The role of scattered trees and habitat diversity for biodiversity of Iberian dehesas

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Iberia Dehesa: A high biodiverse Agroforest

Dehesas and montados are agroforestry systems covering over 4.5 million hectares in SW of Iberian Peninsula. They are renowned as biodiversity-rich systems to the point of being considered as habitat to be protected under the European Habitats Directive. In this work we analyze the relative contribution of scattered trees and habitat diversity on the species richness of four key taxonomic groups, vascular plants, bees, spiders and earthworms.

The effect of trees was assessed by comparing species richness of wood pastures with open pastures both at plot and landscape levels. We expected more species in wooded pastures given that scattered trees provide food, shelter and generate multiple fine-scale gradients of resources. We also expected a reduction of species from open pastures due to the negative effects of woody vegetation for certain species (e.g. shade and lower soil moisture.

The importance of habitat diversity, and more specifically the contribution of marginal habitats (unmanaged, low surface), was analyzed by computing the proportions of shared species among habitats and by estimating species richness at landscape scale including or not marginal habitats. Marginal habitats are expected to increase species richness at landscape scale by supporting species not found in open and wood pastures.

Experimental set up

The study was conducted in C-W Spain (latitude 40º 7' to 40 º 14' N and longitude 6º 0' to 6º 21' W).

The landscape is dominated by dehesas (38.7 % of the land) with mostly scattered *Quercus ilex* trees, with *Quercus suber* and *Quercus pyrenaica* being present in low numbers.

Ten dehesa farms (485 ha each on average) were randomly selected, mapping every habitat and linear features according to a standardized protocol developed by the European BioBio projects.

Within each farm, a randomly selected plot per habitat was retained for further monitoring of biodiversity. A total of 144 plots, grouped in 9 main habitat types, four taxa were monitored, attending to the four major ecological functions which are relevant for farming: Vascular plants (primary production), Wild bees and bumblebees (pollination), Spiders (predation), Earthworms (organic matter decomposition). These four biological groups are relatively easy to monitor, provide relevant information on general environmental conditions and are sensitive to management practices.

RESULTS

In total, 450 plant species, 63 bee species, 130 spider species (7.4 per plot of 0.5 m^2), and 17 earthworm species (2.5 per plot of 0.27 m^2) were recorded.

In each taxa, only some species were abundant and ubiquitous, while most of the species were found only one or few plots.

The estimated richness (Chao2 mean ±S.D.) for four biological groups was 503±20 for plants, 140±40 for bees, 161±14 for spiders and 25±7 for earthworms.
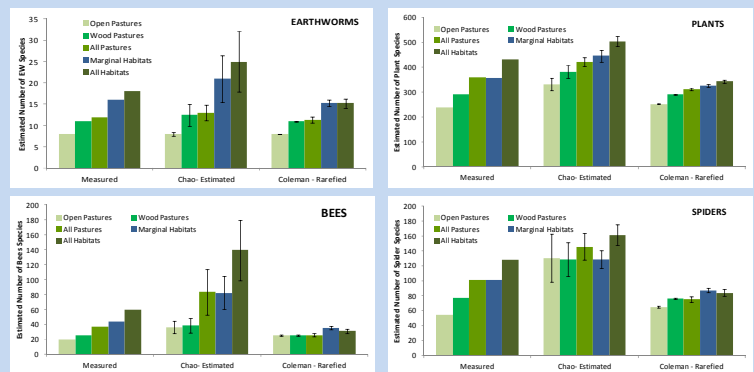
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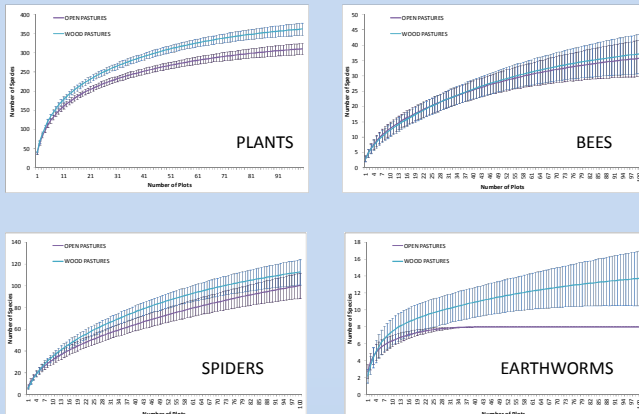
Figure 1. Species accumulation curves to estimate the expected number of species (± CI$_{95\%}$) for four different biological groups, after measuring 42 plots of each type of habitats (open and wood pasture).

### EFFECTS OF HABITAT DIVERSITY

Figure 2. Species richness estimated by extrapolation (Chao2 index) and by rarefaction (Coleman index; set at n=40) for four different biological groups, considering only open pastures vs wood pastures, all pastures (wood + open pastures) vs marginal habitats, and all habitats together.

At plot level, earthworms and spiders were marginally more abundant in open pastures than in wood pastures, being species richness significantly higher in open pastures. Differences were not significant for plants and bees. On the contrary pooling plots, estimated richness (Chao2) of plants and earthworms species was significantly higher in wood than in open pastures. Differences for plants, earthworms and spiders were also confirmed by Coleman-rarefied index (Figure 1).

A high proportion of species (ca. 40%) were observed only in just one habitat per farm, indicating that farm biodiversity strongly depends on the habitat diversity. The analysis of unique and shared species among habitats revealed that every habitat contribute significantly to farm biodiversity. The combination of open and wood pastures gives a higher species richness than wood pasture alone, and the combination of marginal and productive (open + wood pasture) habitats gives a higher species richness than productive habitats alone (Table 1).

TAKE HOME MESSAGE

Here we have shown that trees contribute positively to the biodiversity of four biological groups. Wood pastures are more biodiverse than open pastures.

Trees provide food directly or indirectly to a large number species. Besides, agroforestry systems with scattered trees are fine mosaics of tree-based gradient s (light, nutrient, soil moisture, …).

Although the high biodiversity values found in Iberian dehesas was partly explained by the existence of scattered trees, the intimate mix of tree and treeless pastures has also a significant role.

The low proportion of shared species among habitats indicated that every habitat contributes to the farm biodiversity.

Marginal land uses and linear features, which occupy a low proportion of the farm area, harbored a good number of species that were not found in the main field of dehesas studied.
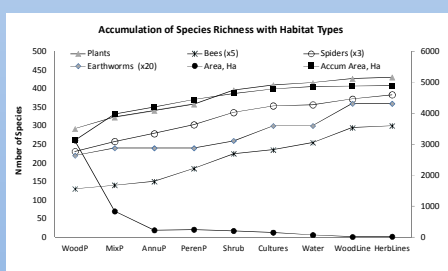
Figure 3. Curves of accumulation of species with different habitats types compared with the accumulation of surface occupied by those habitats. Note that marginal habitats (unmanaged and/or low surface) contribute with a high number of species

Results support policy measures implemented in many European countries, for the maintenance of habitat diversity and farm keystone structures, and reveal that these measures should not be applied exclusively in more intensive farming systems, but also in agroforestry systems, included extensive wood pastures.