrub.
100	16	0561925	9000550	no	GLEY155 GY	7.5YR33	7.5YR33	rag	rag	rag	rag	rag	rag	rag	rag	rag	Edge of sorghum field.
100	17	0562175	9000550	yes (ceramics and daub in top 5cm, marine shell after 50cm)	7.5YR44	7.5YR44	7.5YR44	7.5YR44	7.5YR44	5YR46	5YR46	rag	rag	rag	rag	rag	Dense scrub immediately beneath large tree.
100	18	0562425	9000550	yes (ceramic @5cm and 20- 25cm)	7.5YR44	7.5YR44	5YR46	5YR46	5YR46	rag	rag	rag	rag	rag	rag	rag	Dense bushland aka forest.
100	19	0562675	9000550	no		-				rag	rag	rag	rag	rag	rag	rag	100m from ocean; rag outcropings dominate area.
101	1	0563800	9000050	yes (bone @25cm)	GLEY17N	10YR42	10YR42	10YR42	10YR81	10YR81	10YR81	10YR81	10YR81	rag	rag	rag	Open grass directly off path.
101	2	0 563550	9000000	no	GLEY17N	10YR42	10YR42	10YR42	10YR42	rag	rag	rag	rag	rag	rag	rag	Open grass bordering dense/moderate scrub.
101	3	0563250	9000000	yes (ceramic and bead 5-10cm, rim @70cm).	7.5YR51	7.5YR51	7.5YR51	10YR82	10YR82	10YR82	10YR82	10YR82	rag	rag	rag	rag	Coconut & grass.
101	4	0563000	9000000	no	5YR44	5YR44	5YR34	5YR34	rag	rag	rag	rag	rag	rag	rag	rag	Dense scrubland.
101	5	0562750	9000000	yes (ceramics at top, sterile nearby).	5YR44	5YR44	5YR34	5YR34	rag	rag	rag	rag	rag	rag	rag	rag	Dense scrub & rag outcropping.
101	6	0562500	9000000	yes (few ceramics)	7.5YR33	7.5YR33	7.5YR33	5YR34	5YR34	5YR46	rag	rag	rag	rag	rag	rag	Coconut & grass.
101	7	0562250	9000000	no	10YR44	10YR33	10YR33	5YR34	5YR34	5YR34	rag	rag	rag	rag	rag	rag	Grass btwn scrub.

Transect	STP	Easting	Southing	Cultura IMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
101	21	0561250	9000000	yes (large bead/spindle @20cm, ceramics associated)	2.5YR33	2.5YR33	2.5YR36	2.5YR36	2.5YR36	rag	rag	rag	rag	rag	rag	rag	Moderate scrubland w/o grass.
101	22	0 561000	9000000	yes (ceramics @15cm)	5YR44	5YR44	5YR44	5YR44	2.5YR36	2.5YR36	2.5YR36	rag	rag	rag	rag	rag	Combination of grass and (probably light) scrubland.
102	23	0564250	9000000	no	7.5YR61	7.5YR61	10YR72	7.5YR72	10YR72	10YR72	10YR72	10YR72	10YR72	rag	rag	rag	Open coconut and grassland near ocean.
102	24	0 564250	8999750	no	7.5YR44	7.5YR44	7.5YR44	7.5YR44	rag	rag	rag	rag	rag	rag	rag	rag	Coastal scrubland with sparse grass.
102	25	0564000	8999750	no	5YR31	5YR31	5YR31	2.5YR42	2.5YR42	rag	rag	rag	rag	rag	rag	rag	Tall grass punctuated by mature tree.
102	26	0 564750	8999500		-				_						rag	rag	Tall grass and shrub growth between rag outcrops.
102	27	0565500	8999250												rag	rag	Heavy bush separates area from main trail.
102	28	0565250	8999250		-						-				rag	rag	Intertidal beach and nearshore scrub.
102	29	0565250	8999000	no	GLEY161 10Y	7.5YR41	7.5YR41	7.5YR41	7.5YR82	7.5YR82	7.5YR82	7.5YR82	7.5YR8 2	7.5YR82	rag	rag	Edge of continually cleared field.
103	30	0 560675	9000250	no	GLEY18N	7.5YR43	7.5YR43	7.5YR34	7.5YR34	rag	rag	rag	rag	rag	rag	rag	Grass 5m from scrub near ocean; former lime pit.
103	31	0560925	9000250	no	7.5YR46	5YR46	5YR46	2.5YR36	2.5YR36	2.5YR36	2.5YR36	2.5YR36	rag	rag	rag	rag	Grass btwn scrubland. Wood harvest.
103	32	0 561175	9000250	yes (ceramics in top 20cm).	7.5YR44	7.5YR44	5YR46	5YR46	5YR46	5YR46	rag	rag	rag	rag	rag	rag	Recent re-growth in scrubland that had been cut.
103	33	0 561425	9000250	yes (ceramics and bone).	7.5YR44	7.5YR44	5YR34	5YR34	rag	rag	rag	rag	rag	rag	rag	rag	Open area of short grass with sparse shrubs.
103	34	0561675	9000250	no	7.5YR44	5YR44	5YR44	5YR44	5YR44	5YR44	5YR44	rag	rag	rag	rag	rag	Short grass & sparse tree cover.
103	35	0561925	9000250	yes (ceramics from top 10cm).	7.5YR44	7.5YR44	5YR44	5YR44	5YR44	5YR44	rag	rag	rag	rag	rag	rag	Moderate scrubland with few mature trees.
103	36	0562175	9000250	no	7.5YR44	5YR44	5YR44	5YR44	5YR44	rag	rag	rag	rag	rag	rag	rag	Low grass relatively dense mature tree cover.
103	37			no	GLEY285 BP	2.5YR36	7.5YR34	7.5YR34	7.5YR34	rag	rag	rag	rag	rag	rag	rag	
103	50	562425	9000250	yes (ceramic & shell).	10YR46	10YR46	10YR46	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	rag	rag	rag	Short grass & shrub.
103	51	562675	9000250	yes (small sherd at bottom).	7.5YR46	7.5YR46	7.5YR46	5YR46	rag	rag	rag	rag	rag	rag	rag	rag	Leaf litter and small rag in scrubland.
103	52	562925	9000250	no	7.5YR46	7.5YR46	7.5YR46	5YR46	5YR46	rag	rag	rag	rag	rag	rag	rag	Moderate scrubland.
103	53	563175	9000250	no	10YR71	10YR62	10YR83	10YR83	10YR83	10YR83	10YR83	rag	rag	rag	rag	rag	Cocounut grove with sparse grass cover.
