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Evaluation of environment quality of a protected area in Northern Italy using Syrph the Net method

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Abstract

The present research aims to study the syrphid fauna in a protected area ("Bora", recognized as Site of Community Importance from the EU Habitats Directive) within a highly anthropised area in Northern Italy. Within the study-area, four habitat types were selected using the Corine Land Cover manual, including: eutrophic lake, *Salix* and *Populus* gallery, plain oak forest and Meso-European bush. Observations were assessed using Malaise traps and entomological net. Collected data were analysed using Syrph the Net, an informative standard tool used in Europe for habitat evaluations. Marshy area was the dominant habitat, but hoverfly fauna didn't present a suitable list of species connected to this habitat. Syrphid species typical of bushes and grass lawn were recorded. The sampling of typical forest species showed the important role of wood habitats within the agroecosystem to improve local biodiversity, with the exception of saproxylic syrphid species, which were not sampled.

The stress factors were supposed to be caused not by a specific management deficit but mainly by the isolation of those habitats involved in the biodiversity loss. For conservation purposes and an improved environmental quality, it seems crucial to strengthen landscape connectivity via linking small wet areas and wood remnants of the protected field with sites characterised by high biodiversity.

Key words: Diptera, Syrphidae, Syrph the Net, ecology, conservation.

Introduction

The relationship between agriculture and natural ecosystem has been changed by increasing the ecological consciousness that combined with the emergence of environment management and economic sustainability. A crop is considered as an ecosystem characterised by a close relation between biotic and abiotic components (Altieri, 1999). In this approach, biodiversity acquires a functional role in the maintenance of ecosystem stability (Rossing *et al*., 2003). Habitat destruction and fragmentation are considered to be major issues in landscape management, because they strongly affect the occurrence of species, and thus biodiversity (Turner, 1996; Wood *et al*., 2000; Fahrig, 2003; Tscharntke and Brandl, 2004). For this reason, it's important to ensure suitable ecological nets in rural areas that usually show a high fragmentation and lack of connectivity between crops and ecological infrastructures (Morisi, 2001). With this purpose the region of Emilia Romagna founded, with the Regional Law n. 11 of 2 April 1988, a new kind of protect area denominated Ecological Re-balanced Area (ERA). This typology of area is defined as a natural area, with restricted surface, included in highly anthropised rural areas. Given the fact that such ecological areas are usually sited in degraded zones, it is of primary importance not only to preserve its existing fauna but also to improve it by enhancing the connectivity with other biodiversity islands. The role of these areas, usually located in highly anthropised landscapes, is not only to preserve biodiversity, but also to create a connection among various natural areas.

Several authors suggested that syrphid fauna (Syrphidae Diptera) could be used as bioindicator in environmental area evaluation (e.g. Speight, 1986; 2008a; 2008b; Duelli and Obrist, 1998; Sommaggio, 1999; Speight and Castella, 2001; Sarthou *et al*., 2003; 2004; 2007; Sarthou and Speight, 2005; Speight and Sarthou, 2006). Its use as bioindicator was encouraged by several factors: first of all, syrphid species show different environmental ecological requirements; secondly, most of these species could be easily identified, at least in Central Europe, and also the availability of detailed faunistic studies is considered as an additional practical feature. The Malaise trap has been suggested as the standard method for collecting syrphid species (Speight *et al*., 1998), but this sampling technique could be integrated with other methods in order to increase the efficiency of the monitoring. For example, Burgio and Sommaggio (2007) have demonstrated that Malaise traps can underestimate the populations of some very common species like *Eristalis tenax* (L.), *Eristalis arbustorum* (L.) and *Eristalinus aeneus* (Scopoli), in comparison with yellow traps.

In recent years, a sophisticated professional system called Syrph the Net has been developed for syrphid community evaluation (Speight *et al*., 1998; Speight and Castella, 2001). The principal output of this system is the "biodiversity maintenance function" (BDMF), the ratio between observed and predicted species (Speight and Castella, 2001). An additional parameter is the ratio between the observed but not-predicted species and the observed species. Speight *et al*. (2002) used this method to evaluate the quality of the rural management in order to increase biodiversity in Ireland. Recently, Syrph the Net was also applied in a rural area of Northern Italy (Burgio and Sommaggio, 2007).

