Archaeology in Oceania

Archaeology in Oceania, Vol. 58 (2023): 275–295
DOI: 10.1002/arco.5302

Putting the *Dark Emu* debate into context

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ABSTRACT

In this review of the Dark Emu *debate we start out by summarising Bruce Pascoe's original work and Peter Sutton and Keryn Walshe's critique. However, the majority of this contribution is to place this Australian-focussed debate into broader conceptual, methodological and evidential contexts generally associated with the investigation of early agriculture in other parts of the world. If we are to apply the term "agriculture" to Aboriginal plant management practices, then this requires a global, rather than a continental-centric comparative perspective. We argue debates regarding the character of plant exploitation practices on the Australian mainland, including whether they included forms of agriculture or experimental horticulture, have been hindered by a lack of terminological clarity, the absence of a methodological framework to assess empirically verifiable evidence, and – even more problematically – a lack of relevant data on the putative plants and practices involved. Here, terminology is clarified and a bottom-up, practice-based method is advocated for the assessment of recent (using oral, visual and written histories) and ancient (using archaeological, archaeobotanical and palaeoecological evidence) forms of food plant exploitation in Australia. The terminology and methodological framework are heuristically applied to three scenarios: (1) ethnographic and historical records for the exploitation of underground storage organs (USOs) on the Australian mainland; (2) historical documentation regarding the botany, potential human roles in dispersal, and Aboriginal exploitation of banana (*Musa *spp.), taro (*Colocasia esculenta*) and greater yam (*Dioscorea alata*) in northern Australia and (3) archaeobotanical evidence for the exploitation of USOs and other plants from The Top End.*

Keywords: plant exploitation, archaeobotany, agriculture, cultivation practices, Indigenous Australia, resource intensification, exploitation des plantes, archéobotanique, agriculture, pratiques culturales, Aborigène Australie, intensification des ressources

RESUME

Dans cette revue du débat sur Dark Emu*, nous commençons par résumer le travail original de Bruce Pascoe et la critique de Peter Sutton et Keryn Walshe. Cependant, la majeure partie de cette contribution consiste à placer ce débat axé sur l'Australie dans des contextes conceptuels, méthodologiques et probants plus larges généralement associés à l'étude de l'agriculture primitive dans d'autres parties du monde. Si nous devons appliquer le terme "agriculture" aux pratiques de gestion des plantes autochtones, cela nécessite une perspective comparative globale plutôt que continentale. Nous discutons des débats concernant le caractère des pratiques d'exploitation des plantes sur le continent Australien, y compris le fait qu'ils incluent des formes d'agriculture ou d'horticulture expérimentale, ont été entravés par un manque de clarté terminologique, l'absence d'un cadre méthodologique pour évaluer les preuves empiriquement vérifiables et, ce qui est encore plus problématique, un manque de données pertinentes sur les plantes et les pratiques présumées concernées. Ici, la terminologie est clarifiée et une méthode ascendante, basée sur la pratique, est préconisée pour l'évaluation des formes récentes (à l'aide d'histoires orales, visuelles et écrites) et anciennes (à l'aide de preuves archéologiques, archéobotaniques et paléoécologiques) d'exploitation des plantes alimentaires en Australie. La terminologie et le cadre méthodologique sont appliqués heuristiquement à trois scénarios: (1) documents ethnographiques et historiques pour l'exploitation des organes de stockage souterrains sur le continent australien; (2) la documentation historique concernant la botanique, les rôles humains potentiels dans la dispersion et l'exploitation aborigène de la banane (*Musa *spp.), du taro (*Colocasia esculenta*) et de la grande igname (*Dioscorea alata*) dans le nord de l'Australie; et (3) des preuves archéologiques de l'exploitation d'organes de stockage souterrains et d'autres plantes du Top End.*

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INTRODUCTION

> No ethnographer has the right to assume that what [s]he observes … after … contact is a true image of the traditional economic and social systems …. Many of the present confusions in our understanding … rest on a failure to apprehend the consequences of these changes, and to set ethnographic data in its historical context. (Bulmer, 1965: 236)

Beth Gott speculated that Aboriginal management of *murnong*, or yam daisy (*Microseris scapigera*) maintained and extended the plant's range on the temperate western plains of Victoria (Gott, 1983). Although there is no direct evidence of *murnong* having been planted by Aboriginal Australians, Gott wondered whether the resource intensification and derivation of ecotypes associated with Aboriginal plant management practices were in some ways comparable to forms of cultivation (Gott, 1983). Others have similarly described "fire-stick farming" (Jones, 1969), intensive forms of yam (*Dioscorea hastifolia*) management in southwestern Australia (Hallam, 1989), domiculture and forms of resource intensification in northeastern Australia (Chase, 1989; Hynes & Chase, 1982), as well as hypothesised the existence of forms of horticultural experimentation in northern Australia (Denham, Donohue, et al., 2009; Jones & Meehan, 1989), of people who farmed "but were not farmers" (Gammage, 2012), and of Aboriginal agricultural practices on the Australian mainland (Gerritsen, 2008; Pascoe, 2014).

In this contribution, initial sections briefly summarise Pascoe's (2014) key proposition that agriculture was practiced by some communities on the Australian mainland prior to European colonisation. We then review Sutton and Walshe's (2021) stringent critique, focussing on the lines of evidence used and propositions made. We do not seek – as Sutton and Walshe have done, as well as other commentators (such as Keen, 2021) – to undertake a forensic exposition of ethnographic and historical sources that Pascoe among others (most notably Gerristen, 2008) used to justify claims for pre-European agriculture on the Australian mainland. It will hopefully be clear to the reader that ethnographic and historical sources, as well as existing archaeological and linguistic lines of evidence, are insufficient to address the issue at this time.

Here, we are seeking to inform debate by clarifying terminology and developing a common, practice-based methodological framework to investigate plant exploitation for food in the past. The methodological framework was initially developed to chart the emergence of early agriculture in the highlands of New Guinea (Denham, 2005, 2007a, 2009, 2018) and more recently applied to identify early banana cultivation in the Torres Strait (Williams et al., 2020). Here, the methodological template is tasked to assess Aboriginal plant exploitation practices on the Australian mainland. These conceptual and methodological considerations precede three case studies. First, historical records for plant exploitation practices on mainland Australia are considered in terms of the likely forms of plant exploitation represented, with especial emphasis on Aboriginal use of edible underground storage organs (USOs), such as bulbs, corms, rhizomes, roots and tubers. Second, we reconsider the multidisciplinary evidence for three plants that occur in northern Australia – bananas (*Musa acuminata* ssp. *banksii*), greater yam (*Dioscorea alata*) and taro (*Colocasia esculenta*) (following Denham, Donohue, et al., 2009) – that in other parts of the world are generally considered to be associated with the dispersal of tropical agriculture (Grimaldi et al., 2022). Third, new archaeobotanical evidence for Aboriginal exploitation of USOs and other plants in The Top End is reviewed in terms of the plant exploitation practices represented. Our intention is to move this debate forward and reorient research to uncovering the multidisciplinary evidence needed to address questions concerning the character of plant exploitation practiced by different Aboriginal communities on the Australian continent prior to European colonisation.

THE *DARK EMU* PROPOSITION

In *Dark Emu*, Bruce Pascoe (2014; also see later iterations in Pascoe, 2018, 2019) proposes that some Aboriginal communities on the Australian mainland practiced forms of agriculture at the time of European colonisation of the continent. Pascoe draws on Gerritsen (2008) to propose that agriculture comprises: "selection of seed, preparation of the soil, harvest of the crop, storage of the surpluses, and large populations and permanent housing" (Pascoe, 2014: 19). Pascoe details and discusses a range of different practices from across the continent that have been documented primarily in historical and ethnographic sources from the late eighteenth century onwards - occasionally supplemented by Indigenous, archaeological, botanical and other sources. He interprets these practices to represent agriculture.

Pascoe discusses intensive management and long-term exploitation of seeds, USOs, tree nuts and so on. Some historical accounts described practices akin to tillage and irrigation, while other accounts noted the abundance and storage of grass seed surpluses, as well as casting of seed and replanting of viable USO plant parts. Additionally, some plants are inferred to have undergone forms of domestication: "the desert raisin, or bush tomato (*Solanum centrale*) … has become dependent on people for its propagation and spread" (Pascoe, 2014: 35).

In the subsequent chapters dealing with substantive issues, Pascoe presents and discusses the multidisciplinary evidence regarding: aquacultural practices, especially at Brewarrina and Lake Condah; interpretations of sedentary populations with stone and wooden structures, as well as cemeteries and sacred places; storage and preservation of plant foods, moths and other resources; fire management; and, various beliefs and cultural practices.

Pascoe views the multidisciplinary evidence to indicate that some Aboriginal communities on the Australian

mainland practiced forms of agriculture at the time of European colonisation and, presumably, before. Here, we deliberately leave aside critiques of Pascoe's narrative style, neo-evolutionary and neo-romantic thinking, and the politically-charged context of this debate (see Porr & Vivian-Williams, 2021 and associated commentaries), which are not central to a substantive assessment of the merit of Pascoe's fundamental argument. We now present a brief summary of Sutton and Walshe's (2021) critique of Pascoe's argument and his line of argumentation.

SUTTON AND WALSHE'S CRITIQUE

Sutton and Walshe (2021) challenge the main conclusion of Pascoe's book and also its evidential foundations. Other critiques have gone through the reliability of the lines of evidence used in *Dark Emu* (such as Keen, 2021). We do not reiterate the detailed criticisms here, especially we do not dwell on errors of record or differences of interpretation (Chapter 11 in Sutton & Walshe, 2021; also see Keen, 2021), rather we focus on substantive issues raised by Sutton and Walshe with the intention of moving the debate onto more fertile ground.

The first substantive chapter (Chapter 2) in Sutton and Walshe's book focusses on the spiritual propagation of resources, including plants, by Aboriginal communities. Their discussion of increase and maintenance rituals by different communities is fascinating, and something of interest to a wider audience. These practices highlight the spiritual connection between people and their world, whereby the economic utility of plants, as well as other resources, is interwoven within much broader horizons of recursive interaction, or intentionality. For many, the spiritual connection may have forbidden the cultivation of plants as a violation (Chase, 1989; see below).

Subsequently, Sutton and Walshe highlight the paucity of cultivation-related linguistic terms in Aboriginal languages (Chapter 3), especially related to practices and tools, as well as archaeological evidence for agricultural implements beyond wooden digging sticks and stone hoes (Chapter 12). They also discuss "fire-stick farming" (Chapter 4), a term coined by Rhys Jones (1969) that does not represent plant cultivation nor animal husbandry as ordinarily understood. Rather, Rhys Jones drew attention to how Aboriginal communities used fire to manage landscapes and the animal and plant resources within them.

Seed collecting, tuber conservation and transplantation are not considered by Sutton and Walshe to be associated with cultivation, or incipient or proto-forms of agriculture in the Australian context (Chapters 5–6). Rather, they consider Aboriginal plant management and exploitation practices to be stable end-points (also consider Smith, 2001 for discussion in global context). Subsequent chapters on apparel (Chapter 7), aquaculture (Chapter 8) and dwellings (Chapter 9) are similarly dismissive of any association with agriculture. In their view the stone structures built by Aboriginal communities were not associated with year-round sedentary occupation. For example, the stone structures at Lake Condah, as well as inferred "smoking trees", likely represented temporary or seasonal shelters during exploitation of proximal resources, such as shortfin eels and other resources managed within the wetlands (Chapter 13). Although some locations, such as wetlands, were resource-foci for periods of the year, there is no clear evidence to suggest that they were occupied for most of the year. Indeed, mobility was a key aspect of most Aboriginal lifeways (Chapter 10).

In conclusion, Sutton and Walshe criticise both neo-colonial depictions of wandering hunter-gatherers and Pascoe's proposition of agriculturalists as untruths or fictions of the Aboriginal past. There is much greater complexity than this dichotomous thinking would suggest in the ways Indigenous communities were spiritually and practically connected to their worlds. In the rest of this contribution, we seek to refocus debate onto the concepts, methods and lines of evidence relevant to identify agriculture, especially cultivation practices, in the past.

CONCEPTS AND METHODS FOR THE INVESTIGATION OF PLANT EXPLOITATION IN THE PAST

> The published literature on 'agricultural origins' is characterized by a confusing multiplicity of terms for the conceptual categories that define our discourse. There is little agreement about what is precisely meant by such terms as agriculture, horticulture, cultivation, domestication and husbandry. This semantic confusion militates against clear thinking about the phenomena we investigate, leads to misunderstanding and can provoke unnecessary disputes over interpretation of the evidence. (Harris, 1996: 3)

Semantic confusions permeate debates regarding Aboriginal plant exploitation practices in the recent and distant pasts. Very different conclusions have been reached about the character of Aboriginal plant exploitation practices from effectively the same body of ethnographic and historical data (contrast Pascoe, 2014 and Sutton & Walshe, 2021). While some have argued for "domiculture" (Hynes & Chase, 1982), "experimental horticulture" (Jones & Meehan, 1989) or "agriculture" (Gerritsen, 2008; Pascoe, 2014), Aboriginal exploitation of plants is generally considered consistent with forms of hunting and gathering (Lourandos, 1997; Keen, 2003) or low-level food production (Keen, 2021 following Smith, 2001), which can range from adventitious exploitation of wild plants to more intensive forms of land management and resource intensification (Jones, 1969 to Gammage, 2012). Grasses, like other plants (and even some faunal resources) have been managed using fire (Bowman et al., 2001; Gott, 2005; Russell-Smith et al., 1997; Vigilante & Bowman, 2004). Humans are clearly implicated in the dispersal (Bowman et al., 2015; Kondo et al., 2012; Rangan et al., 2015; Rossetto et al., 2017) and intensification of numerous plant

resources across regions and within landscapes of Australia (Hallam, 1989; Hynes & Chase, 1982; Gott, 1983, 1999).

