Differences in spider species diversity on grapevine plants on terraced and plain vineyards depending on the type of management

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Abstract: In recent years, agricultural ecosystems are considered as very problematic habitats with respect to biodiversity, and this trend is continuously decreasing, however, some agroecosystems, especially some types of vineyard, can host remarkable species and contain a high diversity of invertebrate fauna, comparable with areas under nature protection. The aim of this study was to focus on two types of vineyards: terraced and non-terraced (plain) vineyards, and investigated of araneofauna living on plants of vine grapes. The study analyses spider species spectrum and spider abundance on the grape vine plants. The spectrum of spiders found is relatively poor; the most common spiders were: *Synageles venator* (Lucas, 1836), *Salticus zebraneus* (C. L. Koch, 1837), *Nuctenea umbratica* (Clerck, 1757), *Dictyna uncinata* (Thorell, 1856), *Dictyna arundinacea* (Linnaeus, 1758), *Micaria subopaca* (Westring, 1861), *Marpissa nivoyi* (Lucas, 1846), *Agalenaetea redii* (Scopoli, 1763), but we were not able to identify juveniles up to the specific level (710 specimens). It can be assumed, that some of the observed species and their presence can affect the incidence of grapevine pests significantly. Several interesting species observation were also made (e.g. common occurrence of *Synageles venator*).

Key-Words: biodiversity, araneae, vineyard

Introduction

Impact of landscape heterogenity on different animal groups is well studied topic. Landscape heterogenity is widely discussed issue, because the homogenization is one of the greatest threats to biodiversity [1]. It is known, that sites surrounded by heterogeneous landscapes contained more species than homogenous ones [2]. It is also known, that the recession in farmland biodiversity is related to changing farming practices. Agricultural intensification has been a main cause of farmland biodiversity losses and it has led to a wide degradation in farmland biodiversity [3]. There are few interesting studies which describe influence of landscape diversity and agricultural practices on spiders [4, 5, 6]. We assume that terraced vineyards host richer fauna [7], because it's more heterogeneous and contains not only vineyards itself, but also frontal part of terrace.

From a certain point of view we can draw some conclusions concerning the potential use of spiders as bioindicators [8, 9].

The aim of this study is to focus on two types of vineyards: terraced and non-terraced (plain) vineyards, and concentrate on their araneofauna. Our research was to find out whether vine plant spider fauna on terraced vineyards is richer than vine plant spider fauna in plain areas. So far we only have data about overwintered and early spring spiders.

Material and Methods

Collection and evaluation of materials

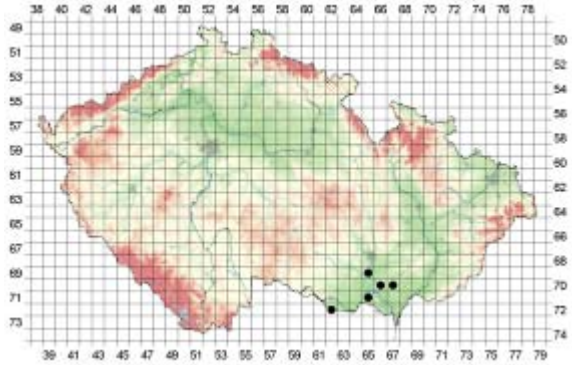
We investigated araneofauna of vine plants on terraced and non-terraced areas across South Moravian region (Czech Republic) by using of cap-board traps. These traps were devised and tested in Torino first in research which purpose was to examine their efficiency. The results of this study shows, that bubble wrap is more effective for trapping bigger spiders and cardboard itself is great for smaller species [10]. We had combined these materials to overtake the widest possible range of spiders captured. Altogether we investigated six locations (240 traps per variant).

Traps were placed and collected monthly. We began at autumn 2013, and traps were collected since the early spring of 2014. On each location two representative sites were selected: one on the terraced vineyard and the other on the non-terraced (plain) vineyard. We placed 20 cardboard traps on the edge of vineyard and in the central part (40 traps per location). Each trap was collected separately into a plastic bag and replaced immediately by a new one (see fig. 4, 5). Material from traps was collected in laboratory conditions. All individuals were determined to species (adults) or families (juveniles). For estimation of species richness we used number of families and number of species.

