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The taxonomic level order as a possible tool for rapid assessment of Arthropod diversity in agricultural landscapes

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Abstract

Increasingly intensive agriculture production methods, involving a widespread use of agro-chemicals and the progressive loss of many natural and semi-natural habitats have led to an impoverished wildlife in agro-ecosystems. The awareness of the necessity to conserve, enhance or restore biodiversity in depleted agricultural landscapes has increased in the last decades. Recently new agro-environment schemes and biological compensation programmes have been proposed and they need biodiversity assessment to verify the efficacy of the planned agricultural practices. However, biodiversity assessments often require much effort in terms of time and economical resources. In particular, when analysing Arthropods, one of the groups most commonly used to assess biodiversity in agro-ecosystems, the employment of taxonomists is required for species identification. In this paper we have tried to develop a rapid procedure to assess Arthropod biodiversity in agro-ecosystems. In particular we tested the reliability of two higher *taxa* as surrogates for Arthropod diversity: order for all the specimens and family for Coleoptera. We collected Arthropods by pitfall traps, both in cultivated and semi-natural micro-habitats, mainly focusing on two different agricultural managements: an intensive wheat field and an experimental one with organic farming and semi-natural habitat conservation. Higher *taxa* results were compared to those obtained from analysing Carabidae at species level. The use of order level allowed us to clearly distinguish among main land uses on the basis of their faunal composition and diversity. Most prominent, order level analyses gave outcomes comparable to those obtained considering Carabidae species. Conversely, analyses conducted at family level for Coleoptera did not reveal any distinction among land uses. Furthermore, we tested the possibility of shortening the sampling period: about 4 months of surveys seemed to give results very similar to those obtained in a whole year of field activity. We propose our methodology as a possible useful short-cut to assess biodiversity in agricultural landscapes at a local scale. Order surrogacy together with the sampling procedure that we adopted could be seen as a preliminary approach, at least in a first phase of an investigation. This method could be particularly useful when results are required rapidly and in a context of limited financial resources.

Keywords: Higher *taxa*; Quick surveys; Biodiversity; Agro-ecosystems; Arthropods; Coleoptera; Carabidae

1. Introduction

The ancient forms of agriculture in western Europe had often led to an increase of biodiversity over the centuries (Duelli and Obrist, 2003; Hoffmann and Greef, 2003; Piorr, 2003). Yet, in the 20th century, the intensification of arable farming systems has resulted in significant losses of both natural and semi-natural habitats and many of their inhabitants (Burel et al., 1998; Zechmeister and Moser, 2001; Moser et al., 2002). Many uncultivated habitats, such as woodlots and hedgerows, have been removed to enlarge the field size and to facilitate cultivation (Burel et al., 1998) leading to a decrease and a fragmentation of the original landscape (Wilcove et al., 1986; Andrén, 1994; Burel et al., 1998). Such processes along with further agricultural practices developed for large-scale production (simplification of crop rotations as well as high input of fertilizers and

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pesticides) have led to an impoverished wildlife, especially in arable landscapes (Aebischer, 1991; Solbrig, 1991; Nentwig, 2003; Pfiffner and Luka, 2003). In particular, the recorded declines in invertebrate populations (e.g. Aebischer, 1991; Woiwood, 1991; Ewald and Aebischer, 1999) have been linked to reductions in landscape heterogeneity (Weibull et al., 2000), loss of non-cropped habitats (Petit and Usher, 1998; Marshall and Moonen, 2002), mechanical disturbance (Holland and Reynolds, 2003), changes in the timing of agricultural practices (Vickery et al., 2001) and the direct and indirect impacts of pesticides (Wilson et al., 1999; Burn, 2000).

The motivation to conserve, enhance or restore biodiversity in depleted agro-ecosystems has increased in the last decades (Duelli and Obrist, 2003; Heyer et al., 2003; Osinski et al., 2003). Indeed, it has become one of the central themes of the "Community Agriculture Policies" of the European Union that aims at developing sustainable agriculture and promoting environmentally friendly practices for nature conservation (Burel et al., 1998; Sauberer et al., 2004). In many European countries new agro-environment schemes have been implemented (Kleijn et al., 2001; Kleijn and Sutherland, 2003; Herzog, 2005; Schmitzberger et al., 2005), which need to be assessed for their efficiency. In such a context evaluation of biodiversity must be developed to compare different types of agriculture and to evaluate the success or failure of the ecological compensation measures (Kleijn et al., 2001).

