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Disentangling the Benefits of Organic Farming for Beetle Communities (Insecta: Coleoptera) in Traditional Fruit Orchards

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Abstract: The conversion of traditional land-use systems into more intensive agriculture forms plays a main role in biodiversity loss. Within this framework, organic management has received widespread attention since it is assumed to enhance multiple taxa, including different groups of insects and plants. However, its contribution to the promotion of organism diversity is still controversial. We developed a study in traditional cherry orchards from the Jerte Valley (western Spain) to examine how coleopteran and plant assemblages are driven by farming system (organic vs. conventional), topographic features, and seasonality. The coleopteran community was examined on the basis of its taxonomic and trophic guild response. Organic orchards supported a higher number of beetle families and a greater plant species richness. Additionally, beetle and plant communities were highly correlated; conventional orchards were more homogeneous in terms of both plant and beetle composition, while organic orchards were more heterogeneous, their composition being also shaped by the hillside aspect. From a more functional approach, the different coleopteran trophic guilds exhibited varying responses to the factors analyzed. The benefits of organic farming were notable even when working in traditional systems: highly valuable habitats for overall biodiversity. Therefore, we highlight the potential of organic orchards for conservation purposes.

Keywords: Coleoptera; cherry orchards; conventional farming; hillside aspect; plant richness; seasonality; trophic guilds

1. Introduction

Agricultural areas constitute the largest ecosystem of the planet and, thus, condition a meaningful array of the world’s biological diversity, with species in those areas being lost rapidly and continuously [1–4]. However, not all forms of agriculture jeopardize farmland biodiversity. Mediterranean countries, such as Spain, Portugal, and Greece, still maintain large areas of high-nature-conservation farmland that are generally well integrated with the environment [5,6]. Low-intensity management, high habitat heterogeneity, and the tendency to preserve substantial amounts of natural or semi-natural vegetation make traditional agroecosystems highly biodiverse and sustainable environments [7–12]. However, for the sake of profitability, traditional agricultural systems have been converted to more intensive land-use forms [5,13–17]. The intensification of agriculture has been identified as one of the main drivers of the decline of biodiversity in general and, specifically, that of insects [18]. This process involves the homogenization of agricultural systems at farm and landscape levels, the enlargement of field size, the loss of natural and semi-natural habitats, the application of increasing amounts of synthetic pesticides and fertilizers, and the intensive use of machinery [4,19–21]. Among the processes mentioned, pesticide application is considered one of the biggest drivers of insect decline. This is mainly due to the impact of insecticides via lethal and sub-lethal effects; however, it also results from the alteration of
habitat features caused by herbicides since plant species composition, strongly affected by this management practice, commonly shapes insect communities [18,22–24].

One of the management strategies that seeks to counteract the negative effects of pesticide application is organic farming, a low-intensity system that develops more environmentally friendly practices than conventional agriculture [25,26]. Among the key management practices characterizing organic farming in Europe is the ban of chemical pesticides and fertilizers, which establishes the most important difference between organic farming and conventional agriculture [27,28].

Organic farming generally supports greater farmland biodiversity and benefits a range of taxa; however, the extent of those benefits is not completely understood, and generalization is not easy across taxa and functional groups [25,29–31]. Although the benefits of organic farming seem to be less prominent in perennial than in annual crops, organic management of fruit orchards may increase insect diversity, improving the balance between sustainability and productivity in the agroecosystem [26,32,33]. Information on insect responses to farming system is available for perennial crops, such as vineyards, apple orchards, and olive orchards [32,34,35], but limited for cherry orchards, even though they comprise 426,000 ha of land worldwide and produce more than 2 million metric tons of cherries annually [36].

Coleopterans are trophically diverse insects that occur in high abundance and richness in cropped areas and are very sensitive to environmental changes [6,24,37–39]. Consequently, they are one of the most studied groups of insects in agricultural systems. However, due to the huge number of species included in this group (the largest order in Arthropoda), the majority of studies focus on specific families such as Carabidae or Staphylinidae—two of the most common taxa in agroecosystems [40–42]. Nevertheless, the response of the whole coleopteran community within these systems is practically unknown [6]. This is linked to the significant taxonomic expertise and the large investments of time needed for sorting samples into species in the case of extremely diverse groups such as beetles. Although diversity estimations based on higher taxonomic levels, such as family, can have some limitations, they have proven effective in evaluating coleopteran community responses to anthropogenic impacts [43–46].

