

## Amphibians and reptiles as indicators in Mediterranean agro-ecosystems: A preliminary study

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**Abstract.** Agroecosystems are very vulnerable environments, due to high anthropogenic pressure that causes depletion and continuous changes. To measure the level of impact generated by agricultural practices, indicators are needed. Arthropods are commonly used as bio-indicators but their sampling requires relatively long-term investigation, consistent human resources and could even hinder the farmers' work. On the contrary investigating herpetofauna with standard methodologies can allow relatively quick surveys, easy taxonomic identification (even at species level) and avoidance of farmer disturbance. Indices of presence and richness can be well related to habitat complexity, in addition considering that Amphibians are linked to both aquatic and terrestrial habitats. Some species are particularly easy to be detected and the ratio of their occurrence can give information on the habitat status. The present study was performed in central Tuscany (Italy), in an area highly subjected to anthropic pressure.

### Introduction

Agro-ecosystems are the most intensively managed environments and probably those which can change very quickly, due to periodic and chronic disturbances caused by agricultural management (Elliott and Cole, 1989). Greatest attention is thus paid to landscape and habitat conservation, including also agricultural practices (Jackson and Piper, 1989). To monitor environmental changes and determine the effects of agro-environmental measures on biodiversity different indicators are required (landscape structure, external inputs or bioindicators such as number of species, presence of key species and so on) (e.g., Bockstaller *et al.*, 1997; Büchs, 2003; Döring *et al.*, 2003). A quick monitoring system (Beattie *et al.*, 1993) or simple indicators (Büchs, 2003) are often required especially in agricultural contexts. Arthropods and birds are probably the most used bioindicators (e.g., Benton *et al.*, 2002), but indeed some problems arise when referring to agro-environments making these indicators unfitting (e.g. the employed scale, the sampling effort and the hindering of the farmer work). On the contrary, amphibian and reptile sampling causes less disturbance to the farmers' work, because they are quite simple to be recognized even at the specific level; moreover, their home ranges are better related to the average field scale size (Buys, 1995).

This work, that is part of a larger one mostly dedicated

to the arthropod diversity and to the evaluation of some agricultural measures, tries to verify the convenience of using reptiles and amphibians as indicators of the *status* of an agro-ecosystem.

### Materials and Methods

#### *Study area*

The Valdera area, central Tuscany (Pisa, Italy), is a region highly subjected to anthropogenic pressure. The landscape is characterised by wide intensively managed arable lands (most of them are devoted to cereal production) while the remaining areas at field margins are covered by woodlots, riparian strips and hedgerows. The climate is mesothermal, humid, Mediterranean (mean annual temperature = 12,7 °C; average annual rainfall = 678 mm).

We identified some "environmental categories", distinguishing areas with different vegetation cover and land use characteristics. Sampling and observations were carried out mainly in four areas: an intensive culture wheat field (F), a woodlot (W) formed by an oak coppice, a pasture (P) used for sheep grazing and the experimental centre "S. Elisabetta" (Vicarello di Volterra, Pisa) belonging to the "Istituto Sperimentale per lo Studio e la Difesa del Suolo" of Florence. In this area we identified four more units:

- (1) grass strips (GS): overgrown with a continuous, thick mantle of herbaceous vegetation and inserted in the cultivated area (average size: 4.40 x 60 m);
- (2) cultivated strips (CS): separated by the grass strips (GS) and characterized by organic farming of cereals (average size = 17 x 60 m);
- (3) meadow (M): next to the strips (GS and CS). The prevalent essence is couch grass;
- (4) riparian (R): strip of vegetation along a ditch made up of herbaceous species and bramble bushes.

#### *Sampling procedures*

Arthropods were collected during a whole year (from May 2003 to May 2004) using pitfall traps. Each trap consisted of a plastic tank filled with an attractive solution of vine grade (with attractive function) and acetylsalicylic acid (with preservative function).