Species richness and diversity are commonly used for conservation purposes and to assess ecosystem fitness (Norton, 1986; Probst and Weinrich, 1993). However, inventories at species level require an enormous amount of resources (Cardoso et al., 2004) mainly due to the necessity of taxonomist employment. This is particularly evident when working on Arthropods that are commonly used for biodiversity surveys in agro-ecosystems. To reduce time and economic efforts several options have been proposed, such as reducing the analysis to particular species groups (e.g. Carabidae beetles), and/or to a subset sampled in the most diverse annual season (Duelli et al., 1999). Other alternative methods not requiring species identification have been suggested; among these the use of morphospecies (Oliver and Beattie, 1993, 1996) and higher *taxa* categories (Gaston and Williams, 1993) as surrogates for species. The effectiveness of the higher *taxa* approach depends on a strong correlation existing between higher *taxa* richness and species richness (Bambach and Sepkoski, 1992; Williams and Gaston, 1994; Balmford et al., 1996). The use of this approach provides obvious benefits in a context of limited financial and human resources and it is particularly useful when rapid biodiversity surveys are required (Andersen, 1995).

We tested the reliability of a simple and fast procedure to compare biodiversity levels among different land uses and agricultural managements. We considered the possibility of using two high *taxa* categories as surrogates for Arthropod diversity in agricultural landscapes: orders for all the Arthropods and families for Coleoptera (a group often used in biodiversity assessment, especially in agro-ecosystems, see, e.g. Asteraki et al., 1995; Petit and Usher, 1998; Woodcock et al., 2005). We focused on two main questions: (a) Are the taxonomic levels order and family viable surrogates for biodiversity (species richness)? (b) If yes, can these surrogates differentiate among or qualify land use types of varying intensity? To test the reliability of the two higher *taxa* as surrogates for species richness we compared the results deriving from order and family analyses with those obtained from species level analyses using Carabidae. This group is one of the most commonly used for biodiversity investigations in agro-ecosystems and it is considered a very sensitive indicator (Asteraki et al., 1995; Petit and Usher, 1998; Pfiffner and Luka, 2003; Aviron et al., 2005; Grandchamp et al., 2005). We examined throughout a year diversity and faunal composition in a typical agricultural landscape (a multiple-use area, mostly dominated by arable lands) in Tuscany, central Italy. We sampled Arthropods using pitfall traps in both cultivated plots and semi-natural habitats. In particular, we focused on the comparison of two different agricultural managements: intensive and experimental cultivation of wheat (*Triticum turgidum* L. var. *durum*), the latter being characterised by organic farming and semi-natural habitat maintenance.

2. Methods

2.1. Study area

The study area is located in the Valdera region, central Tuscany (Italy). The average annual temperature is 12.7 °C and the average annual rainfall is 678 mm, with maximum precipitation in Autumn and Spring (data derived from the meteorological station inside the experimental centre). Soils are termed Vertic Cambisols (Papini et al., 2005) according to the World Reference Base for Soil Resources (FAO, 1998). The landscape is dominated by agricultural land use and the main economic activity is the intensive cultivation of cereals.

Sampling was carried out in seven sites with different land uses, in a range of 2 km^2: a woodlot (W), a pasture (P), a wheat field (F) intensively cultivated with triennial crop rotation and use of agrochemicals, and four sites inside the experimental centre "S. Elisabetta" belonging to the "Experimental Institute for Soil Study and Conservation" (Table 1). These four sites, differing in land use and soil cover characteristics, were identified as: grass strips (GS) alternated with organically cultivated strips (CS), meadow (M) and riparian strip (R) (Table 1).

2.2. Sampling procedures

Arthropods were collected in the seven different sites during a whole year (from May 2003 to May 2004), using

Table 1
The seven surveyed land uses: main environmental features, plant richness[a], number of placed traps and Arthropod order and Coleoptera family diversity[b]

Land use	Abbreviation	Size	Management and main vegetation features	Surroundings	No. of plant species	No. of traps	H_{AO}	H_{CF}
Cultivated strips	CS	17 m × 60 m each	Organically cultivated wheat (*Triticum turgidum* L. var. *durum*)	Experimental centre. Alternated with GS, next to M	3.75 ± 0.96	4 (into different strips)	2.37 ± 0.11	2.55 ± 0.19
Field	F	150 m × 80 m	Intensively cultivated wheat (*T. turgidum* L. var. *durum*)	Intensively cultivated fields of cereals	3.83 ± 1.47	6	1.18 ± 0.26	2.39 ± 0.25
Grass strips	GS	4.40 m × 60 m each	Undisturbed thick mantle of herbaceous species. Prevalence of: *Medicago* spp., *Bromus* spp., *Avena* spp., *Poa* spp.	Experimental centre. Alternated with CS, next to M	9.50 ± 0.82	4 (into different strips)	2.64 ± 0.06	2.95 ± 0.08
Meadow	M	15 m × 90 m	Uncultivated meadow. Prevalent essences: *Bromus* spp., *Avena* spp., *Poa* spp.	Experimental centre. Between the cultivated area (GS + CS) and a shrubby lot	19.13 ± 4.16	8	2.53 ± 0.11	2.28 ± 0.36
Pasture	P	60 m × 70 m	Sheep grazing. Main essences: *Medicago* spp., *Trifolium* spp.	Intensively cultivated fields of cereals	6.00 ± 1.41	4	1.95 ± 0.22	2.57 ± 0.15
Riparian strip	R	Banks are 1–2 m wide	Prevalence of *Rubus* spp. and *Arundo* spp.	Experimental centre	11.75 ± 2.63	4	2.46 ± 0.19	2.15 ± 0.09
Woodlot	W	70 m × 120 m	*Quercus* spp. wood used for silviculture	Intensively cultivated fields of cereals	7.00 ± 0.82	4	2.46 ± 0.08	1.66 ± 0.25