104	40	565875	8997000	yes (ceramic, bone, and quartz)	10YR71	10YR32	10YR32	10YR32	rag	rag	rag	rag	rag	rag	rag	rag	Coconut & grass, rice field.

Transect	STP	Easting	Southing	Cultura IMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
104	41	569750	8997500	yes (ceramics at surface down).	GLEY18N	10YR52	10YR52	10YR52	rag	rag	rag	rag	rag	rag	rag	rag	Atop rice shamba causeway.
104	42	565900	8997400	yes (only surface)	10YR32	10YR32	10YR32	10YR32	rag	rag	rag	rag	rag	rag	rag	rag	Grass cover just beyond rice shamba.
104	43	565775	8997500	no	10YR33	10YR33	10YR33	10YR55	rag	rag	rag	rag	rag	rag	rag	rag	Overgrown fallow rice field.
104	44	565450	8997900	no	10YR33	10YR33	10YR33	10YR55	10YR55	rag	Route to rice shamba 50m away.						
105	45	560380	9001550	no	7.5YR72	7.5YR72	7.5YR72	7.5YR72	10YR53	10YR72							
105	46	560350	9001300	no	10YR53	10YR53	10YR53	10YR53	10YR53	10YR81	10YR81	10YR81	10YR83	10YR83	10YR83	10YR83	
105	47	560350	9001050	no	10YR73	10YR73	10YR73	10YR83	10YR83	10YR83	10YR83	10YR83	10YR83	10YR83	10YR42	10YR42	
105	48	560725	9000825	yes	7.5YR54	7.5YR54	7.5YR54	7.5YR54	7.5YR54	10YR84	10YR84	10YR84	10YR84	10YR84	10YR84	rag	
105	48	560725	9000625	yes	5YR34	5YR34	5YR34	5YR34	5YR34	rag							
106	54	560475	9000630	yes (rim& dec ceramic, bead, shell begins @ 40cm)	7.5YR33	7.5YR33	7.5YR33	5YR34	5YR34	5YR34	rag	rag	rag	rag	rag	rag	Short grass within medium scrubland.
107	55	561000	8998500	yes (few ceramics, daub?).	10YR34	10YR34	10YR34	10YR34	10YR34	10YR56	rag	rag	rag	rag	rag	rag	15m off mangroves within dense bushland.
107	56	561000	8998000	yes (ceramics to 50cm, continue but less prevelant).	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	rag	rag	rag	rag	rag	Medium height grass between scrub & cassava.
107	57	561250	8998000	no	10YR72	10YR56	10YR56	10YR56	rag	rag	rag	rag	rag	rag	rag	rag	Moderate scrubland with no grass cover.
107	58	561000	8998250	yes (ceramics throughout).	7.5YR56	7.5YR56	7.5YR56	7.5YR56	5YR46	5YR46	5YR46	rag	rag	rag	rag	rag	Fallow cassava field.
110	59	565550	8998600	yes (ceramic top 5cm and large piece @30cm).	7.5YR41	7.5YR41	7.5YR41	7.5YR41	7.5YR41	rag	Grass & scrub near mangrove.						

Transect	STP	Easting	Southing	Cultura lMaterials	0ст	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
110	60	566225	8998250	yes (ceramic and slag? In top 20cm).	7.5YR41	7.5YR62	rag	rag	rag	rag	Within sisal shamba, 15m from dense bush.						
110	61	567250	8997900	yes (ceramics from top, maybe rock?).	7.5YR41	7.5YR41	7.5YR41	7.5YR41	rag	rag	rag	rag	rag	rag	rag	rag	Grassland maintained as cow pasturage. Little scrub.
110	62	565875	8997000	no	GLEY16N	10YR32	10YR32	10YR32	10YR32	10YR32	rag	rag	rag	rag	rag	rag	Recently harvested sorghum field.
110	63	565775	8996500	no	10YR32	10YR32	rag	rag	rag	rag	rag	rag	rag	rag	rag	rag	Rag in salinated rice area, some pasturage.
110	63a	565875	8996250	no	10YR32	10YR32	rag	rag	rag	rag	rag	rag	rag	rag	rag	rag	15m from home, 5m from dense bush and rock outcrop.
110	64	565875	8996750	no	10YR32	10YR32	rag	rag	rag	rag	rag	rag	rag	rag	rag	rag	25m from home, near dense bushland.
110	65	564250	8998425	no	10YR54	2.5YR48	7.5YR68	10YR54	2.5YR48	7.5YR68	rag	rag	rag	rag	rag	rag	Little grass near mangrove & scrubland.
110	66	564330	8998250	no	10YR53	10YR53	10YR53	10YR21	rag	rag	rag	rag	rag	rag	rag	rag	Tall grass near scrub; rag.
110	67	564250	8998000	no	10YR41	10YR41	10YR41	10YR41	10YR41	10YR41	rag	rag	rag	rag	rag	rag	Tall grass 25m from sorghum.
110	68	564500	8997750	no	10YR41	rag	rag	rag	rag	rag	Sorghum field immediately abutting cattle area.						
110	69	564775	8997500	no	10YR52	10YR52	10YR52	rag	rag	rag	rag	rag	rag	rag	rag	rag	5m from mangrove in moderate scrubland.
110	70	564975	8997500	no	2.5YR53	2.5YR53	2.5YR53	rag	rag	rag	rag	rag	rag	rag	rag	rag	Clear area btwn mangrove & dense scrub.
110	71	564500	8997500	no	10YR31	10YR31	10YR31	10YR31	10YR46	10YR46	rag	rag	rag	rag	rag	rag	Cattle pasturage with one small palmtree and short grass.
110	72	564500	8997250	no	10YR31	10YR31	10YR31	10YR31	10YR46	10YR46	rag	rag	rag	rag	rag	rag	Pasture w/ trees, short grass, and saw palmetto.
110	73	564250	8997220	yes (surface scatter).	10YR31	10YR31	10YR46	10YR46	rag	rag	rag	rag	rag	rag	rag	rag	Open spit btwn scrubland.
110	74	564500	8997000	yes (surface scatter).	10YR31	10YR31	10YR31	10YR46	rag	rag	rag	rag	rag	rag	rag	rag	Open area between dense bushland.
110	75	564500	8996750	no	10YR31	10YR31	10YR31	10YR46	rag	rag	rag	rag	rag	rag	rag	rag	Open area w/o grass & moderate scrub.
110	76	564250	8997000	no	10YR31	10YR31	10YR31	10YR46	rag	rag	rag	rag	rag	rag	rag	rag	Pasture with low grass near moderate scrubland.