At the outset of any attempt to clarify terminology relevant to understanding plant exploitation in Australia, it should be clearly acknowledged that the terms "agriculture" and "hunter-gatherer" do not just represent economic or subsistence activities. Rather these terms have been overlain with exceptionalist and neo-evolutionary meanings for millennia within European-derived and other historical traditions (Trigger, 2007). The application and associations of these terms have been critiqued previously, both in general and in the Australian context (e.g., David & Denham, 2006). Even though some have argued for the abandonment of the terminology (Terrell et al., 2003), such a position is idealistic and not practical – we still need words to connote and differentiate forms of plant exploitation in the past.

Plant exploitation refers to the human use of plants, especially food plants. Forms of plant exploitation have often been considered to occur along a continuum from adventitious gathering of wild plants at one end of the spectrum to intensive, industrial agriculture at the other end. Most societies until the recent past existed somewhere along the spectrum between these opposite ends; namely, they engaged in "hunting and gathering", "agriculture" or the "middle ground" in-between (Denham & Donohue, 2022; Harris, 1989; Murdock, 1967; Smith, 2001). Most societies globally have engaged in a range of plant management practices to encourage the growth of favoured species. The character of these practices varies greatly and how they are attributed to forms of plant exploitation in the past provides the source of much debate (e.g., Denham, 2007b; Harris, 1989, 1996; Smith, 2001), as in Australia.

From this perspective, many lines of evidence that have been used in the Australian context to argue for or against agriculture are not relevant to its identification in the past. These include those variously deployed by Pascoe and by Sutton and Walshe to bolster their arguments: aquaculture; character of dwellings, built of stone or otherwise; clothing; language terms; storage and accumulation of surpluses; and, world views. Although these lines of evidence do shed light on the vibrance and integrity of traditional Aboriginal lifeways, they are associative or secondary in terms of identifying whether certain communities engaged in cultivation or other practices in the past. For example, in different parts of the world sedentism preceded or followed early forms of agriculture, while other communities were sedentary without agriculture (Fuller et al., 2015). Indeed, there are no necessary cultural packages – such as sedentary living, pottery, polished stone tools, domestic animals, and so on – that necessarily accompany transitions to agriculture, or agricultural lifeways in all cultural and historical contexts (Fuller et al., 2015, 2016).

Some classificatory and evidential problems can be obviated by shifting analytical focus to a "bottom-up" approach that seeks to understand how the constituent practices for a given form of plant exploitation are bound together in particular geographical and historical contexts (initially developed for the New Guinea highlands; Denham, 2007b, 2009, 2011, 2018; Denham & Haberle, 2008; Denham, Fullagar, et al., 2009; advocated by Keen, 2021). The packaging of constituent practices, as well as of the associated plants, in a specific spatio-temporal context provides the evidential foundation for any subsequent determination of plant exploitation type (Figures 1–2). Significantly, these practices – as well as the associated plants – need to be reconstructed for a given landscape or bounded region. It is not appropriate to conflate practices from across a continent, because many probably never co-occurred within a given spatio-temporal context and the resultant sum would be much greater than its constituent parts (Denham, 2018).

The focus on constituent practices is designed to:

(1) avoid dichotomous thinking, namely to avoid binary and monolithic conceptualisations of "hunting-gathering" on one hand and "agriculture" on the other, and thereby to conceive of the boundary between "hunting-gathering" and "agriculture" as fluid and porous;
(2) develop a common conceptual and methodological framework for the investigation of all forms of plant exploitation in the past; and,
(3) show that the emergence of agriculture need not mark a major threshold or break with previous ways of thinking and doing, rather it often represents an expansion of the plant exploitation repertoire.

Several types of practice are employed by groups who are ordinarily referred to as hunter-gatherers, or foragers. These practices can include:

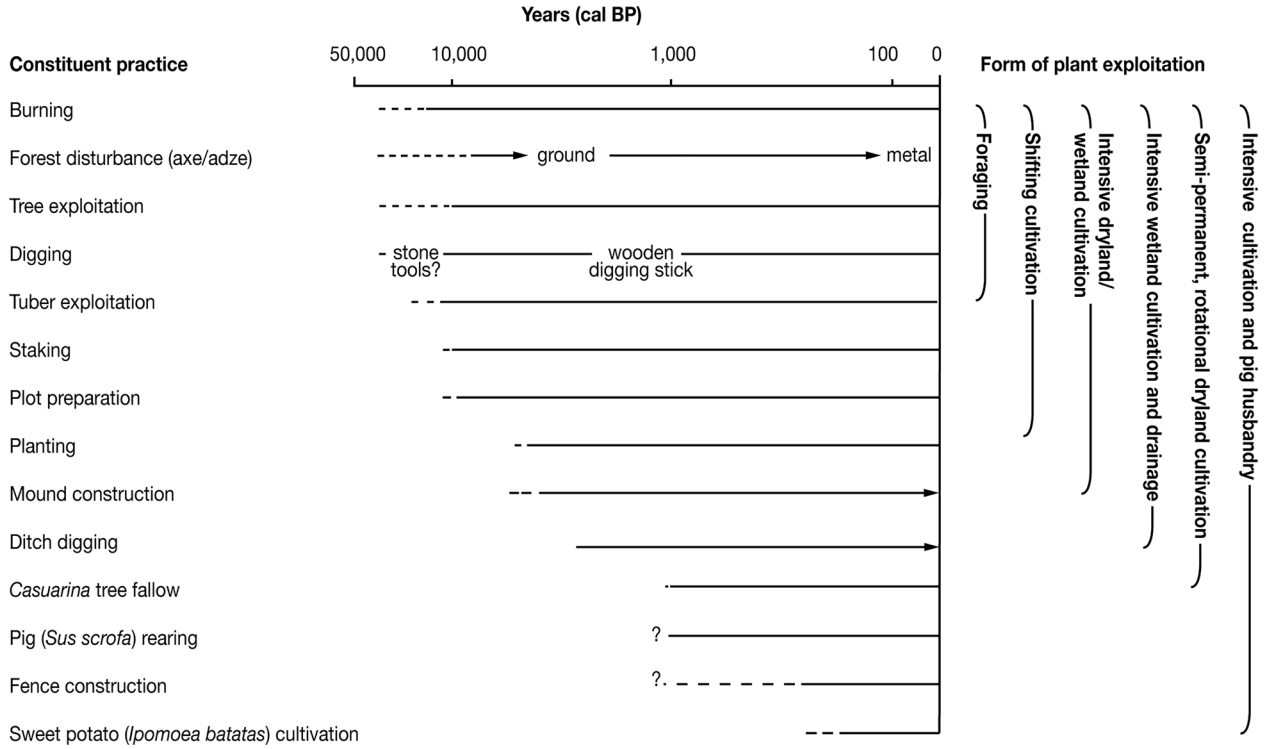
·burning to encourage new growth and to rejuvenate the land;
·tending of favoured plants, including clearing of competing plants;
·exploiting a range of plants for USOs, seeds, nuts, fruits, sago, and other crop products; and,
·(potentially) naming and protecting specific plants, whether of economic, social or spiritual significance.

Other types of practice involve a greater degree of intervention in the reproduction of plants. These practices may include:

·recurrent digging and replanting within friable soils of viable plant parts (such as a fragment of USO);
·transplantation of viable plant parts (such as USO, vine slip or stem sett) from one location to another, whether deliberately or inadvertently through accidental discard and growth; and,
·seed casting without tillage to grow resources within the landscape.

By contrast, other practices are more definitively associated with standard forms of cultivation, whereby planting occurs in specially prepared ground within a defined plot. These practices tend to include:

FIGURE 1. Chronology of multidisciplinary evidence for the constituent practices associated with different forms of plant exploitation, as applied in the Upper Wahgi Valley, Papua New Guinea (amended version of Denham, 2018: fig. 4.19).



·planting of selected phenotypes from viable plant parts (vegetative) or stored seed stock (sexual);
·demarcation of a defined plot, whether through clearance of most vegetation or through earthworks/construction of drainage ditches, fences, irrigation channels, mounds, pits or terraces;
·soil improvement through burning and mulching of cleared debris, composting, manuring and so on; and,
·varying degrees of soil tillage, including minimal tillage with a dibbling or digging stick, as well as more intensive forms involving raised beds or mounds to enable planting.

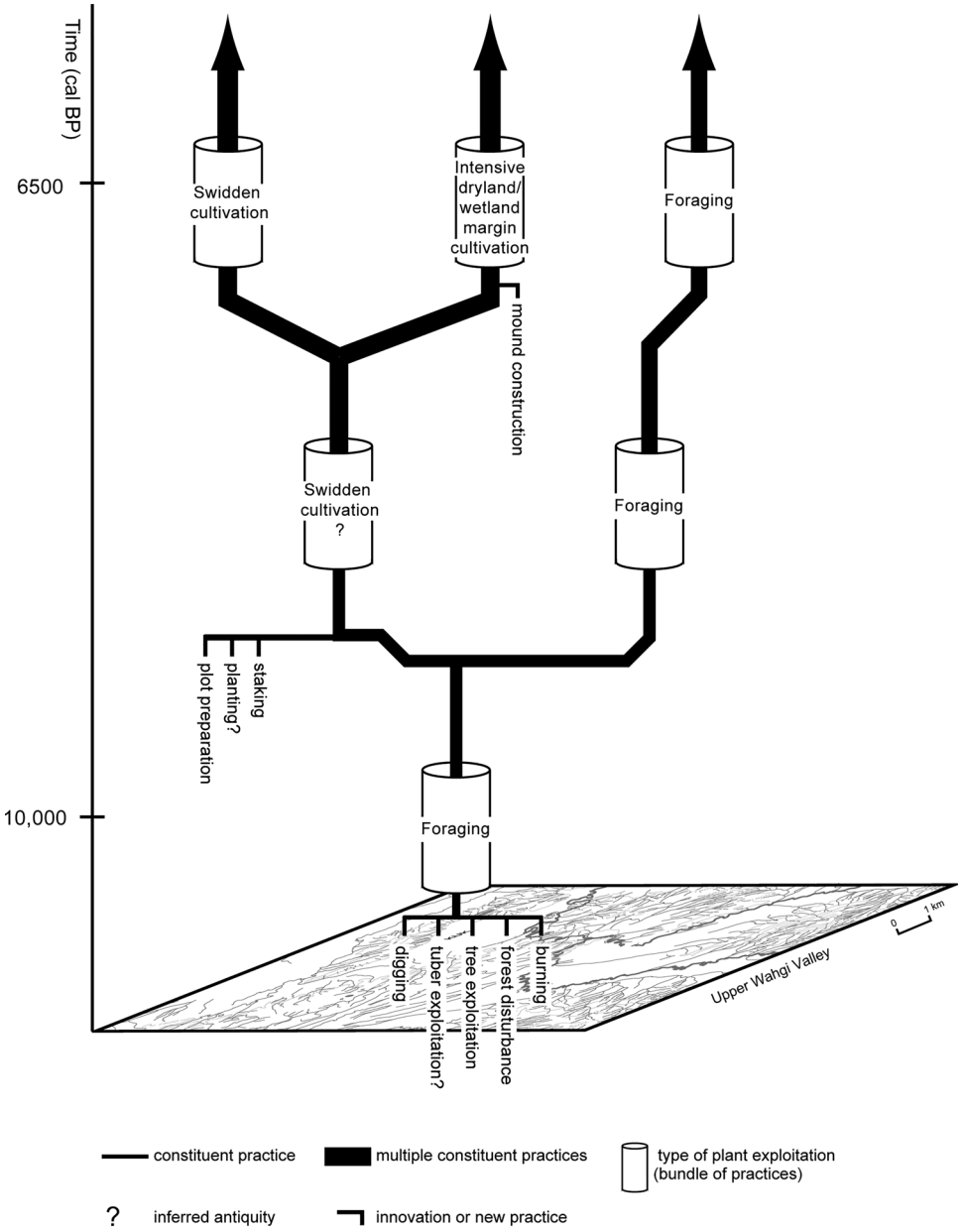
The multidisciplinary evidence for different practices within a given landscape or region enables the form of plant exploitation at different points in time to be determined. However, there has been limited attempt to conceptualise the character of "hunting-gathering", "cultivation" and intervening "middle ground" plant exploitation practices within the Aboriginal Australian context (reviewed by Keen, 2021; also see discussions by Yen, 1995; Denham, Fullagar, et al., 2009; White, 2011; Florin & Carah, 2018). Rather, much debate has been driven by *a posteriori* deduction rather than seeking to assess historical information using an *a priori* conceptual framework.

Here, societies are considered "agricultural" based on the degree to which they reorient the rhythms of their social life around the cultivation, storage and processing of food, including how dependent they are upon cultivated food for their subsistence (Denham, 2018). However, actually measuring the dependence of communities on cultivated food in the past is often difficult and subjective. Additionally, the degrees to which communities in the past reoriented, or routinized (Chase, 1989), their social life and were dependent upon cultivated food require interpretations of a range of multi-disciplinary evidence that are not derived solely from archaeobotanical materials (namely, plant remains recovered from archaeological contexts).

In terms of understanding the distant past of human communities, uniformitarian principles of "the present is the key to the past" are problematic. The distant past could always have been different from the recent past, as documented in oral and written accounts; it could have contained novel forms of plant exploitation for which there are no ethnographic analogues. Nonetheless, ethnographic and historical accounts can serve as heuristic guides for the interpretation of the distant past in a given locale or region (Denham, 2018).

