

# Biodiversity of plants and arthropods in key ecological structures of vineyards of the Alto Douro region

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**Abstract:** Vineyards in many parts of the world can be regarded as monocultures with little remaining native vegetation, often with a suite of introduced weeds, and having ecosystem services at a low level. By contrast, the UNESCO designated Alto Douro Vinhateiro Area has legally protected landscapes and contains a significant area of non-crop habitats (e.g. woodland remnants, grassy slopes, or terraces with natural vegetation and dry stone walls). In this study, we are measuring the interactions of landscape elements and biodiversity, with particular emphasis on natural enemies of the grape berry moth, *Lobesia botrana*. The study began in May 2010, in three pilot farms, mostly vineyards with olive groves, under different growing practices. A detailed inventory was made of the plant communities in key ecological infrastructures, such as woodland remnants, grassy slopes and borders. In 2010, arthropod populations were sampled by D-VAC suction sampling, yellow sticky traps and pit-fall traps, at various distances into the vineyard from natural vegetation, three times during the year. We present the results of measures of abundance and biodiversity indices, at 14-18 locations within the farms. These results will lead to improved understanding of the value of different vegetation types, and of cultural practices, interacting in biodiversity and pest management.

**Key words:** Viticulture, functional biodiversity, ecological infrastructures, arthropods

## Introduction

Conservation of biodiversity is crucial to maintaining or increasing the sustainability and stability of farming systems, for nature conservation, and for crop production. In agricultural systems, biodiversity provides important ecological services, such as recycling of nutrients, management of organisms that are undesirable for agriculture, regulation of the local hydrological cycle and microclimate, and storage of carbon. This functional biodiversity (Böller et al., 2004), has special importance in the Douro Wine Region. Vineyards in many parts of the world can be regarded as monocultures with little remaining native vegetation, often with a suite of introduced weeds, and having ecosystem services at a low level. By contrast, the UNESCO designated Alto Douro Vinhateiro Area has legally protected landscapes and contains a significant area of non-crop habitats (e.g. woodland remnants, grassy slopes, or terraces with natural vegetation and dry stone walls). A quarter of the scrub consists of terraces that were abandoned after the devastation of phylloxera in the late 19<sup>th</sup> century. These “mortuaries” of former vineyards are now overrun with wild flora, and important from the standpoint of biological diversity (Andresen *et al.*, 2004).

Our goal is to understand mechanisms of enhancement of functional biodiversity via ecological infrastructures (EI) existing on farms, such as woodland remnants, shrubby and

grassy slopes. We aim to identify potential ecological infrastructures with influence on arthropod populations, in particular on natural enemies of the European Grapevine Moth (EGM), *Lobesia botrana* (Denis & Schiffermüller).

## Material and methods

### General description

The research occurred in 2010 on the farm Quinta das Carvalhas (41°10'47''N, 7°32'09''O). In its 306 ha, it contains vineyards (42.4%), native woodlands or shrubs (42%), olive groves (6.7%), and some built areas (0.4%). The experimental site is within a vineyard (cv. 'Touriga Nacional') of ca. 1 ha, 8 years old, set on terraces with weeds that are controlled mechanically, and is under integrated pest management. In the beginning of August (4/08) one treatment with fenoxycarb (INSEGAR 25 WG) was applied to control EGM. The vineyard is bordered by a Mediterranean woodland (dominant species are *Quercus suber* L., *Arbutus unedo* L. and *Erica arborea* L.) separated from it by an asphalt road and two shrubby slopes (Fig. 1). Richness (S) were calculated for plant data. Species abundance (N), richness (S), and the Shannon-Wiener biodiversity index ( $H'$ ) for arthropod data were calculated at each date and location. The results are shown as mean  $\pm$  standard error (SE) of the values calculated at each EI sample station.

### Flora Sampling

A detailed inventory of plant communities occurred twice (late May and late September, 2010) in three replicate sampling points at each EI location, as follows: woodland edge (Fig. 1, A), shrubby slopes (Fig. 1, B and C), vine edge (Fig. 1, D), 25 m into vines (Fig. 1, E) and 50 m into vines (Fig. 1, F), for a total of 28 sample stations. The surface of each sample station was about 4 m<sup>2</sup>, which was considered to be a representative size to describe the structure of the sample station. In each location, the diversity, the abundance and cover matrices were calculated.