110	77	564500	8996500	no	inter	inter	inter	inter	inter								

Transect	STP	Easting	Southing	Cultura IMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
110	78	546575	8996255	yes (ceramic throughout).	7.5YR33	7.5YR33	7.5YR33	7.5YR33	7.5YR33	rag	rag	rag	rag	rag	rag	rag	Immediately outside
																	sorghum shamba.
106	79	561075	8997000	no	2.5YR53	2.5YR53	2.5YR53	2.5YR53	2.5YR34	2.5YR46	2.5YR46	rag	rag	rag	rag	rag	Grassland of moderate
									6								height.
106	80	561250	8997000	no	10YR64	10YR64	10YR64	10YR64	10YR64	10YR64	rag	rag	rag	rag	rag	rag	Moderate scrubland with no
																	grass cover.
106	81	561000	8997250	no	7.5YR53	7.5YR53	7.5YR53	7.5YR53	7.5YR54	rag	rag	rag	rag	rag	rag	rag	Moderate scrubland w/
																	moderate height grass cover.
106	82	561000	8997500	yes (one ceramic).	7.5YR41	7.5YR41	7.5YR41	2.5YR42	2.5YR42	rag	rag	rag	rag	rag	rag	rag	Moderate scrubland with low
																	grass cover.
106	83	561250	8997500	no	10YR46	10YR46	10YR46	10YR46	10YR46	rag	rag	rag	rag	rag	rag	rag	Immediately adjacent to
																	dense scrub.
106	84	561000	8997750	yes (ceramics after 20cm).	7.5YR56	7.5YR51	7.5YR51	7.5YR51	7.5YR51	7.5YR51	7.5YR71	7.5YR71	7.5YR7	7.5YR71	rag	rag	Open area covered with low
													1				grass.
200	86	617935	8870610	none retained	7.5YR56	7.5YR56	7.5YR56	7.5YR56	7.5YR68	7.5YR68	7.5YR68	7.5YR68	7.5YR6	7.5YR68	7.5YR68		15m from home; under tree;
													8				no grass, med scrub.
200	87	618185	8871110	yes (sherds, charcoal)	10YR61	10YR64	10YR64	10YR64	10YR64	10YR64	10YR64	10YR64	10YR64	10YR64	10YR64	ŀ	Recently burned scrub with
																	ring of baobabs.
200	88	617935	8870110	yes (sherds, daub, beads, slag)	10YR44	10YR44	10YR44	10YR44	10YR58	10YR58	10YR58	10YR58	10YR58	10YR58	10YR58		Scrub btwn clove trees.
																	Sorghum near.
200	89	617685	8870110	yes (shreds, daub; surface too)	10YR43	10YR54	10YR54	10YR54	10YR54	10YR54	10YR54		ŀ				Open dense low grass near
																	fenced cattle enclosure.
200	90	617435	8870110	none retained	7.5YR56	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46		ŀ	-	-	ŀ	Recent harvest sorghum 5m
											ļ						off cattle enclosure.
200	91	618185	8870110	none retained	10YR54	10YR54	7.5YR86	7.5YR86	7.5YR86	7.5YR86	7.5YR86		ŀ	•	•		Recently burned are under
																	tree; 15m from sorghum.
200	92	618435	8870110	none retained	10YR54	10YR54	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58		ŀ			ŀ	Recent burn of moderate
																	scrub. Nearby baobab.
200	93	617935	8870360	yes (slag)	10YR54	10YR54	10YR43	10YR43	10YR43	10YR68	10YR68	10YR68	ŀ			ŀ	Depression in well watered
				(1 0							= =>/= + +						area & sorghum plot.
200	94	617920	8869840	yes (charcoal)	7.5YR44	7.5YR44	ŀ			ŀ	Scrub, cashew, & grass						
204	0.5	C445C5	0072050	(1 0	2.51/40	2.57/40	2.57/40	2 51/40	2.57/40	2.57/40	2.57/40	2.57/40					throughout.
201	95	611565	8872950	yes (sherd)	2.5Y48	2.5Y48	ŀ			ŀ	Dense bush with no grass;						
204	0.0	644550	0072450	() ()	EVD 46	2.5740	2.57/40	2.5740	2.5746	2.57/40	2.57/40	2.57/40	<u> </u>				upupu to the west.
201	96	611550	8873450	yes (sherds under surface)	5YR46	2.5Y48	2.5Y48	2.5Y48	2.5Y48	2.5Y48	2.5Y48	2.5Y48	ŀ	·	ŀ	ŀ	North edge of millet shamba;
																	dense scrub to North.
201	97	611550	8873700	yes (sherds and bead @30cm)	2.5Y48	2.5Y48	5YR44	5YR44	5YR44	5YR44	5YR44	5YR44	5YR44	ļ	ļ	·	Recently harvested sorghum
																	shamba 10m from road.

Transect	STP	Easting	Southing	Cultura lMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
201	98	612050	8873950	yes (sherds, slag, daub; cease @40cm)	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46					Dense scrub, heavy leaf litter, no grass.
201	99	611300	8873950	yes (sherds @30-60cm)	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	•			Dense scrub directly S; sorghum shamba to N.
201	100	611050	8873950	yes (heavily degraded sherd @40cm)	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58		•			20m from house; moderate to light scrub.
201	101	611550	8873950	yes (sherds from start, slag @ 30cm)	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	•			North edge of sorghum plot. No grass. Scrub to N.
201	102	611800	8873950	yes (sherds to 40cm)	5YR48	5YR48	5YR48	5YR48	2.5Y48	2.5Y48	2.5Y48	2.5Y48					Sorghum shamba.
201	103	611550	8874200	yes (heavily degraded sherd)	7.5YR56	7.5YR56	7.5YR56	7.5YR56	7.5YR56	7.5YR56	7.5YR56						Sorghum shamba bounded by dense bush.
201	104	611550	5879450	yes (sherd @15cm)	7.5YR46	7.5YR46	7.5YR46	7.5YR46									Directly behind abandon homes; school to E.
201	105	611550	8874450	yes (sherds dec body @20- 25cm)	7.5YR 46	7.5YR 46	7.5YR 46	7.5YR 46	5YR46	5YR46	5YR46						Sorghum plot near homes.
202	106	608850	8875725	yes (sherds from top, beads @35cm)	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR31	7.5YR58							15-20m from ocean; ridge of baobabs near.
202	107	608850	8875850	yes (nothing between 40 and 60cm)	7.5YR46	7.5YR46	7.5YR46	7.5YR46	7.5YR46	7.5YR46	7.5YR46	5YR46	5YR46	•			Middle of sorghum field 25m from road.
