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1 **Title:**

2 Changes in landscape composition influence the abundance of insects on maize: the role of fruit
3 orchards and alfalfa crops

4

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19

20 **Abstract**

21 The traditional agricultural landscape of Ebro Basin (NE Spain), which is mainly composed of
22 alfalfa and cereal crops, has undergone changes in recent years, mainly consisting of an increase
23 in the area occupied by intensively managed irrigated orchards. Recently, it has been reported
24 that the presence of a higher proportion of orchards in the landscape and their management
25 negatively affect the abundance and diversity of natural enemies. Two hypotheses are tested in
26 this study: (1) the increased orchard surface has led to a reduction in natural enemies in
27 neighbouring maize crops, and (2) the higher alfalfa proportion of agricultural land enhances the
28 predatory fauna on maize. Maize fields were selected across a landscape gradient created by
29 orchards and field crops (alfalfa and maize) in a buffer of 500 m. The abundance of 17 insect
30 taxa in each maize field was estimated by means of 3 yellow sticky traps per season over three
31 years. The insect abundance was related to the landscape structure (proportions of landscape
32 elements and landscape diversity) and local variables (maize phenology, perimeter/area, weed
33 diversity of the maize edges and abundance of the potential predators or potential prey). Our
34 results show that the proportion of orchards in the landscape had negative effects on the main
35 predators, and alfalfa had positive effects on herbivores and their predators. Semi-natural
36 habitats (non-crop habitats and forest) and landscape diversity had low effects on insect
37 abundance. However, variables at the local level included more significant effects than
38 landscape structure; maize growth stages and abundance of potential prey or predators on the
39 crop were the most influential variables at a local level. Here we show the interplay between
40 different land uses types and local management and their impact on natural enemies and
41 herbivores in maize crops in the Mediterranean area.

42

43 *Keywords:*

44 Agricultural landscape

45 Crop rotation system

46 Landscape structure

47 Local variables
48 Natural enemy abundance
49 Maize pest abundance
50

51 **1. Introduction**

52 Agroecosystems are not static systems over time but are linked to market demand for different
53 food commodities, among other factors. Insects exploiting such agroecosystems and their
54 associated natural or semi-natural habitats need to be able to find the resources provided by the
55 different cover types in ephemeral and disturbed environments (Rusch et al., 2010; Schellhorn
56 et al., 2014). Thus, herbivores and their natural enemies must move among habitats, resulting in
57 spatial or temporal emigrations (Landis et al., 2000; Rand et al., 2006; Tschardtke et al., 2012;
58 Bianchi et al., 2013). The combination of many trophic level interactions, the landscape
59 structure (i.e., its composition and configuration), the management of the crop fields (i.e.,
60 tillage, irrigation, pesticide inputs, harvesting/cutting or rotation) and the constant changes in
61 agricultural policy make it difficult to understand and predict the changing patterns of insect
62 abundance in particular agricultural habitats. Recently, studies have been performed to
63 understand the negative and positive effects of agricultural land use on the conservation of
64 biodiversity and its relation to ecosystem services, with a landscape perspective (Tschardtke et
65 al., 2005). The spatial scale that best predicts the natural enemy density and population
66 dynamics may depend on the specialisation, dispersal capability, and trophic level of a
67 particular natural enemy (Perović et al., 2010; Chaplin-Kramer et al., 2011).

68 Most of the literature on landscape structure and insect abundance relationships has been
69 devoted to the natural enemies of insect pests with the objective of managing habitats for cost-
70 effective pest control (Symondson et al., 2001; Bianchi et al., 2006; Rusch et al., 2010;
71 Tschardtke et al., 2012). By contrast, herbivore responses to landscape variables are much less
72 conclusive in the literature than the data on natural enemies (Bianchi et al., 2006); this is a

73 knowledge gap that should be filled to allow the design of better forms of biological control of
74 crop pests.

75 In the Ebro Basin (NE Iberian Peninsula), in the last 25 years, the authors have studied the
76 composition and abundance of arthropods in winter cereals, maize, and alfalfa in irrigated arable
77 crop rotations. In this area, agricultural landscapes are traditionally dominated by arable crops
78 that are managed by the rotation of winter and summer cereals and alfalfa. In these landscapes,
79 small separate areas of fruit orchards are cultivated. In addition, natural or semi-natural habitats
80 are scattered within the agricultural matrix, shaping the agricultural landscape. More recently,
81 changes in market demand have led to modifications to the composition of agricultural
82 landscapes in the region, with the most significant being an increase in the area of stone fruit
83 orchards (National Bureau of Statistics of Spain, 2017), which have led to the transformation of
84 a landscape dominated by arable fields to an orchard-field crop mix landscape. These changes
85 can modify the abundance of pests and their natural enemies that occur on the crops that make
86 up the landscape.

87 The low economic threshold of stone fruit pests has led to intensive crop management and
88 repeated pesticide treatments, which are considered a main cause of natural enemy reduction in
89 the landscape because pesticides affect their behaviour and habitat recolonisation (Rusch et al.,
90 2010). Consequently, landscapes dominated by stone fruit orchards have been reported to
91 negatively affect the richness of beneficial arthropod species (Samnegård et al., 2018). In
92 contrast, alfalfa fields in this area have been reported to be important reservoirs of natural
93 enemies (Núñez, 2002; Pons et al., 2005; Ardanuy et al., 2018), from which predators show
94 bidirectional movement between neighbouring alfalfa and maize fields (di Lascio et al., 2016;
95 Madeira et al., 2014, 2018; Madeira and Pons, 2016). Additionally, the cover and the
96 composition of herbaceous plants in hedgerows surrounding maize fields may provide resources
97 and shelter for natural enemies of maize pests (Ardanuy et al., 2018).

98 The aim of the present work is to disentangle the influence of the actual agricultural landscape
99 on the composition and abundance of insect fauna in maize fields. Based on the preliminary

100 results obtained by authors in this area, we present two hypotheses: (1) the intensive chemical
101 spraying that is usually practised in orchards in this area has negative consequences for the
102 biological control functions in surrounding maize crops, and (2) alfalfa can act as a reservoir of
103 natural enemies in intensive agricultural landscapes. To test these two hypotheses, we analysed
104 the influence of the landscape structure and local variables on herbivore and predatory insect
105 abundance on maize. A total of 52 maize fields over three years were sampled to determine the
106 abundance of 17 insect groups, 11 predators and 6 herbivores. The abundance of these insect
107 groups was related in spring and summer in an agricultural landscape in a circle of 500 m
108 around the sampled maize fields.

109

110 **2. Methods**

111 **2.1. Study area**

112 This study was carried out in 2015, 2016 and 2017 in the Ebro Basin in north-eastern Spain
113 (41°48'12.20"N, 0°32'45.77"E; 120–346 m altitude; 200–400 mm rainfall, Tmin: 8°-24° C and
114 Tmax: 18°-38° C) (Fig. 1a). Most of the crops in this region are irrigated, and crop fields are
115 interspersed with patches of non-crop habitats (non-productive areas, longer fallows, natural
116 habitats and wetland) and forest repopulated by *Pinus halepensis* (Mill). Crop rotation mostly
117 includes winter (mainly wheat and barley) and summer (mainly maize) cereals and alfalfa.
118 Traditionally, pome fruit orchards and field crops are grown in separate areas. Recently, the
119 surface area of the stone fruit orchards (mainly peaches) has grown exponentially, leading to a
120 mixed landscape characterised by orchards and field crop plots with different shapes and sizes.
121 Pest management in the cereals includes pre- and post-emergence herbicide applications,
122 treatment of seeds of winter cereals with fungicides, and treatment of maize with both
123 insecticides and fungicides. Management of alfalfa consists of 5/6 cuttings during the
124 productive period (March–October), and the crop is in the field for 4-5 years (Madeira et al.,
125 2014). In orchards, management includes from 7 to 14 chemical sprays (insecticides, fungicides
126 and bioregulators), herbaceous cover mowing (approximately once per month), and herbicide
127 and tree fertilisation (Cantero, 2013).

128

129 **2.2. Landscape structure variables**

130 During the 3-year study, 52 maize fields were selected according to the initial gradient of the
131 orchard and field crop proportion in the landscape using aerial photography in a circle buffer of
132 500 m surrounding the maize fields. Due to crop rotation, some of the sampled maize fields
133 changed in this period; thus, we selected 6 maize fields in 2015 and 23 in 2016 and 2017. The
134 size of the maize fields varied between 0.9 and 13.68 ha, and these fields were located at least 2
135 km apart from each other. The agricultural landscape covered was 700 km² (Fig. 1b) (Appendix
136 A.1).

137 The landscape composition was characterised by the proportion of the different landscape
138 elements embedded in a circle buffer with a 500 m radius surrounding the maize fields. In
139 addition, spring and summer characterisations of the landscape composition were conducted to
140 incorporate the seasonal variations of the proportions of cereals in spring and winter cereal-
141 fallows in summer. The landscape composition was described each year by direct field
142 observations, an orthophoto from the Plan Nacional de Ortografía Aérea (PNOA), and
143 geographical information maps of the Instituto Geográfico Nacional of Spain. Then, we
144 quantified the proportions of the landscape elements using ArcGIS software 10.3.1 (ESRI,
145 2015). Next, the 34 landscape elements initially identified in the study were grouped into eight
146 categories: orchards, summer and winter cereals, winter cereal-fallow, alfalfa, non-crop habitats,
147 forest and edges (Table 1 and Fig. 1b) (Appendix A.2).

148 The landscape configuration was characterised by landscape diversity (hereinafter SHDI-L).
149 SHDI-L was calculated as a function of the proportional abundance of each landscape element
150 type, L_i , using FRAGSTAT (McGarigal et al., 2012) as follows:

$$151 \text{SHDI-L} = -\sum_{i=1}^{34} L_i \times \ln L_i$$

152

153 **2.3. Local variables**

154 Local variables included the maize phenology, perimeter to area of the maize fields, Shannon
155 index in maize field edges (hereinafter SHDI-E), and abundance of potential predators (for the

156 study of herbivore species) and potential prey (for the study of predators) (Appendix A.3). In
157 recent years, maize is variably sown in the early (March-April) or late season (at the end of
158 June); consequently, we sampled both early (17 fields in 2016 and 18 fields in 2017) and late
159 sown maize fields (6 fields in 2015 and 2016 and 5 fields in 2017). Maize phenology was
160 recorded at each sampling date according to Ritchie et al. (1992). The perimeter to area of the
161 maize fields was calculated using ArcGIS software. The SHDI-E index was calculated from
162 flora surveys carried out in the edges between the maize and neighbouring fields (orchards,
163 alfalfa or maize) during May and June in 2016 and 2017. In addition, for each sampling point,
164 the cover-abundance of weed species was recorded using the Braun-Blanquet scale (1979) in
165 three rectangular plots ($2 \times 5 \text{ m}^2$) along the edges. Then, the cover-abundance values were
166 transformed into the mean value of the percent cover according to each field, and we calculated
167 the Shannon index as a function of the proportional weed species abundances, E_i :

$$168 \text{ SHDI-E} = - \sum_{i=1}^{52} E_i \times \ln E_i$$

169

170 In addition, we used floristic surveys of the edge cover compositions to transform the cover
171 abundance of species into the mean value of the percent cover according to three types of edges
172 (maize-orchard, maize-alfalfa and maize-maize), calculated the Shannon index (hereinafter H'),
173 and grouped the recorded plant species as dicotyledons or monocotyledons.

174 Autocorrelation can be a problem for classical statistical tests, such as regression, which rely on
175 independently distributed errors (Legendre, 1993), as it may lead to erroneous conclusions
176 regarding the significance of covariates in studies of species-environment relationships (Wagner
177 and Fortin, 2005). Therefore, the degree of correlation between variables was assessed through a
178 Spearman rank correlation between landscape composition, landscape configuration and local
179 variables (Appendix A.4). According to Campbell and Swinscow (2009), some variables were
180 weakly to moderately correlated (Spearman's $\rho < 0.59$), but they were not excluded to build the
181 models as done by Schmidt et al. (2019).