Currently there is a lack of data to indicate that agriculturally-related cultivation occurred on mainland Australia beyond the temporal reach of oral and written histories. Although genetic (Rangan et al., 2015), linguistic (Evans & Jones, 1997) and phytogeographic (Bean, 2007) data can contribute longer term historical insights, each has its own limitations due to more recent genetic reshuffling (e.g., Roullier et al., 2013), language change and shift (e.g., Capell, 1970; McConvell, 2008; Bowern, 2006; also see Donohue, 2013), and the enormous transformation of the

FIGURE 2. Bundling, or packaging, of constituent practices represented in Figure 1 to show the emergence and transformation of different forms of plant exploitation during the early and mid-Holocene in the Upper Wahgi Valley, Papua New Guinea. (Denham, 2018: fig. 4.22).



Australian environment over the last few hundred years (e.g., Adamson & Fox, 1982; Young, 1996).

An emerging body of genetic studies are demonstrating potential human roles in the dispersal of useful plants, such as *Livistona* palms (Kondo et al., 2012), baobab (Rangan et al., 2015) and *Castanospermum australe* (Rossetto et al., 2017); however, human-mediated dispersal and intensification of plants is a common feature of human-plant interactions globally, not just in Australia (Cosgrove et al., 2007; Levis et al., 2018; Oslisly & White, 2007; Roberts et al., 2021). These studies have not looked for, or identified, genetic loci in plants that are associated with phenotypic traits of prolonged cultivation leading to domestication, such as non-shattering in cereals. However, some phenotypic traits are potentially suggestive of prolonged and intensive human management, such as the closed panicle and large seed size in some wild rices found in northern Australia (Henry, 2019). Although these types of phenotypic trait are often associated with the domestication syndrome in cultivated seed-bearing plants (e.g., Fuller, 2007), they could also represent phenotypic responses to growth environment. At this time, such findings are essentially anecdotal and further study is needed. The systematic investigation of the genotypes and phenotypes of Australian food plants, how these changed through time, and what these traits represent

in terms of past human management is still in its infancy.

A schematic methodological framework developed and applied to clarify the record of early agriculture in the highlands of New Guinea (Denham et al., 2003; Denham, 2006, 2007a, 2018), and recently used to identify early agricultural practices on Mabuyag Island in the Torres Strait (Williams et al., 2020), is relevant to the investigation of potential Aboriginal cultivation practices on the Australian mainland (Figure 3). Interpretation rests on the triangulation of three lines of multidisciplinary evidence; each line of evidence is not diagnostic individually (Denham, 2007a, 2011, 2018):

(1) Archaeological evidence of former practices associated with cultivation, such as: digging; staking; building of mounds, pits, raised beds, ditches or retaining walls; tools; and, soils exhibiting characteristics of digging, tillage or improvement.
(2) Palaeoecological and geomorphological evidence of former environmental changes associated with cultivation activities, such as persistent and cumulative disturbance of forest, often associated with burning and soil erosion, with eventual degradation to mosaic habitats variably comprised of secondary forest, disturbance taxa and grassland.
(3) Archaeobotanical evidence of former food plants from archaeological contexts associated with former cultivation practices, especially if in higher than anticipated frequencies (such as bananas [*Musa* spp.] at Kuk Swamp; Lentfer & Denham, 2017), or if representing domesticated plant remains, whether indigenous or introduced (such as introduced banana cultivars [*Musa* cvs.] at Wagadagam on Mabuyag; Williams et al., 2020).

Individually, each line of evidence is unlikely to be diagnostic of cultivation in the past. Taken together, these lines of enquiry provide the evidential foundation for the interpretation of cultivation practices in the past, especially when clear morphological signatures of domestication are not present in plants (see Denham, 2018 and Denham et al., 2020 for elaboration of these ideas in regards to the New Guinea highlands and vegetatively propagated field crops, respectively). Foremost, archaeological evidence of former cultivation practices grounds associated lines of archaeobotanical and palaeoenvironmental evidence (Denham & Haberle, 2008).

EXPLORING THE EXPLOITATION OF USOs IN THE RECENT PAST

> In terms of this [collection vs. production] dichotomy, human beings must *either* find their food ready-made in nature *or* make it themselves. Yet ask any farmer and he or she will say, with good cause, that the produce of the farm is no more made than it is found ready-made. It is *grown* …. *what do we mean by growing things*? On the answer to this question must hinge the distinctions between gathering and cultivation, and between hunting and animal husbandry. (Ingold, 2000: 85, emphasis in original)

People have intervened in two pathways of plant reproduction, using seed (sexual) and other plant-parts (vegetative), under different forms of foraging and agriculture to exploit, cultivate and eventually domesticate plants (Harris, 1989, 1996; Fuller & Denham, 2022). Sexual reproduction is characteristic of grasses, leguminous plants, many herbaceous plants, and some fruit and nut-bearing trees and vines. Asexual reproduction is commonly associated with perennials, such as woody plants (including fruit trees), palms and pandanus, as well as a range of USO-bearing plants, bananas and cane grasses. When people deliberately intervene in the vegetative reproduction of plants, through the removal and replanting of a viable plant-part away from the parent, this type of clonal growth is referred to as vegetative propagation.

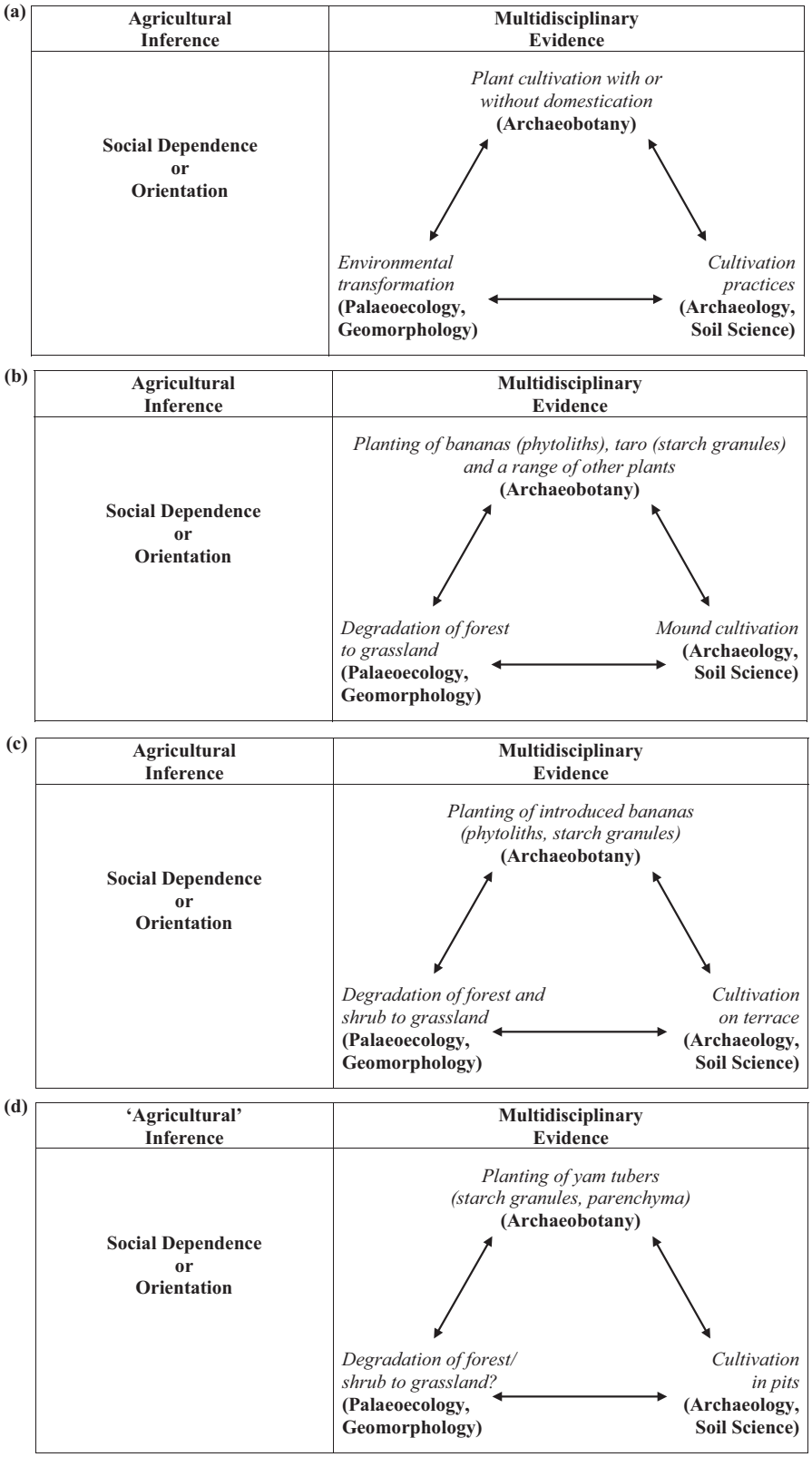
A focus on USOs

Here, there is insufficient space to focus on the full range of plants exploited by different Aboriginal communities across Australia, including fruit, nut and sago-bearing trees, palms, pandans and cycads; seed-bearing grasses and legumes; and, leafy vegetables. Hence, the focus is on Aboriginal exploitation of plants that primarily reproduce vegetatively under management and mostly yield carbohydrate-rich USOs. Vegetative reproduction and propagation are relevant to understanding Aboriginal plant management, although most of the plants involved are still able to reproduce from seed. Such plants tend to have been the focus of plant exploitation practices, including agriculture, in the wet subtropics and tropics globally (Barton & Denham, 2018; Denham et al., 2020). In Australia, these types of plant have been widely exploited, yet of varying dietary significance to communities across the continent.

The inadvertent reproduction of plants, such as through growth from discarded or misplaced plant-parts, like tubers or vine cuttings, is considered a form of vegetative reproduction rather than propagation. Although people are responsible for the translocation of the plant, they do not engage in deliberate propagation practices to reproduce the plant. Rather, the plant-part reproduces under its own "volition", or predisposition, following inadvertent translocation to a new growth location whether midden or rubbish heap, camp location, or elsewhere in the landscape. Inadvertent discard and rubbish heaps "were probably important mechanisms in plant domestication through the generation of asexually-reproducing phenotypes (outside of their natural range), new phenotypes of individual species and through the spontaneous creation of new hybrids of related species, i.e. sympatric hybridisation (Clement et al., 2010)" (Denham et al., 2020: 586).

Similarly, the deliberate or inadvertent intensification of plant resources within a landscape, through burning or disturbance, does not necessarily entail planting. Nevertheless, like gathering practices that increase growth and production through replanting of the parent plant and

FIGURE 3. Schematic diagrams showing: (a) Lines of evidence for inferring agricultural practices in the past (especially those based on vegetative cultivation; amended version of Denham, 2018: fig. 2.5); (b) Multidisciplinary lines of evidence for the cultivation of bananas (*Musa* spp.) and other crops at c.7000–6400 calBP, Kuk Swamp, Upper Wahgi Valley, highlands of Papua New Guinea (see Figures 1–2; Denham et al., 2003; Denham, 2018); (c) Multidisciplinary lines of evidence for the cultivation of introduced banana cultivars (*Musa* cvs.) at c.1380–1290 calBP, Wagadagam, Mabuyag, Torres Strait (Williams et al., 2020); and, (d) Hypothetical schematic representing potential multidisciplinary lines of evidence needed to determine the cultivation of *warran* yams (*Dioscorea hastifolia*) in southwestern Australia (see Figures 4 and 5 upper).



increasing soil friability, these are cognate practices with ambiguous conceptual demarcations; namely they encourage vegetative plant growth in USOs through disturbance and burning, as well as potentially planting. Similar types of practice probably played a role in the domestication of some root crops that were able to take advantage of favourable ecological conditions created by people, namely, the human niche, including: *murnong*, or yam daisy (*Microseris lanceolata*) on the temperate western plains of Victoria (Gott, 1983); yam (*Dioscorea hastifolia*) along the subtropical coast of southwestern Australia (Hallam, 1989); and, *Typha* spp. in temperate wetlands across southern Australia (Gott, 1999).

Furthermore, the relevance of traditional, archaeobotanical concepts of domestication in many of these contexts is not clear. As opposed to the morphogenetic fixation of domestication traits envisaged for cereals, legumes and some fruits (e.g., Fuller, 2007; Fuller et al., 2014), putative domestication signals in most vegetatively reproducing crops – and USOs in particular – represent in part plastic responses to growth environment, including forms of plant management and cultivation (Denham et al., 2020). In this context:

> Plasticity is defined as phenotypic change that is environmentally induced, though the direction and the magnitude of that change are genetically determined. There appears to be considerable variation among clonal plants in the degree to which observed phenotypic change may be considered plastic or nonplastic (i.e. that which is under direct genetic control) in different ecological conditions (Denham et al., 2020: 591).

In subtropical and tropical environments, where many communities have historically been heavily reliant on vegetatively propagated crops such as bananas, cane grasses and USOs, the investigation of agriculture in the past is not reliant upon the identification of domestication traits in plant remains found in archaeological contexts (Hather, 1996; see Denham, 2018 for explication of this perspective). Given this recognition, domestication is increasingly being decoupled conceptually from agriculture (following Hather, 1996) and reformulated into more social (Chase, 1989) and environmental (Yen, 1989) terms.

Accounts of cultivation or planting by Aboriginal groups on the Australian mainland are relatively rare (see reviews by Gammage, 2012; Gerritson, 2008; Pascoe, 2014; Sutton & Walshe, 2021), although horticulture was definitely practised on inter-visible and socially engaged, offshore islands in the Torres Strait (e.g., Harris, 1995; also see Williams et al., 2020). Of relevance for the Australian mainland, Latz (1995) notes the scattering of seeds of *Solanum chippendalei* by Alyawar, and Gilmore (1934) notes the planting of quandong (*Santalum acuminatum*) and other plants. Numerous accounts note how Aboriginal people replanted viable plant parts during harvesting, principally of subterranean storage organs (e.g., Berndt & Berndt, 1993; Gott, 1983). However, incidental planting does not equate to agriculture – as commonly understood – because it may not be associated with reorientations of social life nor with a reliance on cultivated food.