The main purpose of the present research is to study syrphid populations in an ERA characterized by four main habitats. This area is included in an antropised rural area in Northern Italy. A specific aim was to apply Syrph the Net to the list of syrphid collected in order to evaluate the quality of this environment. Another specific purpose was to understand if the local ecological net is suitable to support a syrphid community specific for each studied habitat and to know whether the management of the area is optimal or not. Beside these general purposes, the present research aims to improve the general knowledge about the syrphid fauna and its phenology in Italian environments.

Materials and methods

The environment

The ERA "Bora" is located in San Giovanni in Persiceto, Bologna Province (Northern Italy). This area was created from a retraining project of an old clay cave, concluded in 1994, and recently recognized as Site of Community Importance (SCI - IT4050019) from the EU Habitats Directive. Four habitat typologies have been individuated within the site, by means of Corine Land Cover manual (table1, figure 1).

The first two habitats were assembled in a single area denominated "Wet Zone", including a eutrophic lake and a *Salix* and *Populus* gallery characterized by the presence of hydrophylic natants and rooted vegetation [*Hydrocharis morsus-ranae* (L.), *Lemna* spp., *Nymphaea* spp.]. The other habitat typologies included "Oak Forest" (*Quercus robur* and *Carpinus betulus* forest), and "Bush", representing a meso-European bush composed by a hedgerows of *Crataegus*, *Prunus* and *Ligustrum* and *Graminacee* grasslands (Morisi and Lin, 2007). This last habitat is managed as a free-evolution area without any human intervention.

The climatic conditions, during the sampling seasons, were characterised by a dryness summer spaced out by few but violent storms while, during spring and autumnal months, the precipitations were more copious with, for example, 200 mm of fallen rain in spring 2007, with similar values found in spring and autumn 2008. The temperatures oscillate between 13 °C, in earlier spring, and 33.7 °C, in July 2007.

A Malaise trap was set in each of the following habitats: Wet Zone, Oak Forest and Bush. Traps were baited with 70° alcohol as preserving the collected material (see standard protocols of Syrph the Net) within a plastic collecting-bottle.

Table 1. Codification of the habitats studied.

Name	Cod.	Denomination	Surface (ha)
Wet Zone	3150 - 2216	Natural eutrophic lake	3,2
"	44.614	*Salix* and *Populus* gallery	0,7
Oak Forest	41.2	*Quercus farnia* and *Carpinus betulus* forest	3,5
Bush	31.81	Meso-European bush prunetalia	3,2