182

183 **2.4. Yellow trap catches of herbivores and predators**

184 The abundance of insects in maize fields was estimated using yellow sticky traps (30 ×25 cm,
185 Serbios, Badia Polesine, Italy). Samplings were conducted once a month, and the traps were left
186 active for 1 week. In each field, we placed 3 traps on stakes at the crop canopy height,
187 depending on the growth stage, along a transect perpendicular to the nearest edge (approx. 30
188 m), with the traps 15 m away from each other (Albajes et al., 2013). The traps were then
189 collected and conserved at 6-8°C until insect identification. Individuals were identified at the
190 family, genus or species level depending on their state of conservation. Vouchers of individuals
191 identified at species level were deposited in the laboratory of Entomology of the University of
192 Lleida.

193

194 **2.5. Statistical analyses**

195 The effects of the landscape structure and local variables on the insect abundance on maize were
196 analysed separately for each of the two seasons—spring and summer. We used a linear mixed-
197 effects model with the ‘year’ as the random structure for each mode using the ‘nlme’ package
198 (Pinheiro et al., 2018) for R software (R Development Core Team, 2018). For each field and
199 sampling date, the mean number of each insect taxa selected for identification per trap was log
200 transformed [$\log_{10}(x+1)$] to achieve, as much as possible, a normal distribution of the model
201 residual. In addition, we tested the spatial autocorrelation in the abundance of insects among all
202 fields using Moran’s I statistic (Paradis, 2019) (Appendix A.5). We standardised (mean centred
203 and scaled) landscape metrics for each model using the ‘caret’ package (Max et al., 2018). We
204 applied a multi-model inference approach to obtain a robust parameter estimate using the
205 ‘MuMIn’ package (Bartoń, 2018). The dredge function of the models was used to describe the
206 effects of independent variables on each dependent variable. Models were selected by
207 comparing the Akaike information criterion (AICc) with the values of the full model. Model
208 averaging was performed on the model while set to $\Delta AICc < 2$ (Burnham and Anderson, 2004).
209 The model residuals were graphically inspected with qqplot and histogram graphics to ensure no
210 violation of normality and homoscedasticity assumptions (Zuur et al., 2010). Finally, we used
211 the ‘effects’ package (Fox et al., 2016) to represent the effects in partial residual plots.

212

213 3. Results

214 A total of 316,564 insects were trapped on 585 yellow sticky traps in 52 maize fields during the
215 three years of the study: 39,539 in 2015 ($n = 6$ fields), 201,775 in 2016 ($n = 23$) and 75,250 in
216 2017 ($n = 23$). The identified taxa were: *Coccinella septempunctata* (L.), *Empoasca vitis*
217 (Göethe), *Hippodamia variegata* (Goeze), *Frankliniella occidentalis* (Pergande), *Laodelphax*
218 *striatellus* (Fallén), *Propylea quatuordecimpunctata* (L.) and *Zyginidia scutellaris* (Herrich-
219 Schäffer), *Aeolothrips spp.*, *Nabis spp.*, *Orius spp.*, and *Stethorus spp.* At the family level,
220 Aphididae, Chrysopidae, Miridae, Staphylinidae, Syrphidae and other Thripidae species (other
221 than *F. occidentalis*) were identified. The insect abundances varied between seasons and
222 especially were higher for herbivores in spring (Fig. 2). The most abundant herbivore was *F.*
223 *occidentalis*, followed by *Z. scutellaris*, other Thripidae and Aphididae (Fig. 2). In the case of
224 predators, *Aeolothrips spp.* was the most abundant, followed by Syrphidae, *Stethorus spp.* and
225 *Orius spp.* (Fig. 2). Models of Nabidae and *H. variegata* were not considered because of their
226 low abundance. Miridae were also not considered because of their extremely diverse feeding
227 regimes. Models of Nabidae, *H. variegata* and Miridae can be observed in Appendix B.

228

229 3.1. Flora abundance and composition survey in maize field edges

230 A total of 190 weed species were identified in the maize field edges. The most abundant
231 monocotyledon species were: *Hordeum murinum* (L.), *Sorghum halepense* (L.), *Poa annua* (L.),
232 *Cynodon dactylon* (L.), *Avena sterilis* (L.) and *Lolium rigidum* (Gaudin). In the case of
233 dicotyledons, the most abundant species were: *Malva sylvestris* (L.), *Taraxacum officinale* (L.),
234 *Capsella bursa-pastoris* (L.), *Sonchus oleraceus* (L.), *Chenopodium album* (L.) and *Veronica*
235 *arvensis* (L.). The edges between the maize and orchards showed the highest plant cover (80%)
236 (Fig. 3a) and a dominance of dicotyledons (80%) (Fig. 3b). On the other hand, the edges
237 between maize and alfalfa had low plant cover (48.97%) but the highest H' (1.7) (Fig. 3a).
238 Finally, the edges between maize fields had the lowest H' (1.66) (Fig. 3a) and the highest
239 proportion of monocotyledons (30%) (Fig. 3b).

240

241 **3.2. Responses of insects to landscape structure variables**

242 Most of the parsimonious models for predators and herbivores are shown in Appendix B (1 and
243 2, respectively). The results with only significant variables for predators are shown in Table 2
244 and for herbivores in Table 3. Overall, the abundance of insects was influenced by the landscape
245 structure, with a characteristic seasonal pattern. The landscape variables with higher effects on
246 the insect abundance were the proportion of alfalfa, orchard and edges. Alfalfa was the variable
247 that was most positively related to insect abundances. Especially, in summer, the alfalfa had
248 positive effects on the abundance of aphids and their predators and also on the herbivore thrips
249 (*Frankliniella occidentalis* and other Thripidae) (Fig. 4). In addition, the proportion of orchards
250 was the variable with more negative effects on insect abundances. In Fig.5 it can be seen that
251 orchards was negatively related to two predators in spring, but in summer, they were positively
252 related to two herbivores. In spring, the edges were positively related to *Orius spp.*, the main
253 generalist predator in this area, and to *Z. scutellaris*, this predator's main (Fig. 6). Overall, the
254 proportion of cereals in the landscape was poorly related to insects. The winter cereal was
255 positively related to two specialist predators in spring, and the maize was negatively related to
256 *L. striatellus* in summer. In addition, some semi-natural habitats (forest and non-crop habitat)
257 had a minor impact on the abundance of predators and herbivores.

258

259 **3.3. Responses of insects to local variables**

260 The local variables had important effects in both insect groups. Especially, the variables related
261 to the maize phenology and the predator-prey relationship on maize had high effects on insect
262 abundances (see more parsimonious models for predators and herbivores in Appendix 1 and 2
263 and the significant variables in Tables 1 and 2, respectively). The results show that predators
264 depended more on phenology in spring and herbivores in summer. In addition, the
265 perimeter/area of maize fields was positively related to herbivores and especially SHDI-E (a
266 descriptor of flora diversity in the maize edges) was negatively related to *Orius spp.* (Fig. 7) but
267 positively related to its main preys in summer.

268

269 4. Discussion

270 As initially hypothesised, the proportions of orchards and alfalfa fields in the buffer were the
271 most influential landscape variables for maize insect abundance (Fig. 8). We report for the first
272 time results of the effects of orchard cultivation on herbivore and predator species in
273 neighbouring Mediterranean maize crops. Specifically, the proportion of orchards in the
274 landscape had a negative effect on the aphid predators, such as *P. quatuordecimpunctata* and
275 Syrphidae, as well as on Staphylinidae, the second most abundant generalist predator in maize
276 in both seasons. Some authors have seen similar negative relationships between the orchard
277 surfaces and predator abundance (Samnegård et al., 2018; Yang et al., 2018, 2019). Aviron et al.
278 (2016) concluded that intensively managed orchards had negative effects on the amount of
279 natural colonisation of vegetable crops by predatory mirid bugs coming from surrounding plots.
280 In addition, Markó et al. (2017) reported that the toxic effect of chemicals on predators in
281 orchards was masked by the continuous immigration of predators from surrounding crops,
282 mainly arable crops, which explains why the proximity of orchards is associated with a lower
283 amount of aphid predators in arable crops. Indeed, the influence of orchard management
284 practices on natural enemies has been supported by data showing that their abundance and
285 diversity were higher in organic than in non-organic orchards (Happe et al., 2019).
286 In contrast to the observations for predators, the abundance of some herbivores on maize fields
287 was positively related to the proportion of orchards, a feature especially relevant for two
288 homopteran maize pests, *L. striatellus* (in summer) and *Z. scutellaris* (in both seasons). These
289 two homopterans mainly feed on Poaceae, that is, on orchard ground cover (Wang et al., 2009),
290 which provides greater coverage in comparison with the edges close to the maize fields.
291 Orchard ground cover could act as an abundant source of the two species for surrounding crops,
292 as Frei and Mahnhart (1992) found. The close and positive relationship between the orchard
293 proportion and *L. striatellus* abundance on maize is particularly relevant because that is the
294 main vector of Maize Rough Dwarf Virus (MRDV), a common disease in the area (Achon et al.,

295 2013). In the case of *Z. scutellaris*, its higher abundance on maize relative to the higher orchard
296 proportion in the landscape could have positive consequences for maize, as *Z. scutellaris* has
297 been identified as a key prey to facilitate the early establishment of *Orius spp.* on maize
298 (Albajes et al., 2011).

299 The alfalfa surface was a source of predators for maize, mainly aphid predators in summer,
300 confirming the results of previous studies conducted at the field level in the area (Madeira et al.,
301 2014; Núñez, 2002; Pons et al., 2005). Continuous predator movement of Coccinellidae
302 between alfalfa and maize has been shown in the area in summer and, facilitated by regular
303 alfalfa cutting in the season, explains the positive relationship between the proportion of alfalfa
304 in the landscape and the abundance of those predators on maize (di Lascio et al., 2016). The
305 same explanation can be extended to the other aphid predators found on that crop (Madeira et
306 al., 2014; Madeira and Pons, 2015). However, the abundance of maize aphids was found to be
307 related to the proportion of alfalfa, although the two crops do not share aphid species (Asín and
308 Pons, 1998; Pons et al., 2005; Madeira et al., 2014). A possible reason could be the common
309 presence of aphids on *S. halepense* (an invasive weed that is increasingly abundant in
310 agricultural habitats (Juárez-Escario et al., 2018), which grows permanently around irrigation
311 sprinklers in alfalfa fields, and it has been observed as a source of aphid migration from alfalfa
312 to maize. In fact, it is a relevant feature for the epidemiology of *Maize Dwarf Mosaic Virus*
313 (MDMV) and *Sugarcane Mosaic Virus* (SCMV), two important maize viruses vectored by
314 Poaceae aphids (Achon et al., 1996; Peerzada et al., 2017) from the common virus reservoir.
315 Additionally, the proportion of alfalfa is also related to the abundance in both seasons of *F.*
316 *occidentalis* and other herbivores of the Thripidae family on maize. Although thrips rarely are
317 damaging to these crops in this area (Meissle et al., 2010), they serve as prey for some predators
318 such as *Orius spp.* The abundance of *Orius spp.* on maize was significantly related to the
319 amount of potential prey on that crop but not on the alfalfa, according to a previous study in the
320 area (Ardanuy et al., 2018). As reported by these authors, the role of alfalfa in relation to maize
321 is to provide it with an abundant amount of prey to enhance *Orius spp.* establishment (Madeira

322 et al., 2018). We need more studies to test if the positive effect of alfalfa on predator
323 abundances can be hampered by the orchard surface.

