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Evolution of the tree cover (*Quercus pyrenaica* Willd and *Quercus ilex* subspecies *ballota* (Desf. Samp)) in a dehesa over the last 100 years

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Summary: 1. During the first 60 years, the decrease in the numbers of both the holm oak and the oak was due to tree felling. The first 6 years were devoted to tree felling and cut clearing in order to clear dense forest with a view to transforming it into pasture and farmland; during the next 54 years the cut trees were used as a source of heat for the home and of wood for construction and the making of farming tools and diverse utensils.

2. Tree felling has gradually declined over the last 40 years (it has almost disappeared) as the use of wood has been replaced by gas and gas-oil for fuel and iron and cement for construction. However, the mortality rate has increased. The deaths are mainly the result of the effects of the xylophagous insects (its effects are not usually lethal to trees under 100 yrs. old) and other as yet undetermined causes, perhaps of drought.

3. In stands 2 and 3 (N orientation) agriculture benefitted the old oak, which developed on the fringes and rocky outcrops and immediately invaded the territory as soon as the cultivation of cereals was stopped. A similar phenomenon occurs in the SW orientation with the holm oak.

4. Autochthonous livestock (mainly cattle) on an extensive free range basis impedes the recovery of oak density, eliminating almost all of the youngest ones in the underbrush and shrub phases, when their diameter in the first meter of height is less than 9 cm. It does not eliminate the holm oaks, but greatly retards their growth. When young holm oaks are taller than 2m, they can also be broken by domestic livestock if they do not reach a diameter of 6 cm in the first meter.

5. The end result is a rapid and dramatic decrease in tree-cover.

Key -words: *Quercus pyrenaica*, *Quercus ilex* subsp *ballota*, livestock, Dehesa.

INTRODUCTION

In the C-W provinces of Spain there are large tree covered surfaces (150-2000 ha) pertaining to one person or institution and they are called *dehesas* (Gómez-Gutierrez, 1991). Most of them have been divided up in successive inheritances or have changed hands several times (García-Martín, 1991). They have been traditionally used for the extensive grazing of livestock (cattle and/or sheep) which eat the pasture and the acorns of the tree-cover. The tree-cover is of quite varying density (grazed forest) and irregular distribution, with clearings free of trees and covered with pasture grass or cultivated cereals (Gómez-Gutierrez, 1991). The parts of each *dehesa* with the best soil for agriculture were cultivated and later transformed again into natural pasture, with autochthonous species (not sown by man), with the collaboration of domestic livestock. We have reconstructed and studied the history of the last 103 years of an old *dehesa*, which was divided in 1931 among the heirs. Much interesting information was obtained concerning the evolution of the tree cover, which is different for each type of exploitation or utilization of primary production: pastures with or without alternative farming or an extensive regime of use for domestic livestock (Cuartas and García-González, 1992; Hofmann, 1989).

MATERIAL AND METHODS

The *dehesa* is situated in an area of ecotony between Atlantic and Mediterranean influences, in which oak (*Quercus pyrenaica* Willd) and holm oak (*Quercus ilex* subspecies *ballota* (Desf.) Samp.) are mixed. One of the stands (N° 1) is oriented towards the SW and the other two towards the N. In the first, the holm oak is predominant and in the second and third, the oak tree is predominant.

We selected three stands about which we had reliable information. The data were obtained from the documents or deeds pertaining to inheritances and contracts of sale, as well as pruning,

pollarding, cut clearing, residual stump and tree felling counts, etc. After 1940, the data are known through the direct control of the current owners and their parents, from whom they inherited it.

The number of individuals (tree trunks) was obtained by counting; the dimensions were obtained by direct measurement and the age by counting the rings of the old trees and by direct knowledge of the young trees.

