Ecological focus area – EFA: the biological value of olive groves. A case study in Sardinia (Italy)

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Abstract

Among the CAP (Common Agricultural Policy) 2015-2020 innovations, a mandatory 'greening' component of direct payment has been included to improve sustainable and environmentally friendly agricultural practices in arable lands. Permanent crops[1] are considered as 'greening' by definition and therefore exempted from additional agronomic duties. So far, however, an adequate knowledge of the real biological value of permanent crops is still lacking. In the present work, realized in the context of the MO.NA.CO. project, we monitored animal diversity in olive-groves characterized by three different managements (from low to medium intensity). Monitoring was carried out in Sardinia (Italy), using different animal groups as bio-indicators: Arthropods, Reptiles and Birds. Considering Arthropod orders and Coleopteran families we did not found significant differences in the overall abundance and in the biodiversity indexes. However, faunal composition clearly varied among managements: moreover, the higher or lesser presence of certain taxa highlighted the existence of micro-environmental variables that may be related, for instance, to the level of soil vegetation cover or to the degree of naturalness of the agro-ecosystem. Limitedly to the Arthropod diversity, the comparison with other land uses (including data gathered in previous projects) showed a good potentiality of olive groves as 'ecological focus areas', at least considering the managements here examined. The monitoring of Reptiles and Birds showed the peculiarity of the olive groves located in a hilly area characterized by non-intensive management, which hosted a rich herpetofauna and a bird community typical of habitats characterized by a high degree of naturalness.

The present monitoring provides data for the assessment of the biological value of olive groves and of the potential impact of different managements on faunistic diversity. Future monitoring is needed to improve the knowledge on olive tree plantations characterized by high intensive management.

[1]Permanent crops are ligneous crops, meaning trees or shrubs, not grown in rotation, but occupying the soil and yielding harvests for several (usually more than five) consecutive years. Permanent crops mainly consist of fruit and berry trees, bushes, vines and olive trees. (EUROSTAT glossary http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Permanent_crops).

Introduction

'One of the major novelty of the new CAP 2015-2020 is represented by the environmental component of direct payments, the so-called ecological or greening payment, which is paid per hectare of land and bound by agricultural practices beneficial to the climate and the environment. The greening provides for the application, on the surface eligible for direct payments, three types of agricultural practices: crop diversification, maintenance or introduction of ecological focus areas and maintenance of permanent grasslands.' (Retrieved on the web site of the Italian Ministry of Agricultural, Food and Forestry Policies, 2015).

An area of ecological interest [Ecological Focus Area (EFA)] is an extension of agricultural land on which sustainable crops are grown and/or environmentally friendly agricultural practices are carried out. The main objective of EFA is to improve biodiversity. The fulfilment of the provisions of greening is mandatory for all farmers who are eligible for the CAP contributions. The greening only applies to arable crops under the conditions provided for by Regs (EU) n. 1305 and 1307/2014. All permanent tree crops (orchards, vineyards, olive groves, citrus orchards, etc.) are exempted from the constraints of greening because considered greening by definition. The intrinsic ecological value ascribed to these crops allows them to be paid without any additional agronomic commitment. In the light of above, one criticism is that there is not any distinction between areas characterized by permanent crops that really have a high natural value (*e.g.*, traditional groves secularly contributing to biodiversity) and new intensively managed plantantions, most likely not favouring biodiversity.

In the present work, we report the results obtained by monitoring animal diversity in three Sardinian areas characterized by different olive crop managements (intensity degree: from low to medium). This monitoring has been performed in order to provide data to evaluate the power of the European approach that assigns *tout court* a high biological value to these permanent crops and, so far as possible, to provide scientific data to improve the legislation on greening. Indeed, nowadays, the biological value of olive crops has been less investigated in Italy. It would be desirable that future monitoring activity will be carried out to provide further data for the evaluation of the biological value of olive crops, especially those intensively managed.

Materials and methods

Monitoring areas

Monitoring activity was performed in central-western and south-western Sardinia, in three areas characterized by different managements: Seneghe (Province of Oristano), Narbolia (Province of Oristano), and Villacidro (Province of Medio Campidano) (Figure 1). Some of the main management practices, typical of the three areas, are shown in Table 1. Three sampling sites per area were chosen (OS1, OS2, OS3 in Seneghe; ON1, ON2, ON3 in Narbolia, OV1, OV2, OV3 in Villacidro).

Sampling methods and data analyses

Diversity of ground-dwelling Arthropods

In each of the nine monitoring sites, four pitfall traps have been placed following Biaggini *et al*. (2007, 2011). Traps were filled and emptied every two weeks, from 31/03/2015 to 15/05/2105.

