Parasitoids of *Lobesia botrana* (Lepidoptera: Tortricidae) in Douro Demarcated Region vineyards and prospects for enhancing conservation biological control

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INTEGRATED PROTECTION IN VITICULTURE

INTRODUCTION

Figure 1 Adult of *Lobesia botrana*

Figure 2 Larva of *L. botrana* paratized

Considering the increased regulation of pesticides in Europe and concerns about environmental impacts of viticulture, research about conservation biological control (CBC) of pests has grown in the last two decades. However, little attention has been addressed to main determinants of parasitism of *Lobesia botrana*, a major pest of vineyards in Southern Europe. The Douro Demarcated Region (DDR) landscape and the management practiced on terraced vineyards offers scope for the implementation of an effective CBC strategy against the pest.

This study aimed at: (i) identifying parasitoids associated with each generation of *L. botrana* and estimating their relative abundance in DDR; (ii) evaluating the effect of neighbouring non-crop habitats and management practices (chemical treatments and soil cover) on the parasitism of *L. botrana*.

RESULTS

A total of 3,226 larvae/pupa of *L. botrana* were collected, out of which 485 parasitoids emerged. Fourteen parasitoids were identified: *Eurystaea scutellaris* (Tachinidae), *Baryscapus sp.*, *Elachertus sp.*, *Elasmus cf bistrigatus, Elasmus cf steffani, Elasmus sp.* (Eulophidae), *Campoplex capitator, Itoplectis maculator* (Ichneumonidae), *Brachymeria tibialis, Hockeria sp*. (Chalcididae), *Dibrachys cavus* (Pteromalidae), *Ascogaster quadridentata* (Braconidae), *Goniozus gallicola* and *Goniozus claripennis* (Bethylidae).

Elachertus sp. (Fig. 3A) which is widely distributed from Portugal to France, was responsible for the highest rates of parasitism (up to 62%) recorded in *L. botrana´s* first generation. *C. capitator* (Fig. 3B) and *B. tibialis* (Fig. 3C) were found to have a complementary role, in the first and second generations of the pest, respectively.

The average rates of *L. botrana* parasitism decreased sharply from the first to the third generation, ranging from 0.0 to 61.5% in the first generation, from 0.0 to 36.8% in the second generation and from 0.0 to 12.1% in the third generation.

Figure 3 Most abundant parasitoids of *L. botrana found* in DDR: a) *Elachertus sp*., b) *Campoplex capitator* and c) *Brachymeria tibialis*

The best model (lower AIC) was obtained by combining the interaction between type of soil management (ground cover/bare soil) and the proportion of EI at 100 m, plus the chemical impact of treatments (type of soil management X proportion of EI (100) + chemical impact). This model explained 61.0% of variability (fixed factors explained 11.7%). Figure 4 illustrates the relation between rate of parasitism and the proportion of ecological infrastructures (EI) at 100 m radii, including soil management and chemical treatments impacts.

Concerning **soil management**, the rate of parasitism seems to have increased substantially more in vineyards with ground cover (Fig. 4, three upper blue lines) than in those with bare soil (Fig. 4, three red lines, located below), where parasitism was almost inexistent. However, in vineyards with ground cover, a higher percentage of ecological infrastructures (EI) seem to have had a negative impact on parasitism of *L. botrana*. On the other hand, in vineyards with bare soils, the higher percentage of ecological infrastructures resulted only in a slightly increase of parasitism rates.

When comparing the **impact of chemical pesticides** applied, results indicated that those with higher chemical impact (95% of the score) resulted in a substantial decrease in rates of parasitism. So, the higher rates of parasitism were found in vineyards with ground cover, under the lower rate of chemical impact (0%), pointing to a positive impact of ground cover on parasitism and a negative impact on it of chemical treatments (Fig. 4).

The results of our study indicates that for CBC of *L. botrana* soil cover, including a high proportion of native perennial herbs, and the selection of chemicals with low toxicity to parasitoids must be encouraged.

METHODOLOGY

The study was carried over a 9-year period (2002 to 2015), in 42 commercial vineyards of DDR. Most vineyards were managed under Integrated Production (IP) principles, receiving chemical applications for the control of the main diseases and pests. All pesticides were applied at commercial doses. Indices of impact were calculated to quantify relative management intensity in relation to **pesticide use**, following the methodology proposed by Thomson and Hoffmann (2006).

Samples of larvae / pupae of *L. botrana* were collected from vineyards. In the laboratory, they were placed individually in breeding containers into controlled conditions (22ºC; RH: 65±10%, photoperiod 16:8 (L:D)); according to the generation, the larvae were fed with natural substrate until pupation. Pupae were checked daily until adult of *L. botrana* or parasitoid emergence. Under a stereoscopic microscope, all parasitoids were sorted into morphospecies, preserved in 70% ethanol and later identified. Percentage of parasitism was calculated. For this analysis, only samples with more than 10 individuals of *Lb* were considered.

Landscape composition around each sampling point was calculated within a GIS framework (ArcGIS® 10x, ESRI), with a radius of 50 and 100 m, overlaying aerial photographs of World Imagery (ESRI). The elements woodland / forest / scrubland / shrubby slopes, riparian gallery, water elements and orchards and vegetable gardens, when conducted extensively, were considered as part ecological infrastructures (EI). Four landscape variables were obtained (percentage of vineyards, percentage of EI, Shannon-Wiener and Eveness indexes), at each radius, within each point assessed.