Previous studies have shown different coleopteran taxa to be sensitive not only to management practices, but also to the changing conditions imposed by seasonality, a key factor in Mediterranean climates. These changes in environmental conditions are reflected in plant and insect communities and, specifically, in coleopterans [47–49].

With this in mind, we designed a study in a traditional cherry agroecosystem to evaluate how farming systems (organic vs. conventional) drive coleopteran assemblages, both in taxonomic and functional terms, and to identify the extent to which coleopteran communities are dependent on plant composition. We hypothesized that (i) organic cherry orchards support a greater number of coleopteran families and a higher plant species richness than conventional ones; (ii) there is a relationship between coleopteran and plant communities, the composition of those communities differing between organic and conventional orchards; (iii) most coleopteran trophic guilds benefit from organic farming, although the extent of those benefits varies among guilds.

2. Materials and Methods
2.1. Study Area

Our study took place in 2015 in the Jerte Valley in Extremadura, western Spain (40°10’ N, 5°50’ W). This region is located in the Spanish Central System mountain range and dominated by traditional sweet cherry orchards (Prunus avium L.). The Jerte Valley runs linearly along the course of the Jerte River, with a northeast-southwest orientation (Figure 1). Bottom elevation ranges from approximately 1000 m a.s.l. at the northeastern end to 360 m a.s.l. at the southwestern end. Hillside elevation also decreases from northeast to southwest, from 2200 to 650 m a.s.l. The valley has steep slopes (mean slope = 36%) and a higher solar radiation on the hillside with a southeast-facing exposition (sunny aspect) than
on that with a northwest-facing exposition (shady aspect). The region has a Mediterranean, continental, mountain climate with a sharp seasonal contrast defined by a cold period with low temperatures and plentiful rain and a warm period with high temperatures and low rain. Mean annual temperature and rainfall are 15–16 °C and 1000–1100 mm, respectively, with August being the hottest and driest month (mean temperature = 26 °C; mean precipitation = 9 mm).

Figure 1. Location of the study area in Extremadura, western Spain; location of the 12 cherry orchards sampled across the study area.

Cherry orchards are small to medium (overall less than 1 ha) and composed of high-stem cherry trees cultivated on terraces separated by stone walls. Within orchards, some other isolated fruit tree species can sometimes be found. Cherry production in the Jerte Valley is regulated by the Protected Designation of Origin “Cereza del Jerte” (D.O.P. Cereza del Jerte). Spatial configuration of traditional orchards (both organic and conventional), interspersed with remnant natural vegetation, shapes an agricultural landscape mosaic. The remaining natural vegetation is arranged in an altitudinal succession, consisting of holm oak forests (Quercus ilex L.), oak forests (Quercus pyrenaica Willd.), Cytisus scrublands, and alpine pastures; additionally, there is riverside vegetation associated with the different gorges flowing into the Jerte River.

2.2. Experimental Design and Sampling

Across a study area of 416.6 ha, we sampled 12 cherry orchards under different management regimes (conventionally and organically managed) and located on both sunny and shady hillsides. We focused on three orchards for each of the four combinations: conventional-sunny, conventional-shady, organic-sunny, and organic-shady. Mean plot area was 6414 ± 452 m², mean nearest-neighbor distance was 870 ± 72 m (Figure 1), and the orchards were in an elevation range of 500 to 950 m a.s.l. Organic orchards were certified for organic production (EU Council Regulation 834/2007 [50]), whereby no synthetic fertilizers and pesticides were used; conventional orchards were treated with
synthetic fungicides (e.g., tebuconazole, difenoconazole, mancozeb, dodine), insecticides (e.g., lambda-cyhalotrin, acetamiprid, thiacloprid, spinosad, pyroproxyfen), and fertilizers (e.g., 4812, 91,827, NPK). In organic orchards, the ground cover consisted of resident herbaceous vegetation occasionally managed by mowing; in conventional orchards, the ground cover vegetation was controlled by herbicide application (glyphosate). Selected orchards had a similar age and included a combination of young, full production and old trees.

