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Managed agroforests, swiddening, and the introduction of pigs in Pohnpei, Micronesia: Phytolith evidence from an anthropogenic landscape

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ABSTRACT

Phytolith analysis is increasingly contributing to archaeological studies, especially in the context of agriculture in tropical regions. Plant remains from archaeological sites provide key information on such topics as site function, settlement, past dietary patterns, migrations, and landscape formation. However, in the humid tropics, where good preservation of organic materials is uncommon, identifiable plant macroremains are relatively rare. The inorganic nature of phytoliths makes them a useful tool in Pacific environments. In this study, we analyze phytolith remains from garden features in archaeological context from a western Pacific volcanic island, Pohnpei, Federated States of Micronesia. To understand the manipulation of floral environments, especially agricultural practices, we examine hypotheses regarding how agricultural landscapes were impacted by changes in social and economic systems during the island's late prehistoric and early historic periods; these changes include elaboration of chiefly feasting and the introduction of pigs in the 19th century. Previous research on Pohnpei (e.g. Haun, 1984; Ayres and Haun, 1985, 1990; Ayres et al., 2009; Athens and Stevenson, 2012) has examined Pohnpeian agriculture and sociopolitical change through the study of archaeological features and pollen cores. This project is one of the first, to our knowledge, to examine phytolith data from archaeological contexts on the island. Samples from archaeological gardening contexts document how agricultural landscape shows a response to swiddening, landscape succession patterns, and introduced animals within the managed agroforest. However, phytolith analysis alone is not sufficient and must be used in conjunction with other archaeological data in hypothesis testing.

1. Introduction

Phytolith analysis is becoming an increasingly important tool in the study of past vegetation change and human–plant interactions around the world. In tropical regions, where preservation of organic material is poor, phytoliths, which are composed of SiO_2, are the only plant materials remaining at some archaeological sites. The acidic soils of the Pacific's volcanic landforms can compound the preservation issue, making direct evidence of food production even more difficult to find. Thus, in the Pacific Islands, and indeed on all tropical volcanic islands, phytolith analysis is a tool with a great deal of potential to answer questions about food production practices, vegetation changes, and human–environment relationships (e.g. Denham et al., 2003; Lentfer and Green, 2004; Piperno, 2006; Tromp and Dudgeon, 2015).

This paper examines the use of phytolith analysis combined with direct archaeological methods to better understand past gardening landscapes in Pohnpei, Micronesia. Specifically, we are interested in how gardening practices impacted landscapes in the late prehistoric and historic periods. While there has been some pollen research on Pohnpei, providing a broader regional picture of island vegetation (Haun, 1984; Athens and Stevenson, 2012), this project is the first to use phytoliths to understand landscape on a localized gardening scale. Pollen disperses easily, a characteristic that evolved for the successful propagation of plant species. However, phytoliths form part of the plant structure and are not adapted for dispersal, so their signature is generally much more local (Piperno, 2006). Thus, phytolith analysis can be applied towards understanding the environment of local garden landscapes.

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This study, part of a larger long-term project based at the University of Oregon on Pohnpeian prehistory (e.g. Ayres and Haun, 1985, 1990; Ayres, 1990, 2003; Ayres et al., 2009), uses evidence from two selected archaeological features to understand gardening patterns in localized contexts. The first is an active garden area under long-term use. The second is a yam cultivation enclosure. These two features provide phytolith and microcharocal data that point to swiddening in garden management. In addition, the garden area suggests that the introduction of pigs may have altered the garden landscape by encouraging the growth of annual species.

2. Regional and local setting

The island of Pohnpei is located in the western Pacific Ocean, in central-eastern Micronesia, within the Federated States of Micronesia at 6° 54′ N, 158° 14′ E (Fig. 1). It is a high (volcanic) island, with a central peak located 790 m above sea level (Fig. 2). The area of the island is 310 km^2, making it one of the largest islands in Micronesia. Barrier and fringing coral reefs surround the island to form a lagoon. Due to the mountainous nature of the island, much of the past and present settlement has been along the coastline, although parts of the interior were also extensively utilized (e.g. Davidson, 1967; Bath, 1984).

Pohnpei has one of the highest rates of precipitation in the world, with annual rainfall of 4700 mm in inhabited areas and also a high annual temperature of 29 °C (Bascom, 1965; Haun, 1984). However, humidity and precipitation are somewhat lower between November and June, when trade winds dominate the weather patterns. Ethnographically, this season is referred to as *isol*, while the portion of the year from July–October is referred to as *rahk*. During *isol*, Pohnpeians focus on yam cultivation, while during *rahk*, the focus is on breadfruit cultivation (Hunter Anderson, 1991; Merlin et al., 1992; Balick, 2009).

Pohnpei is divided into several ecological zones that are distributed roughy like concentric circles around the island (Haun, 1984; Balick, 2009). The immediate shoreline is dominated by mangrove forest, and strand vegetation is located slightly inland. Mixed managed forests are located inland from strand vegetation, while rainforests dominate the interior mountains (Haun, 1984; Ayres and Haun, 1985, 1990; Hunter-Anderson, 1991; Balick, 2009). Pohnpeians live and produce the vast majority of their plant foods in the mixed-managed forest zone. These forests are dominated by plants such as breadfruit *(Artocarus altilis*), coconut (*Cocos nucifera*), bananas (*Musa* sp.), yams (*Dioscorea* sp.), taro (*Colocasia esculenta*, *Cyrtosperma merkusii, Alocasia macrorrhizos*, *Xanthosoma sagittifolium*), hibiscus (*Hibicus tiliaceus*) and kava/*sakau* (*Piper methysticum*). Many of the most important plants are not indigenous; they were brought to Pohnpei by initial settlers at the time of colonization.

