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## Comment: Rethinking the Origins of Agriculture

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# A Practice-Centered Method for Charting the Emergence and Transformation of Agriculture

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The conversation dedicated to rethinking the “origins of agriculture” and presented as a series of papers in this issue is, in principle, welcome. My problem with several contributions (Bellwood 2009; Bettinger, Richerson, and Boyd 2009; Cohen 2009; Hayden 2009; Winterhalder and Kennett 2009; all in this issue) is that they remain locked into conceptual frameworks and interpretative positions that arose 20 or 30 years ago. Although this inheritance has a profound influence on all those working on early agriculture in different regions of the world, there is a problem: researchers can limit their horizons to defending and developing prior propositions rather than maintaining an openness to new directions in conceptualizing and investigating early agriculture (e.g., Denham 2007a; Denham, Iriarte, and Vrydaghs 2007). This contribution is intended to be a counterpoint, in which I summarize a practice-centered method recently designed to understand the emergence and transformation of agriculture. The method is illustrated with data with which I am most familiar, from the highlands of New Guinea.

### Outline of Method

My starting point is the concept of “practice,” a term that in a general sense refers to habitual activity or customary modes of action (following Bourdieu 1990). A practice-centered approach is useful for archaeologists studying early agriculture because it focuses attention on the evidence of what people did in the past in terms of burning, forest clearance, transplanting, plot preparation, digging, staking, tillage, and so on. These are the relatively generic constituent practices that make up different forms of plant exploitation. Within this framework, forms of plant exploitation are higher-order categories associated with the co-occurrence, or bundling, of different practices in given historicogeographical contexts. Practices

provide a common conceptual ground to compare different forms of plant exploitation, such as agriculture and foraging, and to chart how they were transformed through time and across space (Denham 2007b, 2008; Denham, Fullagar, and Head 2009; Denham and Haberle 2008; Fairbairn 2005).

Forms of plant exploitation varied considerably across New Guinea in the recent past and are presumed to have done so in the distant past (Denham 2005). Even today, cultivation practices and major crop plants can vary from one valley to another and do vary considerably over wider geographical scales (Bourke and Harwood, forthcoming). Consequently, for those seeking to understand plant exploitation in the distant past, particularly the emergence of agriculture, the conflation of records from geographically dispersed regions may provide a highly inaccurate portrayal of what actually happened at any given locale: the interpretative sum becomes greater than the evidential parts.

### Early Agriculture in the Upper Wahgi Valley

A range of disciplines contribute to our current understanding of the long-term history of plant exploitation and the emergence and transformation of agriculture in the highlands of New Guinea. Methodologically, different types of research, including archaeology, genetics, and paleoecology, provide both direct and indirect evidence of practices in the past. Although the results of each discipline are additive, archaeological data can often be used to clarify and ground more indirect, less specific evidence of practices in the past. To illustrate, archaeological evidence that people cultivated and drained the wetland margin at Kuk has grounded more equivocal lines of evidence, including paleoecological evidence of anthropic landscape transformation and archaeobotanical evidence for the presence and use of food plants, thereby enabling the development of more robust interpretations of

plant exploitation and early agriculture in the past (discussed in Denham 2007*b* and Denham and Haberle 2008).

A chronology of practices in the past can be constructed for the upper Wahgi Valley from various lines of evidence and cross-referenced with forms of plant exploitation documented ethnographically (fig. 1). The historicogeographic specificity of the chronology is secure because it is primarily derived from archaeological, geomorphological, and paleoecological investigations at sites within a relatively confined region. If a broader scale of analysis is used, the chronology would be decontextualized in social and spatial terms (also see Kuijt 2009, in this issue); we would not know specifically that people in a given locale actually brought together, or bundled, practices in these ways.

The practice-centered method advanced here clearly charts the temporal bundling of practices and the transformation of plant exploitation through time in the upper Wahgi Valley (fig. 2). Continuities with earlier forms of plant exploitation are demonstrated; transformations and augmentation of the repertoire result from the adoption of additional practices, whether of local innovation or extralocal introduction. The approach is designed to focus on the transformative nature

of plant exploitation through time rather than viewing each form as a static or monolithic entity.