Localization of studied sites

The study area falls within the South Moravian Region: districts of Znojmo and Břeclav. Particular study sites were: Peklo, Výhon, Morkůvky, Růžový vrch, Gotberg and Nosislav (see fig. 1, 2, 3).

Fig. 1 Localization of study sites



Statistical analyses

The statistical analyses were performed within R environment [11]. We used species density (species per plot, see [12]), spider abundances to compare studied plots. We studied species diversity and abundances in two vineyard types (terraced x plain). For estimation we used Generalized Estimating Equations (GEE) with Poisson error structure (GEE-p) with log link function and "ar1" correlation structure [13, 14].

Fig. 2-7 Examined vineyard terraces

Legend: non-terraced vineyard at Šatov (Znojmo district) (2), terraced vineyard at Blučina (Brno-venkov district) (3), experimental plot on Nosislav (Brno-venkov district) (4), collected cardboard traps (5), Synageles venator (6), Pseudicius encarpatus (7)

Results

Until now we only calculated data from the winter and early spring time (February to April).

The spectrum of spiders was relatively poor; the most common spiders were: *Synageles venator* (Lucas, 1836), *Salticus zebraneus* (C. L. Koch,

1837), *Nuctenea umbratica* (Clerck, 1757), *Dictyna uncinata* (Thorell, 1856), *Dictyna arundinacea* (Linnaeus, 1758), *Micaria subopaca* (Westring, 1861), *Marpissa nivoyi* (Lucas, 1846), *Agalenaetea redii* (Scopoli, 1763), but we were not able to identify juveniles up to the specific level (710 specimens). We found out, that the most common spider there is salticid *Synageles venator*, which usually is not found as such common species. The species did not overwinter on vine plants, but rather occurred there as common during first spring month (1 ex during overwintering, 141 during March 2014). Most of overwintering specimens were not adults (only one *Synageles venator* and *Nuctenea umbratica* was found), the spectrum was dominated by juveniles of genus Philodromus and Salticidae (mainly *Pseudicius encarpatus* (Walckenaer, 1802), *Macaroeris nidicolens* (Walckenaer, 1802) and Salticus spp.). There are big differences between sites, but no significant differences between both types.

Species composition

During the winter time, we found only adults of *Synageles venator* (Lucas, 1836) and *Nuctenea umbratica* (Clerck, 1757). The first species became dominant during spring time in really high abundances (see fig. 9). Other species came later in the season (and they were not previously recorded as juveniles).

Impact of habitat structure

The species composition and total abundance differed significantly between terraced and plain vineyards. In terms of abundance, the only significant results were for adults only (GEE-p, X21 = 56.3, $P < 0.0001$) in case of total abundance for adults (GEE-p, X21 = 26.9, $P < 0.0001$) as well as juveniles (GEE-p, X21 = 9.2, $P = 0.0025$).

Faunistics

Nomenclature and arrangement of families, genera and species follow the most recent version of the World Spider Catalog 15.0 [15]. A total of 285 adult spiders representing four families, and 294 juveniles of 10 families were collected and identified. Considering adults, the largest portion of individuals belonged to the family Salticidae (263 adults) and Dictynidae (14 adults). An interesting finding was the high presence of spider *Synageles venator* (Lucas, 1836) (fig. 6 and 8). It was the dominant species at all studied locations during both spring months.

From the point of view of presence of juveniles, Salticidae was also the richest family (115 juveniles), but there were significant numbers of Philodromidae (96 individuals, see fig. 8) and Dictynidae (34 individuals) as well (fig. 8). Also, juveniles of other families were demonstrably more represented than adult ones. This indicates that species richness will increase in subsequent months.

Discussion

This study analysed the species spectrum and abundance of spiders living on vine plants. We support the hypothesis about importance of vineyard terraces as a source of biodiversity [4], but also we found out that an interesting spider fauna lives there.

In comparison, there were found same several common species as on faces of vineyard terraces published by Kosulic in 2014 (fig. 11), like *Dictyna arundinacea* (Linnaeus, 1758), *Drassodes lapidosus* (Walckenaer, 1802), *Heliophanus auratus* (C. L. Koch, 1835), *Marpissa nivoyi* (Lucas, 1846), *Salticus scenicus* (Clerck, 1757) and *Synageles venator* (Lucas, 1836) [16]. There were found no species listed as critically endangered, endangered and vulnerable spider species according the Red List of threatened species in the Czech Republic [17].