Warran "cultivation" in southwestern Australia

Early historical records document extensive tracts of land utilised for the exploitation of USOs in different parts of Australia (see Gerritsen, 2008; Gammage, 2012 and Pascoe, 2014 for reviews). One of the most comprehensive and oft-cited records describes extensive tracts of land used for growing *warran* (also *warrang*; *Dioscorea hastifolia*) in southwestern Australia:

> We now crossed the dry bed of a stream, and from that emerged upon a tract of light fertile soil, quite overrun with *warran* plants,* the root of which is a favourite article of food with the natives. This was the first time we had yet seen this plant on our journey, and now for three and a half consecutive miles we traversed a fertile piece of land, literally perforated with the holes the natives had made to dig this root; indeed we could with difficulty walk across it on that account, whilst this tract extended east and west as far as we could see. (George Grey, 1841: Vol 2:12 * *warran* noted to be a species of *Dioscorea*)

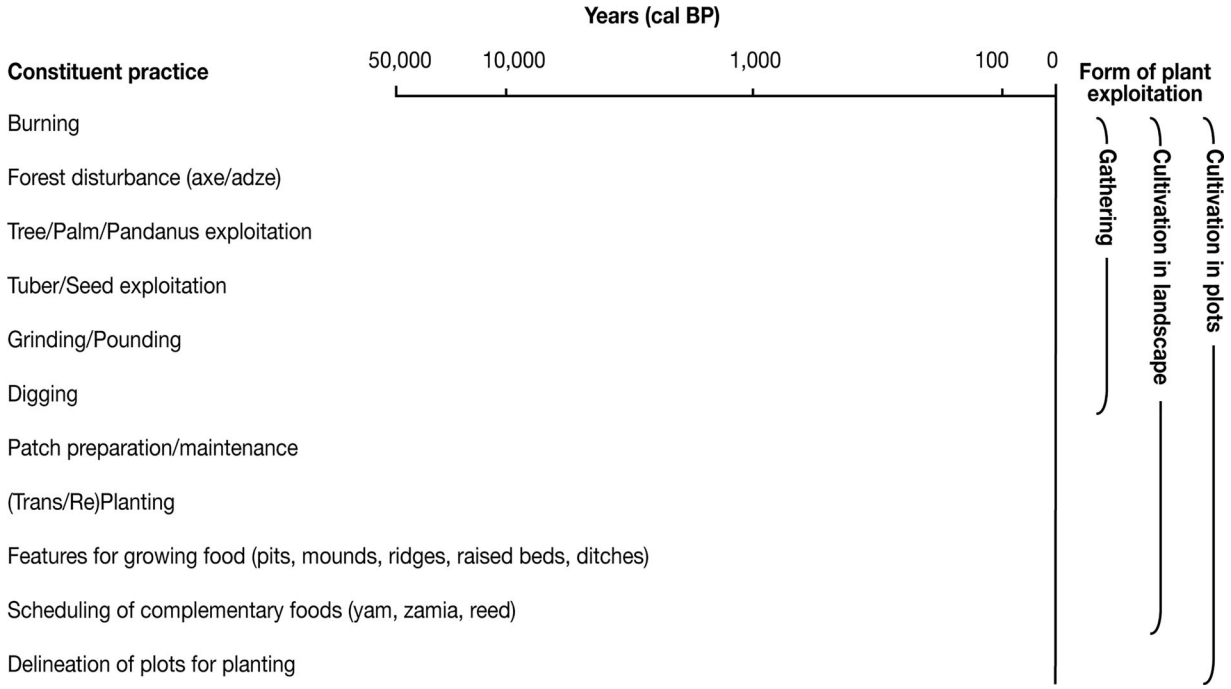
Some of the original chroniclers draw explicit comparison with cultivation (noted in Hallam, 1989).

Although these landscape-scale scenarios certainly entailed some practices seemingly comparable to cultivation in fields, there are differences in terms of planting using curated stock (whether seed or vegetative), delineating plots for planting, and soil preparation. At one level, though, some of these differences are more apparent than real; there is considerable ambiguity and conceptual blurring at the edges. For instance, in traditional horticulture in some areas of the interior of New Guinea: wild and domestic plants can be planted, sometimes adventitiously in gardens; plant exploitation utilises a variety of resources across the landscape, although cultivation primarily occurs within defined plots; and, planting can occur with minimal tillage of soils in some forms of shifting cultivation (Denham, 2005, 2018).

From early historical accounts it is often hard to determine precisely the forms of plant exploitation practiced by Aboriginal communities. The extent of disturbance could indicate deliberate planting and then harvesting akin to cultivation in a field. On the other hand, these practices plausibly represent recurrent and cumulative resource intensification within an extensive tract, or patch, in the landscape. These issues are exemplified here with respect to assessing the character of yam, or *warran*, plant exploitation practices documented in historical records for southwestern Australia (Figure 4; following Hallam, 1975, 1989; also see Macintyre et al., 2020):

(1) People had usage, propriety and firing rights over tracts of land, including over yam patches.
(2) Yam patches were harvested seasonally, with zamia seeds (*Macrozamia* sp.) and reed rhizomes (*Typha* sp.) forming important staples for much of the rest of the year.

FIGURE 4. Unfilled schematic chronological template for plotting the multidisciplinary evidence for constituent practices associated with different forms of plant exploitation in Australia. Note there is considerable variation in the focus of Aboriginal plant exploitation practices between grasses in the arid and semi-arid interior and a more mixed economy including vegetative plants in temperate, subtropical and tropical parts of Australia. The hypothetical chronology proposed here has been developed to illustrate the intensive exploitation of *warran* (*Dioscorea hastifolia*) in southwestern Australia (also see Figures 3d and 5 upper).



(3) Repeated inter-annual harvesting of yam patches over extended periods, at least decades.
(4) During each successive harvesting viable USOs or USO fragments from the parent plant were replanted or left in situ to ensure continued growth of the plant, continuity of resources within the patch, and potentially growth of the patch through time.
(5) Repeated digging ensured aerated and friable soils around the parent plant, encouraged the growth of larger and separated USOs.
(6) Pits were recurrently used and left open after digging, harvesting and (re)planting of viable USO parts.
(7) Human-mediated dispersal of plants across the landscape may have led to the creation of new ecotypes, namely new phenotypic variants (also suggested for *murnong*; Gott, 1983).
(8) Intensive plant exploitation of yams and other plants required orientation of social life and "supported large occupation complexes spanning long time periods" (Hallam, 1989: 137).

In such a scenario, there are clear cognate practices that correspond to, but are not the same as, those of cultivation under agriculture (Table 1). Essentially, these types of Aboriginal practice were functionally equivalent to forms of cultivation in terms of the plant management practices involved. Perhaps the most significant differences are that cognate practices in southwestern Australia occurred across landscapes rather in defined plots and there was a greater focus on the domestication of the environment rather than on the domestication of individual species (cf. Clement et al. 2015; Levis et al., 2018; Yen, 1989). Certainly, the Aboriginal communities involved were reliant on these yam patches, as well as other plant and faunal resources, for their subsistence and had reoriented aspects of their social lives around these activities. Currently it is unclear whether this functional equivalence translates into a direct equivalence in terms of a potential definition of agriculture relevant to the Aboriginal context (see Table 1). A chronological gazetteer of constituent practices would need to be compiled for a particular historical context, most probably for the intensive exploitation of *Dioscorea hastifolia* and other plants in southwestern Australia (as sketched in Figure 4), and then compared against different forms of plant exploitation. Only by adopting this conceptual shift and associated methodological framework could forms of plant exploitation in the past be fully characterised.

REVISITING THREE PLANTS IN NORTHERN AUSTRALIA

It is possible that the first experimental cultivation of such plants as *Colocasia* and possibly yams, bananas, sugar cane, and *Pandanus*, took place at th[e] time when New

Table 1. Comparing plant exploitation of yam (*warran*, *Dioscorea hastifolia*) in southwestern Australia to agricultural norms. (#) = number used in text..

(#)	Aboriginal yam culture	≈	Cultivation under agriculture
(1)	Usufruct/proprietary rights over patches in landscape	≈	Usufruct/ownership of plots, gardens and fields
(2)	Seasonal yam, with complementary zamia and *Typha*, harvesting	≈	Seasonal cultivation of different crops
(3)	Repeated, inter-annual harvesting of same patches	≈	Repeated, inter-annual cultivation within same plots, gardens and fields (often with crop rotations and fallow periods)
(4)	(Re/trans)planting of USO from in situ stock (namely, in ground storage)	≈	Planting from ex situ stock (namely, stored off-site) or ex/in situ stock (namely, stored in ground on-site or nearby)
(5)	Digging ensures aerated and friable soils for replanting and growth	≈	Tillage ensures aerated and friable soils for planting and growth
(6)	Use of earthworks (pits) to enhance growth environment	≈	Use of earthworks (mounds, pits, raised beds, terraces and so on) to enhance growth environment
(7)	Human translocation between patches potentially generates new phenotypes (ecotypes)	≈	Cultivation (management of growth environment and genetic isolation of stock) generates new phenotypes (domesticates)
(8)	Orientation of social life to the growing of food and dependence upon grown food	≈	Orientation of social life to cultivation of food and dependence upon cultivated food

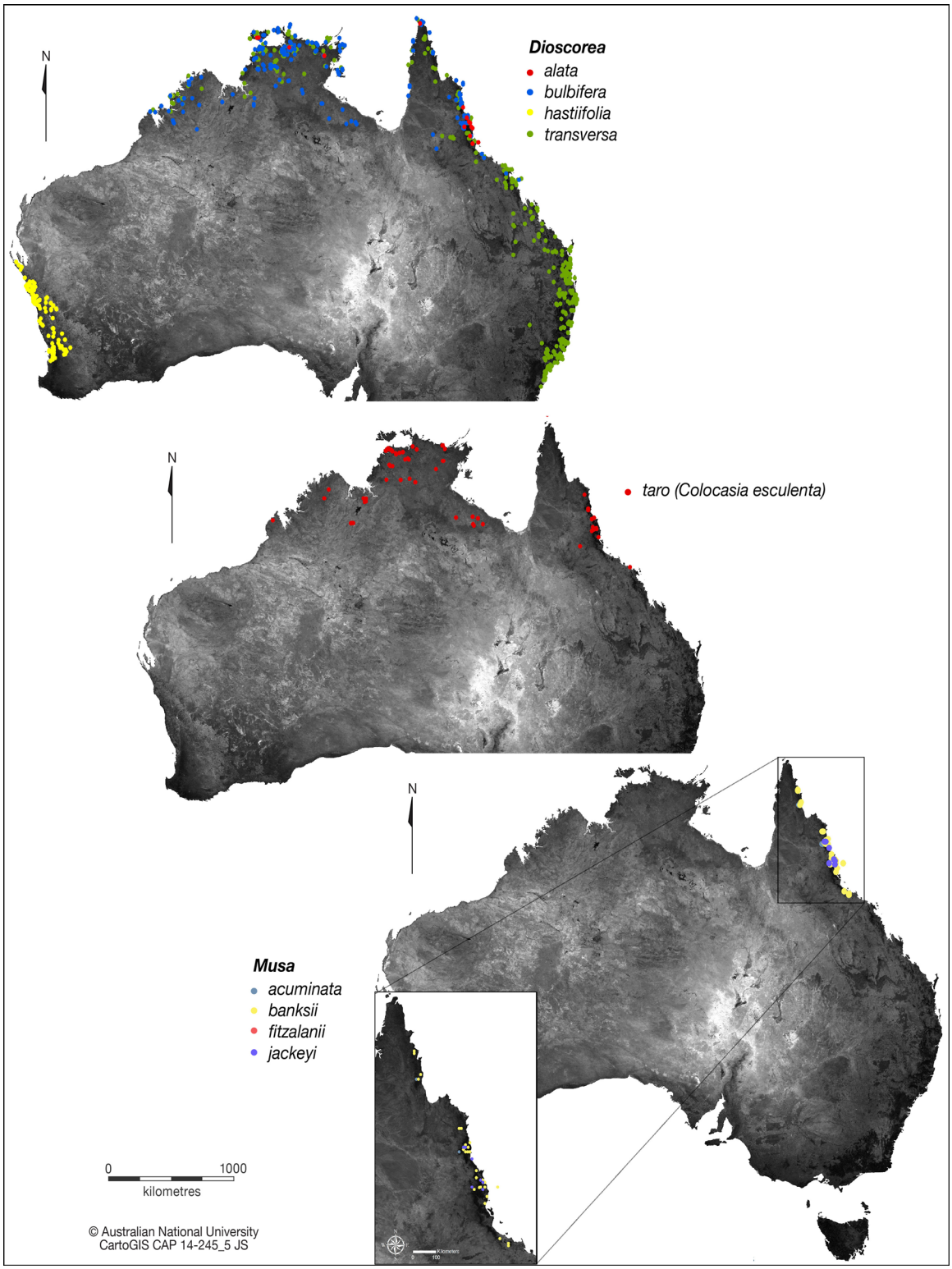
> Guinea and Australia were part of the same landmass. The southern boundary of this experimental horticultural province may have been on what is now Australia (Jones & Meehan, 1989: 132)

Several plants found in the tropical rainforests of northeastern Queensland are considered to be wild relatives of cultivated plants in New Guinea, including bananas (*Musa acuminata* ssp. *banksii*), taro (*Colocasia esculenta*) and yams (particularly *Dioscorea alata* and *D. bulbifera*), as well as several trees, including *Canarium indicum*, *Terminalia catappa* and *Aleurites moluccana*. Although long-known to have been exploited by Aboriginal people (e.g., Golson, 1971; Jones & Meehan, 1989; Matthews 1991), the "wild" status of some of these plants in northern Australia has been questioned (Denham, Donohue, et al., 2009). Are these plants merely part of the tropical flora of northeastern Queensland, or were some of these plants brought into experimental cultivation from the wild by communities living in northern Australia, or were they introduced as cultivars under some form of horticulture through contact with outsiders, whether in the distant or recent past?

