TÜBİTAK

Turkish Journal of Zoology

http://journals.tubitak.gov.tr/zoology/

Research Article

Turk J Zool
(2015) 39: 404-411
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doi:10.3906/zoo-1401-69

Composition and seasonal variation of epigeic arthropods in field margins of NW Portugal

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Received: 29.01.2014 • **Accepted:** 30.07.2014 • **Published Online:** 04.05.2015 • **Printed:** 29.05.2015

Abstract: Field margins act as shelters for different arthropod taxa in agricultural fields. Several factors may promote seasonal changes in arthropod communities, especially in regions with marked seasonality, such as Mediterranean areas. Epigeic arthropods were sampled from the margins of fields located in northwestern Portugal during 2 contrasting seasons, spring and autumn. Organisms were identified to family or order level and seasonal variation in arthropod communities was evaluated. Abundance, group richness, and feeding guild parameters were affected by sampling season, with both abundance and richness being higher in spring. Of the groups captured in both seasons, most evidenced either higher abundance in spring or similar abundance between seasons. Ants constituted one of the most abundant trophic guilds in spring but one of the least captured in autumn, while catches of parasitoids and parasites were not affected by sampling season. Results indicate that the higher taxa approach is useful to distinguish seasonally distinct communities.

Key words: Field margins, seasonal variation, epigeic arthropods, higher taxa, trophic guilds

1. Introduction

The simplification of agricultural landscapes and the use of pesticides have been considered to be some of the main causes of biodiversity loss in agricultural ecosystems (Vandermeer, 1996; Stoate et al., 2001). Seminatural environments, like field margins, can help lessen the effects of such harmful practices, serving as biodiversity refuges (Marshall, 2004). These structures are thought to benefit biodiversity because they may harbor a diverse plant community that can support and act as a shelter or overwintering site for invertebrate and vertebrate communities (Thomas et al., 1992; Marshall, 2004). Moreover, field margins can act as ecological corridors, assuring connectivity between noncrop areas and preventing isolation from other important landscape patches (Altieri, 1999; New, 2005).

Epigeic arthropods are essential elements of terrestrial ecosystems and constitute an important part of the biodiversity present in agricultural areas (Abbott et al., 1979). In these areas epigeic arthropods fulfill a wide variety of ecological roles, influencing ecosystem function (Abbott et al., 1979; Swift et al., 1996). Different species are considered essential in the decomposition process and cycling of nutrients (Paoletti and Hassall, 1999), while many phytophagous species have important economic implications in agriculture, as they may act as pests and have become the target of insecticides and other types of management regimes (New, 2005). By contrast, predator and parasitoid species are viewed as beneficial for agriculture and attempts to preserve or introduce them as biological control agents are common (e.g., Asteraki, 1993; Starý and Gerding, 1993). In general, arthropod communities are fundamental to agricultural ecosystems, with seasonal variation being a common trait, especially in areas undergoing strong climatic seasonality, such as Mediterranean regions (Legakis, 1994; Berg and Bengtsson, 2007).

In Mediterranean environments, epigeic arthropods can be highly diverse, which poses a sampling and identification challenge given the effort and expertise required to study such communities in a given location (Oliver and Beattie, 1996; Moreno et al., 2008). Nevertheless, some approaches to studying such diverse communities have been proposed, such as the use of taxonomic ranks above species level (Oliver and Beattie, 1996). High taxonomic level identification is advantageous because taxonomy experts are not required and it is thus a faster and less expensive technique than species-level identification (e.g., Basset et al., 2004; Biaggini et al., 2007). Although not free of shortcomings, this approach

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has been successfully used to distinguish communities in several ecosystems (Biaggini et al., 2007; Moreno et al., 2008). Namely, this technique may be helpful in describing the most common taxa present in a southern Europe Mediterranean agroecosystem, where epigeic arthropod communities are still poorly understood.

In this study, we describe epigeic arthropod communities in terms of abundance, richness, diversity, and trophic guilds using the higher taxa approach (family and order) in agricultural field margins, comparing 2 distinct seasons (spring and autumn). Our main goal was to determine whether the higher taxa approach is an adequate tool to distinguish the arthropod assemblages of 2 contrasting seasons in an agricultural context.