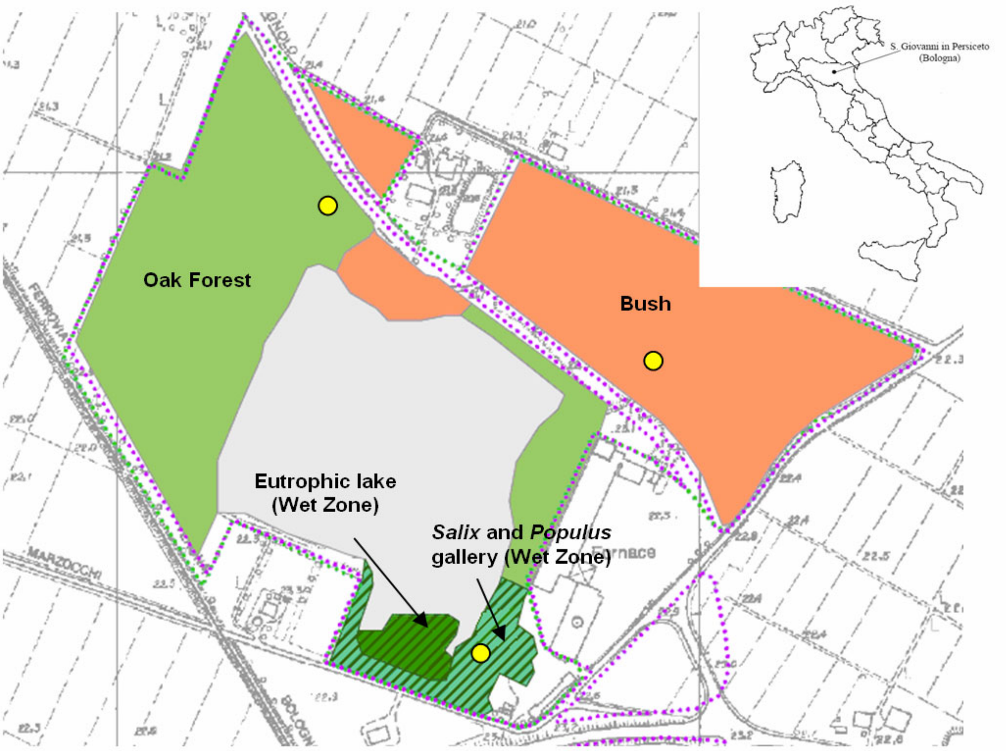

Figure1. The ERA "Bora" with the four habitat type and the location of Malaise trap indicated with yellow circles.

Table 2. List of sampled Syrphidae species in both years (2007 and 2008). N: total specimens collected. Ecological information has been elaborated using Speight, 2008b.

Species	N	Larval diet	Preferred habitat
Wet zone			
Chalcosyrphus nemorum (F.)	3	saprophagous	deciduous wood
Cheilosia scutellata (Fallen)	6	phytophagous	wood
Cheilosia soror (Zetterstedt)	8	phytophagous	deciduous wood
Crysotoxum cautum (Harris)	2	predacious	deciduous wood
Dasysyrphus albostriatus (Fallen)	1	predacious	deciduous wood
Episyrphus balteatus (De Geer)	19	predacious	ubiquitous
Eristalinus taeniops (Wiedemann)	1	saprophagous	wood
Eristalis arbustorum (L.)	2	saprophagous	ubiquitous
Eumerus amoenus (Loew)	8	phytophagous	deciduous wood
Eupeodes corollae (F.)	4	predacious	open grassland
Helophilus pendulus. (L.)	4	saprophagous	wet environment
Heringia brevidens (Egger)	3	predacious	deciduous wood
Melanostoma mellinum (L.)	10	predacious	ubiquitous
Melanostoma scalare (F.)	1	predacious	deciduous wood
Meliscaeva auricollis (Meigen)	1	predacious	deciduous wood
Merodon avidus (Rossi)	1	phytophagous	wood
Myathropa florea (L.)	1	saprophagous	wet environment
Paragus bicolor (F.)	9	predacious	open grassland
Paragus haemorrhous (Meigen)	7	predacious	wet grassland
Paragus subgenus *Pandsyophthalmus* Stuckenberg	11	predacious	open grassland
Paragus pecchiolii (Rondani)	3	predacious	wood
Paragus quadrifasciatus (Meigen)	3	predacious	ubiquitous
Paragus tibialis (Fallen)	3	predacious	open grassland
Pipiza festiva (Meigen)	3	predacious	wood
Scaeva pyrastri (L.)	1	predacious	ubiquitous
Sphaerophoria scripta (L.)	7	predacious	open grassland
Volucella zonaria (Poda)	2	predacious	wood
Xanthogramma pedissequum (Harris)	1	predacious	open grassland
Wet Zone - total species 28, total specimens 125			
Oak Forest			
Chalcosyrphus nemorum (F.)	7	saprophagous	deciduous wood
Cheilosia ranunculi (Doczkal)	1	phytophagous	open grassland
Cheilosia soror (Zetterstedt)	7	phytophagous	deciduous wood
Crysotoxum cautum (Harris)	1	predacious	deciduous wood
Episyrphus balteatus (De Geer)	5	predacious	ubiquitous
Epistrophe eligans (Harris)	1	predacious	deciduous wood
Eumerus amoenus (Loew)	1	phytophagous	deciduous wood
Eupeodes corollae (F.)	2	predacious	open grassland
Helophilus pendulus. (L.)	6	saprophagous	wet environment
Heringia brevidens (Egger)	2	predacious	deciduous wood
Melanostoma mellinum (L.)	2	predacious	ubiquitous
Myathropa florea (L.)	3	saprophagous	deciduous wood
Paragus subgenus *Pandsyophthalmus* Stuckenberg	2	predacious	open grassland
Paragus pecchiolii (Rondani)	1	predacious	wood
Platycheirus scutatus (Meigen)	2	predacious	deciduous wood
Volucella zonaria (Poda)	2	predacious	wood
Xanthogramma pedissequum (Harris)	3	predacious	open grassland
Oak Forest - total species 17, total specimens 48			
Bush			
Episyrphus balteatus (De Geer)	1	predacious	ubiquitous
Eristalis arbustorum (L.)	1	saprophagous	ubiquitous
Eristalis tenax (L.)	1	saprophagous	ubiquitous
Eumerus amoenus (Loew)	1	phytophagous	deciduous wood
Eumerus sogdianus (Stackelberg)	1	phytophagous	open grassland
Eupeodes corollae (F.)	3	predacious	open grassland
Eupeodes latifasciatus (Macquart)	1	predacious	wet environment
Helophilus pendulus. (L.)	2	saprophagous	wet environment
Melanostoma mellinum (L.)	31	predacious	ubiquitous
Melanostoma scalare (F.)	1	predacious	deciduous wood
Paragus bicolor (F.)	7	predacious	open grassland
Paragus haemorrhous (Meigen)	17	predacious	wet grassland
Paragus subgenus *Pandsyophthalmus* Stuckenberg	13	predacious	open grassland
Paragus tibialis (F.)	5	predacious	open grassland
Pipiza festiva (Meigen)	3	predacious	wood
Sphaerophoria scripta (L.)	92	predacious	open grassland
Sphaerophoria rueppelli (Wiedemann)	3	predacious	wet grassland
Bush - total species 17, total specimens 183			