Jones and Meehan (1989) suggested that distributions of numerous economic plants across northern Australia may represent horticultural experimentation during the Terminal Pleistocene or early Holocene, prior to the separation of New Guinea and Australia by the flooding of the land bridge that today marks the Torres Strait. Denham, Donohue et al. (2009) have revived this proposition, but do not discount alternative historical hypotheses, including the introduction of plants and cultivation practices to Australia by horticulturalists from New Guinea or Island Southeast Asia during the mid- to late Holocene, or by Macassan trepangers, European voyagers, Chinese immigrants, or blackbirded Pacific plantation workers within the last few hundred years (Chase 1980; Denham, Donohue, et al., 2009; MacKnight, 1976; Yen, 1995). Plausibly, some plants and some plant populations are associated with each hypothetical scenario. The idea of nascent horticultural practices in northern Australia, whether generic or introduced to specific locales, opens up new realms of historical interpretation that are at odds with most archaeological, ethnographic and historic accounts of Aboriginal lifestyles (e.g., Hiscock, 2008; Keen, 2003), yet resonate with hypotheses regarding Aboriginal cultivation in the recent past (Gerritsen, 2008; Pascoe, 2014).

Three plants found in northern Australia are usually associated with cultivation in other parts of the world, but in the Australian context are considered wild plants: banana

FIGURE 5. Distributions of yams (upper – *Dioscorea* spp.), taro (middle – *Colocasia esculenta*) and bananas (lower - *Musa* spp.) in northern Australia (amended version of Denham, Donohue, et al., 2009: figs. 2a–c; Denham, 2017: fig. 7-5). Note for bananas that both categories *Musa acuminata* and *Musa banksii* represent *Musa acuminata* ssp. *banksii*.



(*Musa* spp.), greater yam (*Dioscorea alata*) and taro (*Colocasia esculenta*) (Figure 5). Historical records and the potential significance of these three plants for understanding Aboriginal plant exploitation in northern Australia have been previously discussed in depth (Denham, Donohue, et al., 2009; Jones & Meehan, 1989; Matthews 1991). Current evidence suggests two plants certainly include an indigenous wild component – bananas and taro – whereas greater yam is a cultivar and was introduced. Here, the botanical histories of these three

plants are revisited, because each potentially adds a different dimension to understanding the longer-term history of plant exploitation in northern Australia.

Banana *(Musa acuminata* ssp. *banksii)*

Early historical records suggest that multiple wild species of banana (*Musa* spp.) were present in northeastern Queensland, yet only *Musa acuminata* ssp. *banksii* existed at the time of Simmonds' survey in 1954 (Denham, Donohue, et al., 2009). Simmonds (1956) assumed that the other species had gone extinct. In contrast to cultivated bananas, the wild bananas in northern Australia are seedy, as noted in 1770 by Joseph Banks (Beaglehole, 1962: 85; and described by von Mueller, 1864). The plant is widely distributed along the coast of northeastern Queensland, where it is generally considered to be native and a coloniser of secondary growth and edge habitats (Dick, 1994). Various plant parts were eaten by Aboriginal communities, including the seedy fruit, conical buds and new shoots (Cribb & Cribb, 1974), as well as leaf-sheaths of the pseudo-stem (Dick, 1994).

One source regarding bananas along this coastline is worthwhile revisiting. von Mueller (1864: 132–134) describes "*Musa banksii*" (now classified to *Musa acuminata* ssp. *banksii*) and notes two occurrences of *Musa paradisiaca*: one is extracted from the diary of Edmund Kennedy on his ill-fated expedition between Rockingham Bay and Cape York; and, the other is a report of abundant plants growing to 20 feet tall by a river at Mackay made by Walter Hill, who was the first curator of the Brisbane Botanical Gardens (1855–1881). Mackay is midway between Townsville and Rockhampton, and this location is significantly further south than other historical records of *Musa* that likely predate the cultivation of introduced bananas with Chinese, European and Pacific Islander immigrants and then plantation cultivation from the mid-1800s onwards. Today plantation cultivation of banana extends almost to Newcastle, presumably wiped out any pre-existing wild populations within their former range, and extends much further south than nineteenth century records of its wild distribution. Since Carl Linnaeus in his *Species Plantarum* (1753), who mistakenly allocated a species name to a hybrid, *Musa paradisiaca* has primarily been used to represent cultivated plantains that are hybrids of *M. acuminata x M. balbisiana*, rather than wild *Musa acuminata*. At present, the status of these two reports of *Musa paradisiaca* in von Mueller cannot be resolved in terms of the species involved; but they most likely represent wild, seedy bananas.

The northeastern Australian coast is considered part of the natural distribution of wild *Musa acuminata* ssp. *banksii* (De Langhe et al., 2009). Historical records indicate the presence of wild, seedy bananas and there are no records of seed-suppressed, starch-rich forms characteristic of domesticated and cultivated bananas and plantains. The aforementioned uses of these wild bananas are relatively consistent with that of other types of plants, although the consumption of the interior leaf-sheaths of the pseudo-stem by communities in northern Cape York is unusual:

> Aborigines [sic] in the areas north of Mossman used to cut the tree down just as the flower emerged. The trunk was cut into lengths and the lengths peeled of leaf-sheaths until only two or three were left covering the flowering stem which, of course, had grown up from the corm or butt. These lengths of stem were baked on hot stones or in hot ashes. It contains a fair amount of starch and the flavour was very like cooked green bananas or plantains (Dick, 1994: 266).

The consumption of the interior of banana pseudo-stems is not common. Another comparable practice was noted while on fieldwork in Karimui on the southern flanks of the main highland range of Papua New Guinea, where an informant mentioned eating starch-rich pseudo-stems of one banana cultivar growing in a mixed banana stand (Denham observation, fieldwork in 2007). The derivation of this practice and the genus or species involved, potentially whether *Musa* or *Enset*, require further investigation in northern Cape York, as well as more broadly. It could be a relict of formerly more widespread practices that occurred on both sides of the Torres Strait.

Taro *(Colocasia esculenta)*

Wild taro in northern Australia produces small and acrid corms with little edible starch. Although considered a minor food plant in The Top End in the recent past (Jones & Meehan, 1989: 126), it could have been more important in the distant past. Taro leaves are also processed, cooked and eaten as a leafy vegetable (Beaglehole, 1962: 85; Cribb & Cribb, 1974: 148). Multiple originating populations of taro (*Colocasia esculenta*) can be hypothesised, including the wild, indigenous plant and introductions principally associated with Chinese and Pacific Island immigrants from the nineteenth century onwards.

Taro corms, like most USOs, are highly plastic; namely, the phenotype is heavily controlled by the environment of growth rather than just by genotypic inheritance (Barron et al., 2022; Denham et al., 2020). The size, shape and phytochemistry of taro corms, like many USOs, are heavily influenced by soil characteristics, rhizosphere and water balance. Thus, the morphology of wild-type taro today cannot be used as a reliable guide as to its domestication status in the past: wild-type taro in northern Australia today could represent the wild, indigenous plant or the feralisation of former cultivars, either domesticated *in situ* or introduced to the continent, that have reverted to wild-type phenotype (Denham, 2008).

Recent genetic analyses of contemporary taro populations in northern Australia, as part of a broader study, hint at genetic and historical layering (Ahmed et al., 2020). Of the 23 samples analysed, 20 were considered to be indigenous wild taro; two were recently introduced, naturalised cultivars; and, one wild-type was potentially a former cultivar introduced to the Kimberley region from Southeast Asia. Previous genetic studies indicated populations of taro in northern Australia were relatively

homogenous (Matthews 1991; Matthews & Terauchi, 1994). Ahmed et al. (2020) study is beginning to reveal the complex genetic and historical layering of wild-type taro populations in different parts of northern Australia.

Greater yam *(Dioscorea alata)*

In contrast to bananas and taro, greater yam is only known as a vegetatively-reproducing cultivar; its wild precursor has not been securely identified (Lebot, 2009). Although sexual reproduction is possible under experimental conditions (Abraham & Gopinathan Nair, 1991) and occurred in the distant past according to genetic analyses (Lebot et al., 1998), it is today only known as an asexually reproducing cultivar. However, once introduced to a new environment it can disperse through fragmentation of tubers and vines, especially along watercourses, to establish highly invasive feral populations.

The distribution of greater yam across northern Australia has historically been under-represented because it was long-considered to be an introduced weed. Until recently populations of introduced weeds were not recorded; they were only eradicated when found. Telford (1986) considers the plant to be naturalised in The Top End and in the rainforests of northeastern Queensland. These disjunct populations likely signify two discrete, but potentially related, histories of introduction: by Macassans and English colonists to The Top End and surrounds; and, by Torres Strait Islanders and post-European colonists to northeast Queensland. Possibly the plant has greater antiquity in northern Australia than a few hundred years, but currently there is no archaeobotanical record to corroborate greater yam before the nineteenth century, even though other yam species have been identified in assemblages of archaeological parenchyma (see Pritchard, 2018).

Greater yam is reported historically on Melville Island, although this was possibly introduced in a shipment of specially requested supplies from Timor to Fort Dundas (correspondence from Maurice Barlow, Fort Dundas, Melville Island, 19 May 1825). Additionally, Windsor Earl (1846) comments on the introduction by the British of cultivated plants from Island Southeast Asia, including Singapore and Timor, to Australia for cultivation at forts, settlements and by colonists. Hence, the British were the likely source of introduction to Melville Island and elsewhere, such as Fort Somerset at the tip of Cape York.

However, it is unlikely the British brought the plant to the interior of The Top End, where greater yam was reported by White (1919) to occur inland along the Johnstone River near Innisfail. In The Top End, greater yam was likely introduced inadvertently or advertently along the coast by Macassan or Papuan trepangers and associated communities. Yams could have been planted as provisions for these trips, or could have become established from discarded or lost plant parts that accompanied the voyagers. Certainly, there was scope for such introductions, given the coming together of numerous cultural groups from Island Southeast Asia, the circum-New Guinea region and The Top End during trepanging season. As Windsor Earl (1846: 239–240) noted:

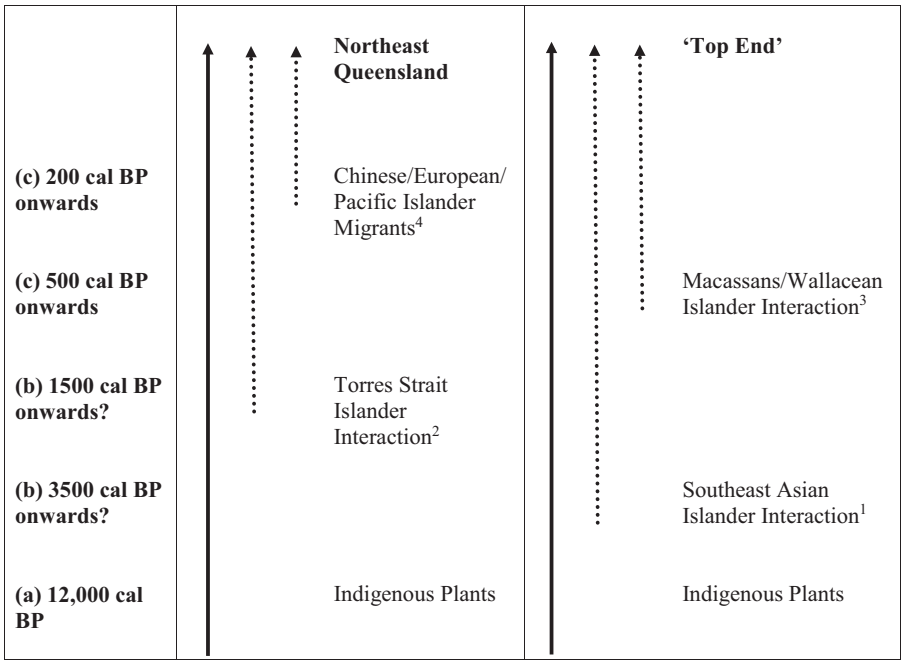
> … nearly every Macassar prahū that arrived from the Gulf of Carpentaria brought two or three individuals from one or other of the tribes that are distributed along the intermediate coast. Indeed, about the month of April, when the prahūs congregate at Port Essington, the population of the settlement became of a very motley character, for then Australians of perhaps a dozen different tribes might be seen mixed up with natives of Celebes and Sumbawa, Badjūs of the coast of Borneo, Timorians, and Javanese, with an occasional sprinkling of New Guinea negroes; and very singular groups they formed, busied, as they generally were, amid fires and smoke, curing and packing the trepang, or sea-slug, which they had collected from the shoals of the harbour.

Similar scenes associated with other forms of social interaction recur along the coastlines of the Moluccas and western New Guinea around this time (Wallace, 1869). These maritime social spheres would have provided ample opportunity for the introduction of plants, as well as ideas and knowledge of planting, harvesting, processing and cooking. The Top End was certainly not a closed or isolated world immediately prior to European colonisation, or potentially earlier (Denham, 2017; MacKnight, 1976).

Comparably, greater yam cultivars could have been sequentially introduced by different groups of immigrants along the northeastern Queensland Coast, including English, Chinese and Pacific Islanders (Chase 1980). However, earlier introductions are possible by Torres Strait Islanders visiting the Australian mainland of Cape York and travelling down the east coast; by people from Cape York travelling to the south coast of New Guinea to obtain canoes and other trade goods; and, through social interactions between communities on Cape York and those in the Torres Strait (see Rowland & Kerkhove, 2022; McNiven 2022; cf. Wasef et al., 2021 for contrary perspective from human genetics). Greater yam was cultivated in the Torres Strait (Haddon, 1935) and given the known interactions with communities along the east coast, it could readily have been advertently or inadvertently introduced to the mainland through deliberate planting or accidental establishment from discarded tubers, respectively.