It is understandable that the first spring months, as mentioned above, rapidly increased abundance of some species of spiders, especially to the individuals in the family Salticidae. Species such as *Synageles venator* (Lucas, 1836), *Pseudicius encarpatus* (Clerck, 1757) or *Salticus scenicus* (Clerck, 1757) - tree dwelling active hunter predators, began to be active with the spring and started invade into installed traps. Usually, glued tapes were filled up by high numbers of caught ants and springtails. It is therefore conclusive, that the first spring spiders invaded in the traps not only for the purpose of hiding, but also for prey.

One of the most interesting findings, as mentioned earlier, was the enormous presence of salticid spider *Synageles venator* (Lucas, 1836). It is question which environmental factor allowed this extension. In study by Chong Chee-Seng [18] was pointed out the significant effect of increase of spider abundance by presence of ant. In this case it was Linyphiidae spiders and these spiders were positively associated with *Lasius* ants. This finding may lead us to a possible analogy between ants found (mostly sticked on sellotape) and *Synageles venator* (Lucas, 1836). It is certain, that the interactions between ants and other arthropods are complex and variable. Because these findings are too speculative, it will be necessary to confirm it by future experiments and further researches. The roles of native ants in vineyards will certainly run out some interesting findings.

Fig. 8 Total abundances particular families of all recorded juvenile spiders

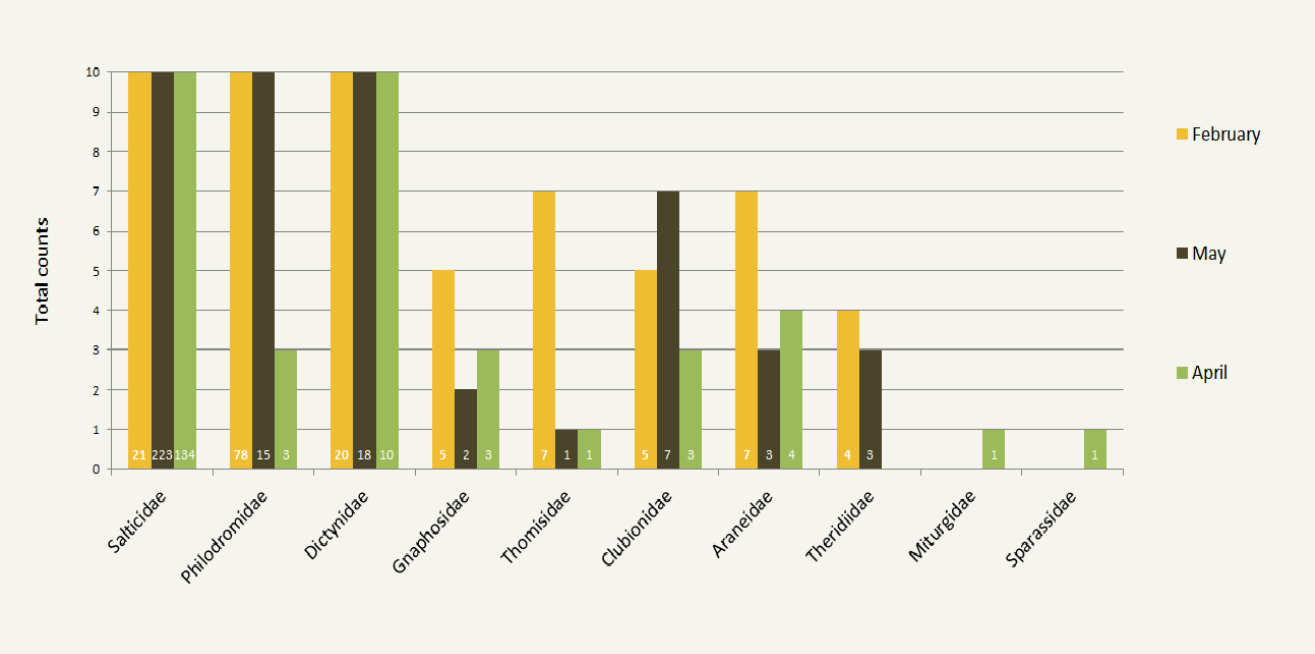
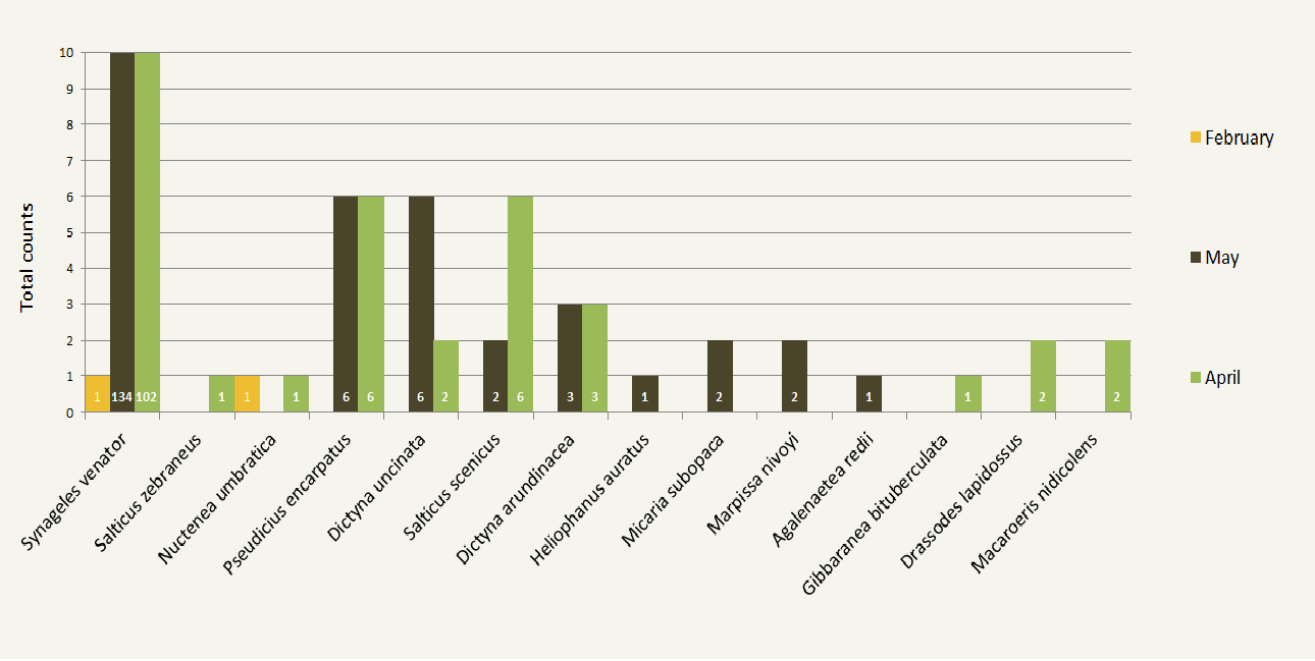