### Hypothetical Scenario of Plant Domestication

A focus on practices separates the identification of early agriculture in the past from associated—and often secondary—phenomena such as domestication, as well as landscape transformation, sedentism, social complexity, and so on (see Denham 2006, 2007*b* for elaboration). From a practice-centered perspective, the varying degrees of domestication evident in traditional New Guinea cultivars are the accumulation of phenotypic and genotypic attributes derived from varied and successive forms of human management, including selection of ecotypes, management of favored plant stands, planting beyond natural range, focused vegetative propagation beyond natural range, and selection for parthenocarpic, seed-suppressed, and sterile forms as well as for less toxic forms.

Although the human role in the creation of cultivars in New Guinea is acknowledged and can be genetically verified (see Lebot 1999 for a review), we do not yet have robust

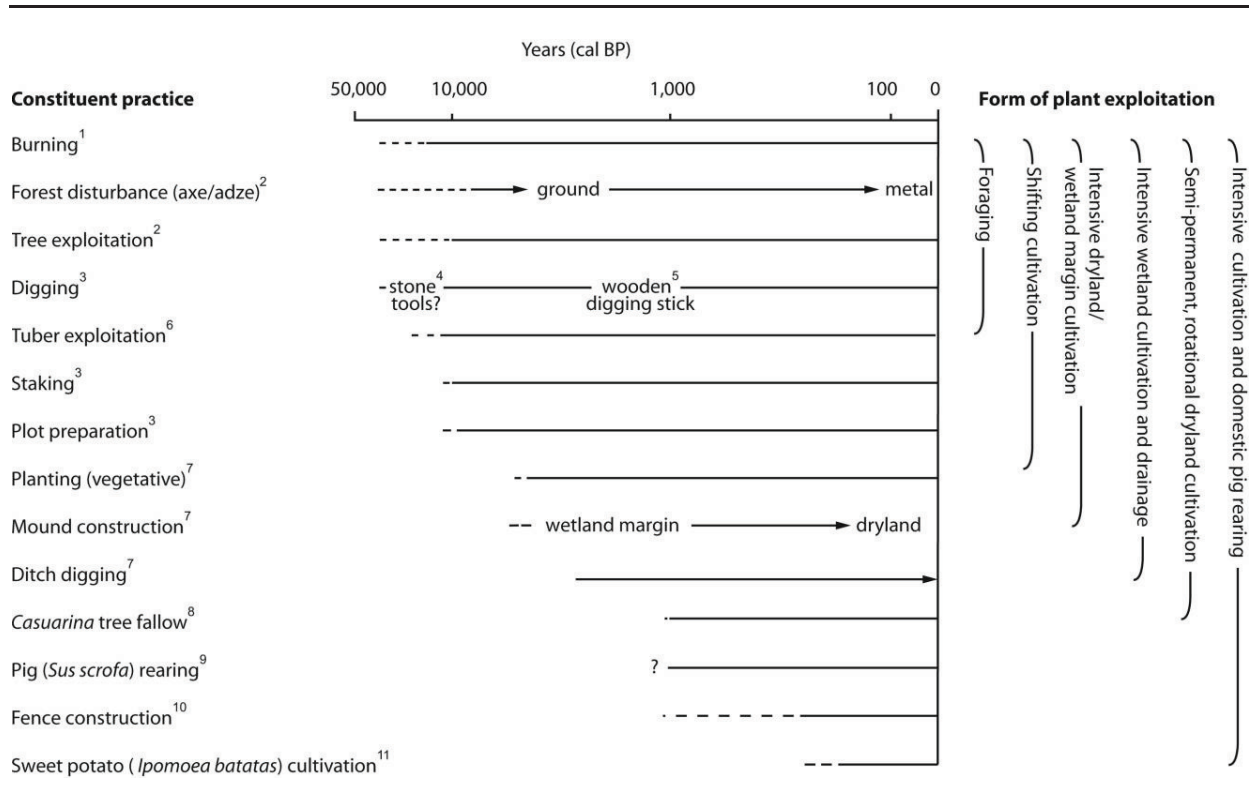


Figure 1. Chronology of practices and forms of plant exploitation in the upper Wahgi Valley (fig. 6 of Denham, Fullagar, and Head 2009). Sources: 1. Denham, Haberle, and Lentfer 2004; 2. Christensen 1975; 3. Denham 2005; 4. Bulmer 2005; 5. Golson et al. 1967; 6. Fullagar et al. 2006; 7. Denham et al. 2003; 8. Haberle 1998; 9. Conservative estimate of introduction to the highlands; 10. Golson 1977; 11. Golson 1982.