324 Edges constitute a non-permanent habitat in the landscape of the study area, especially in annual
325 crops. We did not find weed diversity differences between sampled edges but we found
326 different weed covers that could be more important than the diversity in these habitats. The
327 positive relationship between the edges and the abundance of *Z. scutellaris* and *Orius* spp. is
328 similar to previous results describing the role of edges as a source for both species in the early
329 season (Ardanuy et al., 2018). Thus, the presences of edges are a feature that allows the early
330 establishment of the predator-prey system on the crop and prevents the later development of
331 pest populations in this area, as Albajes et al. (2011) found. Later, the negative relationship of *Z.*
332 *scutellaris* and the proportion of edges in summer is probably because edges become dry, and
333 these species prefer the irrigated cover of orchards.

334 Summer and winter cereals are important components of the landscape in our study region. The
335 proportions of cereals in the buffers studied varied from 0.4% to 50.6% in spring (winter cereal)
336 and 11.2% to 57.1% in summer (mostly maize). However, few relationships were found
337 between insect abundance and the proportion of summer cereals, so that the phenomena of the
338 concentration or dilution of resources do not seem to play an important role in the study area, at
339 least for most of the insects studied, as found by other authors (Otway et al., 2005). Only in the
340 case of *L. striatellus*, for which a negative relationship between its abundance and maize surface
341 in the area was found in summer, can a resource dilution mechanism be postulated, perhaps due
342 to the slow insect population increase during the later development stages of the crop. In
343 contrast, the increased abundance of predators such as *Aeolothrips* spp. And *P.*
344 *quatuordecimpunctata* may be the consequence of higher prey densities resulting from the
345 concentration of developed maize in the landscape in summer. However, this potential
346 mechanism would require further studies. The influence of the proportion of winter cereals on
347 maize insects may occur in spring due to the role of these winter crops as overwintering sites or
348 as a base for early population increase of some insects. In summer, these insects may come from
349 fallows that remain in fields that are not sown again with a summer crop after winter cereal

350 harvesting. *Zyginidia scutellaris* was the only maize herbivore insect related to the amount of
351 winter cereal, and that relationship was significantly negative in spring. This result contrasts
352 with that reported by Ardanuy et al. (2018), who found a significantly positive relationship
353 between the amount of winter cereals and abundance of *Z. scutellaris* on maize in spring. In this
354 case, the authors included the field edges with the surface of winter cereals, which could be the
355 source of the leafhopper for maize in spring. Instead, the greater presence of aphid predators on
356 maize, such as Chrysopidae, in spring could be attributed to the greater abundance of winter
357 cereals because aphids are abundant on winter cereals in spring in the area (Lumbierres et al.,
358 2007). In addition, the greater amount of *Stethorus* spp. On maize in spring in areas with a
359 higher proportion of winter cereals can be explained by the potential abundance of tetranychid
360 mites (Burgio et al., 2004).

361 Non-crop habitats have classically been regarded to enhance the abundance and diversity of
362 natural enemies in the landscape and therefore serve as pest population suppressors (Bianchi et
363 al., 2006 and the review by Gurr et al. (2017)). In this study, the non-crop habitat proportion
364 detected was between 0% min and 26%. However, few significant relationships between the
365 abundance of insects on maize and the proportion of non-crop habitats in the landscape were
366 found. In addition, the low diversity flora of herbaceous plants in non-crop habitats and in edges
367 could have an effect on the maize insects that overwinter in trees or bushes, such as *E. vitis*, as
368 shown by Decante and van Helden (2006). The significantly positive relationship found for the
369 proportion of non-crop habitats and some predators could indicate the roles these non-crop
370 habitats play as a source of predators in our latitudes, although only for a few predatory species.
371 However, this limited role of non-crop habitats may complement the role played by the habitats
372 categorised as edges that have been mentioned above. Forest habitats were a poor source of
373 predators because the diversity of tree species (mostly *P. halepensis*) was low. The forest
374 proportion detected in the buffers showed rather low variation, between 0% and 11.2%. In fact,
375 one of the reasons proposed to explain the limited contribution of non-agricultural habitats on
376 pest suppression has been the relative low proportion of these habitats in the landscape as has
377 been hypothesised by Tschardt et al. (2016). On the other hand, we need more studies to test

378 whether the low effect of semi-natural habitats and edges on predator abundances can be
379 hampered by the orchard surface as found by Ricci et al. (2019).

380 The landscape diversity, as expressed by the Shannon diversity index in the landscape (SHDI-
381 L), showed six significant relationships with maize insects (3 predators and 3 herbivores), all of
382 which were negative. However, much literature on the relationships between landscape diversity
383 and ecosystem services has reported positive values (see the review by Rusch et al., 2016).
384 Some other authors, however, have indicated that landscape diversity itself is not a meaningful
385 characteristic that affects biological control services and pest suppression (f.i. Martin et al.,
386 2016; Rusch et al., 2016; Tschardt et al., 2016; Landis, 2017; Karp et al., 2018). A deeper
387 analysis is probably necessary to understand the relationships between landscape diversity and
388 pest suppression (Médiène et al., 2011; Chisholm et al., 2014).

389 Local variables of sampled maize fields modulated the influence of the landscape on the
390 abundance of the maize insects (Fig. 8). The maize growth stage was the most influential local
391 variable. Most of the significant relationships for predators were positive in spring and negative
392 in summer (abundance of predators increased or decreased, respectively, as the season
393 progressed), whereas the relationships were mostly negative for herbivores (herbivore
394 abundance mostly decreased along both seasons). These insect abundance-crop phenology
395 relationships should prevent us from making definitive conclusions about how the surrounding
396 landscape affects crop insect abundance because this landscape and insect abundance
397 relationship may have temporal patterns rather than being permanent (Raymond et al., 2015) for
398 aphids and their predators. Additionally, coupled predator-prey relationships on the crop were
399 also the most significant variable. Predator-prey relationships may alter the influence of the
400 landscape on crop insect abundance, as seen in this study and in which several of the predators
401 and herbivores recorded were positively related with the abundance of their potential prey and
402 predators, respectively, a feature reported by others (Ardanuy et al., 2018). Other local
403 variables, such as the relation of the perimeter to the area and the diversity in maize field edges,
404 play lesser roles than landscape variables on predators but are noticeable in herbivore insects in
405 summer.

406

407 **5. Conclusions**

408 1. Landscapes dominated by orchards could highly negatively impact the abundance of
409 predators on maize, likely as a result of the intensive management of orchards. In contrast,
410 orchards are a relevant source of homopterans due to the presence of Poaceae in orchard ground
411 cover, especially for vectors of maize virus species.

412 2. The presence of alfalfa in the agricultural landscape enhances the abundance of aphids and
413 their predators in maize crops. Alfalfa also enhances herbivore thrips but not their common
414 predators, such as *Orius* spp. and *Aeolothrips* spp.

415 3. The presence of edges is a relevant feature, especially in the early establishment of prey-
416 predator system of *Z. scutellaris* and *Orius* spp. in spring.

417 4. Semi-natural habitats (non-crop habitats and forest) and landscape diversity play minor role
418 in determining the abundance of insects in Mediterranean maize crops.

419 5. Local variables contribute greatly to explaining insect abundance, especially maize growth
420 stages and the abundance of prey or predators.

421 The results of the present study allow the improvement of maize management practices and the
422 arrangement of landscape composition to enhance biological pest control by the conservation of
423 naturally occurring predators. However, further tests of whether the low effects of semi-natural
424 habitats on naturally occurring predators are due to the intensive orchard management are
425 necessary.

426

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436

437 **Author contribution**

438 G.C.O. collected the data, contributed data and analysis tools, performed the analysis and wrote
439 the paper. F.M. contributed to study design, collected the data and revised the final version. I.B.
440 and S.S collected the data. A.J.E collected the data and revised the final version. R.A.
441 contributed to study design, collected the data, wrote the paper and revised the final version. All
442 authors read and approved the final version of the manuscript.

443

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658

659 Table 1

660 Landscape structure and local variables used in this study.

661

Variables	Categories	Description
Landscape structure	Winter cereals	Proportion of winter cereal (mainly wheat and barley)
	Winter cereal-fallow	Proportion of fallow when winter crop is end (fields under no crop rotation)
	Summer cereals	Proportion of summer cereal (mainly maize)
	Orchard	Proportion of fruits orchards, figs, citrus, dried fruit, vineyard and olive
	Alfalfa	Proportion of alfalfa
	Edges	Proportion of the margin strip (see (Marshall and Moonen, 2002)
	Non-crop habitats	Proportion of no productive areas, longer fallows, natural habitat and waterland
	Forest	Proportion of forest repopulate of <i>Pinus halepensis</i>
Local environment	SHDI-L	Shannon diversity index calculated as landscape diversity in the buffers
	SHDI-E	Shannon diversity index calculated in edges between maize and neighbouring crops*(Marshall and Moonen, 2002)
	Maize phenology	Stage of maize development (Ritchie <i>et al</i> , 1986)
	Perimeter/area	Perimeter to area ratio of the sampled maize field (m ⁻¹)
	Prey/Predator	Abundance of mainly prey and predator by each group of insect

662

663

664 Table 2

665 Model results of the best models relating predator abundance with landscape and local variables.

666 Significant variables in the best models ($\Delta AIC < 2$) are presented. Variables are standardised

667 (mean-centred and scaled). Relative importance is the sum of Akaike's weight associated with

668 the variables in the best models.

669

Specie/Group	Spring season					Summer season				
	Variables	Est.	z value	Pr(> z)	Rel. imp.	Variables	Est.	z value	Pr(> z)	Rel. imp.
<i>Orius spp.</i>	(Intercept)	-2.78	3.34	<0.001		(Intercept)	0.26	0.50	0.61	
	Edges	0.29	2.33	0.019	1	Prey	0.32	7.01	<0.001	1
	Prey	0.77	5.56	<0.001	1	SHDI-E	-0.30	4.62	<0.001	1
	Maize phenology	0.88	7.30	<0.001	1					
<i>Stethorus spp.</i>	(Intercept)	0.31	3.85	<0.001		(Intercept)	1.60	5.95	<0.001	
	Maize phenology	-0.12	2.10	0.036	1	Forest	-0.22	2.00	0.045	1
	Winter cereal	0.15	2.45	0.014	1	Non-crop habitat	0.31	2.19	0.028	1
						Maize phenology	0.33	3.31	<0.001	1
						SHDI-L	-0.29	2.07	0.038	0.89
<i>P. quatuordecimpunctata</i>	(Intercept)	0.52	6.48	<0.001		(Intercept)	0.86	5.72	<0.001	
	Maize phenology	0.31	3.70	<0.001	1	Alfalfa	-0.20	2.27	0.023	1
	Orchard	-0.19	1.93	0.05	0.66	Edges	-0.33	4.35	<0.001	1
						Maize phenology	-0.24	3.59	<0.001	1
						Orchard	-0.18	2.23	0.025	0.59
						Summer cereal	0.18	0.07	0.01	0.41
<i>C. septempunctata</i>	n.a.					(Intercept)	0.01	0.21	0.83	
						Alfalfa	0.02	2.30	0.021	1
Staphylinidae	(Intercept)	-0.54	0.90	0.36		(Intercept)	-0.37	0.96	0.33	
	Prey	0.70	5.03	<0.001	1	Forest	0.18	2.16	0.031	1
	p/a	-0.26	2.71	0.006	1	Prey	0.35	4.58	<0.001	1
	Maize phenology	-0.29	3.74	<0.001	1	p/a	-0.22	2.56	0.011	1
						SHDI-E	-0.21	2.43	0.015	1
						Edges	0.19	2.01	0.044	0.85
						Orchard	-0.17	1.98	0.048	0.64
<i>Aeolothrips spp.</i>	(Intercept)	0.85	1.15	0.25		(Intercept)	-0.71	3.00	0.002	
	Forest	-0.34	2.42	0.015	1	Prey	0.37	7.96	<0.001	1

	Prey	0.33	2.44	0.014	1	Maize phenology	-0.25	3.46	<0.001	1
	p/a	0.39	2.59	0.009	1	Summer cereal	0.24	3.45	<0.001	1
						Fallow-winter cereal	0.15	2.27	0.023	1
Chrysopidae	(Intercept)	0.40	1.99	0.046		(Intercept)	0.82	8.79	<0.001	
	SHDI-L	-0.23	3.12	0.001	1	Edges	-0.16	2.34	0.019	1
	Winter cereal	0.18	2.58	0.009	1	Non-crop habitat	0.30	3.02	0.002	1
	Maize phenology	0.13	1.99	0.046	0.19	p/a	0.14	2.07	0.038	1
						Alfalfa	0.35	2.04	0.041	0.11
Syrphidae	(Intercept)	0.56	3.72	<0.001		(Intercept)	0.03	1.00	0.31	
	Orchard	-0.33	2.08	0.038	0.76	Alfalfa	0.04	2.23	0.025	1
						Prey	0.09	3.62	<0.001	1
						SHDI-L	-0.04	1.96	0.049	0.74

670

671

672 Table 3

673 Model results of the best models relating herbivore abundance with landscape and local
 674 variables. Significant variables in the best models ($\Delta AIC < 2$) are presented. Variables are
 675 standardised (mean-centred and scaled). Relative importance is the sum of Akaike's weight
 676 associated with the variables in the best models.

