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Use and cultivation of plants that yield products other than timber from South Asian tropical forests, and their potential in forest restoration

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ABSTRACT

Rural communities have traditionally valued forests for a diversity of products and services, with timber serving a minor role. No-where has this diversity been greater than in tropical South Asia, and in particular south India and Sri Lanka. As economies advance towards full development and populations become increasingly urbanized, forests become increasingly valued for their services. National development generally occurs at differing rates in different regions, with rural forest dependent communities falling behind and pockets of poverty long remaining. The demand for 'non-timber forest products' (NTFPs) therefore changes from subsistence to monetary based values. Overall, though, forests have suffered an unprecedented decline with development in the tropics, especially in Asia. This necessitates restoration which takes account of the enrichment of economy, wellbeing and culture which forest products provide. Methods for such restoration, and the fundamental principles upon which these must rest, are presented for species yielding NTFP's. In this paper we first review the history of NTFP species use within south India and Sri Lanka. Second we provide a description of the broad regional characterizations of the forest formations within this region in relation to their affiliated patterns of NTFP use and exploitation. We consider seven guilds as a way to categorize NTFP's into autecological groups for application in restoration silviculture, and use it as a framework to suggest restoration protocols for South Asian forests. We use examples of scenarios based on experimental studies of NTFP's in reforestation trials which take account of different social values and land tenures. We conclude with a call for further research.

1. Introduction

Beyond the deserts, it is considered on ecological grounds that tropical Asia, like South America, was continuously covered with closed forest before the advent of humankind (Cerling et al., 1997; Bond et al., 2005). Unlike Africa, these two tropical regions lack the rich browsing fauna which reduces so much of the deciduous woodlands of seasonal Africa to orchard savanna or even grasslands (Bond et al., 2003, 2005). In tropical Asia, only where great rivers gush out of the Himalaya to extensive floodplains do grasslands exist. But the use of fire by Asia's human ancestors has been dated to 1.8 million years ago, and hominid-induced fire must surely have modified tropical Asia's deciduous forests at least since then (Bond et al., 2003, 2005).

Tropical south Asia has had the good fortune to retain traditions of forest use of unique diversity and complexity. These traditions survived remarkably intact through the many invasions of peoples from the temperate north. Such invasions have in fact enriched forest use and tree agriculture. While the Dravidian cultures of South India retained sophisticated traditions of plant use, the Indo-Arians, the Mughals and the European colonists brought fruit species (Kosambi, 1975). These introductions became incorporated into 'tree gardens', diverse mixtures of trees that provide fruit, medicines and spices, which now characterize the more humid parts of the region (Diamond, 2002).

Tree gardens have always remained a separate entity from the natural forest whose uses also achieve an unequalled complexity. Minority peoples in India and the rural poor in Sri Lanka are now mostly confined to the un-irrigable lands of the hills, where the remaining natural forest exists. These peoples conserve in their traditions the specific knowledge of local conditions and habitats, as a continuum of accretion since people first colonized these

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forests. The introduction of irrigation technology, perhaps through the dry warm temperate period of the Indus culture 4-2000 YBP, provided the agricultural wealth and an ease of communication that led to the first urban civilizations (Kosambi, 1975; Maloney, 1992). These in turn fostered the great indigenous religions, Hinduism, Jainism and Buddhism, and a documented pharmacopeia, Ayurveda, that remains the foundation of medical tradition today, in complement to the western 'scientific' tradition (Kosambi, 1975). The increased communication also led to homogenization of knowledge and the spread of a more uniform tradition fostered by lively regional trade in medicinals. Most of these species continued to be harvested from their indigenous forest habitats (Fox, 1995; Mahapatra and Mitchell, 1997).

But the last century has brought challenges to this progress. Although minorities and other poor rural communities have continued to depend largely on their individual place-specific, and more general Ayurvedic knowledge and resources, increases of both rural and urban populations continues to foster increasing demand of NTFP's (Chomnitz and Kumari, 1998; Bhakat and Pandit, 2003). Few current studies have critically examined whether and to what extent demand can be met by natural populations. At the same time, exploitative harvesting of some species for wider markets is leading to threatened extinctions. This has been increasingly reported in the case of herbs from Himalayan alpine grasslands (Olsen, 1998; Adhikari et al., 2004); but even some commoner tree species such as eaglewood (*Aquilaria* species notably *A. krassna*) in East Asia are being threatened (Chakrabarty et al., 1994; Soehartono and Newton, 2001). It is both surprising and worrying how few useful indigenous forest species have been brought into cultivation; and how little experimental work has been done on their silviculture. Research on restoration of degraded forests and wastelands has started to include species that yield products other than timber. The principles and optimal methodologies for such restoration will be presented.