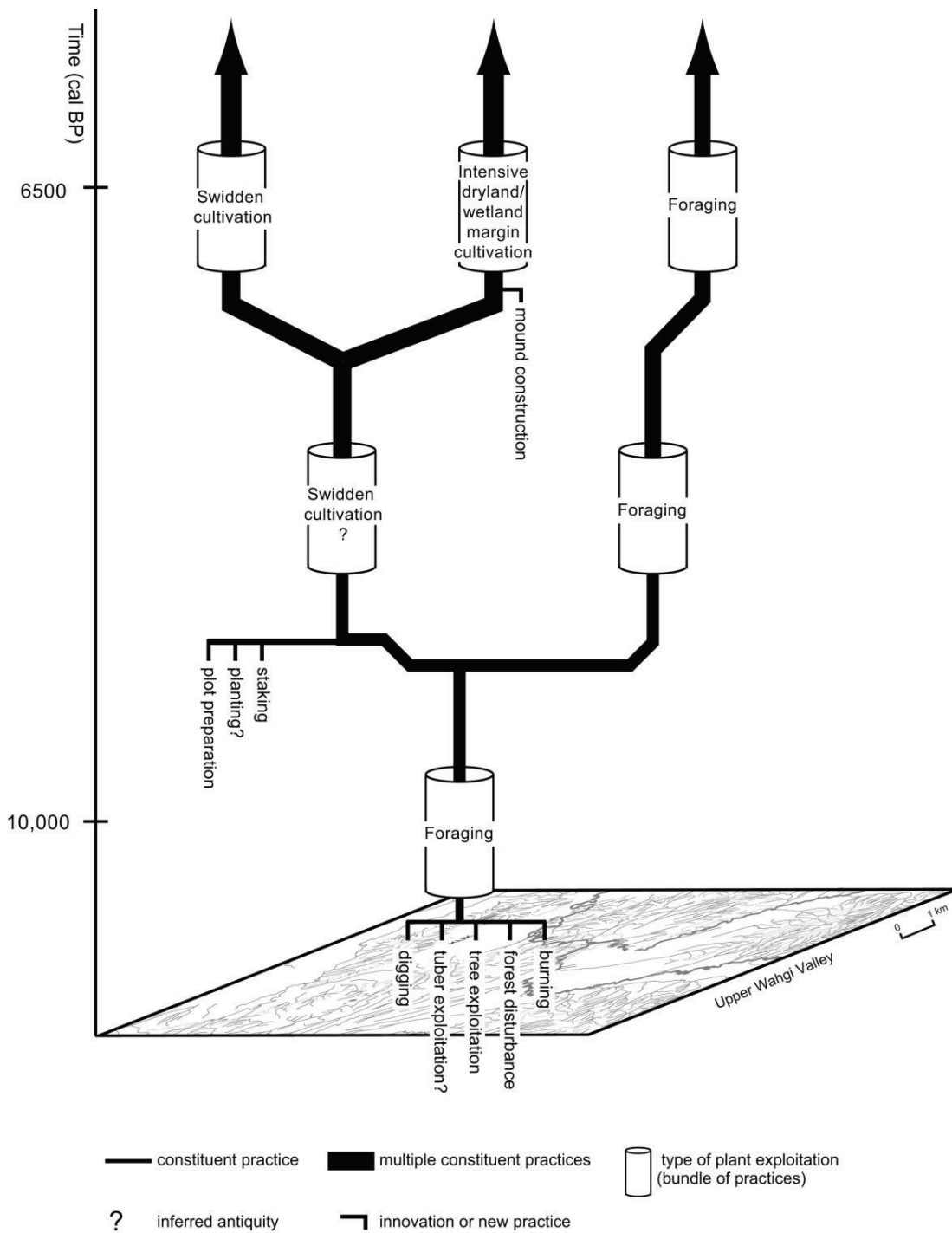


Figure 2. Bundling of practices and transformation of plant exploitation in the upper Wahgi Valley during the early Holocene (amended version of fig. 10 in Denham and Haberle 2008, following style of Gregory 2000, 831, and fig. 2 in Hägerstrand 1970).