Historical Evolution

The dehesa underwent intense clearing of underbrush in 1890-1898, leaving only a limited number of adult trees according to the tradition of tree covered dehesas (savanna-like formations). The three stands where this study was carried out were used for growing cereal until 1931. In that year stands 2 and 3, which are adjacent, were separated by a stone wall; number 2 (Cobos) was abandoned and became covered in pasture for cattle (Morucha breed from Avila) free range grazing on an extensive basis; number 3 (La Bardera) and number 1 (El Montecillo) were used for cereal farming until 1968, when farming was abandoned and it was transformed into pasture. In 1931 the dehesa became the property of the heirs, who carried out intensive tree felling. 1990, 91, and 92 were years of intense drought.

Data on the Three Stands

Stand number	1	2	3
Name	El Montecillo	Cobos	La Bardera
Surface Area	20 Ha	11.2 Ha	7.6 Ha
Orientation	S-W	N-NE	N-NE
Altitude (m.a.s.l)	1110-1130	1120-1132	1132-1143
Slope angle	4°	6°	6°
Geological Substrate	Gabbro	Slate	Slate
Soil	Eutric Cambisol	Humic Cambisol	Humic Cambisol
Age (1993)			
trees	325 (±30) yrs.old	240 (±20) yrs.old	240 (±20) yrs.old
Shrubs	30 (±10) yrs.old	60 (±20) yrs.old	20 (±10) yrs.old
Diameters			
trees			
holm oak	57-70 cm	48-50 cm	48-50 cm
oak	60-80 cm	50-50 cm	50-70 cm
Shrubs			
holm oak	7 - 13 cm	6-17 cm	-----
oak	-----	12-17 cm	8 - 12 cm

RESULTS AND DISCUSSION

Since the original cut clearing carried out between 1890-1900, the predominance of the holm oak in Stand 1, with a southern orientation, and of the oak in Stands 2 and 3, with a northern orientation, has been evident. It was shown that in the last years of the past century, the decrease in numbers was due to massive cut clearing and tree felling carried out to permit a greater dominance and development of pasture in the lower zones and agriculture in the areas between rivers. Up until 1931, the three stands were cultivated using crop rotation . A gradual decrease in the tree cover was observed in all three. Until 1931, tree felling and pollarding were carried out solely to obtain wood for different uses (Gómez-Hernández et al., 1991). In the 1930's the heirs increased the amount of tree felling, which may be described as intense until the 1960's (García-Martín, 1991). During the 1960's, the amount of cultivation began to decrease, as did the demand for wood and firewood.

Stand 1 (fig. 1 and 2)

Holm oak is valued more than oak as a source of energy, and thus underwent a slight decrease in numbers up until the 1930's, as occurred in other places (Pons and Quezél, 1985). In the 1960's decade, the death of trees was caused only by xylophagous insects, and above all by excessive pollarding. In 1970 a striking increase in number of shrubs was noted. But only those growing along the boundaries and in rocky places reached the height of shrubs or young trees.

Oak bushes were completely eliminated by the cattle (Soriger, 1988) in 1982. The adult oaks, already scarce, disappeared due to "natural" death (pruning and insects).

Stands 2 and 3 (fig. 3 and 4; 5 and 6)