202	108	608850	8876100	yes (sherds and bead by 25cm)	10YR46	10YR46	10YR46	10YR46	10YR46	7.5YR46		-		•			Sorghum shamba near cashew tree.
202	109	608850	8876350	yes (degraded @20 and chunky @40cm)	7.5YR46	7.5YR46	7.5YR46	5YR46	5YR46	5YR46	5YR46			•			Immediately outside recently harvested sorghum shamba.
202	110	609100	8875850	yes (degraded sherds in top 20cm)	10YR56	10YR56	10YR56	10YR56	10YR56	10YR56							Edge between fallow field and dense bush.
202	111	609350	8875850	none retained	5YR58	5YR58	5YR58	5YR58									Dense bush.
202	112	608690	8875875	yes (sherds in top 15cm)	10YR56	10YR56	10YR56	10YR56	10YR56	10YR56	10YR56						Moderate scrub 5m from rockface leading to ocean.
202	113	609850	8875850	none retained	5YR58	5YR58	5YR58	5YR58	5YR46	5YR46	5YR46						Maize shamba.
202	114	608850	8876850	none retained	5YR58	5YR58	5YR58	5YR58	5YR546	5YR46	5YR46						Maize shamba.
203	115	624710	8862450	none retained	2.5Y42	2.5Y42	2.5Y42	2.5Y42	2.5Y42	2.5Y42							50m W of main road; NE of school.
203	116	625210	8862450	none retained	10YR62	10YR62	10YR62	7.5YR63	7.5YR63	7.5YR63	7.5YR63						Mod scrub, grass, & cashews.

Transect	STP	Easting	Southing	Cultura IMaterials	0ст	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
203	117	625460	8862450	none retained	7.5YR66	7.5YR66	7.5YR53	7.5YR53	7.5YR58	7.5YR58	7.5YR58						Light downward slope;
																	moderate scrub.
203	118	625960	8862450	none retained	7.5YR53	7.5YR53	7.5YR53	7.5YR53	5YR56	5YR56	5YR58	5YR58	ļ				Recently burned shamba
																	overlooking Mik Bay.
203	119	626210	8862450	none retained	7.5YR66	7.5YR66	7.5YR66	7.5YR66	5YR56	5YR56	5YR56		ļ				Halfway down hill moving
																	toward Mik Bay.
203	120	625710	8862450	yes (sherds, beads)	10YR42	10YR42	10YR42	10YR42	7.5YR46	7.5YR46	7.5YR46	7.5YR46	7.5YR4	7.5YR46	7.5YR46		Between baobabs, 50m S of
													6				downward hill to Mik Bay.
203	121	625710	8862215	none retained	10YR62	10YR62	10YR68	10YR68	10YR68	10YR68	10YR68	•					Downward slope of hill;
																	recently burned mod bush.
203	122	625710	8861950	yes (degraded sherd @ 10 and	10YR53		ļ				Base of hill in banana						
				30cm)													shamba.
203	123	625710	8861450	none retained	2.5Y51	2.5Y51	2.5Y51	2.5Y64	2.5Y64	2.5Y51	2.5Y51	•					Cattle field with thick short
																	grass; Near salt flat.
204	125	620225	8864650	yes (sherds, daub, beads.	10YR43	10YR43	10YR43	10YR43	10YR43	10YR54	10YR54	10YR54	10YR54				Dense bush 50m SW of
				Separated into 20cm													fallow shamba, 20m NE of
				segments)													steep downslope.
204	126	620225	8864150	yes (two heavily degraded	7.5YR53	7.5YR53	7.5YR56	7.5YR56	7.5YR56	7.5YR56	7.5YR56	7.5YR56					Open field with light grass
				sherds)													and palms SE of dense scrub.
204	127	620225	8863900	yes (small heavily degraded	5YR56	5YR56	5YR56	5YR58	5YR58	5YR58	5YR58		ļ				Dense bush 25m S of 2
				sherds)													church buildings.
204	128	620225	8863650	yes (ceramics 40cm to 70cm)	7.5YR58	7.5YR58	7.5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58				Recently burned field with
																	moderate scrub remaining.
204	129	620225	8863400	yes (heavily degraded sherds	5YR56	5YR56	5YR56	5YR56	7.5YR46	7.5YR46	5YR56	7.5YR46	7.5YR4				Recently burned shamba 2
				40-50cm)									6				from path.
204	130	620225	8863150	none retained	7.5YR44	7.5YR44	7.5YR44	7.5YR44	5YR46	5YR46	5YR46						Dense bush with evidence of
																	extensive logging.
204	131	620130	8863660	yes (sherds in top 15cm)	10YR46	10YR46	10YR46	7.5YR58	7.5YR48	7.5YR48	7.5YR48	7.5YR48					Hilltop moderate grass &
																	bush; charocal.
204	132	620725	8863650	none retained	10YR61	10YR41	GLEY245	GLEY245	GLEY245	GLEY245							Green well watered area ripe
							РВ	РВ	PB	PB							with mchicha and coconut.
204	133	620475	8863725	none retained	5YR53	5YR53	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	i.				Edge of hilltop 20m W of
																	cassava field.
204	134	619975	8863650	none retained	7.5YR54	7.5YR54	7.5YR74	7.5YR74	7.5YR74	7.5YR74	7.5YR74	ļ.	į.				Slight scrub and slight
													1				downward slope of hill.
204	135	619725	8863650	none retained	7.5YR46	7.5YR46	7.5YR46	7.5YR58	7.5YR58	7.5YR68	7.5YR68	7.5YR68	į.				Coconut grove. Green valley
																	between two hills.
205	136	618350	8870750	yes (daub @20cm, sherd and	10YR66	10YR66	10YR62	10YR62	10YR62	10YR62	10YR62	10YR62	į.				Light brush 5m S of trail
				charcoal 40cm)													under cashew w/ light grass.

Transect	STP	Easting	Southing	Cultura IMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
205	137	618350	8871250	none retained	10YR74	10YR74	10YR68	10YR68	10YR68	10YR68	10YR68	10YR68					Open area recently burned ringed by baobabs.
205	138	618350	8871500	yes (sherds @50cm, thick @55-60cm)	7.5YR58	75YR58				Directly under large cashew tree, no grass or other plants.							
205	139	618350	8871750	none retained	5YR58	5YR58	5YR58	2.5YR46	2.5YR46	2.5YR46	2.5YR46	2.5YR48	25YR48	2.5YR48	2.5YR48		Fallow field near cassava & and E of active sorghum.