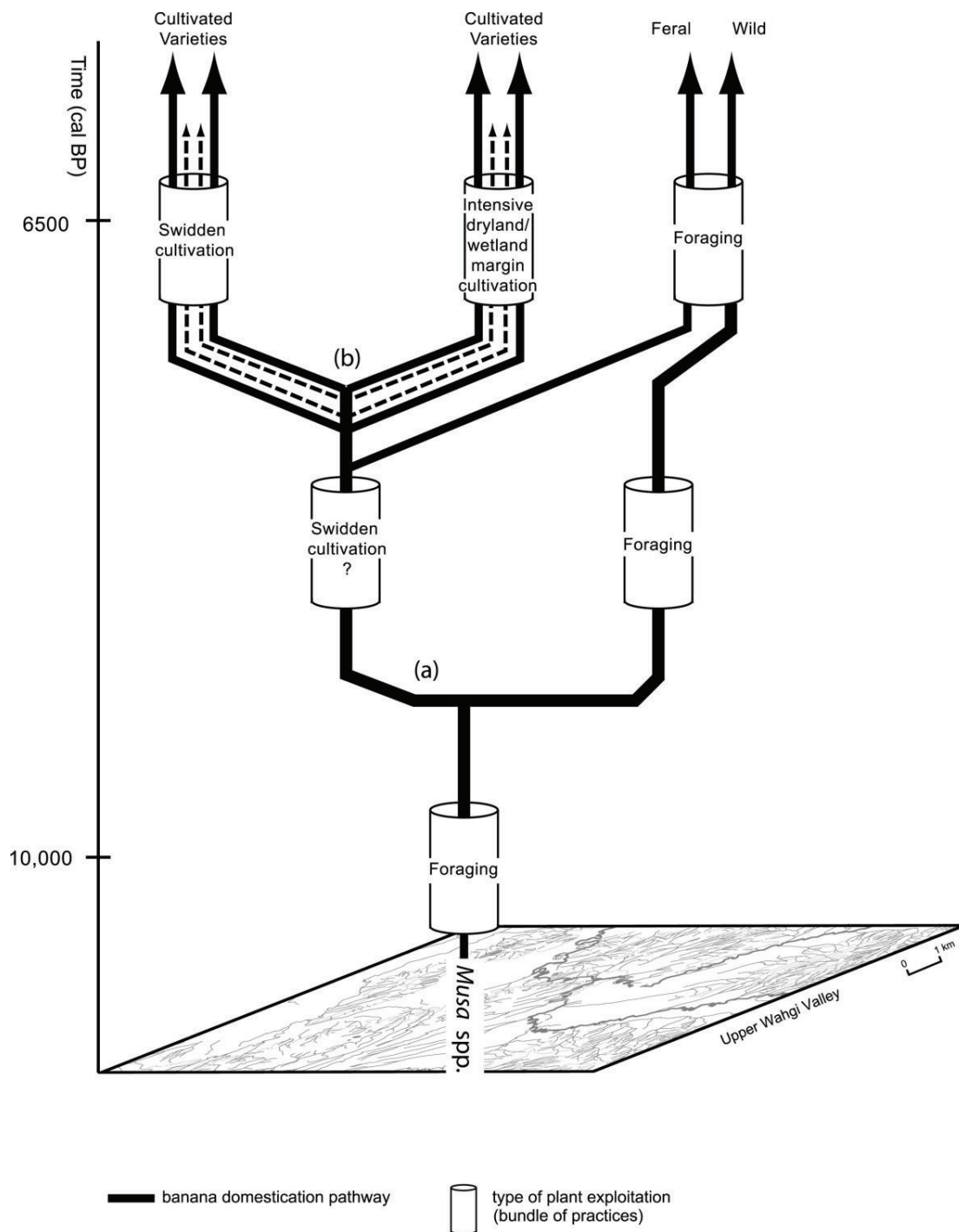


Figure 3. Hypothetical scenario of banana domestication superimposed on forms of plant exploitation in the upper Wahgi Valley during the early Holocene: *a*, initial planting of wild stock, most probably via vegetative propagation; *b*, more systematic vegetative propagation of cultivated stock, leading to the creation of an array of cultivars.