The research covered two monitoring seasons: from April to October 2007 and from March to October 2008. The collection of the biological material was carried out every 2-3 weeks. Syrphid adults were isolated and dry-prepared for determination. Sampling by Malaise traps was integrated by means of entomological nets, with periodical collections during the monitoring seasons once by month.

Syrphid nomenclature was according to Speight (2008b). Indeed, the method of Speight and Castella (2001) and integrating data on syrphid fauna from Po Valley regional lists (Daccordi and Sommaggio, 2002; Burgio and Sommaggio, 2002; Sommaggio, 2010) were applied using Syrph the Net. The latter method was applied on the total number of collected syrphid species per site in all traps. In the analysis of data, migratory species have been excluded.

Data analysis

The number of the samples species (Y) was plotted against the sampling week (X), by means of curvilinear polynomial regression, generating a trend of occurrence of the species for each sampling season.

The habitats of "Bora" were ordered by multivariate analysis, including Principal Component Analysis (PCA) and cluster analysis. The data input was a presence-absence matrix (0: absence of the species; 1: presence of the species) and it included also species collected in other similar habitat of the eastern Po Valley about which the knowledge of Syrphidae fauna is quite good (Sommaggio, 2010). In this way the peculiarity of "Bora" habitats was compared with other sites included in the geographic area of Po Valley (Burgio and Sommaggio, 2002; 2007; Sommaggio and Burgio, 2003; 2004; Sommaggio, unpublished data).

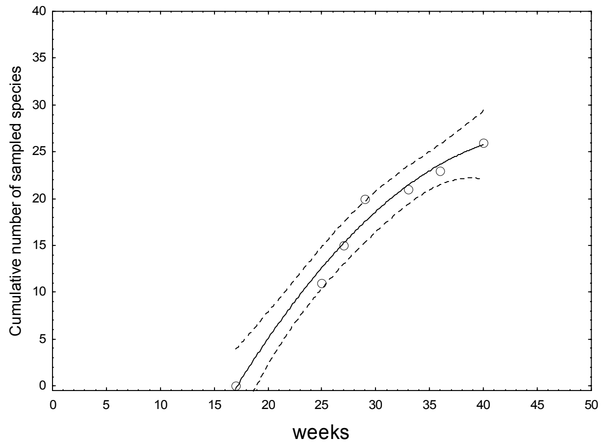

Figure 2. Cumulative trend of the species sampled in 2007, plotted against the weeks of sampling. Equation: $Y = -41.3 + 2.9X - 0.03X^2$, $R^2 = 0.97$, $P < 0.01$. Dotted lines represent the 95% confidence intervals

