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# The prevalence and importance of niche construction in agricultural development in Polynesia

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ABSTRACT

The practice of cultivation has an immediate and long-lasting effect on the environment. Often, we tend to think of these effects in terms of immediate production outcomes, notably increased plant production. However, such modification of the environment has the potential to directly influence of rate and trajectory of agricultural development more generally. Using niche construction, a concept that has proven effective to understand subsistence change elsewhere, we examine pathways of agricultural change in Polynesia. We highlight the prevalence of niche construction in agricultural trajectories in the region, using both a summary of evidence through Polynesia as well as a targeted case study, and illustrate a framework for organizing those trajectories. In doing so, we build on previous attempts at examining the relationship between cultivation and adaptation in the region, which, given that Polynesia is thought of as a model system for investigating human-environmental relationships, can be used as a more general model of agricultural change globally.

## 1. Introduction

No concept has been more important to the study of agricultural change, both past and present, than intensification. Defined as increased labor or capital inputs per unit of land (Brookfield, 1972), intensification provided Boserup (1965:13) a general framework for the study of agricultural change. The concept of intensification spurred the development of an archaeology of agriculture (see Morrison, 1994), creating a research environment where general patterns of agricultural change in different areas were increasingly compared. While intensification has been undoubtedly useful in archaeology, important critiques have been made of both the fundamental assumptions of the original intensification model (Morrison, 1994) and the general usefulness of the concept in archaeology itself (Leach, 1999). Intensification is often part of a typological scheme (after Morrison, 1996) used for broad comparative purposes, but frequently lacking a clear definition (Leach, 1999). Such a typological approach often views variation between intensive and non-intensive agriculture in transformational or essentialist terms (cf. Hart, 1999). These critiques have led to calls to identity alternative ways to conceptualize agricultural change (Brookfield, 2001), especially those alternatives that integrate process and history (Kirch, 1994).

Niche Construction Theory (NCT) (Odling-Smee et al., 2003) provides a useful alternative to intensification for the investigation of archaeologically identifiable agricultural behaviors. Niche construction concerns the ways in which the actions of organisms impact the selective environment of themselves and other organisms. Since cultivation is simply the manipulation of the environment to create conditions for another organism to survive, niche construction is a logical perspective to underpin the archaeological investigation of changing cultivation practices. The premises and potential applications of this framework have been thoroughly examined in the discipline (e.g., Brock et al., 2016; Broughton et al., 2010; Laland and O'Brien, 2010, 2011) and several researchers have begun to investigate agricultural change and other subsistence activities as niche construction (e.g., Collard et al., 2011; O'Brien and Laland, 2012; Rowley-Conwy and Layton, 2011; Scarborough, 2015; Smith, 2007, 2009; Terrell et al., 2003; Wilkinson et al., 2012, 2015; Zeder, 2012). These researchers have highlighted the long-lasting impacts of subsistence activities on environments, other biota, and the environmental and social context within which activities are practiced (e.g., political systems, soil nutrients, previous infrastructural development).

The power of humans to construct niches is exemplified by the ancient colonizers of the Pacific who transported their landscapes (Kirch, 1982), bringing with them plants, animals, and ideas that would transform their new island homes. Cultivation practices in Polynesia (Fig. 1) are variable, reflecting colonization histories, environmental variation, and changing social and cultural practices within related