677

Specie/Group	Spring season					Summer season				
	Variables	Est.	z value	Pr(> z)	Rel. imp.	Variables	Est.	z value	Pr(> z)	Rel. imp.
<i>F. occidentalis</i>	(Intercept)	2.59	2.05	0.04		(Intercept)	2.14	3.04	0.002	
	Predator	0.64	2.55	0.011	1	Alfalfa	0.24	2.66	0.007	1
						Edges	-0.24	2.19	0.028	1
						Predator	0.91	8.68	<0.001	1
						Maize phenology	-0.51	4.92	<0.001	1
						SHDI-E	0.41	4.11	<0.001	1
						SHDI-L	-0.25	2.00	0.045	1
					Winter cereal-fallow	-0.18	2.01	0.044	1	
Other Thripidae	(Intercept)	3.39	3.44	<0.001		(Intercept)	0.12	0.32	0.74	
	Maize phenology	-0.67	3.95	<0.001	1	Alfalfa	0.17	2.35	0.018	1
	Alfalfa	0.46	2.56	0.011	0.96	Predator	0.61	6.89	<0.001	1
						Maize phenology	-0.36	4.24	<0.001	1
						SHDI-E	0.17	2.10	0.035	0.84
						SHDI-L	-0.18	1.95	0.051	1
						Winter cereal-fallow	-0.21	2.73	0.006	1
<i>Z. scutellaris</i>	(Intercept)	2.27	2.63	0.008		(Intercept)	2.24	3.95	<0.001	
	Edges	0.47	2.75	0.005	1	Edges	-0.32	2.21	0.02	1
	Predator	0.60	2.22	0.026	1	Predator	0.49	3.27	0.001	1
	Winter cereal	-0.41	2.30	0.021	0.64	Orchard	0.29	2.30	0.021	1
	Orchard	0.42	1.91	0.05	0.51	p/a	0.29	2.32	0.021	1
						Maize phenology	-0.57	4.11	<0.001	1
						SHDI-E	0.26	2.00	0.045	0.77
<i>E. vitis</i>	(Intercept)	1.86	4.28	<0.001		(Intercept)	0.86	2.51	0.012	
	Non-crop habitat	0.57	2.59	0.009	1	Predator	0.40	4.18	<0.001	1
	Maize phenology	-0.35	2.16	0.031	1	p/a	0.20	2.31	0.021	1
	SHDI-L	-0.44	2.03	0.042	1					

<i>L. striatellus</i>	(Intercept)	0.62	0.72	0.47		(Intercept)	1.41	4.12	<0.001	
	Predator	0.56	2.32	0.02	1	p/a	0.20	2.54	0.011	1
	Maize phenology	0.39	2.44	0.014	1	Maize phenology	-0.37	4.26	<0.001	1
						Predator	0.25	2.73	0.006	0.92
						Non-crop habitat	-0.25	2.22	0.026	0.81
						Summer cereal	-0.30	2.51	0.012	0.67
					Orchard	0.28	2.06	0.039	0.61	
<hr/>										
Aphididae	(Intercept)	2.96	6.72	<0.001		(Intercept)	1.02	7.63	<0.001	
	Maize phenology	-0.97	5.70	<0.001	1	Maize phenology	-0.14	2.33	0.02	1
						Alfalfa	0.13	1.96	0.05	0.83

678

679 Figures.

680 Fig. 1. A. Study region in the Ebro Basin in north-eastern Spain. B. Landscape sampled (2015,
681 2016 and 2017). C. The star point indicates the middle sticky trap in the maize field.
682 Additionally, the different orchard proportions are shown in the landscapes.

683

684 Fig. 2. Abundances of herbivores and predators trapped during the study in spring and summer.

685

686 Fig. 3. Flora abundance and composition survey in maize field edges. A. Mean percentage of
687 edge cover by flora in sampled maize fields and H' according to field neighbouring crop. B.
688 Flora were grouped into dicotyledons and monocotyledons.

689

690 Fig. 4. Effects of the proportion of alfalfa (spring and summer) on the abundance of predators
691 (*P. quatuordecimpunctata*, *C. septempunctata*, Chrysopidae, Syrphidae) and herbivores (other
692 Thripidae, *F. occidentalis* and Aphididae).

693

694 Fig. 5. Effects of the percentage of orchard (spring and summer) in the landscape on the
695 abundance of predators (*P. quatuordecimpunctata*, Staphylinidae, Syrphidae) and herbivores (*Z.*
696 *scutellaris* and *L. striatellus*).

697

698 Fig. 6. Effects of the proportion of edges in the landscape on the abundance of the predator
699 *Orius spp.* and its main prey, *Z. scutellaris*.

700

701 Fig. 7. Effect of SHDI-E on the abundance of the predator *Orius spp.*

702

703 Fig. 8. Significant effects of local and landscape structure variables on each insect group
704 detected. Size of squares indicates the number of relations of the variables with predators or
705 herbivores group.