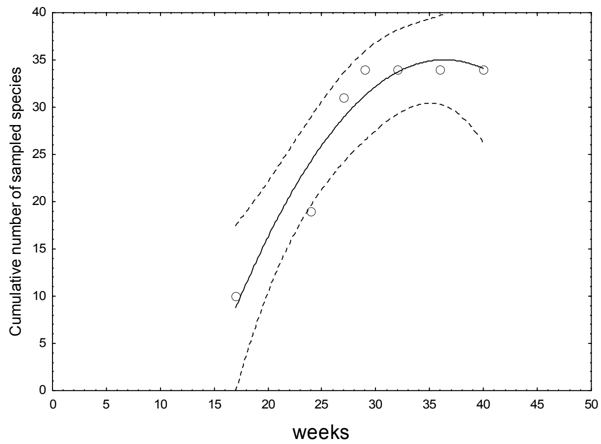

Figure 3. Cumulative trend of the species sampled in 2008, plotted against the weeks of sampling. Equation: $Y = -57.8 + 5.1X - 0.07X^2$, $R^2 = 0.92$, $P < 0.01$. Dotted lines represent the 95% confidence intervals.

Results and discussions

Pooling the species sampled in the three habitats of the "Bora" site, 34 syrphid species were identified. In table 2, the list of syrphid species sampled in each habitat is shown, including the number of collected specimens and ecological information according to Speight (2008b).

Data seem to confirm that Malaise traps are poorly effective in sampling some saprophagous species. In particular, populations of species like *E. tenax*, *E. arbustorum* and *E. aeneus* seem to be underestimated, as reported in previous studies (Sommaggio and Burgio, 2003; Burgio and Sommaggio, 2007). Entomological net did not sample additional species and for this reason the related data were not included in the table.

Our results also demonstrated a cumulative trend of the occurrence of sampled syrphid species plotted against the weeks of observations (figures 2 and 3). The trends, analysed by polynomial regressions, describe the distribution of the collected species according to the day they were sampled. In 2007, about 90% of species was sampled at 36th week, while in 2008 at 27th week. In other words, the plateau of the curve was reached after 4-5 sampling dates in 2008, while in 2007 season the plateau does not seem to be reached. The shape of 2008 curve seems to demonstrate that all the potential species were sampled, because a plateau was clearly reached. This discrepancy in the seasonality trend of captured species could be caused by different climatic condition in the sampling seasons or by a variability of syrphid populations.

The habitats of "Bora" were ordered by means of multivariate analysis (PCA and cluster analysis) by a presence-absence matrix of the species collected, and compared with other similar habitats of the region. The 3 habitats of "Bora" were characterised by a high degree of correlation by PCA (figure 4), with some differences. All the habitats of "Bora", and in particular Bush (indicated as BORA 3) showed a high correlation with other rural areas (D), in according with the localization of the site within similar habitats. Also, Oak Forest (indicated as BORA 2) was highly correlated with other oak woods (G), and Wet Zone was correlated with other wet areas (A) of the Po Valley. In spite of this general trend, ordinations showed also some discrepancies, probably due to