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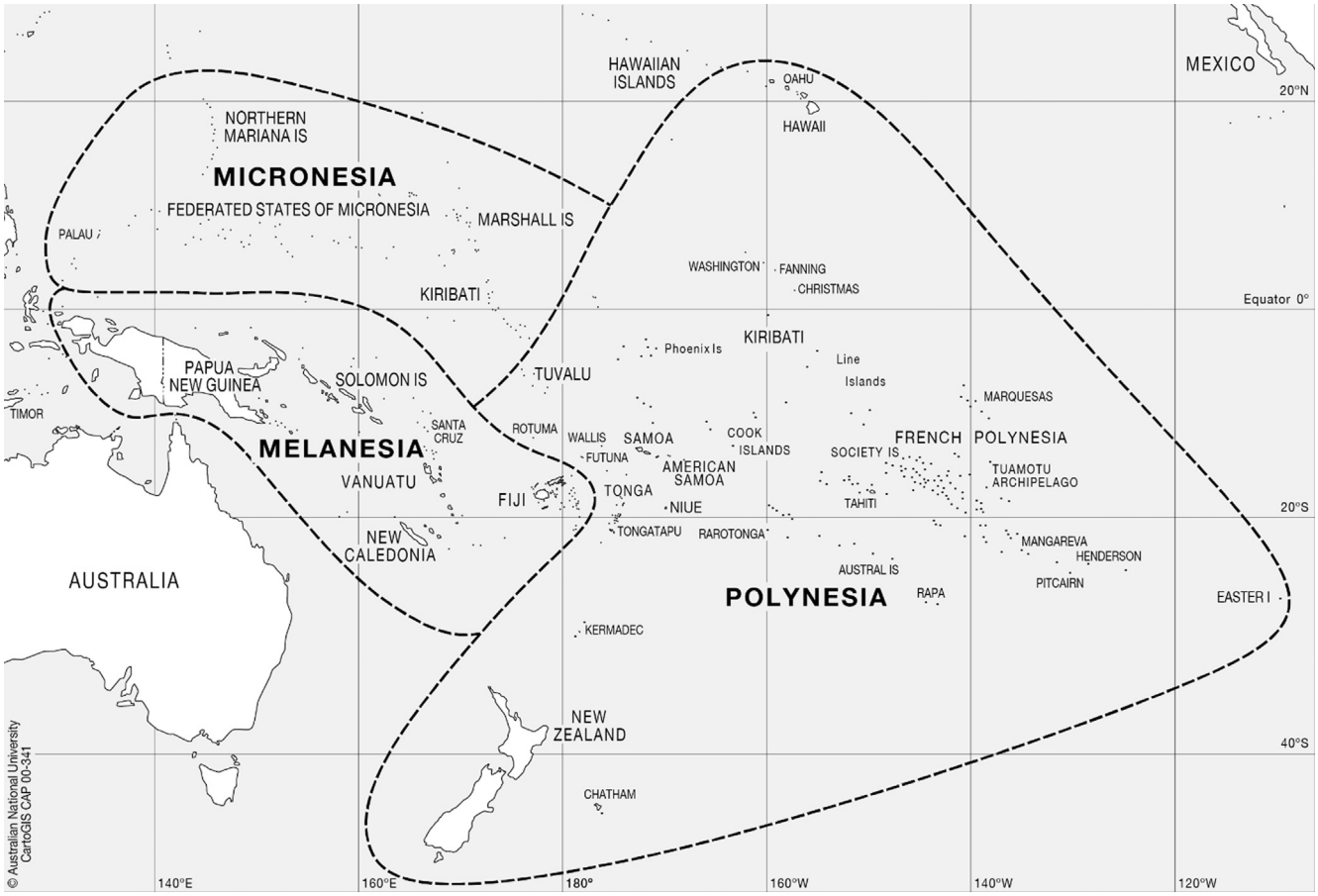


**Fig. 1.** Oceania with Polynesia defined and island groups identified.
Source: CartoGIS services, College of Asia and the Pacific, The National University of Australia

populations inhabiting relatively bounded island ecosystems. Because of this, agricultural practices in Polynesia are a potentially important example of how niche constructing activities have affected the evolution of subsistence systems and socio-ecosystems more generally. Polynesia is not the only region of Oceania where niche construction occurred, as similar practices and sequences also developed in Melanesia and Micronesia. However, here we are using Polynesia as a case study to illustrate these region-wide patterns. In the following section we summarize NCT, paying particular attention to aspects relevant to agriculture. In subsequent sections, we review agricultural change in Polynesia highlighting the fit with niche construction expectations and provide a detailed example from Tikopia to highlight the importance of niche construction in sequences of agricultural change. We conclude by suggesting ways to improve our understanding of the constructed landscapes created through agricultural economies in Polynesia by integrating process and history through the conceptual framework of NCT.

## 2. Niche construction

Lewontin (1982) has long argued that the organism and environment co-evolve. Notably the organism has the ability to modify the environment, actively creating its own selective pressures, which then feedback on future generations. Defined by Laland et al. (2015:4), "niche construction refers to the process whereby the metabolism, activities, and choices of organisms modify or stabilize environmental states, and thereby affect selection acting on themselves and other species." In general, niche construction relates to the evolution of the context of development. Tenets of niche construction acknowledge the influence of past actions in shaping the physical and cultural environments that affect behavioral change by modifying the relative benefits of one path of development or another (Laland et al., 2014). This ability to influence the direction and rate of evolution through behavior is not a restricted process, but, rather, nearly universal (Odling-Smee et al., 2003:18).

Niche construction works in two ways: relocation and perturbation (Odling-Smee et al., 2003; see also discussion in Laland and O'Brien, 2010:306–307). Relocation is simply the movement of a group of organisms to a new habitat. The new habitat, with different environmental characteristics, often exhibits new selective pressures. In reference to humans, a hypothetical scenario may involve a coastal to inland population movement: a move that includes responses to new niches, defined as the sum of the habitat requirements and behaviors allowing a species to persist, and potential hazards. With respect to cultivation, these new environments might feature hazards, topography, or soils that favor certain cultivation techniques or strategies[1] over others. Alongside relocation, perturbation relates to the ecosystem engineering capacity of organisms, humans especially. Ecosystem engineering is the ability of organisms to control the availability and abundance of resources in their ecosystem (Jones et al., 1994), which then affects other organisms. The environment can be manipulated to suit the organism and this modified environment is then inherited by

[1] Terms such as strategy and technique have no generally accepted archaeological definition. Here we use technique to mean a single behavioural class that has a definitive archaeological signature, such as lithic mulch or pondfield. Strategies refer to groups of behaviors, such as those that increase labor inputs or expand areas under cultivation, undertaken for a desired outcome (e.g., increased production, decreased variance). Strategies might have unknown or undesired consequences in conjunction with or absent of the desired outcomes.