In this paper we first provide a review of history of NTFP species use within the tropical region of southern India and Sri Lanka. Second we provide a description of the broad regional characterizations of the forest formations within the region in relation to their affiliated patterns of NTFP use and exploitation. Third we describe the seven main functional and ecological categories (guilds) of NTFP's and provide ten economically important examples. We consider the seven guilds as a way to categorize NTFP's into autecological groups for application in restoration silviculture. We use it here as a framework in our proposed restoration protocols for South Asian tropical forests for different social and economic objectives. We conclude with recommendations for further research and summarize present challenges of NTFP use.

2. A rich and complex history

People cannot survive without a ready supply of carbohydrates. Plant sources in the tropics, doubtlessly also present in ancient time as indicated by surviving nomadic cultures, include palm trunk cores, yams (*Dioscorea, Ipomaea* and *Colocasia*), grass and other seeds (Morrison, 2007; Zohari et al., 2012). Although the starch yielding *Metroxylon* and *Eugeissona* palms yield important sources of starch in the wet tropics of East Asia, neither exists now in tropical South Asia (Ruddle, 1979), while cereal grasses and the prevailing yam genus there, *Dioscorea,* are most abundant in dry regions (Mahapatra and Tewari,2005; Zohari et al., 2012).

Humans arrived in sufficient numbers in South Asia perhaps 100 thousand years ago as the last north temperate ice age was beginning to increase in intensity. During this cooling period, the southwest Indian monsoon abated, probably for prolonged periods (e.g. Wang et al., 2001). Much of the land was likely desert, but there would also have been significant seasonal precipitation to support deciduous forest, well provided with game and sufficiently rich in carbohydrate sources to support nomadic tribes. Lowland evergreen forests would have retreated to those foothill valleys which continued to receive orographic rainfall. Evidence is accumulating, nevertheless, that humans were surviving in such forest refuges both in the Western Ghats and in SW Sri Lanka, where rock shelters provided escape from rain and predators (Perera et al., 2011). Remains of carbohydrate sources have not survived, but a Sri Lankan site yielded shells of *Canarium* nuts, sure evidence that the surrounding forest was rain forest (Coronel, 1996). *Dioscorea,* the major carbohydrate source for Peninsular Malaysian forest negritos, would surely also have been important to South Asian forest dwellers, while the possibility of an early discovery of flour production would have permitted storage of carbohydrate from seasonal tree seeds such as *Vateria,* and even the supra-annually yielding *beraliya* (*Shorea* section *Doona*) in SW Sri Lanka (Gunatilleke et al., 1993). Such plant foods require cooking, so fuelwood, along with hafts for cutting implements, digging sticks and other tools would have been among early harvested NTFPs, as well as medicinals which would surely have been gathered by ancestral hominids (Morrison, 2007).

The date of arrival of cereal cultivation is unclear. The cereals were, likely rice and millet varieties that would have been introduced from the north and east more than 10 thousand years BP (Zohari et al., 2012). The main practice of cultivation would have been swidden; that is to say by slashing forest patches, burning the dried slash which releases nutrients, and cultivation until weeds overtake the capacity to control, then abandonment to natural regeneration (Dove, 1983; Rangarajan, 1999). This would have resulted in the first major change in human dependency on the forest. Here artificial canopy gaps would have been made for the first time, increasing the relative area of successional stages in the forest. These gaps would have been small, having little effect on seed dispersal for regeneration; and occupied for short enough periods in wet climates to have limited impact on soil surface conditions. The most abundant, and therefore many of the most used, NTFPs are successional light demanders, and would have increased as a consequence of swidden. The initiation of cultivation would also have fundamentally changed the role of men and women in food gathering. Whereas mixed bands, or men alone, would have foraged over the long distances formerly necessary to gather sufficient harvests of carbohydrate and many other NTFPs, Swidden, following initial preparation by men, permitted cultivation which women came to dominate. Women, who may always, as now, have been responsible for woody litter fuel collection, also came to dominate the collection of many other accessible NTFPs growing in nearby successional stands (Dove, 1983).

The arrival of irrigation, perhaps 3000 year BP, led for the first time to permanent forest clearance (Kosambi, 1975; Maloney, 1992). This resulted in the retreat of NTFP species to non-irrigable upland forest, much of which continued under swidden as populations expanded; to the fertile riparian fringes where woodland has traditionally been retained as flood defense; and to the deciduous forests of regions too dry for all but local irrigation, and where many NTFP's continued in intensive use and in abundance. Irrigation also produced the excess of food, notably cereals, and facilitation of communication and trade through road building, which provided the means for the first cities, city states, and regional ruling hierarchies. Land tenure became settled and enshrined in tradition or law (Rangarajan, 1999; Sarker, 2011). That resulted, at some time following the loss of the fertile lowlands to irrigation, and the need for ready access to uncommon or long-lived NTFP's, to the origin of the woody 'tree gardens' for which the moister regions of South Asia are so celebrated (Hochegger, 1998; Illukpitiya and Yanagida, 2010).

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