Mediterranean European Silvopastoral Systems

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SUMMARY

Differences between Mediterranean European and other silvopastoral systems are described regarding both their human and natural environments. The long history of human utilization of the Mediterranean European environment has resulted in a close relationship between biodiversity, nature conservation and rational management, especially under the current European high socio-economic situation. Therefore, silvopastoral methods should not be regarded as only productive activities but also, and mainly, as major conservation tools. Services (protection, stability, landscape, structural heterogeneity) and non-timber products (cork, fungus, fodder, fruits, honey) from the tree layer are usually much more important than timber products, including fuelwood, the demand for which has almost disappeared due to the availability of other sources of energy. Other consequences of the European high socio-economic situation are the decrease of shepherding and transhumance, the partial substitution of extensive sheep herds by cattle and the excessive use of concentrate feed, which results in an unbalanced distribution of stocking levels and an uneven utilization of grazing and browsing resources. These changes result in local shrub encroachment, increased fire hazard and loss of biodiversity. Another major feature of European silvopastoral systems is the increasing hunting of big and small game as a new and very profitable type of wild livestock.

Finally, a classification of Mediterranean European silvopastoral systems is presented, regarding the nature and distribution of their major components: tree or shrub layer, grass sward and animals.

KEY WORDS: agroforestry, silvopastoralism, extensive grazing, biodiversity, forest fires

MAJOR FEATURES OF MEDITERRANEAN EUROPEAN SILVOPASTORAL SYSTEMS

Silvopastoral systems are the result of the historical co-evolution of human communities and their, usually difficult, environments. Therefore, the main features of their components are never casual; they have suffered, and overcome, the double and extremely demanding processes of natural and human selection, the latter changing through time, as human demands change with history and with the socio-economic situation. Therefore, these features will be used to describe and classify Mediterranean European silvopastoral systems.

Many authors (Nair 1993, Etienne 1996, Papanastasis 1996, San Miguel 2003) have pointed out that silvopastoral systems have at least four components: man, trees (woody vegetation), sward and animals. Therefore, we will describe the current situation and particularities of Mediterranean European silvopastoral systems by describing the most important features of their components.

Human demands and activities

A long history of human utilization is one of the most relevant features of Mediterranean silvopastoral systems (Le Huerou 1981). There is evidence of human presence (*Homo antecessor*) around the Mediterranean Basin for at least 780,000 years (Bermúdez de Castro *et al*. 1997). The human utilization of fire dates from around 400,000 years, and agriculture and livestock came with the Neolithic revolution, some 10,000 - 12,000 years ago. As a consequence of this long and intense human activity, almost no primary forests remain around the Mediterranean Basin: the whole territory may be considered as a huge agroforestry system. Traditional silvopastoral systems and their natural environment are well adapted to each other. That is why most Mediterranean landscapes and a high percentage of their biodiversity are closely related to human

activities and depend upon them. Therefore, within that region, traditional silvopastoral treatments must be regarded as both productive activities and major conservation tools, the latter becoming increasingly important as the European socio-economic situation improves (Bland and Auclair 1996, Redecker *et al*. 2002, San Miguel 2003) and as urban people demand (and pay for) more environmental quality and more preservation of traditional landscapes and culture. The European Nature 2000 network represents living and promising evidence of these demands.

Another necessary way of preserving rural areas is preserving their people. Sustainable rural development is nowadays one of the basic priorities of the Common Agricultural Policy (CAP). Thus, since traditional and current silvopastoral systems can contribute to the achievement of that objective, they should also be considered as socio-economic conservation tools for rural areas.

Socio-economic improvement, which has been dramatic in Europe since the 1960s, has resulted in deep changes in human demands and activities, and consequently in the management and structure of silvopastoral systems. For example, fuelwood, which is an essential resource in the southern Mediterranean, is no longer important in Europe. As a result, most coppices are not subject to silvicultural treatments and show problems of stability (Serrada *et al*. 1992, Amorini *et al*. 1995). Shepherding and transhumance, which remained commonplace in Mediterranean Europe until the early 1960s (Beaufoy 1994), are seldom used today. Local shrub encroachment, increase in fuel biomass (Beaufoy 1994, Bland and Auclair 1996), reduction in the flow of genetic material between regions and changes (usually reduction) in biodiversity (EGF 1999, Malo *et al*. 2000) are some results of that situation. On the other hand, the density of the tree layer and its regeneration are benefiting from these changes, with the exception of the dehesa system, where sedentary cattle have substituted transhumant sheep herds and restrict natural tree regeneration (Montero *et al*. 2001).

Trees and other woody vegetation

As might be expected, the nature, distribution and role of trees and other woody vegetation of Mediterranean silvopastoral systems depend greatly upon the Mediterranean climate. Summer drought and, usually winter cold, impose severe restrictions on grass and browse growth and thus on animal feeding behaviour. They also regulate the major features of leaves, wood and fruits of woody vegetation and therefore determine its role and distribution within silvopastoral systems.