Traps were emptied and replaced once every fifteen days.

Reptile and amphibian data derive from: animals occasionally fallen into pitfall traps set for the arthropod fauna sampling, field observations of live animals and individuals occasionally caught in water tanks used for runoff and sediment sampling, inside the experimental centre.

Tanks checking and field observations were carried out throughout a year, contemporarily to pitfall sampling.

### Statistical analyses

We used Shannon-Wiener index to assess Arthropod diversity (Shannon, 1948): for each trap we considered the total of individuals analysed at order level. We used EstimateS 5.0.1 to compute randomised accumulation curves independent from sampling temporal order.

Relative abundance of herpetofauna in the different surveyed habitats was calculated using all the available data sources. For each habitat the total number of amphibians and reptiles was divided for the number of traps/tanks. We also determined the cumulative curve relative to the number of caught species (fig.1).

In order to assess herpetofaunal diversity we used the Hierarchical Richness Index (HRI) (French, 1994):  $\sum r_k * n_k$ , where  $r$  represents the rank of the  $k$ -group,  $n$  is the number of specimens of the same group. This index has been chosen because it incorporates both taxonomic diversity and abundance in a single measure of richness that is less confusing than other indexes and it ranks sites according to easily definable objective criteria (Fabricius *et al.*, 2003).

To define an eventual correlation between arthropods and herpetofauna diversity HRI (fig. 2) we tested the correlation with the Spearman non parametric coefficient. A regression curve was calculated too.

### Results

In fig.1 herpetofauna relative abundance (columns) and cumulative number of species (line) are shown: P and F were the “poorest” habitats and CS presented intermediate values of species richness and abundance. The other habitats, with lower anthropogenic disturbance, showed higher values. Fig. 2 shows the results relative to French index for each habitat (second column, divided for the sampling effort), together with number of species (first column) and relative abundance (third one). The riparian unit is the richest one, due to the presence of more amphibians; it is important to notice the differences in the number of species and the abundance between cultivated (organic) strips and the intensive field. Similar results have been found as far as arthropod diversity is concerned, suggesting the usefulness of uncultivated strips or grassy field margins.

Herpetofauna HRI and arthropod Shannon Wiener index resulted to be significantly correlated (Spearman's  $\rho=0.964$ ;  $P<0.01$ ). The obtained

regression curve (fig.3) fits well ( $R: 96,76$ ;  $V.ex: 93,62$ ). The curve has a particular sigmoid shape suggesting the presence of an ecological threshold.