2. Materials and methods

2.1. Study sites and experimental design

The work was carried out in northwestern Portugal, a region characterized by small landholding agriculture usually bordered by a minute field margin and a stone wall (Varela, 2008). Four geographically close sites (F1, F2, F3, and F4) in the municipality of Vila do Conde (41°19′N, 8°40′W) with maize (*Zea mays* L.) in rotation with annual ryegrass (*Lolium multiflorum* Lam.) were selected for the study. In the autumn sampling period, fields had recently been sown with the winter crop, while the spring sampling was performed when the fields were being prepared and sown with maize. Field margins in the region are usually narrow (20–100 cm) and transitory, being composed of spontaneous vegetation, mainly grasses and forbs, which occur after the fields are plowed. Some climbing plants, mostly *Vitis* sp. (Vitaceae) and *Hedera* sp. (Araliaceae), can resist from one year to another and cover the stone walls in some parts. All sites were within rural settings and had similar geologies and soil types. The climate is Mediterranean, with warm dry summers and humid winters (www.ipma.pt). Annual mean temperature averages range between 12.5 and 15.0 °C, total annual precipitation is 1400–1600 mm, and total annual insolation time ranged from 2400 to 2500 h (http://sniamb.apambiente.pt/webatlas/index.html). In the sampling months, total insolation was 175–200 h in April and 150–175 h in November; total precipitation was 80–100 mm in April and 60–80 mm in November; mean air temperature was 11.5–13.0 °C in April and 10.0–12.0 °C in November (www.ipma.pt). As in most agricultural areas of this region, a mixture of pesticides has been applied routinely over 30 years in spring and occasionally in autumn. Farmers use combinations of different products that have varied over the years because of EU bans and/or to avoid plant resistance. A more detailed description of the collection sites, including soil-pesticide profiles, is available in the work of Amaral et al. (2012).

2.2. Arthropod sampling

Surface active arthropods were sampled during 10 straight days in autumn (November 2008) and spring (April 2009), selecting, when possible, nonrainy days. Ten pitfall traps were placed in each field margin close to the stone wall with 2 m of spacing between them. Traps consisted of plastic containers (diameter of 8 cm and height of 16 cm) dug into the soil, with the lip just below the ground surface. To avoid the entrance of small vertebrates, a 30-mm mesh wire piece was used and fixed with staples. Covers were positioned 20–30 mm above the trap to prevent flooding by rainwater. Traps were partially filled (1–2 cm) with a saturated salt solution to trap and preserve invertebrates through the collection period. At the conclusion of the sampling period, traps were filled with ethanol (70%) and taken to the laboratory. Each sample was sieved using a 0.20-mm pore mesh. Invertebrates were sorted from the debris and maintained in a 70% ethanol solution until further analysis. Some of the pitfalls were destroyed during the sampling period and others were filled with debris as a result of farming work. These pitfalls were excluded from the analysis (1 trap from field F2 in autumn and 1 from fields F1 and F2 in spring).

2.3. Arthropod processing

Arthropods were identified to family or, when not feasible, to order, and counted under a stereomicroscope. Few groups were identified only to order level: the 3 Collembolan orders and 4 other groups that accounted for 0.2% of total abundance. Adult and immature individuals were placed in distinct groups as a result of probable differences in resource utilization. As a certain degree of uncertainty existed regarding the correct identification of some Coleoptera, Lepidoptera, and Diptera larvae, these individuals were placed in groups designated by letters. Larvae identified with letters were not taken into consideration for the calculation of number of families, since the family was unknown and could therefore be already present in the adult form. Some individuals of the order Siphonaptera and larvae of the family Sepsidae were excluded to avoid bias in the data caused by the extremely high abundance of these groups in the pitfalls where vertebrates had fallen. Specimens that could not be identified as a result of damage or taxonomic uncertainty were excluded from further analysis.

Throughout this paper the expression "group" will be used to designate the set of different families, orders, larvae, and nymphs identified. Nomenclature and taxonomy of all groups was based on Barrientos (2004). Furthermore, arthropods were classified into 1 of 5 different guilds: herbivores (Her), predators (Pre), saprophagous/fungal

feeders (Sap), parasitoids/parasites (Par), and ants (Ant), based on their different feeding habits (Root, 1967). In the case of ants, a separate guild was created because of the many functions that these animals may have in ecosystems (Hölldobler and Wilson, 1990). Guild classification was based on the major function of the respective group (family, order, larvae). Individuals that could not be assigned to any of the guilds were excluded from this analysis (1.03% of individuals).