Arthropods were identified at the order level, except for the family Formicidae - that was distinguished from the other Hymenottera, given its abundance (Jerez-Valle *et al*., 2014) - as well as for Anellida, Nematoda and Mollusca, for which just the phylum was indicated. For the sake of brevity, in the text we will refer to all the above mentioned groups as 'ground-dwelling Arthropods' or 'arthropodofauna'. Coleoptera were identified at the family level.

To asses the biodiversity levels of olive groves the Shannon-Wiener index (H) was calculated on both Arthropod orders (HArtr) and Coleopteran families (HCol). To test whether the olive groves characterized by the same management differed in Arthropod and Coleoptera abundance (NArtr, NCol) and diversity (HArtr, HCol), these four variables were compared among sites located in the same area. When no differences were found, data from the olive groves of the same area were pooled together in the following comparisons among managements (areas). Kruskal-Wallis test was used for comparisons.

In order to detect possible differences of the faunal composition among areas a PCA (Principal Component Analysis) was performed on the frequencies of both Arthropod orders and Coleopteran families.

Finally, Arthropod order diversity (HArtr) was compared among olive groves and other land uses (agricultural and semi-natural), using both

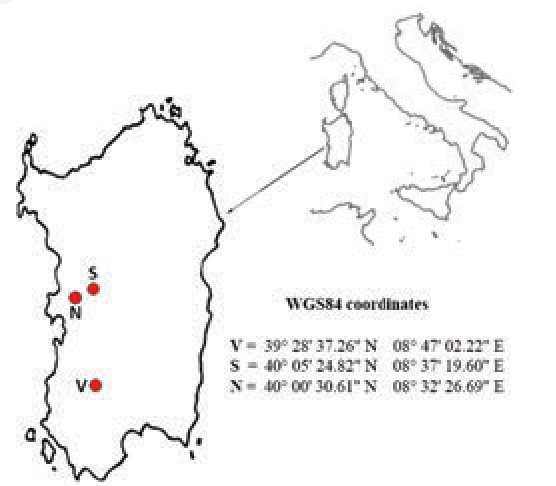

Figure 1. Map of the three areas in which monitoring sites were located: Seneghe (S), Narbolia (N), Villacidro (V).

Table 1. Main management practices in the three monitoring areas.

Area	Altitude (m asl)	Treatments against *Bactrocera oleae*	Other chemicals	Pruning	Ploughing	Mowing	Other managements
Seneghe	200 - 340	Sporadic	No	Less than once a year	No	Sporadic	Sheep grazing for grass control
Narbolia	10-20	Common	No	More frequently, when necessary	Every 5-6 years	Annual	Sheep grazing for grass control
Villacidro	105	Common	Herbicides Fertilizers	More frequently, when necessary	No Use of harrow	Annual	Irrigation

data from Efficond and MO.NA.CO. projects (gathered with the same sampling methods, Table 2). Data regarding the same land use category, but sampled in different areas during the MO.NA.CO. project (M1 and M2, Table 2), were pooled after testing the absence of significant differences (Biaggini *et al*., 2015; Corti *et al*., 2015). ANOVA and Tukey HSD *post-hoc* tests were used for this comparison.

Lacertid/Reptile abundance

In each site 100 m long linear transects were performed walking at constant speed and recording number and species of Lacertid lizards (as well as other Reptiles, when present) observed within 1 m on both sides of the line. Three or four transects *per* site (depending on the site extension) were performed and replicated three times, simultaneously with the Arthropod sampling.

To test the possible influence of olive grove management on Reptile abundance, both lizard and reptile abundances, were compared among the three areas using Kruskal-Wallis and Tukey HSD *post-hoc* tests.

Finally, in order to determine the herpetofauna living in the surroundings of the sampled olive groves, in Seneghe, Narbolia and Villacidro we surveyed an area of about 5 km radius around the monitoring sites, searching for Amphibians and Reptiles during repeated samplings.

Avifauna survey

Given the high mobility of birds, two biases may likely occur when surveying avifauna at field scale: multiple records of the same individual as well as additional counts of species in transit. To avoid such risks, the following method, modified from Mackinnon (1990), was adopted. Transects and point counts were performed, recording each individual and drafting lists of just three species. Each species had to be present just once per list, but it could be repeated in the following list. The frequency of each species was calculated as the ratio between its records and the total number of drafted lists. Bird surveys were performed together with Arthropod and herpetofauna samplings.

A PCA was performed on the frequencies of species. Two categories of species were also defined: i) typical of open habitats and/or able to take advantage of human altered environments; ii) typical of forested habitats and/or not advantaged by the presence of human activities. The frequencies of these two categories were compared among areas (and managements), using the G test.

Results

Diversity of ground-dwelling Arthropods

We identified 4677 Arthropods and 1315 Coleoptera. Descriptive statistic of Arthropods and Coleoptera abundance (NArtr, NCol) and diversity (HArtr, HCol) in the three monitoring areas is shown in Table 3.