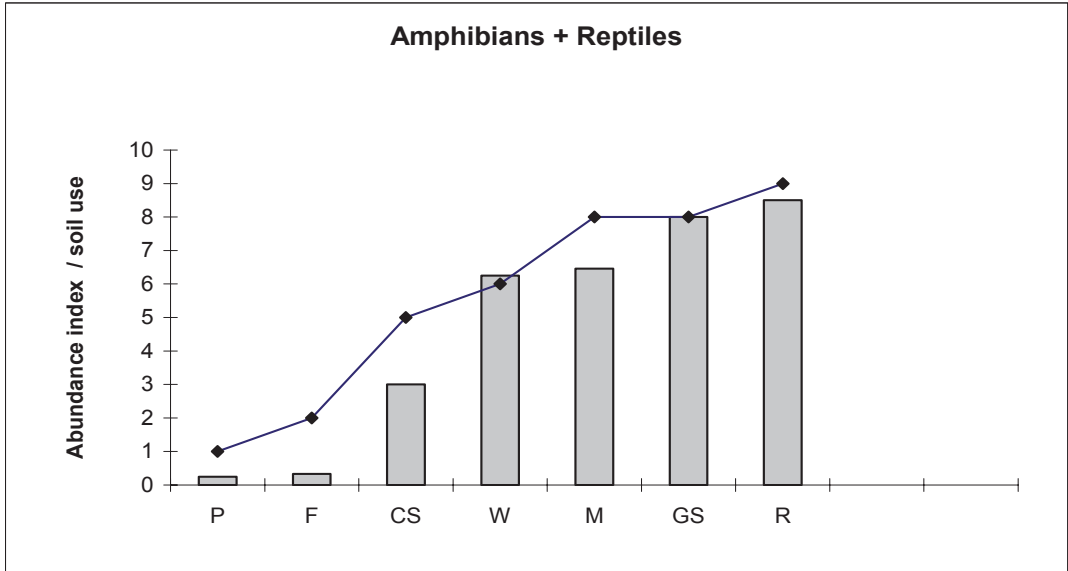
### Discussion

Arthropods are commonly used as bio-indicators in agro-ecosystems and their reliability is confirmed by a large number of studies (e.g., Brown, 1991; Kremen *et al.*, 1993; Duelli, 1997; Döring *et al.*, 2003; Duelli and Obrist, 2003; Jeanneret *et al.*, 2003). However arthropod sampling can necessitate relatively long-term investigations and their taxonomic identification, particularly at the specific level, requires an enormous amount of resources in terms of time, money and specialists (Cardoso *et al.*, 2004). Using arthropods as indicators can therefore turn out to be too much expensive and time consuming when quick biodiversity surveys are required. This happens, for example, in agro-ecosystems where the possible hindering of farmers' work must be considered, too. In the present study, that is part of a wider research mainly focused on arthropods, we tried to find an alternative way, proposing herpetofauna as a possible indicator. In fact investigating amphibians and reptiles can offer some benefits: they are widespread in the Mediterranean regions, also in anthropic modified areas, they require relatively quick survey time using standard methodologies and their taxonomic identification, even at species level, is relatively simple. In particular, some species are easy to be detected and the ratio of their occurrence can give information on the habitat status (Corti *et al.*, 2001). The use of herpetofauna could provide a useful shortcut for biodiversity surveys in agro-ecosystems, making possible a great saving of financial and human resources. The results show conformity to the indication deriving from Arthropods, confirming the importance of semi-natural habitats for the preservation of biodiversity in agro-environments. As a preliminary deduction, we can affirm that herpetofauna could be used as an agro-environmental indicator, at least at a local level.

### Acknowledgements

We are very grateful to the “Istituto Sperimentale per lo Studio e la Difesa del Suolo” of Florence for allowing us to work in the experimental centre of Vicarello (Pisa) and in particular Paolo Bazzoffi, director of the Section of Physics. We also thank Marco Dellacasa and Leonardo Dapporto for their help and suggestions.

**Figure 1.** Relative abundance of herpetofauna in each habitat (columns) and cumulative number of species (line). For soil use abbreviations see subchapter Study Area in Material and Methods.



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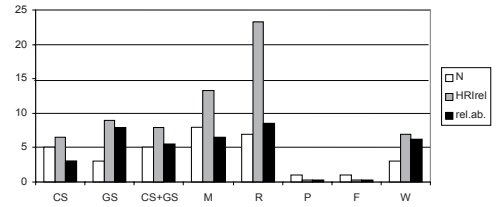
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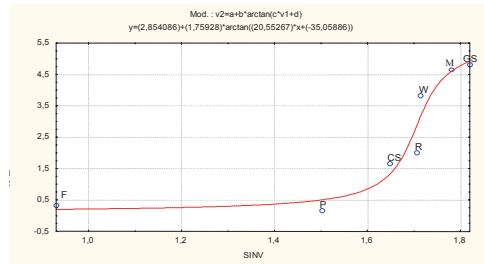
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**Figure 2.** Diversity and abundance of herpetofauna. The first column shows the number of species found in each habitat, the second shows the HRI value (considering the sampling effort), the third the relative abundance.



**Figure 3.** Correlation between Arthropod diversity (Shannon index) and herpetofauna richness (HRI, modified for the total number of species).

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