Figure 1

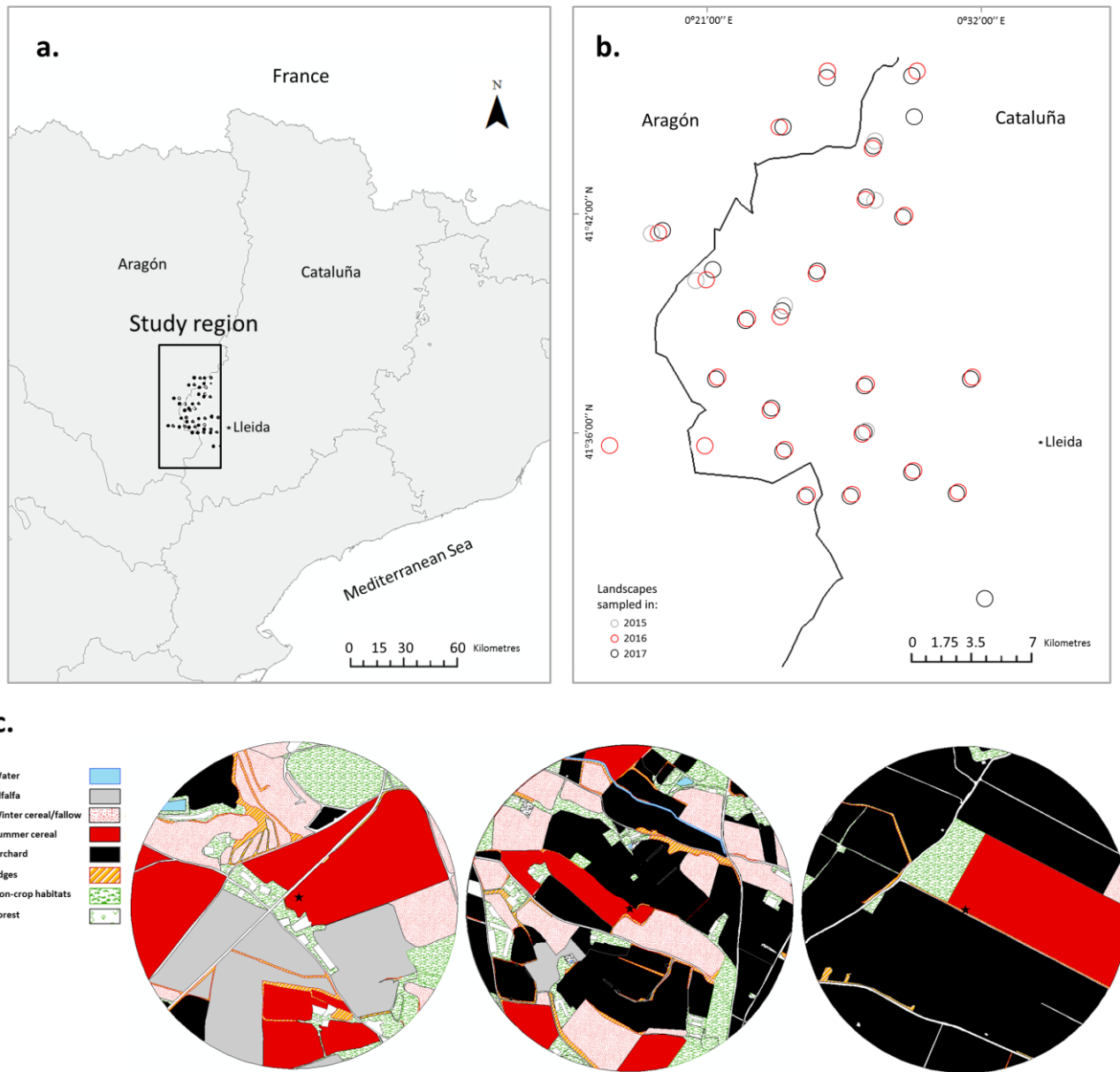


Figure 2

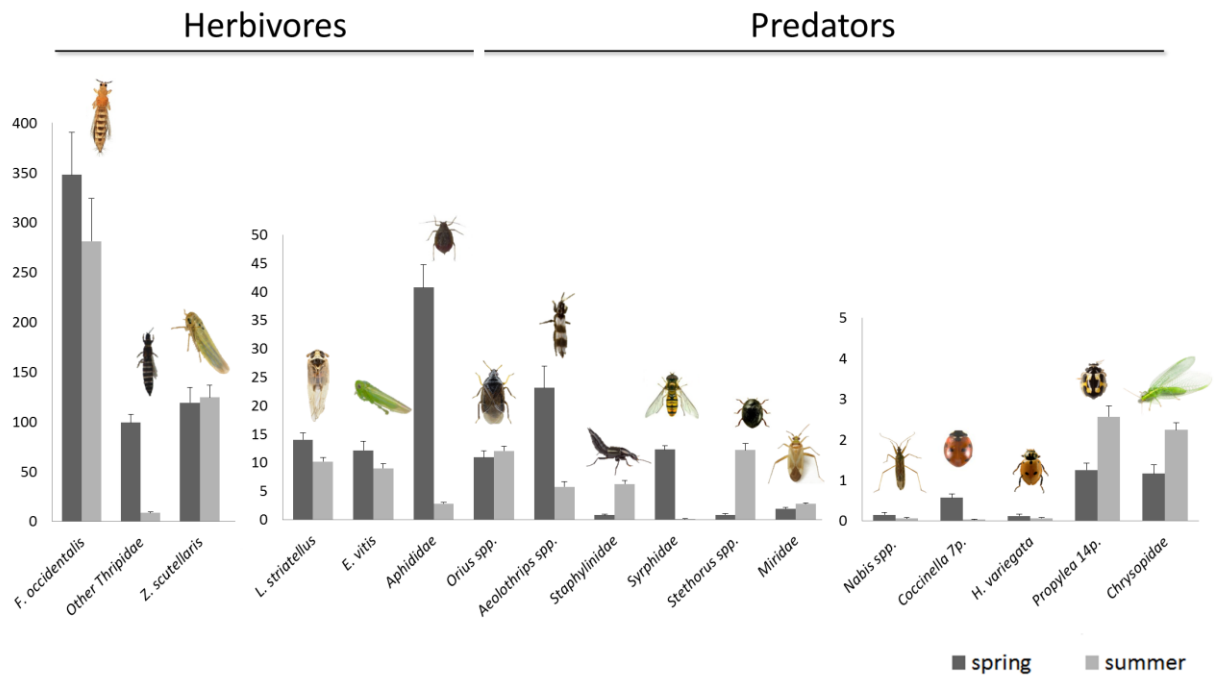
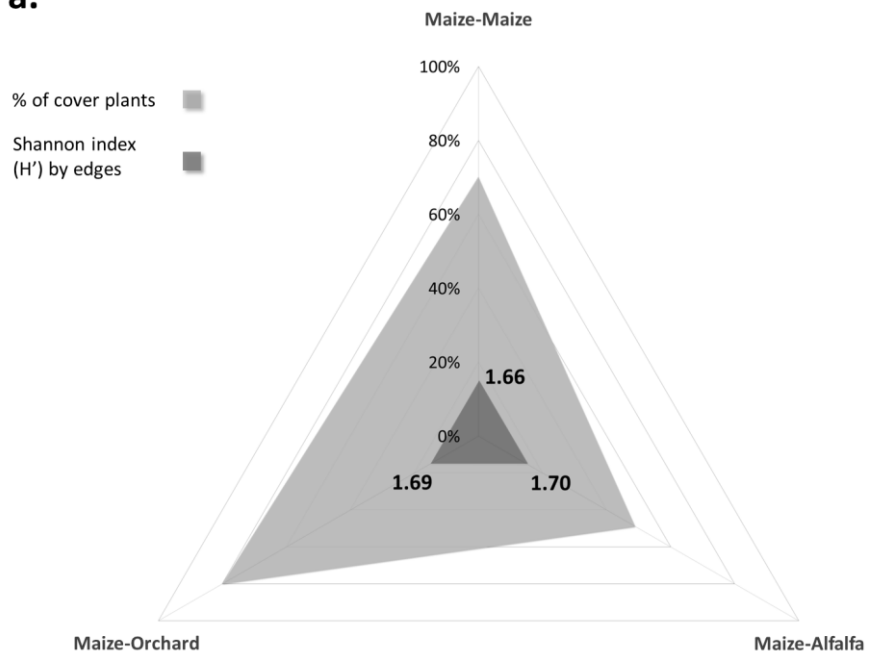


Figure 3

a.



b.

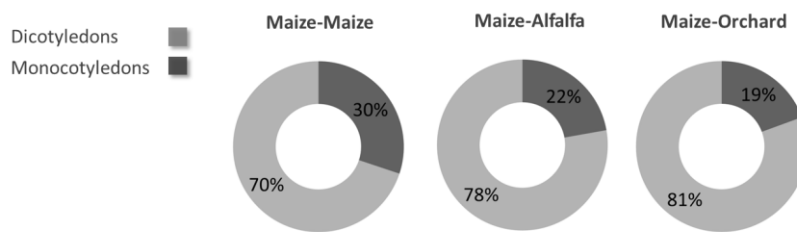
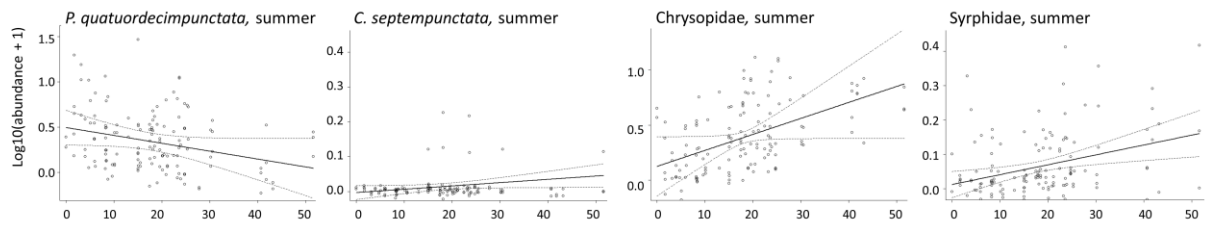


Figure 4

Predators



Herbivores

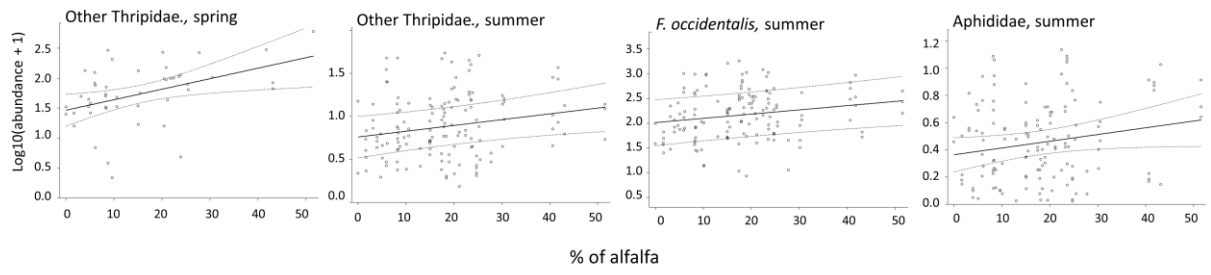
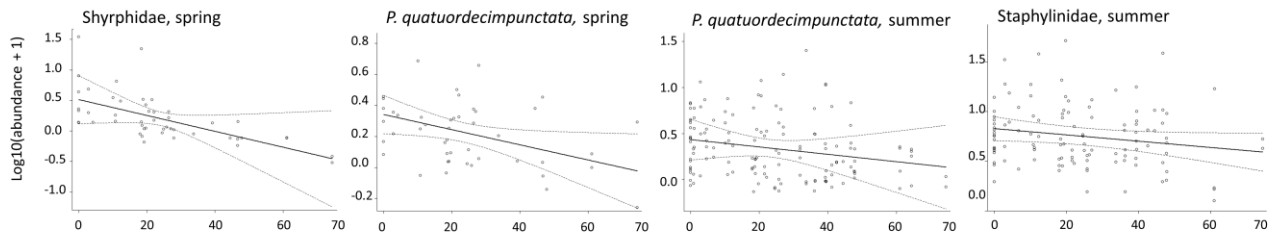


Figure 5

Predators



Herbivores

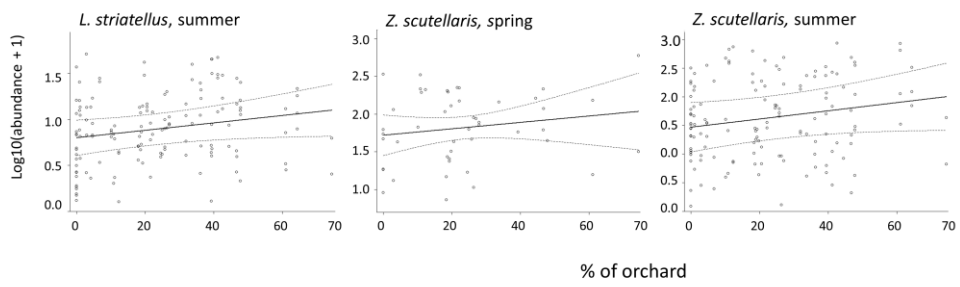


Figure 6

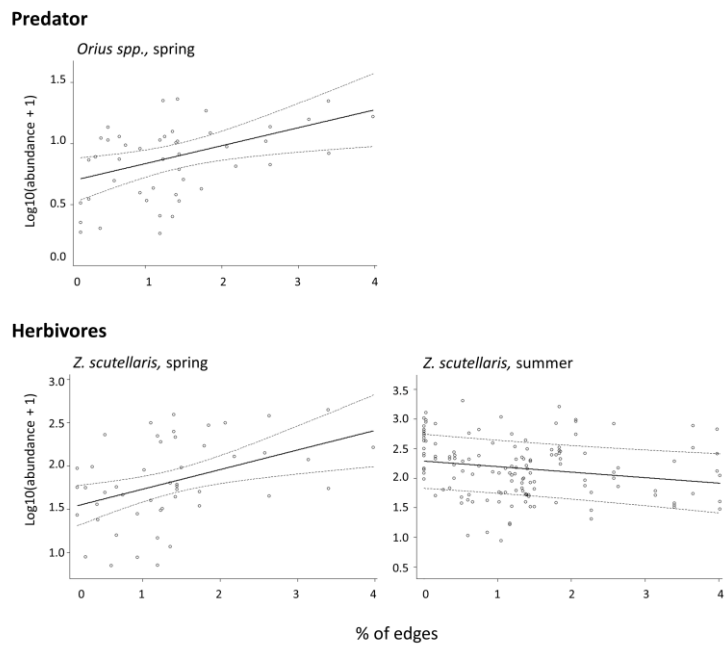


Figure 7

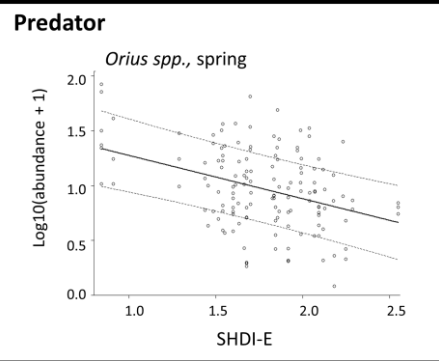
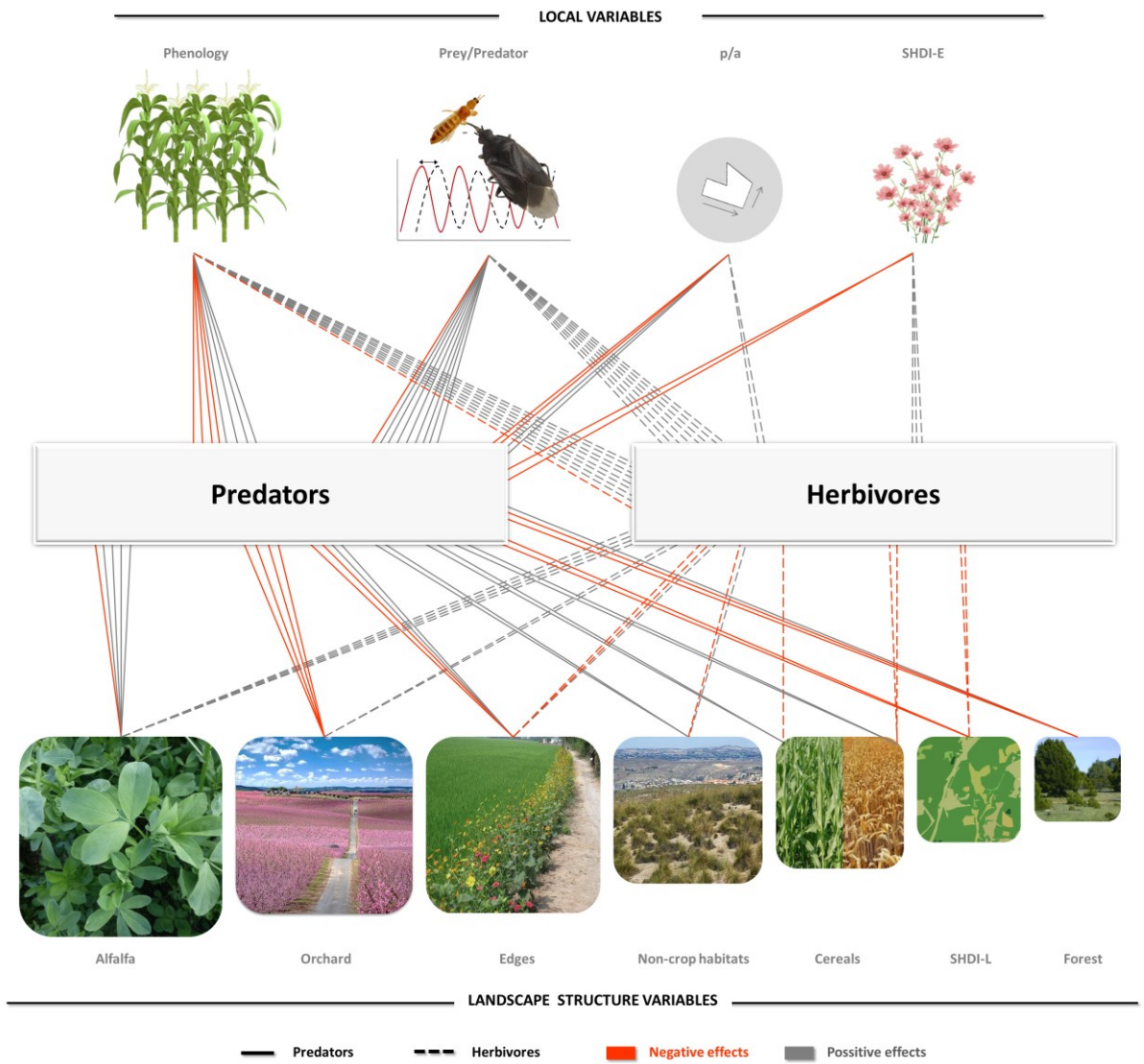