205	140	618350	8872250	none retained	5YR56				·	Dense bush with heavy leaf litter little to no grass.							
205	141	618350	8872500	none retained.	5YR56	5YR56	5YR56	5YR44	5YR44	5YR44	5YR44	5YR44	•			•	Dense bush little grass, heavy leaf litter.
205	142	617350	8871750	yes (charcoal @40cm).	5YR68	5YR68	5YR68	5YR68	5YR58	5YR58	5YR58	5YR58	5YR58			•	Cashew and cassava farm 5m N of dense bush.
205	143	617850	8871750	yes (charcoal and sherds @ 50 - 55cm, continue to 60cm).	7.5YR68	7.5YR68	7.5YR68	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58	5YR58			Cassava shamba.
205	144	618110	8871750	yes (handpicked charcoal 10- 20cm lense).	7.5YR58	7.5YR58	7.5YR58	7.5YR58	5YR58	5YR58	5YR58	5YR58					Thick grass under cashew 5m E of cassava shamba.
205	145	618600	8871750	none retained.	5YR46					Moderate scrub with thich and high grass.							
205	146	618850	8871750	none retained.	5YR46						Recently harvested sorghum shamba, some stalks remain.						
206	147	624060	8865070	none retained	5YR58	5YR58	5YR58	7.5YR58	7.5YR58								Dense scrub with mangrove 25m S and baobabs 15m E and S.
206	148	624060	8864820	yes (sherds, beads; separate 0-30 and 30cm+).	10YR73	7.5YR42	7.5YR42	7.5YR42	10YR73	10YR73	10YR73	10YR73	10YR73	10YR73			Sand spit between ocean, mangrove, and pockets of bush to N and S.
206	149	624060	8864570	none retained.	7.5YR64	7.5YR64	7.5YR64	7.5YR53	7.5YR53	7.5YR53	5YR68	5YR68					10m E of high water mark in coastal scrub, no grass cover.
207	150	626000	8861820	none retained.	2.5Y52	10YR63	10YR63	10YR21	7.5YR46								Open sand flat 100m W of main road near mang.
207	151	626560	8861620	yes (two sherds in top 20cm, again @ 60cm)	10YR63	10YR63	10YR63	10YR53	10YR53	10YR53	10YR54	10YR54	10YR54	10YR54	10YR54		Base of hill. Sorghum plot & pasturage.
207	152	626810	8861820	none retained.	7.5YR56						Small hill w/ light grass cover.						
207	153	627310	8861820	yes (two sherds in top 15cm).	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR56	7.5YR56	7.5YR56					Light grass near scrubland & construction.
207	154	627580	8861820	yes (two sherds @ 25cm).	10YR74	10YR74	10YR64	10YR64	10YR64	10YR64							Local dump w/ rag.

Transect	STP	Easting	Southing	Cultura lMaterials	0ст	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
207	155	628060	8861820	not excavated.													CENTER OF TOWN.
207	155	627060	8861820	yes (degraded sherd from surface).	10YR63	10YR63	10YR63	10YR63	10YR63	10YR68	10YR68	10YR68	10YR68	10YR68	10YR68		Open area btwn homes. Light gras w/ baobab.
207	156	627060	8862020	yes (degraded body sherd @ 20cm).	10YR62	2.5Y56	2.5Y51	2.5Y56	2.5Y68	2.5Y61		-			•		Base of hill. Open area.
207	157	627060	8861570	none retained.	7.5YR44					Moderate level bushland 15m W of cassava field.							
207	158	627060	8861320	yes (two heavily degraded sherds).	10YR54	10YR54	10YR54	10YR54	10YR54	10YR54							Ligh scrubland 25m N/NE of modern house. No grass.
207	159	627060	8860820	yes (two heavily degraded sherds in top 10cm).	7.5YR66					Open area with little low scrubland in new housing development.							
208	160	610940	8866950	ABANDONED TRANSECT													ABANDONED TRANSECT
209	161	623300	8865960	yes (sherds @ 20cm).	2.5Y63	2.5Y63	7.5YR46	7.5YR42	7.5YR42	7.5YR42	-	-					Light grass area central to ring of modern homes.
209	162	623300	8866210	yes (heavily degraded body sherds @20cm associated with ash lense).	7.5YR58						Open recently burned light scrubland- no leaves remain. 5m E of main road.						
209	163	623100	8866460	yes (sherds and slag from the top).	10YR73	10YR73	10YR73	7.5YR56	7.5YR56	7.5YR56	7.5YR56	7.5YR56					Ligh scrubland 20m E of precipitous drop to mangroves.
209	164	623350	8866460	none retained.	7.5YR58					Area recently burned and remaining vegetation cut but not cleared.							
209	165	623600	8866460	yes (sherds in top 20cm).	7.5YR64	7.5YR64	7.5YR64	7.5YR64	7.5YR64	7.5YR68	7.5YR68	7.5YR68	7.5YR6 8	7.5YR68			Recently burned area 10m W of ocean.
209	166	623100	8866710	none retained.	7.5YR63	7.5YR63	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58					Cashew farm between trees.
209	167	623100	8866960	none retained.	10YR64	7.5YR44	7.5YR44	7.5YR44	7.5YR44	7.5YR44							Center of recently harvested sorghum field.
209	168	623100	8867460	none retained.	10YR31	10YR31	10YR31	10YR31	10YR31	10YR31							
210	169	621400	8857280	none retained.	5YR68	5YR68	5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR6 8				Fallowing cassave shamba on edge of actively farmed area. Dense bush in fallowing area.
210	170	621900	8857280	yes (sherds to 30cm).	5YR68	5YR68	5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR6 8				Cassava shamba.
210	170a	621650	8857530	none retained.	5YR68	5YR68	5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR6 8				Cleared area between cashew trees.
210	171	621650	8857030	none retained.	5YR68	5YR68	5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR6 8			•	Cassava shamba.

Transect	STP	Easting	Southing	Cultura IMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
210	172	621650	8857280	none retained.	5YR68	5YR68	5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR68	2.5YR6				Edge of cassava shamba near
													8				dense bushland.
211	175	627150	8858850	yes (charcoal @50cm).	7.5YR46	7.5YR46	7.5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	5YR46	-	-	Cassava plot 25m S of hill.
211	177	627150	8858600	none retained.	5YR44	5YR44	5YR44	5YR68	5YR68	5YR68	5YR68	5YR68	5YR68				Cassava shamba.
211	178	626900	8858850	none retained.	5YR44	5YR44	5YR44	5YR68	5YR68	5YR68	5YR68	5YR68	5YR68				Cassava shamba.