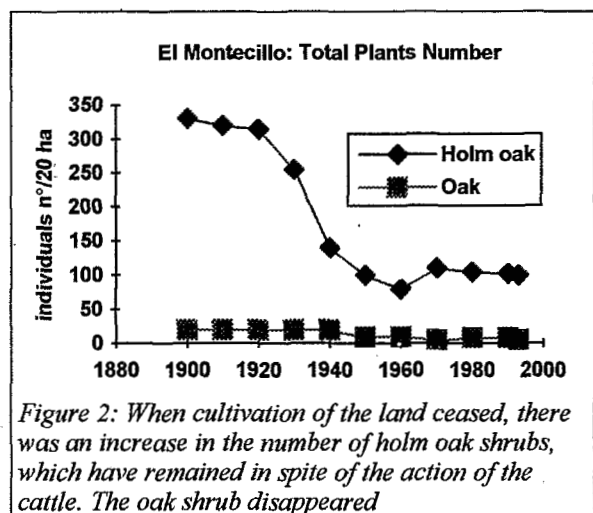
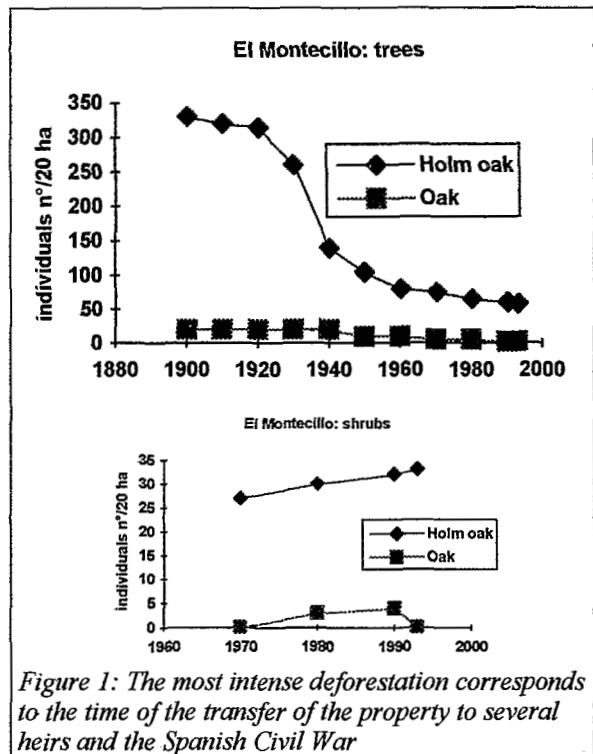
Here, the oak is the dominant tree species and adult holm oaks are scarce. The reduction of their numbers was due to the effects of felling in the 1930's in both stands and from cut clearing carried out in Stand no. 2 in 1948. Beginning in the 1960's, the mortality rate increased, but only as a consequence of diseases (xylophages) and drought (Terradas and Savé, 1992; Margaris, 1981). In No. 2, after 1931, a manifest increase in shrub sized oaks and holm oaks was noted. And in stand no. 3 there was no increase in holm oaks and the number of oaks was checked in 1990 by hungry livestock. Those which managed to reach a diameter of 7 cm survived; this measurement seems to mark the limit of resistance to the pressure of livestock. The young holm oaks, which were more resistant, could withstand the pressure of livestock as from 6 cm of diameter.

CONCLUSIONS

1. Tree felling was the main cause of the decrease in tree cover in the first 60 years of the century.
2. Domestic livestock (cattle) eradicate oak in their young phases -in years of scarcity or excess load- and check the growth of the holm oak. In dry years the effects are very acute and oak shrubs and bushes with less than 7 cm of diameter are eliminated. Cattle, then, are the primary cause of the elimination of oak shrubs, thus impeding the incorporation of new individuals which would compensate the mortality rate of the old ones.
3. The drought (climatic change?) of the last two decades has shown its effects in three ways:
 - a) A striking increase in lethal diseases
 - b) A strong increase in the pressure of livestock with a deficit in their grass diet.
 - c) A notable increase in the mortality rate due to lack of water.
4. If measures are not taken in this respect, thousands of hectares of dehesas in a similar situation will be treeless within 50 years.

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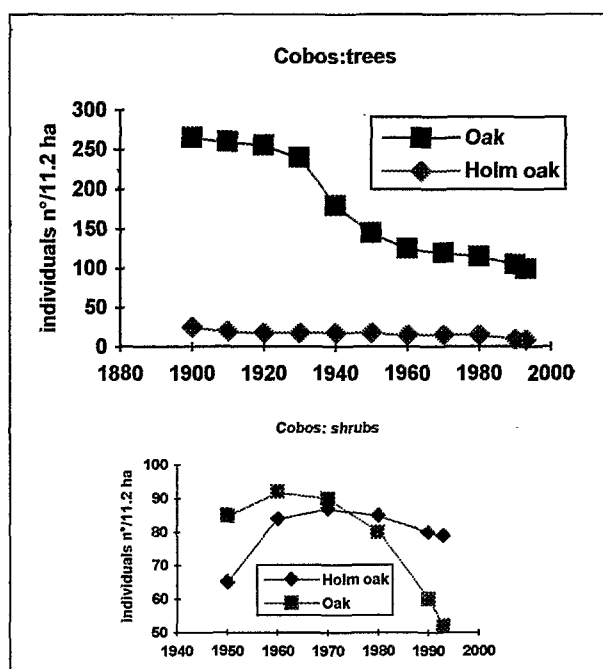