Fig. 9 Total abundances of adult specimens and grid map of the Czech Republic with the studied localities marked



Conclusion

Against the common expectations that intensive agricultural land is species poor and that particular plants did not host so many species (specimens), we found the opposite – vine plants host during winter rich and valuable fauna. The difference between different types of sites (terraced vs. plain) was found. The species spectrum contained several very interesting species (e. g. *Marpissa nivoyi* (Lucas, 1846), *Micaria subopaca* (Westring, 1861), *Pseudicius encarpatus* (Walckenaer, 1802) (fig. 7, 9) and *Synageles venator* (Lucas, 1836). Most interesting was the discovery of very common occurrence of *Synageles venator* – the widely distributed species with very low abundances, with unknown life history and with positive association

with ants. This species needs a special focus in future study.

In the future, we can think about the importance of spiders in vineyards as a bioindicators of environmental cleanliness – there raises the question "Whether and how are spiders affected by treatment on vineyards?" Given that so far there are no scientific studies on that topic, it would be interesting to see lethal and sublethal effects of pesticides, fungicides and other chemicals used in vineyards during the season.

We believe, that this research will help to define the potential of vineyard spiders and decode the questions, like biocontroling and bioindicating, which we have mentioned earlier.

Acknowledgement

The research was financially supported by individual project of IGA MENDELU Brno No. IP8/2014 and partially also by team project of IGA MENDELU Brno No. TP7/2014.

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