archaeobotanical chronologies for charting different stages of the domestication process for any food plant. Archaeobotanical evidence currently enables only chronologies of presence, processing, and planting to be constructed (see table 2 of Denham 2005; also consider Yen 1996). Even though the evidence is lacking, we can integrate information regarding past practices and archaeobotanical data to generate informed hypotheses regarding the stages of domestication for some food plants at specific locales in the past. The approach can be illustrated if we consider how certain food plants might have been transformed through time after their incorporation into different forms of plant exploitation. The general method can be exemplified with respect to a hypothetical domestication scenario for bananas (*Musa* spp.; fig. 3).

Although *Musa* spp. grew in the Kuk vicinity during the terminal Pleistocene and early Holocene, the most significant species for the history of banana domestication is *Musa acuminata* ssp. *banksii* (Carreel et al. 2002; De Langhe and de Maret 1999; Denham et al. 2003; Perrier et al. 2009). From the history of plant exploitation in the upper Wahgi Valley (fig. 2), we can speculate that bananas were probably exploited by foragers as part of broad-spectrum diets. Through time, people began to focus on starch-, fat-, and protein-rich plants, of which banana was one (Denham and Barton 2006). During the early Holocene, and potentially earlier, people began to move bananas around the landscape, either through the planting of seed or through the vegetative propagation of suckers. It is not known with certainty whether *M. acuminata* ssp. *banksii* spread to the upper Wahgi Valley during the early Holocene as a result of human agency, wetter and warmer climates during the early Holocene, or a combination of the two. Similarly, it is not possible to determine whether the plants documented archaeobotanically at this time still retained the potential to reproduce sexually or whether they reproduced asexually (clonally).

During the early Holocene, people are likely to have planted bananas and, plausibly, other plants as well as to have exploited a range of wild plants. By ca. 7000/6500 cal BP, multiple lines of evidence indicate cultivation, including bananas, on the wetland margin at Kuk (Denham et al. 2003; Denham, Haberle, and Lentfer 2004). Genetic research suggests that persistent cultivation of *M. acuminata* ssp. *banksii* diploids, especially if vegetative, may have favored the anthropic selection of parthenocarpy, production of mature fruit without fertilization; seed suppression, reduction in size of seeds and increased proportion of pulp within fruit; and sterility, inability of plants to reproduce sexually (De Langhe et al. 2009; Perrier et al. 2009; cf. associated issues concerning gene expression in Gremillion and Piperno 2009, in this issue). Some of these cultivars plausibly interbred with feral and wild plants, at least until the advent of cooler, drier, and more variable climates during the mid-Holocene (Brookfield 1989), after which sexual reproduction of plants in some highland locations probably ceased. Continued anthropic selection, via veg-

etative propagation, of cultivated plants led to the creation of an array of cultivars.

Although multidisciplinary evidence of past practices can be superimposed with a hypothetical history of the early stages of banana domestication, this scenario is unlikely to be unique to the upper Wahgi Valley or even the highlands of New Guinea. Hypothetical histories for the domestication of other food plants could also be sketched for the highlands, including *Pandanus* spp., sugar cane (*Saccharum officinarum*), taro (*Colocasia esculenta*), and some yams (*Dioscorea* spp.). The archaeobotanical verification of these domestication hypotheses requires new fieldwork, the acquisition of suitable samples, and the systematic application of plant macrofossil and microfossil techniques, especially phytolith, starch grain, and parenchyma analyses.

## Concluding Point

People in New Guinea have continually expanded their plant exploitation repertoire over time through the adoption of local innovations or extralocal introductions, in terms of both practices and plants. There are clear continuities in forms of plant exploitation through time, especially from foraging to the earliest forms of agriculture. Although we may be no nearer answering the question of why agriculture emerged, we do have better conceptual and methodological tools to investigate the history of long-term agriculture and plant domestication, to generate hypotheses concerning how forms of plant exploitation changed through time, and to drive the search for new substantive information about the past.

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