Due to their sclerophyllous evergreen nature, many Mediterranean trees and shrubs become real fodder reserves for livestock and wildlife, especially ungulates but also rabbits. Their nutritive value is neither high nor too low, being lower than green but higher than senescent grass. However, their browse is always available, so livestock and wildlife feeding behaviour is believed to consist of selecting food with the aim of optimising nutrient uptake while maximizing forage consumption (Perevolotsky 1996, Danell and Bergström 2002). The result is that sclerophyllous trees and shrubs mitigate hunger periods (summer and winter) and usually increase wildlife carrying capacity as compared to temperate systems (e.g. 20-30 red deer individuals/km^2 in Mediterranean silvopastoral systems vs. 4-10 in temperate forests). That is why oak coppices and shrublands (maquis, garrigue and many others) are so important for wildlife and extensive livestock in Mediterranean Europe (Papanastasis 1999, San Miguel *et al*. 1999). However, their ability to resist browsing is limited, so special care must be taken to guarantee their preservation and, especially, their natural regeneration (San Miguel *et al*. 1999, San Miguel 2003). Another consequence of the climate on sclerophyllous trees is their low productivity of heavy wood, which is excellent as fuel but not for industrial purposes. Therefore non-timber products (cork, fungus, fodder, fruits, honey) coming from the tree layer are usually much more important than timber products. Finally, fruits, and especially acorns, become a strategic and very valuable complement for herbage and browse resources.

From an ecological point of view, the specific effect of scattered trees in Mediterranean silvopastoral systems is a reduction of climatic stress, an improvement of soil moisture levels (Joffre *et al*. 1991, 1999) and, therefore, a parallel improvement of herbage production, both in quantity and quality, and also in the length of the vegetative period. That is why, seeking for a maximization of the positive tree-sward relationship, their distribution is usually a uniform one, as opposed to that of many temperate systems, where trees or shrubs are located in lines or clumps with the aim of reducing their competition with the herb layer.

Mediterranean pines are not interesting for livestock or wildlife browsing. However, grazing plays a fundamental role in reducing fuelwood and fire hazard in pine plantations, increases their grazing possibilities and may even improve their wood quality (Perevolotsky and Haimov 1991, Etienne, 1996, 2000, 2002). Nevertheless, some native junipers (*J. thurifera, J oxycedrus* and others) show an acceptable browsing value under a continental Mediterranean climate.

A final comment on the role woody vegetation plays in Mediterranean European silvopastoral systems: as a consequence of the variability of the Mediterranean climate, the increasing levels of erosion and desertification and the improvement of the European socio-economic situation, the so-called services and environmental rent (Campos *et al*. 2001) produced by trees and shrubs, are more and more important each day and their value often surpasses that of direct products (EGF 1999, Pardini *et al*. 2003; San Miguel 2003).

Sward

Mediterranean swards are usually constituted by terophytes and perennial, summer-senescing herbs, the growth of which usually stops or reduces in winter due to cold. Therefore, most Mediterranean European silvopastoral systems show two periods of lack or shortage of green herbage: summer and winter. One response of livestock and wildlife to that situation is migrating: transhumance or shorter seasonal herd movements. Another response is seeking for better sources of nutrients, which usually come from woody perennials, as stated above. As a consequence, as spring herbage production is usually very high, only a moderate percentage of total herbage production (usually between 40-60%) is effectively used by non-migrating livestock, the rest senesces and is no longer used due to its low nutritional quality. However, the current need to sustain higher stocking rates without transhumance imposes the additional utilization of agricultural by-products, supplements and even (more and more each day) agricultural crops used by grazers, both domestic and wild. With such high quality supplementary food, even senescent grass could be fully used.

Legumes are the most important component of Mediterranean silvopastoral systems swards due to the low nutritional quality of senescent grass and their usually low soil fertility. Senescent legumes usually show an acceptable energy and protein content and provide protein-rich fruits and seeds in late spring and summer. Besides, they contribute to soil enrichment in nitrogen. That is why many pastoral treatments within those systems are aimed at increasing legume abundance in natural and artificial swards.

Another particularity of Mediterranean European swards is their high levels of biodiversity (Beaufoy 1994, Pineda *et al*. 1991), especially within silvopastoral systems, which are the result of their long history of low-intensity and diversified utilization by domestic and wild herbivores, and also of transhumance (movement of plant genetic material and fertility by animals). The higher diversity levels shown by silvopastoral systems are the result of an additional source of structural and micro-ecological diversity: the nature, size and distribution of woody perennials. Similar Californian Mediterranean pastures show high levels of biodiversity (Rice 1989), although these are lower than in Mediterranean Europe. Furthermore, a high percentage of that biodiversity comes from seeds in the soil, which are essential for the persistence of herbage swards under the highly variable Mediterranean climate. That is another difference between Mediterranean and temperate swards.