Figure 3: The decrease in the number of oaks due to tree felling is not compensated by the contribution of shrubs because these are eliminated by the cattle

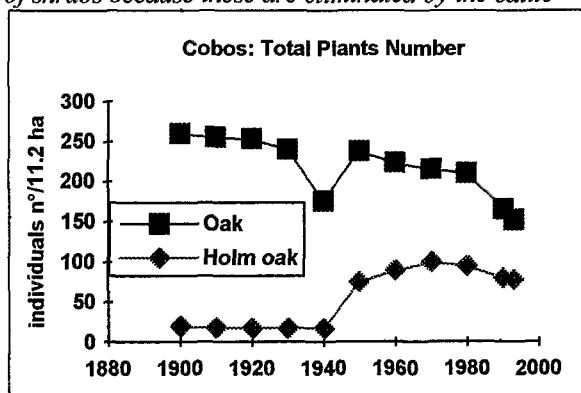


Figure 4: Note the negative effect of the cattle on the oaks. The holm oaks can bear the pressure and increase their numbers

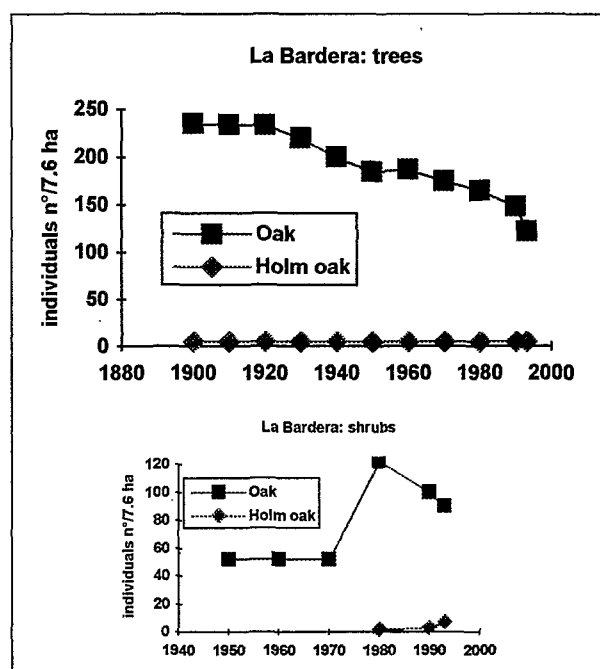


Figure 5: The adult trees show a notable increase in mortality rate in the last decade, as a result of attacks by xylophagous insects and drought

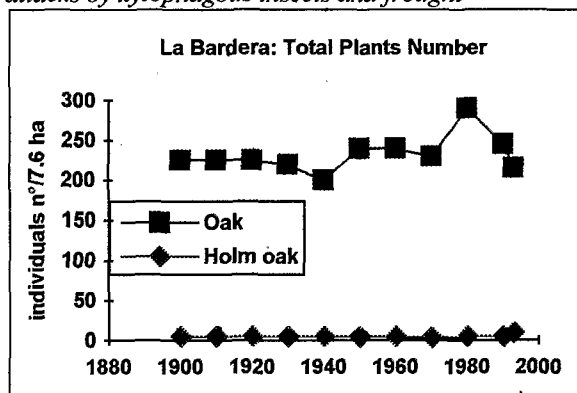


Figure 6: When the property was converted into pasture, the cattle destroyed the shrubs. Disease and drought affect centenarian trees