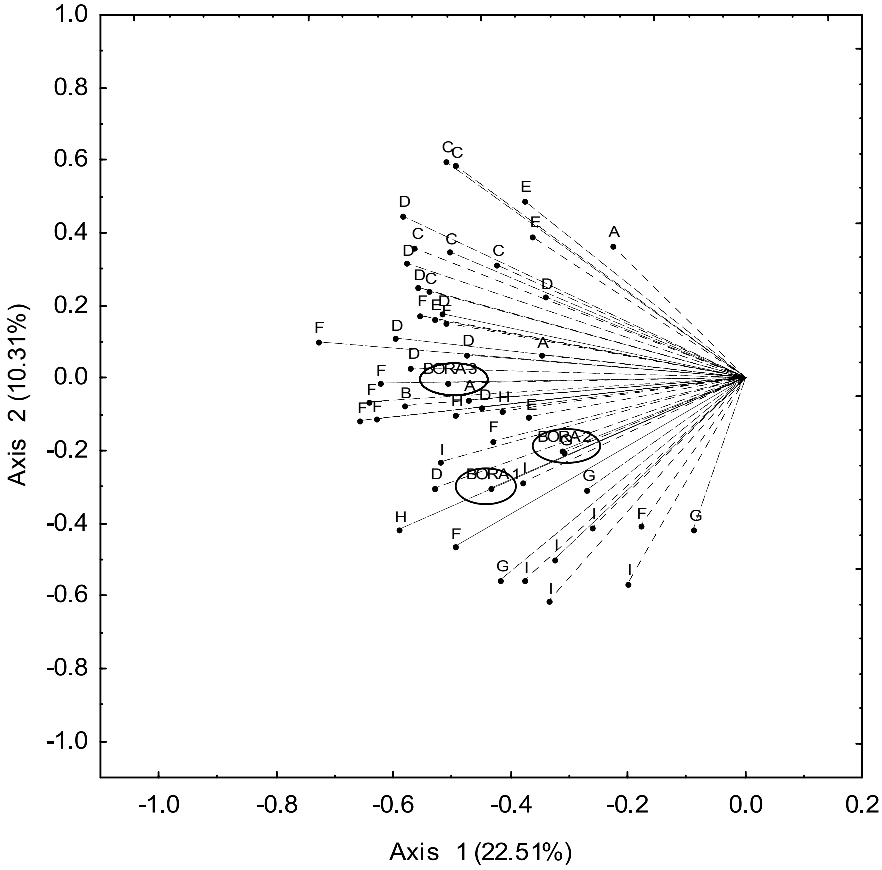

Figure 4. Ordination of the 3 habitats within "Bora" in comparison with other sites of eastern Po Valley (Emilia-Romagna and Veneto Regions), by means of Principal Component Analysis.
BORA 1 = Wet Zone; BORA 2 = Oak Forest; BORA 3 = Bush; A = wet areas; B = orchards; C = marshes; D = other rural sites; E = ponds; F = wet woods; G = oak woods; H = dunes; I = pinewoods.

the relative heterogeneity of certain habitats (i.e. habitat A = wet areas). For example, Wet Zone is moderately correlated with two ponds (E), another wet area (A) and some marshes (C). Our interpretation is that the fauna of a site is strongly affected by the matrix of the landscape in which it is located. Cluster analysis (figure 5) showed similar results in the ordination, but in this case the difference with other wet areas (A) increased. It is remarkable that cluster analysis, in general, resulted in a more homogeneous ordination of the habitat categories, for example (A) (wet areas) and (F) (wet wood) were more close each others.

Figure 6 shows the relative proportions of the trophic categories (A) and preferred habitats (B) calculated on the species sampled in the site: 54% of the species displays a predator diet, a distribution of larval requirement typical of rural environments. Data show a relative high portion of phytophagous species (23% of the total), probably related to the re-naturalization of the habitats within the site.

The trophic categories linked to wet environments (aquatic saprophagous = 13% of the total) and to the recycling of the organic matter (terrestrial saprophagous = 10% of the total) seem to be poorly represented, in comparison with other studies employed in similar Italian environments (Sommaggio and Burgio, 2004; Burgio and Sommaggio, 2007). About 40% of species is linked to wood environment and only 9% of the species belongs to the wet environment. Interestingly, the percentage of ubiquitary species (18% of the total) is lower than those usually found in other rural Italian landscapes, leading to the interpretation that "Bora" shows a higher ecological specialization.

The results presented in the table 3 were analysed processing the collected syrphid species with Syrph the Net. Two indices of BDMF were calculated for each considered environment. The first one was calculated by accounting the total number of syrphid species, while the second one was estimated by excluding the univoltine spring species from the expected species list. In 2007 season, the sampling started in a period characterised by rains and temperatures which were lower than the average, and for this reason the species characterised by early flights could not be adequately represented, as our accumulation seem to confirm (figures 2 and 3): in 2007 the first two samplings accounted for about 55% of the species sampled, while in 2008 the first two samplings recorded about 85% of the species.

Considering the total species sampled in the three habitats (whole site) the BDMF reached a value of 37.8%, considering all species, and a value of 41.5%, excluding spring species. These values are considered