Numerous opportunities existed for the accidental introduction of plants to northern Australia. Haddon (1935) suggested that the horticultural focus of three islands in the Torres Strait – Nagir, Mabuyag and Dauan – arose due to their role as trading hubs. McCarthy (1939) identified similar trading routes encompassing the Torres Strait and extending southwards to Princess Charlotte Bay on the east coast and to "Baravia", or Wenlock River on the west coast of Cape York. Hage and Harary (1996) also suggested that the canoe trading routes from the New Guinea south coast to Cape York could have facilitated the movement of plants and animals (also see McNiven, 2008). Certainly, Papuan canoe makers provisioned those buying and transporting their canoes with food for their journey south.

FIGURE 6. Potential multi-layered histories of plant introductions for Northeast Queensland and "Top End". Indigenous contribution is dominant, as noted for taro (Ahmed et al., 2020; Matthews 1991; Matthews & Terauchi, 1994). Notes: [1]Balme et al., 2018, [2]McNiven 2022; Rowland & Kerkhove, 2022, [3]MacKnight, 1976, [4]Chase, 1980, 1989.



The greater yam is a cultivar, namely a domesticated plant that was introduced to the Australian mainland at some time in the past and subsequently incorporated into Aboriginal subsistence practices in some capacity. Even though a plant domesticate, the greater yam was potentially incorporated into Aboriginal subsistence practices as a "wild" plant; its establishment increased the availability of USOs in the landscape. It could have spread into the interior of The Top End and away from the coast in northeastern Queensland as a commensal that flourished in disturbed habitats around encampments and across the landscape, especially following burning or disturbance to vegetation. Greater yam could have been planted, as documented for other USOs in the region, or it could have become established in new locales from discarded plant parts left in disturbed ground and subsequently dispersed through fragmentation. As with the introduction of the dingo (*Canis familiaris*) to Australia over 3000 years ago (Balme et al., 2018; Corbett, 2001), the adoption and incorporation of a domesticate into traditional lifeways need not signify a fundamental shift in the character of those lifeways; namely, Aboriginal communities could have continued to pursue largely hunting-gathering-fishing lifestyles that included the exploitation of a feral
cultivar.

Historical and botanical layering

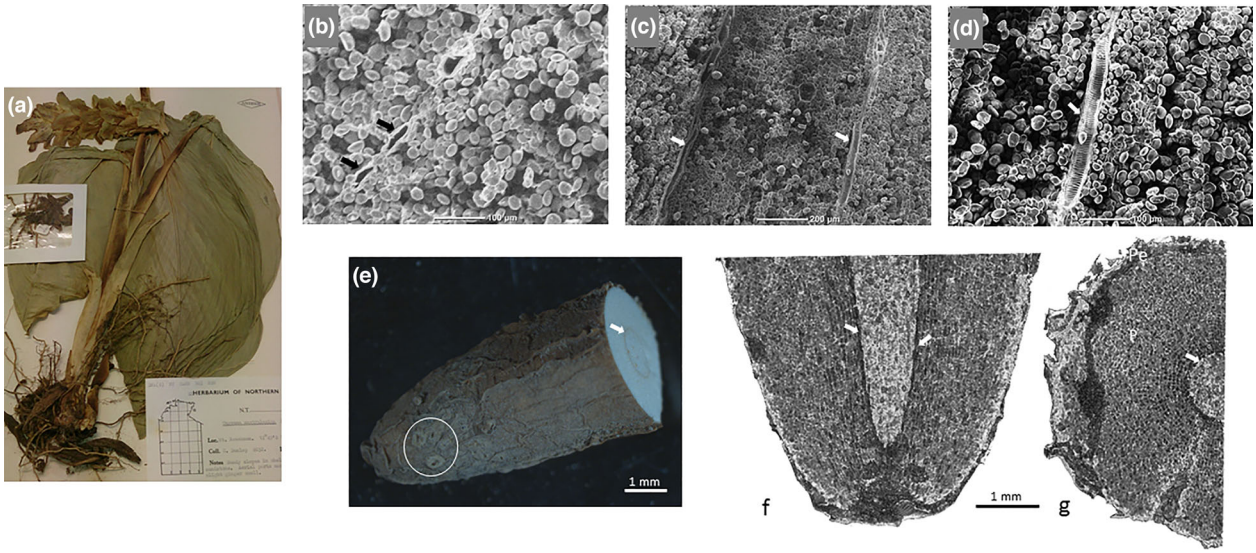
A major social consideration in assessing the character of plant exploitation in the past is the resistance, or lack of receptivity, of communities to the adoption of formal modes of agriculture (Chase, 1980, 1989). For Aboriginal communities in the Lockhart River region of Cape York "agricultural practices are a wasteful and illegitimate activity in the landscape – 'It is not our way; it is alright for other people. We get our food from the bush'." (Chase, 1989: 52). Although, Chase (1989: 51) noted:

> It is not unlikely that, within the last 10 000 years, individuals independently experimented with plant regeneration in ways we label as agriculture. But, as we know from the history of ideas in our own society, there is a large barrier between the creation of new ideas and practices at this level, and their public acceptability as a new authority for routine action.

For Chase (1989), like others, the barrier in large part comprised "highly complex and deeply integrated religious beliefs and practices" (Chase, 1989: 51).

The historical significance of bananas, taro and greater yam in northern Australia can be read in many ways. At face value, banana and taro populations could represent wild populations stranded in northern Australia following post-glacial sea-level rise and formation of the Gulf of Carpentaria and Torres Strait during the early Holocene (Lambeck & Chappell, 2001; also see Chappell, 2005), which have been supplemented by introduced cultivars over the last few hundred years of increased interaction with outsiders (Figure 6). Nonetheless, given the known histories of interaction, alternative scenarios of experimental horticulture in specific locales of northern Australia should not be discounted out of hand.

FIGURE 7. Reference specimens of Zingiberaceae *Curcuma australasica* (native turmeric), a monocot rhizome that grows in The Top End. (a) Photograph of whole plant reference specimen CANB 260443 with multiple rhizomes. Desiccated specimen NT 7838: SEM images of distal end showing; (b) part of vascular ring with flattened, elongated xylem in transverse view; (c) in longitudinal view (arrows); and (d) xylem with annular thickenings at higher magnification; (e) RLM image showing ridges and warts on outer surface (circle), note vascular ring in oblique view (arrow); microCT images of dissected specimen after charring in (f) virtual longitudinal view; and (g) transverse view – note single ring of vascular tissue (arrows) inside multiple layers of parenchyma (P) (provided by Jeni Pritchard; Pritchard et al. submitted: Fig. S7).



THE CONTRIBUTION OF ARCHAEOBOTANY: RECENT RESEARCH IN THE EAST ALLIGATOR REGION

Until recently, archaeobotanical progress on Aboriginal use of plants in the past had been hindered by a lack of expertise and the availability of modern reference materials, especially with respect to the investigation of USO exploitation (Denham, Atchison, et al., 2009). The exploitation of USOs can be investigated through starch granule analysis (Torrence & Barton, 2006), often supplemented by the study of raphides (Crowther, 2009), and through the study of archaeological parenchyma (Hather, 2000). Archaeological parenchyma generally refers to the soft tissues of plants, such as a root or tuber fragment, that are preserved in archaeological contexts in charred and sometimes in desiccated or waterlogged form.

Following the pioneering work of Annie Clarke, archaeobotanical deficiencies are now being addressed through research into archaeological parenchyma at multiple sites in the East Alligator Region of The Top End. Clarke (1985, 1989) undertook a preliminary macrobotanical study, incorporating the reporting of archaeological parenchyma, at Anbangbang I. She identified remnants of unidentified desiccated tuber skins and rootlets of *Nymphea* and *Triglochin*.

Jeni Pritchard (2018) has recently applied microCT scanning and visualisation technology to create a modern reference collection of USOs and to investigate archaeological parenchyma at two rockshelters, Birriwilk and Binjarran, on Manilikarr Country in the East Alligator Region. These sites were excavated as part of a community-led archaeological project that sought to explore the temporal depth of oral traditions regarding former activities at rockshelters (Shine 2014). At Birriwilk, a variety of USO-types were utilised during the mid or late Holocene, including bulbs/buds, primary roots/tap roots, a tuber and a possible aerial bulbil (Pritchard et al., submitted).

Anna Florin (Florin et al., 2020) has also undertaken archaeobotanical investigations of assemblages dating back over 50000 years at Madjedbebe, perhaps the most well-known site in the East Alligator region (Clarkson et al., 2017). Her research has encompassed a range of plant types, including seeds, stone fruits and archaeological parenchyma (Florin et al., 2020, 2022). So far, tuber fragments from greater yam (*Dioscorea alata*) or other introduced root crops have not been identified from pre-European contexts in these archaeobotanical studies.

Only now are the technologies, methods and reference collections being developed to appropriately investigate archaeological parenchyma in the Australian context. Although the systematic investigation of archaeological parenchyma is at a relatively early stage of application, these types of investigation are essential to understand how Aboriginal communities used USOs in the past. As well as providing substantive information on how people used diverse plant resources in the past, the reference collections of modern specimens compiled as part of these studies will also hopefully be made freely available to other researchers in order that research capacity can be built and accumulate

through time (Figure 7; see Barron & Denham, 2022; Barron et al., 2022).

To date, the results of all these archaeobotanical investigations in the East Alligator region of the Top End are consistent with the exploitation of USOs, seeds, nuts, fruits and other plant parts by hunting, gathering and fishing groups as part of broad-spectrum diets. This is not surprising given that all the sites investigated are rockshelters, which would be the places where people took food to be processed, cooked and consumed. Any attempt to investigate whether communities cultivated plants in the past would require multidisciplinary investigation at open sites of food production, such as former patches or plots, rather than at rockshelters. Nonetheless, the archaeobotanical assemblages from rockshelters provide fundamental information on the range of plants exploited, as well as possible indications of the changing dietary significance of different groups of plants through time.

CONCLUSION

Debates concerning the character of Aboriginal plant exploitation practices are beset by a lack of terminological clarity, methodological rigor and empirically verifiable evidence of the plants and practices involved. In terms of terminology:

(1) "Plant exploitation" is a generic term that refers to the use of plants by people, with emphasis here on the use of plants for food.
(2) "Form of plant exploitation" refers to the higher-order designation attributed to a set of constituent practices, namely as to whether they represent "hunting-gathering", "low-level food production", "agriculture" and so on.
(3) "Cultivation" refers to the planting and growing of food, usually in prepared ground.
(4) "Agriculture" is applied to societies or communities who orient their social life to, and are reliant upon, the cultivation of plants for food.

We propose a practice-based methodological framework for the investigation of Aboriginal plant exploitation practices that has application in the recent (documented in oral and written records) and distant (documented in archaeological and palaeoenvironmental records) pasts. In the distant past, agricultural practices can be inferred through a method of triangulation using archaeological evidence of cultivation practices, archaeobotanical evidence of the plants grown, and palaeoenvironmental evidence consistent with disturbance and clearance for cultivation. Although this methodological approach has been successfully applied in the highlands of New Guinea (Denham et al., 2003) and the Torres Strait (Williams et al., 2020) it has yet to guide multidisciplinary investigations on the Australian mainland. Only with the design of comparable multi-disciplinary projects will robust lines of key evidence be obtained to assess the character of Aboriginal plant exploitation practices in the distant past, namely before the reach of oral and written histories.

The *Dark Emu* debate has captured public and academic imaginations. Rather than resolving questions of whether Aboriginal communities on mainland Australia practiced agriculture in the past, the greatest legacies of this debate will be the enormous impetus it has given to the investigation of Aboriginal plant exploitation, which has been woefully understudied especially through archaeobotany (Denham, Atchison, et al., 2009; Denham et al., 2022), as well as the national conversation it has fostered on the politics of representation for Aboriginal societies, both past and the present (as signalled by Pascoe, 2014: 129). Ultimately, answers to questions of whether some Aboriginal communities on the Australian mainland practiced agriculture, or whether none did at any point in their history, will not be found through the selective mining of ethnographic and historical records. Such answers can only be found through in-depth multidisciplinary investigation of plant management practices for specific landscapes in the past – using a combination of archaeology, archaeobotany and palaeoecology – supplemented by phenotypic and genotypic investigations of the plants involved. Problematically for those seeking a speedy conclusion to this debate, we do not know if some communities on the Australian mainland practiced forms of agriculture in the distant past because we do not yet have the necessary lines of evidence, especially archaeobotanical, at hand; effectively, we do not know the answer to the question because we have not looked.

ACKNOWLEDGEMENTS

Foremost the authors acknowledge numerous communities across Island Southeast Asia, the circum-New Guinea region and Australia who have shared their time and knowledge over the last 35 years. We thank: Sara Booth for her assistance with archival research in 2008–2009; Uri Gilad for assistance with compilation of the GIS with linguistic and plant data presented in Figure 5; Jeni Pritchard for permission to use Figure 7; Kay Dancey and Jenny Sheehan for graphics support for the production of Figures 1, 3 and 5; and, Ian Keen and Nicolas Peterson for comments on an earlier draft. The ideas presented here on Aboriginal plant exploitation have benefitted over the years from various discussions with Huw Barton, Richard Cosgrove, Anna Florin, Jack Golson, Beth Gott, Sylvia Hallam, Dan Metcalfe, Jeni Pritchard and Rob Williams. Denham's participation in writing this paper was funded by an Australian Research Council Future Fellowship award (FT150100420). The authors greatly appreciate the constructive criticisms of the journal editors and two anonymous reviewers on a previous version of this paper. The research was funded by an Australian Research Council Future Fellowship (FT150100420) to Tim Denham.

Open access publishing facilitated by Australian National University, as part of the Wiley - Australian

National University agreement via the Council of Australian University Librarians.