Figure 8



706

1. Specific information on coordinates, area size and sampling date for selected maize fields.

Site	Year	Latitude	Longitude	Field area (ha)	1 sampling	2 sampling	3 sampling	4 sampling
1	2015	41.5964056	0.49829722	4.78	16-June	14-jul	10-August	31-August
2	2015	41.7637278	0.48048889	8.26	16-June	15-jul	10-August	31-August
3	2015	41.6813139	0.4143	6.39	16-June	16-jul	10-August	31-August
4	2015	41.7374056	0.47555556	2.10	16-June	17-jul	10-August	31-August
5	2015	41.7005917	0.36340278	5.43	16-June	18-jul	10-August	31-August
6	2015	41.7247139	0.33173889	8.99	16-June	19-jul	10-August	31-August
7	2016	41.7255639	0.50210556	10.02		6-July	10-August	5-September
8	2016	41.5841333	0.52859722	3.54		6-July	10-August	5-September
9	2016	41.5964056	0.49829722	1.19		6-July	10-August	5-September
10	2016	41.6157278	0.46467778	4.78		6-July	10-August	5-September
11	2016	41.7758694	0.41687222	2.26		6-July	10-August	5-September
12	2016	41.8012833	0.45139444	2.13	8-June	6-July	10-August	5-September
13	2016	41.6158667	0.29285	0.90	8-June	6-July	10-August	5-September
14	2016	41.7637278	0.48048889	8.26	8-June	6-July	10-August	5-September
15	2016	41.6413028	0.46846389	2.56	8-June	6-July	10-August	5-September
16	2016	41.6298361	0.40223333	7.00	8-June	6-July	10-August	5-September
17	2016	41.6813139	0.4143	6.39	8-June	6-July	10-August	5-September
18	2016	41.6476667	0.36586944	3.12	8-June	6-July	10-August	5-September
19	2016	41.6424778	0.54061667	2.03	8-June	6-July	10-August	5-September
20	2016	41.7374056	0.47555556	2.10		6-July	10-August	5-September
21	2016	41.5857222	0.45993056	6.13	8-June	6-July	10-August	5-September
22	2016	41.6091889	0.41255	6.89	8-June	6-July	10-August	5-September
23	2016	41.6128111	0.35600278	4.84	8-June	6-July	10-August	5-September
24	2016	41.6758	0.38911667	4.57	8-June	6-July	10-August	5-September
25	2016	41.7005917	0.36340278	5.43	8-June	6-July	10-August	5-September
26	2016	41.5852111	0.42567222	10.71	8-June	6-July	10-August	5-September
27	2016	41.8014694	0.50940278	2.30	8-June	6-July	10-August	5-September
28	2016	41.7001278	0.43849444	5.00	8-June	6-July	10-August	5-September
29	2016	41.7247139	0.33173889	8.99	8-June	6-July	10-August	5-September
30	2017	41.7255639	0.50210556	10.00			10-August	6-September
31	2017	41.5841333	0.52859722	3.54			10-August	6-September
32	2017	41.5964056	0.49829722	1.19			10-August	6-September
33	2017	41.6157278	0.46467778	4.78			10-August	6-September
34	2017	41.7758694	0.41687222	2.26	08-may	22-June	10-August	6-September
35	2017	41.8034167	0.45074167	2.68			10-August	6-September
36	2017	41.7779667	0.50997222	13.68	08-may	22-June	10-August	6-September
37	2017	41.7637278	0.48048889	8.42	09-may	22-June	10-August	6-September
38	2017	41.6413028	0.46846389	2.56	10-may	22-June	10-August	6-September
39	2017	41.5284861	0.54404167	12.96	11-may	22-June	10-August	6-September
40	2017	41.6298361	0.40223333	3.82	12-may	22-June	10-August	6-September
41	2017	41.6813139	0.4143	5.67	13-may	22-June	10-August	6-September
42	2017	41.6476667	0.36586944	3.12	14-may	22-June	10-August	6-September
43	2017	41.6424778	0.54061667	2.03			10-August	6-September
44	2017	41.7374056	0.47555556	2.10	14-may	22-June	10-August	6-September
45	2017	41.5851583	0.45881667	1.38	15-may	22-June	10-August	6-September
46	2017	41.6091889	0.41255	6.80	16-may	22-June	10-August	6-September
47	2017	41.6752111	0.38916944	4.64	17-may	22-June	10-August	6-September
48	2017	41.7016917	0.36513611	3.68	18-may	22-June	10-August	6-September
49	2017	41.5855361	0.42595556	7.54	19-may	22-June	10-August	6-September
50	2017	41.7996694	0.50986389	4.26	20-may	22-June	10-August	6-September
51	2017	41.7001278	0.43849444	9.05	21-may	22-June	10-August	6-September
52	2017	41.7247139	0.33173889	8.99	22-may	22-June	10-August	6-September

708
709

710 **2.** Summary statistics (mean, SE, minimum and maximum) of landscape proportion variables in
711 spring and summer (alfalfa, winter cereal, fallow-winter cereal, summer cereal, orchard, edges,
712 non-crop habitat and forest), perimeter to area in maize fields (m⁻¹), Shannon index (SHDI-L
713 and SHDI-E) and maize phenology (stage of development followed Ritchie *et al.* 1992).
714 Variables were measured around each selected maize field in 500m of radii circle in northern
715 Spain in 2015, 2016 and 2017.

	Variable	Mean	Max.	Min.	SE
Spring	Alfalfa	16.56	51.58	0.00	2.18
	Winter cereal	22.86	50.65	0.37	2.38
	Summer cereal	19.26	49.93	0.00	2.24
	Orchard	22.95	74.41	0.00	3.07
	Edges	1.46	3.98	0.15	0.17
	Non-crop habitat	8.45	25.96	0.90	0.90
	Forest	2.10	11.24	0.00	0.59
	p/a	0.02	0.08	0.01	0.00
	SHDI-L	1.71	2.15	0.87	0.05
	SHDI-E	1.91	2.55	1.44	0.05
	Maize phenology			VT-R1	V3-V5
Summer	Alfalfa	17.34	51.58	0.00	1.56
	Fallow-winter cereal	9.57	40.39	0.00	1.31
	Summer cereal	31.83	57.08	11.23	2.05
	Orchard	23.74	74.41	0.00	2.73
	Edges	1.36	4.02	0.15	0.15
	Non-crop habitat	8.80	33.07	0.32	0.91
	Forest	1.90	11.24	0.00	0.47
	p/a	0.03	0.08	0.01	0.00
	SHDI-L	1.67	2.15	0.87	0.04
	SHDI-E	1.79	2.55	0.84	0.05
	Maize phenology			R5-R6	V6-V13

716

717 3. The abundances of potential predators (for herbivores) and abundances of potential prey (for
 718 predators) trapped with sticky yellow traps and it used as local variables in the models.

Potential predator	Potential prey (herbivores)
<i>P.</i>	
<i>quatuordecimpunctata</i>	Aphididae
<i>C. septempunctata</i>	Aphididae
Chrysopidae	Aphididae
Syrphidae	Aphididae
<i>H. variegata</i>	Aphididae
<i>Stethorus spp.</i>	Specialist of <i>Tetranychus spp.</i> No included any prey in the model
<i>Orius spp.</i>	Aphididae, <i>F. occidentalis</i> , other Thripidae, <i>Z. scutellaris</i> , <i>E. vitis</i> and <i>L. striatellus</i>
Staphylinidae	Aphididae, <i>F. occidentalis</i> , other Thripidae, <i>Z. scutellaris</i> , <i>E. vitis</i> and <i>L. striatellus</i>
<i>Aeolothrips spp.</i>	<i>F. occidentalis</i> and other Thripidae
Nabidae	Aphididae, <i>F. occidentalis</i> , other Thripidae, <i>Z. scutellaris</i> , <i>E. vitis</i> and <i>L. striatellus</i>
Miridae	Phytophagous. No included any prey in the model

719
 720

721 **4. Correlations between variables**
 722 Spearman rank correlation coefficients (Spearman's rho) between landscape composition,
 723 landscape structure and local environment within 500m diameter landscape buffer around
 724 sampled maize fields. Significant at: * $p < 0.05$; ** $p < 0.01$.

Spring season	Alfalfa	Winter cereal	Summer cereal	Orchard	Edges	Non-crop habitat	Forest	SHDI-L	Maize phenology
Alfalfa	1								
Winter cereal	-0.12	1							
Summer cereal	-0.04	-0.14	1						
Orchard	-0.51**	-0.33*	-0.42**	1					
Edges	-0.20	-0.03	-0.05	0.12	1				
Non-crop habitat	-0.25	-0.11	-0.24	0.08*	0.08	1			
Forest	0.17	-0.22	-0.25	0.09	0.19	0.05	1		
SHDI-L	-0.15	0.21	-0.18	-0.17	0.28**	0.63**	0.20	1	
Maize phenology	-0.08	-0.01	-0.09	0.17	-0.15	0.17	-0.01	0.06	1
SHDI-E	-0.04	0.16	0.22	-0.24*	-0.03	-0.05	0.09	0.13	-0.08
p/a	-0.14	0.06	-0.06	-0.07	0.39**	0.40**	-0.01	0.33**	-0.04

Summer season	Alfalfa	Fallow-winter cereal	Summer cereal	Orchard	Edges	Non-crop habitat	Forest	SHDI-L	Maize phenology
Alfalfa	1								
Fallow-winter cereal	-0.01	1							
Summer cereal	-0.13*	0.18	1						
Orchard	-0.37**	-0.46**	-0.64**	1					
Edges	-0.18*	-0.18*	-0.05	0.15	1				
Non-crop habitat	-0.35**	-0.12	-0.18*	0.10*	0.19**	1			
Forest	0.23**	-0.07	-0.28	-0.04	-0.07	0.05	1		
SHDI-L	-0.15	-0.12	-0.34**	0.11**	0.34**	0.63**	0.27	1	
Maize phenology	-0.01	-0.10	0.08	-0.06	-0.22	0.12	0.10	-0.01	1
SHDI-E	-0.03	-0.29	-0.08	0.03	0.12	0.24**	0.33**	0.41**	0.24
p/a	-0.15	0.04	-0.06	0.04*	0.37**	0.23	-0.19	0.27**	-0.09

725
 726 Values of $|\text{rho}| \leq 0.39$, 0.4 and 0.59, \geq were considered respectively as weak and moderate
 727 (Campbell & Swinscow 2009).
 728 Campbell, M.J. & Swinscow, T.D.V. (2009) *Statistics at Square One*, 11th Edition. Wiley-
 729 Blackwell, Chichester, West Sussex.
 730

731 5. Moran's Index (correlation coefficient) calculated in predator and herbivores groups sampled
 732 with sticky yellow traps in 52 points during 3 years in northeastern Spain.