NArtr did not show significant differences among sites located in the same area (Table 3), and among different areas (managements) (N = 101, H = 0.809, P= 0.667) (Figure 2).

NCol did not significantly varied among sites in the areas of Villacidro and Seneghe (Table 3); in Narbolia we found that the site ON1 hosted significantly more Coleoptera than ON3 (Multiple

Table 2. List of the land uses involved in the comparison of Arthropod diversity levels, and data sources.

Land use	Sampling dates	Project	References
Pasture M1 Set-aside M1 Arable lands M1 Olive groves M1	8/5-5/6/2013	MO.NA.CO.	Biaggini *et al*., 2015 Corti *et al*., 2015
Olive groves M2	31/3-28/4/2015	MO.NA.CO.	Present article
Pasture EF Set-aside EF Arable lads EF Woodlot EF Riparian strip EF	23/3-3/5/2004	EFFICOND	Biaggini *et al.*, 2007, 2011

Table 3. Descriptive statistic of Shannon index (H) and abundance (N) calculated for Arthropod orders (Artr) and Coleoptera families (Col) (values refer to single samplings), and comparisons of these variables among sites of the same area.

Area	Var.	Average value	Minimum	Maximum	St. Dev.	Intra-area comparisons
Villacidro (N=32)	NArtr	47.469	22	110	23.860	H = 0.150. P = 0.928
	NCol	15.438	0	44	12.743	H = 1.822. P = 0.402
	HArtr	2.050	1.028	2.681	0.384	H = 0.721. P= 0.697
	HCol	1.309	0	2.609	0.701	H = 2.143. P= 0.3425
Narbolia (N=34)	NArtr	47.706	11	116	22.030	H = 3.245. p = 0.197
	NCol	18.588	0	72	15.800	H = 11.192. P = 0.004
	HArtr	2.014	1.007	2.627	0.338	H = 2.249. P= 0.325
	H Col	1.138	0	2.264	0.577	H = 6.391. P = 0.041
Seneghe (N = 35)	N Artr	43.886	13	101	20.342	H = 0.100. P = 0.951
	N Col	5.400	0	16	4.139	H = 3.767. P = 0.152
	H Artr	1.993	0.848	2.824	0.401	H = 0.217. P = 0.897
	H Col	0.949	0	2.352	0.737	H = 6.4291. P = 0.040

Comparisons: P=0.003). Comparing NCol among the 9 sites (not pooled in relation to areas) we found that ON1 was the richest one (N=101, H=35.943, P<0.001), significantly richer than all Seneghe sites (Multiple Comparisons: P<0.01). Excluding ON1 from the analyses and comparing NCol among areas (as done for the other variables) we found significantly lower Coleopteran abundance in Seneghe (N=89, H=16.824, P<0.001. Multiple Comparisons: Seneghe < Villacidro, P<0.001; Seneghe < Narbolia, P=0.020) (Figure 2).

Regarding the Shannon index, HArtr was comparable among sites of the same area (Table 3), and among different managements (N=101, H=0.627, P=0.731) (Figure 3). Analyzing the diversity of Coleoptera we found just negligible differences among olive groves belonging to the same area in Narbolia (Table 3, Multiple Comparisons: OS2 > OS1, P=0.048) and in Seneghe (Table 3, Multiple Comparisons n.s.). Comparing HCol among managements we found not significant differences (N=101, H=0.947, P=0.139) (Figure 3).

Higher variability among managements arose from the analysis of faunistic composition, considering Arthropod orders and Coleoptera families. For both taxonomic levels, the PCA distinguished Seneghe from the other two areas. As far as orders are concerned, the first and the second components explained together nearly 80% of total variance (PC1 49.12%, PC2 28.29%). PC1 distinguished Seneghe from the other sites. It was characterized by the following main coefficients: Coleoptera -0.75, Collembola 0.60, Araneae -0.15, Hymenoptera Formicidae 0.24 (Figure 4). PC2, with the main coefficient being Diptera 0.88, Hymenoptera Formicidae -0.36, Coleoptera -0.22 and Collembola -0.21, partially distinguished Narbolia from Villacidro (Figure 4). The PCA performed on Coleoptera separated Seneghe from the other areas along PC1 axis, too. PC1 explained 47.85% of the total variance and it was characterized by the following principal coefficients: Scarabaeidae -0.79 and Nitidulidae 0.55.

Anova performed on Arthropod diversity (HArtr) of various land uses (Table 2) showed significant differences (N=214, F=32.92, P<0.001) (Figure 5); *post-hoc* results are shown in Table 4.

Lacertid/Reptile abundance

Species of Amphibians and Reptiles observed in the surroundings of the monitoring sites are listed in Table 5. The total number of observed species varied from 8 in Villacidro, to 9 in Narbolia and 14 in Seneghe. Nevertheless, during transecting we observed in total 5 species, with a maximum of 3 species per area (Table 5).