DATA AVAILABILITY STATEMENT

Data sharing and availability is not applicable to this article as no new data were created or analysed in this study.

CONFLICT OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

Abraham, K., & Gopinathan Nair, P. (1991). Polyploidy and sterility in relation to sex in *Dioscorea alata* L. (Dioscoreaceae). *Genetica*, 83, 93–97.

Adamson, D. A., & Fox, M. D. (1982). Change in Australasian vegetation since European settlement. In J. M. B. Smith (Ed.), *A history of Australasian vegetation* (pp. 109–146). McGraw-Hill.

Ahmed, I., Lockhart, P. J., Agoo, E. M. G., Naing, K. W., Nguyen, D. V., Nedhi, D. K., & Matthews, P. J. (2020). Evolutionary origins of taro (*Colocasia esculenta*) in Southeast Asia. *Journal of Ecology and Evolution*, 00, 1–14.

Barton, H., & Denham, T. P. (2018). Vegecultures and the social-biological transformations of plants and people. *Quaternary International*, 489, 17–25.

Balme, J., O'Connor, S., & Fallon, S. (2018). New dates on dingo bones from Madura Cave provide oldest firm evidence for arrival of the species in Australia. *Scientific Reports*, 8, 9933.

Barron, A., & Denham, T. P. (2022). A protocol for identifying archaeological parenchyma using microCT: Steps towards a virtual reference collection. *Journal of Archaeological Science: Reports*, 46, 103682.

Barron, A., Pritchard, J., & Denham, T. P. (2022). Identifying archaeological parenchyma in three dimensions: Diagnostic assessment of five important food plant species in the Indo-Pacific region. *Archaeology in Oceania*, 57, 189–213.

Bean, A. R. (2007). A new system for determining which plant species are indigenous in Australia. *Australian Systematic Botany*, 20, 1–43.

Beaglehole, J. C. (1962). *The endeavour journal of Joseph Banks, 1768–1771*. Angus & Robertson.

Berndt, R. M., & Berndt, C. H. (1993). *A world that was: The Yaraldi of the Murray River and the Lakes, South Australia*. Melbourne University Press.

Bowern, C. (2006). Another look at Australia as a linguistic area. In Y. Matras, A. McMahon, & N. Vincent (Eds.), *Linguistic areas: Convergence in historical and typological perspective* (pp. 244–265). Palgrave Macmillan..

Bowman, D. M. J. S., Garde, M., & Saulwick, A. (2001). *Kunj-ken makka man-wurrk* (fire is for kangaroos) landscape burning in central Arnhem land seen through an ethnographic lens. In A. Anderson, I. Lilley, & S. O'Connor (Eds.), *Histories of old ages: Essays in honour of Rhys Jones* (pp. 61–78). Pandanus Books.

Bowman, D. M. J. S., Gibson, J., & Kondo, T. (2015). Outback palms: Aboriginal myth meets DNA analysis. *Nature*, 520, 33.

Bulmer, R. N. H. (1965). Review of R.F. Salisbury, From Stone to Steel, Melbourne, 1962. *Pacific Historical Review*, 34, 235–236.

Capell, A. (1970). Linguistic change in Australia. In A. R. Pilling & R. A. Waterman (Eds.), *Diprotodon to detribalization: Studies of change among Australian aborigines* (pp. 240–255). Michigan State University Press.

Chappell, J. (2005). Geographic changes of coastal lowlands in the Papuan past. In A. Pawley, R. Attenborough, J. Golson, & R. Hide (Eds.), Papuan pasts*:* Cultural, linguistic and biological histories of Papuan-speaking peoples (pp. 525–540). Pacific Linguistics 572. Pacific Linguistics, Research School of Pacific and Asian Studies, The Australian National University.

Chase, A. K. (1980). Which way now? Tradition, continuity and change in a north Queensland Aboriginal community (Unpublished PhD thesis). University of Queensland.

Chase, A. K. (1989). Domestication and domiculture in northern Australia: A social perspective, In D. R. Harris & G. C. Hillman (Eds.), *Foraging and farming: The evolution of plant exploitation* (pp. 42–54). Unwin Hyman.

Clarke, A. (1985). Preliminary archaeobotanical anaylsis of the Anbanbang I site. In R. Jones (Ed.), *Archaeological research in Kakadu National Park* (pp. 77–96). National Parks and Wildlife Service and The Australian National University Prehsitory Pacific Studies.

Clarke, A. (1989). Macroscopic plant remains. In W. Beck, A. Clarke, & L. Head (Eds.), *Plants in Australian archaeology* (pp. 54–89). Anthropology Museum, University of Queensland.

Clarkson, C., Jacobs, Z., Marwick, B., Fullagar, R., Wallis, L., Smith, M., Roberts, R. G., Hayes, E., Lowe, K., Carah, X., Florin, S. A., McNeil, J., Cox, D., Arnold, L. J., Hua, Q., Huntley, J., Brand, H. E. A., Manne, T., Fairbairn, A., & Pardoe, C. (2017). Human occupation of northern Australia by 65,000 years ago. *Nature*, 547, 306–310.

Clement, C. R., Denevan, W. M., Heckenberger, M. J., Braga Junqueira, A., Neves, E. G., Teixeira, W. G., & Woods, W. I. (2015). The domestication of Amazonia before European contact. *Proceedings of the Royal Society B: Biological Sciences*. Published: 07 August 2015. https://doi.org/10.1098/rspb.2015.0813

Clement, C. R., de Cristo-Araújo, M., d'Eeckenbrugge, G. C., Pereira, A. A., & Picanço-Rodridgues, D. (2010). Origins and domestication of Native American crops. *Diversity*, 2, 72–106.

Corbett, L. (2001). *The Dingo in Australia and Asia*. J.B. Books Australia.

Cosgrove, R., Field, J., & Ferrier, Å. (2007). The archaeology of Australia's tropical rainforests. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 251, 150–173.

Cribb, A. B., & Cribb, J. W. (1974). *Wild food in Australia*. William Collins.

Crowther, A. (2009). Morphometric analysis of calcium oxalate raphides and assessment of their taxonomic value for archaeological microfossil studies. In M. Haslam, G. Robertson, A. Crowther, S. Nugent, & L. Kirkwood (Eds.), *Studies in residue and ancient DNA analysis in Honour of Thomas H. Loy* (pp. 102–128). ANU Press.

David, B., & Denham, T. P. (2006). Unpacking Australian prehistory. In B. David, B. Barker, & I. McNiven (Eds.), *The social archaeology of indigenous societies* (pp. 52–71). Aboriginal Studies Press.

De Langhe, E., Vrydaghs, L., de Maret, P., Perrier, X., & Denham, T. P. (2009). Why bananas matter: An introduction to the history of banana domestication. *Ethnobotany Research and Applications*, 7, 165–177.

Denham, T. P. (2018). *Tracing early agriculture in the highlands of New Guinea: Plot, mound and ditch*. Routledge.

Denham, T. P. (2017). Breaking down barriers: Prehistoric species dispersals across Island Southeast Asia, New Guinea and

Australia. In N. Boivin, R. Cressard, & M. Petraglia (Eds.), *Human dispersals and species movements: From prehistory to the present* (pp. 164–193). Cambridge University Press.
Denham, T. P. (2011). Early agriculture and plant domestication in New Guinea and Island Southeast Asia. *Current Anthropology*, 52, (S4), S379–S395.
Denham, T. P. (2009). A practice-centred method for charting the emergence and transformation of agriculture. *Current Anthropology*, 50, 661–667.
Denham, T. P. (2008). Traditional forms of plant exploitation in Australia and New Guinea: The search for common ground. *Vegetation History and Archaeobotany*, 17, 245–248.
Denham, T. P. (2007a). Early to mid-Holocene plant exploitation in New Guinea: Towards a contingent interpretation of agriculture. In T. P. Denham, J. Iriarte, & L. Vrydaghs (Eds.), *Rethinking agriculture: Archaeological and ethnoarchaeological perspectives* (pp. 78–108). Left Coast Press.
Denham, T. P. (2007b). Early agriculture: Recent conceptual and methodological developments. In T. P. Denham & J. P. White (Eds.), *The emergence of agriculture: A global view* (pp. 1–25). Routledge.
Denham, T. P. (2006). The origins of agriculture in New Guinea: Evidence, interpretation and reflection. In I. Lilley (Ed.), *Blackwell guide to archaeology in Oceania: Australia and the Pacific Islands* (pp. 160–188). Blackwell.
Denham, T. P. (2005). Envisaging early agriculture in the Highlands of New Guinea: Landscapes, plants and practices. *World Archaeology*, 37, 290–306.
Denham, T. P., Barton, H., Castillo, C., Crowther, A., Dotte-Sarout, E., Florin, A., Pritchard, J., Barron, A., Zhang, Y., & Fuller, D. Q. (2020). The domestication syndrome in vegetatively propagated field crops. *Annals of Botany*, 125, 581–597.
Denham, T. P., Crowther, A., & Barron, A. (2022). Archaeobotanical futures in the Indo-Pacific. *Archaeology in Oceania*, 57, 155–159.
Denham, T. P., & Donohue, M. (2022). Mapping the middle ground between foragers and farmers. *Journal of Anthropological Archaeology*, 65, 101390.
Denham, T. P., & Haberle, S. G. (2008). Agricultural emergence and transformation in the Upper Wahgi valley during the Holocene: Theory, method and practice. *The Holocene*, 18, 499–514.
Denham, T. P., Haberle, S. G., Lentfer, C., Fullagar, R., Field, J., Therin, M., Porch, N., & Winsborough, B. (2003). Origins of agriculture at Kuk Swamp in the Highlands of New Guinea. *Science*, 301, 189–193.
Denham, T. P., Donohue, M., & Booth, S. (2009). Revisiting an old hypothesis: Horticultural experimentation in northern Australia. *Antiquity*, 83, 634–648.
Denham, T. P., Fullagar, R., & Head, L. (2009). Plant exploitation on Sahul: From colonisation to the emergence of regional specialisation during the Holocene. *Quaternary International*, 202, 29–40.
Denham, T. P., Atchison, J., Austin, J., Bestel, S., Bowdery, D., Crowther, A., Dolby, N., Fairbairn, A., Field, J., Kennedy, A., Lentfer, C., Matheson, C., Nugent, S., Parr, J., Prebble, M., Robertson, G., Specht, J., Torrence, R., Barton, H., … Matthews, P. (2009). Archaeobotany in Australia and New Guinea: Practice, potential and prospects. *Australian Archaeology*, 68, 1–10.
Dick, H. (1994). Wild banana – Musa banksii. *Australian Plants*, 17, 266.
Donohue, M. (2013). Who inherits what, when? contact, substrates and superimposition zones. In B. Bickel, L. A. Grenoble, D. A. Peterson, & A. Timberlake (Eds.), *Language typology and historical contingency: In honor of Johanna Nichols* (pp. 219–240). Typological Studies in Language, 104. John Benjamins.
Evans, N., & Jones, R. (1997). The cradle of the Pama-Nyungans: Archaeological and linguistic speculations. In P. McConvell & N. Evans (Eds.), *Archaeology and linguistics: Aboriginal Australia in global perspective* (pp. 385–417). Oxford University Press.
Florin, S. A., & Carah, X. (2018). Moving past the 'Neolithic problem': The development and interaction of subsistence systems across northern Sahul. *Quaternary International*, 489, 46–62.
Florin, S. A., Fairbairn, A. S., Nango, M., Djandjomerr, D., Marwick, B., Fullagar, R., Smith, M., Wallis, L. A., & Clarkson, C. (2020). The first Australian plant foods at Madjedbebe, 65,000-53,000 years ago. *Nature Communications*, 11, 924. https://doi.org/10.1038/s41467-020-14723-0
Florin, S. A., Fairbairn, A. S., Nango, M., Djandjomerr, D., Hua, Q., Marwick, B., Reutens, D. C., Fullagar, R., Smith, M., Wallis, L. A., & Clarkson, C. (2022). 65,000 years of changing plant food and landscape use at Madjedbebe, Mirarr Country, northern Australia. *Quaternary Science Reviews*, 284, 107498.
Fuller, D. Q. (2007). Contrasting patterns in crop domestication and domestication rates: Recent archaeobotanical insights from the Old World. *Annals of Botany*, 100, 903–924.
Fuller, D. Q., & Denham, T. P. (2022). Coevolution in the arable battlefield: Pathways to crop domestication, cultural practices and parasitic domesticoids. In T. R. Schultz, R. Gawne, & P. N. Peregrine (Eds.), *The convergent evolution of agriculture in humans and insects* (pp. 177–208). The Vienna Series in Theoretical Biology. The MIT Press.
Fuller, D. Q., Denham, T. P., Arroyo-Kalin, M., Lucas, L., Stevens, C., Qin, L., Allaby, R. G., & Purugganan, M. D. (2014). Convergent evolution and parallelism in plant domestication revealed by an expanding archaeological record. *Proceedings of the National Academy of Sciences (USA)*, 111, 6147–6152.
Fuller, D. Q., Kingwell-Banham, E., Lucas, L., Murphy, C., & Stevens, C. (2015). Comparing pathways to agriculture. *Archaeology International*, 18, 61–66
Fuller, D. Q., Stevens, C., Lucas, L., Murphy, C., & Qin, L. (2016). Entanglements and entrapment on the pathway toward domestication. In L. Der & F. Fernadini (Eds.), *Archaeology of entanglement* (pp. 151–172). Left Coast Press.
Gammage, B. (2012). *The biggest estate on earth: How aborigines made Australia*. Allen & Unwin.
Gerritsen, R. (2008). *Australia and the origins of agriculture*. British Archaeological Reports Limited.
Gilmore, M. (1934). *Old days, old ways: A book of recollections*. Angus and Robertson.
Golson, J. (1971). Australian aboriginal food plants: Some ecological and culture-historical implications. In D. J. Mulvaney & J. Golson (Eds.), *Aboriginal man and environment in Australia* (pp. 196–238). Australian National University.
Gott, B. (2005). Aboriginal fire management in south-eastern Australia: Aims and frequency. *Journal of Biogeography*, 32, 1203–1208.
Gott, B. (1999). *Cumbungi*, *Typha* species: A staple Aboriginal food in southern Australia. *Australian Aboriginal Studies*, 1999, 33–50.
Gott, B. (1983). *Murnong - Microseris scapigera*: A study of a staple food of Victorian Aborigines. *Australian Aboriginal Studies*, 2, 2–17.