Coleopteran community was sampled monthly from April to August in each of the 12 selected orchards (5 × 12), using two sampling methods. The sampling period in each month was selected in order to ensure similar weather conditions. We captured canopy-dwelling beetles using a suction machine modified from a gardeners’ blower-vacuum [51]. In each cherry orchard, we randomly selected 13 cherry trees that were vacuumed for 2 min along low, medium, and high strata (1, 1.5, and 2 m). To collect ground-dwelling beetles, 20 pitfall traps (9 cm diameter, 12 cm depth), arranged in linear transects along the terraces and separated by 12 m, were placed in each cherry orchard. Traps were filled with 100 mL of a solution of 70% alcohol and 10% ethylene glycol antifreeze/coolant in a 3:2 ratio (1:1 in August to avoid evaporation due to high temperatures). Pitfalls remained active for 4 consecutive days each month. Collected coleopterans were identified to family level by the authors and were sorted into trophic guilds. Several studies have confirmed the validity of using a higher-taxon approach (e.g., family taxonomic resolution) to describe diversity patterns, finding high correlations between data with high and low taxonomic resolutions [43–46].

Additionally, from 22 May to 26 May, vegetation was assessed in all 12 selected orchards by inventorying their floristic composition as presence or absence data. Plant specimens were collected and conserved in herbarium sheets for their posterior identification by a taxonomist.

2.3. Data Analysis

Considering that we intended to evaluate the response patterns of the whole coleopteran community and, given the high completeness values exhibited by both vacuuming and pitfall-trap sampling (non-parametric Chao 1 estimator [52]: 96% of the 24 estimated families for vacuuming and 80% of the 49 estimated families for pitfall traps), we pooled beetles from both sampling methods for data analyses. We explored the spatial structure of beetle assemblages by applying a Mantel test (Euclidean distance) between a matrix of geographic coordinates of sampled orchards and a matrix of Bray–Curtis similarity coefficients of beetle family composition, finding no spatial autocorrelation ($r = 0.016, p = 0.393$).

We applied generalized linear models (GLMs) to analyze the effects of farming system (organic vs. conventional farming) and hillside aspect (sunny or shady) on coleopteran abundance and on the number of beetle families. Models were tested for independence by the autocorrelation function (ACF); as no temporal correlation was found, sampling month was included in the models as an explanatory variable. A negative binomial error structure was used to control for overdispersion. Optimal models were selected by stepwise backward selection. A GLM with negative binomial distribution was also fitted to test for the effect of farming system and hillside aspect on plant species richness.

Coleopteran community structure, both in terms of family composition and guild composition, was assessed by applying non-metric multidimensional scaling (NMDS) in order to explore coleopteran assemblage patterns over the sampling months. The dissimilarity between the sampling units was calculated using the Bray–Curtis dissimilarity index. In addition, permutational multivariate analyses of variance (PERMANOVA) were conducted to analyze spatial (organic vs. conventional) and temporal (over sampling months) changes in coleopteran family and guild composition. The analyses were based on 9999 permutations stratified by aspect (sunny and shady aspect). Among sampling months, post hoc pairwise comparisons were also made based on 9999 permutations stratified by aspect.
A co-inertia analysis was also performed for each sampling site to test for a significant relationship between beetle and plant communities. In the first step of the analysis, the coleopteran data matrix (families, abundance data) and the plant data matrix (species, presence and absence data) were processed separately by principal component analysis (PCA). In the second step, the two ordinations were combined in a co-inertia analysis (CoIA) to explore the co-structure between the beetle and plant communities. In the third step, the significance of the overall relationship (the co-structure of beetle and plant communities) was tested by performing a Monte Carlo permutation test using 9999 random permutations.