The comparison of Reptile abundance (number of Reptiles / 100 m)

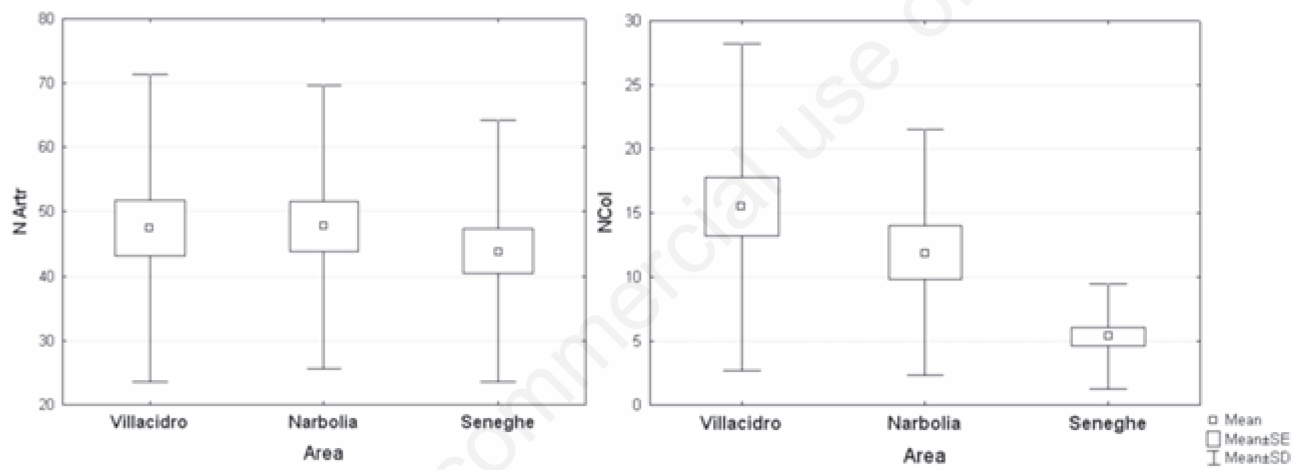

Figure 2. Abundance of Arthropods (NArtr) and Coleoptera (NCol) in the three areas of Villacidro, Narbolia and Seneghe.

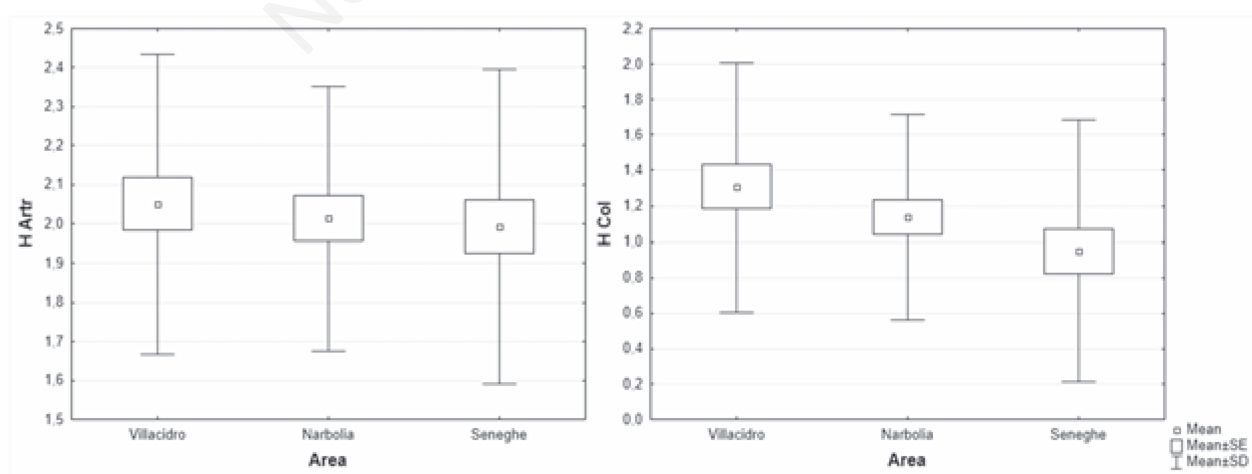

Figure 3. Shannon index of Arthropod orders (HArtr) and Coleoptera families (HCol) in the monitoring areas of Villacidro, Narbolia and Seneghe.

among managements indicated significant differences (Kruskal-Wallis test, N=90, H=10.628, P<0.001); *post-hoc* test revealed a higher number of Reptiles per transect in Seneghe in comparison to both Narbolia (P=0.002) and Villacidro (P<0.001). The same analysis performed on just Lacertids, gave analogous results, with Seneghe showing the highest abundance per transect (Kruskal-Wallis test, N=90, H=20.042, P<0.001; *post-hoc*, Seneghe > Narbolia, Villacidro, P<0.001) (Figure 6).