[a] Mean number of plant species (±S.D.) recorded around each trap.

[b] Mean values of Shannon–Wiener index (±S.D.) of Arthropod orders (H_{AO}) and Coleoptera families (H_{CF}) collected in the whole sampling period.

pitfall traps. We placed a total of 34 traps in the investigated area (Table 1). In each site traps were located in grids of 30 m × 10 m on average. Considering the small size of the surveyed sites, this kind of trap distribution allowed us to cover about the whole area.

Each trap consisted of a plastic tank (8 cm diameter) filled with 150 ml of a solution made up of vinegar (attractive function) and acetylsalicylic acid (preservative function); every tank was inserted in the soil so that its lip was just at the ground level. We assumed that species response to the attractant was equally distributed in the communities sampled in the different habitat types. A non-transparent plastic cover was placed 10 cm above each trap to prevent flooding from rainwater and evaporation of the inside solution. Traps were emptied and replaced once every 14 days. In order to gain a measure of plant richness of the sampled sites, we counted the plant species present in 1 m^2 plots (Woodcock et al., 2006) around each trap (Table 1).

Arthropods were identified to order level (Arthropod orders = "AO") and Coleoptera were identified to families (Coleoptera families = "CF"). Among Coleoptera, Carabidae were determined to species level (Carabidae species = "CaS"), only for the seasonal sample giving the strongest contrasts in the high taxonomic level analyses.

2.3. Statistical analyses

To compare similarity patterns of the higher *taxa* composition of the 34 traps among the seven different land use types, we performed multidimensional scaling, using SPSS 9.05 software. For each trap we calculated the relative proportions of both AO and CF, considering the total number of specimens captured in the whole sampling period. In order to avoid the complications present in analysing compositional data we arcsine transformed the proportions. We used euclidean distance as dissimilarity measure (Manly, 1986). The goodness of multidimensional scaling results is measured as stress value. As stress provides an indication of distortion relative to the original data, low values of stress (lower than 0.1) are considered optimal (Manly, 1986). To evaluate if AO and CF showed comparable patterns of similarity among traps we performed Mantel test (Mantel, 1967) among the euclidean distance dissimilarity matrices used in multidimensional scaling. We used Matman 1.0 software with 10,000 permutations for this analysis.

For the annual sample of each trap we assessed biodiversity values of both AO and CF using Shannon–Wiener index (Shannon and Weaver, 1948). We used EstimateS 5.0.1 to generate randomised accumulation curves independent from sampling temporal order. Focusing on CS, M, and F (we chose M as reference semi-natural habitat) we calculated both AO and CF Shannon–Wiener index values considering the total specimens collected in each of the three sites. These biodiversity values were tested for differences by ANOVA. Scheffe post-hoc test was applied for pair-wise comparisons. We used SPSS 9.05 for these analyses.

In order to verify if a shorter sampling period would lead to the same results obtained in a whole year of field work, we divided our data into three sub-groups. The first one covered the period ‘‘Spring–Summer’’, from the ending of March to harvest: for this purpose we put together data collected at the beginning (6 May to 12 August 2003) and at the end of our sampling activity (23 March to 3 May 2004). The second period, ‘‘Autumn’’, started with harvest and ended at sowing time (12 August to 18 November 2003); the third one, ‘‘Winter’’, lasted until the beginning of Spring (18 November 2003 to 23 March 2004). For each seasonal period and for CS, M and F we calculated the Shannon–Wiener index values and we tested them with ANOVA, using Scheffe post-hoc pair comparisons. For the season showing the strongest contrasts in such analyses, considering again CS, M and F, we calculated for each trap the Shannon–Wiener index values of CaS, CF and AO. Pearson test was applied to verify if the biodiversity values of the 18 traps showed correlations among the three taxonomic levels.