To evaluate the **impact of landscape**, as well as of **management practices** (soil cover vegetation and chemical treatments) on percentage of parasitism, Generalized Linear Mixed Models (GLMM) were performed (GLMM). Pearson's correlations were previously used, to determine which landscape variables were more related with parasitism rates, and the percentage of EI at the radius of 100 m was selected. Thus, this landscape variable, as well as the variables soil cover vegetation and chemical impact of treatments were used as fixed factors, while year and variety were used as random factors. A set of models was performed by combining the random and fixed variables. After this process, we got a set of 20 alternative models, from which we selected the most parsimonious, using the Aikake Information Criteria (AIC). All analyses were taken with the function contained in the package "lme4" written for the R environment (Bates et al. 2013; R 2012).

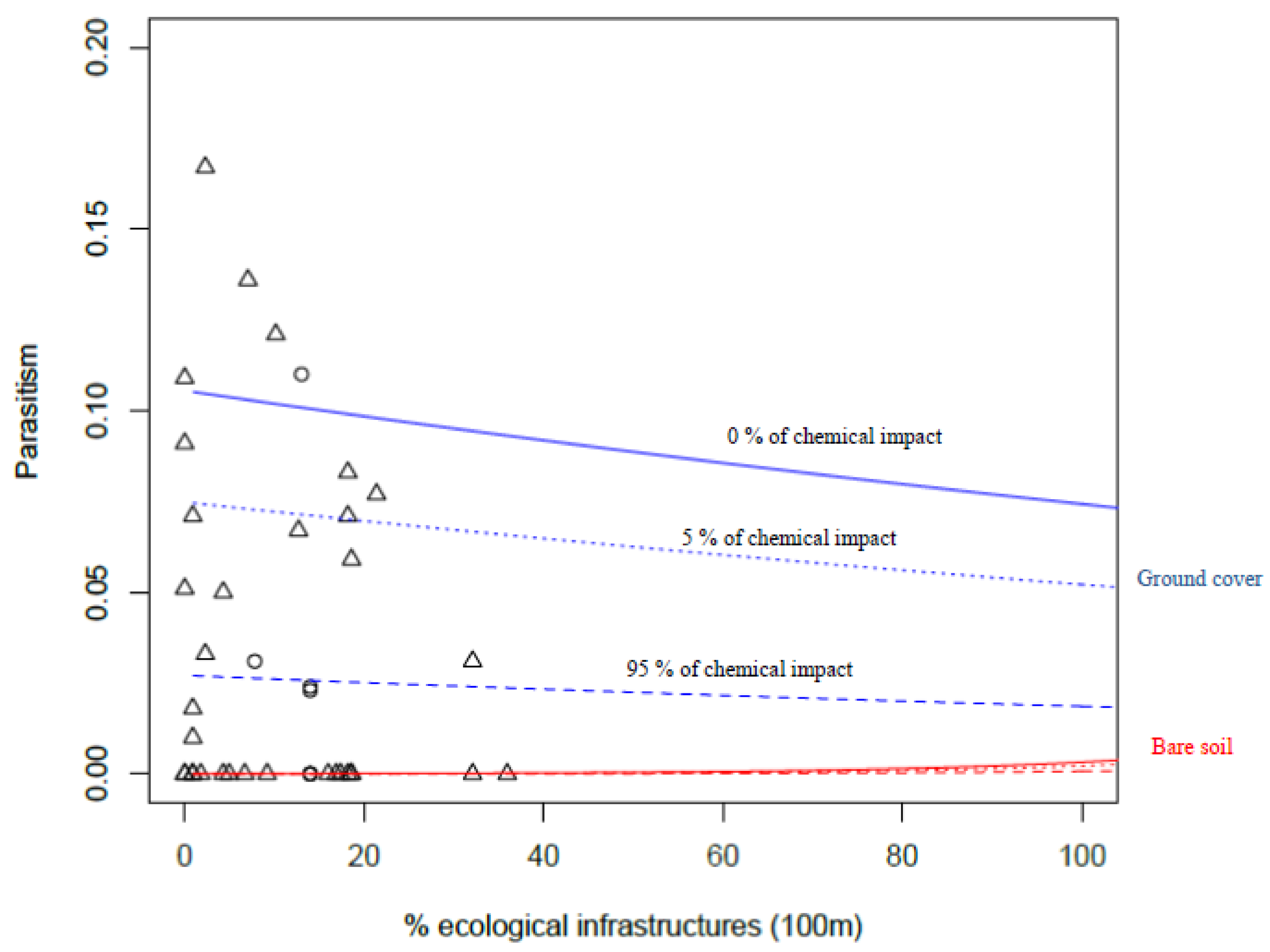

Figure 4 Evolution of parasitism rates, according to the proportion of ecological infrastructures at 100 m. The three lines in blue represents the relation obtained in vineyards with ground cover (solid line - predictions of the model with 0% of the chemical impact (score=0); dotted line- predictions of the model with 5% of the chemical impact measured on the experiment; dashed line- predictions of the model with 95% of the chemical impact measured on the experiment). The three lines in red located below represents the same relations, but in vineyards with bare soil.

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