

## Summary of Ph.D. Thesis

# The effect of habitat fragmentation and road-verges on composition of plants and invertebrates in the Great Hungarian Plain

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## **(1) Introduction**

Anthropogenic interference is the leading cause of landscape change and loss of biodiversity worldwide and Hungary is no exception. The Southern part of the Hungarian Great Plain was originally covered by forest steppes. It has its own endemic flora and fauna. Recently the majority of the natural forest has been changed to the forest plantations to meet the growing demand of timber production. This process resulted in habitat fragmentation and modification, and biodiversity was adversely affected. Conservation of habitat specialist fauna in these fragmented habitats requires conservation of natural habitat patches and their connectivity.

The amount and spatial arrangement of natural habitat fragments have an important role in determining how organisms are distributed in highly modified landscapes. Matrix around the fragmented patches has a significant effect on biodiversity. It can interfere with the dispersal of the species, however, it also can provide a non-hostile environment if well maintained. Most of the literature is based on habitat fragment and landscape matrix as two separate divisions where fragments are solely considered as appropriate habitat for the species, completely neglecting the importance of the quality matrix around the habitat fragments. Hereby, we attempt to study the importance of landscape quality in biodiversity conservation. Landscape quality characterises the compositional heterogeneity of the landscape. It considers both the quality of the matrix and the habitat fragments within the landscape.

Linear landscape elements (LLEs) also play Important role in conserving arthropods as they can minimise the isolation effect between the habitat fragments. Road verges are artificial LLEs that are generally constructed for the purpose of transport however it has been studied that if they are maintained well, they have the potential to turn into seminatural habitats and preserve the biota in highly fragmented habitats.

The purpose of this dissertation is to understand the species composition and diversity of arthropods in a highly modified landscape in the Danube–Tisza Interfluvium in southern Hungary. More specifically, we aimed to study:

(1) The effect of landscape quality and habitat type on the diversity pattern of flora and fauna of forest-steppe fragments.

(2) The importance of linear landscape elements such as road verges in the planted forest on conserving arthropod fauna.

## **(2) Material and methods**

### **Study region**

Our study was conducted in Kiskunság region in the southern part of Hungary. The main natural habitat type of the study region is a forest-steppe and the dominant land use types are semi-natural plantation forests and agriculture. Forest steppe is characterised by alternation of small forest patches scattered in grasslands creating a mosaic like structure. The dominant soil types are various calcareous soils with

high sand and low moisture content. Mean annual precipitation is 500–550 mm.

### **Study 1**

We selected 18 landscapes with forest-steppe fragments size from 0.2- 6 hectare and calculated its quality by drawing 500m radius buffer circles and measured the area of patches of different landcover types. We established sampling sites in the forest habitats, in the steppes of each forest-steppe fragment and in the landscape matrix of pine plantations of selected landscapes ( $18 \times 3=54$  sampling sites). We collected data on plants, spiders and ants using pitfall traps. We used Non metric multidimensional scaling (NMDS) to visualize community composition of sampling sites. We calculated Beta diversity indices, species turnover and nestedness component in natural forest and steppe. We used GLMMs to determine the effect of habitat type (i.e. forest, steppe and plantation), landscape quality, fragment size and their first order interaction on the species richness and specialist species richness of the herb layer and arthropods with “village” as random factor.

### **Study 2**

We selected 30 sampling sites, 10 in each, the grassland component of forest-steppes, pastures and road verges near pine forests. All study sites were in range of 50 km and around 4 villages. We collected data on spiders, true bugs and ants with pitfall and sweep net techniques. We calculated Functional diversity using moisture preference,

shading tolerance and dispersal ability of arthropods. We calculated the single trait FD measure, community weighted mean (CWM) for all traits of the three arthropod groups. We used linear mixed models to determine the effect of habitat type as fixed effect and villages around sampling sites as random effect on species richness and FD indices. We used NMDS to visualise community composition of arthropods in these three habitats and lastly, we used Indicator value analysis to distinguish indicator species of given habitats.

### **(3) Results**

#### **Study 1**

We recorded 164 plant species, 5595 adult spiders of 111 species, 8773 ants belonging to 32 species. Community composition of plants, spiders and ants was influenced by habitat type. We found higher number of indicator species in forest and in steppe, but relatively low number for plantations. Beta diversity was higher for steppe component of forest steppe than for forests indicating a higher degree of isolation for steppes than forests. Increasing landscape quality increased plant richness of small fragments, but decreased it in large fragments. Plant species richness was highest in forests followed by steppes and lowest in plantations according to the GLMM. Landscape quality also positively affected spider richness but had no effect on ants

#### **Study 2**

We collected a total of 1598 adult spider individuals, 5537 adult true bugs and 16,425 adult ants from 114, 147 and 27 species, respectively. Road verges has higher FD of spiders than steppe component of forest steppe and pastures. Road verges has higher species richness for spiders and ants. There was significant difference in species composition of road verges and pastures according to NMDS. Majority of the indicator value species in road verges were generalist species.