For the same season, focusing on CS, M and F, we performed again multidimensional scaling in order to visualize the similarity patterns of species faunal composition and the corresponding higher *taxa* outcomes. To evaluate if the different taxonomic levels (AO, CF and CaS) showed comparable patterns of similarity among traps we performed Mantel test among the euclidean distance dissimilarity matrices used in multidimensional scaling. We used Matman 1.0 software with 10,000 permutations for this analysis. Besides this, to test if the similarities among land uses highlighted by multidimensional scaling were statistically consistent, we used a dyadic approach. We compared the euclidean distances among all the possible pairs of CS and F traps versus the ones among all the pairs of traps belonging to CS and M. We tested the differences by Mann–Withney *U*-test verified by Monte Carlo (10,000 iterations) to avoid errors due to non-independence of data.

3. Results

We collected a total of 185,666 Arthropods and 25,319 Coleoptera. We identified 26 orders of Arthropods among which Collembola, Diptera, Coleoptera and Hymenoptera represented 53.8%, 15.4%, 14.0% and 5.0% of the collected specimens, respectively. As for Coleoptera we found 50 different families: the most numerous ones were Staphylinidae (43.7%), Carabidae (20.6%), Nitidulidae (13.6%), Curculionidae (4.5%), and Anthicidae (4.1%). We collected a total of 890 Carabidae in the Autumn sample (the sampling time that revealed the strongest contrasts in high taxonomic level results, Table 2) of CS, M and F. We identified 23 Carabidae species among which *Carabus violaceus*, *Carabus coriaceus*, *Pterosticus melas* and *Carabus rossii* were the most numerous (representing the 28.6%, 22.7%, 18.3% and 14.3% of the total specimens, respectively).

Multidimensional scaling performed on the frequencies of AO showed a clear distinction of the traps into four groups (Fig. 1). Indeed, the W, P, and F traps clustered into three separate groups, while the ones located in quite undisturbed open habitats (M, R, GS) and in the cultivated strips (CS) were represented in the same cluster. The stress value of the analysis was very low (stress = 0.017). The same analysis performed on CF frequencies showed a less clear distinction among sites and only W traps were clearly separated from the others (Fig. 2). The stress value was quite low (stress = 0.085). Mantel test revealed a high correlation between the similarity patterns obtained from AO and CF annual samples (Spearman’s rho = 0.302, $P = 0.002$).

Multidimensional scaling analyses performed on CS, M, and F Autumn samples revealed that CS and M traps were similar for both AO and CaS faunal composition while F traps were clearly distinct (Fig. 3a and c). In contrast, when considering CF frequencies, the pattern of similarity among CS, M and F traps was quite different (Fig. 3b), but still separated the three land uses fairly well. The stress values were 0.009 for AO, 0.123 for CF and 0.067 for CaS.

Table 2

Shannon–Wiener index values of Arthropod orders (H_{AO}), Coleoptera families (H_{CF}) and Carabidae species (H_{CaS})[a] recorded in three different land uses[b], and ANOVA comparisons[c]

Index type	Land use			ANOVA comparisons		
	CS ($n = 4$)	F ($n = 6$)	M ($n = 8$)	*F*	*P*	Post-hoc
H_{AO}	2.37 ± 0.11	1.18 ± 0.26	2.53 ± 0.11	113.957	<0.001	CS > F***, M > F***
H_{CF}	2.55 ± 0.19	2.39 ± 0.25	2.28 ± 0.36	1.106	0.356	–
SS H_{AO}	2.38 ± 0.09	1.51 ± 0.55	2.48 ± 0.15	15.853	<0.001	CS > F**, M > F***
SS H_{CF}	2.19 ± 0.39	1.90 ± 0.11	1.98 ± 0.47	0.788	0.472	–
A H_{AO}	2.19 ± 0.21	0.88 ± 0.26	2.74 ± 0.13	156.999	<0.001	M > CS***, CS > F***, M > F***
A H_{CF}	2.10 ± 0.27	2.42 ± 0.41	2.12 ± 0.28	1.832	0.194	–
A H_{CaS}	2.54 ± 0.22	1.189 ± 0.38	2.34 ± 0.27	6.494	0.009	CS > F*, M > F*
W H_{AO}	2.02 ± 0.14	1.45 ± 0.21	1.74 ± 0.15	13.754	<0.001	CS > M*, CS > F***, M > F*
W H_{CF}	2.02 ± 0.49	1.91 ± 0.26	2.21 ± 0.33	1.329	0.294	–

[a] Mean of Shannon–Wiener index values (±S.D.) obtained from the whole year sample and from each season samples (SS, Spring–Summer; A, Autumn; W, Winter).

