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

Carlos, C.[1,2], Afonso, S.[1]; Crespí A.[2]; Aranha J. [2]; Thistlewood, H.[2,3], Torres, L.[2]

[1] ADVID – Association for the Development of Viticulture in the Douro, Quinta de Santa Maria, Apt. 137, 5050 -106 Godim, Portugal, cristina.carlos@advid.pt
[2] CITAB – Centre for the Research and Technology of Agro-Environmental and Biological Sciences, University of Trás-os-Montes and Alto Douro, 5001-801, Vila Real, Portugal
[3] Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, Summerland, BC, Canada

Introduction

UNESCO designated *Alto Douro Vinhateiro (ADV)* 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 19th century. These "mortuaries" of former vineyards are now overrun with wild flora, and are 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.

Material and methods

General description

The research occurred in 2010 on Quinta das Carvalhas (41º10'47''N, 7º32'09''O). 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 under integrated pest management. 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, 2).

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.

Arthropod Sampling

Arthropod populations were sampled in each EI by D-VAC suction for one min, three times during the summer (July, August and September), with three replicate sampling points per EI, each separated by 50-60 m.

All collected individuals were sorted to Order or Suborder taxa and classified under binocular microscope into Recognizable Taxonomic Units (RTUs).

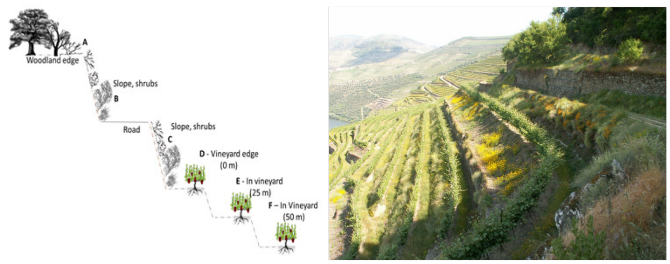

Fig. 1, 2- Photo and representation of the landscape of the experimental site at Carvalhas.

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 ± standard error (SE) of the values calculated at each EI sample station.

Results

Flora

In May 2010, **106 species** were identified from **35 families**. The most rich families were Asteraceae (13.2%), Fabaceae (13.2%) and Poaceae (12.3%). In September, **62 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 (B and 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).

Table 1. Mean (±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%).

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

Fig. 3- Evolution of the vegetation on the slope in a vineyard located in the ADV region. A) 27/05, B) 5/09

Table 2. Mean (±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	D slope	E	E slope	F	F slope
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)	21.0 (11.5)	9.0 (3.8)	21.3 (8.3)	13.3 (3.2)	58.0 (20.2)
	Sept	104.3 (23.5)	72.3 (30.9)	71.7 (23.8)	29.3 (8.7)	47.0 (6.4)	7.0 (0.6)	53.7 (24.8)	12.3 (2.2)	193.7 (98.3)
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)	15.0 (7.7)	8.0 (3.2)	16.0 (6.0)	8.3 (2.0)	20.3 (4.3)
	Sept	31.7 (5.2)	36.0 (8.5)	39.0 (8.7)	15.7 (3.5)	25.0 (4.5)	5.3 (0.3)	20.7 (5.2)	9.7 (0.9)	27.3 (6.9)
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)	3.3 (0.8)	2.6 (0.8)	3.5 (0.8)	2.8 (0.4)	3.6 (0.3)
	Sept	3.7 (0.2)	4.7 (0.3)	4.6 (0.2)	3.2 (0.4)	4.2 (0.4)	2.3 (0.1)	3.5 (0.2)	3.1 (0.1)	3.0 (0.3)

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

These results indicates 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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