2.4. Data analysis

Data were pooled by season for abundance and richness analysis and by field for community analysis. Differences between seasons were analyzed using PRIMER-E 6 (Clarke, 2003) and SigmaPlot 11 (www.sigmaplot.com). In the analyses using PRIMER-E 6, a $\log_{10}$ (x + 1) transformation was applied to the dataset. Similarity percentages (SIMPER) were calculated to establish which groups contributed most to the difference between seasons. Resemblance matrices were generated using the Bray–Curtis similarity measure and were used to compute nonmetric multidimensional scaling (nMDS) with group average cluster overlay. The nonparametric test ANOSIM (analysis of similarities) was used to test the differences between communities of distinct seasons. Differences in abundance and richness between seasons were calculated using Mann–Whitney U tests and differences between trophic guilds were determined by Kruskal–Wallis test followed by Dunn's post hoc test ($P < 0.05$), because data did not meet the criteria of normal distribution or variance homogeneity. Diversity indices (Shannon, Simpson, and Pielou's evenness) were computed for each season and compared with ANOVA because the test's criteria were met.

3. Results

3.1. Abundance and community composition

A total of 6960 individuals were identified, belonging to 135 different taxonomic groups (mean ± SE catch per trap = 90.4 ± 9.4 individuals, n = 77) and comprising 29 distinct arthropod orders (for a complete list of taxa, see Appendix 1; on the journal's website). The most abundant order was Hymenoptera (43.20% of catches) and Coleoptera was the most diverse, with a total of 30 distinct families. Spring samples had the highest abundance, comprising a total of 5780 individuals (65–429 individuals per trap) belonging to 122 groups (15–39 groups per trap). The 8 most abundant orders represented 95% of catches, while the other 21 orders accounted for the remaining 5%. The autumn samples collected 1180 individuals (2–62 individuals per trap) belonging to 90 groups (2–24 groups per trap). Hymenoptera was the most captured order, with nearly 30% of catches (for a list of total and relative contributions of groups to abundance for each season, see Appendix 2; on the journal's website).

Some of the groups were exclusively captured in 1 of the seasons, with 45 groups being exclusive to spring and 13 to autumn. The SIMPER analysis evidenced higher abundances in the spring of groups that contributed most and accounted for 35% of differences between seasons. The exception was the Scelionidae group, which evidenced no significant difference in abundance between seasons (Mann–Whitney U test = 1534.0; $n_1 = 38$, $n_2 = 39$, $P = 0.593$) (Table 1). Only 2 of the families representing more than 1% of autumn or spring catches were found in higher abundances in autumn, namely Hydrophilidae (Mann–Whitney U test = 1314.5; $n_1 = 38$, $n_2 = 39$, $P = 0.045$) and Glomeridae (Mann–Whitney U test = 1348; $n_1 = 38$, n_2

Table 1. Breakdown of average dissimilarities between spring and autumn into contributions of groups that accounted for 35% of dissimilarities (SIMPER analysis). Abundance data are $\log_{10}$ (x + 1) transformed.

Group	Spring	Autumn		
	Average Abundance		Contribution to dissimilarity (%)	Cumulative contribution (%)
Formicidae	4.04	1.19	8.08	8.08
Entomobryomorpha	3.00	0.94	5.85	13.93
Porcelionidae	1.39	0.08	3.65	17.58
Histeridae	1.32	0.28	3.42	20.99
Gnaphosidae	1.35	0.16	3.26	24.25
Diapriidae	1.75	0.69	3.22	27.47
Scelionidae	1.37	1.45	2.9	30.37
Staphylinidae	1.71	0.76	2.66	33.03
Lygaeidae	0.97	0.02	2.35	35.38

= 39, P = 0.015). For all other groups, abundance was higher in spring or differences between seasons were not significant.

