



Another vision of sound tree and forest management: Insights from traditional ash shaping in the Moroccan Berber mountains

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ABSTRACT

The dimorphic Ash tree (*Fraxinus dimorpha*) is a keystone species in the functioning of agro-sylvo pastoral systems and livelihoods found on the northern slopes of the Atlas Mountains of Morocco. It grows in spontaneous woodlands and forests which are fully integrated within agro-ecosystems. Local populations have for centuries shaped ash stands by sequentially trimming and pollarding individual trees for providing fodder, house roof building material and ecosystem services for the overall social-ecological system. Exploitation follows very strictly observed 4-year cycles of exploitation of pollarded trees, which allows the harvesting of each individual tree for foliar forage after 4 years of regrowth, and at the same time shaping and letting some well-grown branches develop for further cycles in order to provide diameter-standardized poles (after 8 years) and beams (after 28–32 years) for house roof construction. The management of tree regeneration is also illustrative of deep-seated Traditional Ecological Knowledge. Overgrazed trees or new seedlings are protected by means of stone walls. Resprouts with the most vigorous and straightest stems are selected and linked to each other, in order to favor, when growing, trunk anastomosis. This highly original practice allows an increase in foliage production of 36% after a 4-year cycle, compared to non-anastomosed trees, and promotes the resilience and longevity of the trees. The main discrepancies in the vision of what might constitute 'good' forest management between local stakeholders and professional foresters concern (1) the scale of the management unit (individual trees and overall forested landscape vs tree stand), (2) the partial (diffuse) exploitation of living trees vs intensive cycles of exploitation of the whole tree stand, and (3) flexibility and pro-active management of heterogeneity vs homogenization. This perspective offers an alternative basis for rethinking forest management strategies in a context of global change, and original insights for conserving anthropized forest ecosystems without excluding people.

1. Introduction

There are recurring questions regarding the ecological sustainability of resource management within traditional rural societies, and the underlying significance and rationale of practices related to this knowledge. Hence, Traditional Ecological Knowledge has been the object of renewed interest during the last four decades, both as a feature of human cultural patrimony (Auclair et al., 2011), and as a basis for rethinking innovative forest management practices (Parotta and Agnoletti, 2007). At the same time, well-established scientific postulates such as desertification and af- or de-forestation processes, have sometimes been questioned in the light of their long-term effects on the environment, and new approaches concerning the place of human beings in the ecosystems (Davies, 2005, Fairhead and Leach, 1995). More generally, it is the place of humans in the ecosystem and their

impact that have been the focus of intensive debate. Although numerous studies have clearly demonstrated that human activities could lead to dramatic environmental and biodiversity destruction (Soule, 2013), several authors have argued that anthropogenic impacts are not to be considered in a monolithic way, since they can lead, in certain circumstances, to conservation and enhancement of biodiversity and ecosystem functioning (Siebert and Belsky, 2015). This point of view has been in particular put forward with regard to the Mediterranean region, a hotspot of biodiversity associated with a long-standing intensive human use and disturbance (Blondel, 2006, Gauquelin et al., 2018). At a more local scale, very few studies have tried to detail concretely the actual mechanisms at work in shaping sustainable cultural practices based on traditional knowledge (Blanco et al., 2015).

Trees and forests, due to the diversified resources they offer, their longevity and their leading ecological role with regard to the

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functioning of highly representative ecosystems, constitute interesting models to shed light on the human-environment interactions that have been woven at a local scale for millennia in traditional rural societies (Szabo, 2010). In particular, the exploitation of living trees without destroying them, usually considered as depredatory practices, has been shown to present certain advantages in terms of enhancing their biological development and their conservation (Turner et al., 2009). These Culturally Modified Trees (CMT) are embedded within diversified systems of belief and perception, which also enshrine preservation and conservation insights resulting from observation and experience (Turner et al., 2000). However, their usual primary function is to provide diversified resources which contribute to the livelihoods and resilience of local societies. They also provide ecosystem services at different scales, from individual parts of the tree to the overall rural landscape.

For all these reasons, trees and forest patches have historically always been included within agro-forestry and land use systems worldwide, at times when human societies were highly dependent upon local natural resources. In some regions, such as Europe (Slotte, 2001, Petit and Watkins, 2004), these practices have been mostly lost. In other areas, such as Asia (Singh et al., 2015), they are still alive, and contribute to the livelihood of millions of people. In Morocco, trees and forests have been and still are the pillar of several traditional farming systems. Endemic Argan (*Argania spinosa*) forest, widely known because of the famous cosmetic oil it produces, is a well-known example of a co-evolved human-tree ecosystem (McGregor et al., 2009) that presents all the characteristics of what may be called rural (Genin et al., 2013) or domestic (Michon et al., 2007) forests. In most parts of Morocco, diversified agroforestry systems have been developed. This is particularly the case in the mountains of the High Atlas, where original traditional practices are commonly found for managing forest resources for combined fodder and timber production (Hammi et al., 2010; Genin and Simenel, 2011; Genin et al., 2016). It would appear that the case of the very sophisticated management system associated with the use of *Fraxinus dimorpha*, a native ash tree spontaneously growing in some parts of the Moroccan High Atlas, has not yet been documented. However, management practices involved are highly original, particularly those linked to promote twig coalescence, and could offer valuable insights as a basis for devising alternative forest management strategies in other regions.