On the other hand, generalized linear models (GLMs) were fitted to evaluate the effects of the farming system (organic vs. conventional orchard management) and the hillside aspect (sunny or shady) on the abundance of each coleopteran trophic guild. As a temporal correlation was not found, sampling month was also included in the models as an additional explanatory variable. Models were fitted with a negative binomial distribution to deal with overdispersion. Optimal models were obtained by stepwise backward simplification. To represent the association between the abundances of each of the different coleopteran trophic guilds and the distinct types of evaluated orchards (organic-sunny aspect, conventional-sunny aspect, organic-shady aspect, and conventional-shady aspect), a correspondence analysis (CA) was performed.

All the analyses were carried out using R 4.0.3 software (Vienna, Austria) [53].

3. Results

A total of 12,659 specimens belonging to 42 families were collected: 5174 individuals from 41 families were found in organic cherry orchards, and 7485 specimens from 29 families were captured in conventional cherry orchards. Concerning trophic guilds, a total of 5015 predators, 1623 phytophages, 20 pollen-feeders, 105 fungivores, 3426 xylophages, 2372 saprophages, and 97 coleopterans with mixed feeding habits were collected (Table S1). Additionally, a total of 79 plant species were recorded in organic and 35 in conventional cherry orchards (Table S2).

3.1. Taxonomical Response

In our analysis of the effects of the farming system, the hillside aspect, and the seasonality on beetle abundance and on the number of beetle families, results from the GLMs showed that beetle abundance was significantly affected by the month, with coleopteran densities decreasing over the season (Table 1). The number of beetle families was affected not only by the month, with a decreasing number of families as the season progressed, but also by the farming system (Table 1), with organic orchards supporting a significantly greater number of beetle families than conventional ones.

Table 1. Summary of the results of the coleopteran and plant taxonomical response. Parameter estimates for the final generalized linear models (GLMs) assessing the effect of the farming system (organic vs. conventional), the hillside aspect (sunny or shady), and the temporality (sampling month) on beetle abundance and on the number of beetle families and parameter estimates for the GLM assessing the effect of the farming system and the hillside aspect on plant species richness. Reference coefficients are system (conventional), aspect (shady), and month (April) (** p < 0.01, *** p < 0.001).

| Response Variable           | Factor           | Estimate | Std. Error | z      | p         |
|----------------------------|------------------|----------|------------|--------|-----------|
| Number of beetle families   | Intercept        | 2.780    | 0.252      | 11.023 | <2 x 10^{-16}  *** |
|                            | System (organic) | 0.483    | 0.115      | 4.201  | 2.66 x 10^{-5} *** |
|                            | Month            | -0.123   | 0.040      | -3.041 | 2.36 x 10^{-3} **  |
| Beetle abundance            | Intercept        | 7.553    | 0.527      | 14.323 | <2 x 10^{-16}  *** |
|                            | Month            | -0.384   | 0.086      | -4.485 | 7.29 x 10^{-6} *** |
| Plant species richness      | Intercept        | 2.603    | 0.119      | 21.954 | <2 x 10^{-16}  *** |
|                            | System (organic) | 0.675    | 0.149      | 4.542  | 5.58 x 10^{-6} *** |
When analyzing family turnover, PERMANOVA revealed that beetle assemblage composition varied significantly between organic and conventional cherry orchards (Table 2). In addition, both PERMANOVA pairwise comparisons and NMDS (stress = 0.161) showed that all sampling months significantly differed in coleopteran composition (Table 2, Figure 2a).

Table 2. Results of the PERMANOVA analyses for coleopteran assemblages, testing spatial (farming system) and temporal (sampling month) variability on beetle family composition and trophic guild composition. Pairwise comparisons between sampling months (April, May, June, July, and August) for beetle assemblage composition (both for family and trophic guild composition) are also provided (* p < 0.05, ** p < 0.01, *** p < 0.001).