[b] CS, cultivated strips; M, meadow; F, field.

[c] $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.

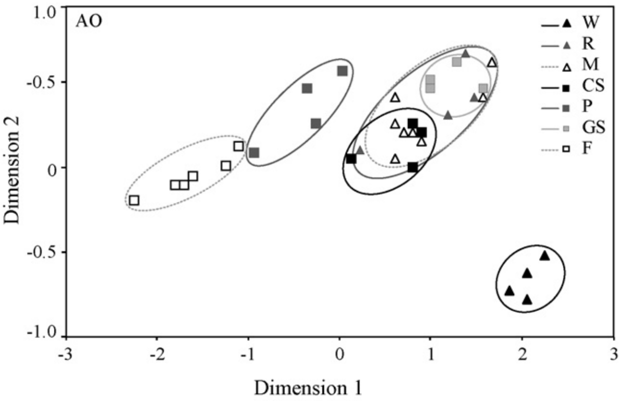

Fig. 1. Multidimensional scaling performed on the frequencies of Arthropod orders (AO) considering the whole sampling period. Triangles and squares indicate the pitfall traps of the seven surveyed sites (see Table 1 for abbreviations). Ellipses group together the pitfalls belonging to the same land use.

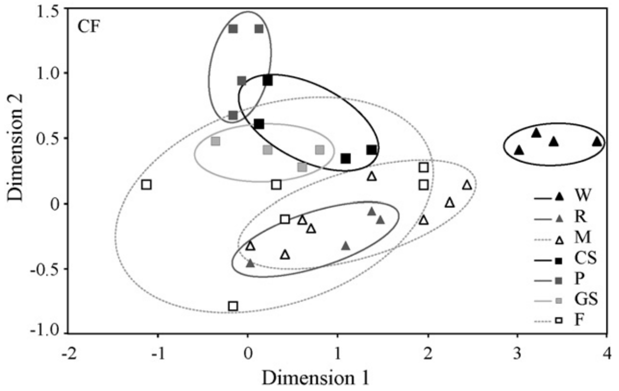

Fig. 2. Multidimensional scaling performed on the frequencies of Coleoptera families (CF) considering the whole sampling period. Triangles and squares indicate the pitfall traps of the seven surveyed sites (see Table 1 for abbreviations). Ellipses group together the pitfalls belonging to the same land use.

Accordingly, Mantel test indicated a very high correlation between the similarity patterns of AO and CaS (Spearman's rho = 0.949, $P < 0.001$) while weaker correlations were found between AO and CF (Spearman's rho = 0.280, $P = 0.007$) and between CaS and CF (Spearman's rho = 0.362, $P = 0.002$). The dyadic comparisons of euclidean distances between pairs of CS and M traps vs those of CS and F traps confirmed the patterns of similarity indicated by multidimensional scaling. In fact, considering AO and CaS, the CS faunal composition was significantly more similar to the M one than to the F one (AO: Mann–Withney U-test: $n_1 = 32$, $n_2 = 24$; $U = 75$, Monte Carlo $P < 0.001$; CaS: Mann–Withney U-test: $n_1 = 32$, $n_2 = 24$; $U = 128$, Monte Carlo $P < 0.001$). In contrast, CF composition in CS showed no significantly higher similarity with that of M or F (Mann–Withney U-test: $n_1 = 32$, $n_2 = 24$; $U = 382$, Monte Carlo $P = 0.981$).

