Finding the Connections between Paleoecology, Ethnobotany, and Conservation in Madagascar

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Abstract

Studying Madagascar's late prehistoric past can add a useful dimension to ethnobotany research, as it has to conservation efforts. These studies provide evidence that people first arrived about two millennia ago. The plants they brought to Madagascar are predominantly south Asian in origin, including coconut, banana, rice, and hemp, pointing to their probable Indonesian origins. Later plant additions, such as castor bean, came from Africa and reflect a second wave of human migration. The subsequent development of indigenous agriculture was affected by the limitations of climate and soils, and also by the effects of ecological changes that were largely anthropogenic. Additional information on these remote times can be gleaned from early literature, especially Mediterranean and Islamic references. These types of multidisciplinary investigations, aimed at recovering additional early cultural and ecological elements, can have the positive effect of developing stronger ties between ecology and culture in Madagascar, perhaps helping to heal the unfortunate rift between conservation and the social sciences currently so evident there.

Résumé

Découvrant les Liensentre la Paléoécologie, l'Ethnobotanie, et la Conservation au Madagascar. Étudier le passé préhistorique de Madagascar peut ajouter une dimension utile à la recherche d'ethnobotanie, comme il fait pour les efforts de conservation. Ces études fournissent l'évidence que les humains sont arrivés pour la première fois il y a environ deux milennia. Les plantes qu'ils ont apportées au Madagascar sont principalement d'origine sud-Asiatique, et comprisent la noix de coco, la banane, le riz, et le chanvre, se dirigeant à leurs origines probables indonésiennes. Les additions plus tards des plantes, telles que des graines de ricin, sont venues d'Afrique et reflètent une deuxième vague de migration humaine. Le développement subsequént de l'agriculture indigène a été affecté par les limitations du climat et des sols, et également par les effets des changements écologiques qui étaient en grande partie anthropogènes.

Information additionnelle de ces époques reculées peut être glanée de la littérature tôt de, particulièrement de references méditerranéennes et islamiques. Ces genres d'investigations multidisciplinaires, viseés à récupérer de premiers éléments culturels et écologiques additionnels, peuvent avoir un effet positif de développer des liens plus forts entre l'écologie et la culture du Madagascar, peut-être aidant à guérir la fissure malheureuse entre la conservation et les sciences sociales actuellement évidente ici.

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Introduction

Investigations of late prehistoric times have come to be recognized in recent years as an important element in planning for the future in terms of ecological and cultural restoration. New findings from paleoecology, paleontology, and archaeology in Madagascar (reviewed in Burney *et al*. 2004) have added a fresh dimension to discussions of conservation priorities and strategies there. Although the relevance of this new information to ethnobotany has been less explored, this is a fertile area for future investigation.

Studies of past human connections to plants may take the form of archaeobotany, the study of plant remains in archaeological sites, or more generally, paleoethnobotany, the study of any type of evidence for past utilization of plants. In the latter case, one might resort to a variety of indirect methods, ranging from detection of fossil pollen grains from human-introduced plants and human-modified plant communities in sediments, to ethnographic investigations of oral traditions concerning ancient plant uses. In any case, the pursuit of any information likely to be as fragmented as this benefits greatly from a multidisciplinary approach.

This article will trace several lines of evidence that illustrate the growing linkages and point to additional possible new connections between paleoecology's new findings on Madagascar and the goals of ethnobotanical research there. These relevant categories include: 1) improvements in our understanding of the nature and composition of prehuman environments; 2) the emerging picture regarding when people arrived, and who they were; 3) earliest evidence for human uses of plants on Madagascar, including imported species; and, 4) anthropogenic landscape transformation and its consequences for agriculture. This review is followed by suggestions regarding future directions for paleoethnobotanical research and applications.

Madagascar's Vegetation before Humans

French colonial botanists in the early twentieth century, acting on very little direct evidence, nevertheless re-created an entire scenario for the transformation of the original vegetation of the island that not surprisingly cast the native people in a rather negative role in these changes. Humbert (1927) and Perrier de la Bathie (1936) for instance, viewed prehuman Madagascar as a kind of Eden in which virtually the entire landscape in all climate zones and soil types hosted dense "climax" forests. This vegetation was rapidly transformed to grassland and arid bushland, they maintained, when the proto-Malagasy arrived and proceeded to burn the landscape. They speculated that the endemic megafauna of giant lemurs, elephant birds, tortoises, and pygmy hippos went extinct primarily as a result of this transformation of the landscape, perhaps aided by direct predation on the naïve fauna.

For two decades, evidence showing a more complex scenario has been accumulating (e.g. Burney 1987a,b,c, 1993, 1999, Burney *et al*. 1997, 2003, 2004, Gasse & Van Campo 1998, Goodman & Rakotozafy 1997). In this empirically based reconstruction (see Table 1), prehuman Madagascar was a mosaic of not only forest, but environments in which prehuman fires and megafaunal herbivory were major factors, including wooded savanna, open grassland, and semiarid bushland. Burney *et al*. (2003) paint the most detailed picture, citing evidence from the occurrence of *Sporormiella* spores, a fungus that grows on dung of large mammals, in combination with microscopic charcoal particles, pollen data, and AMS 14C dating of collagen from bones of the extinct animals, that humans probably transformed the environment first by inadvertently over-hunting large herbivores, resulting in increased plant biomass at ground level, leading to more frequent and destructive fires, ultimately culminating in

Table 1. Chronological highlights of the human settlement of Madagascar (adapted from Burney *et al*. 2004).