| Variable | d.f. | MS    | R²   | F      | p          | Month     | F   | p   |
|----------|------|-------|------|--------|------------|-----------|-----|-----|
| System   | 1    | 0.894 | 0.047| 4.085  | 5.0 × 10⁻⁴ | April vs. August | 6.732 | 1.00 × 10⁻⁴ | *** |
| Month    | 4    | 1.580 | 0.332| 7.223  | 1.0 × 10⁻⁴ | April vs. July  | 6.699 | 1.00 × 10⁻⁴ | *** |
| Residuals| 54   | 0.219 | 0.621|        |            | April vs. June  | 4.347 | 4.00 × 10⁻⁴ | *** |
| Total    | 59   | 1.000 | 1.000|        |            | August vs. May  | 6.043 | 1.00 × 10⁻⁴ | *** |

Results from the GLMs showed that plant species richness was significantly affected by the farming system, with organic orchards reaching higher richness values than conventional ones (Table 1). In addition, the co-inertia analysis, which evaluates the relationship between beetle and plant variables and correlates this relationship to the sampling site, showed that beetle and plant datasets were highly correlated (Monte Carlo test: RV coefficient = 0.869, p Value = 0.0042, permutation 9999 times) (Figure 3a). The first two components of the CoIA accounted for 48.35% of the variance in the dataset, with axis 1 (horizontal) accounting for 26.184% and axis 2 (vertical) accounting for another 22.167% (Figure 3b). Conventional cherry orchards were homogeneous in terms of plant and beetle composition since they were grouped closely together, while organic orchards showed a more heterogeneous composition and were, to some extent, grouped by hillside aspect (sunny and shady). Beetles, such as Malachiinae, Coccinellidae, Curculionidae, and Api- oninae, and plants, such as *Portulaca oleracea* L., *Vulpia myuros* (L.) C.C.Gmel., *Bromus sterilis* L., *Chenopodium sp.*, *Parietaria sp.*, *Amaranthus sp.*, and *Lamium sp.*, contributed more to conventional orchards (Figure 3c,d). Conversely, Meloidae, Byrrhidae, Brentinae, Tenebrionidae, Silphidae, or Dasytinae beetles and plants, such as *Tuberaria guttata* (L.) Fourr., *Muscari comosum* (L.) Mill., *Pteridium aquilinum* (L.) Kuhn, *Rumex bucephalophorus* L.,
Trifolium arvense L., Trifolium campestre Schreb., Trifolium repens L., Holcus lanatus L., Rubus ulmifolius Schott, Crepis capillaris (L.) Wallr., or Cyperus badius Desf., were mainly found in organic orchards (Figure 3c,d; see Tables S1 and S2 for abbreviation equivalences).

3.2. Trophic Guild Response

Concerning coleopteran trophic guilds, results from both the GLMs and the CA ($\chi^2 = 3697.338; \text{d. f.} = 18; p = < 0.0001$) showed that different guilds exhibited varying responses to the farming system, the hillside aspect, and the seasonality. Predator and phytophagous abundances were affected only by the month, with lower densities of both guilds being found as the season progressed (Table 3). Although only marginally significant, pollen-feeder abundance also decreased over the months; however, this tendency differed between farming systems, the abundance decline being more marked in conventional than in organic cherry orchards (Table 3, Figure 4). Fungivorous beetles were affected by both the farming system and the month, exhibiting greater frequencies in organic orchards and decreasing abundances as the season progressed (Table 3, Figure 5). Xylophages responded to the farming system and the hillside aspect and tended to be associated more with conventional orchards and with orchards located on the shady hillside (Table 3, Figure 5). For their part, saprophages were, to some extent, favored by organic farming, although the effect of the farming system was only marginally significant. Finally, beetles with mixed feeding habits were affected by both the farming system and the month, exhibiting greater frequencies in organic orchards and decreasing abundances as the season progressed (Table 3, Figure 5).
Figure 3. Co-inertia analysis (CoIA) of the relationship between coleopteran assemblages (on the basis of families) and plant communities (presence and absence data). (a) Co-structure between plant samples (arrow base) and beetle samples (arrow tip); black and red circles for conventional orchards located in the shady aspect; black and yellow circles for conventional orchards located in the sunny aspect; green and red circles for organic orchards located in the shady aspect; green and yellow circles for organic orchards located in the sunny aspect. Arrow length corresponds to the dissimilarity between the plant data and the coleopteran data (the shorter the arrow, the better the concordance between the two projections). Sites are more similar in terms of plant and beetle composition when they group more closely together; (b) distribution of eigenvalues of CoIA and components of the standardized principal component analysis of the beetle (left) and plant (right) datasets projected onto the co-inertia axes; (c,d) plots show the contribution of the beetle and plant variables, respectively, to the canonical space. Vectors pointing to the same direction are correlated, and longer vectors contribute more to the structure.
Table 3. Summary of the results of the coleopteran trophic guild response. Parameter estimates for the final generalized linear models (GLM) assessing the effect of the farming system (organic vs. conventional), the hillside aspect (sunny or shady), and the temporality (sampling month) on the abundance of each coleopteran trophic guild. Parameters are estimated with a 95% confidence interval. Reference coefficients are system (conventional), aspect (shady), and month (April) (. * p < 0.1, ** p < 0.01, *** p < 0.001).