	Specie/Group	Moran's I (observed)	p-value
Predators	<i>Orius spp.</i>	-0.0257	0.9127
	<i>Stethorus spp.</i>	0.0233	0.4459
	<i>P. quatuordecimpunctata</i>	0.0676	0.1252
	<i>C. septempunctata</i>	-0.0410	0.6843
	Staphylinidae	-0.0612	0.4814
	<i>Aeolothrips spp.</i>	-0.0923	0.1103
	Chrysopidae	-0.0200	0.9948
	Syrphidae	0.0091	0.4516
	Nabidae	-0.0183	0.9612
	<i>H. variegata</i>	-0.0087	0.7838
	Miridae	0.0004	0.7327
Herbivores	<i>Frankliniella spp.</i>	-0.0246	0.9256
	Other Thripidae	0.0752	0.1013
	<i>Z. scutellaris</i>	-0.0180	0.9788
	<i>E. vitis</i>	-0.0630	0.4565
	<i>L. striatellus</i>	0.0523	0.2255
	Aphididae	-0.0083	0.8439

733

734

735

736 1. Most parsimonious model results of the best models explaining predators abundance
 737 (log₁₀(x+1) transformed). All variables present in the best models ($\Delta AIC < 2$) are presented;
 738 significant *p* values are in bold characters. Abundance was calculated as average of three traps
 739 by field, 6 fields in 2015 and 23 fields in 2016 and 2017. All explanatory variables are
 740 standardised (mean-centred and scaled).

Specie/Group	Spring season						Sumer season							
	Variables best model	Est.	SE	z	Pr(> z)	Relative importance	N containing model	Variables best model	Est.	SE	z	Pr(> z)	Relative importance	N containing model
<i>Orius spp.</i>	(Intercept)	-2.78	0.81	3.34	0.000828			(Intercept)	0.26	0.51	0.50	0.6166		
	Edges	0.29	0.12	2.33	0.019992	1	2	Prey	0.32	0.05	7.01	<2e-16	1	15
	Prey	0.77	0.13	5.56	3.00E-08	1	2	SHDI-E	-0.30	0.06	4.62	3.80E-06	1	15
	Maize phenology	0.88	0.12	7.30	<2e-16	1	2	Orchard	-0.11	0.06	1.83	0.0675	0.77	11
	Forest	-0.22	0.12	1.85	0.064499	0.69	1	Edges	0.11	0.07	1.55	0.1208	0.57	8
<i>Stethorus spp.</i>	(Intercept)	0.31	0.08	3.85	0.000117			(Intercept)	1.60	0.27	5.95	<2e-16		
	Maize phenology	-0.12	0.06	2.10	0.036098	1	5	Forest	-0.22	0.11	2.00	0.045489	1	6
	Winter cereal	0.15	0.06	2.45	0.014466	1	5	Non-crop habitat	0.31	0.14	2.19	0.028752	1	6
	SHDI-L	-0.08	0.08	1.02	0.306267	0.3	2	Maize phenology	0.33	0.10	3.31	0.000947	1	6
	Edges	-0.05	0.06	0.90	0.366216	0.17	1	SHDI-L	-0.29	0.14	2.07	0.038312	0.89	5
	Forest	-0.05	0.06	0.78	0.437193	0.16	1	SHDI-E	0.18	0.11	1.63	0.103758	0.7	4
	Non-crop habitat	0.12	0.08	1.47	0.141906	0.14	1	Orchard	-0.17	0.09	1.83	0.067859	0.6	3
								Summer cereal	0.15	0.11	1.39	0.164354	0.25	2
								Alfalfa	0.15	0.10	1.44	0.150366	0.12	1
<i>P. quatuordecimp.</i>	(Intercept)	0.52	0.08	6.48	<2e-16			(Intercept)	0.86	0.15	5.72	<2e-16		
	Maize phenology	0.31	0.08	3.70	0.000218	1	9	Alfalfa	-0.20	0.09	2.27	0.023353	1	9
	Orchard	-0.19	0.10	1.93	0.053668	0.66	5	Edges	-0.33	0.08	4.35	1.37E-05	1	9
	Edges	0.12	0.08	1.50	0.134001	0.45	4	Maize phenology	-0.24	0.07	3.59	0.000328	1	9
	Alfalfa	-0.16	0.09	1.69	0.09027	0.4	3	SHDI-L	0.13	0.08	1.72	0.086029	0.61	5
	Summer cereal	0.11	0.08	1.34	0.17946	0.15	2	Orchard	-0.18	0.08	2.23	0.025961	0.59	6
	Forest	0.08	0.08	0.96	0.337007	0.08	1	Summer cereal	0.18	0.07	2.58	0.009838	0.41	3
<i>C. septempunctata</i>	(Intercept)	0.48	0.24	1.95	0.0507			(Intercept)	0.00	0.02	0.21	0.832		
	Non-crop habitat	-0.16	0.09	1.67	0.0951	0.66	11	Alfalfa	0.02	0.01	2.30	0.0215	1	7
	Forest	-0.13	0.09	1.50	0.1343	0.41	7	Prey	0.02	0.01	1.67	0.0954	0.84	6
	Orchard	-0.11	0.08	1.24	0.2152	0.18	3	Summer cereal	0.01	0.01	1.04	0.2971	0.13	1
	Alfalfa	0.11	0.09	1.21	0.2262	0.26	5	Orchard	-0.01	0.01	0.94	0.3479	0.13	1
	SHDI-L	0.12	0.11	1.05	0.293	0.11	2	Non-crop habitat	-0.01	0.01	0.93	0.3506	0.13	1
	Prey	0.05	0.06	0.89	0.3749	0.09	2	Forest	-0.01	0.01	0.60	0.5469	0.1	1
	Winter cereal	0.09	0.09	1.03	0.3038	0.09	2	Edges	-0.01	0.01	0.52	0.6022	0.1	1
Staphylinidae	(Intercep	-0.54	0.58	0.90	0.365992			(Intercep	-0.37	0.38	0.96	0.3373		
	Prey	0.70	0.14	5.03	5.00E-07	1	11	Forest	0.18	0.08	2.16	0.0308	1	9
	p/a	-0.26	0.09	2.71	0.006684	1	11	Prey	0.35	0.08	4.58	4.70E-06	1	9
	Maize phenology	-0.29	0.07	3.74	0.000184	1	11	p/a	-0.22	0.09	2.56	0.0106	1	9
	Edges	-0.15	0.08	1.87	0.062003	0.61	6	SHDI-E	-0.21	0.09	2.43	0.0152	1	9
	SHDI-L	0.17	0.09	1.83	0.066619	0.61	6	Maize phenology	-0.20	0.11	1.88	0.0607	0.86	8
	Winter cereal	0.10	0.08	1.31	0.188725	0.22	3	Edges	0.19	0.09	2.01	0.0442	0.85	7
	SHDI-E	0.09	0.07	1.26	0.208818	0.17	2	Orchard	-0.17	0.08	1.98	0.0482	0.64	5
	Non-crop habitat	-0.13	0.10	1.35	0.176119	0.1	1	Alfalfa	-0.15	0.09	1.70	0.0892	0.41	3
	Orchard	-0.12	0.07	1.57	0.116711	0.08	1	Non-crop habitat	0.11	0.08	1.33	0.1843	0.19	2
								Summer cereal	0.15	0.09	1.65	0.0998	0.19	2

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Specie/Group	Spring season					Sumer season					Relative importance	N containing model		
	Variables best model	Est.	SD	z	Pr(> z)	Variables best model	Est.	SD	z	Pr(> z)				
Chrysopidae	(Intercept)	0.40	0.20	1.99	0.04682	(Intercept)	0.82	0.09	8.79	<2e-16				
	SHDI-L	-0.23	0.07	3.12	0.00178	1	8	Edges	-0.16	0.07	2.34	0.01912	1	16
	Winter cereal	0.18	0.07	2.58	0.00982	1	8	Non-crop habitat	0.30	0.10	3.02	0.00254	1	16
	Forest	0.10	0.07	1.42	0.15627	0.35	3	p/a	0.14	0.07	2.07	0.03847	1	16
	Edges	0.09	0.07	1.27	0.20415	0.31	3	Orchard	0.21	0.24	0.85	0.39557	0.62	10
	Maize phenology	0.13	0.07	1.99	0.04677	0.19	6	SHDI-L	-0.14	0.08	1.70	0.0901	0.57	8
	Alfalfa	0.09	0.07	1.25	0.21021	0.18	2	Prey	0.11	0.08	1.26	0.20954	0.3	5
							Summer cereal	0.27	0.25	1.07	0.28536	0.26	5	
							Fallow-winter cereal	0.17	0.17	0.94	0.34592	0.26	3	
							Forest	-0.05	0.07	0.79	0.42844	0.14	3	
							Alfalfa	0.35	0.17	2.04	0.04151	0.11	2	
Syrphidae	(Intercept)	0.56	0.15	3.72	0.0002			(Intercept)	0.03	0.03	1.00	0.315352		
	Orchard	-0.33	0.16	2.08	0.038	0.76	16	Alfalfa	0.04	0.02	2.23	0.025919	1	10
	Alfalfa	0.27	0.14	1.83	0.0679	0.56	12	Prey	0.09	0.02	3.62	0.000292	1	10
	Non-crop habitat	-0.21	0.12	1.60	0.1091	0.45	10	SHDI-L	-0.04	0.02	1.96	0.049613	0.74	7
	Maize phenology	-0.16	0.12	1.26	0.2068	0.31	8	Forest	-0.02	0.02	1.25	0.212244	0.27	3
	SHDI-L	-0.22	0.12	1.69	0.0919	0.27	6	Non-crop habitat	-0.03	0.02	1.21	0.225286	0.26	3
	Summer cereal	-0.17	0.14	1.19	0.2336	0.13	3	p/a	-0.02	0.02	1.12	0.263375	0.18	2
	Winter cereal	-0.21	0.14	1.40	0.1609	0.09	2	Fallow-winter cereal	0.01	0.02	0.64	0.524696	0.08	1
	Prey	-0.11	0.10	1.17	0.2432	0.03	1	Maize phenology	-0.01	0.02	0.62	0.538462	0.08	1
SHDI-E	0.13	0.11	1.10	0.2711	0.03	1	Orchard	-0.01	0.02	0.53	0.599379	0.08	1	
Aeolothrips spp.	(Intercept)	0.85	0.72	1.15	0.25007			(Intercept)	-0.71	0.23	3.00	0.002678		
	Forest	-0.34	0.14	2.42	0.01573	1	4	Prey	0.37	0.05	7.96	<2e-16	1	8
	Prey	0.33	0.13	2.44	0.01475	1	4	Maize phenology	-0.25	0.07	3.46	0.000533	1	8
	p/a	0.39	0.15	2.59	0.00962	1	4	Summer cereal	-0.24	0.07	3.45	0.000559	1	8
	SHDI-E	-0.16	0.14	1.15	0.25049	0.23	1	Fallow-winter cereal	0.15	0.06	2.27	0.023068	1	8
	Edges	-0.15	0.15	0.97	0.33125	0.18	1	Forest	-0.12	0.07	1.75	0.079378	0.77	6
	Alfalfa	-0.14	0.15	0.92	0.35763	0.17	1	SHDI-L	0.13	0.07	1.84	0.066066	0.77	6
								p/a	0.11	0.06	1.65	0.098715	0.61	5
							Edges	-0.08	0.07	1.01	0.312484	0.19	2	
							Orchard	0.07	0.11	0.69	0.487675	0.09	1	
Nabidae	(Intercept)	1.93	0.49	3.85	0.000119			(Intercept)	-0.06	0.07	0.79	0.429		
	Prey	-0.29	0.07	3.84	0.000124	1	5	Prey	0.03	0.01	2.14	0.0325	1	7
	Winter cereal	-0.10	0.06	1.68	0.092569	0.71	4	Alfalfa	0.03	0.02	1.86	0.0635	0.88	6
	p/a	0.05	0.06	0.83	0.405554	0.14	1	p/a	-0.01	0.02	0.65	0.518	0.12	2
	Forest	-0.05	0.06	0.87	0.386231	0.13	1	Edges	-0.01	0.02	0.59	0.5569	0.12	1
	SHDI-L	0.04	0.06	0.69	0.491456	0.12	1	Fallow-winter cereal	0.01	0.02	0.60	0.5505	0.12	1
							Non-crop habitat	-0.01	0.02	0.56	0.5767	0.12	1	
							Summer cereal	0.01	0.02	0.51	0.6138	0.11	1	
Miridae	(Intercept)	0.95	0.29	3.14	0.00169			(Intercept)	0.90	0.25	3.58	0.000349		
	Non-crop habitat	-0.15	0.10	1.48	0.13983	0.32	3	SHDI-E	-0.23	0.06	3.84	0.000125	1	21
	Summer cereal	-0.11	0.10	1.04	0.29916	0.16	2	SHDI-L	0.18	0.07	2.49	0.012834	1	21
	p/a	-0.08	0.10	0.80	0.42378	0.08	1	Maize phenology	-0.11	0.05	2.00	0.04594	0.96	20
	SHDI-E	0.08	0.10	0.81	0.4163	0.07	1	Orchard	0.11	0.08	1.37	0.171541	0.54	11
	Maize phenology	0.08	0.10	0.77	0.44164	0.14	2	Non-crop habitat	-0.10	0.07	1.34	0.18059	0.35	8
	Winter cereal	0.07	0.10	0.68	0.4972	0.07	1	Alfalfa	0.10	0.07	1.32	0.187083	0.28	6
	Alfalfa	0.08	0.10	0.76	0.44877	0.07	1	p/a	0.06	0.05	1.07	0.285957	0.28	7
	SHDI-L	-0.06	0.10	0.58	0.56387	0.07	1	Fallow-winter cereal	-0.07	0.06	1.14	0.253781	0.17	4
							Summer cereal	0.04	0.13	0.30	0.761093	0.17	4	
H. variegata	(Intercept)	0.58	0.22	2.61	0.00903			(Intercept)	0.02	0.03	0.75	0.453747		
	Prey	-0.14	0.07	2.02	0.04374	1	13	Maize phenology	-0.05	0.01	3.69	0.000222	1	16
	Maize phenology	-0.15	0.11	1.28	0.20062	0.28	4	Prey	0.03	0.02	1.75	0.080755	0.78	12
	Non-crop habitat	-0.12	0.09	1.27	0.20277	0.23	3	SHDI-E	-0.02	0.01	1.47	0.142096	0.45	7
	Orchard	-0.11	0.09	1.21	0.22645	0.22	3	Orchard	-0.02	0.01	1.40	0.162412	0.28	4
	Edges	-0.10	0.09	1.04	0.30065	0.12	2	Summer cereal	0.02	0.01	1.28	0.201567	0.18	3
	Summer cereal	0.09	0.09	0.99	0.32131	0.07	1	Forest	0.01	0.02	0.89	0.37391	0.14	3
	SHDI-E	0.08	0.09	0.91	0.36329	0.06	1	Fallow-winter cereal	0.01	0.01	0.77	0.438942	0.05	1
	p/a	-0.08	0.09	0.90	0.36806	0.06	1	Alfalfa	0.01	0.01	0.54	0.590857	0.04	1
	Forest	-0.08	0.09	0.87	0.38272	0.06	1	Non-crop habitat	-0.01	0.01	0.48	0.632022	0.04	1