212	179	617750	8858650	yes (dec body sherd @ 15cm).	10YR42	10YR42	10YR42	10YR42	10YR42	10YR64	10YR64	10YR64	10YR64	10YR64			Scrub directly off of road
																	moving E-W through Liwelu.
212	180	617500	8858650	none retained.	10YR42	10YR42		•		Cassava shamba.							
212	181	617250	8858615	yes (degraded body sherd @	10YR53	10YR53	10YR53			Sorghum & cassava shamba.							
				20cm).													Area clear of weeds, scrub.
212	182	618000	8858700	none retained.	7.5YR63	7.5YR63	7.5YR46	7.5YR46	7.5YR46	7.5YR46	7.5YR46	7.5YR46					50m from home. Cashew,
																	banana, & coconut, no grass.
212	183	618250	8858650	yes (sherds @30cm to 45cm).	7.5YR46					Cleared area in middle of							
																	modern village.
212	184	617680	8857580	none retained.	10YR51	10YR51	10YR51			Overgrown moderate scrub							
																	peripheral to burned farm.
212	185	617750	8858150	none retained.	7.5YR54	7.5YR54	10YR44	10YR44	10YR44	10YR44	10YR44	10YR44	10YR44	10YR44			Cassava shamba on slope.
																	Heavy grass cover.
212	186	617750	8858400	none retained.	10YR44	10YR44	10YR44			Moderate scrubland area.							
212	187	617750	8858900	none retained.	7.5YR53	7.5YR5	7.5YR53			Moderate scrubland on							
													3				middle of hill.
212	188	617750	8859150	none retained.	7.5YR53	7.5YR5	7.5YR53			Moderate scrubland where							
													3				hill flattens toward valley.
212	189	618750	8858650	none retained.	7.5YR44	7.5YR4	7.5YR44			Scrubland behind modern							
													4				house. Near bananas.
300	190	589265	9450735	sherds to 90cm. Bone @ 20cm.													Low scrub on sand.
				Daub @ 40cm. 90cm sterile.													
300	191	589115	9450935	Ceramics 0-20cm, 60-100cm.	GLEY12.	GLEY12	GLEY161	GLEY161		Open, STP directly between							
				Daub, bone. Rag @ 50cm.	5N	.5N	0Y	0Y		raised shamba and path.							
				Daub @ 80cm. Char. 50, 80cm.													
300	192	588965	9451135	Consistant ceramics	7.5YR64	7.5YR64	7.5YR64	7.5YR64	7.5YR64	10YR63	10YR76	10YR76	10YR76	10YR76	10YR76		Small fallow bit between two
				throughout STP.													raised fields.
300	193	588815	9451325	Charcoal @ 20cm. Ceramics &	7.5YR54	7.5YR5	7.5YR54	7.5YR54		Light scrub 5m north of farm							
				daub. Sassanian @59cm. Slag									4				and very near coconut
				@ 90cm.													processing area.
300	194	588665	9451525	N/A.	7.5YR61						Contact between cassava and						
																	coast.

Transect	STP	Easting	Southing	Cultura IMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
301	195	588765	9450735	N/A.	7.5YR72	7.5YR72	7.5YR72	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR52					Cassava plot. Banana and some larger trees in area.
301	196	5889015	9450735	N/A.	7.5YR72	7.5YR72	7.5YR72	7.5YR72	7.5YR31	7.5YR31	7.5YR31	7.5YR72	7.5YR3 1	7.5YR31	7.5YR31		Base of small hill between cassava and wet rice.
301	197	5888515	9450735	Charcoal @ 15cm. Degraded body sherd @ 20cm.	7.5YR54	7.5YR5 4	7.5YR66	7.5YR66		Open flat field with short grass. Pasture area.							
301	198	588265	9450735	One piece of granite- not retained.	10YR66	10YR66	10YR66	10YR66	10YR66	GLEY15N	GLEY15N	GLEY15N					Cassava to east and small stream to west.
301	199	588015	9450735	Ceramics @ 90cm to 100cm.	7.5YR53	7.5YR5 3	10YR43	10YR43		Edge of active cassava plot & fallow plot.							
301	200	587765	9450735	Charcoal 20-30cm.	7.5YR31	7.5YR3 1	7.5YR31			Dense tall tree cover. Banana and coconut palm around.							
301	201	587515	9450735	Iron ore @ 25cm.	7.5YR46	7.5YR46	7.5YR46	7.5YR31	7.5YR31	10YR81	•						Open area directly adjacent to stream. Grass cover.
301	202	587265	9450735	Ceramics @ 50cm.	7.5YR71	7.5YR7 1	7.5YR71	7.5YR71	•	Open area in small village. Grass cover.							
301	203	587015	9450735	Charcoal 30 to 40cm.	7.5YR71	7.5YR71	7.5YR71	7.5YR71	7.5YR71	7.5YR71	7.5YR31	7.5YR31	7.5YR3 1	7.5YR31	7.5YR31	•	Area of dense growth under cashew tree.
301	204	586765	9450735	Charcoal @ 60cm.	10YR54	10YR72	10YR72	10YR54	10YR54	ē	Open area near stand of brush- recently cleared.						
301	205	586515	9450935	Body sherd @ 35cm.	10YR64	10YR52	10YR52	10YR52	10YR52	•	Short grass in open area uphill from rice shamba.						
301	206	586015	9450735	N/A.							·	-				•	Raised cassava plot w/only short grass.
301	207	585765	9450735	N/A.								-				·	Short grass between areas of heavy cover.
301	208	585515	9450735	N/A.	7.5YR68	7.5YR68	7.5YR68	7.5YR68	7.5YR68	7.5YR68	5YR68	5YR68	5YR68	5YR68	5YR68	·	Light and low scrub near large cashews and palms.
301	209	585265	9450735	N/A.	7.5YR31	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR58	7.5YR31	7.5YR3	7.5YR31	7.5YR31		Leaf litter under cashew tree.
302	210	589089	9450911	Ceramics & glass to 20cm w/ increase after 20cm.	10YR31	10YR31	10YR31	10YR31	10YR31	10YR31			-				Between two cassava shambas 10m south of hut.
302	211	588912	9451088	Ceramics 50-90cm.	10YR63	10YR63	10YR63	10YR63	10YR63	10YR63	10YR42	10YR42	10YR42	10YR42	10YR63	10YR63	Edge of cassava shamba both active and inactive.
302	212	588736	9451264	Sherds in top 20cm including Islamic blue on white.	10YR42	10YR42	10YR42	10YR42	10YR63	10YR63	10YR63	10YR63	10YR63	10YR63	10YR63		Budding cassava shamba 75m east of stone buildings.