Total abundance per trap (Mann–Whitney U test = 2223.0; n_1 = 38, n_2 = 39, P < 0.001) (Figure 1a) and richness per trap (Mann–Whitney U test = 2130.5; n_1 = 38, n_2 = 39, P < 0.001) (Figure 1b) were both significantly higher in spring than in autumn. Diversity and evenness indices evidenced significantly higher values in autumn when compared to spring (Table 2). The nMDS analysis evidenced high similarities between samples collected within the same season (Figure 2) and ANOSIM further evidenced a clear separation between the communities of spring and autumn (R = 0.917; P = 0.029).

3.2. Trophic guild composition

In total, 2281 ants (Ant), 1797 saprophagous/fungal feeders (Sap), 1489 predators (Pre), 728 parasitoids/parasites (Par), and 593 herbivores (Her) were caught. For all guilds, except for parasitoids/parasites, abundance was significantly higher in spring (Kruskal–Wallis test H = 235.8, P < 0.001) (Figure 3).

4. Discussion

The results of this study evidenced seasonal differences in abundance, richness, and composition of arthropod groups, either taxonomic or functional. Differences in diversity and evenness values pointed to the strong dominance of some taxa in spring, as opposed to a less dominated assemblage in autumn.

The distinctness in arthropod abundance, richness, and communities between seasons is usually interpreted as being related to fluctuations in climatic factors, such as temperature, precipitation, or day length, especially in strongly seasonal Mediterranean regions (Legakis, 1994; Lionello et al., 2006). These factors, in combination with distinct life-histories, are thought to greatly influence arthropod assemblages (Wolda, 1988; Leather et al., 1995). In fact, the arthropod community captured in spring was quite distinct from the arthropod community captured in autumn. Samples belonging to the same season presented high similarities and were very distinct from the other season's samples, evidencing the differences in abundance, richness, and taxonomic groups found. The lower

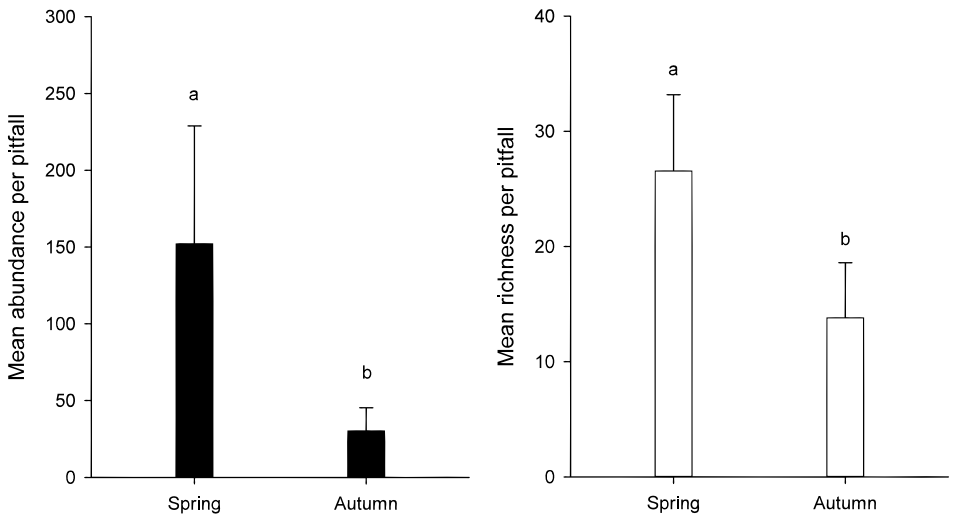

Figure 1. a) Mean abundance per pitfall in autumn and spring. Seasons were compared using a Mann–Whitney U test; **b)** mean group richness per pitfall in autumn and spring. Seasons were compared using a Mann–Whitney U test. Bars represent means ± standard deviation. Distinct letters between seasons indicate statistical differences (P < 0.001).

Table 2. Diversity measures computed for each season (spring and autumn) with corresponding standard deviations. H' – Shannon diversity index ($\log_e$), D – Simpson diversity index (1-D), J' – Pielou's evenness. Seasons were compared using ANOVA. Level of significance between seasons for each diversity measure is presented in the table below.