Time	Event
2300 cal yr BP (350 cal yr BC)	First evidence for humans, in form of modified bones of extinct megafauna and pollen of introduced *Cannabis*.
230-410 cal yr AD	Drastic decline of coprophilous *Sporormiella* fungus spores in sediments, due to reduced megafaunal densities. Abrupt increases in charcoal particles follow in southwest sites, signaling increased human impact on the local landscape. Charcoal increase comes later in other regions, as humans spread up the west coast and into the interior.
780-1010 cal yr AD	Earliest indirect evidence for livestock proliferation, based on *Sporormiella* resurgence in northwest Madagascar.
Ca. 1000-1400 cal yr AD	Charcoal particle evidence suggests deforestation was underway in the lowland rain forests. Islamized Indian Ocean traders active on coasts. Peak development of the entrepot of Mahilaka on the NW coast, followed by collapse. *Sporormiella* resurgence in highlands suggests pastoralism has reached this area.
1500 AD	Portuguese explorer Diogo Dias lands on north shore of Madagascar.

the loss of the megafauna through a combination of impacts.

In any case, the result was a depauperation of many highland and semiarid environments, with dominance by grasses and pyrogenic woody communities, increased loss of soil nutrients to leaching and erosion, and silting of rivers. These effects were probably exacerbated by the increasingly arid climates in these Southern Hemisphere latitudes in the late Holocene.

Botanical Clues to Human Origins in Madagascar

The prehistoric settlement of Madagascar is one of the great mysteries of human migration. That the world's fourth largest island would lie undiscovered a few hundred kilometers off the coast of Africa until two millennia ago, only to be settled first by Indonesians from the other side of the Indian Ocean, is as improbable as if Columbus had landed in the New World to be greeted by blond-haired, Scandinavian-speaking Vikings (Diamond 1997). Lacking compelling evidence for the initial settlement events (Dewar & Wright 1993), early investigators had invoked the highly indirect and somewhat controversial techniques of glottochronology to show that the Malagasy language demonstrates an Indonesian origin, and that these colonists had separated from closely related Austronesian language-speakers in the highlands of Borneo roughly two millennia ago (Dahl 1951).

Subsequent paleoecological work has shown, from multiple lines of independent evidence, that people probably first settled the island around 2300 years ago. These lines of evidence include the first occurrence of pollen of hemp (*Cannabis* sp.) in sediments throughout the island at approximately this date. In addition, decreasing percentages of pollen of woody species and an increase in ruderal (disturbance-adapted) pollen types (Burney 1999), a large increase in microscopic charcoal particles in sediments (Burney 1987c, Gasse & Van Campo 1998), decline of dung-fungus spores (Burney *et al*. 2003), and earliest evidence for butchery of large animals that later become extinct (Burney 1999, MacPhee & Burney 1991, Perez *et al*. in press) all support this approximate date. In addition, the earliest written account of a place that might be Madagascar appears in the writings of the Greek geographer Herodotus around 400 B.C. He told of a place beyond the "Mountains of the Moon" at the source of the Nile, with giant birds. He learned of this place, he said, from Egyptian priests. Vague as this reference is, it strongly suggests that someone, by this time, had seen the largest birds that ever lived, which survived on Madagascar until well after the time of initial human colonization (Burney *et al*. 2004).

As to who these earliest Malagasy people were, there are additional bits of compelling evidence beyond language and such cultural attributes as boat construction and burial practices suggestive of an Indonesian connection. This evidence is ethnobotanical in nature. In addition to hemp, which was thought to have been brought from Asia to Africa by Indonesian traders over two millennia ago (Merlin 2003), other adventive Asian plants in the African region were certain coconut (*Cocos nucifera* L.) varieties (Harries 1992), the banana (*Musa acuminata* X*balbisiana* Colla.) (McMaster 1962), and rice (*Oryza sativa* L.) (Dewar & Wright 1993). It would appear, from accounts by medieval Arab geographers such as Abul Hasan Ali Masu'di (c. 947 A.D.) and Ibn Battuta (c. 1345 A.D.) that a thriving trade had long been well-established between Indonesian merchant sailors and "Zinj" (Zanzibar) on the Tanzanian coast across the Moçambique Channel from Madagascar.