302	213	588559	9451415	N/A.	10YR53	10YR53	10YR53	10YR31	10YR31	10YR31	10YR31	10YR31	10YR31	10YR53	10YR53	•	Open cassava shamba.

Transect	STP	Easting	Southing	Cultura lMaterials	0cm	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
302	214	588035	945145	3 to 4 pieces of daub- not retained.								•				•	Contact between cassava and stand of dense trees.
302	215	588309	945145	Small cluster of sherds.													Open low grass area between two raised cassava shambas.
302	216	588033	9451967	Sherds from 60-100cm.	7.5YR62	7.5YR62	7.5YR62	7.5YR31	7.5YR31	7.5YR31	7.5YR31	7.5YR31	7.5YR3 1	10YR72	10YR72	-	Open area low grass between two cassava shambas.
302	217	587700	9452319	N/A.	10YR68	10YR68	10YR68	10YR68	10YR41	10YR41	10YR41	•				•	Very slight hillslope 5-10m from wet rice agriculture.
302	218	587505	9452495	N/A.	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR71	7.5YR71	7.5YR52	7.5YR5 2	7.5YR52	•	•	Open area on outskirts of village.
302	219	587329	9452671	N/A.	10YR63	10YR63	10YR63	÷	Open area within village.								
302	220	587153	9452847	N/A.	10YR42	10YR42	10YR42	10YR42	10YR76	10YR76	10YR76	10YR76	10YR76	10YR76	•	·	Village against hut near cement making area.
302	221	586977	945623	N/A.	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR41	7.5YR41	7.5YR41	7.5YR4 1	7.5YR71	7.5YR71	-	Open area between houses and cassava shambas.
302	222	586801	945311	N/A.	10YR66	10YR66	10YR66	10YR66	10YR53	10YR53	10YR53	10YR66	10YR66		÷	÷	Light scrub fallow pasturage.
302	223	586449	9453551	N/A.	10YR53	10YR53	10YR53	10YR53	10YR31	10YR31	10YR31	10YR62	10YR62	10YR51	10YR51		Open pasturage near banda.
302	224	586625	9453375	N/A.	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR31	7.5YR31	7.5YR31	7.5YR31	7.5YR3 1	7.5YR72	7.5YR72		Open fallow area short grass near active cassava shamba.
303	225	588240	9451833	Heavy mix of rag, daub, ceramic, and prayer stones.	7.5YR51	7.5YR51	7.5YR51	7.5YR51	7.5YR42	7.5YR42	7.5YR42	7.5YR42	7.5YR4 2	7.5YR61	7.5YR61		Pasture w/ evidence of degraded plots.
303	226	588240	9451633	Sherds 0-60cm.	10YR52	10YR52	10YR52	10YR32	10YR32	10YR32	10YR76	10YR76	10YR76				Trough of active raised cassava shamba.
303	227	588140	9451733	N/A.	7.5YR31	7.5YR3 1	7.5YR31	7.5YR31	7.5YR31	Contact between active and fallow cassava shambas.							
303	228	588340	9451733	Sherds and bone throughout.	7.5YR31	7.5YR3 1	7.5YR31			Edge of site overlooking mangroves.							
303	229	588750	9451308	N/A.	7.5YR52	7.5YR5 2	7.5YR31	7.5YR31		Active cassava shamba.							
303	230	588650	9451208	N/A.	7.5YR73	7.5YR73	7.5YR73	7.5YR53	7.5YR73	7.5YR73	7.5YR73	7.5YR73	7.5YR7 3	7.5YR73	7.5YR73		Contact between cassava shamba and scrub stand.
304	231	588736	9450206	N/A.	10YR42	10YR68	10YR68		Contact btwn two cassava plots near home.								
304	232	588559	9450030	Three diagnostic sherds and one piece of charcoal.	10YR42	10YR42	10YR42	10YR42	10YR42	10YR68	10YR68	10YR68	10YR68	10YR68	10YR71	10YR71	Open hilltop fallow/ degraded cassava plot.

1	Transect	STP	Easting	Southing	Cultura lMaterials	0ст	10cm	20cm	30cm	40cm	50cm	60cm	70cm	80cm	90cm	100cm	110cm	Local Conditions
244 S88206 9449672 N/A 7.57872 7.5	304	233	588353	9449853	N/A.	GLEY13N	GLEY13N	GLEY13N	GLEY15N	GLEY15N	GLEY15N	GLEY15N	GLEY15N	GLEY15	GLEY17N	GLEY17N		Open area with cashew trees
1														N				all around.
255 S8030	304	234	588206	9449672	N/A.	7.5YR71	7.5YR71	7.5YR71	7.5YR41	7.5YR41	7.5YR41	7.5YR41						Dense tree stand, no grass,
No.																		heavy leaf litter.
304 25 887853 9449324 N/A. GLEY13N GLEY3N GLEY8N GL	304	235	588030	944950	N/A.	GLEY151	GLEY151	GLEY151	GLEY18N	GLEY18N	GLEY18N							Sandy area between cashews
1						0Y	0Y	0Y										near small pond.
27 287500 9448971 N/A. 7.57842 7.57868 7.5	304	236	587853	9449324	N/A.	GLEY13N	GLEY3N	GLEY8N	GLEY8N	GLEY8N	GLEY8N							Open sand spit with sparse
Second S																		grass cover near pond.
304 236 \$87324 948744 N/A. 7.5YR52 7.5YR63 7.5YR72 7.5YR72 7.5YR72 7.5YR72 7.5YR72 7.5YR72 7.5YR72 7.5YR72 7.5	304	237	587500	9448971	N/A.	7.5YR42	7.5YR7	7.5YR78	7.5YR78		Open pasture located within							
Second S														8				degraded raised agriculture.
304 239 587147 9488618 N/A. 10YR62 10YR63 10YR64 1	304	238	587324	9448744	N/A.	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR52	7.5YR68	7.5YR68	7.5YR6	7.5YR68	7.5YR68		Trough of active raised
304 240 586974 9448441 N/A. 107852 107852 107852 107852 107852 107852 107852 107852 107852 107852 107852 107852 107852 107852 107852 107852 107862 107862 107862 107862 107862 . Fallow area adjacent to active cassava plots. 304 241 586794 9448265 N/A. 7.57852 7.57852 7.57852 7.57852 7.57868 7.57868 7.57868 7.57868 7.57868 7.57868 7.57868 7.57868 7.57868 7.57868 7.57869 7.57879 7.														8				cassava shamba.