Season	Spring	Autumn	Significance
H'	2.51 ± 0.32	3.06 ± 0.27	P = 0.041
D	0.81 ± 0.07	0.95 ± 0.03	P = 0.008
J'	0.59 ± 0.06	0.80 ± 0.05	P = 0.002

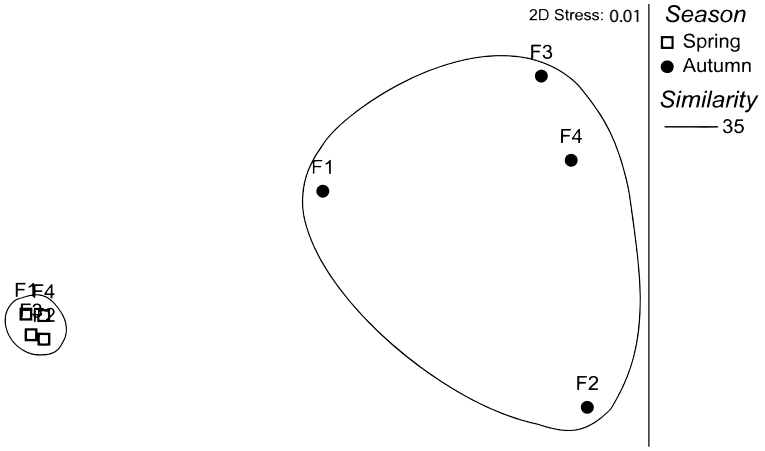

Figure 2. Nonmetric multidimensional scaling (nMDS) ordination in 2 dimensions computed for the 4 sites in spring and autumn. Lines group fields with a similarity of 35% or higher based on a group average cluster analysis. The value of stress is represented.

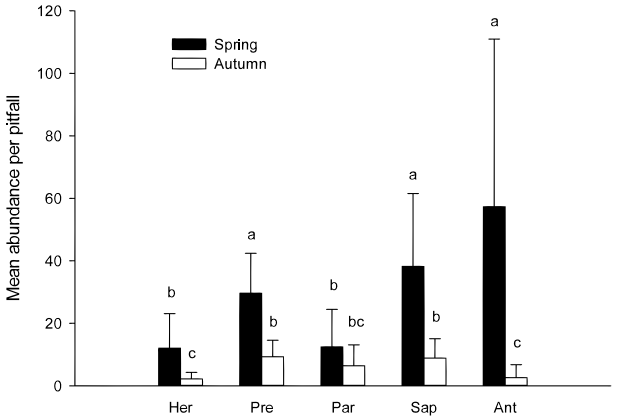

Figure 3. Mean abundance per pitfall for each guild in spring and autumn. Seasons were compared using a Kruskal–Wallis test followed by a Dunn's post hoc test ($P < 0.05$). Bars represent means ± standard deviation. Distinct letters indicate statistical differences.

abundances and richness of arthropods registered in the autumnal sampling period (November) are not surprising given the proximity of winter, which is typically the season with lowest arthropod abundance (Wolda, 1988; Leather et al., 1995), and considering the differences in seasonal factors registered between the sampling seasons (lower values of total insolation, total precipitation, and mean air temperature registered in November). Moreover, some of the groups were more abundant in autumn, but the abundance of others seemed unaffected by sampling season and the majority was more abundant in spring. Other studies have also found a seasonal trend for total abundance of arthropod groups, but with individual taxa exhibiting distinct seasonal patterns (e.g., Greenberg and McGrane, 1996). This likely reflects the high variability among life-histories and life-cycles of the captured groups.

The results of feeding guilds evidenced a trend of higher abundance in spring when compared to autumn, which is not surprising since total arthropod abundance was much lower in autumn. Ants were the most abundant trophic guild in spring, although not significantly higher than saprophagous/fungal feeders and predator abundance. In fact, ant dominance, sometimes in conjunction with the Coleoptera, has been found in natural Mediterranean areas (e.g., Legakis, 1994; Doblas-Miranda et al., 2007) and seems also to be a trait in Mediterranean agroecosystems, at least in spring and summer (e.g., Santos et al., 2007; Pérez-Bote and Romero, 2012). Nevertheless, and since our study used pitfall traps, the distance and size of the ant colony or its distance from the trap may be highly influential for catch results (Greenslade, 1973). Moreover, lower catches in autumn may be related to the slowing of metabolic rates, given that some ant species may enter some form of diapause in late autumn and winter (Hölldobler and Wilson, 1990).