| Response Variable | Factor                      | Estimate | Std. Error | z     | p          |
|-------------------|-----------------------------|----------|------------|-------|------------|
| Predators         | Intercept                   | 6.742    | 0.591      | 11.400| <2 × 10^{-4} | *** |
|                   | Month                       | -0.410   | 0.096      | -4.269| 1.96 × 10^{-5} | *** |
| Phytophages       | Intercept                   | 5.554    | 0.572      | 9.715 | <2 × 10^{-4} | *** |
|                   | Month                       | -0.391   | 0.093      | -4.197| 2.71 × 10^{-5} | *** |
| Pollen-feeders    | Intercept                   | 3.872    | 2.637      | 1.468 | 0.142      |
|                   | System (organic)            | -4.366   | 3.018      | -1.447| 0.148      |
|                   | Month                       | -1.070   | 0.553      | -1.935| 0.053      |
|                   | System (organic): Month     | 1.025    | 0.603      | 1.701 | 0.089      |
| Fungivores        | Intercept                   | 3.002    | 1.098      | 2.734 | 0.00625    | ** |
|                   | System (organic)            | 0.954    | 0.505      | 1.890 | 0.03877    |
|                   | Month                       | -0.540   | 0.182      | -2.965| 0.00303    | ** |
| Xylophages        | Intercept                   | 4.949    | 0.487      | 10.169| <2 × 10^{-16} | *** |
|                   | System (organic)            | -1.490   | 0.564      | -2.643| 0.00821    | ** |
|                   | Aspect (sunny)              | -1.564   | 0.564      | -2.773| 0.00555    |
| Saprophages       | Intercept                   | 3.304    | 0.268      | 12.351| <2 × 10^{-16} | *** |
|                   | System (organic)            | 0.644    | 0.378      | 1.704 | 0.0883     |
| Mixed feeding habits | Intercept                | 8.807    | 2.110      | 4.174 | 2.99 × 10^{-5} | *** |
|                   | System (organic)            | 2.097    | 0.802      | 2.615 | 0.00893    | ** |
|                   | Month                       | -2.014   | 0.446      | -4.512| 6.41 × 10^{-6} | *** |

Figure 4. Significant effects of the farming system and the temporality on the abundance of pollen-feeding beetles. Estimated mean ± SE of abundance in conventional (black line) and organic (green line) cherry orchards throughout the different sampling months.
When analyzing guild turnover, PERMANOVA revealed that beetle guild composition varied significantly between organic and conventional cherry orchards (Table 2). In addition, both PERMANOVA pairwise comparisons and NMDS (stress = 0.134) showed that coleopteran guild composition was significantly different for all sampling months, with the exception of April and August, which were similar in this regard (Table 2, Figure 2b).