304	304	239	587147	9448618	N/A.	10YR62	10YR62	10YR62	10YR42	10YR42	10YR42	10YR42	10YR42	10YR53	10YR53	10YR53		Open pasture in degraded
241 586794 9448265 N/A. 7.5YR52 7.5YR52 7.5YR52 7.5YR68 7.																		raised agriculture area.
304 241 586794 9448265 N/A. 7.5YR52 7.5YR52 7.5YR52 7.5YR52 7.5YR68 7.	304	240	586974	9448441	N/A.	10YR52	10YR62	10YR62	10YR62	10YR62		Fallow area adjacent to						
10 10 10 10 10 10 10 10																		active cassava plots.
304 242 586618 9448080 N/A. 7.5YR53 7.5YR53 7.5YR53 7.5YR53 7.5YR53 7.5YR53 7.5YR53 7.5YR53 7.5YR53 7.5YR63	304	241	586794	9448265	N/A.	7.5YR52	7.5YR52	7.5YR52	7.5YR68	7.5YR68	7.5YR68	7.5YR68						Hill slope going down to wet
304 243 586441 9447911 N/A. 10YR51 10YR51 10YR58 10YR68 10YR68 10YR68 10YR68 10YR68																		rice. Degraded plots.
243 586441 9447911 N/A. 10YR51 10YR51 10YR52 10YR53 10YR54 10YR66 10YR6	304	242	586618	9448080	N/A.	7.5YR53	7.5YR6	7.5YR63	7.5YR63		Dense forest and bush							
Shamba. Sample S														3				around small village.
244 589265 9449735 N/A. 10YRS3 10YRS2 10YRS3	304	243	586441	9447911	N/A.	10YR51	10YR51	10YR68	10YR68	10YR68	10YR68	10YR68						Trough of raised cassava
245 589265 9449485 N/A. 10YR52 10YR53 10YR63																		shamba.
245 589265 9449235 N/A. 10YR52	305	244	589265	9449735	N/A.	10YR53	10YR66	10YR66	10YR66			Fallow area w/ grass &						
Separative Sep																		coconut, edge of village.
305	305	245	589265	9449485	N/A.	10YR52	10YR52	10YR72	10YR72		Open fallow area near small							
247 589265 9448735 N/A. 7.5YR31 7.5YR31 7.5YR31 7.5YR31 7.5YR31 7.5YR31 7.5YR31 7.5YR32 7.5YR72 7.5YR7																		stream and homes.
305 247 589265 9448735 N/A. 7.5YR31 7.5YR31 7.5YR31 7.5YR31 7.5YR31 7.5YR31 7.5YR31 7.5YR72 7.	305	246	589265	9449235	N/A.	10YR62	10YR62	10YR62	10YR62	10YR62	10YR62	10YR66	10YR66	10YR66	10YR66	10YR66		Trough of active raised
2 cover, banana nearby. 248 589265 9448485 Charcoal @ 30cm. 10YR51 10YR51 10YR51 10YR51 10YR51 10YR51 10YR51 10YR51 10YR63 10YR64 10YR65 10YR66 10YR																		cassava shamba.
248 589265 9448485 Charcoal @ 30cm. 10YR51 10YR51 10YR51 10YR51 10YR51 10YR51 10YR63 10YR63 10YR63 10YR63 10YR63 10YR63 10YR63 . Fallow degraded raised cassava shamba. 305 249 589265 9448235 N/A. 7.5YR53 7	305	247	589265	9448735	N/A.	7.5YR31	7.5YR31	7.5YR31	7.5YR31	7.5YR72	7.5YR72	7.5YR72	7.5YR72	7.5YR7	7.5YR72	7.5YR72		Area under tree. Heavy leaf
Second S														2				cover, banana nearby.
249 589265 9448235 N/A. 7.5YR53 7.5YR5	305	248	589265	9448485	Charcoal @ 30cm.	10YR51	10YR51	10YR51	10YR51	10YR51	10YR63	10YR63	10YR63	10YR63	10YR63	10YR63		Fallow degraded raised
1																		cassava shamba.
305 250 589265 9447985 N/A. 10YR52 10YR52 10YR52 10YR52 10YR52 10YR56 10YR56 10YR56	305	249	589265	9448235	N/A.	7.5YR53	7.5YR53	7.5YR53	7.5YR53	7.5YR53	7.5YR31	7.5YR31	7.5YR31	7.5YR3	7.5YR31	7.5YR31		Open grass pasture on slight
Cassava plot & pasture. Cassava plot & pasture. September 251 Sep 265 9447265 N/A. 10YR71 10YR71 10YR72 10YR52 10YR52 10YR52 10YR52 10YR51 10YR81 10YR8														1				hill down to water.
305 251 589265 9447265 N/A. 10YR71 10YR71 10YR52 10YR52 10YR52 10YR52 10YR52 10YR81 10YR81 10YR81 10YR81 10YR81 10YR81 . Fallow cassava plot & pasture. 305 252 589265 9446985 N/A. 10YR52 10Y	305	250	589265	9447985	N/A.	10YR52	10YR52	10YR52	10YR52	10YR56	10YR56	10YR56	10YR56	-	ļ.	ļ.		Open area near active
Separation Sep																		cassava plot & pasture.
305 252 589265 9446985 N/A. 10YR52 10YR66 10YR66 10YR66 10YR66 10YR66 Open short grass pasture with palms. 305 253 589265 9446735 N/A. 10YR62 10YR62 10YR62 10YR62 10YR62 10YR62 10YR71 10YR71 10YR71 10YR71 10YR71 10YR71 10YR31 . Beneath stand of trees-	305	251	589265	9447265	N/A.	10YR71	10YR71	10YR52	10YR52	10YR52	10YR52	10YR81	10YR81	10YR81	10YR81	10YR81		Fallow cassava plot &
NA NA NA NA NA NA NA NA																		pasture.
305 253 589265 9446735 N/A. 10YR62 10YR62 10YR62 10YR62 10YR62 10YR62 10YR71 10YR71 10YR71 10YR71 10YR71 10YR71 10YR71 10YR71 . Beneath stand of trees-	305	252	589265	9446985	N/A.	10YR52	10YR66	10YR66	10YR66	10YR66	Open short grass pasture							
																		with palms.
heavy leaf litter and no grass	305	253	589265	9446735	N/A.	10YR62	10YR62	10YR62	10YR62	10YR62	10YR71	10YR71	10YR71	10YR71	10YR71	10YR31	.	Beneath stand of trees-
																		heavy leaf litter and no grass.

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