Grey, G. (1841). *Journals of two expeditions of discovery in North-West Australia* (Vol. 2). T. and W. Boone.
Grimaldi, I. M., Van Andel, T. R., & Denham, T. P. (2022). Looking beyond history: Tracing the dispersal of the Malaysian complex of crops to Africa. *American Journal of Botany*, 109, 193–208.
Haddon, A. C. (1935). *Reports of the Cambridge anthropological expedition to Torres Straits: General ethnography* (Vol. 1). Cambridge University Press.
Hage, P., & Harary, F. (1996). *Island networks: Communication, kinship and classification structures in Oceania*. Cambridge University Press.
Hallam, S. J. (1989). Plant usage and management in Southwest Australian Aboriginal societies. In D. R. Harris & G. C. Hillman (Eds.), *Foraging and Farming: The Evolution of Plant Exploitation* (pp. 136–151). Unwin and Hyman.
Hallam, S. J. (1975). *Fire and Hearth: A study of Aboriginal usage and European usurpation in southwestern Australia*. Australian Institute of Aboriginal Studies.
Harris, D. R. (1989). An evolutionary continuum of people-plant interaction. In D. R. Harris & G. C. Hillman (Eds.), *Foraging and farming: The evolution of plant exploitation* (pp. 11–26). Unwin Hyman.
Harris, D. R. (1995). Early agriculture in New Guinea and the Torres Strait divide. *Antiquity*, 69(Special Number 265), 848–854.
Harris, D. R. (1996). Introduction: Themes and concepts in the study of early agriculture. In D.R. Harris (Ed.), *The origins and spread of agriculture and pastoralism in Eurasia* (pp. 1–9). University College London Press.
Hather, J. G. (1996). The origins of tropical vegeculture: Zingiberaceae, Araceae and Dioscoreaceae in Southeast Asia. In D. R. Harris (Ed.), *The origins and spread of agriculture and pastoralism in Eurasia* (pp. 538–550). University College London Press.
Hather, J. G. (2000). *Archaeological parenchyma*. Archaeotype Publications.
Henry, R. K. (2019). Australian wild rice populations: A key resource for global food security. *Frontiers in Plant Science*, 10, 1354.
Hiscock, P. (2008). *Archaeology of ancient Australia*. Routledge.
Hynes, R., & Chase, A. K. (1982). Plants, sites and domiculture: Aboriginal influence on plant communities. *Archaeology in Oceania*, 17, 138–150.
Ingold, T. (2000). *The perception of the environment*. Routledge.
Jones, R. (1969). Firestick farming. *Australian Natural History*, 16, 224–228.
Jones, R., & Meehan, B. (1989). Plant foods of the Gidjingal: Ethnographic and archaeological perspectives from northern Australia on tuber and seed exploitation. In D. R. Harris & G. C. Hillman (Eds.), *Foraging and farming: The evolution of plant exploitation* (pp. 120–135). Unwin Hyman.
Keen, I. (2003). *Aboriginal economy and society: Australia at the threshold of colonisation*. Oxford University Press.
Keen, I. (2021). Foragers or farmers: *Dark Emu* and the controversy over Aboriginal agriculture. *Anthropological Forum*, 31(1), 106–128. https://doi.org/10.1080/00664677.2020.1861538
Kondo, T., Crisp, M. D., Linde, C., Bowman, D. M., Kawamura, K., Kaneko, S., & Isagi, Y. (2012). Not an ancient relic: The endemic *Livistona* palms of arid central Australia could have been introduced by humans. *Proceedings of the Royal Society B*, 279(1738), 2652–2661.
Lambeck, K., & Chappell, J. C. (2001). Sea level change through the last glacial cycle. *Science*, 292, 679–686.
Latz, P. K. (1995). *Bushfires and bushtucker*. IAD Press.
Lebot, V. (2009). *Root and tuber crops: Cassava, sweet potato, yams and aroids* (Vol. 17). Crop Production Science in Horticulture. CABI Publishing.
Lebot, V., Trilles, B., Noyer, J. L., & Modesto, J. (1998). Genetic relationships between *Dioscorea alata* L. cultivars. *Genetic Resources and Crop Evolution*, 45, 499–509.
Lentfer, C., & Denham, T. P. (2017). The archaeobotany of Kuk. In J. Golson, T. P. Denham, P. J. Hughes, P. Swadling, & J. Muke (Eds.), *Ten thousand years of cultivation at Kuk Swamp in the highlands of Papua New Guinea* (pp. 163–184). Terra Australis 46. ANU E Press.
Levis, C., Flores, B. M., Moreira, P. A., Luize, B. G., Alves, R. P., Franco-Moraes, J., Lins, J., Konings, E., Peña-Claros, M., Bongers, F., Costa, F. R. C., & Clement, C. R. (2018). How people domesticated Amazonian forests. *Frontiers in Ecology and Evolution*, 5, 171. https://doi.org/10.3389/fevo.2017.00171
Lourandos, H. (1997). *Continent of hunter-gatherers: New perspectives in Australian prehistory*. Cambridge University Press.
Macintyre, K., Dobson, B., & Hayward-Jackson, I. (2020). Yam lands: The mystery of a holy landscape. Anthropology from the Shed. Retrieved from https://anthropologyfromtheshed.com/project/indigenous-yam-cultivators-of-southwestern-australia
MacKnight, C. (1976). *The Voyage to Marege: Macassan trepangers in Northern Australia*. Melbourne University Press.
Matthews, P. J. (1991). A possible wild type taro: Colocasia esculenta var. aquatilis. *Indo-Pacific Prehistory Association Bulletin*, 11, 69–81.
Matthews, P. J., & Terauchi, R. (1994). The genetics of agriculture: DNA variation in taro and yam. In J. G. Hather (Ed.), *Tropical archaeobotany: Applications and new developments* (pp. 251–262). Routledge.
McCarthy, F. D. (1939). 'Trade' in Aboriginal Australia, and 'trade' relationships with Torres Strait, New Guinea and Malaya. *Oceania*, 9, 405–438; 10: 1.
McConvell, P. (2008). Language mixing and language shift in Indigenous Australia. In J. Simpson & G. Wigglesworth (Eds.), *Children's language and multilingualism: Indigenous language use at home and school* (pp. 237–260). Bloomsbury.
McNiven, I. J. (2008). Inclusions, exclusions and transitions: Torres Strait Islander constructed landscapes over the past 4000 years, northeast Australia. *The Holocene*, 18, 449–462.
McNiven, I. J. (2008). Beyond bridge and barrier: Reconceptualising Torres Strait as a co-constructed border zone in ethnographic object distributions between Queensland and New Guinea. *Queensland Archaeological Research*, 25, 25–46.
Murdock, G. P. (1967). *Ethnographic atlas*. HRAF Press.
Oslisly, R., & White, L. (2007). Human impact and environmental exploitation in Gabon during the Holocene. In T. P. Denham, J. Iriarte, & L. Vrydaghs (Eds.), *Rethinking Agriculture: Archaeological and Ethnoarchaeological Perspectives* (pp. 347–360). Left Coast Press.
Pascoe, B. (2014). *Dark Emu: Aboriginal Australia and the birth of agriculture*. Magabala Books.
Pascoe, B. (2018). *Dark Emu. Aboriginal Australia and the birth of agriculture*. Magabala Books.
Pascoe, B. (2019). *Young Dark Emu: A truer history*. Magabala Books.
Porr, M., & Vivian-Williams, E. (2021). The tragedy of Bruce Pascoe's *Dark Emu*. *Australian Archaeology*, 87, 300–304.
Pritchard, J. (2018). *MicroCT investigation of archaeological parenchyma from Bindjarran and Birriwilk rockshelters in*

southwest Arnhemland, Australia [Unpublished Masters Sub-Thesis]. School of Archaeology and Anthropology, Australian National University.

Pritchard, J., Shine, D., Barron, A., Wood, R., Nayinggul, A., & Denham, T. submitted. MicroCT analysis of archaeological parenchyma identifies underground storage organs (USOs) and an aerial bulbil from late Holocene contexts at Birriwilk rockshelter, Arnhem Land, northern Australia. *Journal of Archaeological and Anthropological Sciences*.

Rangan, H., Bell, K. L., Baum, D. A., Fowler, R., McConvell, P., Saunders, T., Spronck, S., Kull, C. A., & Murphy, D. J. (2015). New genetic and linguistic analyses show ancient human influence on baobab evolution and distribution in Australia. *PLoS ONE*, 10, e0119758.

Roberts, P., Buhrich, A., Caetano-Andrade, V., Cosgrove, R., Fairbairn, A. S., Florin, S. A., Vanwezer, N., Boivin, N., Hunter, B., Mosquito, D., Turpin, G., & Ferrier, Å. (2021). Reimagining the relationship between Gondwanan forests and Aboriginal land management in Australia's "Wet Tropics". *iScience*, 24, 102190.

Rossetto, M., Ens, E. J., Honings, T., Wilson, P. D., Yap, J.-Y. S., Costello, O., Round, E. R., & Bowern, C. (2017). From songlines to genomes: Prehistoric assisted migration of a rain forest tree by Australian Aboriginal people. *PLoS ONE*, 12, e0186663.

Roullier, C., Benoit, L., McKey, D. B., & Lebot, V. (2013). Historical collections reveal patterns of diffusion of sweet potato in Oceania obscured by modern plant movements and recombination. *Proceedings of the National Academy of Sciences (USA)*, 110, 2205–2210.

Rowland, M. J., & Kerkhove, R. C. (2022). Evidence of external contact between the Pacific Basin and the east coast of Australia during the Holocene: A review. *Queensland Archaeological Research*, 25, 47–66.

Russell-Smith, J., Lucas, D., Gapindi, M., Gunbunuka, B., Kapirigi, N., Namingum, G., Lucas, K., Giuliani, P., & Chaloupka, G. (1997). Aborignal resource utilisation and fire management practice in western Arnhem Land, monsoonal northern Australia: Notes for prehistory, lessons for the future. *Human Ecology*, 25, 159–195.

Shine, D. (2014). *Changing places: An archaeological study of Manilikarr Country in western Arnhem Land* [Unpublished PhD thesis]. Monash University, Australia.

Simmonds, N. W. (1956). A banana collecting expedition to South Asia and the Pacific. *Tropical Agriculture*, 33, 251–271.

Smith, B. D. (2001). Low-level food production. *Journal of Archaeological Research*, 9, 1–43.

Sutton, P., & Walshe, K. (2021). *Farmers or hunter-gatherers?* Melbourne University Publishing.

Telford, I. R. (1986). Dioscoraceae. *Flora of Australia*, 46, 196–202, 219.

Terrell, J. E., Hart, J. P., Barut, S., Cellinese, N., Curet, A., Denham, T. P., Kusimba, C. M., Latinis, K., Oka, R., Palka, J., Pohl, M. E. D., Pope, K. O., Williams, P. R., Haines, H., & Williams, P. R. (2003). Domesticated landscapes: The subsistence ecology of plant and animal domestication. *Journal of Archaeological Method and Theory*, 10, 323–368.

Torrence, R., & Barton, H. (2006). *Ancient starch research*. Left Coast Press.

Trigger, B. G. (2007). *A history of archaeological thought* (2nd ed.). Cambridge University Press.

Vigilante, T., & Bowman, D. M. J. S. (2004). Effects of individual fire events on the flower production of fruit-bearing tree species, with reference to Aboriginal people's management and use, at Kalumburu, North Kimberley, Australia. *Australian Journal of Botany*, 5, 405–415.

von Mueller, F. J. H. (1864). Musaceae. *Musa Banksii*. In *Fragmenta Phytographiae Australiae, 1863–1864* (Vol. 4, pp. 132–134). Auctoritate Gubern. Coloniæ Victoriæ.

Wallace, A. R. (1869). *The Malay Archipelago*. Macmillan and Co.

Wasef, S., Wrobel, G., Wright, N., Wright, J. L., Adams, S., Kariwiga, J., Leavesley, M., Collard, M., & Westaway, M. C. (2021). A contextualised review of genomic evidence for gene flow events between Papuans and Indigenous Australians in Cape York, Queensland. *Quaternary International*, 603, 22–30.

White, C. T. (1919). Order Dioscorideae. Botany Bulletin, 21, Contributions to the Queensland Flora: 22. Brisbane: Department of Agriculture and Stock.

White, J. P. (2011). Revisiting the 'Neolithic Problem' in Australia. *Records of the Western Australian Museum Supplement*, 79, 86–92.

Williams, R. N., Wright, D., Crowther, A., & Denham, T. P. (2020). Multidisciplinary evidence for early banana (*Musa* cvs.) cultivation on Mabuyag Island, Torres Strait. *Nature Ecology & Evolution*, 4(10), 1342–1350. https://doi.org/10.1038/s41559-020-1278-3

Windsor Earl, G. (1846). *Enterprise in Tropical Australia*. Madden and Malcolm.

Yen, D. E. (1989). The domestication of environment. In D. R. Harris & G. C. Hillman (Eds.), *Foraging and farming: The evolution of plant exploitation* (pp. 55–75). Unwin Hyman.

Yen, D. E. (1995). The development of Sahul agriculture with Australia as bystander. *Antiquity*, 69(Special Number 265), 831–847.

Young, A. R. M. (1996). *Environmental change in Australia since 1788*. Oxford University Press.