Finally, also the comparison of the number of Reptile species per transect showed a higher richness in Seneghe (Kruskal-Wallis test, H=11.499, P<0.001; Seneghe > Narbolia, Villacidro, P<0.001) (Figure 6).

Avifauna survey

We registered 44 species in the three monitoring areas (the complete list is available in Corti *et al.*, 2015). The PCA performed on species frequencies showed a clear distinction of the area of Seneghe along PC1 axis (Figure 7). PC1 (30.48% of total variance) was carachterized by the following coefficient: *Cyanistes caeruleus* -0.59, *Fringilla coelebs* -0.46, *Sylvia atricapilla* -0.30, *Turdus merula* -0.19, *Corvus cornix* 0.37, *Sylvia melanocephala* 0.19.

The peculiarity of Seneghe's avifauna is also clearly shown in Figure 8. G test highlighted significant differences in the frequencies of the two categories of bird species (more or less able to adapt to human altered landscapes, see definitions) (G=49.98, P<0.001) among areas.

Discussion

The results obtained thanks to the MO.NA.CO. project by monitoring animal diversity in olive groves represent a contribution to the assessment of the 'ecological value' of these permanent crops.

The use of multiple indicators allowed us to highlight various aspects related to the environmental protection in agricultural landscapes.

As regards the analysis of invertebrates, the three considered managements did not seem to notably affect neither the abundance nor the biodiversity index values of the taxonomical level order. On the contrary, differences were found when examining the faunistic composition. Analyzing the relative frequencies of Arthropod orders, indeed, we found that the olive groves located in Seneghe, in the hilly area characterized by low management intensity and by relatively low human impact, clearly differed from the others. Previous studies had shown

Table 4. Tukey HSD *post-hoc* test comparing Arthropod diversity (HArtr) among ten land uses.

	1	2	3	4	5	6	7	8	9	10
1		0.002	< 0.001	< 0.001	n.s.	n.s.	n.s.	n.s.	< 0.001	n.s.
2	0.002		n.s.	n.s.	n.s.	< 0.001	0.024	n.s.	< 0.001	n.s.
3	< 0.001	n.s.		n.s.	n.s.	< 0.001	0.011	n.s.	< 0.001	n.s.
4	< 0.001	n.s.	n.s.		n.s.	< 0.001	0.011	n.s.	< 0.001	n.s.
5	n.s.	n.s.	n.s.	n.s.		0.044	n.s.	n.s.	< 0.001	n.s.
6	n.s.	< 0.001	< 0.001	< 0.001	0.044		n.s.	0.002	< 0.001	0.024
7	n.s.	0.024	0.011	0.011	n.s.	n.s.		n.s.	< 0.001	n.s.
8	n.s.	n.s.	n.s.	n.s.	n.s.	0.002	n.s.		< 0.001	n.s.
9	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001		< 0.001
10	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	< 0.001	(

1. Arable lands M1; 2. Pasture M1; 3. Olive groves M2; 4. Olive groves M1; 5. Set-aside M1; 6. Set-aside EF; 7. Riparian strip EF; 8. Pasture EF; 9. Arable lands EF; 10. Woodlot EF).

Table 5. Amphibians and Reptiles observed in Seneghe, Narbolia and Villacidro, in areas (5 km radius) around the monitoring sites (a) and along transects (t).

Order	Species	Seneghe		Narbolia		Villacidro	
		a	t	a	t	a	t
Amphibia	*Discoglossus sardus*	•				•	
	Bufo balearicus	•					
	Hyla sarda	•		•		•	
Reptilia	*Emys orbicularis*	•					
	Testudo graeca	•		•			
	Euleptes europaea	•					
	Hemidactylus turcicus	•				•	
	Tarentola mauritanica	•	•	•	•	•	
	Chalcides chalcides	•		•		•	•
	Chalcides ocellatus	•					
	Algyroides fitzingeri	•		•			
	Podarcis siculus	•	•	•	•	•	•
	Podarcis tiliguerta	•	•	•	•		
	Natrix maura			•		•	
	Hierophis viridiflavus	•		•		•	•
Total number of species		14	3	9	3	8	3