Animals

The variability of environmental situations and the nature and diversity of feeding resources of Mediterranean European silvopastoral systems have promoted the utilization of a high diversity of livestock species and breeds and their seasonal movement (transhumance). However, dramatic changes in the European socio-economic situation since the 1960s have resulted in the following changes in the role of their livestock and wildlife:

- Partial substitution of extensive, low intensity grazing for semi-intensive management regimes.
- Dramatic decrease of transhumance and shorter seasonal herd movements.
- Reduction of livestock variety: species and breeds.
- Partial substitution of sheep by cattle, as a result of the lack of shepherds and CAP subsidies.
- Partial substitution of traditional breeds by industrial crossing, which results in a loss of adaptation to the natural environment and native fodder supply.
- Excessive use of concentrate feed.
- Uneven distribution of stocking rates, which results in shrub encroachment in some areas

(usually those located far away from villages and roads) and overgrazing in some others (usually those located within the close surroundings of villages and roads).

The most important consequence of these changes is the de-coupling of the natural environment and its fodder productivity, on the one hand, and livestock raising practices, on the other. Social, economic and policy aspects are becoming more and more important each day for the design and management of Mediterranean European silvopastoral systems.

As a consequence of shrub encroachment and fire hazard increase, livestock, and especially browsers or opportunist herbivores, e.g. goats, are considered suitable (and productive) tools for reducing fuel from coppices, high forests and fuel breaks and are, therefore, regarded as forest allies (Perevolotsky and Haimov 1991, Etienne 1996, 2002, Gutman *et al*. 2001). Pasture improvement is an appropriate treatment to increase stocking rates and browsing.

Another major feature of European silvopastoral systems is the increasing consideration of big and fair game as a new and very profitable type of wild livestock (San Miguel *et al*. 1999, Pardini *et al*. 2003). Hunting is currently one of the most important sources of profitability for Mediterranean silvopastoral landowners. That situation could be considered as favourable, since profitability is essential for the preservation of those systems. However, new problems of sustainability are arising for these new types of silvopastoral systems, especially for those including wild ungulates (San Miguel *et al*. 1999). Even some endangered wildlife species should be considered products (or services) of silvopastoral systems, since those systems constitute their habitat and since society is concerned about their conservation (which requires suitable silvopastoral management) and pays for it (San Miguel, 2003). Two paradigmatic cases are the Iberian lynx (*Lynx pardinus*), the most endangered feline in the World, and the Iberian imperial eagle (*Aquila adalberti*), one of the most endangered raptors in the World. Three LIFE-Nature projects are being carried out in Spain with the aim of recovering those species, where silvopastoral treatments, aimed at preserving their habitat and at increasing rabbit numbers (their basic prey), are major developments (San Miguel, 2003).

CLASSIFICATION OF MEDITERRANEAN EUROPEAN SILVOPASTORAL SYSTEMS

Many attempts have been made to classify agroforestry systems, and particularly silvopastoral systems (Nair 1993, Etienne 1996). We have adapted Etienne's (1996) basic classification, which takes account of the distribution of woody and herbaceous vegetation and animals, and have elaborated a classification of Mediterranean European silvopastoral systems which is shown in Table 1.

Table 1.- Classification of Mediterranean European silvopastoral systems (1).

Grazing and browsing in shrublands or forests (2)	Shrublands	Natural shrublands		• Maquis • Garrigue • Legume shrublands • Xerophytic shrublands • Saline & Nitrophyllous shrublands • Other
		Fodder shrub plantations		• *Atriplex* sp. • *Medicago arborea* • *Opuntia* sp. • Other
	Forests	Coppices		• Usually *Quercus* sp.
		High forests	Conifers	• Some wild Junipers Provide forage for livestock & wildlife
			Broadleaved	• Usually provide browse and sometimes fruits for livestock and wildlife
Scattered trees (or shrubs) on swards	Wild trees	Fodder trees (browse, fruits)		• Dehesas & montados • Other
		Non-fodder trees		• Xerophytic conifer Woodlands
	Plantations (usually agricultural trees)			• Olive (*Olea europaea*) • Almond (*Prunus dulcis*) • *Pinus pinea* • Leguminous fodder trees (*Ceratonia, Robinia, Gleditsia*,…) • Other
Mosaic of different land uses within one management unit	Two or more of the following land uses: forests, woodland, shrubland, rangeland, cropland			

(1) Regarding plant components. Each one may be used by livestock or game species, and often by both.

(2) The separation between forests and shrublands, on one hand, and scattered trees on swards, on the other, lies on the herb layer. That of forests and shrublands is composed mainly of their characteristic species. However, that of scattered trees on swards is mainly composed by species characteristic of early successional stages, strongly influenced by grazing.

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