In the case of herbivores, abundance is closely related to the growth rate of plants, and therefore individuals are expected to be most abundant in the plant growing season and less abundant in colder periods with a shortage of plant resources (Legakis, 1994; New, 2005). This is consistent with the higher numbers of herbivores captured in spring when compared to autumn in our samples. The low catches of herbivores compared to other guilds were also found in some other studies of ground-dwelling invertebrates (e.g., Doblas-Miranda et al., 2007; Noordijk et al., 2010). The numerical dominance of the other guilds, which could be related to higher amounts of food in soil litter (Doblas-Miranda et al., 2007), might be a possible explanation, but

assignment of higher taxa to trophic groups may not be excluded as an important source of bias.

The saprophagous and fungal feeder trophic group generally has high amounts of food in litter and is generally more abundant in wetter, but not cold, seasons (Legakis, 1994). This may help explain the higher abundance of this group in spring and in relation to other trophic groups, since precipitation in our spring sampling period was higher. However, the overall saprophagous and fungal feeders' catches may have also been influenced by the methodology used, because traps remained in the fields for 10 straight days and the trapping solution used may have allowed catches to decompose, likely attracting saprophagous species (Porter, 2005).

The parasitoids collected in our study, which formed the majority of its corresponding trophic group, were all adults and can be found in a variety of habitats, including, but not restricted to, the soil surface (Masner, 1993a, 1993b). Many are known to feed on nectar, and sources of this food item, which can be provided in field margins, influence both the abundance and diversity of parasitoids (Marino and Landis, 1996). Additionally, these animals spend much of their adult lives in search of hosts for their offspring (Fellowes et al., 2005), with many such hosts being found in our study. It was, therefore, not surprising that some parasitoids were captured in our field margins. Furthermore, parasitoid and predator abundance is less dependent on seasons than abundance of herbivores, given that certain amounts of food are always available for such trophic groups (Legakis, 1994), which is consistent with similar abundances for the parasitoid and parasites trophic group between seasons, but not for predators. For this trophic group, probably the lower general abundance of arthropods serving as prey in autumn may have been most important.

Pitfall trapping is one of the most common methods to sample epigeic arthropods (e.g., Greenslade, 1964; Thomas and Marshall, 1999). However, some caution is needed in interpreting results of pitfalls, because catches depend on the activity of species. Therefore, more mobile species tend to be caught in higher numbers, while slower taxa tend to be captured less. Environmental temperature is also relevant, because temperature influences mobility of arthropods (Legakis, 1994). Nevertheless, this method can be more advantageous than others in some occasions. Namely, Churchill and Arthur (1999) reported that their pitfalls collected the majority of families and species present in their study area, revealing highly marked spatial and temporal patterns in spider family and species richness of heathlands in Tasmania, while the sweep net method only evidenced spatial trends and visual search did not evidence any spatial or temporal pattern. Despite its shortcomings, it is a simple and cheap method that requires little effort to sample many distinct arthropod groups and is particularly suited for same-habitat comparisons (Topping and Sunderland, 1992; Weeks and McIntyre, 1997). In this particular case, it was useful in providing an abundance of individuals from distinct orders and families sufficient to allow comparisons between seasons.

A low taxonomic resolution was used in this study, with organisms being identified to family (most cases) or order level. This low taxonomic resolution can influence interpretation of results, given that many distinct species may be clumped together in a higher taxon, or the higher taxon may represent only a single species. Nevertheless, the higher taxon approach has already been used successfully to distinguish sites at genus, family, or order level (e.g., Báldi, 2003; Biaggini et al., 2007) and, despite its shortcomings, it seems to be useful in cases where a quick survey is needed or when there is shortage of resources (Biaggini et al., 2007; Moreno et al., 2008). In fact, the arthropod communities in our study appeared well separated between seasons, despite the low taxonomic resolution used.