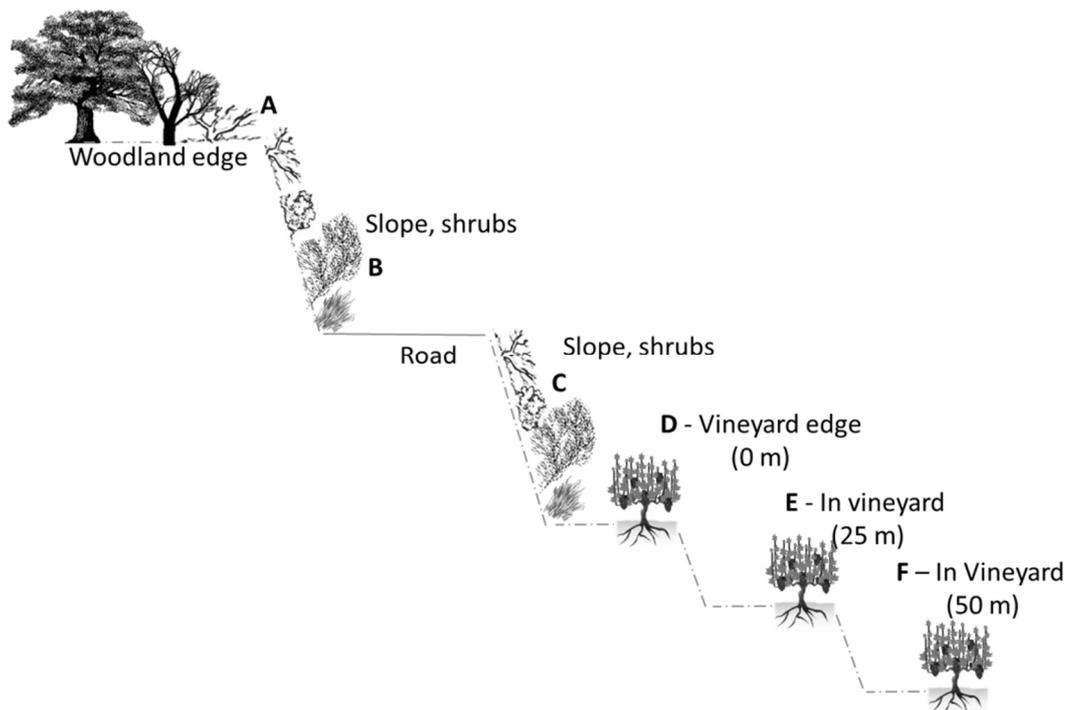


Figure 1. Representation of the landscape at the experimental site of Quinta das Carvalhas.

### **Arthropod Sampling**

Arthropod populations were sampled in each EI by D-VAC suction for one min, along a transect of 20 m around the same point where the flora was assessed, three times during the summer (July, August and September), with three replicate sampling points per EI, each separated by 50-60 m. In the first sampling period, the vines were assessed at the same time as their surrounding vegetation, and in the two others periods, the samples of vines were done separately from the surrounding vegetation. All collected individuals were sorted to Order or Suborder taxa and classified under binocular microscope into Recognizable Taxonomic Units (RTUs).

## **Results and discussion**

### **Flora**

In May 2010, 106 species were identified from 35 families. The most species rich families were Asteraceae (13.2%), Fabaceae (13.2%) and Poaceae (12.3%). In September, 62 plant species were recorded from 32 families, the most abundant being Asteraceae (16.1%) and Poaceae (9.7%).

Analysis of the diversity of species at each EI (Table 1), indicated that shrubby slopes (under woodland, B and under road, C) were the locations with highest values of species richness. All of the points within the vineyard were less diverse than locations in the border (decreasing inversely with distance). However, the species richness at the slope of the vineyard was higher than that between the rows at the same distance (Table 1). In September, the highest diversity was observed on the border (woodland, A, and shrubby slope B). In the vineyard, the diversity was higher between rows than in slopes, because the grass on the slope was mechanically cultivated late in the season, preventing regrowth of the grass.