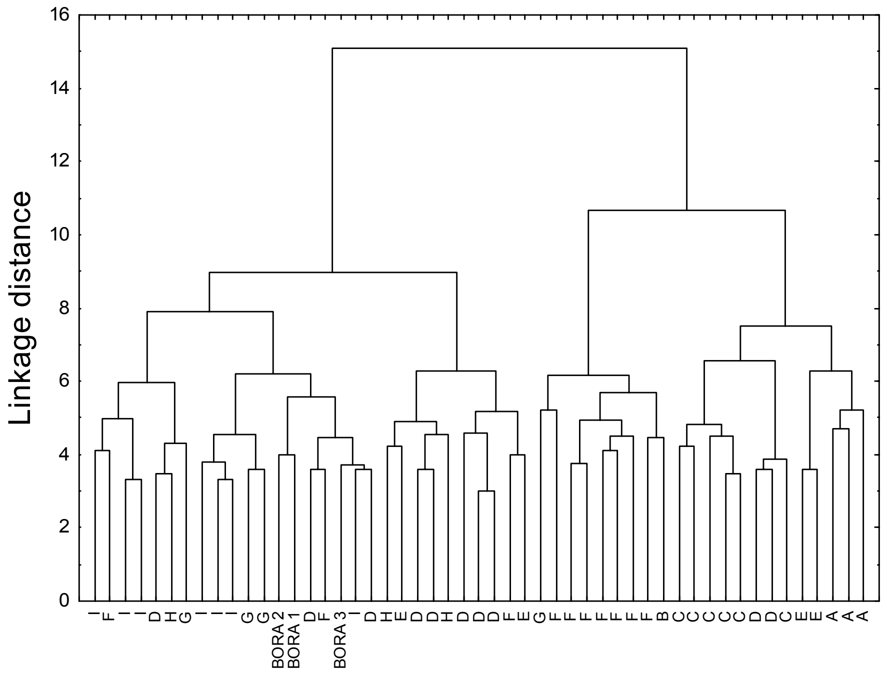

Figure 5. Ordination of the 3 habitats within "Bora" in comparison with other sites of eastern Po Valley (Emilia-Romagna and Veneto Regions), by means of Cluster Analysis. Ward's method was used as linkage rule.
BORA 1 = Wet Zone; BORA 2 = Oak Forest; BORA 3 = Bush; A = wet areas; B = orchards; C = marshes; D = other rural sites; E = ponds; F = wet woods; G = oak woods; H = dunes; I = pinewoods.

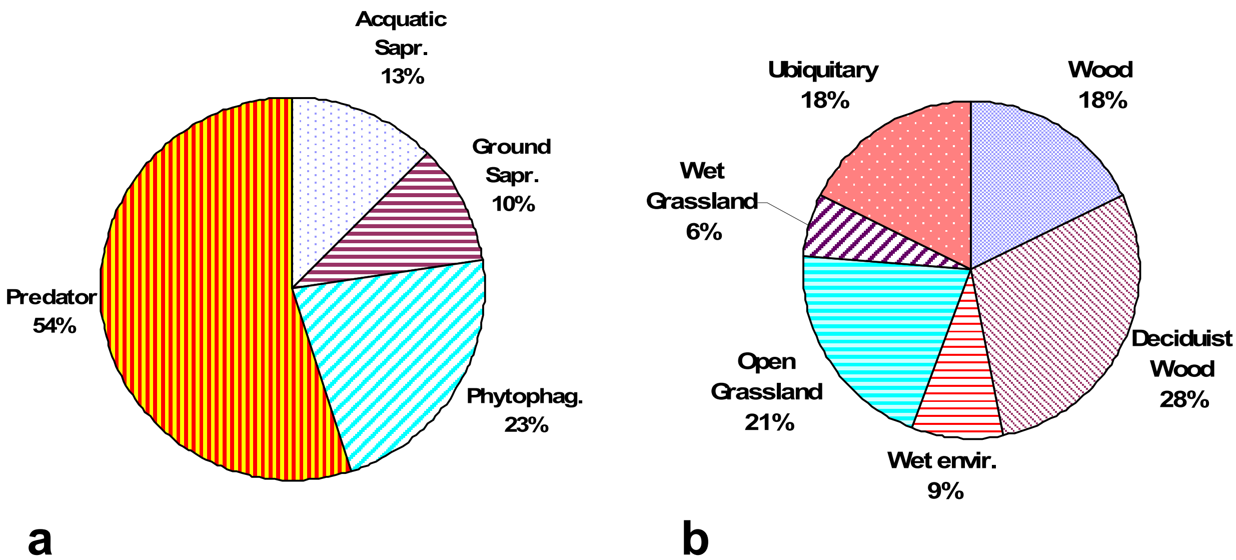

Figure 6. A. Larval diets in whole site. B. Preferred environment (the category "deciduist wood" includes the species that live only in this kind of forest, while "wood" shows the species found in any kind of forest).

under the threshold (50%) of a good conservation state of environment (Speight and Castella, 2001).