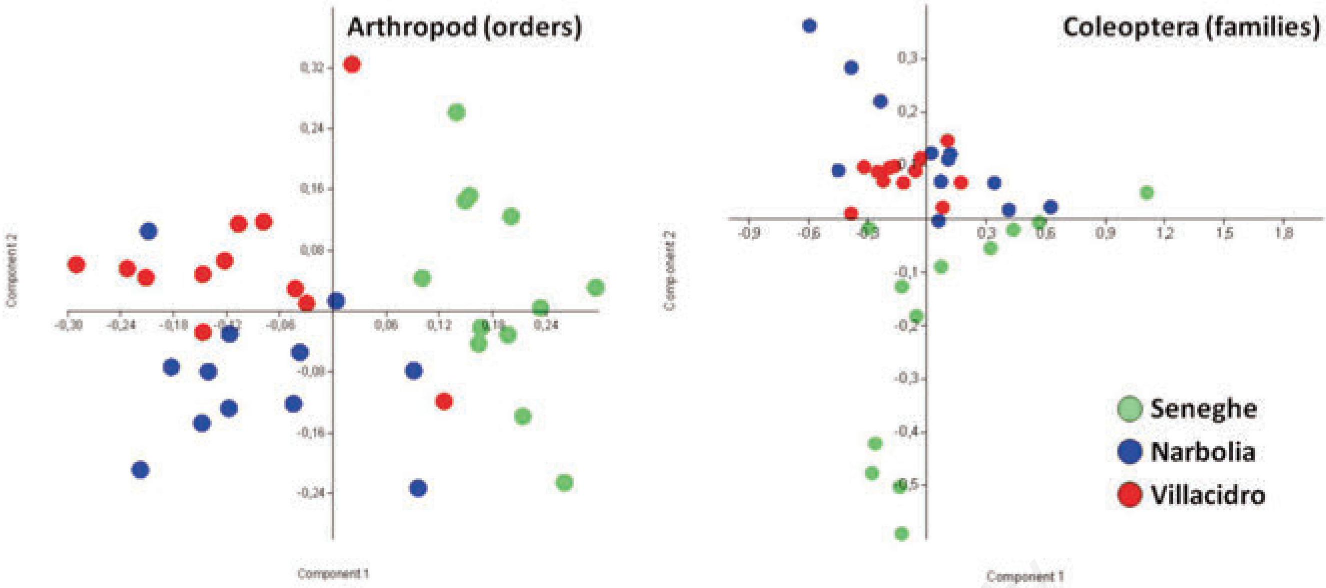

Figure 4. PCA performed on the frequencies of Arthropod orders (left) and Coleoptera families (right) in the three monitoring areas (indicated by different colours). Each circle represent one pitfall.

that soil Arthropods examined at higher taxonomic levels proved to be usefull to discriminate between olive grove managements (Ruano *et al*., 2004; Cotes *et al*., 2010; Jerez-Valle *et al*., 2014). Among the main distinguishing factors of the low intensively managed olive groves, we found a greater presence of Collembola and a lesser percentage of Coleoptera. In Seneghe such abundance of Collembola - essentially detritivores which are usually associated with litter and humid microhabitats - might partially depend on the presence of dry stone walls and / or rocky outcrops. These elements can offer particularly favorable moisture conditions that may last even during the dry season. The moisture conditions of the substrates is a variable strongly affecting the presence of this taxon (Rebek *et al*., 2002). In addition, the trunk of large olive trees can provide analougous moisture gradient in the soil, as well as an opportunity of refuge for Collembola. These insects are also strongly affected by ploughing and other agricultural practices altering the upper soil layers (Dittmer and Schrader, 2000), one more factor that might explain their relevant presence in the Seneghe sites. On the other hand, soil management in olive orchards can also influence the presence of ground-dwelling beetles (Castro *et al*., 1996; Morris and Campos, 1999; Cotes *et al*., 2009). The analysis of the faunistic composition of Coleoptera families also showed the same pattern of similarities among areas and managements. In fact, the sites located in the surroundings of Seneghe were distinguishable from the others mainly because of the relatively high presence of Scarabaeidae, seemingly linked to the availability of *pabulum*, due to the occasional presence of grazing animals (*e.g*., sheep).

A finer level of analysis can give some more information about the possible effects of olive grove managements on insects. Curculionidae were fairly well represented in Seneghe, at least when compared to the other areas. They are mainly plant-eating insects: the presence of both strictly floricolous (*e.g.*, the genus *Lixus*) and nocturnal species (*e.g.*, *Otiorhynchus*), could indicate a quite high degree of plant diversity in the Seneghe olive groves. As a whole, in Seneghe, the abundance of Curculionidae and Collembola (already discussed), together with the prevalence of specific genera within the two taxa, could be interpretated as indicative of an ecosystem porely altered by the human activities, and with low managing pressure (in terms of both chemicals and mechanical practices). Moreover, the high diversity of Coleoptera, as inferred from a qualitative analyses of the lower taxonomical levels (genera), could indicate a more complex ecological structure of the beetle community in Seneghe (presence of many trophic categories: phytophagous, coprophagous, *etc.*).

On the other hand, the olive groves in Narbolia were characterized by a high presence of Coleoptera Cetonidae, mainly belonging to the genera *Oxythyrea* and *Tropinota*. These beetles are tipically floricolous and their presence could indicate the abundance of annual therophytes (particularly Asteraceae).