A fertile area for additional research would be to comb ancient texts for more of this type of paleoethnobotanical information. In addition, pollen and plant macrofossil studies in Madagascar and East Africa would help clarify these plant movements. For instance, a pollen record from Drotsky's Cave in Botswana (Burney *et al*. 1994) shows that hemp had reached this far inland in southern Africa by more than two millennia ago, implying rapid spread of this plant with many uses through diverse human populations, once it was introduced. The plant was also known in the Middle East by this time (Merlin 2003). The banana also spread rapidly, becoming an important early staple of Bantu agriculturalists in Uganda (McMaster 1962). The coconut became so widespread in Africa in early times that debate has continued as to whether it in fact might be native (Harries 1992).

Fossil pollen also provides evidence for a subsequent human migration. The castor bean (*Ricinus communis* L.), an African plant valued for medicinal and insecticidal qualities, appears in the pollen record of Madagascar's highlands about 1000 years ago (Burney 1987b). This corresponds to evidence from the re-appearance of *Sporormiella* spores in the same sediments, at this point most likely a proxy for livestock, probably signaling the advent of large-scale pastoralism in Madagascar. It is believed that Islamized Indian Ocean traders, sometimes referred to as Swahili or Afro-Arab peoples, began colonizing the west coast of Madagascar about this time (Dewar & Wright 1993). These people would likely have brought castor beans and cattle-raising to the island. Another fertile field of investigation would be to look for other fossil plant evidence at this time on the island, as one would guess that other African crops may have been brought, as well as African weed species that may have come with the livestock or been favored by their grazing habits.

Landscape Transformation: Consequences for agriculture

One of the sad ironies of Malagasy lifeways is that suitable adaptive responses to the landscape transformations apparently set in motion by human colonization have probably led synergistically to further landscape transformation (Jolly 1982). Increased burning in the highly seasonal environments of the central highlands, for instance, has promoted further leaching of the lateritic soils, already leached for millennia, thus hampering plant regeneration and any subsequent soil improvement and fostering ever more frequent fires.

Once the Malagasy had converted the diverse mosaic of woodlands, bushlands, and grasslands of the interior into a depauperate steppe, agricultural possibilities were limited. Despite the popular depiction of the island as the “most degraded landscape on earth,” it has been recently argued from comparative evidence from other tropical regions that options here are essentially limited by the circumstances (Kull 2000). What has emerged over the centuries following colonization of the vast highlands of Madagascar is a simple system, in which the uplands provide cattle grazing, through the periodic burning of the dry standing crop of grass to promote a green flush, and the flat valley bottoms receive whatever sediment, nutrients, and water run off this extractive system and sequester them in rice paddies that provide nearly all the available cropland. One could say that the Malagasy mine their protein from the hills, which consequently bleed whatever nutrients remain into the valleys, where they grow their carbohydrates.

Although this is not a pretty picture, and certainly not a poster-child of the incipient conservation movement on the island (mostly transplanted from the West), it has nevertheless functioned as the mainstay of the preindustrial economy for many centuries. The system is in danger of collapse today primarily because it is not sustainable in a rapidly growing population. Without forests in the valley heads to sequester and slowly release water and nutrients to the pondfields at the bottom, the entire system is not likely to maintain its traditional high yields. Rice is an extremely productive crop, allowing relatively high population densities (similar to the taro pondfields of the Polynesian cultures), but there are limits to how many people the system can support, and many analysts believe Madagascar is at or beyond those sustainable limits already (Wright 1997).

On many Pacific islands, as well as Madagascar’s Indian Ocean neighbors, the Mascarenes and Seychelles, concepts of ecological restoration, cultural reinvigoration, and sustainability have gained considerable traction in recent years. There is similar potential in Madagascar, but several obstacles persist. One is obvious: poverty. Development, whether sustainable or not, but particularly sustainable, costs money and requires time. But obstacles also exist in other realms. The knowledge base, that is, the ecological and agricultural know-how to find better solutions, is weak. Ethnobotany, tempered by the longer time perspective afforded by paleoecological and archaeological studies, can play a role here, in understanding the value and potential of diversified and more sustainable agricultural techniques.

There is another obstacle that ethnobotany can help remedy. The Malagasy people are by nature and tradition suspicious of innovation, through the hard conservatism that comes from living on a challenging landscape. Foreign “experts” have repeatedly and rather consistently failed in their efforts to offer the Malagasy an alternative to the time-honored agricultural strategies they have developed through two millennia of trial and error. If progress is to be made, it will almost certainly require a certain humility on the part of aid workers, recognizing that traditional knowledge of the land has a place in modern strategies. In its multidisciplinary, multicultural way, ethnobotany can provide a model for bringing the linked concepts of cultural and ecological restoration to the forefront. What is desperately needed here, as well as in many other developing countries, is a healing of the rift between conservation and the social sciences. Stronger ties between ecology and culture, practical experience has shown, can best be developed by fostering an indigenous movement in this direction. There is nothing that well-meaning foreigners can do for Madagascar that will do more good for these combined goals than providing quality education for young Malagasy -- both scientists and farmers – that will enable them to lead the way to a better future for their island.

In short, preserving Malagasy traditional culture and the unique biota of Madagascar must be treated as part of the same urgent mission. Ethnobotanists rooted in a knowledge and respect for the past have an important role to play in meeting this challenge.

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