#### **(4) Conclusion**

Land use intensification by planting non-native forest plantations results in habitat deterioration and loss of biodiversity. The main implication of our study is that enhancing landscape quality by changing land use type and increasing the share of the fragmented natural habitat in the landscape would help to maintain the unique biodiversity and habitat specialist species. Furthermore, our results indicate that road verges should be considered an important reserve for grassland specialists, as they provide secondary linear habitats for many arthropod species.

## LIST OF PUBLICATIONS

**MTMT Author ID: 10071558**

### LIST OF PUBLICATIONS RELATED TO THIS THESIS

Kaur H, Torma A, Gallé-Szpisjak N, Seat J, Lorinczi G, Modara G, Galle R (2019) Road verges are important secondary habitats for grassland arthropods. *J Insect Conserv* 23, 899–907  
<https://doi.org/10.1007/s10841-019-00171-9>

Impact factor 2.262

Gallé R, Tölgyesi C, Torma A, Bátori Z, Lőrinczi G, Szilassi P, Gallé-Szpisjak N, Kaur H, Makra T, Módra G, Batáry P. Matrix quality and habitat type drive the diversity pattern of forest steppe fragments. *Perspect Ecol Conserv* (accepted)

Impact factor 4.677

### OTHER ARTICLES

Gallé R, Tölgyesi C, Császár P, Bátori Z, Gallé-Szpisjak N, **Kaur H**, Maák I, Torma A, Batáry P, (2021) Landscape structure is a major driver of plant and arthropod diversity in natural European forest fragments. *Ecosphere* (accepted).

Impact factor: 3.171

Ingle K, Gallé-Szpisjak N, **Kaur H**, Gallé R (2019) Forest type interacts with milkweed invasion to affect spider communities. *Insect Conserv Diver* 12: 321-328

<https://doi.org/10.1111/icad.12346>

Impact factor:2.729

Ingle K, **Kaur H**, Gallé-Szpisjak N, Bürgés J, Szabó A, Gallé R (2020) Winter-Active Spider Fauna is Affected by Plantation Forest Type. *Environ Entomol* 49:601–606  
<https://doi.org/10.1093/ee/nvaa025>  
Impact Factor: 1.586

### **Presentations**

**Kaur H**, Gallé R, Torma A “Road verges as important secondary habitats for grassland arthropods” 5th Student conference on conservation science Tihany, Balaton Limnological Institute, Centre for Ecological Research H-8237,3 Klebelsberg Kuno str. Tihany, Hungary, 27-31 August 2019.

Šeat J, **Kaur H**, Gallé R, Torma A “The role of road verges as secondary linear habitats for forest steppe heteroptera, 8th European Hemiptera Congress Zawiercie, Katowice Poland, 24-29 June 2018.

### **Poster**

**Kaur H**, Gallé R Road verges functionally important or not? 31st European Congress of Arachnology, Vác, Hungary, 08–13 July 2018.

### **Other scientific work**

Training on ‘Assessing multi-taxon diversity in forest ecosystems’ by European cooperation in science and technology. Arezzo, Italy, 28-30 Sep 2021.



Summer school on “Aegean seminars for computational ecology and evolution 2018” by The ecology and evolutionary biology society of Turkey. Venue: Izmir institute of technology, Izmir, Turkey, 16-22 Sep 2019.

## **Declaration**

As the responsible author of the scientific publication, I certify that the results reported in the Ph.D. dissertation and the following publication were not used to acquire any Ph.D. degree previously and will not be used in future either.

Kaur H, Torma A, Gallé-Szpisjak N, Seat J, Lőrinczi G, Módra G, Gallé R (2019) Road verges are important secondary habitats for grassland arthropods. *J Insect Conserv* 23, 899–907  
<https://doi.org/10.1007/s10841-019-00171-9>

Gallé R, Tölgyesi C, Torma A, Bártori Z, Lőrinczi G, Szilassi P, Gallé-Szpisjak N, Kaur H, Makra T, Módra G, Batáry P. Matrix quality and habitat type drive the diversity pattern of forest steppe fragments. Currently under review in the journal *Perspect Ecol Conserv*.

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