4. Discussion

Between the two farming systems, organic orchards supported the highest plant species richness and the greatest number of beetle families. This is consistent with the fact that management practices differ between farming systems; these differences are quite significant when it comes to the ground cover management. Plant-cover mowing carried out in organic orchards constitutes a less intensive practice than herbicide application in conventional ones; herbicide use is a factor that constrains and drives plant diversity [54,55]. In addition, plant species richness is strongly correlated to global farmland biodiversity [37]. Thus, fewer constraining and selective practices conducted in organic orchards allow them to support a higher richness not only of plants, which would lead to a greater microhabitat and spatio-temporal resource diversification, but also of coleopterans [56,57]. This was illustrated by the fact that organic farming positively affected the number of beetle families but not beetle abundance. In addition, seasonality also shapes coleopteran communities, with both beetle abundance and the number of beetle families decreasing over the season.

In our evaluation of beetle community composition, a similar pattern was observed: beetle communities differed between organic and conventional orchards, and a marked family shift throughout the months was detected. Habitat features derived from the farming system, such as synthetic pesticide input, different levels of structural complexity derived from specific practices, or the availability of resources, can determine organisms’ association to a specific habitat [27,30,31,56,58–69] and could help to explain the observed differences between organic and conventional management.

In addition, the drastic seasonality of the Mediterranean climate imposes deep temporal differences in ecosystem properties and, thus, a high temporal heterogeneity. These changing conditions shape plant and insect communities, particularly coleopteran as-
semblages, which can exhibit very different structures due to changes in environmental conditions and resources [47–49].

According to previous studies [6,70–73], our results showed that coleopteran communities are highly correlated with plant communities. Conventional orchards were very similar in their composition of plants and beetles, again illustrating how the constraining nature of management practices leads to more homogeneous communities [24,54,74]. Organic orchards, however, showed a more heterogeneous composition; moreover, orchards located on the same hillside aspect seemed to harbor slightly more similar plant and beetle communities. Practices applied in organic orchards are less constraining; this may allow other factors, which are primarily hidden by management, to play a more significant role in shaping communities. For example, the hillside aspect is a factor that can drive plant assemblages through differences in water distribution, temperature, and solar radiation between sunny and shady slopes, resulting in a different plant composition [75]. In any case, anthropogenic factors have been identified as crucial in shaping plant communities in cropped areas. In this regard, arable weeds are filtered according to functional traits that respond to management practices; specifically, herbicides, a strongly determinant factor for the flora, select for species with late germination [54,76]. This is consistent with the species found to better define the structure of conventional orchards, such as *Portulaca oleracea*, *Chenopodium* sp., and *Amaranthus* sp. These species have a natural tolerance for some herbicides or exhibit traits that allow them to withstand the negative effects of this treatment [74]. In our examination of coleopterans, families that exploit widely distributed resources, such as Coccinellidae or Curculionidae, contributed more to the structure of conventional orchards, reflecting how more generalist beetles are less constrained by management practices such as weed and pest control [24,77].

This trend holds when analyzing beetle guilds’ response: trophic guilds exploiting ubiquitous resources did not respond to the farming system, contrary to those depending on specific resources with a more restricted availability. Additionally, seasonality was a highly conditioning factor for all trophic guilds except for those which depend on temporally continuous resources that remain stable throughout the season (i.e., xylophages and saprophages). This, again, reflects the changing conditions linked to the Mediterranean climate [47–49,78].

Predatory and phytophagous beetles were not affected by the farming system. While this result is somewhat surprising, similar trends have been reported in other studies [30,33]; only the month drove the abundances of these trophic guilds. Summer drought is the defining feature of the Mediterranean climate. At least two consecutive months of aridity (July and August) occur during the hottest period of the year, when herbaceous plants dry out. This drastic seasonality implies a marked variation in resource availability over time [79–81], with plant and prey availability presumably being reduced. Seasonality also conditioned pollen-feeding beetles, whose abundance generally decreased over the months, although this decline differed between organic and conventional orchards. Within agroecosystems, spatio-temporal stability restricts biodiversity levels [82]. Survival, flowering, or nectar supply might be reduced by increasing aridity, resulting in lower resource availability for flower-dependent animals [83]. In less plant-diverse habitats, such as conventional orchards, the supply of pollen resources could be restricted to the early season, because the plants dry out as the season progresses. On the contrary, more plant-diverse habitats, such as organic orchards, could buffer the negative effects of seasonality by supplying floral resources over a longer period of time, thus, smoothing the reduction of pollen-feeding coleopterans throughout the months [78].