Table 1. Mean ( $\pm$ SE,  $n=3$  replicates sites) of plant species richness at each EI, Carvalhas 2010

Month	A	B	C	D slope	D	E slope	E	F slope	F
May	10.7 (1.2)	20.7 (2.2)	24.0 (5.6)	22.0 (0.0)	14.0 (2.0)	16.0 (0.0)	10.7 (1.3)	11.0 (1.5)	10.3 (2.9)
Sept.	9.0 (2.0)	9.7 (2.0)	7.3 (0.7)	2.5 (0.7)	8.0 (1.0)	4.3 (0.3)	5.0 (0.6)	4.0 (0.0)	7.3 (1.2)

### **Arthropods**

A total of 3,559 individuals were collected: Insecta (80.4%) and Arachnida (19.6%). Nine orders of insects were identified: Hemiptera were 43.6% of the global abundance, Hymenoptera (17.6%), Coleoptera (7.8%), Diptera (7.4%), Thysanoptera (2.7%), Neuroptera (0.5%), Lepidoptera (0.5%), Orthoptera (0.1%) and Trichoptera (less than 0.01%). Spiders represented 13.1% of the global abundance and Acari 6.5%.

402 Recognizable Taxonomic Units (RTU) were identified: as Hymenoptera with 30.8% of global richness in RTU, Hemiptera (21.1%), Araneae (15.9%), Diptera (13.9%), Coleoptera (11.9%), Thysanoptera (2.2%), Lepidoptera (2.0%), Neuroptera (1.0%), Acari (0.5%), Orthoptera (0.2%) and Trichoptera (0.2%).

In July (Table 2), the locations within the vineyard and its surrounding vegetation (D, E, F) showed higher abundances and richness than in the shrubby slopes (B and C). Compared with the other data collected singly, this result emphasizes the value for increasing biodiversity of the vegetative area that surrounds the vines. At other times of the year, the shrubby slopes (B and C)

provided the highest values of abundance, richness and diversity. As observed for the flora, on all three dates, values of abundance, richness and diversity generally decreased with increasing distance from the border locations (Table 2). This also indicates a positive impact of the EI on biodiversity of arthropods in the vineyard.

Table 2. Mean ( $\pm$ SE) of abundance (rows N), species richness (rows S) and diversity (Shannon Wiener index rows H') of arthropods collected ( $n= 3$  replicate sites) in D-VAC samples in three months, Carvalhas, 2010.

	Month	A	B	C	D	E	F
N	July	-	23.7 (1.2)	27.7 (11.8)	*64.3 (15.9)	*48.0 (4.2)	*37.3 (10.1)
	Aug	82.3 (29.6)	106.3 (35.6)	61.3 (13.5)	21.3 (6.1)	9.0 (3.8)	13.3 (3.2)
	Sept	104.3 (23.5)	72.3 (30.9)	71.7 (23.8)	29.3 (8.7)	7.0 (0.6)	12.3 (2.2)
S	July	-	19.0 (0.6)	18.3 (4.4)	*28.7 (7.0)	*26.0 (3.5)	*20.3 (3.7)
	Aug	28.7 (2.7)	53.3 (7.8)	31.0 (2.0)	13.3 (2.9)	8.0 (3.2)	8.3 (2.0)
	Sept	31.7 (5.2)	36.0 (8.5)	39.0 (8.7)	15.7 (3.5)	5.3 (0.3)	9.7 (0.9)
H'	July	-	4.1 (0.0)	3.9 (0.2)	*4.2 (0.3)	*4.3 (0.2)	*4.0 (0.2)
	Aug	3.8 (0.7)	5.3 (0.1)	4.5 (0.0)	3.5 (0.2)	2.6 (0.8)	2.8 (0.4)
	Sept	3.7 (0.2)	4.7 (0.3)	4.6 (0.2)	3.2 (0.4)	2.3 (0.1)	3.1 (0.1)

\*- The data collected in July at locations D, E and F are a mix of both vines and plants growing under them

From D-VAC samples, the results indicate that the presence of wooded or shrubby vegetation adjacent to vineyards, or grassy vegetation on the slopes, can enhance the biodiversity of arthropods within the farm as a whole, and preservation or manipulation of these habitats has value. Consequently, the preservation or sustainable manipulation of these habitats should be considered. The effects of the habitats specifically upon vineyard arthropods is being assessed in samples that are still being collated.

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