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2. Most parsimonious model results of the best models explaining herbivores abundance (log₁₀(x+1) transformed). All variables present in the best models ($\Delta AIC < 2$) are presented; significant *p* values are in bold characters. Abundance was calculated as average of three traps by field, 6 fields in 2015 and 23 fields in 2016 and 2017. All explanatory variables are standardised (mean-centred and scaled).

Specie/Group	Spring season						Summer season							
	Variables best model	Estimate	SE	z	Pr(> z)	Relative importance	N containing model	Variables best model	Estimate	SE	z	Pr(> z)	Relative importance	N containing model
<i>F. occidentalis</i>	(Intercept)	2.59	1.23	2.05	0.0404			(Intercept)	2.14	0.70	3.04	0.00234		
	Predator	0.64	0.25	2.55	0.0107	1	6	Alfalfa	0.24	0.09	2.66	0.00782	1	4
	SHDI-E	-0.32	0.17	1.88	0.0602	0.76	4	Edges	-0.24	0.11	2.19	0.02827	1	4
	Summer cereal	-0.24	0.17	1.35	0.1769	0.53	4	Predator	0.91	0.10	8.68	<2e-16	1	4
	Alfalfa	0.22	0.17	1.28	0.2012	0.42	3	Maize phenology	-0.51	0.10	4.92	8.70E-07	1	4
								SHDI-E	0.41	0.10	4.11	3.94E-05	1	4
Other Thripidae	(Intercept)	3.39	0.97	3.44	0.000584			(Intercept)	0.12	0.37	0.32	0.74777		
	Maize phenology	-0.67	0.16	3.95	7.69E-05	1	15	Alfalfa	0.17	0.07	2.35	0.01895	1	4
	Alfalfa	0.46	0.17	2.56	0.010429	0.96	14	Predator	0.61	0.09	6.89	<2e-16	1	4
	Forest	-0.33	0.17	1.82	0.068755	0.51	7	Maize phenology	-0.36	0.08	4.24	2.25E-05	1	4
	Predator	0.40	0.26	1.49	0.13644	0.39	6	SHDI-E	-0.17	0.08	2.10	0.03559	0.84	3
	SHDI-L	0.23	0.17	1.35	0.177258	0.27	4	SHDI-L	-0.18	0.09	1.95	0.05114	1	4
	Non-crop habitat	0.24	0.17	1.38	0.166606	0.23	3	Fallow-winter cereal	-0.21	0.08	2.73	0.00637	1	4
	p/a	0.20	0.17	1.13	0.257585	0.17	3	Non-crop habitat	0.10	0.10	1.02	0.3097	0.23	1
	Orchard	-0.28	0.20	1.38	0.16715	0.08	2	Summer cereal	-0.05	0.08	0.64	0.52573	0.17	1
<i>Z. scutellaris</i>	(Intercept)	2.27	0.84	2.63	0.00861			(Intercept)	2.24	0.56	3.95	7.70E-05		
	Edges	0.47	0.17	2.75	0.00591	1	14	Edges	-0.32	0.14	2.21	0.02772	1	3
	Predator	0.60	0.26	2.22	0.02679	1	14	Predator	0.49	0.15	3.27	0.00106	1	3
	Winter cereal	-0.41	0.17	2.30	0.02172	0.64	8	Orchard	0.29	0.13	2.30	0.02173	1	3
	Maize phenology	0.30	0.17	1.73	0.08386	0.62	8	p/a	0.29	0.13	2.32	0.02061	1	3
	Orchard	0.42	0.21	1.91	0.05649	0.51	8	Maize phenology	-0.57	0.14	4.11	3.99E-05	1	3
	Alfalfa	0.31	0.19	1.58	0.11535	0.18	3	SHDI-E	0.26	0.13	2.00	0.04536	0.77	2
	Summer cereal	-0.22	0.16	1.28	0.19988	0.16	2	Fallow-winter cereal	0.10	0.15	0.69	0.48807	0.23	1
	Forest	0.25	0.19	1.32	0.18616	0.14	2							
	p/a	0.19	0.18	1.04	0.29868	0.11	2							
<i>L. striatellus</i>	(Intercept)	0.62	0.83	0.72	0.4703			(Intercept)	1.41	0.34	4.12	3.73E-05		
	Predator	0.56	0.23	2.32	0.0201	1	8	p/a	0.20	0.08	2.54	0.01122	1	33
	Maize phenology	0.39	0.16	2.44	0.0149	1	8	Maize phenology	-0.37	0.09	4.26	2.07E-05	1	33
	Edges	0.28	0.15	1.81	0.0703	0.76	6	Predator	0.25	0.09	2.73	0.00625	0.92	30
	SHDI-E	0.19	0.15	1.24	0.2148	0.23	2	Non-crop habitat	-0.25	0.11	2.22	0.02615	0.81	29
	Summer cereal	0.18	0.15	1.14	0.2557	0.1	1	Summer cereal	-0.30	0.12	2.51	0.01208	0.67	22
	SHDI-L	-0.17	0.16	1.06	0.2898	0.1	1	Orchard	0.28	0.13	2.06	0.03908	0.61	20
	Non-crop habitat	-0.15	0.15	0.97	0.3312	0.1	1	SHDI-L	0.18	0.11	1.67	0.09474	0.59	20
	Orchard	-0.14	0.15	0.88	0.381	0.09	1	SHDI-E	-0.13	0.09	1.42	0.15645	0.44	16
								Forest	-0.15	0.09	1.69	0.09165	0.43	13
								Alfalfa	0.15	0.10	1.48	0.13884	0.3	10
								Fallow-winter cereal	-0.08	0.11	0.74	0.46008	0.14	5
								Edges	-0.07	0.09	0.80	0.42317	0.02	1
<i>E. vitis</i>	(Intercept)	1.86	0.43	4.28	1.87E-05			(Intercept)	0.86	0.34	2.51	0.012		
	Non-crop habitat	0.57	0.21	2.59	0.00953	1	7	Predator	0.40	0.10	4.18	2.95E-05	1	23
	Maize phenology	-0.35	0.16	2.16	0.03058	1	7	p/a	0.20	0.09	2.31	0.0208	1	23
	SHDI-L	-0.44	0.21	2.03	0.04265	1	7	SHDI-E	-0.15	0.09	1.70	0.0896	0.73	16
	Summer cereal	-0.25	0.16	1.48	0.13832	0.26	1	Edges	-0.16	0.10	1.67	0.0942	0.67	15
	Forest	-0.20	0.16	1.20	0.23113	0.22	2	Maize phenology	-0.12	0.09	1.31	0.1891	0.45	11
	Winter cereal	0.23	0.17	1.35	0.17606	0.17	1	Forest	0.12	0.09	1.29	0.1968	0.32	7
	Predator	0.29	0.24	1.17	0.24329	0.13	1	Orchard	0.07	0.08	0.91	0.3612	0.23	7
	p/a	0.20	0.17	1.11	0.26518	0.12	1	Summer cereal	-0.06	0.08	0.79	0.4301	0.09	3
Aphididae	(Intercept)	2.96	0.43	6.72	<2e-16			(Intercept)	1.02	0.13	7.63	<2e-16		
	Maize phenology	-0.97	0.17	5.70	<2e-16	1	16	Maize phenology	-0.14	0.06	2.33	0.02	1	15
	SHDI-E	-0.28	0.17	1.67	0.0952	0.6	10	Alfalfa	0.13	0.06	1.96	0.0504	0.83	12
	SHDI-L	0.21	0.17	1.16	0.2463	0.6	10	Non-crop habitat	0.13	0.08	1.54	0.1245	0.38	5
	Edges	-0.29	0.17	1.67	0.0945	0.58	9	SHDI-L	-0.12	0.08	1.57	0.117	0.2	3
	Summer cereal	-0.26	0.17	1.49	0.137	0.46	7	Orchard	-0.10	0.09	1.09	0.2752	0.16	3
	Predator	-0.20	0.18	1.04	0.2966	0.09	2	SHDI-E	-0.06	0.06	1.03	0.3052	0.13	2
	Winter cereal	0.16	0.16	0.96	0.3372	0.08	2	p/a	0.05	0.06	0.79	0.4301	0.11	2
	Alfalfa	0.14	0.17	0.81	0.4207	0.04	1	Forest	0.05	0.06	0.74	0.4624	0.1	2
								Summer cereal	-0.13	0.08	1.62	0.1055	0.06	1
								Predator	0.04	0.07	0.60	0.5485	0.05	1
								Edges	-0.04	0.07	0.59	0.5573	0.05	1

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