The earliest evidence of possible occupation comes from pollen cores in the Leh en Luhk Swamp in Awak dating to 2330–2920 cal BP, indicating environmental disturbance (Haun, 1984; Ayres and Haun, 1990); this core contains high levels of charcoal likely resulting from land clearing. The earliest dates of occupation with secure archaeological context in Pohnpei come from Temwen Island, specifically at the Nan Madol Site. Ayres (1990) has dated pre-islet reef deposits containing ceramics to 2000 BP; Athens (1980, 1990) has also reported early pottery in the area. Between 1600 and 1000 BP, there seems to have been a shift towards permanent cultivation plots incorporating significant arboriculture. Ayres and Haun's archaeological data also demonstrate that food production became intensified, supporting what has been ethnographically

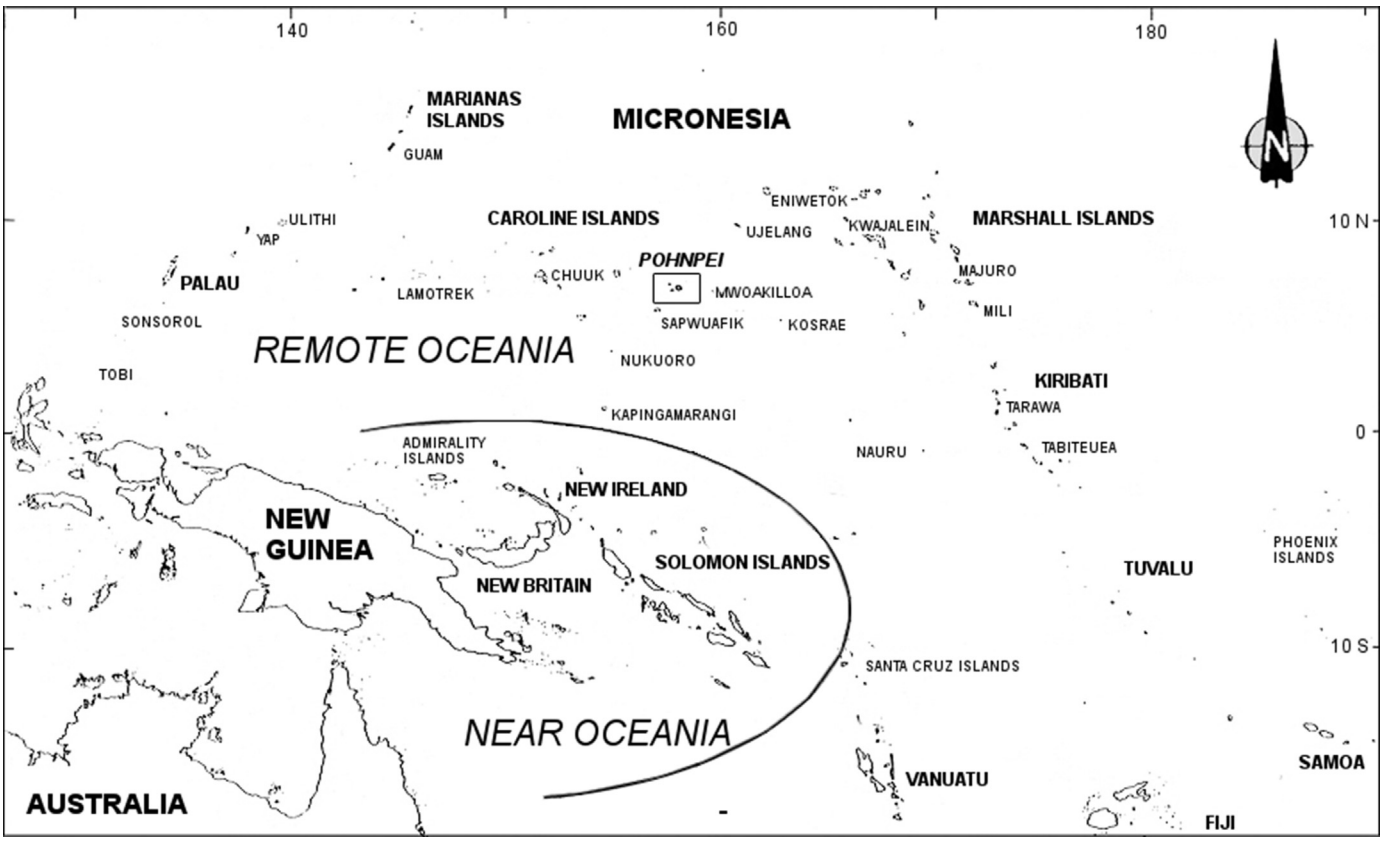

Fig. 1. Map of the western Pacific Ocean. Modified from original map by W.S. Ayres.

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