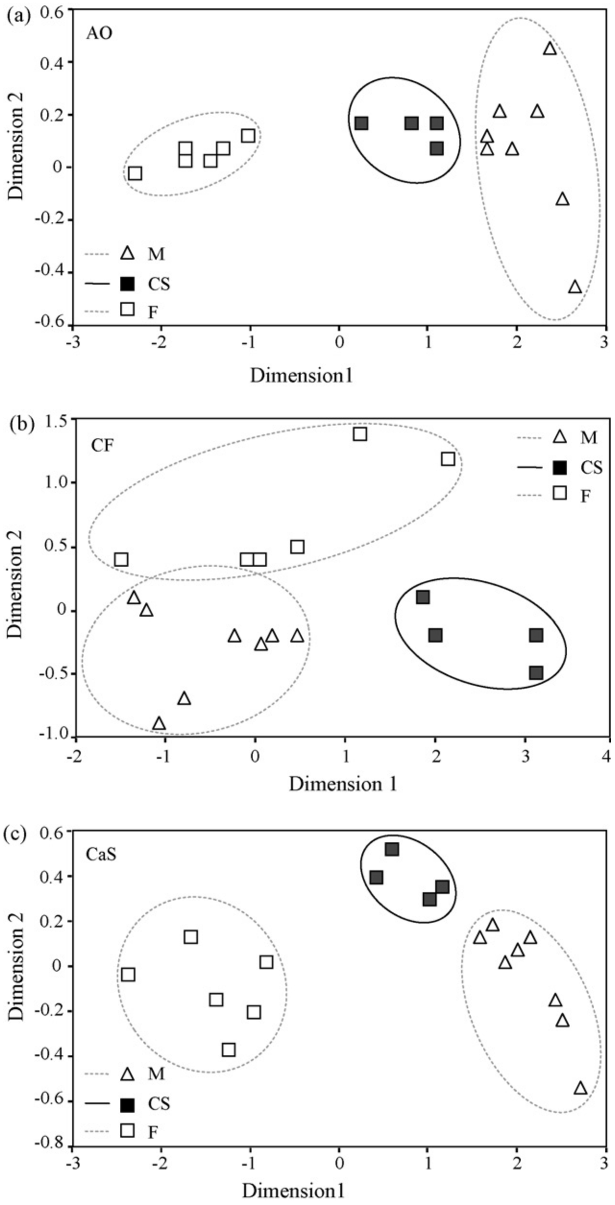

Fig. 3. Multidimensional scaling performed on the frequencies of Arthropod orders (a), Coleoptera families (b), and Carabidae species (c), considering the autumnal samples of the meadow (M), of the experimental cultivated strips (CS) and of the intensive wheat field (F). Ellipses group together the pitfalls belonging to the same land use.

We obtained analogous results considering the values of Shannon–Wiener biodiversity index. Indeed, for AO, accumulation curves of Shannon–Wiener index indicated that M and CS annual samples were characterized by similar values, while F showed clearly lower biodiversity values (Fig. 4a). In particular, the two F traps with the lowest values were the ones placed further from the vegetated margin of the cultivated area. ANOVA performed on the AO Shannon–Wiener index values calculated on the total of the sampled specimens, confirmed that the biodiversity levels found in F were the lowest among the three sites (Table 2); in contrast, the difference between the biodiversity values of CS and M

