Continental Island Formation and the Archaeology of Defaunation on Zanzibar, Eastern Africa

Mary E. Prendergast*, Hélène Rouby2,3, Paramita Punnwong4, Robert Marchant5, Alison Crowther6, Nikos Kourampas7,8, Ceri Shipton9,10, Martin Walsh11, Kurt Lambeck3, Nicole L. Boivin12,13

1 Department of Sociology & Anthropology, Saint Louis University, Madrid, Spain, 2 Laboratoire de Géologie de l’École Normale Supérieure, UMR 8538 du CNRS, 75231 Paris, France, 3 Research School of Earth Sciences, The Australian National University, Canberra, ACT 0200, Australia, 4 Faculty of Environment and Resource Studies, Mahidol University, Salaya, Nakhon Pathom 73170, Thailand, 5 Environment Department, York Institute for Tropical Ecosystems, York, United Kingdom, 6 School of Social Science, The University of Queensland, Brisbane, Australia, 7 Office of Lifelong Learning, University of Edinburgh, Edinburgh, Scotland, United Kingdom, 8 Biological and Environmental Sciences, University of Stirling, Stirling, Scotland, United Kingdom, 9 McDonald Institute for Archaeological Research, University of Cambridge, Cambridge, United Kingdom, 10 British Institute in Eastern Africa, British Academy, Nairobi, Kenya, 11 Wolfson College, University of Cambridge, Cambridge, United Kingdom, 12 Research Laboratory for Archaeology and the History of Art, School of Archaeology, University of Oxford, Oxford, United Kingdom, 13 Max Planck Institute for the Science of History, Jena, Germany

* mprendergast@post.harvard.edu

Abstract

With rising sea levels at the end of the Pleistocene, land-bridge or continental islands were formed around the world. Many of these islands have been extensively studied from a biogeographical perspective, particularly in terms of impacts of island creation on terrestrial vertebrates. However, a majority of studies rely on contemporary faunal distributions rather than fossil data. Here, we present archaeological findings from the island of Zanzibar (also known as Unguja) off the eastern African coast, to provide a temporal perspective on island biogeography. The site of Kuumbi Cave, excavated by multiple teams since 2005, has revealed the longest cultural and faunal record for any eastern African island. This record extends to the Late Pleistocene, when Zanzibar was part of the mainland, and attests to the extirpation of large mainland mammals in the millennia after the island became separated. We draw on modeling and sedimentary data to examine the process by which Zanzibar was most recently separated from the mainland, providing the first systematic insights into the nature and chronology of this process. We subsequently investigate the cultural and faunal record from Kuumbi Cave, which provides at least five key temporal windows into human activities and faunal presence: two at the end of the Last Glacial Maximum (LGM), one during the period of post-LGM rapid sea level rise and island formation, and two in the late Holocene (Middle Iron Age and Late Iron Age). This record demonstrates the presence of large mammals during the period of island formation, and their severe reduction or disappearance in the Kuumbi Cave sequence by the late Holocene. While various limitations, including discontinuity in the sequence, problematize attempts to clearly attribute
defaunation to anthropogenic or island biogeographic processes, Kuumbi Cave offers an unprecedented opportunity to examine post-Pleistocene island formation and its long-term consequences for human and animal communities.

Introduction

Rising seas at end of the Last Glacial Maximum (LGM) in the terminal Pleistocene transformed coastlines, drowning land bridges and leaving islands in their wake. Particularly notable examples of continental or land-bridge islands are found in modern-day Indonesia, New Guinea, Tasmania, and Britain, but numerous smaller islands were also formed along coastlines across the globe. The isolation of nascent islands can have significant impacts on fauna [1-4], including loss of species diversity through a process known as faunal relaxation. Most studies of faunal relaxation, however, come from modern cases, often artificial "islands" formed through damming or habitat fragmentation, for example [5-9]. Fossil records for recently formed continental islands are rare [10-12], and in many cases, studies of faunal change are complicated by human colonization [13-15]. Long-term paleoecological and archaeological records are therefore critical to address the complex interaction of influences on island biota, including island biogeography, climate change, and anthropogenic habitat modification, hunting, and species translocations. An understanding of the long-term dynamics of faunal change is not only essential to address these issues, but is also central to the conservation of island biodiversity today [15], particularly in an era of intensive human-mediated defaunation [16].

In the western Indian Ocean, studies of island biogeography and the impacts of human settlement on faunal biota have been largely limited to the late Holocene and have focused on Madagascar [17-19] or oceanic islands such as the Mascarenes [20-24] and Comoros [21, 25-28]. The continental islands of eastern Africa, including the Lamu, Mafia, and Zanzibar archipelagos, lack faunal records with sufficient time-depth to permit analysis of the effects of post-LGM island formation, with one important exception. Archaeological fieldwork at Kuumbi Cave (S 6°21'40", E 39°32'33"), on Zanzibar Island (also known as Unguja Island), has revealed the deepest cultural and faunal sequence for any island in the region. This site offers a unique temporal perspective, enabling an examination of faunal change and human impacts during the terminal Pleistocene and Holocene.

Zanzibar is the largest island in the eponymous archipelago. Unlike the second-largest island of Pemba, which has been isolated since at least the early Pliocene [29] (cf. [30]), Zanzibar has been periodically part of the mainland during sea level lowstands associated with Quaternary glaciations. Zanzibar would, however, have been an island during most Quaternary interglacial periods and was most recently separated from the mainland when sea levels rose following the LGM. Zanzibar is also by far the best-documented island in the region in terms of geology, contemporary flora and fauna, and ethnography of recent hunting and animal consumption practices [28, 31-35]. This is largely thanks to Zanzibar’s longstanding prominence in global economies, illustrated by its role in, for example, the premodern spice trade and, more recently, global tourism [36-37]. Zanzibar thus makes an excellent case study for exploring the effects of island formation and human occupation on animal populations.

Despite this research history, there are major gaps in our knowledge of Zanzibar. The first is the temporal and spatial sequence of the island’s separation from the mainland following the LGM, and the establishment of the economically important mangroves and reefs that fringe the island. While the separation of Zanzibar has been discussed in general terms [29, 34, 38], no detailed study of its terminal Pleistocene-early Holocene formation has been made, even though this is imperative to understanding the island’s history and biogeography, as well as its