The aim of this article is hence to describe and analyze traditional practices of shaping the dimorphic ash tree found in the Berber High Atlas mountains of Morocco for both foliage and living wood exploitation and tree regeneration. We hypothesized that apart from this tree being a keystone species with regard to agro-pastoral livelihoods, these practices are ecologically sound for its long-term conservation, socially effective in promoting long-term continuous agro-pastoral activities, and could offer some interesting more general insights for alternative approaches to planting for the purposes of tree and forest management.

2. Material and methods

2.1. Native dimorphic ash stands in the high Atlas mountains and study site

Fraxinus dimorpha is called 'Imts' in the Berber language. It is a tree species native to the mountains of North Africa and Central Asia. It occupies a particular ecological niche in the central High Atlas, being located mainly at the bottom of rocky slopes and ravines with temperature inversions, at an altitude between 1200 and 2000 m. The dimorphic ash tree is characterized by two types of leaves, depending on the development stage of the tree and the level of browsing. It is typically a multi-functional tree for the local community, providing firewood, timber mainly for the roofs of houses and agricultural tools, food (spices) and medicinal products, and its leaves are used for dyeing textiles. But the most critical use is as fodder in the autumn (end of

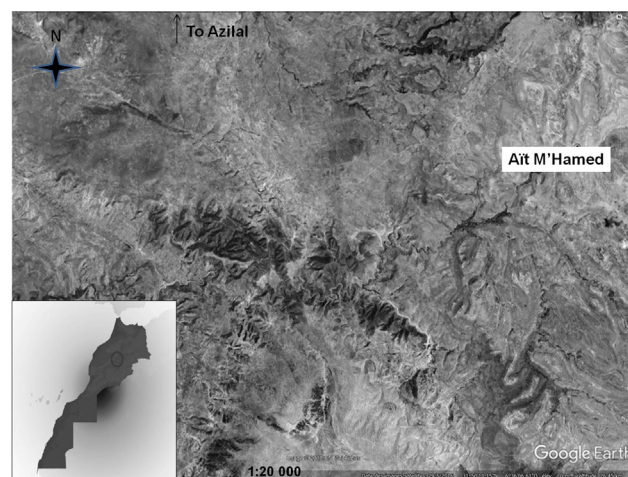


Fig. 1. Location of the survey on the uses and management of Dimorphic ash in the Central High Atlas of Morocco.

August to November), in a period when standing range forage is scarce and dry (Genin et al., 2016).

Ash tree stands constitute fragmented wooded areas throughout the Atlas, covering less than 5% of the total forested area. We focused our investigations on the rural district (*Commune*) of Ait M'Hamed, located in the Central High Atlas, Azilal Province, where the dimorphic ash is the most widespread tree species in the landscape (Fig. 1). The altitude ranges from 1300 to 1700 m. The climate is Mountain Mediterranean with annual rainfall between 450 and 600 mm, a mean minimum temperature in winter of 5 °C and a mean maximum temperature in summer of 28 °C. Local agropastoral systems are low input systems based on small stock rearing (goats and sheep), and on unirrigated cereal cultivation (wheat and barley). Flocks are composed of 20–150 sheep and goats in various proportions. The local Berber inhabitants are linked to the famous Ait Atta nomadic tribal Confederation, but sedentarized in the 19th century.

Forests occupy about 25% of the total territory of Ait M'Hamed, and are divided into two categories: those constituted in the coldest areas of the dimorphic ash, and those constituted of holm oak (*Quercus ilex*). These two species also occur together to form mixed forests and parklands. The structure of ash tree stands is of three types: (1) scattered trees (10–40 trees/ha) in the very harsh lapiaz plateau with calcareous flush rocks, (2) parklands or 'tree savanna'-like, as referred to by Boffa (1999), with a density ranging from 50 to 800 trees/ha, or 3) denser forests (1000–2000 trees/ha). *Fraxinus dimorpha* is always spontaneous, and it is never planted by the local inhabitants. Parklands are either cultivated with cereals in the understory, or not.

2.2. Participant ethnoecological survey

Ethnobotanical and ethnobiological fieldwork was carried out in accordance with standard procedures issued by the International Society of Ethnobiology (2006), consisting of anthropological and ethnobotanical fieldwork methods such as participant observation and interviews. Fieldwork included semi-structured interviews and participant observations with 63 individual farmers (mainly male family heads) by means of snowball sampling (Biernacki and Waldorf, 1981). They took place during the pollarding period, from August to November. Each interview was performed directly on parklands in the Berber language in order to facilitate information transmission, and lasted two to three hours. Information was obtained concerning (1) the structure of production means (number of trees owned, number of heads owned, fields and crops), (2) the actual practices related to trees (number of branches cut per day in relation with the size of the flock, criteria of selection for individual trees to be exploited, rotation of

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