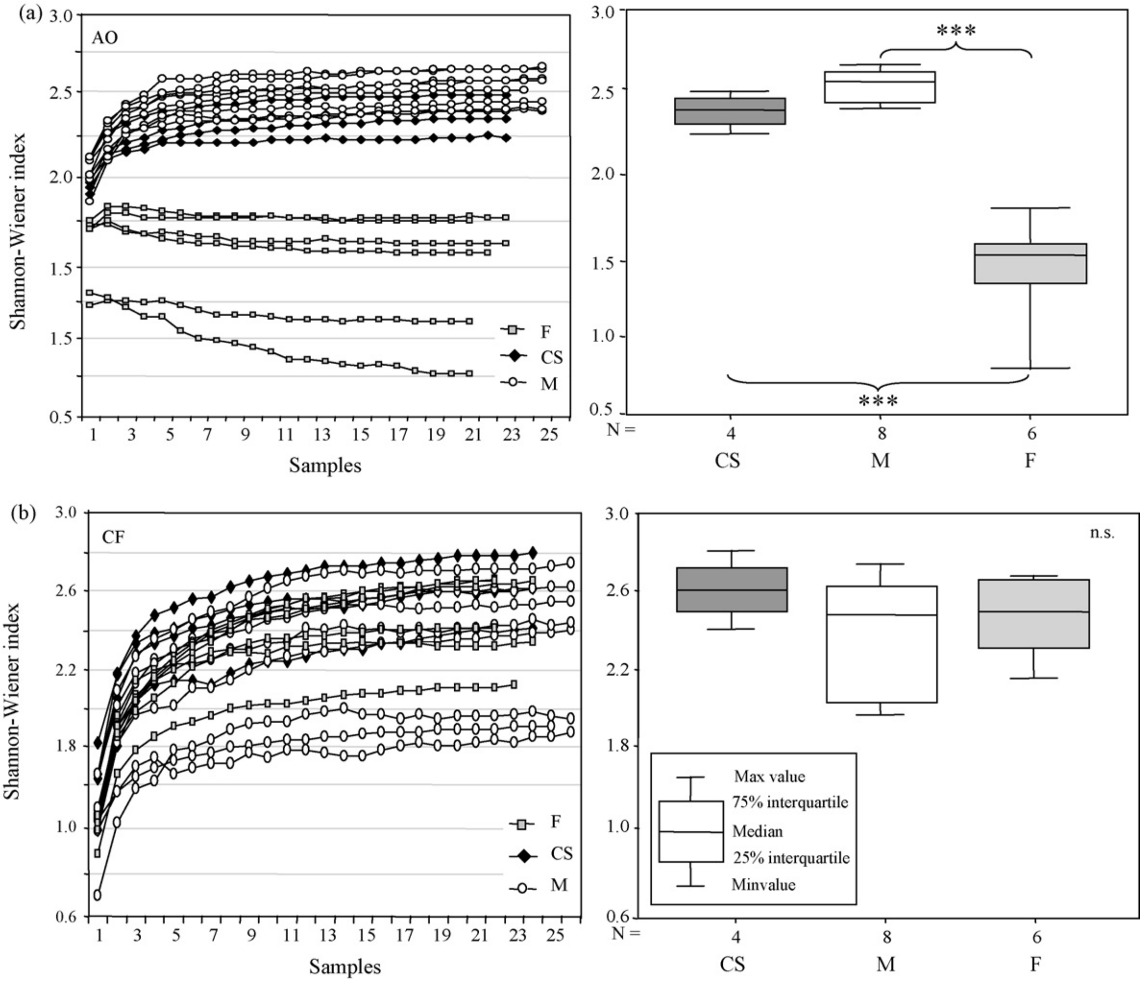

Fig. 4. Shannon–Wiener index of Arthropod orders (a) and Coleoptera families (b), considering the whole sampling period. The intensive wheat field (F), the experimental cultivated strips (CS) and the meadow (M) were considered. On the left: Shannon–Wiener index accumulation curves. Each line represents a single trap. On the right: ANOVA pair-wise comparisons of Shannon–Wiener index values among the three sites. Boxplots show median, interquartile, and extreme values.

was not statistically significant (Table 2) (Fig. 4a). As for CF biodiversity accumulation curves, all the traps showed values clustered in the same range (Fig. 4b). ANOVA analysis performed on the Shannon–Wiener index values confirmed this observation revealing no differences in the biodiversity levels of CS, M and F (Table 2) (Fig. 4b). The shape of the Shannon–Wiener index accumulation curves indicated that a well-defined plateau was reached for each trap, for both AO and CF.

Concerning the seasonal investigations, ANOVA performed on AO Shannon–Wiener index values of CS, M and F revealed significant differences for each of the three periods in which the year was divided. In particular, F was always characterized by the lowest levels of biodiversity (Table 2). CS and M showed significantly different biodiversity levels both in Autumn and in Winter, and no significant differences in Spring–Summer (Table 2). ANOVA performed on CF Shannon–Wiener index values of CS, M and F showed no significant differences in any of the three seasons (Table 2). ANOVA performed on the Shannon–Wiener index values calculated on the total of CaS collected in Autumn in CS, M and F, revealed no differences in biodiversity levels between CS and M, while they both differed from F (Table 2). Considering the autumnal samples of CS, M and F, Pearson test confirmed the previous results, revealing a positive significant correlation among the Shannon–Wiener index values of AO and CaS ($n = 18$, Pearson corr. = 0.611, $P = 0.007$), while no correlations were found either between CF and AO ($n = 18$, Pearson corr. = −0.332, $P = 0.178$) or between CF and CaS ($n = 18$, Pearson corr. = −0.382, $P = 0.118$).

4. Discussion

Our study suggested a possible approach for fast and simple biodiversity assessments in agro-ecosystems, at least at a local scale. Analyses of Arthropod fauna performed at order level allowed the distinction of different land uses on the basis of their faunal composition and diversity. Most prominently, the similarities among sites highlighted by the order level study were completely analogous to those obtained analyzing Carabidae species. This group is considered among the most appropriate indicators for different types of open habitats (Eyre and Luff, 1990).

The correlation between higher *taxa* analysis results and the ones obtained at species level is the basic requirement for considering a surrogacy viable (e.g. Williams and Gaston, 1994; Balmford et al., 1996; Cardoso et al., 2004). The results we obtained at order level perfectly matched the analyses of Carabidae species, focused on the comparison of CS, M and F (Fig. 3). Indeed the two taxonomical level analyses revealed the same pattern of relations among land uses considering both faunal composition (see results of multidimensional scaling, Mantel tests and Mann–Withney comparisons) and Shannon–Wiener index levels (see ANOVA comparisons and Pearson test). On the contrary the same analyses performed at family level for Coleoptera showed different results. In particular, Coleoptera family composition revealed a less clear distinction among all the investigated sites and no differences in Shannon–Wiener index levels among CS, M and F. Such results suggested that the family level may be not suitable for analyzing the diversity of Coleoptera that, when examined at specific level, revealed to be very sensitive indicators (Asteraki et al., 1995; Petit and Usher, 1998; Pfiffner and Luka, 2003; Grandchamp et al., 2005).