Soil in agroecosystems undergoes variations induced by agricultural practices, such as tilling, fertilizing, or herbicide application (Boone et al., 1999), although possibly affecting organisms to a lesser extent in field margins (Marshall and Moonen, 2002). In fact, many studies have shown that sown or naturally regenerated field margins have higher diversity and/or a higher abundance of arthropods than the adjacent cropped fields (e.g., Meek et al., 2002; Smith et al., 2008), which can be related to the higher floral richness and structural diversity found on margins compared to crops (Thomas and Marshall, 1999; Asteraki et al., 2004). Nevertheless, field margins are sometimes the target of pesticides and may have a lowered arthropod abundance when compared to unsprayed margins (e.g., de Snoo, 1999). Herbicides were routinely applied in our study fields and margins, but the majority are reported as not harmful for arthropods. However, habitat changes, caused by reduction of plant diversity, modification of physical conditions, and reduction of food items, may have impacts in communities (e.g., Haughton et al., 2001; Taylor et al., 2006). Despite this, in our study's margins, herbicide application only occurred after the spring sampling period (Amaral et al., 2012), with these seminatural structures usually being very diverse in terms of flora at that time of year. This may help explain why epigeic arthropods inhabiting field margins were so diverse and abundant in spring.

In conclusion, the communities of spring and autumn appeared well separated; the spring assemblage was revealed to be the most rich and abundant group, but diversity and equitability were higher in the autumn assemblage. These results reveal that the higher taxa approach was sufficient to distinguish arthropod assemblages between seasons, indicating its usefulness in contexts with limited time and resources, at least with assemblages collected in distinct seasons in an agroecosystem. The rich arthropod communities found, despite the narrowness of the margins, evidence the role of these structures as biodiversity refuges in agroecosystems.

Acknowledgments

We appreciate the assistance of AR Agra and R Bicho for help in animal sampling and sieving. This research was supported by FEDER through COMPETE-Programa Operacional Factores de Competitividade and by national funding through FCT-Fundação para a Ciência e Tecnologia within the research project LAB-PET – Lacertid Lizards As Bioindicators of Pesticide Exposure and Toxicity in Intensive Market Garden Agriculture (FCT PTDC/AMB/64497/2006) and through a FCT PhD Grant to MJ Amaral (SFRH/BD/31470/2006).

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Appendix 1. List of all captured taxa.

Orders	Families	Orders	Families
Araneae	Agelenidae		Lathridiidae
	Dysderidae		Leiodidae
	Gnaphosidae		Melyridae
	Linyphiidae		Nitidulidae
	Liocranidae		Ptiliidae
	Lycosidae		Ptinidae
	Nemesiidae		Scarabaeidae
	Salticidae		Silphidae
	Tetragnathidae		Silphidae larvae
	Zodariidae		Sphindidae
Coleoptera	A larvae		Staphylinidae
	Anthicidae		Tenebrionidae
	Apionidae		Throscidae
	B larvae	Craspedosomatida	Craspedosomatidae
	Byrrhidae	Diptera	Calliphoridae
	Carabidae		Camillidae
	Chrysomelidae		Cecidomyiidae
	Cicindelidae		Ceratopogonidae
	C larvae		Chironomidae
	Cleridae		Chironomidae larvae
	Coccinellidae		Chloropidae
	Corylophidae		Diastatidae
	Cryptophagidae		Drosophilidae
	Curculionidae		Fanniidae
	Dermestidae larvae		Hybotidae
	D larvae		M larvae
	Dryopidae		Muscidae
	Elateridae		Odiniidae
	Erotylidae		Opomyzidae
	G larvae		Pallopteridae
	Histeridae		Phoridae
	Hydrophilidae		Psychodidae
	I larvae		Scathophagidae
	Lampyridae		Sciaridae
	Lampyridae larvae		Sciaridae/Mycetophilidae larvae

Appendix 1. (Continued).