In Villacidro, where olive groves underwent a more intense management, we did not record a particular negative effect of treatments and

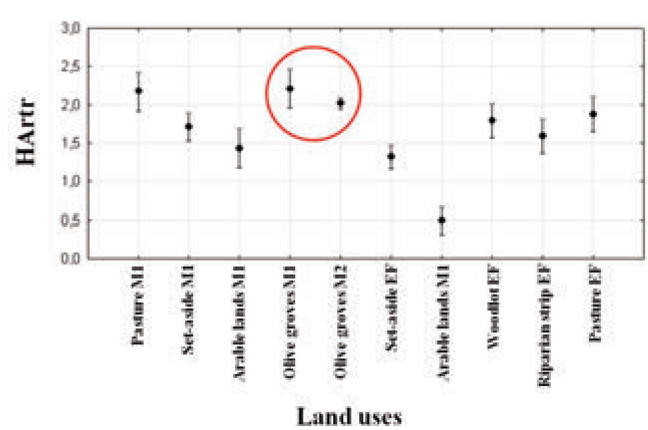

Figure 5. Comparison of Arthropod order diversity (HArtr) among different land uses, with data deriving from the projects Efficond and MO.NA.CO. The red circle highlights the olive groves.

mechanical practices on the epigean entomological fauna.

As far as herpetofauna is concerned, in the areas surrounding the monitoring sites we recorded from 8 to 14 species (Table 5). However, just three species were observed along the transects performed in the olive groves. Two of these species (*Tarentola mauritanica* and *Podarcis siculus*) are relatively anthropophilous and/or common in agricultural areas. The olive groves in Seneghe showed the highest values of reptile abundance and species frequency per transect. The areas strictly surrounding the olive groves of Seneghe and Narbolia hosted more species than those around Villacidro.

Analogous results, highlighting the peculiarity of Seneghe olive groves (the less intensively managed in our sampling design), were obtained from the analyses of avifauna. When discussing the data about birds, it is necessary to underline the key role of landscape features in influencing the species occurrence. Even the most sedentary species, indeed, easily exceeds the field scale in its daily movements. Also for this reason, the monitored olive groves were chosen inside areas dominated by homogeneous management, in order to dampen, as far as possible, the influence of adjacent land uses. As seen for invertebrates, the less intensive management (Seneghe) was distinguishable from the others thanks to the differences in its faunistic composition. In Seneghe, species typical of forested habitats and/or usually not advantaged by the presence of buildings or human activities predominated. On the contrary, in Narbolia and Villacidro, located in plain areas

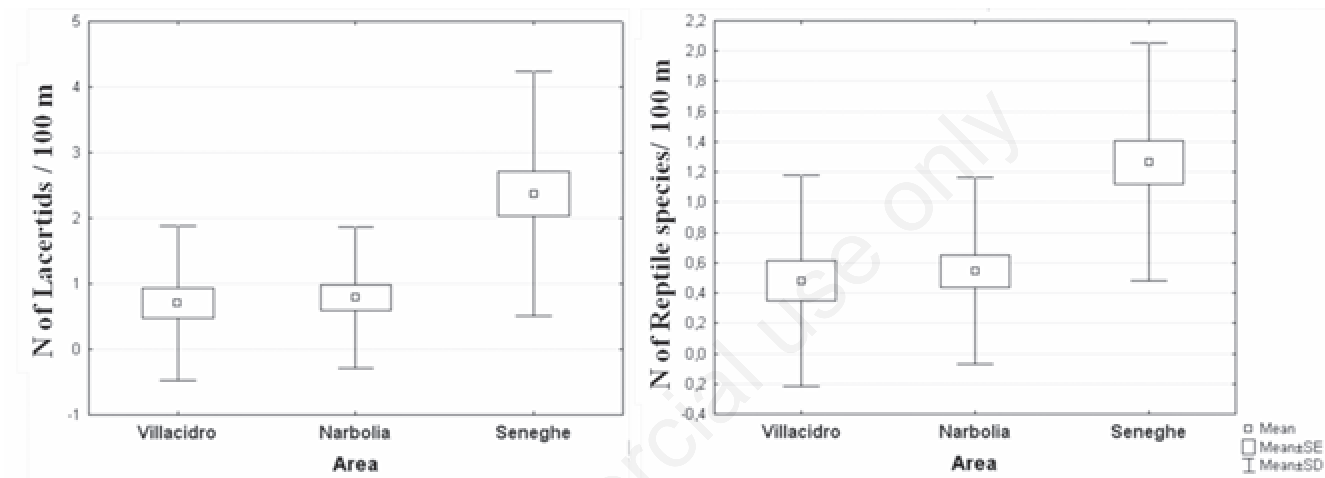

Figure 6. Number of Lacertids (left) and Reptile species (right) observed in the monitoring sites during transecting.