Arthropod order composition varied among sites characterized by different land uses of varying intensity. This was true even when the surveyed sites were close to one another and small in size (e.g. inside the experimental centre). Considering the position of the cultivated strips (CS), next to the meadow (M) and alternated with the undisturbed grass strips (GS), we could expect them to show a faunal composition similar to that of such semi-natural habitats. In accordance with this hypothesis, the order composition analysis showed that the cultivated strips, and the experimentally cultivated area as a whole (CS + GS), were more similar to the surveyed semi-natural open habitats, such as the meadow and the riparian strip (R), compared to the intensively cultivated field (F) (Fig. 1). Analogous results, even more emphasized, were obtained when taking into account Shannon–Wiener index. In both the annual and the seasonal investigation of order diversity, the experimentally cultivated strips showed Shannon–Wiener index levels higher than those of the intensively cultivated field and generally similar to those of the meadow. Moreover, considering just the surveyed open habitats (that is excluding the woodlot), the highest levels of order Shannon–Wiener index were found in the sites showing the highest plant species richness per sampling plot (Table 1). The only exception was represented by the cultivated strips that, in spite of presenting a relatively low number of plant species, were characterized by high Shannon–Wiener index values. These observations are in accordance with the results of previous studies that pointed out the importance of organic farming in combination with semi-natural area maintenance in order to preserve and enhance Arthropod assemblages in agricultural landscapes (e.g. Pfiffner and Luka, 2003).

Several advantages of the use of higher *taxa* have been proposed such as the great simplification of the taxonomical identification, which allows considerable saving of time and of human resources (Andersen, 1995; Sauberer et al., 2004). Obviously, in our study, the use of order level made the Arthropod taxonomical identification particularly simple and feasible also for non specialists. Order recognition, in fact, requires few completely unambiguous morphological features (obvious external characteristics) that a relatively untrained individual can easily and quickly utilize. Other approaches, such as the use of morphospecies, have been tested in order to simplify and speed up the taxonomical identification of Arthropods. Yet several problems might arise in morphospecies recognition when analyzing *taxa* exhibiting extreme sexual dimorphism, developmental polymorphism or presenting polymorphic social castes (e.g. ants) (Oliver and Beattie, 1993). In such cases mistakes in the analysis could be avoided by including only one sex, sexually mature individuals and a single caste (e.g. worker nonalate ants) respectively, which, however, might cause some species to be missed (Oliver and Beattie, 1993). Moreover, the widespread dependence on internal anatomies and genetic differentiation for species identification within many invertebrate *taxa* could limit the use of the morphospecies approach (Oliver and Beattie, 1996).

Another important element to develop a fast way to estimate biodiversity could be the verification that a shorter sampling period (4 months on average, in our study) would lead to results comparable to those obtained in a whole year of field work. The Arthropod order analyses in all the three considered seasonal periods was in accordance with both the seasonal analysis of Carabidae species and the annual investigation of order diversity. Considering Coleoptera families, no differences in Shannon–Wiener index levels were revealed in any ‘‘season’’ among different sites, thus confirming the results obtained in the whole year of sampling activity.

As far as the adopted sampling procedure is concerned, the use of pitfall traps resulted quite practical. Pitfall trapping is among the most widespread standardized methods for collecting the epigeal active Arthropod fauna (Southwood, 1978; Asteraki et al., 1995; Thomas and Marshall, 1999; Pfiffner and Luka, 2003; Duelli and Obrist, 2003). Such traps are relatively inexpensive and easy to set and collect (Thomas and Marshall, 1999). Furthermore, the components we chose for the attractive solution (vinegar and acetylsalicylic acid) were inexpensive and suitable for an easy standardization of the collections.

5. Conclusion

We suggest that our methodology could be a useful short-cut to compare biodiversity levels in agricultural landscapes, at least in a first phase of investigation. The procedure we used, in particular order level surrogacy, could be seen as a preliminary approach when it is not possible to identify the specimens at a low taxonomic level in a reasonable period of time and in a context of limited financial resources.

To our knowledge, the efficiency of order level surrogacy have been poorly investigated. However it could offer several advantages. Identification of Arthropod orders is particularly unambiguous and feasible also for non specialist taxonomists, so allowing an obvious saving of time and resources. Moreover, the use of such a high taxonomical level provides information on a large number of *taxa* (Cardoso et al., 2004), thus permitting the retention of broad biological information useful for the understanding of distribution patterns (Eggleton et al., 1994; Williams et al., 1994; Gaston et al., 1995). Further studies are needed to test whether our results are region-specific or whether they are of a more generic nature with regards to arable landscapes.

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