Orders	Families
	Sepsidae
	Sepsidae larvae
	Sphaeroceridae
	Syrphidae
	Tachinidae
	Tipulidae
	Tipulidae larvae
	Xylomiidae larvae
Entomobryomorpha	
Geophilomorpha	
Glomerida	Glomeridae
Hemiptera	Aphididae
	Cicadellidae
	Cicadellidae nymphs
	Cimicidae
	Cydnidae
	Lygaeidae
	Lygaeidae nymphs
	Reduviidae
	Tingidae
Hymenoptera	Aphelinidae
	Apidae
	Brachonidae
	Ceraphronidae
	Diapriidae
	Eulophidae
	Figitidae
	Formicidae
	Formicidae larvae
	Ichneumonidae
	Megaspilidae
	Mymaridae
	Platygasteridae
	Proctotrupidae
	Scelionidae
Isopoda	Armadilidiidae
	Porcellionidae
Isoptera	Rhinotermitidae
Julida	Julidae
Lepidoptera	Arctiidae
	Geometridae larva
	Y larvae
	Z larvae
Lithobiomorpha	Lithobiidae
Mecoptera larvae	
Microcoryphia	Machilidae
Opiliones	Phalangiidae
	Sclerosomatidae
Orthoptera	Acrididae
	Gryllidae
Poduromorpha	
Polydesmida	Polydesmidae
Polyxenida	
Pseudoescorpiones	Chthoniidae
	Garypidae
	Neobisiidae
Scolopendromorpha	Cryptopidae
Scutigeromorpha	Scutigeridae
Siphonaptera	
Symphyla	Scolopendrellidae
	Scutigerellidae
Symphypleona	
Thysanoptera	Merothripidae
	Phlaeothripidae
Trichoptera	Limnephilidae larvae

Appendix 2. Total number of catches (Ab) and percentage abundance (% Ab) of orders and families captured in each of the seasons and in both (total). Groups that represent less than 1% of catches in at least one of the seasons are represented as "Others". Larvae and nymphs are grouped together.

Order	Family	Spring		Autumn		Total
		Ab	% Ab	Ab	% Ab	% Ab
Hymenoptera	Formicidae	2179	37.70	102	8.64	32.77
	Scelionidae	197	3.41	157	13.31	5.09
	Diapriidae	219	3.79	49	4.15	3.85
	Platygasteridae	25	0.43	24	2.03	0.70
	Other families	34	0.59	21	1.78	0.79
	Total Hymenoptera	2654	45.92	353	29.92	43.20
Coleoptera	Staphylinidae	183	3.17	49	4.15	3.33
	Carabidae	156	2.70	44	3.73	2.87
	Histeridae	180	3.11	21	1.78	2.89
	Coleoptera larvae	79	1.37	41	3.47	1.72
	Hydrophilidae	14	0.24	47	3.98	0.88
	Other families	210	3.63	41	3.47	3.61
	Total Coleoptera	822	14.22	243	20.59	15.30
Entomobryomorpha		846	14.64	75	6.36	13.23
Araneae	Linyphiidae	95	1.64	86	7.29	2.60
	Gnaphosidae	121	2.09	9	0.76	1.87
	Lycosidae	26	0.45	53	4.49	1.14
	Other families	109	1.89	12	1.02	1.74
	Total Araneae	351	6.07	160	13.56	7.34
Hemiptera	Lygaeidae	2	0.03	20	1.69	0.32
	Aphididae	6	0.10	12	1.02	0.26
	Cicadellidae	45	0.78	33	2.80	1.12
	Hemiptera nymphs	111	1.92	26	2.20	1.97
	Other families	164	2.84	91	7.71	3.66
	Total Hemiptera	156	2.70	1	0.08	2.26
Diptera	Diptera larvae	94	1.63	23	1.95	1.68
	Phoridae	11	0.19	21	1.78	0.46
	Sciaridae	26	0.45	2	0.17	0.40
	Other families	38	0.66	4	0.34	0.60
	Total Diptera	325	5.62	51	4.32	5.40
Isopoda	Porcellionidae	193	3.34	4	0.34	2.83
	Armadilidiidae	32	0.55	15	1.27	0.68
	Total Isopoda	225	3.89	19	1.61	3.51
Pseudoscorpiones	Chthoniidae	108	1.87	39	3.31	2.11
	Other families	28	0.48	2	0.17	0.43
	Total Pseudoscorpiones	136	2.35	41	3.47	2.54
Poduromorpha		44	0.76	24	2.03	0.98
Opiliones	Phalangiidae	8	0.14	15	1.27	0.33
	Other families	11	0.19	21	1.78	0.46
	Total Opiliones	19	0.33	36	3.05	0.79
Symphypleona		30	0.52	23	1.95	0.76
Julida	Julidae	26	0.45	17	1.44	0.62
Glomerida	Glomeridae	1	0.02	16	1.36	0.24
Other groups		137	2.37	31	2.63	2.41
Total		5780	100.00	1180	100.00	100.00