In table 3 BDMF values have also been calculated for each habitat (Wet Zone, Oak Forest and Bush). Oak Forest and Wet Zone seem particularly stressed, with BDMF values lower than 40% (except for Oak Forest BDMF calculated without spring species: 41.7%.), while Bush has a BDMF value of 53.9 %, which is acceptable.

The very low value linked to the Wet Zone is coherent with the hypothesis of the absence of species typical of the marshy. For example in a previous study employed in an area of San Giovanni in Persiceto, adjacent to "Bora", it was recorded the presence of *Neoascia interrupta* (Meigen) and other saprophagous species like *Parhelophilus frutetorum* (F.) (Burgio and Sommaggio, 2002). In our opinion this lack can be related to different causes: i) an habitat deficit, even if it seems to have the necessary element to sustain this kind of fauna; ii) lack of connectivity of the site with similar surroundings habitats or iii) a strong predatory pressure performed by high odonata,

Table 3. Summary of results obtained with Syrph the Net. BDMF = Biodiversity maintenance function.

Habitat	Expected species by Syrph the Net	Expected species (excluding spring species)	Observed species	Observed but not expected species	% BDMF 1 (total)	% BDMF 2 (excluding spring species)
Whole site	90	84	34	0	37.8	41.5
Wet Zone (excluding gallery forest)	33	30	15	0	45.5	50.0
Wet Zone (total)	43	41	15	0	34.9	36.6
Oak Forest	56	48	20	0	35.4	41.7
Bush	52	52	28	0	53.9	53.9
Microhabitat						
Foliage	22	21	8	0	36.4	38.1
Overmature/senescent trees	14	12	1	0	7.14	8.33
Mature trees	21	20	6	0	28.57	30
Shrubs / Bushes	20	19	7	0	35	36.8
On herb layer	26	26	15	0	57.7	57.7
In herb layer	15	14	6	0	40	42.86
Water plants	13	13	0	0	0	0
Submerged sediment/debris	12	12	4	0	25	25
Water-saturated ground	17	7	0	6	35.29	35.29

amphibians, reptiles and fish populations, protected in this Area (Morisi and Lin, 2007), which could have depressed the populations of aquatic larvae species.

Another reason of the low value of BDMF could be related to the absence of some important saproxilyc species, linked to mature forest, senescent tree and rotten wood, like *Ferdinandea cuprea* (Scopoli), *Myolepta vara* (Panzer), *Milesia crabroniformis* (F.), *Criorhina berberina* (F.), typical of wooded areas. Considering the wooden environment only, some species which are uncommon in an intensive agricultural contest were found, including *Heringia brevidens* (Egger), *Cheilosia soror* (Zetterstedt) and *Chalcosyrphus nemorum* (F.).

Concerning Bush, the conservation of biodiversity is higher in comparison with the other micro-habitats. This habitat shows some of the characteristic species of hedgerow and open grassland like *Paragus quadrifasciatus* (Meigen), *Paragus tibialis* (Fallen), *Paragus haemorrhous* (Meigen), mainly with predator diet. The species sampled in this habitat were all common, and there were not found rare species or characterised by particular ecological demand. The Bush habitat, for its spatial location, plays an important role as centre of dispersion and reproduction for beneficial predatory species which can contribute to the conservative biological control. About remaining species, *Pipiza festiva* (Meigen), probably represents a vicariant species of *Pipiza nocticula* (L.), typical in central Europe and characterised by a very similar ecological demand. We remark the absence of very common species in the "Bora" site, like *Syrphus ribesii* (L.), *Syrphus torvus* (Osten-Sacken) and *Scaeva selenitica* (Meigen). Further investigations could be necessary to clarify this aspect.

Conclusions

Samples species represented the studied environment adequately, in spite of a low number of specimens collected. Our data seem to suggest that the conservation status of "Bora" is not suitable to guarantee a sufficient pool of syrphid species that is typical of the habitats within the site. This could be due to the lack of connectivity of the site with other surrounding natural environments. In other words the "Bora" area seems to be relatively isolated from other biodiversity sources which are typical of similarly re-naturalised habitats. In particular, this case study highlights a lack of species linked to marshy environments and saproxylic species typical of senescent woods. In order to improve the quality of this environment it seems necessary to implement the presence of wet areas and to conserve old trees, thus enhancing the functional biodiversity.

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