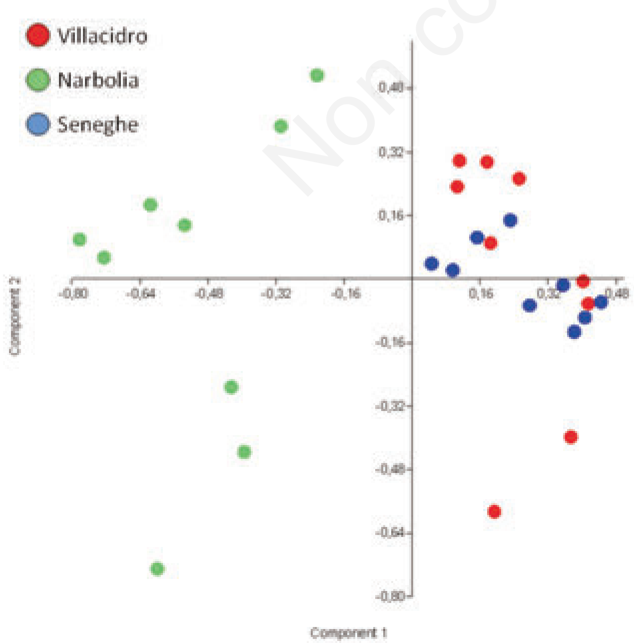

Figure 7. PCA performed on the frequencies of bird species in the three monitoring areas (indicated by different colours).

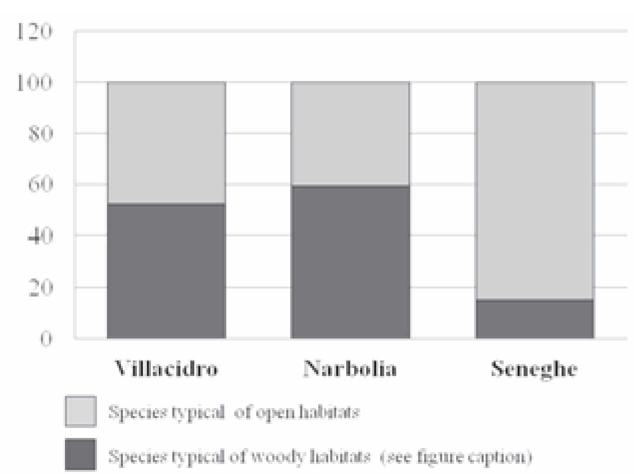

Figure 8. Frequencies of bird species in the three monitoring areas (Villacidro, Narbolia, Seneghe), classified in the two following categories: i) species typical of open habitats and/or able to take advantage of some human altered environments; ii) species typical of woody habitats and/or not advantaged by the presence of buildings or human activities.

with higher anthropic disturbance, species typical of open habitats and/or able to take advantage of human presence were more abundant.

In general, the comparison of the three olive grove managements revealed differences for all the selected indicators (ground-dwelling invertebrates, Coleoptera, Reptiles and Birds): abundance and faunal composition varied among areas, often stressing the 'peculiarity' of the less intensive managed sites. However, none of our results can be interpretated as absolutely indicative of a higher biological value of one kind of management with respect to the others. Previous studies already demonstrated that traditional olive groves show high levels of biodiversity and low rates of soil erosion (Loumou and Giourga, 2003) and for these reasons, their maintenance favours environmental conservation. On the other hand, the comparison among olive groves and other agricultural and semi-natural land uses (using Arthropod orders as indicators), showed a good potentiality of olive groves as ecological focus areas. Once more, it has to be stressed that the managements that we have considered in the present work ranged from low to medium intensity. The use of chemicals was just occasional in Seneghe, scarce in Narbolia (treatments just on the olive trees), more extensive in Villacidro; the soil cover was present throughout the year in Seneghe, for large part of the year in Narbolia and for a shorter period in Villacidro. Finally, all sites were located inside landscapes with relatively high heterogeneity, charcatcterized by cultivated areas of rather small extensions and by the presence of ecotonal boundaries (particularly in Seneghe). Obviously, these factors positively affect biodiversity and, as such, our results cannot be applied to other systems, such as intensively managed vast monocultures. As a matter of facts, it has been demonstrated that the replacement of the mosaic landscapes including traditional olive orchards with the intensive olive monocultures reduces both biodiversity and landscape values (Grove and Rackham, 1993; Santos and Cabral, 2003; Siebert, 2004).

The present work gives a contribution to the knowledge of the biological value of olive groves, indicating a good potentiality of these crops as ecological focus areas, particularly referring to less intensively managed systems. Future studies are obviously needed to implement data on similar managements and/or more intensive one.

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