Although, at first sight, the effect of the farming system on fungivorous beetles can be difficult to ascertain, because they can be unaffected by pesticide use in orchards [84], we found that they benefited from organic farming; we observed similar results for saprophages and, more markedly, for mixed-feeding coleopterans, which is in line with previous studies [73,85]. Surprisingly, xylophagous coleopterans were strongly affected by both the farming system and the hillside aspect, showing a preference for conventional
orchards from the shady hillside. For this trophic guild, habitat amount and quality (i.e., the degree in which habitat requirements are fulfilled) is determinant [86]. The observed pattern might reflect differences in tree management (e.g., pruning, proportion of trees in full production and old trees) between organic and conventional orchards, which might create differences in habitat suitability. However, employing a higher-taxon approach (i.e., family level) could be limiting our capacity to unveil xylophagous response. Anyway, traditional orchards have been identified as valuable habitats that support a large number of xylophagous coleopterans [12].

5. Conclusions

Our results reflect that, in general, type of farming system is a factor that heavily drives plant and coleopteran assemblages, and organic orchards support higher diversity levels of both groups. The benefits of organic farming are detectable not only at a taxonomic level, but also when applying a more functional approach; they are clearly appreciable even when working in traditional systems, which are, in the first instance, very diverse habitats considered highly valuable for overall biodiversity [12,76]. With this in mind and considering that both plants and coleopterans are good surrogates of overall biodiversity [37,87], we highlight the potential of organic orchards for conservation purposes.

In our system, landscape is a mosaic composed of small conventional and organic orchards interspersed with remnants of natural vegetation. Within this landscape mosaic, organic orchards are highly suitable habitats that increase spatio-temporal stability, thus, enhancing the resilience of the system. Given concerns about the decline of insects worldwide, documenting insect diversity in agricultural areas serves an essential purpose to disentangle the potential of cropped areas with different features in terms of conservation. Evaluating the capacity of agroecosystems to provide key resources and how this capacity is affected by farming management is of prime importance to enhance the ecological functioning of agricultural systems.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/agriculture12020243/s1: Table S1: list of beetle families sampled. For each family, the trophic guild, as well as the abundances per cherry orchard type (organic or conventional), and month are provided; Table S2: list of plant species inventoried from the 12 cherry orchards evaluated in the study area. For each replicate, data on abundance of each beetle family, as well as data on recorded plant species, are provided.

Author Contributions: Conceptualization, N.R.-R., J.D.A. and L.B.-P.; methodology, N.R.-R., J.D.A., E.T., V.d.P. and L.B.-P.; validation, N.R.-R., J.D.A., E.T., V.d.P. and L.B.-P.; formal analysis, N.R.-R., J.D.A. and E.T.; investigation, N.R.-R., J.D.A., E.T., V.d.P. and L.B.-P.; resources, N.R.-R., J.D.A., E.T., V.d.P. and L.B.-P.; data curation, N.R.-R.; writing—original draft preparation, N.R.-R.; writing—review and editing, N.R.-R., J.D.A., E.T., V.d.P. and L.B.-P.; visualization, N.R.-R., J.D.A., E.T., V.d.P. and L.B.-P.; supervision, J.D.A. and L.B.-P.; project administration, J.D.A. and L.B.-P.; funding acquisition, J.D.A. and L.B.-P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Universidad de Salamanca, grant number Programa I: A2019-USAL.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available in the Supplementary Materials.

Acknowledgments: Many thanks to the taxonomic specialists Enrique Rico (Universidad de Salamanca) and Sergio Montagud (Universitat de València) for plant and coleopteran identification, respectively. We are very grateful to the cherry growers Francisco Acera, Roberto Díaz, Aníbal Leralta, Jesús Carlos Manjón, Manuel Martín, Rafael Morales, Dionisio Moreno, José María Prieto, and Simeón Simón who allowed us to conduct this experiment in their orchards.

Conflicts of Interest: The authors declare no conflict of interest.
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